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"SUSTAINABLE PRODUCTION AND CONSUMPTION"

MOTiP 06

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The Proceedings of
International Conference on Management of Technology, Innovation, and Project (MOTIP) 2023

"Sustainable Production and Consumption"

February 11th, 2023
Surabaya, Indonesia

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Interdisciplinary School of Management and Technology
Institut Teknologi Sepuluh Nopember (ITS), Indonesia

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- Dr. Ir. Tatang Akhmad Taufik M.Sc.
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AGENDA

The conference will be held online on February 11th, 2023 via Zoom platform. Kindly check your presentation schedule by looking for your paper ID (from Easy Chair) on the room in parallel session. The link of the zoom meeting for the webinar and each parallel room can be accessed to https://its.id/LinkMOTIP06

Time (GMT+7)	Agenda
08.00-08.25	**Opening** *(Link Zoom: https://its.id/OpeningMOTIP06)* Welcome Speech from Chair of MOTIP 06, Gita Widi Bhawika, S.ST., M.MT. Opening Speech from Dean of SIMT ITS, Prof. I Nyoman Pujawan, Ph.D, CSCP
08.25-08.30	Break
08.30-10.45	**Parallel Sessions 1 (Room: A, B, C, D, E, F, G, H, I)** 08.30-08.45: 1st Presenter 08.45-09.00: 2nd Presenter 09.00-09.15: 3rd Presenter 09.15-09.30: 4th Presenter 09.30-09.45: 5th Presenter 09.45-10.00: 6th Presenter 10.00-10.15: 7th Presenter 10.15-10.30: 8th Presenter 10.30-10.45: 9th Presenter
10.45-13.00	**Parallel Sessions 2 (Room: J, K, L, M, N, O, P, Q, R)** 10.45-11.00: 1st Presenter 11.00-11.15: 2nd Presenter 11.15-11.30: 3rd Presenter 11.30-11.45: 4th Presenter 11.45-12.00: 5th Presenter 12.00-12.15: 6th Presenter 12.15-12.30: 7th Presenter 12.30-12.45: 8th Presenter 12.45-13.00: 9th Presenter
13.00-13.30	Break (ISHOMA)
13.30-14.30	**Keynote Speech** *(Link Zoom: https://its.id/KeynoteClosingMotip06)* "Sustainable Production and Consumption" **Speaker: Dr. Daryl Powell, Chief Scientist and Research Manager at SINTEF Manufacturing, Adjunct Professor, Department of Industrial Economics and Technology Management, Norwegian University of Science and Technology** **Moderator: Dewanti Anggrahini, S.T., M.T.**
14.30-14.45	QnA
14.45-14.50	Break
14.50-15.15	**Closing Ceremony and Best Papers Announcement** *(Link Zoom: https://its.id/KeynoteClosingMotip06)* Closing from Vice Dean of SIMT ITS, Ir. R. Haryo Dwito Armono, S.T., M.Eng., Ph.D.

NOTES

General Rules

1. Dress code: formal or batik (no t-shirt).
2. Presenter should be use the virtual background download here https://its.id/VBMotip06. Thus, the video should be on during presentation.
3. Rename your zoom account with format: ID_full name, example: 150_Widya Kusumawardhani.
4. Kindly join the sessions using this link (https://its.id/LinkMOTIP06)
5. To obtain certificate of presenter, you must attend the whole session, from opening session, parallel sessions, giving presentation, until closing ceremony by accessing this link during the conference.
6. The proof of attendance can be a screen shoot of the webinar page, containing the material slide and/or the speaker, your face, and your name.
7. Please fill this attendance report by uploading your proof of attendance using this link (https://its.id/Motip06_AttendanceForm)
8. Our staff will check your name anytime during conference for certificate eligibility.

Presentation Rules

1. The Session chairs will conduct the parallel session, they will be helped by an assistant as an administrator and a time keeper.
2. You must attend to the webinar at least 5 minutes before the opening session will be started. Kindly report to the session chair when you arrive at virtual meeting before the session is started.
3. The presentation time is 15 minutes per presenter, including question and answer. Session chair will interrupt and stop the presentation if the time is over.
4. Presentation slide and speech must be delivered in English, the presentation template can be downloaded https://its.id/PPTTemplateMotip.
5. Question and answer must be delivered in English.

Technical Suggestions

1. Presentation using laptop/computer is preferable.
2. You should looking for comfortable and quite place to avoid any disturbance for the whole session.
3. Before the conference, make sure that your connection, audio, video, and any other technical function in your zoom application running properly.
4. Having back up/alternative internet connection is preferable.
5. For those who not familiar to present in the ZOOM Platform, we facilitate you to try it in our Practice Session which will held by request.

SCHEDULE SESSION 1

Room A
Innovation Design Management

Topic : Innovation Design Management
Chair : Dr. Ir. Tatang Akhmad Taufik M.Sc.
Assistant : Dyah Putri Oktaviandy
Link Zoom : https://its.id/Motip06_RoomA

No	Time	ID Paper	Author	Affiliation	Title
1	08.30-08.45	14	A Busro Punjung Sasmito and Ellya Zulaikha	ITS	VOCATIONAL HIGH SCHOOL STUDENT COMPETENCY DEVELOPMENT INNOVATIONTHROUGH DESIGN THINKING APPROACH
2	08.45-09.00	33	Rizqi Fauzil Azhar and Ellya Zulaikha	ITS	STUDY OF ENTERPRISE CONTRACTS USING DESIGN THINKING IN THE MYTENS CASE
3	09.00-09.15	57	Daghastaniy Fairuzza Arfa and Ellya Zulaikha	ITS	BOJONEGORO KAYANGAN API DEVELOPMENT STRATEGY USING DESIGN THINKING METHOD
4	09.15-09.30	74	Verdian Andiansyah and Ellya Zulaikha	ITS	DESIGN-THINKING-BASED INNOVATION STRATEGY FOR THE PARENTING COMMUNITY PLATFORM DEVELOPMENT
5	09.30-09.45	83	Krisnayanti Aditasari, Rahmatsyam Lakoro and Reny Nadlifatin	ITS	PRODUCT DESIGN INNOVATION BASED ON PRIVET'S CUSTOMER PREFERENCES
6	09.45-10.00	95	Sultan Hapriansyah, Hepi Handayani and Mahendra Maulana	ITS	3D MODELLING FLOOD INUNDATION USING LIDAR AND AERIAL PHOTOGRAMMETRY UAV
7	10.00-10.15	102	Rut Meiliana Sigalingging, Tatang Akhmad Taufik and Agus Windarto	ITS	A STUDY OF CREATING ROADMAP AND ACTIVITY PROGRAM OF CREATIVE INNOVATION CENTER STP ITS USING DESIGN THINKING METHOD PERIOD 2022-2026
8	10.15-10.30	103	Irhamna Carreca and Octaviyanti Wahyurini	ITS	Study of Campus TV Content Development Model Using Design Thinking Method
9	10.30-10.45	104	Helena Allaitsi Muzakiroh and Octaviyanti Dwi Wahyurini	ITS	DEVELOPMENT OF USER INTERFACE AND USER EXPERIENCE DEALER MANAGEMENT SYSTEM (DMS): CASE STUDY OF WULING MOTOR

SCHEDULE SESSION 1

Room B
: Decision System Analysis

Topic : Decision System Analysis
Chair : A.A. Bgs. Dinariyana Dwi Putranta, S.T., MES, Ph.D
Assistant : Indriani Puspitasari
Link Zoom : https://its.id/MOTIP06_RoomB

No	Time	ID Paper	Author	Affiliation	Title
1	08.30-08.45	6	Kemas Robby and Wahyu Wibowo	ITS	EFFORTS TO MAINTAIN HEALTH INDEX ON DISTRIBUTION SERVICES OF PT PLN (PERSERO)'s CEMPAKA SUBSTASION IN BANJARBARU
2	08.45-09.00	15	Singgih Prabowo and Ervina Ahyudanari	ITS	EVALUATION OF CONSORTIUM PARTNER SELECTION PROCESS USING PROCESS ANALYTICAL HIERARCI (AHP) METHOD
3	09.00-09.15	22	Dafid Handiarko and Udisubakti Ciptomulyono	ITS	Implementation of The Topsis Method to choose Priorities of Multi Power Plant System Designs
4	09.15-09.30	25	Aditya Prayogo Zufri and A.A.B. Dinariyana Dwi Putranta	ITS	SUPPLIER SELECTION AND DETERMINATION OF COAL CAPACITY AT PT. SEMEN GRESIK REMBANG PLANT
5	09.30-09.45	26	Guntur Suryaning Hadi, Dyah Santhi Dewi and Ratna Sari Dewi	ITS	CRITICAL SUCCESS FACTOR AND BARRIER ANALYSES ON THE IMPLEMENTATION OF INDONESIAN MINING SAFETY MANAGEMENT SYSTEM: CASE STUDY A NICKEL MINE & PROCESSING COMPANY
6	09.45-10.00	36	Muh. Samsul Rijal Anwar and Suparno	ITS	SELECTION OF PRIORITIES FOR TOURISM DEVELOPMENT USING ANP AND TOPSIS
7	10.00-10.15	46	Hardi Rizkyanto and A.A.B. Dinariyana	ITS	DETERMINING THE PRIORITY OF FEEDER MAINTENANCE AS A SUPPORT OF THE 20 kV NETWORK RELIABILITY IMPROVEMENT PROGRAM USING THE AHP-TOPSIS METHOD
8	10.15-10.30	50	Prawira Aziz Cendekiawan and Bambang Syairudin	ITS	SUPPLIER ASSESSMENT BASED ON GREEN PROCUREMENT USING ANALYTICAL NETWORK PROCESS METHOD AT GLOVE MANUFACTURING COMPANY
9	10.30-10.45	73	I Gusti Ketut Anom and I Ketut Gunarta	ITS	DETERMINATION OF FUEL DISTRIBUTOR LOCATION IN PAPUA PROVINCE USING SPATIAL MULTI CRITERIA DECISION ANALYSIS

SCHEDULE SESSION 1

Room C
: Business Management

Topic : Business Management
Chair : Bobby Ardiansyah Miraja, S.M., M.MT
Assistant : Wahyu Aditya Rachman
Link Zoom : https://its.id/Motip06_RoomC

No	Time	ID Paper	Author	Affiliation	Title
1	08.30-08.45	27	Rafi Irfan Pranata and Udisubakti Ciptomulyono	ITS	DESIGNING BUSINESS MODEL CANVAS WITH BLUE OCEAN STRATEGY APPROACH FOR SME HOMESTAY
2	08.45-09.00	38	Vania Margaretta and Sri Rahayu Hijrah Hati	Universitas Indonesia	DETERMINANTS OF GREEN PURCHASE INTENTION THROUGH THE APPLICATION OF STIMULUS ORGANISM RESPONSE THEORY (SOR)
3	09.00-09.15	65	Bachtiar Rismantono and Jerry Dwi Trijoyo Purnomo	ITS	ANALYSIS OF THE INFLUENCE OF PERCEIVED VALUES, PERCEIVED RISK, AND CUSTOMER SATISFACTION ON WILLINGNESS TO PAY MORE: A Case Study on Netflix
4	09.15-09.30	69	Yeni Yatus Shalehah and Reny Nadlifatin	ITS	SOCIAL MEDIA MARKETING STRATEGY TO INCREASE BODY CARE PRODUCT' BRAND AWARENESS
5	09.30-09.45	78	Gusti Ayu Putu Tirta Dewi and Octaviyanti Dwi Wahyurini	ITS	MARKETING STRATEGY THROUGH INSTAGRAM REELS CONTENT IN IMPROVING CUSTOMER ENGAGEMENT IN LOCAL FASHION UMKM BASED ON CULTURE
6	09.45-10.00	100	Adhyra Widyanti and Reny Nadlifatin	ITS	DETERMINANTS OF CONSUMER-BASED BRAND EQUITY IN LOCAL WOMEN'S CLOTHING BRANDS USING THE STRUCTURAL EQUATION MODELING APPROACH
7	10.00-10.15	114	Nurul Idzi Lutvi Putri and Mahendra Wardhana	ITS	CUSTOMER BEHAVIOR TOWARDS BRAND BUILDING PROCESS IN ART FASHION RETAIL
8	10.15-10.30	117	Alvin Agung Bayuadi and Reny Nadlifatin	ITS	UNDERSTANDING THE FACTORS THAT INFLUENCE THE PURCHASE INTENTION ON BATTERY ELECTRIC VEHICLE (BEV)
9	10.30-10.45	125	Shabila Gadis Halida and Dr. Ir. Arman Hakim Nasution, M.Eng	ITS	Model Business Integration Model and BSC Framework in Construction Industry

SCHEDULE SESSION 1

Room D
: Risk Management/Analysis

Topic : Risk Management/Analysis
Chair : Anny Maryani, S.T., M.T
Assistant : M. Kamil Hari Mulya
Link Zoom : https://its.id/Motip06_RoomD

No	Time	ID Paper	Author	Affiliation	Title
1	08.30-08.45	17	Bagus Eka Saputra and Erma Suryani	ITS	INCREASING WASTEWATER RECOVERY WITH FAILURE MODE EFFECT ANALYSIS METHOD
2	08.45-09.00	28	Andi Fahma Isnaeni and AAB Dinariyana	ITS	COMBINATION OF FMEA AND AHP-TOPSIS FOR ANALYSIS OF MAINTENANCE STRATEGY AT OIL AND GAS PRODUCTION FACILITIES
3	09.00-09.15	42	Ahmad Husayn Tohari and I Putu Artama Wiguna	ITS	THE ANALYSIS OF RISK RESPONSE ON WELL-CONNECTION IN "MAHAKAM BLOCK"
4	09.15-09.30	72	Afril Andona and Mokh Suef	ITS	WASTE ANALYSIS USING VALUE STREAM MAPPING AND FAILURE MODE & EFFECT ANALYSIS METHODS: CASE STUDY OF CIGARETTE HIGH TAR COMPANY PT XYZ
5	09.30-09.45	76	Moh. Ali Kosim and Nani Kurniati	ITS	RISK ANALYSIS OF STATIC EQUIPMENT IN THE CORROSION LOOP OF CO2 REMOVAL OF AMMONIA PLANT BY IMPLEMENTING RISK BASED INSPECTION
6	09.45-10.00	101	Gadis Fazrina Rasam and I Nyoman Pujawan	ITS	RISK MANAGEMENT OF ENGINEERING, PROCUREMENT, CONSTRUCTION (EPC) PROJECTS USING HOUSE OF RISK METHOD: A Case Study of An EPC Consultant Company
7	10.00-10.15	106	Nurjannah Bestaria	ITS	RISK ANALYSIS OF COST, TIME, AND QUALITY OF THE INTERIOR CONSTRUCTION PROJECT OF HOTEL A IN SORONG CITY
8	10.15-10.30	107	Robby Suma Prayogata	ITS	ANALYSIS OF DIFFERENCES RESULTS OF THE DELAY OF COMPLETION OF THE ABC MALL DEVELOPMENT PROJECT USING HOUSE OF RISK (HOR) AND FAULT TREE ANALYSIS (FTA) + EVENT TREE ANALYSIS

SCHEDULE SESSION 1

Room E
: Industrial Management

Topic : Industrial Management
Chair : Rizki Revianto Putera, S.T., M.T.
Assistant : Mizati Dewi Wasdiana
Link Zoom : https://its.id/Motip06_RoomE

No	Time	ID Paper	Author	Affiliation	Title
1	08.30-08.45	24	Novia Respati Wibijantari and Imam Baihaqi	ITS	SUPPLIER SELECTION AND INVESTMENT ANALYSIS OF PALLETIZATION ROBOT : A CASE STUDY
2	08.45-09.00	37	Asmaul Khusnah and Raja Oloan Saut Gurning, S.T., M.Sc., Ph.D.	ITS	THE EXPLORATION OF EFFECTIVENESS SCENARIOS OF IMPLEMENTING CONSIGNMENT NOTES (CN) FOR IMPORTED GOODS SHIPMENTS OF INDONESIAN MIGRANT WORKERS THROUGH POSTAL SERVICES WITH THE ANALYTICAL HIERARCHY PROCESS (AHP) METHOD
3	09.00-09.15	43	Anargya Widyatama and Imam Baihaqi	ITS	DESIGNING OPTIMUM INVENTORY POLICY: A CASE STUDY OF THE STATE-OWN ELECTRICITY COMPANY
4	09.15-09.30	63	Dian Lintang Beauty Permatasari and I Nyoman Pujawan	ITS	IMPROVING SERVICE QUALITY IN TRUCKING COMPANY USING THE QUALITY FUNCTION DEPLOYMENT (QFD) METHOD
5	09.30-09.45	64	Shavira Rasyida Zein and I Nyoman Pujawan	ITS	UNDERSTANDING CUSTOMER'S CONTINUANCE INTENTION TOWARD ONLINE SHOP:LOGISTIC SERVICE QUALITY, PERCEIVED AGILITY, AND COMPANY REPUTATION PERSPECTIVE
6	09.45-10.00	84	Putu Audrina Utama and Iwan Vanany	ITS	OPTIMISATION OF DISTRIBUTION ROUTE IN KOPI BANYUATIS THROUGH VEHICLE ROUTING PROBLEM USING CLARKE AND WRIGHT'S SAVING HEURISTICS METHOD
7	10.00-10.15	85	I Wayan Nudra Bajantika Pradivta and Nurhadi Siswanto	ITS	ANALYSIS OF WASTE PRODUCTION LAYOUT USING THE LEAN SIX SIGMA METHOD CASE STUDY: DIGITAL BABY SCALE AT PT. XYZ
8	10.15-10.30	88	Fasya Nabila and Mokh. Suef	ITS	RE-PLANNING OF QUALITY CONTROL SYSTEM TO RESPOND CUSTOMER REQUIREMENTS CHANGES
9	10.30-10.45	91	Ratna Palupi and I Nyoman Pujawan	ITS	STRATEGY TOWARD SUSTAINABLE SUPPLY CHAIN: A CASE STUDY OF LNG PRODUCTION COMPANY

SCHEDULE SESSION 1

Room F
: Information System Management

Topic : Information System Management
Chair : Dr. Rizka Wakhidatus Sholikah, S.Kom.
Assistant : Maulita Nahdiyah
Link Zoom : https://its.id/Motip06_RoomF

No	Time	ID Paper	Author	Affiliation	Title
1	08.30-08.45	19	Galih Rhendra Putra and Prof. Erma Suryani, S.T., M.T., Ph.D.	ITS	ANALYSIS OF FACTORS AFFECTING THE ACCEPTANCE LEVEL OF THE DIGILEARN LEARNING MODEL USING UNIFIED THEORY OF ACCEPTANCE AND USE OF TECHNOLOGY2 (UTAUT2)
2	08.45-09.00	21	Mochamad Sidiq and Arman Hakim Nasution	ITS	Digital Transformation 4.0 Implementation in Petrochemical Company
3	09.00-09.15	29	Muhammad Novis Ibrahim and Vita Ratnasari	ITS	THE BEHAVIORAL INTENTION TO USE PLN MOBILE TO OBTAIN ELECTRICITY SERVICES WITH A MODIFIED UTAUT2 MODEL
4	09.15-09.30	41	Yuliana Sangka' and Erma Suryani	ITS	RECOMMENDATION OF INFORMATION TECHNOLOGY GOVERNANCE USING COBIT 2019
5	09.30-09.45	51	Alif Mawaddah Alfiana and Bagus Jati Santoso	ITS	EVALUATION OF SUPPLY CHAIN SOFTWARE AS A SERVICE IMPLEMENTATION USING HUMAN, ORGANIZATION, AND TECHNOLOGY-FIT (HOT-FIT) FRAMEWORK
6	09.45-10.00	75	Aulia Arif Wardana and Erma Suryani	ITS	Evaluation of Information Security Management in Micro, Small, and Medium Enterprises (MSMEs) using Penilaian Mandiri Keamanan Informasi (PAMAN KAMI)
7	10.00-10.15	89	Ivan Widiyanto and Bagus Jati Santoso	ITS	DEVELOPMENT OF MICROSERVICES ARCHITECTURE MODEL IN XYZ HIGHER EDUCATION BY UTILIZING THE DOMAIN DRIVEN DESIGN METHOD IN DETERMINING THE IMPLEMENTED SERVICES LIST
8	10.15-10.30	109	Suwignyo RAHMAN and Vincent Didiek Wiet ARYANTO	University of Dian Nuswantoro, Semarang, Indonesia	SERVICE ORIENTATION DELIVERY OF SERVICE TOWARD DIGITAL MARKETING AND SERVICE PERFORMANCE
9	10.30-10.45	118	Mohammad Sofyan Asma, Dr.techn. Ir. Raden Venantius Hari Ginardi, M.Sc and Dr. Rizka Wakhidatus Sholikah, S.Kom	ITS	IMPROVING CUSTOMER EXPERIENCE IN THE FINANCIAL INDUSTRY IN FACING INDUSTRY 4.0 THROUGH THE DEVELOPMENT OF INDONESIAN CHATBOT APPLICATIONS

SCHEDULE SESSION 1

Room G
: Project Management

Topic : Project Management
Chair : Siska Arifiani, S.Kom., M.Kom.
Assistant : Rahma Putera
Link Zoom : https://its.id/Motip06-RoomG

No	Time	ID Paper	Author	Affiliation	Title
1	08.45-09.00	8	Heru Budi Prasetyo and Ir. Ervina Ahyudanari, ME, PhD	ITS	CONTRACTOR PERFORMANCE ASSESSMENT MODEL WITH PAIRWISE COMPARISON METHOD IN THE PRODUCTION FACILITY DEVELOPMENT PROJECT IN THE OIL FIELD OF PT. XYZ
2	09.00-09.15	23	Nike Septivani	STMA Trisakti	PROJECT SCHEDULING CONCEPTS FOR ACTIVITIES OF AN EVENT ORGANIZER
3	09.15-09.30	30	Didik Setyawan and A.A.B Dinariyana	ITS	SHIPYARD SELECTION IN THE PROCUREMENT PROCESS OF WARSHIPS USING FUZZY ANP METHOD
4	09.30-09.45	44	Laurentius Kevin Hendinata, Nur Abdillah Siddiq, Ahmad Ilham Rokhul Fikri, Michael Alfano Suprapto, Ribka Prilia	UGM	WOOD-BASED ENERGY-SAVING WINDOWS: UTILIZATION OF TRANSPARENT WOOD FROM MAHOGANY TIMBER FOR STRUCTURAL APPLICATIONS
5	09.45-10.00	52	Mega Tricitanya and Bagus Jati Santoso	ITS	EFFECTIVENESS OF APPLICATION OF WORK FROM HOME TO SCRUM-BASED PROJECT COMPLETION
6	10.00-10.15	62	Mahendra Wahyu Dinaryanto and Ridho Bayuaji	ITS	USING THE AHP-CPM INTEGRATED METHOD IN COMMISSIONING AND STARTUP SCHEDULING OF EPCI PROJECT OF GAS PRODUCTION FACILITIES CONSTRUCTION
7	10.15-10.30	96	Wallen Jusri Sihotang and Mohammad Arif Rohman	ITS	ROOT CAUSE ANALYSIS OF CONSTRUCTION DELAY IN JRAGUNG DAM SEMARANG
8	10.30-10.45	98	Fadhil Arya Dhiwanto and I Nyoman Pujawan	ITS	ANALYSIS OF THE SUPPLY CHAIN FACTORS AFFECTING DELAY OF INFRASTRUCTURE PROJECTS

SCHEDULE SESSION 1

Room H

: Organizational Performance Management

Topic : Organizational Performance Management
Chair : Andre Parvian Aristio, S.Kom., M.Sc
Assistant : Sri Wahyuni
Link Zoom : https://its.id/MOTIP06_RoomH

No	Time	ID Paper	Author	Affiliation	Title
1	08.30-08.45	16	Nabilla Aulia and Tatang Ahmad Taufik	ITS	APPLICATION OF SERVQUAL METHOD, KANO MODEL AND IMPORTANCE-PERFORMANCE ANALYSIS METHOD IN CUSTOMER ANALYSIS OF HEAVY EQUIPMENT AND GENSET BUSINESS
2	08.45-09.00	40	Maria Ivania Nuryantari and Sri Gunani Partiwi	ITS	Analysis of Employees' Readiness of PT PLN ULP Makale as Agent of New PLN Mobile Application
3	09.00-09.15	47	Ragil Wigas Wicaksana and Vita Ratnasari	ITS	THE ANALYSIS OF JOB SATISFACTION AND ORGANIZATIONAL COMMITMENT INFLUENCE TOWARDS YANTEK OFFICER WORK STRESS MODERATION PERFORMANCE (ULP KUPANG CASE STUDY)
4	09.15-09.30	54	Rizky Endang Mustika and Dr. Ir. Mokh. Suef	ITS	ANALYSIS OF USER SATISFACTION IN THE QUALITY OF PORT SERVICES IN BOOM BANYUWANGI REGENCY
5	09.30-09.45	56	Aullia Kusuma Wardani and Reny Nadlifatin	ITS	THE INFLUENCE OF CORE VALUES AKHLAK, LEADERSHIP MODELS, AND WORK FACILITIES ON THE PERFORMANCE THROUGH JOB SATISFACTION AS AN INTERVENING VARIABLE IN DIGITAL TRANSFORMATION ERA
6	09.45-10.00	71	Yohana Ratna Amelia and I Ketut Gunarta	ITS	BUSINESS VALUATION PROPERTY DEVELOPMENT STUDY CASE PT.X
7	10.00-10.15	77	Ibtida Harakah Syaurah and Mohammad Arif Rohman	ITS	FACTORS INFLUENCING THE APPLICATION OF ENERGY EFFICIENCY IN BUILDINGS
8	10.15-10.30	87	Fadhil Iqbal Imansyah and Sri Gunani Partiwi	ITS	FORMULATION OF A HUMAN RESOURCES FULFILLMENT STRATEGY IN ACCORDANCE WITH THE COMPANY'S BUSINESS STRATEGY
9	10.30-10.45	94	Arif Malvin Rizqullah and Dr. Ir. Bambang Syairudin, MT	ITS	ANALYSIS OF SATISFACTION LEVEL OF PLANNING CONSULTANT SERVICE COMPANY WITH INTEGRATION METHODS OF SERVQUAL, KANO, AND QFD. CASE STUDY: PT. KONSULTAN PERENCANA

SCHEDULE SESSION 2

Room I
: Industrial Management

Topic : Industrial Management
Chair : Gita Widi Bhawika, S.ST., M.MT., CSCA
Assistant : Titin Eriyanawati
Link Zoom : https://its.id/Motip06_RoomI

No	Time	ID Paper	Author	Affiliation	Title
1	10.45-11.00	34	Sahala Hutagalung and Prof. Iwan Vanany	Institut Teknologi Sepuluh Nopember Surabaya	SPARE PARTS CONTROL ANALYSIS IN HEAVY EQUIPMENT REPAIR COMPANY
2	11.00-11.15	35	Adhitya Mahardhika and Niniet Indah Avitrida	Institut Teknologi Sepuluh Nopember Surabaya	INVENTORY MANAGEMENT FOR STEEL MATERIAL AT SHIPYARD REPAIR COMPANY
3	11.15-11.30	45	Maulivia Rizma and Iwan Vanany	Institut Teknologi Sepuluh Nopember Surabaya	Forecasting and Material Inventory Control in the Electrical Distribution Industry
4	11.30-11.45	55	Mochammad Nabil Rheza Wibawa and Bambang Syairudin	Institut Teknologi Sepuluh Nopember Surabaya	THE IMPLEMENTATION OF TOTAL PRODUCTIVE MAINTENANCE IN REDUCE LOSES AND INCREASE THE EFFICIENCY OF LINE PELLETIZING IN PET FOOD INDUSTRY
5	11.45-12.00	59	Ni Kadek Dewi Pradnyawati	Institut Teknologi Sepuluh Nopember Surabaya	ANALYSIS OF FACTORS AFFECTING B2B PRODUCT SALES USING THE SUPPORT VECTOR MACHINE METHOD AT PT XYZ
6	12.00-12.15	60	Muhammad Faris Sandra Saputra and Bambang Syairudin	Institut Teknologi Sepuluh Nopember Surabaya	IMPLEMENTATION OF LEAN MANUFACTURING TO MINIMIZE WASTE WITH WASTE ASSESSMENT MODEL METHOD IN FARIS COLLECTION
7	12.15-12.30	66	Adityo Firmansyah and Suparno Suparno	Institut Teknologi Sepuluh Nopember Surabaya	ENHANCEMENT OF ENERGY EFFICIENCY THROUGH BLOWDOWN BOILER CYCLE ANALYSIS WITH FMEA (CASE STUDY IN PT ADF)
8	12.30-12.45	67	Tri Hatmono and Nani Kurniati	Institut Teknologi Sepuluh Nopember Surabaya	Raw Mill Parameter Optimisation to Reduce Power Consumption Using Response Surface Methodology (RSM)
9	12.45-13.00	82	Yoviani Jelitasari and Suparno	Institut Teknologi Sepuluh Nopember Surabaya	QUALITY IMPROVEMENT OF 50 KG GAS CYLINDER USING SIX SIGMA IN PT. PINDAD

SCHEDULE SESSION 2

Room J
: Business Analytics

Topic : Business Analytics
Chair : Jerry Dwi T Purnomo, M.Si, Ph.D
Assistant : Indriyanti Nirmalasari
Link Zoom : https://its.id/Motip06RoomJ

No	Time	ID Paper	Author	Affiliation	Title
1	10.45-11.00	58	Muhammad Syarifuddin and Achmad Choiruddin	Institut Teknologi Sepuluh Nopember Surabaya	CUSTOMER SEGMENTATION OF HOUSEHOLD ELECTRICITY CUSTOMERS USING K-MEANS CLUSTERING BASED ON LRFMP MODEL
2	11.00-11.15	61	Aski Yuniar Rosadi and Bagus Jati Santoso	Institut Teknologi Sepuluh Nopember Surabaya	MODEL DEVELOPMENT OF AUTOMATIC TANK GAUGING DATA INTEGRATION AS A REALTIME STOCK MONITORING SOLUTION FOR AVIATION FUEL TERMINAL
3	11.15-11.30	79	Faiz Riskullah and Achmad Choiruddin	Institut Teknologi Sepuluh Nopember Surabaya	Analysis of the Influence of Macroeconomic Factors and Foreign Exchanges on the JCI with the Supervised Machine Learning Method
4	11.30-11.45	124	Guson Kuntarto, Irwan Prasetya Gunawan, Jimmy Chen, Rizky Novriyedi, Lilyani Barrung and Berkah Iman Santoso	Universitas Bakrie	DWIPA II+ : Ontology-based Mobile Intelligent Recommender System for Tourist Itineraries in the Borobudur Temple Area
5	11.45-12.00	127	Guson Kuntarto, Rafi Ramadhan Bahari, Prima Mulyasari Agustini, Eli Jamilah, Clara Velita Pranolo and Mutiara Julia Ifra	Universitas Bakrie	The Role of Multinomial Naive Bayes Algorithm on Media Monitoring System to Classify Online News Concerning Ciletuh Geopark
6	12.00-12.15	157	Prayoga Erlangga	Institut Teknologi Sepuluh Nopember Surabaya	TIME SERIES IMPLEMENTATION IN THE COVID-19 PANDEMIC SALES OF FIRE AND WATER
7	12.15-12.30	164	CONRAD NDARU PANJI NARENDRO	Institut Teknologi Sepuluh Nopember Surabaya	ANALYSIS IMPACT OF PANDEMIC COVID-19 ON ACCOMODATION AND FOOD BAVERAGE SEKTOR INDUSTRY OF BALI PROVINCE USING INTER REGIONAL INPUT OUTPUT MODEL APPROACH
8	12.30-12.45	172	Dewi Sinta	Institut Teknologi Sepuluh Nopember Surabaya	COMPARATIVE ANALYSIS OF APBN AND ADB FINANCING SCHEMES AT PANTOLOAN PORT
9	12.45-13.00				

SCHEDULE SESSION 2

Room K

: Decision Making Analysis

Topic : Decision Making Analysis
Chair : Dr. Emmy Pratiwi, S.T
Assistant : Erwina Adhyarini
Link Zoom : https://its.id/Motip06_RoomK

No	Time	ID Paper	Author	Affiliation	Title
1	10.45-11.00	81	Atika Mitzalina and Jerry Dwi Trijoyo Purnomo	Institut Teknologi Sepuluh Nopember Surabaya	Critical Success Factor Analysis That Affects The Sanitation Development Program Including Septic-Tank Installation in Surabaya City
2	11.00-11.15	93	Mochamad Arifin and Nurhadi Siswanto	Institut Teknologi Sepuluh Nopember Surabaya	SUPPORT SYSTEM IN STRATEGIC DECISION MAKING FOR THE SELECTION OF MINE TRANSPORTATION MODE AT PT XYZ USING AHP AND PROMETHEE METHODS
3	11.15-11.30	108	Mochammad Farel Adhitabima	Institut Teknologi Sepuluh Nopember Surabaya	DESIGN OF A SUPPLY CHAIN PERFORMANCE MEASUREMENT SYSTEM FOR THIRD PARTY LOGISTICS COMPANIES USING SUPPLY CHAIN OPERATIONS REFERENCE AND AHP METHODS
4	11.30-11.45	119	Adi Hermawan, Tatang Akhmad Taufik	Institut Teknologi Sepuluh Nopember Surabaya	Implementation Strategy Target Off-Block Time (TOBT) On Domestic Flights: A Case Study Of Soekarno Hatta International Airport
5	11.45-12.00	120	Ahmad Dilal Furqoni and Adithya Sudiarno	Institut Teknologi Sepuluh Nopember Surabaya	HOUSING DEVELOPMENT PLANNING AROUND PERTAMINA TUBAN USING AHP SWOT ANALYSIS AND FUZZY
6	12.00-12.15	142	Yogha Julianto, Eko Budi Santoso and R.V. Hari Ginardi	Institut Teknologi Sepuluh Nopember Surabaya	COST-BENEFIT ANALYSIS FOR TANGIBLE, QUASI-TANGIBLE AND INTANGIBLE FACTORS IN PENSION PAYMENT DIGITALIZATION PROJECTS IN INDONESIA'S SOCIAL INSURANCE COMPANY
7	12.15-12.30	147	Ade Junior and Raja Oloan Saut Gurning	Institut Teknologi Sepuluh Nopember Surabaya	The Analysis Of Make Or Buy Decision Oil & Gas Company In Maintenance Dredging Activities With NPV & MCDA Approach (Multi Criteria Decision Analysis)
8	12.30-12.45	161	Arif Husnurrofiq	Institut Teknologi Sepuluh Nopember Surabaya	PRIORITY SELECTION OF WELL INTERVENTION WORK PLAN WITH A COMBINATION OF AHP & TOPSIS METHODS IN THE OIL AND GAS FIELD X, PT. XYZ
9	12.45-13.00				

SCHEDULE SESSION 2

Room L
: Investment and Financial Management

Topic : Investment and Financial Management
Chair : Gogor Arif Handiwibowo ST., M.MT.
Assistant : Ahmad Enggal Maossyara
Link Zoom : https://its.id/Motip06_RoomL

No	Time	ID Paper	Author	Affiliation	Title
1	10.45-11.00	12	Muhammad Qomaruddin and Haryo Dwito Armono	Institut Teknologi Sepuluh Nopember Surabaya	COMPARATIVE STUDY OF FINANCIAL FEASIBILITY AND SENSITIVITY ANALYSIS OF FSO ASSET AND LEASES
2	11.00-11.15	13	R Wahyu Prayogo Arsetyo and Wahyu Wibowo	Institut Teknologi Sepuluh Nopember Surabaya	PROFITABILITY IMPROVEMENT STRATEGY IN A STATE OWNED CONSTRUCTION COMPANY (CASE STUDY: PT. ADHI KARYA (PERSERO), TBK. DEPARTMENT OF BUILDING)
3	11.15-11.30	31	Ahmad Rifai and Bagus Santoso	Institut Teknologi Sepuluh Nopember Surabaya	Data Analysis on Collectability to the Currency of Retail Credit Products at Bank XYZ
4	11.30-11.45	39	Resti Fauziah and Nurhadi Siswanto	Institut Teknologi Sepuluh Nopember Surabaya	EFFICIENCY ANALYSIS OF MSME LOAN DISBURSEMENT BY STATE OWNED BANKS USING DATA ENVELOPMENT ANALYSIS METHOD
5	11.45-12.00	48	Aditya Putra Prasetyo and Tatang Akhmad Taufik	Institut Teknologi Sepuluh Nopember Surabaya	INVESTMENT ANALYSIS OF ENTERPRISE DATA WAREHOUSE IMPLEMENTATION WITH IT BALANCED SCORECARD AND INFORMATION ECONOMICS
6	12.00-12.15	70	Bram Ispriadi Yuliantoro, Arman Hakim Nasution and Bram Ispriadi Yuliantoro	Institut Teknologi Sepuluh Nopember Surabaya	ANALYSIS OF INVESMENT DECISIONS IN THE POWER SUPPLY PROCUREMENT PROJECT ON THE PHE-30 PLATFORM AT PT PHE WMO WITH AHP AND TOPSIS METHODS
7	12.15-12.30	86	Hapsak Pamungkas	Institut Teknologi Sepuluh Nopember Surabaya	ALTERNATIVE INVESTMENT SCHEMES ON KRIAN-LEGUNDI-BUNDER-MANYAR (KLBM) TOLL ROAD
8	12.30-12.45	128	Ade Noni R.	Institut Teknologi Sepuluh Nopember Surabaya	FINANCIAL STATEMENTS FRAUD DETECTION MODEL FOR THE LISTED COMPANY IN THE INDONESIAN STOCK EXCHANGE (Case Study for the Listed Company in the Indonesian Stock Exchange of 2018 - 2021)
9	12.45-13.00	132	Maman Nurochman and I Putu Artama Wiguna	Institut Teknologi Sepuluh Nopember Surabaya	INVESTMENT ANALYSIS OF DEVELOPMENT OF EXTRACTION ASPHALT FACTORY AT BUTON

SCHEDULE SESSION 2

Room M

: Innovation Design Management

Topic : Innovation Design Management
Chair : Yogantara S. Dharmawan, S.Kom., MBusProcessMgt., MCE
Assistant : Dyah Putri Oktaviandy
Link Zoom : https://its.id/Motip06_RoomM

No	Time	ID Paper	Author	Affiliation	Title
1	10.45-11.00	122	Melviana Anggraini, Bobby A. A. Nazief and Farisya Setiadi	University of Indonesia	Information System Strategic Planning: A Case Study Pusat Investasi Pemerintah
2	11.00-11.15	133	Mastuty Ayu Ningtyas, Yupit Sudianto and Febriliyan Samopa	Institut Teknologi Sepuluh Nopember Surabaya	ENTERPRISE ARCHITECTURE PLANNING WITH TOGAF-ADM FRAMEWORK AND ISO 27001:2013 AT TELKOM SURABAYA INSTITUTE OF TECHNOLOGY
3	11.15-11.30	137	Hanasa Shelviani and Arry Akhmad Arman	ITB	A Systematic Literature Review Malware Detection
4	11.30-11.45	140	Nidia Avisyah Putri, Mudjahidin Mudjahidin and Tony Dwi Susanto	Institut Teknologi Sepuluh Nopember Surabaya	DEVELOPMENT OF SMART LIVING FRAMEWORK TO RESILIENCE AGAINST THE COVID-19 PANDEMIC (CASE STUDY: MAKASSAR CITY)
5	11.45-12.00	148	Huda Elmatsani, Heru Nurasa, Ida Widianingsih, Enjat Munajat and Supriana Suwanda	Universitas Padjadjaran	Digital Transformation in Public Administration: A Bibliometric Mapping
6	12.00-12.15	154	M. Burhanuddin Muflihul Hasan and Raden Venantius Hari Ginardi	Institut Teknologi Sepuluh Nopember Surabaya	IT GOVERNANCE IN SCADA TECHNOLOGY TO IMPROVE COMPANY PERFORMANCE USING COBIT 2019
7	12.15-12.30	156	Faris Fitrianto	Institut Teknologi Sepuluh Nopember Surabaya	Analysis of the Impact of the Use of Yantek Mobile PLN Using the TTF Perspective and IS Success Model on Employee Performance
8	12.30-12.45	163	Juan Vandendungan and Vita Ratnasari	Institut Teknologi Sepuluh Nopember Surabaya	Modeling Behavior of Use and Acceptance of PLN Mobile Application Using Technology Acceptance Model 3
9	12.45-13.00				

SCHEDULE SESSION 2

Room N
: Project Management

Topic : Project Management
Chair : Deqi Rizkiva Radita, S.T., M.S
Assistant : Yusra Nusaibah Noor
Link Zoom : https://its.id/Motip06_RoomN

No	Time	ID Paper	Author	Affiliation	Title
1	10.45-11.00	110	Ariesta Kusumawardana and Aab Dinariyana	Institut Teknologi Sepuluh Nopember Surabaya	THE APPLICATION OF RELIABILITY-CENTERED MAINTENANCE METHOD TO DETERMINE MAINTENANCE STRATEGY IN UTILITY PRODUCTION FACILITIES
2	11.00-11.15	112	Ihwan Nul Hakim, Ihwan Nul Hakim and Farida Rachmawati	Institut Teknologi Sepuluh Nopember Surabaya	ANALYSIS OF THE PPP SCHEME'S IMPLEMENTATION IN THE TIGA DIHAJI DAM PROJECT
3	11.15-11.30	115	Nadya Primadian	Institut Teknologi Sepuluh Nopember Surabaya	SUPPLY CHAIN PERFORMANCE MEASUREMENT IN CONSTRUCTION COMPANY USING THE SCOR MODEL
4	11.30-11.45	143	Alya Nur Shabrina and Muhammad Ahsan	Institut Teknologi Sepuluh Nopember Surabaya	Maintenance Scheduling Optimization in Cosmetics Manufacturer using Power Law Process Method
5	12.15-12.30	171	Gilang Almaghribi and Rendra Agus Triyono	PT Wijaya Karya (Persero) Tbk.	Calculation of Motor Operated Valve Looping Cable with Traveling Salesman Problem Method
6	12.00-12.15	149	Ilham Akbar and Nurhadi Siswanto	Institut Teknologi Sepuluh Nopember Surabaya	EVALUATION OF EXTRUDER MACHINE MAINTENANCE IN ORDER TO IMPROVE THE EFFECTIVENESS OF MAINTENANCE TIME USING MARKOV CHAIN METHOD
7	12.15-12.30	165	Dodid Wibowo	Institut Teknologi Sepuluh Nopember Surabaya	MAINTENANCE MANAGEMENT ON MAIN ENGINE OF CONTAINER SHIP, WORKING WITH SLOW STEAMING USING RELIABILITY- CENTERED MAINTENANCE
8	12.30-12.45	170	Andina Prima Putri, Agun Syahrul, Christianto Credidi Septino Khala and Basyaruddin Basyaruddin	Institut Teknologi Kalimantan	POTENTIAL ANALYSIS OF GALAM WOOD FOR SIMPLE HOUSE CONSTRUCTION
9	12.45-13.00				

SCHEDULE SESSION 2

Room O

: Risk Management/Analysis

Topic : Risk Management/Analysis
Chair : Dr. Dhimas Widhi Handani
Assistant : Nurul Fadilla
Link Zoom : https://its.id/Motip06_RoomO

No	Time	ID Paper	Author	Affiliation	Title
1	10.45-11.00	123	Arifin Arifin, Ishardita Pambudi Tama and Yeni Sumantri	Departement of Mechanical Engineering, Brawijaya University	INCREASING THE EFFECTIVENESS OF CNC TURNING MACHINES USING THE OVERALL EQUIPMENT METHOD EFFECTIVENESS (OEE) AND FAULT TREE ANALYSIS (FTA)
2	11.00-11.15	130	Yohana Waladow	Institut Teknologi Sepuluh Nopember Surabaya	SUPPLY CHAIN RISK MANAGEMENT IN HOT MIX ASPHALT INDUSTRY
3	11.15-11.30	134	Andhy Setyawan	PLN	ANALYSIS OF PROJECT PERFORMANCE FAILURE FACTORS ON INVESTMENT PROJECT OF RELIABILITY IMPROVEMENT 500 KV SYSTEM AT PT. PLN (PERSERO) UNIT TRANSMISSION OF EASTERN JAVA AND BALI
4	11.30-11.45	136	Ollandio Graciela and Niniek Fajar Puspita	Institut Teknologi Sepuluh Nopember Surabaya	Integration of Failure Mode and Effect Analysis (FMEA) and Quality Functional Deployment (QFD) to Improve Quality of Exercise Book
5	11.45-12.00	159	Ridho Aflah Bekti	Institut Teknologi Sepuluh Nopember Surabaya	ANALYSIS OF AMMONIUM SULFATE FACTORY GREEN PRODUCTIVITY MANAGEMENT USING FAILURE MODE AND EFFECT ANALYSIS METHOD (FMEA)
6	12.00-12.15	162	Ulfaturrahmi Ulfaturrahmi and Ratna Sari Dewi	Institut Teknologi Sepuluh Nopember Surabaya	RISK FACTOR ANALYSIS WITH JOB SAFETY AND HOUSE OF RISK ANALYSIS APPROACH (CASE STUDY PT SEGAR AGRO NUSANTARA)
7	12.15-12.30	168	Gilang Almaghribi, Rendra Agus Triyono and Risqi Rotbi	PT Wijaya Karya (Persero) Tbk.	Quality Control Circle Process on Electronic Engineering Document Management in EPC Company
8	12.30-12.45	169	Prita Devalini, Budisantoso Wirodirjo and Prita Devalini	Institut Teknologi Sepuluh Nopember	ASSESSMENT OF SAFETY RESILIENCE IN NICKLE MINING & MINERAL PROCESSING INDUSTRY TO REDUCE WORK ACCIDENTS
9	12.45-13.00	20	Aditya Satria Prabowo and Ervina Ahyudanari	ITS	RISK ANALYSIS ON CHANGE OF CARGO QUANTITY DUE TO DEVIATION OF BERTHING PORT FROM TANJUNG PRIOK PORT TO PATIMBAN PORT

SCHEDULE SESSION 2

Room P
: Business Management

Topic : Business Management
Chair : Reny Nadlifatin, S.Kom., MBA., Ph.D
Assistant : Aziz Astqolani
Link Zoom : https://its.id/Motip06_RoomP

No	Time	ID Paper	Author	Affiliation	Title
1	10.45-11.00	129	Galih Pranata, Eko Santoso and Dewi Septanti	Institut Teknologi Sepuluh Nopember Surabaya	ANALYSIS OF THE LEVEL OF COMMUNITY PARTICIPATION IN REALIZING ECOTOURISM IN THE COASTAL AREA, BULAK DISTRICT, SURABAYA CITY
2	11.00-11.15	139	Dendy Ramadhan and Reny Nadlifatin	Institut Teknologi Sepuluh Nopember Surabaya	THE EFFECT OF INSTAGRAM MARKETING ON CONSUMER PURCHASE DECISIONS THROUGH BRAND AWARENESS, BRAND TRUST AND BRAND LOYALTY AT TENTWO COFFEE SURABAYA
3	11.15-11.30	153	Fakhri Aulia Abdillah and Wahyu Wibowo	Institut Teknologi Sepuluh Nopember Surabaya	DETERMINATION OF OPTIMUM POINT OF PRODUCTION PROCESS OPERATIONAL PARAMETERS IN NPK GRANULATION PLANT PT XYZ
4	11.30-11.45	155	Abiyyu Naufal Suhanto and Erma Suryani	Institut Teknologi Sepuluh Nopember Surabaya	ANALYSIS OF FACTORS AFFECTING CUSTOMER INTEREST IN MAKING PURCHASES ON ONLINE MARKETPLACE WITH UTAUT2 APPROACH
5	11.45-12.00	158	Muhammad Bayu Prasetyo, Udisubakti Ciptomulyono and Mohamad Yusak Anshori	Institut Teknologi Sepuluh Nopember Surabaya	BUSINESS STRATEGY ANALYSIS USING IE MATRIX, SWOT MATRIX AND AHP STUDY CASE: XYZ CAKE SHOP AS MSME BUSINESS
6	12.00-12.15	166	Awang Ferawan, Niniet Arvitrida and Catarina Paramita	Institut Teknologi Sepuluh Nopember Surabaya	ANALYSIS OF CONSUMER BEHAVIOR ON PURCHASING DECISIONS THROUGH PURCHASE INTENTION WITH MARKETING STRATEGY AS A MODERATING VARIABLE AT BABYSHOP RETAIL
7	12.15-12.30	171	Gilang Almaghribi and Rendra Agus Triyono	PT Wijaya Karya (Persero) Tbk.	Calculation of Motor Operated Valve Looping Cable with Traveling Salesman Problem Method
8	12.30-12.45	174	Ruly Kurniadi and Syarifa Hanoum	Institut Teknologi Sepuluh Nopember Surabaya	ANALYSIS OF PUBLIC SATISFACTION IN PUBLIC SERVICES SUMEKAR HOSPITAL IN SUMENEP CITY
9.	12.45-13.00	99	Nabila Dhea Adisty and Jerry Dwi Trijoyo Purnomo	Institut Teknologi Sepuluh Nopember Surabaya	Customer Loyalty Analysis Towards Online Shopping In Indonesia

Organizational Enablers for Digitalization in Norwegian Industry

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Abstract. Norway has a long cultural tradition for organizing its working life. A dialogue-based and cooperation-oriented model constitutes the way work life functions locally in companies as well as at the national level. This article addresses how the basic values of this practice promote processes of industrial digitalization in Norway. The digitalization of industry and society has many faces, but the focus here is on organization, forms of collaboration and management that create the foundation for successful digital implementation in the industry. Within the framework of a working life that requires ever-increasing competence at all levels, this article shows that intra-corporate collaboration between management and employees generates common goal understanding and process commitment. This paper highlights seven organizational enablers for digitalization in a Norwegian industrial context. Our findings from a cross-case analysis of data collected through 33 case studies of successful digitalization processes at Norwegian companies in a diverse set of industries suggest that the digitalization of industry requires cross-functional and inter-organizational collaboration to develop more specialized expertise from all employees, and this serves as a key element for success within industrial digitalization.

Keywords: Digitalization · Operations management · Multiple case study

1 Introduction

Today's industrial challenge is largely about how to generate increased competitiveness through the strategic implementation of digital technologies. Operators and machines must cooperate with an interaction we have not envisaged before [2]. Technological impact will again alter our ways of organizing and manage industrial production. Access to current information is no longer reserved for managers only [3]. Hierarchical organizations are replaced by flatter structures with autonomous production teams. These teams have access to all the data needed to do a good job. The operator must increasingly communicate with the robot through programming, computing has become cloud-based and information is visually distributed via screens and other digital platforms. This new human – machine interface (HMI) calls for specialized skills among operators and a reconsidered understanding of being a leader. The communication and division of responsibilities between manager and employee are changed in a way that requires a dynamic organization that can cope with change.

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Digital solutions create a framework for how to organize processes, workplaces and communication in the future.

2 Theoretical Background

2.1 The Norwegian Model as an Enabler for Industrial Development

In Norway there is a well rooted tradition based on dialogue and involvement. It is a tripartite co-operation with the Norwegian Confederation of Trade Unions (LO), the Confederation of Norwegian Enterprise (NHO), and the Norwegian government constitute this model. Formal cooperative measures go back to 1935 when board representation for employees was fixed by law [4]. The Norwegian model (NM) for work-life design is a cooperative model based on trust and respect among the parties involved. Trust is the key element for success in this model. Both the employer and the employee side of work-life have agreed upon a series of tools to avoid unnecessary use of energy in search of best performance. The unions, and specifically the employee representatives, have a demanding role in such a model. On one hand, they are the representatives of the employees' interests. On the other hand, they are obliged to co-operate with the employer, and align the company's goals and employees' interests. This challenging role has been described as the balance between "boxing and dancing" [5]. The model is culturally embedded in all levels of Norwegian work life, and it sets a strong guideline for priorities made in work-life. Management and organization mirror this in a direct way. This dialogue based and involving way of organizing generates a true feeling of motivation and a sensation of being both useful and important. The voice of the employees is heard, and they feel ownership to both process and result. This way of organizing work-life has also produced a higher level of trust between leaders, employee representatives and unions in Norway compared with other countries [7].

2.2 Industry 4.0

Germany launched its so-called "Industrie 4.0" initiative in 2011 as part of the country's high-tech industrial strategy, introducing the idea of a fully integrated industry [6]. Since then, Industry 4.0 has gained worldwide interest and has opened up a range of new business potential and opportunities [7]. A commonly accepted overview of Industry 4.0 technologies includes: Autonomous robots, simulation, horizontal and vertical integration, industrial internet of things, cybersecurity, cloud computing, additive manufacturing, augmented reality and big data analytics [8]. Together, these technologies are considered to be the pillars of Industry 4.0, presenting manufacturers with opportunities for digitalization and integration of physical and virtual environments building capabilities for better problem-solving and learning in action – leading to increased operational performance and competitiveness. Inspired by Industry 4.0, the Norwegian government announced a strategy for a 'greener, smarter and more innovative' industry in 2017, which has become commonly known simply as "digitalization" [9]. Thus, in recent years, Norwegian industrial companies have been increasingly adopting Industry 4.0 technologies.

3 Methodology

Our research design is guided by the following research question: *What are the organizational enablers for digitalization in the Norwegian industry?* Given this what-type question, we selected a multiple case study approach [10], as this enabled the identification of organizational enablers in real digitalization processes and with a relatively full understanding of the nature and complexity of digitalization. This article is built on a multiple case-study conducted among Norwegian industrial companies in 2019. The study was called, *Pioneering Norwegian industrial companies and their experiences from digitalization.* The research foundation SINTEF was given a mandate by the Ministry of Trade, Industry and Fisheries (NFD) to explore how digitalization could strengthen future industrial production in Norway. Over a six-month period, SINTEF conducted a total of 170 interviews distributed across 33 *successful companies*[1] in a diverse set of industries including automotive, defense, food, maritime and process industry. The set of selected companies included all the finalist of *Årets smarteste industribedrift* (Smartest Industrial Company of the Year in Norway). A written report summarized the semi-structured interviews at each company. Trade union representatives, production and top leaders responsible for digitalization and technology developers were interviewed about their experiences with digitalization and their thoughts about its effects on future manufacturing. Responses were triangulated with company documentation and extensive field notes that were collected during company meetings and tours. For an increased accuracy of the empirical findings and increased construct validity [11], the results have been reviewed by a working group that included participants from industry, research/academia, NFD and the SINTEF researchers that conducted the interviews. The study of 33 cases enabled a fruitful cross-case analysis, an easier identification of representative relationships between the informants' experiences during the digitalization processes and their causes, and thereby a higher internal and external validity [12]. An interview guide was used, which focused on four main areas: (i) Curiosity in using new technology, (ii) Integration and utilization of digital tools (technology opportunities) throughout the business, (iii) Changing business models as a result of digital opportunities, and (iv) Reflections on the future. Potential benefits of using the NM of work-life organisation was defined as an overarching focus.

4 Discussion

When focusing on organizational enablers for implementing digitalization in the industry, the analysis of the SINTEF study data can be summarized in the following emergent themes:

Ensuring Company Democracy. Decisions regarding the implementation of new digital technology includes the employees in a direct way. Job content becomes altered,

[1] A *successful company* was defined as a company that can demonstrate successful development and implementation of digital technology.

new skills are required and processes must be reorganized due to new and increasingly complex technology [13, 14]. Within such a framework, it is most important to make sure that the "voice of the employee" is heard. Our study showed that the industrial companies genuinely involved the employees at an early stage in the process. By doing so, the company management gained trust, transparency and support from the union. By establishing this relation early on, several major elements were secured:

- The management secured a higher degree of momentum in the upcoming process of implementing new digital technology
- The union could influence decisions along the process
- The process produced less errors since decisions were considered from different angles during the process. A clean process requires less adjustment afterwards
- Collective goals generated a collective feeling of ownership to the solution. A broad involvement also creates a common vision
- Employees understood that digital technology also includes jobs with more stimulating content, which may replace tedious operations [14]
- Employees felt increasingly comfortable, since they mastered the new technology.

For instance, one of the case companies, a manufacturer of heavy mechanical parts for offshore installations, has managed to streamline their well-rooted internal processes by giving their operators a smartphone with digital work instructions. However, right from the start, they involved relevant operators in the team that was developing the technological solution, alongside technology developers. Moreover, during many days the operators were observed while working and their feedback during and after the workshops that were organized along the project, were recorded and they were the starting point for real improvements. The company regarded this close and early involvement of the operators as decisive for the smooth adoption of the new technology among employees with very different background. This and all the other effects listed above are a product of organizing the process in accordance with the NM.

If one compares the implementation of new digital technology with the introduction of robots in the 70s and 80s, then this study shows a distinct difference in the attitude of the unions. Back then, the unions tried to hold back the implementation of robots due to the fear of losing jobs. The confrontation between trade union and management characterized the international automotive industry to a great extent [15]. The SINTEF study of Norwegian industrial companies show that employee representatives today sees digital technology as a necessity to safeguard future jobs and competitiveness. They genuinely support the measure and most of the companies involve employees in the whole process. It is important for companies to take advantage of this common attitude as they work on digitalization.

Safeguarding Well-Balanced External Relations. Digital implementation calls for digital skills. Medium sized and smaller companies do often lack internal IT skill required for identifying and implementing digital technologies [16]. Organizing processes is often left with the option of using external consultants. Such solutions bring both pros and cons, but our study showed that a company easily can become too dependent on a single sub-contractor/supplier. A company's IT solutions require a high degree of trust in the relationship between customer and supplier. On one side, it is

important for an IT provider to know the company well. On the other hand, such a customer-supplier relationship can develop into something unhealthy if the relationship leaves the customer in a lock-in position. The customer must use his/her position in an active manner which indicates that the customer - supplier relationship is of a positive nature. For industrial companies, it is important to secure healthy and well-balanced relations to external support when implementing new digital solutions. For instance, another company in the survey developed in-house a dashboard and decision-making system for production management, by help of an off the shelf Microsoft app. Earlier, the company would have contracted consultants for this type of development. However, their experience was that the process took too long and there was insufficient collaboration with their personnel during the process. Thereby the technology adoption was more cumbersome, and the development contributed to a much lesser extent to organizational learning and growth than during the in-house development. Nevertheless, the in-house development required a broad set of competences, that traditionally, many industrial companies did not have. The personnel needed to understand how to extract the necessary data, structure the data, analyze it, and ensure a user friendly and real-time presentation of the results on the dashboard.

Valuing Internal IT Skills. The SINTEF study also showed how important internal IT skills can be when digitalizing the industry. Employees with "above average" IT interest can make a huge difference in these processes. By actively searching for new IT solutions in their daily work, they can combine their personal IT interest with IT situations needed to be solved at work. Leaders who understand this potential organize for joining internal opportunities with company needs. Such processes often show the company what choices and opportunities that exist. Employees with IT skill knows company routines, products and internal affairs, and therefore they can also play the role of a bridge builder. For instance, at a tool producer in the survey the operators are allowed to program the machines that they use. To this end, the company created a forum for knowledge sharing and joint learning that included both senior operators and apprentices, and both older and young personnel. By seeing their digital competencies valued, the operators' motivation for their working place and for contributing to digital improvements increased even more. Thus, employees' own commitment and knowledge thirst increases the company's opportunities to capture new technology/opportunities.

Recognizing Young Talent. Another key element for a successful digital implementation is how the company organize their internal resources in general. Leaders need to understand what a digital transformation really is about. The SINTEF study showed some examples of processes that were suffering from insufficient digital maturity and understanding at management level. Leaders must enter these digital processes at an early stage and then follow up by taking an active and genuine part. Several companies in the survey stated a distinct awareness to join younger employees with leaders responsible for decision making, rather than sideline young talent – which is often a symptom of "Big Company Disease" [17]. A number of respondents reflected that the younger "digital native" generation often has a greater ease of understanding the opportunities and limitations of key enabling technologies, than the older and more "analog" generation, to which many of their leaders belonged. By actively including young employees in the project teams, companies can improve

the outcomes of their digitization endeavor. Moreover, by organizing pre-projects, project groups, pilot projects, etc. companies ensured a higher degree of digital competence in digitalization projects. This shows that different forms of conscious diversity enhance the quality of a digitalization process.

Building Cross-Functional Autonomous Teams. Teamwork in the industrial production has been the way to organize production for a long time [18]. Analyzed data from the study show that operators still work in teams, but they work more autonomously due to the implementation of digital technologies. Relevant information has become more visual and accessible [19]. Due to this development, operators have gained the opportunity to see and understand a broader part of the value chain. Some of the companies also stated an awareness to organize teams in a cross-disciplinary manner. By doing so, they also created a unit more capable of thinking in an innovative way. This trait can be helpful since product development and improvement related work often is initiated at the shop floor.

Promoting Learning in Action. Operators and engineers work more closely when using digital solutions. They unite in digitized processes with digital tools in their common quest for improved practice. One of the companies located their engineers in the areas of manufacturing in order to safeguard a close relation between engineers and operators. Operators and engineers may have different ways of interpreting a problem, but by joining efforts, they are able to reach a higher level of understanding which again adds value to the product/process. This way of work organization was not common earlier when the work force was organized in traditional silos – a further symptom of "Big Company Disease" [17].

Organizing for Flexibility. A common mention for many of the companies in the study was their awareness to organize for change. Flexibility, therefore, stands out as a key feature for a successful digitalization. Quick responses, flexible solutions and an adjustable structure of organizing work has become essential for preventing loss of time and other resources [20]. The ability to continuously adapt to changing circumstances has become a key feature. Systems and processes need to solve contextual changes in order to perform optimally. The companies in the study organized their processes accordingly to safeguard these features.

5 Conclusion

There are numerous ways to derive great value from digitalization. Fostering internal collaboration through greater engagement of employees is one of them. This paper has highlighted seven organizational enablers for digitalization in a Norwegian industrial context. The findings are based on a cross-case analysis of data collected through 33 case studies of successful digitalization processes at Norwegian companies in a diverse set of industries. Collaboration between management and employees also emerged as a necessary success criterion for digitalization. Flatter and cooperation-oriented models are well suited to cope with the dynamic and demanding processes of digital transformation. Such an approach can prevent the loss of useful energy on resistance

through building a joint taskforce promoting digitalization. The NM holds traits that give Norwegian companies a potential and valuable advantage that can be useful for industrial digitalization. Finding the best way to digitalization will vary from company to company depending on their competence, resources and digital maturity. Thus, our findings suggest that it makes sense to utilize both external and internal organizational possibilities. They may, together with digital technologies, boost the digital transition in search of more efficient industrial production.

In terms of limitations, we recognize that the Norwegian context specifically represents both the major strength and weakness of the study. This is because the NM appears to present us with an advantage for industrial digitalization. However, further work should test the seven enablers in other industrially developed countries.

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EFFORTS TO MAINTAIN HEALTH INDEX ON DISTRIBUTION SERVICES OF PT PLN (PERSERO)'s CEMPAKA SUBSTASION IN BANJARBARU

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ABSTRACT

Cempaka Substation is one of PT PLN (Persero)'s assets located in Banjarbaru and transformer plays an important role in distribution of electricity. As new South Kalimantan capital, Banjarbaru has potential to experience increase of customers in line with regional progress and impact on transformer loading where maximum safe loading limit is 80% of its capacity. One way to find out transformer loading is to estimate load by considering customers. Forecasting casual method of regression analysis is methods used to estimate transformer loading by considering relationship between transformer loading data and customer data. The results of estimation of transformer load are used to determine health index and provide recommendations to PLN in order to maintain reliability of electricity distribution and transformer can operate according to its technical age. The results of research analysis for 2023 – 2025 show that health index of each transformer in Cempaka Substation is still in good category and during fault scenarios 1 and 2 transformer going out shows health index of transformers 5, 6, and 7 varies between sufficient, insufficient, and bad. The recommendations given are to carry out monitoring of loading, partial customer outages, maintenance, addition of new transformers, and construction of new substations.

Keywords: Forecasting Casual, Costumers, Transformer Load, Heath Index.

1. INTRODUCTION

Electric power distribution system consists of generation, transmission, distribution, and customers. Generation is process of generating electricity, where electricity is result of energy changes (Kementrian ESDM;2019). PT PLN (Persero) Unit Pelaksanan Transmisi (UPT) Kalimantan Selatan Kalimantan Tengah (KSKT) is units of PT PLN (Persero) Unit Induk Pembangkitan dan Penyaluran (UIKL) which is engaged in distribution of electricity transmission from generators to distribution. Substation (GI) is final stage in distribution of high-voltage level electricity and there is a transformation process of electrical voltage from a voltage level of 150/70 kV (kilo Volts) to a voltage level of 20 kV. Process of transformation from high voltage level to medium voltage level occurs in power transformer. Distribution is process of distributing electricity from substation using medium voltage to be distributed to customers. Process of distributing electricity in distribution ends in distribution transformer. Distribution transformer

transforms medium voltage to low voltage (20 kV to 220 Volt) so that electricity can be enjoyed by customers. Increasing number of customers certainly affect the use of electricity. High use of electricity certainly affects operation of power transformer, where is capacity of power transformer in distributing electric power follows the use of electric power. The role of power transformer becomes very vital because it is a voltage conversion tool capable of distributing electric power.

Capacity of the power transformer is determined by the use of load consumed by customers. loading of power transformers at PT PLN (Persero) is expressed in amperes on secondary side of power transformer. Surat Edaran (SE) 0017/E/DIR/2014 concerning standard health index for load of power transformers is 80% of its capacity. This is done to maintain reliability of electric power distribution and power transformer can operate according to its technical age. Cempaka Substation is one of substations in South Kalimantan Province, precisely in Banjarbaru City. Banjarbaru City is capital city of South Kalimantan to replace Banjarmasin City which was ratified in Undang Undang no. 8 of 2022 concerning South Kalimantan. As a new capital of South Kalimantan Province and a supporting city for Nusantara, Republic of Indonesia future capital in East Kalimantan Province, and has an indirect impact on regional progress. Along with regional progress, City of Banjarbaru has potential to add new customers in household, industry, and government sectors. Based on existing problems, researcher wants to take a case study of estimated load of power transformers at the Cempaka Substation PT PLN (Persero) UPT KSKT as one of preventive steps in implementing health index standard for operating transformer loading and maintaining reliability of electricity distribution.

The data used are peak loading data on secondary side of power transformer in form of amperes and electricity customer data. Power transformer load data was obtained from PT PLN (Persero) UPT KSKT in 2017-2021 and electricity customer data was obtained from PT PLN (Persero) ULP (Unit Layanan Pelanggan) Banjarbaru for 2017-2021. Estimation of power transformer load was carried out using causal forecasting method for 2023-2025. Casual forecasting method uses regression analysis by considering the causal relationship between X variable and Y variable. Variable X is electricity customer data and variable Y is data of transformer load in ampere units. Furthermore, data from estimation of transformer load is calculated by calculating percent load capacity of transformer to determine its health index.

2. LITERATURE REVIEW

Casual forecasting is based on forecasting results which are compiled on the pattern of relationships between the variables sought or forecasted with variables that influence or are independent, not time. In this forecasting, it is assumed that the predicted factor or variable shows a causal influence relationship with one independent variable. The advantage of using casual forecasting is greater success or accuracy, and it is often used for decision making (Zunaidhi, Rival, et al; 2012).

Regression analysis is a very valuable method for today's management. The applications of regression analysis are almost limitless. In general, there are two objectives for regression analysis (Barry Render et al; 2015):

1. Understand the relationship between the independent variable and the dependent variable.
2. Predict the value of one variable based on the values of other variables.

The transformer or transformer functions to transform the power (current and voltage) of the AC (Alternating Current) system to another current and voltage system at the same frequency (PT PLN (Persero); 2014). The transformer uses electromagnetic principles, namely ampere's law and faraday's induction, where changes in current or electric fields can generate magnetic fields

and changes in magnetic fields / magnetic field fluxes can generate induced voltages (IEC 60076-1; 2011). Health index is a quantitative scale based on load measurements of a power transformer equipment. PT PLN (Persero) has established provisions related to asset management, one of which is through Surat Edaran 0017/E/DIR/2014 concerning determination of health index of power transformers as described in table 2.1:

Table 2.1 Online Assessment Matrix on Power Transformers

Characteristic Group	Characteristic	Health Index			
		Good	Sufficient	Less	Bad
Load Reading and Profiling	Transformer Load	<60%	60%≤ - ≤ 80%	80%< - < 100%	≥ 100%

Power transformer loading can be calculated using equation 1:

$$\% \text{ Load} = \frac{S}{K\,Trafo}\ x\ 100\% \qquad (1)$$

S = Transformer Load Consumption Power (MVA)
K Trafo = Power Transformer Power Capacity (MVA)

The power consumption of the power transformer can be calculated using equation 2:

$$S = I_{load}\ x\ \sqrt{3}\ x\ V\ x\ Cos\ \varphi \qquad (2)$$

I_{load} = Current (*Ampere*)
V = Voltage (Kilo *Volt*)
$Cos\ \varphi$ = Operating Phase Angle

3. METHODS

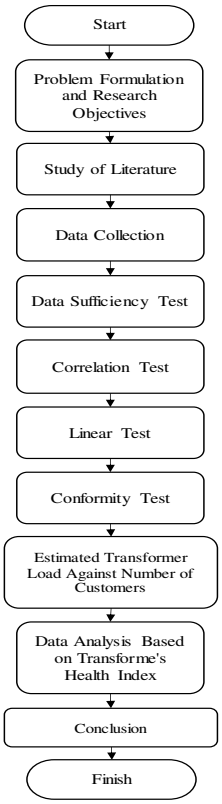

Figure 3.1 Research Flow

Analysis method is carried out by using forecasting casual regression analysis method. Regression is included in measuring instrument used to measure the existence of correlation between variables. Regression is defined as a forecast or estimate. Regression analysis can predict or predict value of dependent variable more accurately. Linear regression is a regression where independent variable (variable X) has the highest rank of one (Jerald Greenberg, et al; 2010). This method is used to determine transformer load forecast which is influenced by the number of customers. This method uses power transformer load data as Y variable and number of customers as X variable in the past to determine estimated load in future. Independent variable used is the number of customers in 2017-2021, and dependent variable used is peak load of power transformer in 2017-2021. Load data and number of customers data are tested for data sufficiency test, correlation test, linearity test, and conformity test as a requirement estimation method of forecasting casual regression analysis. Data sufficiency test is carried out to determine minimum amount of data that must be available in estimation calculation. Next, do a correlation test to find out correlation between independent variable (X) and dependent variable (Y). Next test stage is linearity testing so that it can ensure model can be approached with a linear regression analysis model. Suitability test was carried out by meeting indicators for RMSE, SD, MAE, and R^2 values. After the data has been tested, next process is to calculate the estimated loading of the power transformer which is influenced by the number of customers. After load estimation calculation phase is complete, next step is to calculate percent loading of power transformer. Results of the percent loading of power transformers are then used to state the health index of power transformers based on **table 2.1** regarding the online assessment matrix on power transformers. Estimation of electricity load is carried out for next three years (2023 – 2025) due to ease in submitting an investment budget within PT PLN (Persero) so that use of budget is more targeted and planning needs of electricity supply by PT PLN (Persero) UPT KSKT can be known. The final stage of this research is to draw conclusions based on data analysis that has been done, so that it becomes the final result that explains this research as a whole.

4. RESULT

Tabel 4.1 Regression Analysis Test Results

No	Test	Transformer 5		Transformer 6		Transformer 7	
		Day	Night	Day	Night	Day	Night
1	Data Sufficiency Test	1082	1082	1082	1082	1082	1082
2	Corelation Test	0,295	0,343	0,439	0,602	0,656	0,753
3	Linier Test	0	0	0,005	0	0	0
4	Conformity Test						
	a. Autocorrelation Test	2	2	2	2	2	2
	b. t Test	13,21	15,59	20,88	32,2	37,11	48,82
	c. Coefficient of Determination	8,68%	11,71%	19,24%	36,20%	42,99%	56,63%
	d. Regression Model	0,010761*X5 + 24,1	0,013796*X5 + 7,6	0,015385*X6 + 3,8	0,019330*X6 - 187,4	0,028091*X7 - 887,3	0,027568*X7 - 797,6
	e. RMSE	70,30	76,36	130,18	106,05	127,99	95,47
	f. SD	70,32	76,38	130,22	106,08	128,02	95,50
	g. MAE	54,77	62,20	98,01	73,25	89,02	63,20

Table 4.1 shows data sufficiency test needed as many as 1082 pieces to perform estimation calculations. Load and customer data in each transformer amounted to 1826 pieces. Furthermore, for correlation test, it can be assumed that there is a positive correlation between transformer load variable and number of customers variable. Linear test can be assumed to have a linear relationship between transformer load variable and number of customers variable because significance value is < 0.05. Autocorrelation testing can be assumed that regression model does not experience autocorrelation symptoms because value of d > dU and (4 – d) > Du (dU value = 1.92412) (Ghozali; 2016). T-test can be assumed that there is an influence between transformer load variable and number of customers because value of t count > t table (t table = 1.9613). Value of coefficient of determination from table 4.1 shows that variable number of customers has as much effect as value in **table 4.1** on the transformer load variable. Regression model is used to estimate transformer load in 2023 – 2025.

Table 4.2 Transformer 5 Load Estimation Results

Month	Transformer 5				
	Costumers	C Day (Ampere)	% Trafo	C Night (Ampere)	% Trafo
31/12/2023	31451	362,55	35,54	441,50	43,28
31/12/2024	32438	373,16	36,58	455,11	44,62
31/12/2025	33338	382,85	37,53	467,54	45,83

Results of estimated load of transformer 5 based on **table 4.2** state that health index of transformer 5 during daytime peak loads is in good condition because transformer load is < 60% of transformer capacity of 30 MVA. While load of transformer 5 when night peak load is in good condition because transformer load is < 60% of capacity of transformer 5.

Table 4.3 Transformer 6 Load Estimation Results

Month	Transformer 6				
	Costumers	C Day (Ampere)	% Trafo	C Night (Ampere)	% Trafo
31/12/2023	65247	1007,63	49,39	1074,02	52,65
31/12/2024	67261	1038,62	50,91	1112,96	54,55
31/12/2025	69099	1066,89	52,30	1148,50	56,30

Results of estimated load of transformer 6 based on **table 4.3** state that the health index of transformer 6 during daytime peak loads is in good condition because transformer load is < 60% of transformer capacity of 60 MVA. While load of transformer 6 when night peak load is in good condition because transformer loading is < 60% of capacity of transformer 6.

Table 4.4 Transformer 7 Load Estimation Results

Month	Transformer 6				
	Costumers	C Day (Ampere)	% Trafo	C Night (Ampere)	% Trafo
31/12/2023	60960	825,12	40,44	882,93	43,28
31/12/2024	62904	879,74	43,12	936,54	45,91
31/12/2025	64684	929,72	45,57	985,59	48,31

Estimation results of transformer 7 load based on **table 4.4** state that health index of transformer 7 during daytime peak load is in good condition because transformer load is < 60% of transformer capacity of 60 MVA. While load of transformer 7 at peak night load is in good condition because transformer load is < 60% of capacity of transformer 7.

One thing related to system reliability is outage of transformer unit in serving customers. Contingency N - 1 is a scenario of unexpected events in a transformer that is disturbed, so that load at that time will be transferred to another transformer and transformer must be able to carry additional load (Syamsurijal; 2008). Transformers that carry additional loads from transformers going out have potential to experience overload and affect health index of transformer. **Figure 4.1** shows a single line diagram of transformers in Cempaka Substation installation.

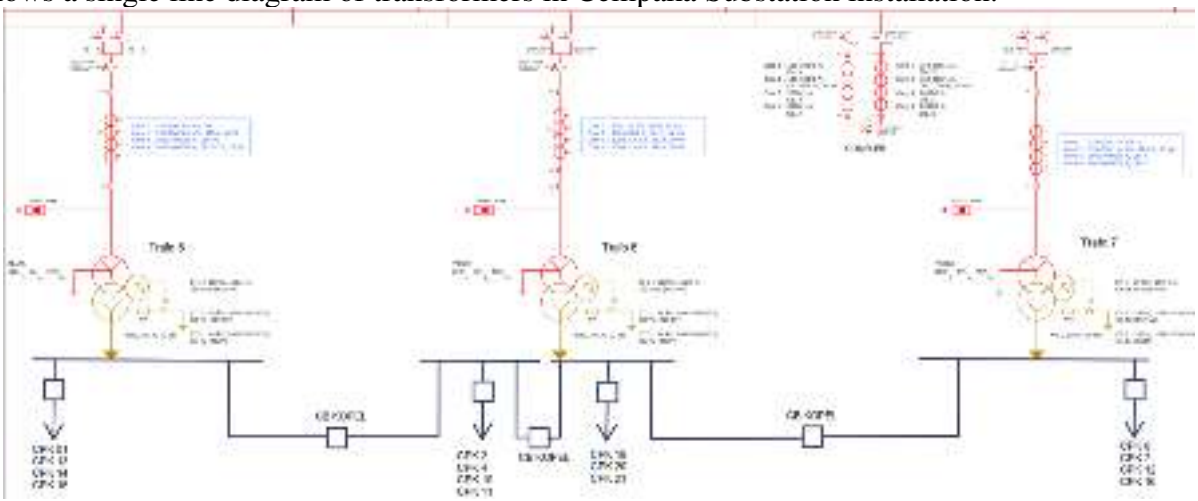

Figure 4.1 Single Line Diagram of Transformers In Cempaka Substation

Transformer faults can occur due to internal factors and external factors. Internal disturbances come from the transformer itself which is caused by the equipment on the transformer, and the protection relay (transformer safety system), external disturbances come from outside the transformer caused by animals, weather, and 20 kV feeders. If transformer 5 experiences a blackout, load on transformer 5 can be transferred to transformer 6. This also applies when transformer 6 goes out, load on transformer 6 is transferred to transformer 5 and transformer 7. In addition, if transformer 7 goes out, the load on transformer 7 can be transferred to transformer 6 and some load of transformer 6 can be transferred to transformer 5. Disturbance also has potential to cause 2 transformers to go out at same time, so a simulation is needed to determine health index of transformer. If transformer 5 and transformer 6 experience a black out, then transformer 7 must bear burden of transformer 5 and transformer 6. In addition, if transformer 5 and transformer 7 experience a black out, then transformer 6 must bear burden of transformer 5 and transformer 7. This applies if the transformer 6 and transformer 7 are going out, so transformer 5 must bear the burden of transformer 6 and transformer 7. Following is a simulation estimate that will occur if one of transformers goes out.

Table 4.5 Transformer 6 Load Estimation Results

Month	Transformer 6				
	Costumers	C Day (Ampere)	% Trafo	C Night (Ampere)	% Trafo
12/2023	96699	1491,51	73,11	1682,07	82,45
06/2024	98222	1514,95	74,26	1711,53	83,89
01/2025	99941	1541,40	75,55	1744,77	85,52

By default, installation at the Cempaka Substation, load of transformer 5 can be transferred to transformer 6 if transformer 5 has a disturbance or offline maintenance. Estimation results in **table 4.5** when daytime peak load of transformer 6 carries an additional load from transformer 5 which is offline shows that health index criteria is sufficient with load value of around 60%≤ - ≤

80%. Meanwhile, at night peak load, transformer 6 shows health index in less criteria with load value of around 80% < - < 100%.

Table 4.6 Transformer 5 Load Estimation Results

Month	Transformer 5				
	Costumers	C Day (Ampere)	% Trafo	C Night (Ampere)	% Trafo
12/2023	64075	713,6	69,96	891,6	87,40
06/2024	65087	724,5	71,03	905,5	88,77
01/2025	66229	736,8	72,23	921,3	90,32

By default, the installation at Cempaka Substation, load of transformer 6 can be transferred to transformer 5 & 7 if transformer 6 has a disturbance or offline maintenance. Estimation results in **table 4.6** when daytime peak load of transformer 5 which carries an additional load from transformer 6 which is offline shows health index criteria is sufficient with load value of around 60%≤ - 80%. Meanwhile, at night peak load, transformer 6 shows health index in less criteria with load value of around 80% < - < 100%.

Tabel 4.7 Transformer 7 Load Estimation Results

Month	Transformer 7				
	Costumers	C Day (Ampere)	% Trafo	C Night (Ampere)	% Trafo
12/2023	93583	1742	85,36	1782	87,36
06/2024	95082	1784	87,43	1824	89,39
01/2025	96774	1831	89,76	1870	91,67

Estimation results in **table 4.7** when daytime peak load of transformer 7 which carries additional loads from transformer 6 which is offline, it shows that health index criteria is less with load value of around 80% < - < 100%. Meanwhile, at night peak load, transformer 7 shows health index in less criteria with load value of around 80% < - < 100%. Next, we calculate estimated health index of transformer 5 & 6 when transformer 7 has a breakdown or offline maintenance.

Table 4.8 Transformer 6 Load Estimation Results

Month	Transformer 6				
	Costumers	C Day (Ampere)	% Trafo	C Night (Ampere)	% Trafo
12/2023	93583	1443,58	70,76	1621,84	79,50
06/2024	95082	1466,63	71,89	1650,81	80,92
01/2025	96774	1492,66	73,17	1683,52	82,52

Estimation results in **table 4.8** when daytime peak load of transformer 6 which carries additional loads from transformer 7 which is offline shows that health index criteria is sufficient with load value of around 60%≤ - ≤ 80%. Meanwhile, at night peak load, transformer 6 shows health index in less criteria with load value of around 80% < - < 100%.

Table 4.9 Transformer 6 Load Estimation Results

Month	Transformer 5				
	Costumers	C Day (Ampere)	% Trafo	C Night (Ampere)	% Trafo
12/2023	64075	713,6	69,96	891,6	87,40
06/2024	65087	724,5	71,03	905,5	88,77
01/2025	66229	736,8	72,23	921,3	90,32

Estimation results in **table 4.9** when daytime peak load of transformer 5 which carries an additional load from transformer 6 shows that health index criteria is sufficient with load value of around 60%≤ - ≤ 80%. Meanwhile, at night peak load, transformer 5 shows health index in less criteria with load value of around 80% < - < 100%. Following is a simulation estimate that will occur if two transformer go out.

Table 4.10 Transformer 7 Load Estimation Results

Month	Transformer 7				
	Costumers	C Day (Ampere)	% Trafo	C Night (Ampere)	% Trafo
12/2023	157658	3541	173,59	3549	173,95
06/2024	160169	3612	177,05	3618	177,34
01/2025	163003	3692	180,95	3696	181,17

Estimation results in **table 4.10** when daytime and night peak load of transformer 7 which carries an additional load from transformer 5 & transformer 6 shows that health index criteria is bad with load value ≥ 100%.

Table 4.11 Transformer 6 Load Estimation Results

Month	Transformer 6				
	Costumers	C Day (Ampere)	% Trafo	C Night (Ampere)	% Trafo
12/2023	157658	2429,37	119,08	2860,60	140,22
06/2024	160169	2468,00	120,97	2909,15	142,60
01/2025	163003	2511,60	123,11	2963,94	145,28

Estimation results in **table 4.11** when daytime and night peak load of transformer 6 which carries an additional load from transformer 5 & transformer 7 shows that health index criteria is bad with load value ≥ 100%.

Table 4.12 Transformer 5 Load Estimation Results

Month	Transformer 5				
	Costumers	C Day (Ampere)	% Trafo	C Night (Ampere)	% Trafo
12/2023	157658	2429,37	119,08	2860,60	140,22
06/2024	160169	2468,00	120,97	2909,15	142,60
01/2025	163003	2511,60	123,11	2963,94	145,28

Estimation results in **table 4.12** when daytime and night peak load of transformer 5 which carries an additional load from transformer 6 & transformer 7 shows that health index criteria is bad with load value ≥ 100%.

5. CONCLUSION

Conclusion of this study shows that there is an increase in customers during 2023 - 2025 for each transformer so that there is an increase in transformer load. Average estimated load for transformer 5 is 39.98%, transformer 6 is 51, 84%, and transformer 7 is 43.14% with health index in good category. When the N-1 contingency occurs, transformer 5 goes out, average estimated load of transformer 6 is 79.13% with a sufficient health index category. When transformer 6 goes out, average estimated load for transformer 5 is 79.95% with a sufficient health index category and average estimated load of transformer 7 is 88.50% with a less health index category. When transformer 7 goes out, average estimated load of transformer 6 is 76.5% with sufficient health index category and average estimated load of transformer 5 is 79.95% with sufficient health index

category. When scenario 2 of the transformer goes out, average estimated load of transformer 5, transformer 6, and transformer 7 is ≥ 100% with bad health index category.

Recommendation of this research for PT PLN (Persero) regarding the results of estimated load vary from good, sufficient, less, and bad categories for 2023 – 2025. The recommendations for PT PLN (Persero) are:

a Health index in good category:
   [1] PT PLN (Persero) can add new customers to maximize electricity sales and can increase profits for company by not forgetting to monitor load so that it does not exceed 80% of transformer capacity.

b Health index in sufficient category:
   [1] PT PLN (Persero) requires maintaining a transformer asset and repairing it so that it is always in a state of readiness to carry out its functions effectively and efficiently in accordance with applicable standards. Transformers that are carried out maintenance are expected to prevent premature damage to transformer components, can operate reliably and minimize disturbances. Reliable transformer performance can affect lack of customer power outages. Maintenance on transformer includes in services inspection, in services measurement, and shutdown measurement.

c Health index in less and bad category:
   [1] The installation of a new transformer is carried out to improve the reliability of electric power distribution, improve electricity service without blackouts to customers and the need for high electricity consumption. Installation of a new transformer is carried out when the loading of the existing transformer is close to 80% and the existing substation still has sufficient land to add 1 transformer.
   [2] Substation construction is carried out if the existing substation does not have sufficient land for the installation of a new transformer and the transformer loading exceeds 80%. The provision of stable and continuous electric power is an absolute requirement that must be met in meeting the demand for electric power. The new substation is expected to be the answer to increase the reliability of electric power distribution, and the potential to add new customers.

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CONTRACTOR PERFORMANCE ASSESSMENT MODEL WITH PAIRWISE COMPARISON METHOD IN THE PRODUCTION FACILITY DEVELOPMENT PROJECT IN THE OIL FIELD OF PT. XYZ

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ABSTRACT

PT. XYZ is one of the oil and gas exploration and production companies in Indonesia. In order to increase total oil production and natural gas several projects will be carried out. Based data for the last 6 projects shows a delay in project completion of 38.28% and an additional cost of 10.42% so companies need indicators to assess contractor performance to become a reference for improving contractor performance in future projects. The Pairwise Comparison method which is based on the results of interviews with experts and questionnaires is analyzed by validation tests, reliability and hypothesis analysis. It was found that the contractor's performance was divided into 7 main criteria and 30 sub criteria resulting that Quality as the criterion with the highest score of 22.74% and Financial criteria as the lowest criterion with a value of 9.06%. The implementation of the contractor performance assessment model on 3 contractors is resulting that contractor B as a contractor highest value of 80.80%, contractor C with 80.06% and contractor A with 65.46%. The Quality Criteria has the highest importance weight with the sub-criteria in the form of Construction Quality, this shows that the quality of the construction results has the highest influence on evaluating contractor performance.

Keywords: project, contractor, assessment indicator, pairwise comparison, quality

1. INTRODUCTION

The world of construction projects is an industry that has a high level of complexity. This complexity can be seen from the many stages of the production process in this industry, starting from the feasibility study stage, the briefing stage, the design engineering stage, the material procurement stage, the construction/implementation stage, the testing stage (pre-commissioning), the initial stage of production (startup), to the operational and maintenance stage (operation & maintenance). The complexity of the project can also be seen from the many parties involved, both directly and indirectly, starting from the team of contractors, planning consultants, supervisors, suppliers, financial planners, and others.

Of all the stages and teams involved, the construction/implementation stage is a stage that needs important attention so that the main goal of producing a quality project can be achieved, Umam & Dani Syafitri (2017). Construction is also a complex system because every construction project has different problems even though it has the same type of project because it adapts to the

workplace environment and certain functions, designs or preferences used. These things will cause problems that can impact project performance, Kiew, Ismail, & Yusof (2013).

PT. XYZ is a state-owned company engaged in the field of oil and gas exploration and production at the national level which operates several wells and production facilities spread throughout the territory of the Negara Kesatuan Republic of Indonesia which consists of 4 assets, namely Asset 1, which has an office in Jambi, Asset 2 with an office in Prabumulih, Asset 3 with an office in Cirebon, and Asset 4 with an office in Surabaya.

In the 6 last projects in Aset 4 area of production, there was run with many problems and makes the cost overrun 10,42% from the budget and schedule overrun up to 38,28% from the original contract. Those overrun make the contractor need to improve the weakness or the worse performance during project running divide by per discipline. It can be seen on the Table 1 below.

Table 1. Data overrun for 6 last projects

No	Project Named	Schedule Overrun	Cost Overrun
		%	%
1	Subsea Pipeline Construction For Gas Lift And Top Side Modification BW Platform	13,79%	(2,63%)
2	Upgrading Hydrocyclone AW Platform	64,88%	16,76%
3	Penggantian Dan Instalasi Heat Exchanger E-655 Di Platform PPP Field Poleng	56,02%	8,76%
4	Pengadaan Dan Pemasangan Fire And Gas System Di AW Platform	41,29%	14,54%
5	Upgrading System SCADA Field Poleng	28,75%	7,45%
6	Retrofit Vessel V-501	24,97%	17,64%
	Average overrun	**38,28%**	**10,42%**

On the basis of the background of the problems mentioned above, in order to obtain an assessment of the performance indicators of the implementing contractor, it is necessary to resolve the following matters:

1. What are the main criteria and sub-criteria in assessing contractor performance?
2. What method is used to evaluate contractor performance indicators?
3. What is the implementation of the contractor performance appraisal model for several contractors in the PT. XYZ project environment?

On the basis of the background and formulation of the problems presented above, the objectives of the research to be achieved include:

1. Determine the performance evaluation criteria and sub-criteria for implementing contractors
2. Propose a model for assessing contractor performance indicators using the pairwise comparison method
3. Conduct a simulation model for assessing contractor performance indicators in the PT. XYZ

2. LITERATURE REVIEW

According to KBBI, a project is a work plan with specific goals (irrigation, power generation, etc.) and with a clear completion time, Anonymous, (2022). There are so many

definitions of a project, according to BS 6079-2:2000 Project Management Vocabulary in Lester, (2014) a project is defined as a unique process consisting of a series of controlled and coordinated activities with start and end dates, carried out to achieve a goal that fulfills specific requirements, including time, cost and resources.

Project performance is how the project works by comparing the real work results with the estimated working methods in the work contract agreed upon by the work owner or the owner and the implementing contractor. The success and failure of a project is influenced by the performance of the implementing contractor. Identification and measurement of performance indicators needs to be done to determine the success or failure factors of a project.

Performance can be seen by referring to the level of success in carrying out the responsibilities and capabilities possessed to achieve the goals that have been set and mutually agreed upon. Performance is declared good and successful if the desired goals can be achieved properly, Carr, (1993). Project performance can be measured and evaluated using many performance indicators related to various dimensions such as time, cost, quality, customer satisfaction, client turnover, business performance, health and safety. Time, cost and quality are the dominant performance evaluation dimensions, Omran, Abdalrahman, & Pakir, (2012).

According to Gibson, et al (1990) in Hutagalung, (2018) performance is a success in achieving a predetermined goal. Organizational performance shows an achievement of the goals that have been previously set by the organization, whether measured from the vision, mission, goals and targets at the start of the plan. This achievement is inseparable from the resources working within the organization.

Performance indicators are a unit of measure that can be used to see the factors that influence the achievement of project objectives. In determining the right performance indicators, it depends on a good understanding of things that are important for an organization, in this case for the contracting company implementing the project (Vyas & Kulkarni, 2013) in Agsarini I., (2015)

Pairwise Comparison Method is a method that can be used in a decision-making system by taking into account the factors of perception, preference, experience, combining personal judgments and values into a logical way. This method uses scaling where objects are compared in a pair. This pair is made equal, where one object is not made more positive than another object. In this method the assessor from the expert judgment is asked to choose one of the paired objects, The selected object is one that better describes the characteristics that accordance with their knowledge, or something that is preferred, depending on the measurement objective, Thomas L. Saaty (1980)

3. METHODS

3.1 Population and Research Sample

The population can be described as a generalization area in which there are objects/subjects that have certain qualities and characteristics determined by the researcher to be studied and then drawn conclusions. The research sample is part of the number and characteristics possessed by the population. Sugiyono, 2012 in Agsarini i, (2015). The population of this study is a project implemented in the production facility area of PT. XYZ is a total of 3 (three) projects, while the samples that will be taken are from employees from the staff level to managers from both project owners and contractors as well as expert judgment. Respondent data can be seen in Table 3.2 below with a total of 41 respondents.

3.2 Data Collection

According to Sugiono, 2013 in Iryana & Kawasati, (2018) data collection techniques are the most strategic step in the research being conducted. Because the process of collecting data from this study is qualitative and quantitative data, data collection techniques can be obtained using the following method

3.2.1 Interview

Interviews are one method of collecting data by providing several questions directly or face to face that are considered important to informants who support the preparation of this research. This method is intended to find out things related to respondents in more detail. As for the interviews, respondents were selected who had the following criteria:

• Have experience in the field of construction at least 10 years

• Have supporting knowledge and education

• Have a good reputation

While the interview material is the determination of the relevance of the criteria for evaluating the contractor's performance with 7 selected initial variables proposed to assess the suitability of these criteria, the interviewees will provide confirmation on determining whether the criteria are relevant or not in measuring contractor performance and accompanied by justification.

3.2.2 Questionnaire (Questionnaire)

The next method of data collection is by questionnaire or questionnaire, in which this method of data collection is carried out by asking several written questions or indirectly to respondents to answer these questions. The questionnaire was created to measure and assess directly the level of compatibility or satisfaction of the respondents with the performance of contractors working on production facility projects which can be seen from the variables asked.

The next stage is the analysis of the data that has been obtained, where this stage is the last and most important stage with the following details:

3.2.3 Validity Test

At the time of collecting data with a questionnaire, the data collected will be tested for the validity of the data whether it is valid or invalid. Furthermore, by using the program https://www.spss-tutorials.com/spss-what-is-it/Statistical Package for the Social Sciences (SPSS) the validity test applies Bivariate Pearson correlation (Pearson correlation). This analysis correlates each item's score with the total score. The total score is the sum of all items. This test will use a two-tailed test with a significance level of 0.05. While the test criteria are if r count > r table (2-sided test table with sig 0.05) then the instrument or question items posed have a significant correlation with the total score or it can be concluded that the data collected is valid.

3.2.4 Reliability Test

The reliability test is used to determine the consistency of the factor in its use when it is used many times at different times. In the SPSS program there is a method commonly used, namely the Alpha method (Cronbach's). This method is suitable for assessment analysis with a score in the form of a scale (eg 1-4, 1-5, etc.) or with a ranged score (eg 0-20, 0-50, etc.). The decision-making criteria can use certain limits such as 0.6 so that the questionnaire can be declared reliable if it has a Cronbach's alpha value > 0.6.

3.2.5 Performance Assessment by Weighting the Main Criteria Pairwise Comparison Method

Where to calculate the contractor's performance will be carried out to determine the relevance of the criteria taken from previous research situations as shown in Table 2.1 and the results of interviews with experts. The variables proposed in the interview with the expert will become basic data to be further processed and bring up the weight of each variable used in assessing contractor performance.

Table 2. Pairwise Comparison Matrix

Element	managerial	Finance	Engineering Ability	Experience	Quality	Time	HR
managerial	1						
Finance		1					
Engineering Ability			1				
Experience				1			
Quality					1		
Time						1	
HR							1
score							

Filling in the matrix elements in Table 3.4, is as follows:
a. Element a (i,j) = 1, where 1=1, 2, 3…n for this study, n=7
b. Upper triangular matrix elements as input
c. The lower triangular matrix elements have the formula for i ≠j

4. RESULTS

In this study, the respondents were project owners (Project Manager and Senior Construction Engineer) and asset owners (Field Manager and Assistant Manager) at PT. XYZ as many as 4 people. Respondents were asked to fill out a Contractor Performance Assessment (PKK) questionnaire for 3 contractors who carried out the project in the same environment, namely at the PT. XYZ. The Contractor Performance Assessment Model was prepared based on literature studies, the results of an initial survey with experts (Risk Managers) and academics as well as a questionnaire from 41 respondents with the appropriate composition of respondents. Table 3.2 provides an assessment of the level of importance of the 7 variables assessed as performance indicators contractor according to what has been described in sub-chapter 2.2.4

The three contractors work on different projects as follows;

1. Contractor A, working on the Retrofit Vessel V-501 project which includes offshore Engineering, Procurement, Fabrication and Construction work. The project duration is from 2021 to 2022 with a budget value of Rp. 4,799,000,000
2. Contractor B, is working on the Upgrading Hydrocyclone project with the main work being Demolish the existing hydrocyclone unit. The project, which will be carried out from 2021 to 2022, is in the form

of installing a new hydrocyclone unit, piping system installation, electrical and instrument system installation, precommissioning and commissioning with a contract value of Rp. 3,310,426,354,-

3. Contractor C, working on the Fire & Gas Detector System project at one of the offshore platforms at PT. XYZ. This project lasts from 2020 to 2021 with a contract value of RP. 11,050,000,000, - with work covering Engineering, Procurement and Installation on an offshore platform.

Based on the pairwise comparison matrix and the spiderweb diagram, it can be seen that the highest weight percentage is in variable E (quality) of 22.84%. After that, the variable G (Human Resources) ranks next with a value of 16.96%. In 3rd place there is variable D (Experience) with a weight of 15.49%. The 4th place is followed by variable C (technical ability) with a weight of 15.44%. The next variable is F (Time) with a weight of 10.90% which ranks 5th. In the 6th and 7th order there is variable A (Managerial) with a weight of 9.40% and variable B (Finance) with a weight of 9.06%.

The amount of weight on variable E (quality) indicates that quality is very important to always prioritize for every contractor in completing work as stated by (Srpová, 2012) that quality is an important factor that will affect the performance of an organization and also a strategy to become more competitive. The variable G (Human Resources) is also important because it supports the success of the project so that it can be completed with good quality.

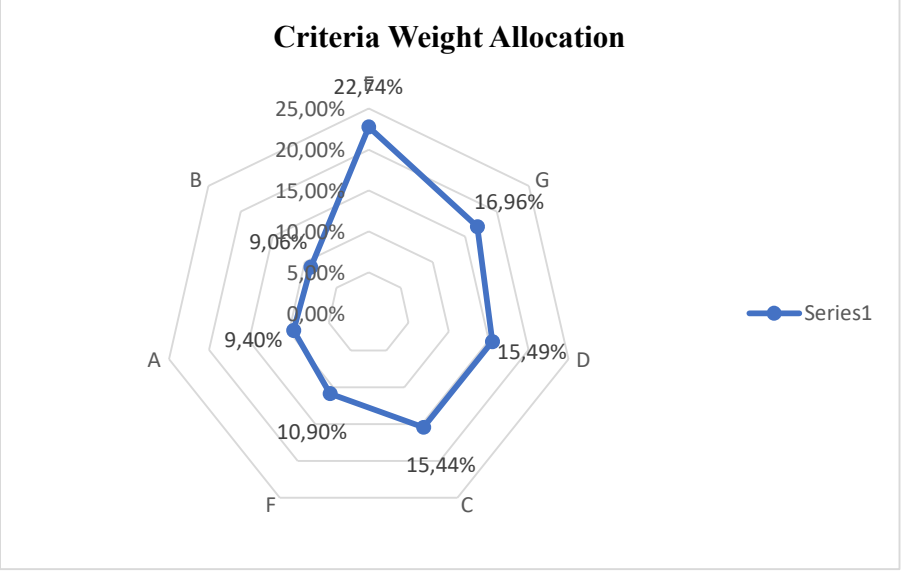

Figure 1. The spiderweb diagram of the Pairwise Comparison Level 1 results

After carrying out the pairwise comparison process for level I or the main criteria and having known the weight of each criterion, the next step is to calculate the priority of the sub criteria or level II criteria. The priority weight of the main sub criteria is determined based on the results of interviews, discussions or questionnaires which are filled out jointly by the Manager, Senior Staff, Contractor Leader, and the relevant Engineer.

The main sub-criteria measurement indicators are described as follows:

A. Managerial, has the following assessment indicators;

1. Regulatory compliance and business ethics
2. Project management

3. Organizational management
4. Communication

B. Finance, has the following measurement indicators;
1. Budget accuracy
2. Payment of suppliers
3. Labor welfare

C. Technical ability, has the following measurement indicators;
1. Good relationship with customers
2. Up to date technology
3. Document management
4. Relations with stakeholders

D. Experience, has the following measurement indicators;
1. The team's experience
2. Offshore project execution
3. Handling offshore fabrication projects

E. Quality, has the following measurement indicators;
1. Good construction quality
2. Adequate facilities & assets
3. Conformity of documents
4. Complaints received

F. Time, has the following measurement indicators;
1. Controlling the duration of the project
2. Adaptation to change
3. Project time planning
4. Accurate schedule

G. Human Resources, has the following measurement indicators;
1. Honesty and Integrity
2. Discipline and Responsibility
3. Commitment
4. Proficiency in using tools
5. Workforce Management
6. Training
7. Individual ability
8. Minimum turnover

Based on the result of questionnaire for each contractor assessment performance, contractor B with 80,80% is the highest rank of other contractor, Contractor C with 80,06% is the second, and Contractor A only gets 65,46%. Quality aspect is the main drive of contractor A and contractor C with highest result of performance, experience for contractor B.

6. CONCLUSIONS

Modeling of Performance Assessment Contractors for oil field development projects at the offshore platform location consists of 2 criteria, namely level 1 criteria (consisting of 7 criteria) and level 2 criteria (consisting of 30 sub-criteria). At level 1 criteria consists of Managerial, Financial, Technical Ability, Experience, Quality, Time, and Human Resources. Each criterion has sub-criteria so that in total 30 sub-criteria are obtained which can be seen in Figure 4.1 on page 69. The results of this study produce an assessment model with performance indicators that have been tested by Pairwise Comparison. Based on the data analysis from the questionnaire, it shows that the weighting

of each level 1 criterion is divided as follows; 22.74% for Quality; 16.96% for Human Resources; 15.49% for Experience; 15.44% for Technical Ability; 10.90% for Time; 9.40% for Managerial; and 9.06% for Finance.

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COMPARATIVE STUDY OF FINANCIAL FEASIBILITY AND SENSITIVITY ANALYSIS OF FSO ASSET AND LEASES

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ABSTRACT

YYY Floating Storage and Offloading (FSO) Vessel has served as a Marine Terminal for almost 12 (twelve) years, and the time has come for drydock. The need of the FSO can be fulfilled by operating FSO YYY assets or leases. This study will determine the most appropriate alternative operating scheme to meet FSO needs using capital budgeting with NPV and IRR parameters. The paper will also discuss the sensitivity analysis to obtain the most variables influencing the financial parameter. The result of the study found that the option of leasing FSO is a better choice than the option of utilizing FSO assets. The sensitivity analysis results of the NPV illustrate that changes in the oil price variable significantly influence changes in the NPV value. If the oil price falls below 26% of its current price, it will cause the NPV to become negative. In addition, an increase in FSO rental costs above 162% of the current price will make FSO operations using the FSO lease scenario unattractive, because the NPV will be lower than the NPV option scheme using FSO assets.

Keywords: capital budgeting, economic feasibility, floating storage and offloading, sensitivity analysis

1. INTRODUCTION

YYY Floating Storage and offloading (FSO) vessel has been operating as a XXX Marine Terminal for almost 12 (twelve) years, and the time has come for drydocking. The Classification Agency will carry out periodic surveys to ensure that a ship still meets the operational requirements based on the classification (Wilastari, 2020). FSO YYY is anchored temporarily at the Jetty, in preparation for the drydocking process. An FSO must be available at the XXX Marine Terminal to maintain oil and gas production operations. Currently, the YYY FSO is temporarily replaced by the ZZZ Tanker rental unit because the YYY FSO classification status has expired. The availability of the FSO can be fulfilled by operating an FSO YYY asset or lease. Typical FSO ships can be seen in Figure 1.1.

Several studies related to financial feasibility have been carried out, including by Dasep & Wiwiek (2019) who conducted research to determine the feasibility of OLC and SLF projects and to examine optimal project financing alternatives either with fully equity funded or with a combination of debt and equity. Novie (2012) analyzed whether the ABC cough medicine product to be launched by PT XYZ could have a beneficial impact on the company and conducted a scenario analysis carried out from the projected financial statements of PT XYZ, then provided input on the decision to launch the cough medicine product. Ananda & Andika (2018) conducted

an investment feasibility analysis of fixed assets in the form of replacing old assets with new assets at Serabi MSMEs in Surakarta, Central Java using capital budgeting techniques. Akhmad (2019) applies capital budgeting analysis in the investment plan of fixed assets in shipping companies, to find out whether the addition of fixed assets can be said to be feasible or not to be implemented. Pratama (2020) comparing the heavy equipment usage system between rental and purchase, research was conducted by analyzing the feasibility of purchasing excavators and renting excavators.

Research needs to be done that conducts a financial feasibility study and compares the financial feasibility of an alternative FSO operating scheme using own assets and rental, in order to obtain the best alternative operating scheme. Sensitivity analysis was also carried out to find out what variables should be monitored and controlled, because they have the most influence on the financial, and what the value limits are so that the operational financial of the job remain positive. This study will provide results in the form of the selection of the most appropriate alternative operating scheme options financially. It will also be obtained the variables that have the most influence on the financial area, and what is the limit value so that the operational finances of the FSO remain positive.

Figure 1. 1 FSO. Taken from the Encyclopedia of Ocean Engineering (p 1079) (Weicheng, 2022)

2. LITERATURE REVIEW

2.1 Floating Storage and Offloading (FSO)

Floating storage and offloading (FSO) vessels are floating structures or vessels that can be used for hydrocarbon and crude oil exploration activities offshore (Fabya, 2019). The FSO has facilities to store crude oil, so it can be used to receive and store crude oil produced from oil fields and lifting crude oil to tankers. If there are problem with the FSO, it can cause disruptions to oil and gas production operations.

FSO was chosen as a facility in the process of oil and gas exploitation because FSO can move from one place to another (mobile platform) when the area cannot be exploited. Therefore, the floating platform has a very important role in developing oil fields in deep or medium-sized sea areas and is an alternative choice to use as a fixed platform. FSO is a floating platform that is widely used in operational conditions like this (Garry, Daniel, & Rudi, 2021).

2.2 Types of Business Costs

An understanding of the types of business costs in a business feasibility study is used to separate the types of costs in the calculation of financial feasibility. To run a business, you need two types of costs as follows (Suliyanto, 2010).

1.2.1 Investment Costs

Investment is an investment in one or more assets that are owned and usually long-term in the purpose of getting profits in the future. Examples of investment costs are the cost of purchasing land and buildings, the cost of purchasing machinery and equipment, the cost of purchasing vehicles, the cost of building production facilities, the cost of equipment overhaul.

1.2.2 Operating Costs

Operational costs are all costs that must be incurred in order for business activities to operate or run normally. Examples of operational costs are material costs, including raw material costs, auxiliary material costs, fuel costs, personal costs, including salaries, benefits and bonuses, other costs, including electricity, water, and operation and maintenance costs.

2.3 Financial Feasibility

Financial feasibility needs to be analyzed to find out whether the business carried out will benefit or not. To avoid losses received by investors, investors must know their investment proposals with long-term risks that will be accepted. If the risk is too great or causes large losses, the investor will not continue investing. The risk faced is the rate of return on invested capital in the long term. Avoiding these risks requires careful analysis and calculation. Analysis of the planning process and making investment decisions on fixed assets can be done with capital budgeting calculation techniques.

Mbabazize (2014) explains that it involves how resources should be allocated within the company to maximize shareholder wealth. The decision on capital budgeting involves the commitment of a large amount of money in a particular project, and such a decision is difficult to cancel without economically and financially disrupting the organization. Meanwhile, Viviers & Cohen (2011) suggests that capital budgeting is the process of analyzing investment opportunities in long-term assets that are expected to generate benefits for more than one year. According to Khamees (2010) capital budgeting is the process of using funds to acquire operational assets that help a company to earn future income.

In capital budgeting, it includes how much resources the company has that will be allocated in order to maximize profits through the right investment decisions. It can be said that in capital budgeting there are plans that will be implemented in the future. Capital budgeting analysis is carried out with several techniques, including net present value (NPV) and internal rate of return (IRR).

2.4 Net Present Value

(Karim, 2011) states that the valuation of investment projects is based on net present value (NPV) is a method of assessing investment in investment projects using measures; present value of EAT net cash flows (proceeds) plus depreciation after being taken into account with the present value capital outlay. An investment project is said to be profitable if the present value of net cash flow is greater than the present value of investment or the net present value is positive.

Investment appraisal using the NPV method is usually used when the cost of capital of the investment is known and the required of return expected by the investor on his investment plan has been determined in value.

In general, this NPV criterion says that the project will be worth choosing if the NPV value is positive. Conversely, if a project has a negative NPV, it will not be selected because the project is not feasible to run. NPV is formulated as follows:

$$NPV = \sum_{t=0}^{n} \frac{(C)^t}{(1+i)^t} - \sum_{t=0}^{n} \frac{(CO)^t}{(1+i)^t} \quad (2.1)$$

with:
NPV = net present value,
(C) t = cash inflow year t,
(CO) t = cash outflow year t,
I = relevant discount rate used to find NPV,
N = the engineering lifespan of the project,
t = time.

2.5 Internal Rate Of Return

(Karim, 2011) states that the Internal Rate of Return (IRR) is a margin/fee/profit sharing rate that makes the PV of future proceeds equal to the PV of capital outlays. Assessment of investment in investment projects based on IRR is a method of valuation of investment projects using measures; net cash flows (proceeds) are calculated at a certain interest rate (IRR). An investment project is considered profitable if the IRR is greater than the desired margin / fee / profit sharing level or the IRR is greater than the cost of money (risk level plus SWBI).

Investment appraisal using the IRR method is usually used if there are two or more investment options. To determine which project investment to choose when assessed from the IRR calculation, it is usually the project that gives the highest IRR value that will be selected.

IRR analysis is formulated with the following equation:

$$\sum_{t=0}^{n} \frac{(C)^t}{(1+i)^t} - \sum_{t=0}^{n} \frac{(CO)^t}{(1+i)^t} \quad (2.2)$$

With:
(C) t = cash flow in year t,
(CO) t = cash outflow year t,
I = relevant discount rate used to find NPV,
n = engineering lifespan of the project,
t = time.

With project cash outflows are generally the first cost (Cf), the security becomes:

$$\sum_{t=0}^{n} \frac{(C)^t}{(1+i)^t} - (Cf) = 0 \quad (2.3)$$

2.6 Sensitivity Analysis

Sensitivity analysis is the process of analyzing risky projects by estimating the net present value for each of the pessimistic, most likely, and optimistic values for each of the variables considered. Sensitivity analysis involves the process of determining how the distribution of all possible returns for a particular project is affected by changes in one particular input variable, which is carried out by estimating the pessimistic, most likely, and optimistic value NPV of each variable. There is only one variable at a time that changes and is analyzed while the other variable is a constant. This process is designed to separate those variables that have a significant impact on the estimated net present value of the project. The term sensitivity analysis here includes other similar generic terms such as scenario analysis and what if analysis.

There are two common methods used to determine variables at a pessimistic and optimistic level. The first method is carried out by taking certain values for the variables estimated as an extension and proforma forecasting technique, with the values taken representing predictable events, either through statistical approaches, expert assessments or management opinions or with consideration of capability limits.
The second method is to use a more mechanistic approach, where the variable level is selected without reference to future value trends, but by establishing the level of the variable value higher or lower than the most likely value (Dayananda, 2002)

3. METHODS

Research methodology is the stages of the study, or the steps that the researcher must follow at the time of conducting the study. This research methodology is the basis of a systematic, structured and clear research process.

3.1 Research Flow

The composition of this study follows the research flow as stated in Figure 3.1 and can be explained as follows:

1. conduct studies first before conducting research, namely observations of the subject to be studied, namely the operation of the FSO at the XXX Marine Terminal Special Terminal. This is done to get the background and importance of the problem to be researched, followed by formulating the problem and determining the purpose of the research.
2. looking for the necessary literature references to obtain a theoretical basis that will be used to support research and achieve research objectives. In addition, library references are also used as references and comparisons, which will be included in the review of previous research results that are appropriate and have similar themes or similarities in their subject matter to find out the position of the research.
3. collecting data obtained from the company's internal parties in the form of primary data by conducting direct discussions with speakers, and secondary data in the form of documents and data obtained from several reports, records, and several literature reviews, such as books and journals.
4. the next stage is to identify the constituent components of the cost. The constituent components of these costs are arranged into cashflow which will later be analyzed for financial feasibility using capital budgeting.
5. the next stage is to conduct a financial feasibility analysis through the capital budgeting method. This analysis was performed by analyzing the NVP and IRR of each of the alternatives. In addition, the NPV Contractor and Goverment will also be analyzed in the PSC of the Cost Recovery scheme to find out the NPV of both parties.
6. after that the results of the financial feasibility analysis of the two alternatives will be compared. This is done to find out which alternative is the best financial feasibility.
7. continued with the analysis of sensitivity to the most appropriate alternatives, to find out which variables have a significant impact on the NPV value.
8. results – the results of the analysis are concluded and given recommendations.

3.2 Research Concept

In this study, feasibility analysis and financial comparison were carried out with quantitative techniques focused on calculating financial feasibility using the capital budgeting

concept approach. Financial feasibility and comparison analysis is used to obtain financial feasibility and find out the best alternative operating schemes from the financial side.

In addition, this study will also conduct a sensitivity analysis on the most appropriate alternative operating scheme to find out what variables must be monitored and controlled, because it has the most effect on the finances of the work, and what is the limit on its value so that the FSO operational finances still remain economical.

3.3 Data Collection

In this study, data is needed in accordance with the study method to be carried out. The data used in this study are secondary data. Secondary data is data that is not directly obtained by the author. The secondary data are in the form of Production Profile data, ICP rate, field operating costs, FSO drydock investment costs, FSO operating & maintenance costs, FSO fuel costs, and FSO rental costs. These data will be analyzed using capital budgeting to obtain financial feasibility. In addition, supporting data is also obtained from the results of literature studies and previous research.

3.4 Determination of Criteria

Criteria are measures, regulations and standards that are used as a reference for decision makers to be able to use attributes, goals and objectives as a reference. The first thing to do is to conduct literature studies and interviews with competent experts in the field of drydock FSO and its operations, to find out about what criteria may be used in this study.

There are several known capital budgeting criteria such as Net Present Value (NPV), Internal Rate of Return (IRR), Cost and Benefit Ratio (C/B ratio). In research the project must meet a minimum of two criteria, the first is Net Present Value (NPV), and the second requirement is the Internal Rate of Return (IRR). The Net Present Value (NPV) of income and expenditure is calculated on top of the assumption of the age of the vessel (N) years, the final amount must be positive in order for the investment to be profitable at the assumed discount rate – or if alternatives are being compared, the amount must be greater (Kurniawati, Aryawan, & Baidowi ,2016). The IRR requires a minimum rate of return equal to or higher than the savings interest rate offered by Commercial Banks (Newman et.al, 2004). More specifically, the criteria used in the financial feasibility analysis in this study are as follows:

1. if the NPV is positive, then the project proposal can be accepted, and the higher the NPV price the better, but if the NPV is negative, then the project proposal is rejected. If the NPV is 0, it means normal.
2. for an IRR, the criteria used are that if the IRR is greater than the desired return flow (i), then the project is accepted, but if the IRR is smaller than the desired return flow (i), the project is rejected.

3.5 Alternative Selection

To meet the needs of the FSO can be met by using the following alternatives:

1. Use of FSO YYY

   This alternative has a prominent criterion, namely the need for Capital Expenditure (CapEx) for the implementation of drydock FSO so that the FSO can be activated its classification status and is fit to operate. In addition, after the FSO is operational again, Operation Expenditure (Opex) is also needed to finance the operational and maintenance needs of the FSO.

2. Use of leased FSO
   This alternative has a prominent criterion, namely that only Operation Expenditure (Opex) is required to pay the FSO rental fee and its operation & maintenance costs.

3.6 Data Analysis

From the results of data collection, the data obtained will be analyzed using the capital budgeting method. Each alternative to meeting FSO needs will be compiled cashflowand calculated financial feasibility. From the results of the analysis, NPV and IRR values will be obtained. In addition, NPV Contractor & Goverment will also be analyzed in the PSC Cost Recovery scheme to find out the NPV of both parties. These values are used as considerations to determine financial viability. After that, the results of the financial feasibility analysis of each alternative operating scheme will be compared to obtain which operating scheme is the best financial feasibility.

In addition, this study will also conduct a sensitivity analysis on the right alternative to find out what variables must be monitored and controlled, because it has the most effect on the finances of the work, and what is the limit on its value so that the FSO's operational finances still remain positive.

4. RESULTS

4.1 Data and Assumptions

To support the work on this final project, certain data and assumptions are needed. The data and assumptions used include the following:

- production profile using PT ABC production forecast data
- oil price is USD 65 / Bbls
- oil production operational cost is USD 9.41/Bbls with an escalation of 2% annually
- docking cost FSO YYY is USD 50.815.969
- the O&M FSO YYY charge when operation is USD 2,578,360/year
- YYY FSO fuel cost is USD 2,336,821/year
- insurance (P&I) FSO YYY is USD 473,079.8/year
- the temporary FSO charter price for 10 years is USD 17,000/day
- the temporary FSO charter price for only 2 years is USD 22,000/day
- the temporary charter FSO fuel is 2,454,171.17/year
- the cost of FSO YYY temporary anchore with Remaining on Board (ROB) is USD 906,325.83
- the cost of FSO YYY temporary anchore without Remaining on Board (ROB) cost was USD 382,728.57
- the cost of the YYY FSO cleaning tank is USD 5,271,920
- the fuel cost for YYY's FSO is USD 258,814.28
- Project lifetime is 10 years adjusted to the validity period of the FSO Classification.
- The financial calculations carried out in this study use the assumption that there is no change in the dailyrate of the FSO lease during the lifetime of the Project.

In the operational scheme using FSO YYY, when FSO YYY is in drydock, a lease FSO is needed as a temporary replacement until the FSO YYY is completed dry dock and ready to operate. In the operational scheme using a leased FSO, the YYY FSO is not drydocked, then the YYY FSO will remain anchored in the jetty temporarily and requires a anchore and fuel fee for the

operation of the O&M FSO YYY when it is docked. To reduce the cost, the YYY FSO tank must cleaned, so that the cargo tank is clean and does not risk oil spillage in the waters, so that the Insurance (P&I) of the FSO YYY can be deactivated. In addition, it also reduce the need for fuel because some system on the FSO can be turned off because there is no ROB in the cargo tank after tank cleaning, for example lighting and IGS.

4.2 Financial Analysis and Comparison

Each FSO needs fulfillment operation scheme option at XXX Marine Terminal is analyzed to find out whether the business being made will benefit or not, and to find out which FSO needs fulfillment operation scheme option is better financially.

4.2.1 Financial Analysis opsi operating scheme using FSO YYY

The cash flow constituent cost component of the operating scheme option using the YYY FSO consists of:

- oil production
- oil production operational cost
- Drydock FSO YYY
- FSO YYY O&M
- FSO YYY fuel
- FSO YYY insurance (P&I)
- charter temporary FSO until drydock FSO YYY process is completed
- charter temporary FSO fuel

Project financial calculations in table 4. 1 is carried out using the capital budgeting method by calculating the NPV and IRR parameters.

Table 4. 1 Option Project Financial Analysis Using YYY FSO

No	Description :		Year										
			2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
1			0	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
2	Interest Rate (%)	11,33%											
3	Oil Price / Bbls	USD 65	65	65	65	65	65	65	65	65	65	65	65
4	Production	(MBbl/Year)	2	2	2	2	2	1	1	1	1	1	0
5	Oil Operational Cost	(USD)	- 24.511.346	- 23.670.483	- 23.134.351	- 21.206.166	- 18.493.620	- 16.472.260	- 15.089.296	- 12.418.776	- 9.006.612	- 6.495.792	- 4.699.630
6	Drydock Cost of FSO YYY	USD 50.815.969	- 25.407.985	- 25.407.985									
7	O&M FSO YYY	USD 2.578.360			- 2.578.360	- 2.578.360	- 2.578.360	- 2.578.360	- 2.578.360	- 2.578.360	- 2.578.360	- 2.578.360	- 2.578.360
8	FSO YYY Fuel	USD 2.336.821			- 2.336.821	- 2.336.821	- 2.336.821	- 2.336.821	- 2.336.821	- 2.336.821	- 2.336.821	- 2.336.821	- 2.336.821
9	Insurance (P&I) FSO YYY	USD 473.080			- 473.080	- 473.080	- 473.080	- 473.080	- 473.080	- 473.080	- 473.080	- 473.080	- 473.080
10	Charter Temporary FSO	USD 22.000/day	- 8.052.000	- 8.030.000									
11	Charter Temporary FSO Fuel	USD 6.705,39/day	- 2.454.171	- 2.447.467									
12	Revenue	in million USD	156,419	148,091	141,899	127,522	109,030	95,208	85,505	68,992	49,055	34,686	24,603
13	Expenditure	in million USD	- 60,426	- 59,556	- 28,523	- 26,594	- 23,882	- 21,861	- 20,478	- 17,807	- 14,395	- 11,884	- 10,088
14	Net Cash Flow	in million USD	95,994	88,536	113,377	100,927	85,148	73,348	65,027	51,185	34,660	22,802	14,515
15	Discount Factor (i)	P/F	1,000	0,898	0,807	0,725	0,651	0,585	0,525	0,472	0,424	0,381	0,342
16	DCF (PV)	in million USD	95,994	79,525	91,474	73,143	55,427	42,887	34,153	24,147	14,687	8,679	4,962
17	NPV (in million USD)	525,078											
18	IRR =	#DIV/0!	IL =		NPVL =								
			IU =		NPVU =								

From the results of the project financial calculations on the Operating Scheme Option Using FSO YYY, the NPV Project was obtained at USD 525.078 million. The IRR value is not calculated because the cash flow is all positive, the value of the year from zero to the 10th year.

4.2.2 Financial Analysis opsi operating scheme using Lease FSO

The cash flow constituent cost component of the operating scheme option using the Lease FSO consists of:

- oil production
- oil production operational cost

- charter FSO
- charter FSO fuel
- FSO YYY temporary anchore fee
- FSO YYY tank cleaning
- FSO YYY fuel
- FSO YYY insurance (P&I)

Project financial calculations in table 4. 2 is carried out using the capital budgeting method by calculating the NPV and IRR parameters.

Table 4. 2 Project Financial Analysis Options Using Lease FSO

No	Description :		Year										
			2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
1			0	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
2	Interest Rate (%)	11,33%											
3	Oil Price / Bbls	USD 65	65	65	65	65	65	65	65	65	65	65	65
4	Production	(MBbl/Year)	2	2	2	2	2	1	1	1	1	1	0
5	Oil Operational Cost	(USD)	- 24.511.346	- 23.670.483	- 23.134.351	- 21.206.166	- 18.493.620	- 16.472.260	- 15.089.296	- 12.418.776	- 9.006.612	- 6.495.792	- 4.699.630
6	Charter FSO	USD 17.000/day	- 6.222.000	- 6.205.000	- 6.205.000	- 6.205.000	- 6.222.000	- 6.205.000	- 6.205.000	- 6.205.000	- 6.222.000	- 6.205.000	- 6.205.000
7	Charter FSO Fuel	USD 6.705,39/day	- 2.454.171	- 2.447.466	- 2.447.466	- 2.447.466	- 2.454.171	- 2.447.466	- 2.447.466	- 2.447.466	- 2.454.171	- 2.447.466	- 2.447.466
8	FSO YYY temporary Anchor	USD 906.326	906.326	- 382.729	- 382.729	- 382.729	- 382.729	- 382.729	- 382.729	- 382.729	- 382.729	- 382.729	- 382.729
9	Tank Cleaning FSO YYY	USD 5.271.920	- 5.271.920										
10	FSO YYY temporary Anchor Fuel	USD 707	- 258.814										
11	Insurance (P&I) FSO YYY	USD 380.468	- 380.468										
12	Revenue	in million USD	156,419	148,091	141,899	127,522	109,030	95,208	85,505	68,992	49,055	34,686	24,603
13	Expenditure	in million USD	- 40,005	- 32,706	- 32,170	- 30,241	- 27,553	- 25,507	- 24,124	- 21,454	- 18,066	- 15,531	- 13,735
14	Net Cash Flow	in million USD	116,414	115,386	109,730	97,281	81,477	69,701	61,380	47,538	30,989	19,155	10,868
15	Discount Factor (i)	P/F	1,000	0,898	0,807	0,725	0,651	0,585	0,525	0,472	0,424	0,381	0,342
16	DCF (PV)	in million USD	116,414	103,643	88,532	70,500	53,038	40,755	32,237	22,426	13,132	7,291	3,716
17	NPV (in million USD)	551,683											
18	IRR =	#DIV/0!	IL =		NPVL =								
			IU =		NPVU =								

From the results of project financial calculations on the Operation Scheme Option Using FSO YYY, the NPV Project was obtained at USD 551.683 million. The IRR value is not calculated because the cash flow is all positive, the value of the year from zero to the 10th year.

4.2.3 Comparison of Financial Study Results

Comparison of the results of financial analysis, presented in table 4. 3 as follows:

Table 4. 3 Comparison Table of Project Financial Analysis Results

No.	Parameter	Operation schema options using FSO YYY	Operation schema options using Lease FSO
1	NPV	USD 525.078.287,5	USD 551.683.123,04
2	IRR	The IRR value is not calculated because the cash flow is all positive, the value of the year from zero to the 10th year	

a comparison of the NPV values of the two options shows that the Operating Schema Option Using the YYY FSO has a greater NPV value than the Operating Schema Option Using the Lease FSO. This suggests that the Operating Scheme Option Using a Lease FSO will have more benefit for the compan, and from the financial criteria should be the preferred option.

4.2.4 Sensitivity analysis

Sensitivity analysis was carried out on the selected option, namely the option of meeting FSO needs with Rental FSO, to see the effect of NPV on the probability of change in costs that are dominant in cashflow, namely crude oil prices, FSO rental costs, and fuel costs for Rental FSOs. Analisis sensitivity to NPV is presented in figure 4.1.

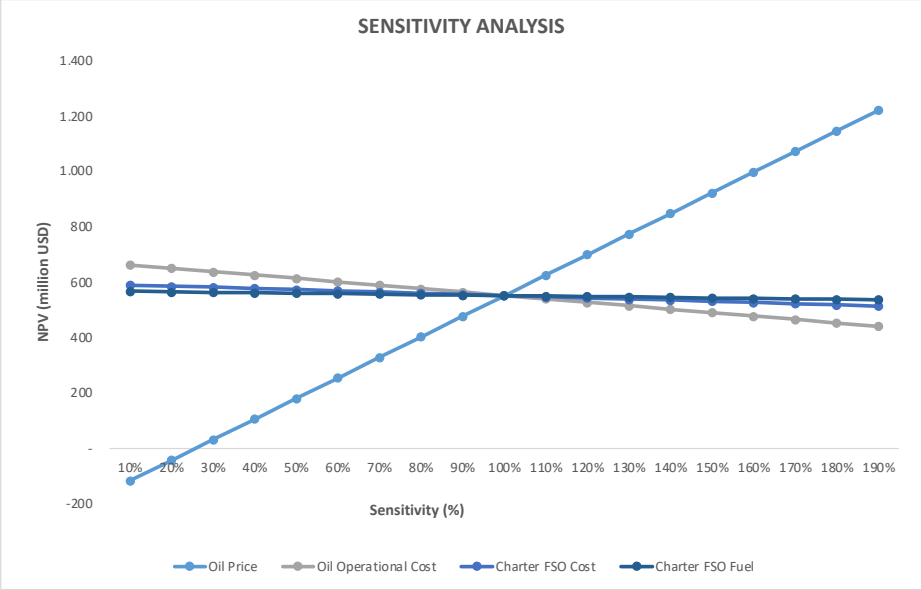

Figure 4. 1. Sensitivity Analysis to NPV KKKS

Based on the sensitivity analysis to NPV in figure 4.1, it is illustrated that changes in the oil price variable have the greatest influence on changes in NPV values. And if the oil price falls below 26% of its current price, it will cause the NPV to become negative. In addition, an increase in FSO charter costs above 162% of the current offering value, will result in meeting the operational needs of the FSO using the FSO Lease scenario becoming unattractive, as its NPV will be lower than the NPV option of the FSO Asset usage scheme.

6. CONCLUSIONS

Based on the results of data analysis and discussions that have been carried out and based on the objectives of this study, the following conclusions can be drawn:

1. the result of the project financial calculation in the Operation Scheme Option Using FSO YYY obtained the NPV Project of USD 525,078,287.5. Meanwhile, the results of the project financial calculation in the Operating Scheme Option Using the Lease FSO obtained the NPV Project of USD 551,683,123.04. The IRR value is not calculated because the cash flow is all positive, the value of the year from zero to the 10th year.
2. a positive NPV value on both options from the results of financial calculations indicates that both options are economical to run
3. a comparison of the NPV values of the two options shows that the Operating Schema Option Using the YYY FSO has a greater NPV value than the Operating Schema Option Using the Lease FSO. This suggests that the Operating Scheme Option Using a Lease FSO will benefit the company more, and from the financial criteria should be the preferred option.
4. the results of the sensitivity analysis to NPV, it was found that changes in the oil price variable had the greatest influence on changes in NPV values. If oil price falls below 26% of its current price, it will cause the NPV to become negative. In addition, an increase in FSO charter costs above 162% of the current offering value, will result in meeting the operational needs of the FSO using the FSO Lease scenario becoming unattractive, as its NPV will be lower than the NPV option of the FSO Asset usage scheme.
5. the most appropriate alternative operating scheme for meeting FSO needs is alternative 2 (operation scheme option using Lease FSO)

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PROFITABILITY IMPROVEMENT STRATEGY IN A STATE OWNED CONSTRUCTION COMPANY (CASE STUDY: PT. ADHI KARYA (PERSERO), TBK. DEPARTMENT OF BUILDING)

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ABSTRACT

PT. Adhi Karya (Persero), Tbk Building Department (ADHI Building) is a state owned enterprise that in the last 5 years (2017-2021) recorded unstable profitability performance. Obtaining a new contract is one of the main things in forming this performance. In addition, the condition of PT. Adhi Karya (Persero), Tbk, which is still not the best state-owned construction company in obtaining new contracts and net profit, also requires determining the right strategy, one of which is through increasing the profitability performance of ADHI Gedung. This research is a qualitative descriptive study using primary data in the form of questionnaires and interviews, as well as secondary data from company documents and existing literature. Internal environmental evaluation using IFE and external using EFE. Formulation of alternative strategies using the SWOT matrix (Strengths, Weaknesses, Opportunities, Threats), and priority strategies using the QSPM (Quantitative Strategy Planning Matrix) method. The top 5 strategic alternatives that have been implemented in 5 years are obtained, namely optimizing project acquisition in IKN development, following and conducting socialization of the latest regulations, maximizing the application of BIM and internal company software, conducting JOs with other planners and/or contractors, and implementing umbrella contracts on main materials.

Keywords: profitability performance improvement strategy, SWOT, construction company

1. INTRODUCTION

PT. Adhi Karya (Persero), Tbk. The Building Department (hereinafter referred to as ADHI Building) is one of the BUMNs with large qualifications that is in the infrastructure services cluster, especially in building construction work. In the last 5 years (2017-2021), ADHI Building recorded unstable profitability performance. Obtaining a new contract is the main thing that influences this performance. For this reason, the right strategy is needed to improve the profitability performance of ADHI Building, bearing in mind that during this period as a corporation, PT. Adhi Karya (Persero), Tbk. has not been the best BUMN in obtaining new contracts and annual net profit when compared to other BUMN contractors.

2. LITERATURE REVIEW

According to Government Regulation of the Republic of Indonesia Number 14 of 2021 concerning Amendments to Government Regulation Number 22 of 2020 concerning Regulations for Implementing Law Number 2 of 2017 concerning Construction Services, it is explained that

construction services are construction consulting services and/or construction work. The regulation also explains that construction work is the whole or part of an activity that includes the construction, operation, maintenance, demolition and rebuilding of a building.

According to David (2002), the financial condition and performance of a company can be seen from the financial ratios as follows:

a. Liquidity ratio
   The liquidity ratio describes a company's ability to pay short-term debt, which among other things can be measured by the cash ratio, current ratio and quick ratio.
b. Solvability ratio
   The solvability ratio describes the company's ability to pay its obligations which can be measured, among others, through the interest-bearing debt to equity ratio (Debt to Equity Ratio-DER) which serves to measure the balance of debt owned by the company with its own capital.
c. Profitability ratio
   The profitability ratio is a comparison consisting of net income divided by sales, income before tax divided by sales, net income divided by total assets, and net income divided by total shareholder funds.
d. Growth ratio
   The growth ratio has several ratios, namely the growth rate indicated by sales and the growth rate indicated by profit.

The influence of internal factors on the success of a company, especially construction service companies, is dominated by management, organization, human resources, finance, corporate culture (Teng M., 2002). Still according to Teng M., (2002), external factors are in the form of macroeconomics, laws and regulations, technology and innovation, social politics, and a competitive environment.

Strategy is a large-scale and future-oriented plan, to interact with competitive conditions in achieving company goals (Pearce II, 2009). The several elements in the process of formulating a strategy (David, 2011) include environmental observation, strategy formulation, strategy implementation, and evaluation and control.

ADHI as a construction company that spans various business lines such as construction, investment, property, industry, and energy, has several networks or departments, one of which is the Building Department which is engaged in building construction.

3. METHODS

The research was conducted in June - October 2022 in the office where the interviewees worked. This research is a quantitative descriptive study with data and information collection techniques used in this study including interviews, questionnaires, and literature studies. This study uses a sampling technique based on non-probability sampling with a purposive sampling technique in the hope that the selected respondents have knowledge and understanding of the building construction business (Table 1). The stages in the processing and analysis of the data obtained can be seen in Table 2.

Table 1. Research Respondent Sample

No	Respondent	Position
A	Internal	
1	Yan Arianto	General Manager of ADHI Building
2	Endang Rukmana	Marketing bureau manager

3	M. Nofrial	Finance, human resources, and general bureau managers
4	Bagus Prima Anugrah	Engineering and BIM bureau managers
5	Ahmad Bashori	Legal and risk bureau managers
6	Purwadi Hendro	Procurementand equipment bureau managers
7	Sigit Santoso	QHSE bureau managers
8	Handi Darmawan	Estimating bureau managers
9	Satya Erlangga	Experties of estimating bureau
B	Eksternal	
1	Punto Kusumapatra	Head of Building Division PT. Virama Karya (Persero)
2	Tri Wahyuedi	Head of Business Development Division PT. Yodya Karya (Persero)
3	Juanda Sirait	Airport Facilities Senior Manager PT. Angkasa Pura I (Persero)

Table 2. Data Processing and Analysis Techniques

Step	Purpose	Analysis Tools	Output
1	ADHI Building performance evaluation	Gather facts by interviewing and studying literature	Factors affecting profitability
2	Internal analysis External analysis	Functional aspects of the company PESTEL Analysis	Company strengths and weaknesses Company opportunities and threats
3	Internal and external evaluation	EFE and IFE Matrix	The company's current position in the IE matrix quadrant
4	Formulation of company performance improvement strategy	SWOT Matrix	The resulting strategies for improving company performance

In conducting an internal analysis of the company, the aspects used are the functional aspects of the company which consist of management, marketing, human resource, finance, engineering and BIM, QHSE, estimating, supply chain management and equipment, legal and risk. To analyze and identify external environmental factors, PESTEL analysis is used, which stands for P (Politics), E (Economics), S (Social), T (Technology), E (Environmental/Environmental), and L (Legal). The IFE Matrix is a tool used to evaluate a company's internal environment and to reveal its strengths and weaknesses. Meanwhile, the EFE matrix is useful in summarizing and evaluating economic, socio-cultural, environmental, political, governmental, legal, technological and competitive information in strategy formulation.

The IE matrix is used to summarize the evaluation results of internal and external factors by placing the company in one of the nine cells, where each cell is a step condition that must be taken by the company.

SWOT analysis is an analysis to determine the company's internal factors, namely strengths and weaknesses, and external factors, namely opportunities and threats. SWOT analysis is used to maximize strengths and opportunities, minimize external threats, turn weaknesses into strengths and take advantage of shared opportunities while minimizing internal weaknesses and external threats.

QSPM (Quantitative Strategic Planning Matrix) aims to determine the order or priority of alternative strategies by evaluating the attractiveness of alternative strategies based on the matrix in the evaluation phase and IFE and EFE factors.

4. RESULTS

4.1 ADHI Building Performance Evaluation for the 2017-2021 period

ADHI Gedung's profitability performance in 2017-2021 can be seen in the Table 3.

Table 3. ADHI Building Profitability Performance in 2017-2021

No	Description	Period				
		2017	2018	2019	2020	2021
A	Liquidity Ratio					
1	Cash ratio	0,70%	0,23%	0,35%	0,17%	0,07%
2	Current ratio	108,09%	110,41%	106,48%	103,61%	102,97%
3	Quick ratio	104,86%	104,53%	102,82%	101,09%	101,38%
B	Solvability Ratio					
1	Debt to Equity Ratio (DER)	12,34	9,61	15,42	27,30	33,32
C	Profitability Ratio					
1	Gross profit margin	7,22%	10,75%	10,58%	8,56%	9,89%
2	Net profit margin	7,28%	9,68%	6,12%	4,31%	4,43%
3	Return on assets ratio	7,49%	9,43%	6,09%	3,53%	2,91%
4	Return on equity ratio	100,00%	100,00%	100,00%	100,00%	100,00%
D	Growth Ratio					
1	Sales growth	21,94%	-30,33%	30,58%	29,78%	-8,32%
2	Net profit growth	1,20%	-7,39%	-17,45%	-8,57%	-5,86%

Based on the above conditions, it can be concluded that one of the things that affect the above performance is the acquisition of new contracts. With the business cluster as a contractor, obtaining project contracts is the main priority because it will shape further aspects such as liquidity, solvency, profitability and growth. As for the current conditions (31 December 2022), the acquisition of ADHI Building contracts is still below the 2022 Company Work and Budgeting Plan. Even if you look at the Annual Reports from other BUMN contractors (PT. Hutama Karya (Persero), PT. Pembangunan Perumahan (Persero), Tbk., PT Wijaya Karya (Persero), Tbk., and PT Waskita Karya (Persero), Tbk.) in the last 5 years (2017-2021), as a corporation, PT. Adhi Karya (Persero), Tbk. has never been the best in obtaining new contracts and annual net profit as shown in Figures 1 and 2.

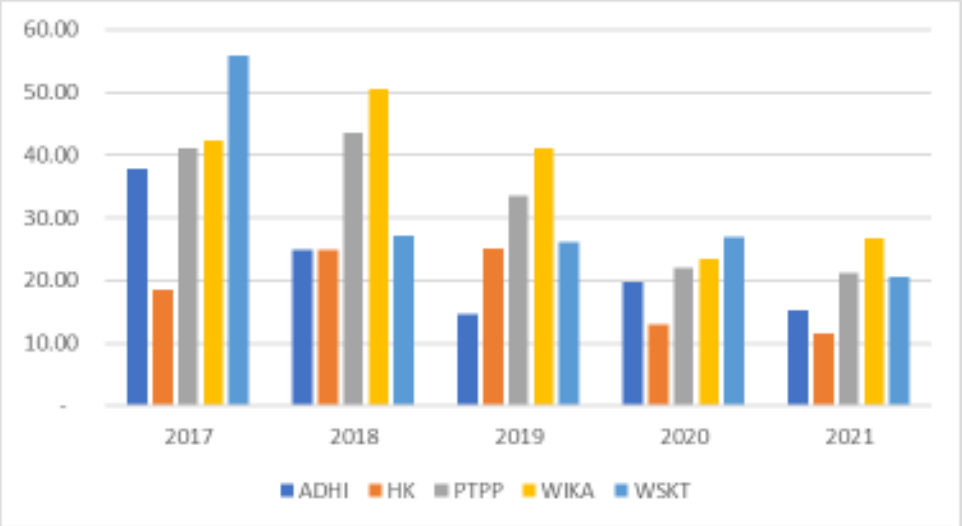

Figure 1. Acquisition of New Corporate Contracts for 2017-2021

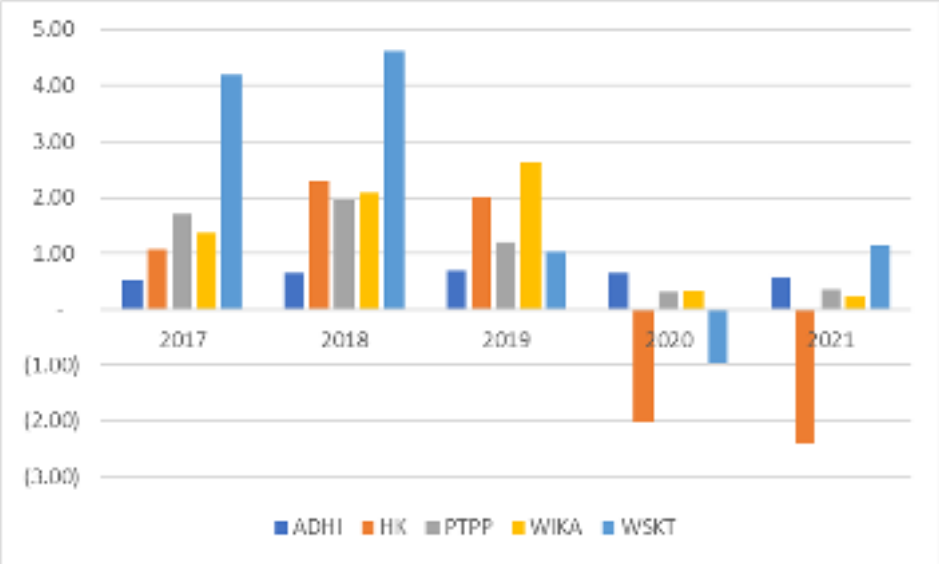

Figure 2. Acquisition of Corporate Net Profit for 2017-2021

4.2 Internal environment analysis

Identification of internal strategic factors is done by direct interviews with internal company respondents in terms of management, marketing, finance, human resource, and general aspect, engineering and BIM, legal and risk, SCM and equipment, QHSE, and estimating aspect.

After recapitulating the strengths and weaknesses, the factors were sorted through a questionnaire regarding the level of significance which was distributed to ADHI Building managers as respondents. The results of the questionnaire were then recapitulated and the average weight on each factor was calculated so as to get 5 factors with the highest average weight on strengths and weaknesses, then do the calculation of the score obtained from the multiplication of the weight with the rating which can be seen in Table 4.

Table 4. ADHI Building's Strengths and Weaknesses

No	Internal Strategic Factors	Weight	Ranking	Score
A	Strength			
1	Have a militant spirit in seeking and winning tenders	0,103	4	0,41
2	The dominant sources of project funds are state budget (APBN), regional budget (APBD), and state owned enterprise budget (BUMN)	0,103	4	0,41
3	Use of BIM in tenders and project implementation	0,104	3	0,31
4	Commitment in implementing QHSE	0,104	4	0,42
5	Breakthrough towards lean construction and digital construction	0,100	4	0,40
	Total	0,515		1,96
B	Weakness			
1	Limited time in detailing tender documents	0,104	2	0,21
2	Gaps in terms of human resource capabilities	0,095	2	0,19
3	Understanding of applicable regulations	0,095	2	0,19
4	Incorrect determination of JO (Joint Operation) partners	0,095	2	0,19
5	Limited ownership of heavy equipment	0,096	2	0,19
	Total	0,485		0,97
	Total of strengths and weaknesses	1,000		2,93

Based on table 4, it can be seen that ADHI Building's main strength is having a commitment to implementing QHSE which was given a weight of 0.104 by respondents with a score of 0.42. As for weaknesses, time constraints in detailing selected tender documents are the main weaknesses with a weight of 0.104 and a score of 0.21.

With a total IFE matrix score of 2.93, then ADHI's IFE Building is in average condition, where the average value limit is 2.0 to 2.99. The value of 2.93 also indicates a strong internal company position.

4.3 External environment analysis

This study uses PESTEL analysis in analyzing the company's external environment to identify strategic factors in the form of company opportunities and threats.

The results of the questionnaire were then recapitulated and the average weight on each factor was calculated so as to get 5 factors with the highest average weight on opportunities and threats, then do the calculation of the score obtained from the multiplication of the weight with the rating which can be seen in Table 5.

Table 5. ADHI Building's Opportunities and Threats

No	External Strategic Factors	Weight	Ranking	Score
A	Opportunities			
1	Opportunities in IKN (National Capital City) development projects	0,108	4	0,43
2	Ownership and ability of contractors to use BIM	0,104	4	0,41
3	The concept of smart building in building construction	0,099	3	0,30
4	HPS (Owner Estimated Price) adjustments to the mandatory use of new technology and concepts in a project	0,099	3	0,30
5	The use of software in the company's internal operations	0,095	4	0,38
	Total	0,505		1,82
B	Threats			
1	Political tenure affects development plans	0,104	2	0,21
2	Increase in fuel prices	0,104	3	0,31
3	Tender regulations with the lowest price system	0,103	3	0,31
4	Obligation to complete the work according to the contract	0,099	4	0,39
5	Language and cultural barriers in working with foreign companies	0,086	3	0,26
	Total	0,495		1,48
	Total of opportunities and threats	1,000		3,30

In table 5, the best opportunity that must be optimized is the opportunity in the IKN (National Capital City) development project with the highest weight from 0.108 respondents and has been responded very well by companies with a score of 0.43. While the biggest threat that must be watched out for is the increase in fuel prices chosen by respondents with a weight of 0.104 and a score of 0.31.

With a total EFE matrix value of 3.30, then in terms of EFE ADHI building is in a high condition, where the high score limit is 3.0-4.0. This value also indicates that the company responds well to the opportunities and threats that exist in its industry.

4.4 Grand Strategy (Internal-External Matrix Analysis)

With an IFE value of 2.93 and an EFE of 3.30, the company's position is in cell II which shows ADHI Gedung as a grow and build company. Intensive strategies such as market

penetration, market development, product development, or integration strategies are appropriate strategies for companies in this cell.

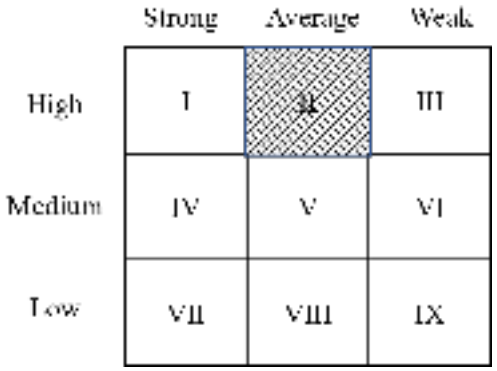

Figure 3. Position of ADHI Building

4.5 Alternative Strategy Formulation (SWOT Analysis)

Based on existing internal and external strategic factors and referring to the development of strategies produced by the IE matrix, a SWOT analysis is carried out which is useful in determining alternative strategies that can be developed.

Table 6. ADHI Building SWOT Analysis

Internal Factor / **External Factors**	**Strength (S)** 1. Have a militant spirit in seeking and winning tenders 2. The dominant sources of project funds are state budget (APBN), regional budget (APBD), and state owned enterprise budget (BUMN) 3. Use of BIM in tenders and project implementation 4. Commitment in implementing QHSE 5. Breakthrough towards lean construction and digital construction	**Weakness (W)** 1. Limited time in detailing tender documents 2. Gaps in terms of human resource capabilities 3. Understanding of applicable regulations 4. Incorrect determination of JO (Joint Operation) partners 5. Limited ownership of heavy equipment
Opportunities (O) 1. Opportunities in IKN (National Capital City) development projects 2. Ownership and ability of contractors to use BIM 3. The concept of smart building in building construction 4. HPS (Owner Estimated Price) adjustments to the mandatory use of new technology and concepts in a project	**SO Strategy** 1. Optimizing project acquisition in IKN development (S1, S2, S4, S5, O1, O3) 2. Maximize the application of BIM and company internal software (S1, S3, O2, O5)	**WO Strategy** 1. Conduct JO with other planners and/or contractors (W1, W2, W4, W5, O1, O3, O4)

5. The use of software in the company's internal operations		
Threats (T) 1. Political tenure affects development plans 2. Increase in fuel prices 3. Tender regulations with the lowest price system 4. Obligation to complete the work according to the contract 5. Language and cultural barriers in working with foreign companies	**ST Strategy** 1. Implementing umbrella contracts on key materials (S1, S2, T1, T2, T3, T4)	**WT Strategy** 1. Participate in and socialize the latest regulations (W3, W4, T1, T3, T4, T5)

4.6 Priority Strategy QSPM

The strategy in the SWOT matrix is given weight and rating again so as to produce the highest score which will be the strategy carried out by the company. The results can be seen in Table 7.

Table 7. ADHI Building Strategy Rating Value

No	Alternative Strategy	TAS (Total Attractive Score)	Strategy Rating
1	Optimizing project acquisition in IKN development	7,53	I
2	Maximize the application of BIM and internal company software	6,73	III
3	Conduct JO with other planners and/or contractors	6,28	IV
4	Implementing umbrella contracts on key materials	6,10	V
5	Participate in and socialize the latest regulations	6,90	II

Based on Table 7, it can be seen that the highest ranking strategy is optimizing project acquisition in IKN development. This strategy is expected to increase the profitability of ADHI Gedung.

4.7 Strategy Implementation

After obtaining 5 (five) strategies from the QSPM results, the company will implement them in the next 5 (five) year activity plan.

Table 8. ADHI Building Strategy Implementation 2023-2027

No	Activity Plan	PIC	Year				
			2023	2024	2025	2026	2027
1	Optimizing project acquisition in IKN development						
	- Create 1 (one) tender team and a special marketing team for IKN tenders	GM, Marketing Mgr, Estimating Mgr					
	- Requiring each project to request work and personnel references from the project owner	GM, HR Mgr, Marketing Mgr, PM					
	- Increase the number of staff participation in the skills certification	GM, HR Mgr					

	process - Socializing Mobox to project owners and consultants	GM, Eng & BIM Mgr, PM					
2	Maximize the application of BIM and internal company software - Registering the company at several construction service regulatory associations - Reactivate ALC (Adhi Learning Center) by inviting speakers from outside	GM, HR Mgr, Legal Mgr GM, HR Mgr					
3	Conduct JO with other planners and/or contractors - Requiring the submission of progress reports using BIM - Acceleration towards BIM 9D and 10D - Speed up internal software development	GM, Eng&BIM Mgr GM, Eng&BIM Mgr GM, Eng&BIM Mgr					
4	Implementing umbrella contracts on key materials - Sharpen the RACI evaluation in determining the JO both with planners and contractors	GM, Marketing Mgr, Legal Mgr					
5	Participate in and socialize the latest regulations - Umbrella contracts on concrete iron and steel profiles	GM, SCM Mgr					

6. CONCLUSIONS

Based on the results of the study it can be concluded that the top 5 alternative strategies were implemented in 5 years: optimizing project acquisition in IKN development, participate in and socialize the latest regulations, maximize the application of BIM and internal company software, Conduct JO with planners and/or other contractors, and implementing umbrella contracts on key materials.

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VOCATIONAL HIGH SCHOOL STUDENT COMPETENCY DEVELOPMENT INNOVATION THROUGH DESIGN THINKING APPROACH

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ABSTRACT

Several vocational high schools (SMK) in Indonesia need to meet the labor market demands due to a lack of competency in their graduates. The SMK experiences this lack of graduate competence mainly because of the low-quality student input dominated by families from middle- to lower-class backgrounds. Indonesia's government is making sure that SMK students are more skilled by putting in place a curriculum based on constantly updated skills to keep up with changes in education and industry. This study uses a design thinking approach to identify teachers' and students' difficulties in the learning process and increase student competence. This research recommended that individual or personal learning should play a more significant role in the learning process. Students should be able to determine specific development programs and learning objectives according to their expectations. In addition, the direct application of learning in school business units that involve students directly can increase student interest and enthusiasm to participate in the learning process.

Keywords: Vocational High School, Innovation, Competency, Motivation, Design Thinking

1. INTRODUCTION

Education is one of the essential components in determining the quality of human resources and the nation's progress. The educational process can create creative and innovative ideas in the time's dynamics (Rahayu dkk, 2022). According to Indonesian Law No. 20 of 2003, education is a planned effort to create a learning process to make students actively develop their potential and have spiritual strength, self-control, personality, intelligence, noble character, and skills. Nurkholis concluded that education is an effort to guide children from birth to reach physical and spiritual maturity in interacting with nature and its environment. Implementation of education is inseparable from the role of educational institutions in achieving planned targets. Soenarto et al. (2017) suggested that educational institutions are places to print human resources with managerial competence and unique expertise. Hence, educational institutions must maintain quality improvement to produce graduates who meet the needs of society.

Rifma et al. (2018) suggest that Vocational High Schools (SMK), as one of the institutions providing vocational education, have an essential role in preparing generations that can compete in various economic and industrial sectors. In particular, vocational education is expected to be a driving force for strengthening the local or national economy. Vocational education institutions

are expected to produce a workforce that is reliable and competent according to their fields, able to adapt to the work environment and job demands, and has high competitiveness to compete with other workers. With these increased demands on fieldwork, it is no longer possible for several SMKs have failed to meet the workforce's needs following expectations. SMK ABC is a private vocational school located in Madiun Regency, East Java Province, about 200 km from Surabaya has an environment that is generally in the lower middle-class economy community population. The Central Bureau of Statistics stated that of the 744 thousand people in this district had agricultural and plantation livelihoods with a poverty line value of Rp. 380,287/capita/month, below the average value of the East Java Province poverty line recorded in Rp. 445.139,-/capita/month (Office of Communication and Information for East Java Province). This fact shows the condition of the community environment in Madiun Regency, which is quite behind from an economic standpoint.

The government has made efforts to enhance the quality and quality of SMK education by developing a competency-based curriculum, which was implemented early in 2004. Therefore, the competency-based curriculum continues to be evaluated, improved, and perfected so that the latest curriculum refinement, namely the Merdeka Curriculum, was implemented in early 2022 to meet the community's needs.

Research related to increasing student competence has been carried out, including by Amalia & Suwatno (2016), that Competency Based Training is reasonably practical and has a significant favorable influence on the mastery of student competencies. In addition, Zakir (2012) states that the critical thing to note in the learning process to improve student competence is individual differences related to the level of student development and the level of student self-esteem, student learning readiness, and finally, student motivation. In addition to these matters, the role of the curriculum is inseparable from student competence in the learning process.

2. LITERATURE REVIEW

The educational institution that is the object of research is SMK ABC, which is one of the educational institutions located in Madiun Regency, which is geographically located approximately 100 km in the southern part of the capital city of East Java Province, Surabaya. More than 744 thousand souls inhabit the regency, which has an area of 1010.82 km2. The SMK ABC has held a 3-year vocational education program for over 37 years with accreditation level B. SMK ABC can significantly contribute to supporting government programs in creating superior young people. SMK ABC provides educational facilities and infrastructure in classrooms, multimedia rooms, mechanical workshops, computer laboratories, and libraries to keep the learning process. Apart from that, to ensure that the curriculum runs smoothly, educational institutions are also supported by experienced teaching staff from various disciplines. Many of the existing facilities and infrastructure need to be repaired or updated to keep up with technological advancements and the shift in the world of education toward digitalization to provide comfort and smooth learning processes and, ultimately, increase schools' competitiveness with other educational institutions.

SMK ABC also provides several expertise programs that are in demand by the business world and industry: Computer Network Engineering (TKJ), Light Vehicles and Automotive Engineering (TKR), and Institutional Accounting & Finance (AK). Mainly The students have family backgrounds that are lower middle class with lower parental income. Considering this low financial ability is also a consideration of innovation that educational institutions will take a more active role in increasing student competency.

Educational curriculum development

Through the ministry of education and culture, the government refocused its attention on competency-based learning in 2013, resulting developing of a competency-based curriculum that emphasized the attainment of specific student competencies. Implementing the Merdeka Curriculum, which will begin in February 2022, will continue refining the learning process that emphasizes competence. The implementation of this curriculum is timed to anticipate the worsening learning crisis during the COVID-19 health pandemic in early 2018; consequently, it is necessary to restore the education system in terms of curriculum and efforts to strengthen the capacity of teachers and school principals. Following the National Education System Law, the Merdeka Curriculum replaces the National Standardized School Examination (USBN) with a competency assessment, thus restoring schools' freedom to determine graduation. The evaluation of student competency consists of a written exam and other more comprehensive forms of evaluation. The Merdeka Curriculum also implements a minimum competency assessment and a character survey to replace the National Examination (UN). This implementation is intended to reduce pressure on teachers, students, and parents, as well as the perception that the National Examination is a suboptimal instrument for enhancing the quality of national education (Vhalery R et al., 2022).

Competency-Based Education

Competency-based education (CBE) is a teaching, learning, and assessment strategy that focuses on demonstrating student learning outcomes and attaining proficiency in specific competencies for each subject. CBE is an innovative approach to higher education that organizes academic content or delivery based on students' prior skills and knowledge (U.S. Department of Education, 2014). CBE emphasizes a person's ability to perform well at work to meet the requirements of specific industries or professions (Alainati S.J, 2021). Csajbok I, 2022 states that CBE is a student-friendly educational and individual learning method which makes it more flexible. Students can advance based on their acquired knowledge and abilities.

Design Thinking

Design thinking (DT) is a collaborative and inventive method of resolving complex problems. DT can be applied when problems or opportunities cannot yet be defined, but an innovative idea or concept with a positive and significant impact is required. According to Lewrick M. (2015), the Hasso Plattner Institute (HPI) divides design thinking into six steps: understand, observe, define a point of view, ideate, prototype, and test. The IDEO Design and Innovation agency determines five simple steps in the microcycle to generate new ideas through iteration, which focuses on the implementation process since the best ideas are ultimately useless if they are not implemented.

Figure.1 The IDEO design thinking model (Lewrick M et al., 2015)

The design thinking process consists of five stages: empathy, problem identification, ideation as a solution step, prototype creation, and prototype testing.

3. METHODS

The research that will be conducted will employ the design-thinking methodology to investigate problems and propose various potential solutions. The stages of the research are broadly classified as empathy, define, ideation, prototype, and testing, as depicted in the following flowchart.

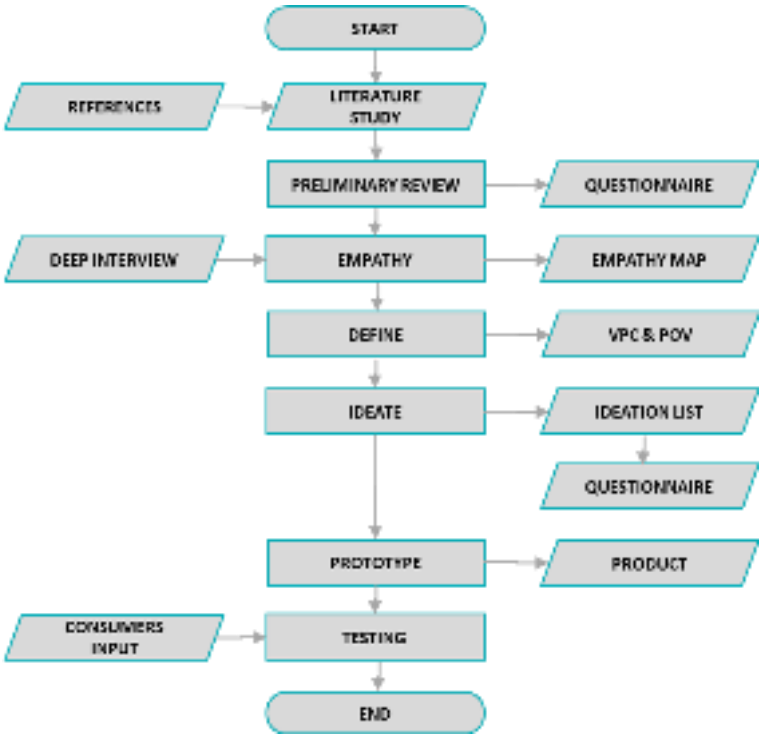


Figure 2 research Flowchart

Preliminary Assessment

An overview of the condition of students and the school environment is required. Students in the tenth, eleventh, and twelfth grades from all areas of expertise, including Computer Network Engineering, Automotive Light Vehicle Engineering, and Institutional Financial Accounting, were evaluated initially. The preliminary assessment consisted of students filling out a questionnaire containing information about extracurricular activities, study time outside of school, conditions of the learning process at school, and school-provided training.

Empathy

At the empathy stage, a map is created that generally describes what students and teachers experience and how they feel during the learning process, based on in-depth interviews with students and teachers to gain a deeper understanding. Four subject teachers and five students from the twelfth grade were interviewed because they were deemed representative of the students and teachers. The in-depth interview process collected samples from two groups of students: those who excel (qualified students, or QS) and those who require coaching (need improvement students, or NIS). In the process of empathy, a list of pains or things that become obstacles/difficulties and gains or items that can increase the motivation of students and teachers for the learning process is compiled.

Define

The pain and gain are then examined in greater detail during the define stage. Pain and gain are enhanced using the Value Proposition Canvas (VPC) and the Point of View (PoV) tools. Several pains identified during the empathy phase are analyzed to determine solutions for resolving the difficulties faced by students and teachers. The same is accomplished by analyzing the specified gains and identifying the gain creators to increase the motivation of both students and teachers in the learning process. The primary challenges faced by students and instructors have successfully developed pain relievers and gain generators, which are then analyzed further using the Point of View tool, and how might we ask questions? This tool makes it simple to convert pain relievers and gain creators from students and teachers into an idea for enhancing student competence. The final product of the define phase is a list of questions designed to solicit ideas from students and teachers about how to answer the question of pain and gain.

Ideate

To enhance ideas, stakeholders, such as students and teachers, can be enlisted to provide opinions and input regarding ideas for resolving pain and achieving gains that they have previously expressed. Ideas must respond to the list of questions arranged in Point of View dan how might we ask. Diverse ideas necessitate grouping to facilitate the prototyping phase. A questionnaire distributed to students and teachers determines which ideas will be implemented as prototypes. Students and teachers participated in a prototype test to ensure that the proposed learning program met the needs of students and teachers.

Prototype

Under consideration of their ability, the SMK ABC will select and implement the ideas with the highest scores and those whose values intersect.

Testing

This testing of the prototype is a series of ideation iterations intended to produce an ideal prototype capable of meeting the needs of students and teachers. The prototype was evaluated using a discussion-based method and in-depth interviews with students and teachers. Various insights are obtained through discussions and interviews to refine improve the prototype.

4. RESULTS

The researchers administered a questionnaire to SMK ABC students to determine and observe the condition of the school environment. The questions concerned after-school activities, the amount of time spent studying at home, family support for the student's education, convenience at school, training received from the school, and expectations upon completion of vocational education. Eighty-eight student respondents followed the questionnaire, and from the analysis conducted, it was found that student activity outside of school hours was as follows:

- 59.1% of students used their free time to assist their parents inside and outside the home.
- 15.9% of students worked to support their families.
- The remaining students had no outside-of-school routine.

. This result demonstrates that students' responsibility outside school is to contribute to the family's economic well-being; consequently, this will impact the student's mastery of learning material in the home environment. This condition may also explain why students are generally unfocused and disinterested in the learning process, mainly if the school environment is not significantly different from the home environment, which requires students to maintain their focus and seriousness at school.

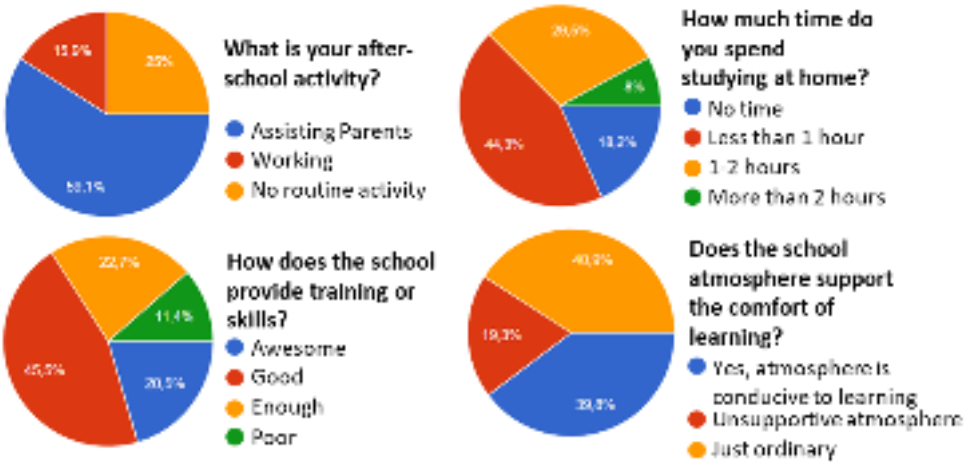


Figure 3 Educational satisfaction questionnaire

Empathy

At the empathy stage, only four teachers and five students were interviewed. Students with good grades were selected to represent groups with a strong interest in and enthusiasm for learning. In contrast, students with lower grades who required guidance were chosen to represent groups with interest in education but low school grades. The selected teacher respondents were science and expertise subject teachers (English and Entrepreneurship). The empathy map reveals that to improve the quality of learning, the teacher expects students to be more enthusiastic and moral, thereby making it easier for the teacher to deliver learning material.

On the other hand, the teacher feels uncomfortable when their students do not demonstrate proper etiquette. Conversely, students are less enthusiastic about the learning process when they are in a school environment that is less supportive in terms of both facilities and teacher treatment. On the other hand, students feel comfortable and enthusiastic if their teachers are approachable and their learning is flexible regarding time and materials.

Define

The pain reliever and gain creator were discovered during the define stage analysis.

Table 1. Identified Pain reliever and Gain Creator

Pain Reliever	Gain Creator
• Appropriate learning facilities to facilitate the teaching and learning process and routine school activities. • A system of education that is more affordable and accessible to students • A positive and comfortable school environment that motivates students to learn more. • School regulations that meet the needs of both teachers and students	• A system of education that is more adaptable, allowing students to select their learning plans based on their circumstances and needs. • Teachers who can create a more sociable and comfortable learning environment • Good moral character makes it easier for students to follow the learning process. • More diverse school activities as an outlet for student creativity.

Ideate

The selected idea is then weighted using the questionnaire method to determine the idea that meets the user's preferences or expectations (students and teachers). The questionnaire is

weighted with a scoring system to identify which concept is most and least appealing to each user (minimum 1-maximum 5). The questionnaire's scores for each notion supplied are listed in the table below.

Table 2. Grouping and weighing ideas

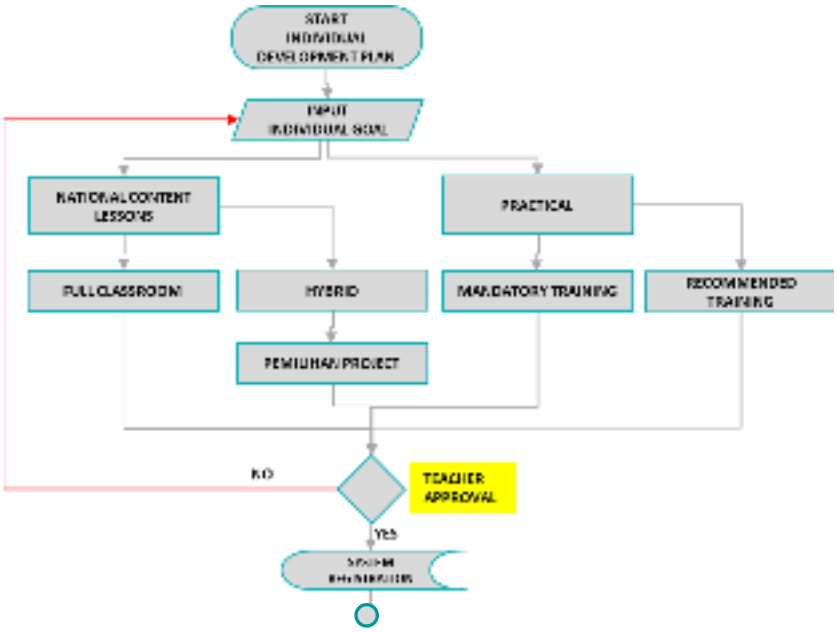
Generated Ideate	Students / Teachers
Cluster-1: Pancasila's youth character development	
A1. Share moral moments before beginning each class	514 / 73
A2. Students conduct interviews with community leaders to become more familiar with environmental programs.	507 /59
A3. Observation by students to identify positive actions or behaviors and those that need improvement.	530 / 70
A4. Students' ideas are channeled through school-sponsored creative thought events.	552 / 64
A5. Students establish their learning objectives and development program.	576 / 61
Cluster-2: SMK as a center of excellence	
B1. A game-based learning platform is used in the teaching and learning process.	520 / 57
B2. Establishing school business units as marketing channels for student products	555 / 65
B3. study comparing service standards with those of educational institutions or other industries	548 / 64
B4. Weekend education games	536 / 52
B5. Incorporating student participation and university aid in the formulation of school rules	524 / 54
B6. The school provides equipment management and completes learning equipment in the laboratory.	551 / 62
Cluster-3: Driving teacher	
C1. The learning process occurs outside the classroom or relates to the natural world.	551 / 56
C2. Every day, students are allowed to choose the subjects or classes they decide to attend.	572 / 41
C3. The school provides refreshing facilities for students	578 / 59
C4. Periodic updating of the extracurricular list	562 / 56
C5. Exams with a system of project assignments tied to environmentally sustainable initiatives	507 / 58
C6. Several times every month, hybrid classes will be offered.	536 / 52
C7. Students establish their study regimen	580 / 47
Cluster-4: Merdeka Curriculum	
D1. Inviting guest lecturers, business practitioners, and entrepreneurs as webinars or seminar speakers.	533 / 64
D2. The school offers teacher training and management training that conforms to industry standards.	527 / 61
D3. Offering pupils coaching sessions and psychological support.	553 / 62
D4. Counseling students by regularly visiting students' homes and engaging with their parents.	503 / 62
D5. Monthly wake-up calls for students and teachers to discuss difficulties in the school environment.	548 / 64

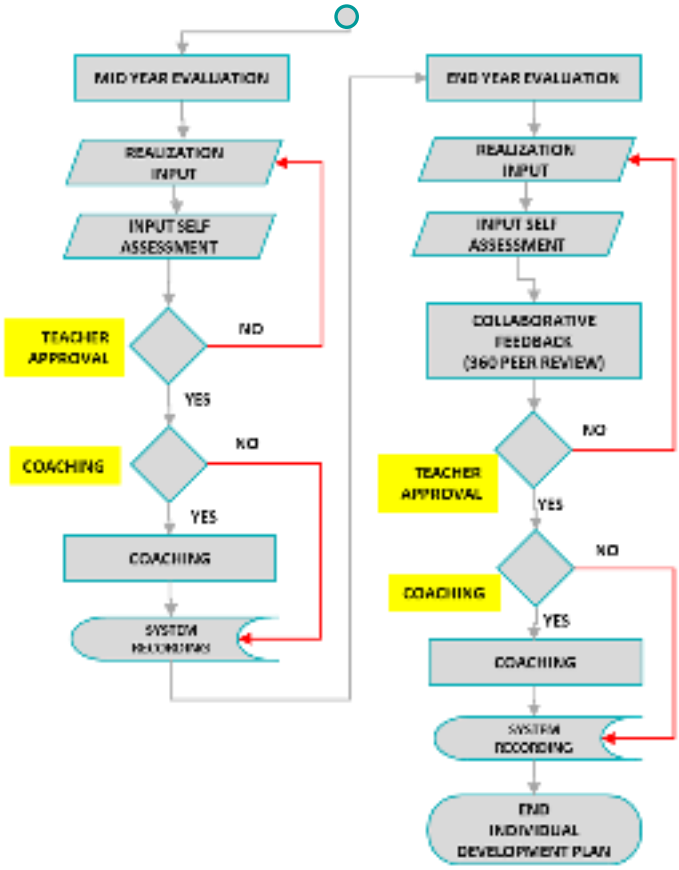
In table 3, the top three ideas requested by students are C7, C3, and A5. This idea indicates that students want to determine their learning process and expect comfortable school conditions to help them feel more at ease in the school environment. According to Shemshack (2020), learning is an individual experience that allows people to develop their abilities, perspectives, skills, and understanding. The personal learning model can assist individuals in meeting their needs. While A1, A3, and B2 are teachers' three most common ideas, A1 is the least popular. The ideas that pupils disliked the most were D4, C5, and A2, but the teacher found C2, C7, and B4 to be the least fascinating.

Prototype

One of the three ideas students were most interested in at the prototype stage was selected, specifically, the A5 proposal. This proposal was chosen because children are the school's primary stakeholders, these ideas are more likely to be adopted, and they align with the goal of the Merdeka Curriculum. The second prototype is one of the overlapping concepts, namely the B2 concept, which entails the development of a school business unit whose administration comprises all stakeholders (school, teachers, and students). The A5 idea stresses non-classroom or project-based learning procedures for many disciplines, as well as training programs that adapt to the needs of students so that the learning process becomes more individualized by taking into consideration the needs of each student. The paradigm of project-based learning is one of the most popular among teachers and students. This model gives an educational experience and possesses its allure (Nurhayati, 2017).

Figure 4. Idea A5 flowchart





Testing

The A5 ideation prototype was tested on the ideation flowchart design with users, particularly instructors and students, to obtain feedback for future design enhancements. The design test consisted of discussions with and interviews with the school's principal, curriculum-in-charge assistant principal, and a class 11 student. The B2 ideation prototype underwent field testing in the form of a culinary business unit comprised of students and teachers. The execution of concepts that have been in operation for a few days is then reviewed with a teacher or student input.

The risk associated with the A5 concept, namely the hybrid learning approach, is the potential implementation of topic projects as a substitute for regular classroom learning, which is unlikely to be efficient since this project will not have intensive supervision from the teacher. Therefore to avoid this, hybrid class projects must be performed in the school environment so that teachers from relevant disciplines can perform their supervisory function and ensure that the project can be accomplished according to its intended goal.

6. CONCLUSIONS

Thru the stages of design thinking, it is possible to recognize the SMK ABC students' and teachers' needs and difficulties in the learning process. the recommended ideas are:

- A5 (Students determine their development programs and personalized learning goals)
- B2 (Conducting school business units as platforms for commercializing student products)

Above ideas would be a strategy to address the diverse needs and challenges students, and teachers face during the learning process. The author argues that it is necessary to iterate advanced prototype testing stages to discover an ideal model of an ideation prototype. Additionally,

educational institutions should conduct a study of the risk management that might be required for the implementation of new concepts. The author also recommends involving practitioners or experts in the field of education in validating the learning model prototype.

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EVALUATION OF CONSORTIUM PARTNER SELECTION PROCESS USING PROCESS ANALYTICAL HIERARCI (AHP) METHOD

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ABSTRACT

The process of selecting colleagues with the aim of meeting the criteria when participating in the tender process and at the project execution stage is absolutely necessary. This selection process follows government and employer regulations by adjusting the relevant requirements. In some cases, there is a discrepancy or incompatibility with consortium partners in implementing the project. This has an impact on the quality of work that is not met. This thesis is a re-evaluation of the actual conditions in the selection of consortium partners by utilizing the application of the AHP method. The criteria are compiled based on the latest analysis and track record if the collaboration has been carried out before. The main subject of concern is experience from the aspect of organizational capabilities and having credibility to achieve project success. Evaluation is carried out as a form of correction that refers to relevant procedures and science in order to be a benchmark for the achievement of the consortium process if needed in the future. The expected research result is the acquisition of a method of selecting consortium partners in order to achieve cooperation between organizations through a mutually beneficial consortium and in accordance with the scientific process so that it is expected to contribute both to the company and the organization in it and as a solution for the completion of work.

Keywords : Process Analytic Hierarchy (AHP), Consortium Evaluation, Construction Projects

1. INTRODUCTION

The selection of consortium partners was met referring to closeness related to previous collaboration experiences. In addition, restructuring often creates obstacles (retirement of personnel, changes in positions, changes in traditional stakeholders, etc.) where this occurs both internal organizations and consortium partners. In general, the problem can be described as follows:

1. How do you differentiate the selection of an existing consortium and its impact on the company's operations?
2. How to select a consortium based on Process Hierarchy Analysis?
3. What are the results of the assessment of the consortium partners based on the Process Hierarchy Analysis?

2. LITERATURE REVIEW

Referring to the journal "Proposal of a method for selecting suppliers considering risk management (www.emeraldinsight.com/0265-671X.htm), the theme in this study is close to the method used in research in the journal. Furthermore, the stages of meeting the needs can be implemented until the desired results are obtained. During the research, the method proposed by

Chen and Wu (2013) was discovered, which applied the AHP technique developed by Thomas L. Saaty in 1970 as a solution to solving complex decision problems. Its application can be adopted to determine weights based on data comparisons

3. METHODS

Analytical Hierarchy Process (AHP) is a concept, tool, technique or method in making and making decisions for complex, unstructured and multi-attribute problems by ranking the existing decision alternatives and then choosing the best with criteria determined through a numerical value. Furthermore, AHP is widely used in decisions for many criteria, planning, resource allocation and prioritization of strategies that users have in conflict situations. Through the AHP method a complex problem can be broken down into groups which are then arranged into a hierarchical form so that the problem will appear more structured and systematic. In this study, AHP was used as a determining factor for prospective consortium partners

4. RESULTS

The identification carried out aims to get consortium partners through a weighting assessment. The main thing to consider is the composition of the partnership so that it passes the prequalification process by referring to regulations. There are 3 large companies which have close ties from their countries of origin which make it possible to become the leaders of the consortium, this is strengthened by the background of the companies' origins. The relationship factor and the ease of communication factor will be beneficial in terms of proposal completion if clarification is needed and work completion if declared as the winner of the tender.

4.1 Selection Criteria for Internal JV

				Konsorsium						Alternatif Partnership Perusahaan Jepang											
										1		2		3		4		5		6	
PTK 007	Mandatory Requirement			Score	TR	Score	SI	Score	MDI	Score	ITC	Score	CHY	Score	IHI	Score	JGC	Score	NS	Score	TY
		Status Perusahaan	DC = Strong (3) NC = Medium (2) FC = Weak (1)	3	NC	2	NC	2	NC	2	NC	2	NC	1	FC	2	NC	1	FC	2	NC
		Perjanjian Konsorsium	Open = Strong (3) Indicative = Medium (2) HOA = Weak (1)	2	Indicative	2	Indicative	2	Indicative	2	Indicative	3	Open	3	Open	2	Indicative	3	Open	2	Indicative
		SPDA	Active = Strong (3) in progress = Medium (2) Inactive = Weak (1)	3	Active	3	Active	3	Active	1	In Active	3	Active	1	In Active	3	Active	2	In Progress	3	Active
		Pengalaman Dasar & Nilai Pengalaman Tertinggi	LNG Contractor = Strong (3) Combine System = Medium (2) No Experience = Weak (1)	2	Project Combined System & Unit	3	LNG Project Contractor	3	LNG Project Contractor	1	Project Combined System & Unit	3	LNG Project Contractor	3	LNG Project Contractor	3	LNG Project Contractor	2	Project Combined System & Unit	2	Project Combined System & Unit
		Pengalaman Spesific	Contractor For Gas Processing 300> mmscfd = Strong (3) Between 150 - 300 mmscfd = Medium (2) <150mmscfd or Other = Weak (1)	3	>300 mmscfd	3	>300 mmscfd	3	>300 mmscfd	1	<150mmscfd or Other	3	>300 mmscfd	3	>300 mmscfd	3	>300 mmscfd	2	Between 150 - 300 mmscfd	3	>300 mmscfd
		Kepemilikan Workshop (70% pabrikasi di Indonesia)	Own Yard = Strong (3) Subcont Yard = Medium (2) No Yard = Weak (1)	2	Subcont Yard	3	Own Yard	3	Own Yard	1	No Yard	2	Subcont Yard	2	Subcont Yard	2	Subcont Yard	2	Subcont Yard	2	Subcont Yard
		Komitmen Pembagian	N/A																		
		Komitmen Keselamatan	N/A																		
			Company Score	15		16		16		8		16		13		15		12		14	

Figure 1. Internal JV

The selection of co-workers is carried out by the company more quickly before the tender announcement is issued to anticipate co-workers with high ratings who will join other consortia. The analysis in the table above obtained an assessment for the company's internal consortium as follows:

• TR : 15
• SI : 16
• MDC : 16

Alternative coworkers for companies originating from same country :

• ITC : 8
• CHY :16
• IHI : 13
• JGC : 15
• NS : 12
• TY : 14

The results of the assessment show that CHY received the highest score, namely 16. This assessment makes the company a candidate to join the internal company consortium.

4.2 Selection Criteria for Possible Competitor JV 1

				Konsorsium						Komposisi dimungkinkan											
										1		2		3		4		5		6	
PTK 007	Mandatory Requirement			Score	JGC	Score	KBR	Score	TCH	Score	MEI	Score	GN	Score	RK	Score	AK	Score	WK	Score	PP
		Status Perusahaan	DC = Strong (3) NC = Medium (2) FC = Weak (1)	2	NC	2	NC	2	NC	2	NC	2	DC	3	DC	3	DC	3	DC	3	DC
		Perjanjian Konsorsium	Open = Strong (3) Indicative = Medium (2) HOA = Weak (1)	2	Indicative	2	Indicative	2	Indicative	3	Open	3	Open	3	Open	3	Open	3	Open	3	Open
		SPDA	Active = Strong (3) in progress = Medium (2) Inactive = Weak (1)	3	Active	3	Active	3	Active	3	Active	3	Active	3	Active	3	Active	3	Active	3	Active
		Pengalaman Dasar & Nilai Pengalaman Tertinggi	LNG Contractor = Strong (3) Combine System = Medium (2) No Experience = Weak (1)	3	Project Combined System & Unit	3	LNG Project Contractor	3	LNG Project Contractor	2	Project Combined System & Unit	2	Project Combined System & Unit	2	Project Combined System & Unit	2	Project Combined System & Unit	2	Project Combined System & Unit	2	Project Combined System & Unit
		Pengalaman Spesific	Contractor For Gas Processing 300> mmscfd = Strong (3) Between 150 - 300 mmscfd = Medium (2) <150mmscfd or Other = Weak (1)	3	>300 mmscfd	3	>300 mmscfd	3	>300 mmscfd	2	Between 150 - 300 mmscfd	3	>300 mmscfd	2	Between 150 - 300 mmscfd	1	<150mmscfd or Other	2	Between 150 - 300 mmscfd	1	<150mmscfd or Other
		Kepemilikan Workshop (70% pabrikasi di Indonesia)	Own Yard = Strong (3) Subcont Yard = Medium (2) No Yard = Weak (1)	2	Subcont Yard	2	Own Yard	2	Own Yard	3	Own Yard	3	Own Yard	2	Subcont Yard	2	Subcont Yard	2	Subcont Yard	2	Subcont Yard
		Komitmen Pembagian	N/A																		
		Komitmen Keselamatan	N/A																		
			Company Score	15		15		15		15		16		15		14		15		14	

Figure 2. Competitor 1

The results of the assessment show the possibility of competitor 1 shown in JV-2 (JGC, KBR, Technip, Rekind and Guna Nusa) where the average score obtained is 15.13 and it is also similar to JV-6 (JGC, KBR, Technip, Rekind and Guna Nusa) where the value of 15.13 is the sum of the criteria values for each company and then the average is carried out.

4.3 Selection Criteria for Possible Competitor JV 2

				Konsorsium						Komposisi dimungkinkan											
										1		2		3		4		5		6	
				Score	TY	Score	IKPT	Score	WK	Score	MEI	Score	GN	Score	RK	Score	AK	Score	WK	Score	PP
PTK 007	Mandatory Requirement	Status Perusahaan	DC = Strong (3) NC = Medium (2) FC = Weak (1)	2	NC	2	NC	3	NC	2	NC	2	DC	3	DC	3	DC		DC	3	DC
		Perjanjian Konsorsium	Open = Strong (3) Indicative = Medium (2) HOA = Weak (1)	2	Indicative	2	Indicative	3	Indicative	3	Open	3	Open	3	Open	3	Open		Open	3	Open
		SPDA	Active = Strong (3) in progress = Medium (2) Inactive = Weak (1)	3	Active	3	Active	3	Active	3	Active	3	Active	3	Active	3	Active		Active	3	Active
		Pengalaman Dasar & Nilai Pengalaman Tertinggi	LNG Contractor = Strong (3) Combine System = Medium (2) No Experience = Weak (1)	2	Project Combined System & Unit	2	LNG Project Contractor	2	LNG Project Contractor	2	Project Combined System & Unit	2	Project Combined System & Unit	2	Project Combined System & Unit	2	Project Combined System & Unit		Project Combined System & Unit	2	Project Combined System & Unit
		Pengalaman Spesific	Contractor For Gas Processing 300> mmscfd = Strong (3) Between 150 - 300 mmscfd = Medium (2) <150mmscfd or Other = Weak (1)	3	>300 mmscfd	2	>300 mmscfd	2	>300 mmscfd	2	Between 150 - 300 mmscfd	3	>300 mmscfd	2	Between 150 - 300 mmscfd	1	<150mmscfd or Other		Between 150 - 300 mmscfd	1	<150mmscfd or Other
		Kepemilikan Workshop (70% pabrikasi di Indonesia)	Own Yard = Strong (3) Subcont Yard = Medium (2) No Yard = Weak (1)	2	Subcont Yard	2	Own Yard	2	Own Yard	3	Own Yard	3	Own Yard	2	Subcont Yard	2	Subcont Yard		Subcont Yard	2	Subcont Yard
		Komitmen Pembagian	N/A																		
		Komitmen Keselamatan	N/A																		
			Company Score	14		13		15		15		16		15		14		0		14	

Figure 3. Competitor 2

The results of the assessment show the possibility of competitor 2 shown in JV-2 (TY, IKPT, RK and GN) where the average score obtained is 14.17 and it is similar to JV-4 (TY, IKPT, AK and GN) where the score of 14.17 is the sum of the scores criteria of each company and then averaged

Result of Internal Partner Scoring

Perusahaan	Nilai	Perusahaan Konsorsium	
		Nama	Score
TR	15	JV-1	13,75
SI	16		
MDC	16		
ITC	8		

Perusahaan	Nilai	Perusahaan	
		Nama	Score
TR	15	JV-2	15,75
SI	16		
MDC	16		
CHY	16		

Perusahaan	Nilai	Perusahaan	
		Nama	Score
TR	15	JV-3	15
SI	16		
MDC	16		
IHI	13		

Perusahaan	Nilai	Perusahaan	
		Nama	Score
TR	15	JV-4	15,5
SI	16		
MDC	16		
JGC	15		

Perusahaan	Nilai	Perusahaan	
		Nama	Score
TR	15	JV-5	14,75
SI	16		
MDC	16		
NS	12		

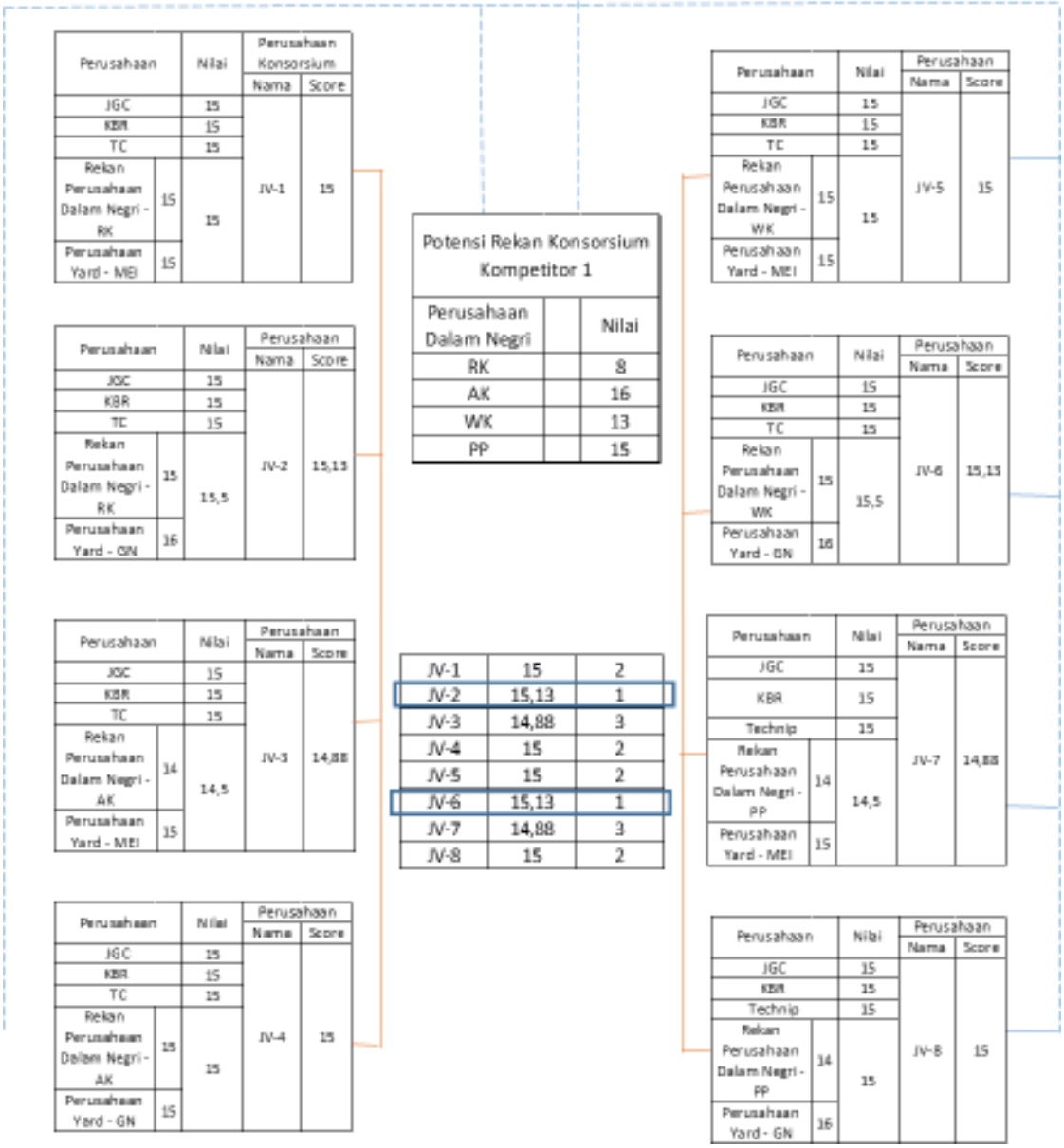
Perusahaan	Nilai	Perusahaan	
		Nama	Score
TR	15	JV-6	15,25
SI	16		
MDC	16		
TY	14		

Potensi Ideal Rekan Konsorsium	
Same Origin Country	Nilai
ITC	8
CHY	16
IHI	13
JGC	15
NS	12
TY	14

Hasil Penilaian Perusahaan Konsorsium		
Perusahaan	Nilai	Ranking
JV-1	13,75	6
JV-2	15,75	1
JV-3	15	4
JV-4	15,5	2
JV-5	14,75	5
JV-6	15,25	3

The highest ranking results for the consortium configuration are shown in JV-2 (TR, SI, MDC and CHY) where the average value obtained is 15.75.

Result of Competitor 1



Perusahaan	Nilai	Perusahaan Konsorsium	
		Nama	Score
JGC	15	JV-1	15
KBR	15		
TC	15		
Rekan Perusahaan Dalam Negri - RK	15		
Perusahaan Yard - MEI	15		

Perusahaan	Nilai	Perusahaan	
		Nama	Score
JGC	15	JV-2	15,13
KBR	15		
TC	15		
Rekan Perusahaan Dalam Negri - RK	15		
Perusahaan Yard - GN	16		

Perusahaan	Nilai	Perusahaan	
		Nama	Score
JGC	15	JV-3	14,88
KBR	15		
TC	15		
Rekan Perusahaan Dalam Negri - AK	14		
Perusahaan Yard - MEI	15		

Perusahaan	Nilai	Perusahaan	
		Nama	Score
JGC	15	JV-4	15
KBR	15		
TC	15		
Rekan Perusahaan Dalam Negri - AK	15		
Perusahaan Yard - GN	15		

Potensi Rekan Konsorsium Kompetitor 1		
Perusahaan Dalam Negri		Nilai
RK		8
AK		16
WK		13
PP		15

JV-1	15	2
JV-2	15,13	1
JV-3	14,88	3
JV-4	15	2
JV-5	15	2
JV-6	15,13	1
JV-7	14,88	3
JV-8	15	2

Perusahaan	Nilai	Perusahaan	
		Nama	Score
JGC	15	JV-5	15
KBR	15		
TC	15		
Rekan Perusahaan Dalam Negri - WK	15		
Perusahaan Yard - MEI	15		

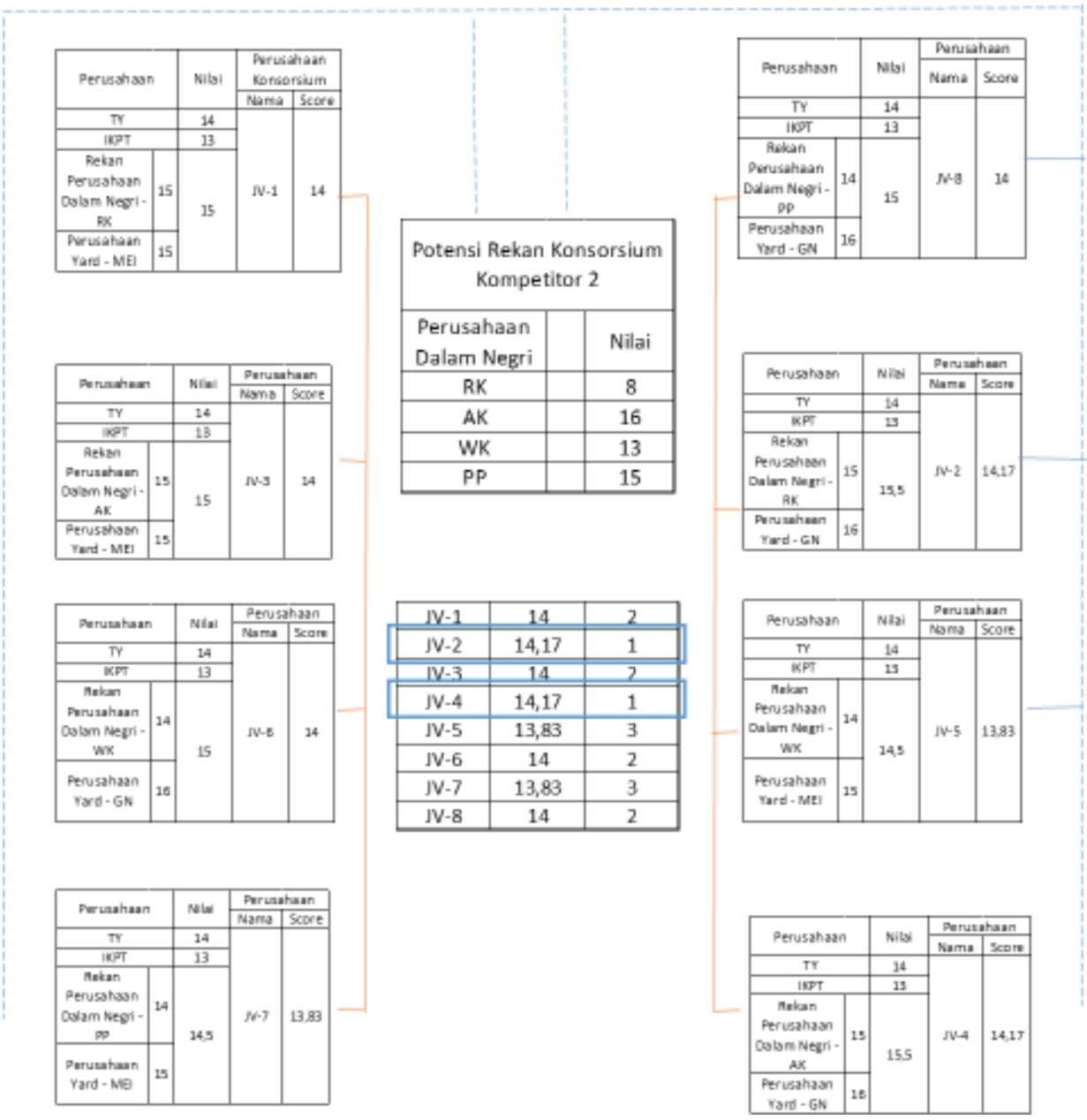
Perusahaan	Nilai	Perusahaan	
		Nama	Score
JGC	15	JV-6	15,13
KBR	15		
TC	15		
Rekan Perusahaan Dalam Negri - WK	15		
Perusahaan Yard - GN	16		

Perusahaan	Nilai	Perusahaan	
		Nama	Score
JGC	15	JV-7	14,88
KBR	15		
Technip	15		
Rekan Perusahaan Dalam Negri - PP	14		
Perusahaan Yard - MEI	15		

Perusahaan	Nilai	Perusahaan	
		Nama	Score
JGC	15	JV-8	15
KBR	15		
Technip	15		
Rekan Perusahaan Dalam Negri - PP	14		
Perusahaan Yard - GN	16		

The results of the assessment show the possibility of competitor 1 shown in JV-2 (JGC, KBR, Technip, Rekind and Guna Nusa) where the average score obtained is 15.13 and it is also similar to JV-6 (JGC, KBR, Technip, Rekind and Guna Nusa) where the value of 15.13 is the sum of the criteria values for each company and then the average is carried out.

Result of Competitor 2



The results of the assessment show the possibility of competitor 2 shown in JV-2 (TY, IKPT, RK and GN) where the average score obtained is 14.17 and it is similar to JV-4 (TY, IKPT, AK and GN) where the score of 14.17 is the sum of the scores criteria of each company and then averaged.

6. CONCLUSIONS

The results of the implementation of the method as part of the Multiple Choice Decision Making implementation of consortium partner selection and evaluation as a form of improvement in order to achieve overall company operational progress can be explained as follows:

A. Referring to the discussion of the results of the selection of consortium partners when compared to the currently running consortium, this is progress considering that the combination of 4 consortium members received a maximum rating of 15.75 when compared to the ratings of other consortia which received ratings of 15.13 and 14.17
B. Fulfillment of tender requirements can be met, referring to the configuration scheme in which each member of the consortium achieves the parameters of company status assessment, consortium agreement, basic experience & highest experience value, specific experience, and workshop ownership for manufacturing needs.

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APPLICATION OF SERVQUAL METHOD, KANO MODEL AND IMPORTANCE-PERFORMANCE ANALYSIS METHOD IN CUSTOMER ANALYSIS OF HEAVY EQUIPMENT AND GENSET BUSINESS

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ABSTRACT

PT Altrak 1978 specializes in heavy equipment and generators. By grouping customers from 2017 to 2022, they discovered that customer dissatisfaction reached an average of 16,3 unsatisfied customers, 53,8 neutral customers, and 117,2 satisfied customers. Over the period 2017 to 2022, Cummins's service revenue dropped from 102 billion to 93 billion with a peak of 180 billion in 2019. In addition, Cummins' customer base fell from 818 to 688 with a peak of 892 in 2019. SERVQUAL analyzes the discrepancy between customer desires and the service provided. In the Kano model, customer satisfaction is measured by how well the company performs. The Importance-Performance Analysis method analyzes work that is considered a priority. Based on the results of the research, customer satisfaction has not been achieved, as indicated by the average value of customer satisfaction -0.25 on the SERVQUAL score, in the one-dimensional attribute Kano model has six statements that have a linear relationship between performance and customer satisfaction, on attractive attributes, there are eight statements that can increase customer satisfaction if performance is improved, and in the IPA quadrant one there are three attributes that must be focused on and quadrant two has 13 attributes whose performance must be improved.

Keywords: *Importance-Performance Analysis,* Kano, *SERVQUAL.*

1. INTRODUCTION

Rapid development of technology makes it easy for customers to have access to more and more sellers who market similar products. For this reason, a seller needs to produce superior and high-value products and services among other competitors to attract the attention of customers. Companies can increase their competitiveness by improving their service quality. One way to measure service quality is by looking at the number of customer complaints. A high number of complaints means that the company's services have not met customer expectations. This, in turn, makes it less likely that customers will use that company's services in the future (Taufik & Maharani, 2022). This research was conducted at PT Altrak 1978 which is engaged in the heavy equipment and generators sector and has been established since 1978. PT Altrak 1978 is the official distributor of the Cummins brand originating from America, Cummins products themselves can be

used on heavy equipment as the main engine, the main engine on ships and trains, and can be used as an engine in generators or a generator supplied entirely by the Cummins brand called Cummins power generator. The Cummins brand which has been supplied by PT Altrak in 1978 has been used throughout Indonesia up to Liberia. From 2017 to 2022 (Q1-Q3), PT Altrak 1978 conducted a customer satisfaction survey on the performance of the service department (**Table 1.1**)

Tabel 1.1 Customer satisfaction survey results

Year	Total Survey Fillers	Total Customers	Persentase Survey Fillers	*detractor*	*passive*	*promoter*
2017	96	818	11,74%	5	34	57
2018	188	878	21,41%	20	72	96
2019	240	892	26,91%	24	67	149
2020	181	826	21,91%	22	56	103
2021	255	769	33,16%	15	65	175
2022	164	688	23,84%	12	29	123
Average				16,3	53,8	117,2

Information:
Detractor : dissatisfied
Passive : neutral
Promoter : satisfied

Detractor customers have the possibility to stop using the services provided by PT Altrak 1978 because they feel dissatisfied, while neutral passive customers cannot be known whether they will use the service or stop. If PT Altrak 1978 does not carry out developments in its services, there will be a possibility that customers will switch to competitors in order to get service satisfaction.Termination of service use by customers can have a direct impact on income and buying and selling of companies which can be seen in **Table 1.2**.

Tabel 1.2 Total customers, transactions, and income of PT Altrak 1978

Year	Total Customers	Total Transaction	Total Income
2017	818	952	Rp 102.908.365.269
2018	878	1045	Rp 134.022.673.859
2019	892	1077	Rp 180.135.500.125
2020	826	962	Rp 124.422.539.679
2021	769	906	Rp 119.674.141.600
2022	688	811	Rp 93.009.939.821

Customer satisfaction can be achieved through price, product quality, and service quality. By understanding the characteristics of customers, companies are able to understand the right type of approach and increase customer satisfaction. Customer loyalty has contributed to increasing the number of new customers, because loyal customers will recommend the seller's products and services to other customers. Therefore, as explained by Sari (2018), customer loyalty needs to be considered because it is able to optimize revenue and realize efficiency in company utilization. This study aims to help understand the level of customer satisfaction in providing suggestions, input,

and recommendations for improvement for companies so they can develop services that customers receive.

2. LITERATURE REVIEW

Customer Satisfaction

On the basis of the above understanding, satisfaction is a person's emotional level after comparing the performance or achievement of perceived expectations (Armaniah et al., 2019). Determining the level of customer satisfaction can be observed by the company by paying attention to five factors. The following five factors are described by Lupiyoadi (2017):

a. Service quality

Consumers will achieve satisfaction when they get good service and are in line with expectations.

b. Product quality

Consumer satisfaction can be realized from the evaluation of the proven quality of the products used.

c. Price

Pricing that tends to be cheap with similar quality will contribute added points to consumers.

d. Emotional

Products and services with certain brands will foster a sense of pride and increase prestige for the wearer.

Service Quality Method

Using the abbreviation SERVQUAL, the Service Quality approach defines how high customer satisfaction is (Parasuraman et al., 1985). The guideline highlights that consumers' perceptions of the quality of a company's services are more favorable and vice versa depending on how much an attribute's performance (or attribute performance) increases compared to expectations for that attribute (Mawartika, 2019). The Servqual method is a tool used to measure the gap between service quality perceptions and expectations. It does this by looking at the attributes of each dimension and determining the difference between what was received and what was expected. This gap value is then used to gauge overall service quality. (Taufik & Suwanto, 2022).

It's crucial to focus on service quality, which has five dimensions and is necessary for a product's value to be capable of satisfying customers. These aspects are listed below (Zeithaml et al., 1990)

1. The capacity of service providers to correctly accommodate services and provide the given services within the specified timeframe is referred to as reliability.
2. The capacity and responsiveness of service providers to fulfill client requests, let consumers know when services will be delivered, and also deliver services in accordance with a defined time, are all examples of responsiveness.
3. Assurance is the ability of service providers to persuade clients to put their faith in performance and ensure client security. This involves having a firm grasp on competency, courtesies, credibility, and security while addressing any issues or queries brought by clients.
4. Empathy in terms of the company's comprehension of the issues faced by consumers, responsibility for their requirements, assurance that each client receives attention, as well as enabling access to communication so that customers may more easily express their wants and expectations.
5. Tangible factors include the aesthetics of physical spaces, how effectively businesses employ equipment and supplies, and how well service providers operate.

Kano Model

Kano Model was created by Noriaki Kano in 1984 with the intention of classifying product and service features according to whether or not they satisfied consumer demands (Kano et al., 1984). The Kano model aims to demonstrate that changes in customer satisfaction may happen in tandem with changes in the demands that customers have those businesses satisfy (Wijaya, 2018). According to Wijaya (2018), Kano's methodology isolates six characteristics that have an impact on how satisfied customers feel:

1. Must-be Attribute (M)

The must-be or basic needs category has an effect on customer dissatisfaction due to the low working method of the attributes used. For example, service friendliness is an added point for a satisfied consumer. However, friendliness does not necessarily guarantee the achievement of consumer satisfaction.

2. One-Dimensional Attribute (O)

The presence of an attribute can contribute to the level of customer satisfaction naturally. This is what is included in the category of one-dimensional attribute or performance needs. For example, when a shopping center sets big discounts, how high the discount proposed certainly affects the increasing consumer satisfaction.

3. *Attractive Attribute* (A)

The absence of attribute performance in this category does not necessarily reduce consumer satisfaction. For example, a beauty product will not disappoint consumers even though it does not present an additional bonus.

4. *Indifferent Attribute* (I)

The effort or performance exerted on this attribute has no effect on increasing customer satisfaction perceptions. That is, the performance of this attribute does not contribute significant changes to customer satisfaction.

5. *Reversal Attribute* (R)

The higher the performance value generated from this attribute actually makes consumers more dissatisfied. Conversely, the low performance value of this attribute causes higher customer satisfaction.

6. *Questionable Attribute* (Q)

This attribute indicates contradictory customer requirements or confusing responses that require further investigation before being included in the analysis (Shahin et al., 2017)

Important-Performance Analysis Method

Martilla & James (1977) first introduced the Important-Performance Analysis (IPA) method. This method is a method that focuses on observing the performance (performance) of service quality that is currently felt with expectations or ideal interests (importance) related to service quality.

In Eriyanto (2015) quoted by Umam et al. (2018), an analysis process carried out to detect vital aspects of performance in an organization to achieve customer satisfaction. The Important-Performance Analysis method approach is applied in order to obtain evidence related to the level of service user satisfaction with product quality. Product development priorities focus on product features that are relatively more important to customers so that marketing strategies can be developed effectively, especially when compared to the performance of other similar products (Deng et al., 2009).

Based on the Importance-Performance Map, the location of each variable in the four quadrants can be translated into:

1. Quadrant 1 *(Concentrate These), High Importance-Low Performance*

Variables in this quadrant must be a priority and urgency to improve service performance, plan activities, and focus on departments to strengthen performance (Akinci et al., 2022). In this quadrant, you can also see major organizational weaknesses that require immediate corrective action (Nagy et al., 2020).

2. Quadrant 2 *(Keep Up the Good Work), High Importance-High Performance*

The Customer Satisfaction Quadrant is a set of attributes that are considered fundamental to customers and the performance of these has met expectations. This quadrant is also considered as a strength or competitive advantage of the company. The organization is expected to be able to maintain the sustainability of these attributes.

3. Quadrant 3 (Low Priority), Low Importance-Low Performance

Customers do not place this aspect as an essential aspect and field facts reveal that its performance is not that special. The quadrants on these variables have little effect on customers and the resulting benefits do not contribute significantly. Likewise with the use of limited resources, which should be allocated to variables in other quadrants.

4. Quadrant 4 *(Possible Overkill)*, *Low Importance-High Performance*

Loading aspects that are not considered too important or even customers feel these aspects are excessive. Variables belonging to this quadrant can be overcome by saving costs by the company (Salomon et al., 2018). These costs can then be diverted to other organizational activities that are more productive and important.

3. METHODS

In **Figure 1**, the research flow is in the form of a flowchart which consists of systematic research stages that explain the research implementation from problem identification to the completion of the research stage.

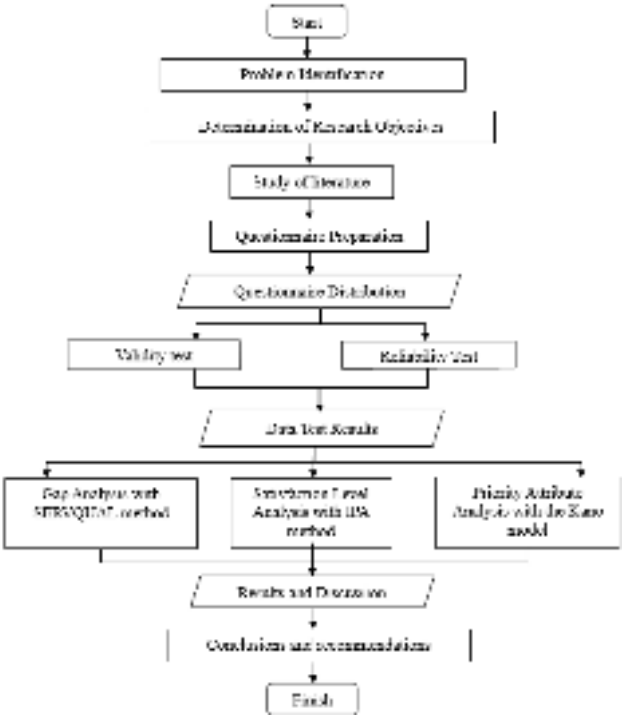

Figure 1 the research flow

4. RESULTS

Service Quality Method

In conducting gap analysis, it is necessary to represent questions for each dimension that have the largest negative value from the calculation of the SERVQUAL score as a representative for determining gaps. After determining the questions that represent each dimension, then proceed with analyzing which gaps represent based on the statements given. A series of questions can be seen in **Table 4.1** below.

Tabel 4.1 Gap analysis *SERVQUAL*

Code	Question	K	H	K-H	*Gap*
T1	The company has the latest and adequate equipment to support work	3,22	3,45	-0,23	2
T2	K3 standard employee clothing for work in the field	3,13	3,36	-0,23	2
T3	The location of the company is easy to reach	3,20	3,25	-0,05	5
R1	The company provides services as promised	3,11	3,35	-0,24	4
R2	The company provides services as promised	2,96	3,35	-0,39	4
R3	Employees show sincerity in dealing with customer problems	2,94	3,31	-0,37	3
R4	Employees are reliable and trusted in dealing with customer problems	3,32	3,37	-0,06	3
R5	The company has a good and accurate document system and historical record	2,99	3,32	-0,33	2
RP1	The company provides a quick response to customer problems	2,87	3,37	-0,50	3
RP2	The company precisely tells when the work will be done	2,72	3,33	-0,61	4
RP3	Work done in accordance with the time notified	2,59	3,10	-0,51	4
RP4	Companies can notify the exact time of delivery of goods	2,59	3,11	-0,52	3
RP5	Goods arrived at the time promised by the company	2,54	3,16	-0,62	4
RP7	Customers get enough service time and work from employees	3,16	3,37	-0,21	1
A1	Employees have knowledge and skills that support work	3,38	3,44	-0,06	2
A2	Customers feel comfortable, safe, no worries, when interacting with employees	3,32	3,48	-0,16	1
A3	Employees are always polite and friendly to customers	3,49	3,51	-0,02	3
A4	Employees can be trusted with the level of quality of work	3,34	3,51	-0,17	3
E1	Employees pay personal attention to the interests of customers	3,16	3,33	-0,16	5
E2	Employees provide input and understanding of the problems faced by customers	3,28	3,34	-0,05	1
E3	Employees understand customer needs and wants	3,15	3,35	-0,20	5
E4	Employees put the interests of customers first	3,28	3,48	-0,20	5

Information:

K: Reality

H: Hope

Gap 1 *(Knowledge Gap)*

Gap 2 *(Standards Gap)*

Gap 3 *(Delivery Gap)*

Gap 4 *(Communications Gap)*

Gap 5 *(Service Gap)*

Kano Model

Grouping of the Kano Model attributes is seen through proving the answers to the functional (if yes) and dysfunctional (if no) questions that have been answered by the customer. The answers that have been collected are then entered into the Kano Model attribute classification table so that it can be seen what attributes represent the customer's answers in **Table 4.2**.

Tabel 4.2 Kano's Attribute

Question	If yes					If no					Attribute Kano
	Customers Answer					Customers Answer					
	5	4	3	2	1	5	4	3	2	1	
T1	61	20	15	21	41	2	2	59	26	69	O
T2	60	24	16	34	24	2	1	57	67	31	A
T3	42	46	7	17	46	2	3	56	43	54	I
R1	62	25	8	11	52	2	2	52	22	80	O
R2	62	25	7	12	52	2	0	55	22	79	O
R3	40	50	9	25	34	2	1	62	33	60	I
R4	60	32	8	33	25	2	1	59	43	53	A
R5	38	48	12	37	23	2	0	62	64	30	I
RP1	60	27	9	22	40	2	1	51	35	69	O
RP2	41	44	8	24	41	2	0	58	48	50	I
RP3	60	21	8	16	53	2	0	54	15	87	O
RP4	40	42	10	13	53	2	1	55	15	85	Q
RP5	61	20	7	16	54	2	0	51	19	86	O
RP6	41	46	12	33	26	2	1	77	44	34	I
RP7	63	23	8	28	36	2	1	82	28	45	A
A1	63	22	14	31	28	2	1	58	41	56	A
A2	41	44	15	36	22	2	1	86	42	27	I
A3	45	44	12	35	22	2	1	60	47	48	A
A4	63	26	11	36	22	2	0	61	49	46	A
E1	40	47	14	35	22	2	1	59	70	26	I
E2	38	49	14	35	22	2	0	63	69	24	I
E3	61	27	13	35	22	2	1	59	48	48	A
E4	60	27	14	33	24	2	1	66	42	47	A

Kano's attribute analysis begins with M > O > A > I, with the following description:

M (*must be)* : none.
O (*one dimentional)* : T1, R1, R2, RP1, RP3, and RP5.
A (*attractive)* : T2, R4, RP7, A1, A3, A4, E3, and E4.
I (*indifferent)* : T3, R3, R5, RP2, RP6, A2, E1, and E2.

Important-Performance Analysis Method

Determination of the IPA matrix is needed to find out each question based on the results of the questionnaire which can later be determined in quadrants 1, 2, 3, or 4.

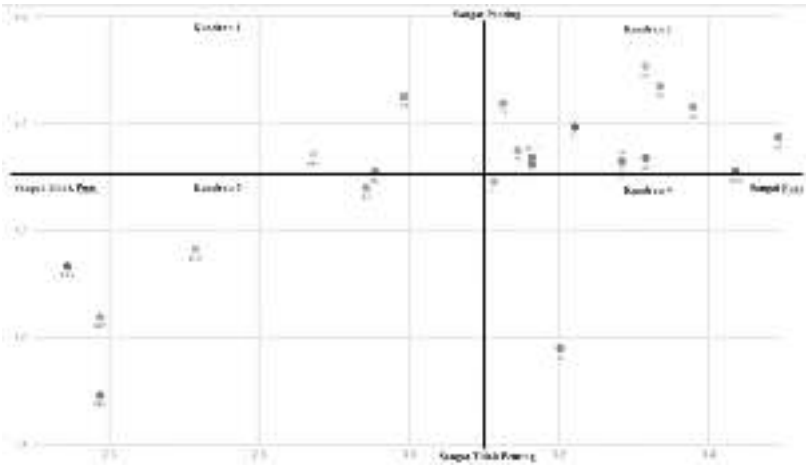

Figure 2 IPA Quadrant Matrix

Quadrant1 *(Concentrate These)* : R2, R5, and RP1.
Quadrant2 *(Keep Up the Good Work)*: T1, T2, R4, RP6, RP7, A1, A2, A3, A4, E1, E2, E3, and E4.
Quadrant3 *(Low Priority)* : R3, RP2, RP3, RP4, and RP5.
Quadrant4 *(Possible Overkill)* : T3 and R1.

5. CONCLUSIONS

Results of the questionnaires that were distributed and examined in the presentation of the previous chapter proved to be the answer to the problem, leading to the following conclusions:

1. Calculations in Table 4.5 prove that the company has not been able to meet service expectations based on customer standards, only one statement has a positive value, namely RP6 (employees are willing to help customers) which indicates that employees are limited in their willingness to help customers in overcoming problems experienced by customer.
2. Gaps occur in 22 of the 23 questions examined using the SERVQUAL method, gaps occur because the performance provided by employees has not met the expectations desired by customers. Improved employee performance can help increase customer satisfaction.
3. It is necessary to intensify the increase in one-dimensional and attractive attributes based on the Kano model measurement in statements T1 (the company has the latest and adequate equipment to support work), R1 (the company provides services as promised), R2 (the company provides services as promised), RP1 (the company provides quick responses to customer problems), RP3 (work is done according to the set time), and RP5 (goods come according to the time promised by the company) which are included in the one-dimensional attribute, which is a statement representing the level of customer satisfaction that will increase if performance improvements are also carried out, the company must ensure that the equipment used by employees is adequate for work, improve the quality of service provision and services according to promises, respond quickly to customer complaints, evaluate employee work speed and time, and ensure goods

arrive according to schedule. promised act. In addition, the attractive attributes consist of statements T2 (employee clothing with K3 standards for working in the field), R4 (employees can be relied upon and trusted in dealing with customer problems), RP7 (customers get enough service time and work from employees), A1 (employees have knowledge and skills that support work), A3 (employees are always polite and friendly to customers), A4 (employees can be trusted with the level of quality of work), E3 (employees understand the needs and desires of customers), and E4 (employees prioritize customer interests) explains that this statement represents the level of customer satisfaction which will increase along with increased performance, but customer satisfaction will not decrease significantly if performance is not improved. Companies can improve the quality of employee clothing according to K3 standards, evaluate employee skills and knowledge, especially in new products, and conduct exposure to the impact that will occur if employees can pay attention to customer problems. The absence of a statement on the reversal attribute indicates that there are no attributes that, when performance is improved, will have a negative impact on customer satisfaction.

4. In determining the level of importance assessed by customers, the IPA method is used which must be focused on quadrant 1 (concentrate these) which are quadrants that have statements that are considered important by customers, but the resulting performance is not in line with customer expectations. This quadrant reveals an indication that the main weakness that needs to be improved is employee performance quickly. Statements included in this quadrant are R2 (the company provides services as promised), R5 (the company has a good and accurate document and history recording system) and RP1 (the company provides quick responses to customer problems).

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INCREASING WASTEWATER RECOVERY WITH FAILURE MODE EFFECT ANALYSIS METHOD

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ABSTRACT

This study aims to analyze the factors causing the high load of wastewater pollution, design a solution strategy to increase the utilization of wastewater into new products and develop follow up plans to reduce the risk of wastewater pollution using the FMEA and 5W2H methods. This research was conducted using Pareto diagrams, Cause and Effect diagrams and Failure Mode & Effect analysis (FMEA). The results of research on the factors that influence the high load of wastewater pollution at the IPAL outlet PT. Petrokimia Gresik is the most dominant PO4 wastewater pollution load 0.93 kg/ton from all pollution load parameters at the PT. Petrokimia Gresik Gresik. This research produces 4 alternative improvement experiment design. The best experiment design is created a new Phosphate Recovery Unit so that it can reduce the PO4 pollution load 0.00040 kg/ton or decrease 99% from the initial (existing) condition. From the calculation of the feasibility investment costs, return on investment (ROI) 21.98% is obtained within 1 year and a payback period (PP) 4.5 years.

Keywords: Wastewater, FMEA, Recovery

1. INTRODUCTION

Wastewater is water that comes from a process in an activity. In accordance with Government Regulation of the Republic of Indonesia No. 22 of 2021 concerning the Implementation of Environmental Protection and Management, the quality of wastewater discharged into the environment (water bodies) must meet the wastewater quality standards determined by the Government, the Government in this case is the Ministry of Environment and Forestry. One of the efforts to control wastewater is to treat wastewater at the Wastewater Treatment Unit. However, wastewater can be recovered into a product that is worth selling and supports government programs, namely PROPER and Circular Economy.

The amount of wastewater at PT Petrokimia Gresik is increasing due to the addition of several new factories and the performance of old factories is decreasing. In this regard, the quality of wastewater still meets the wastewater quality standards in accordance with the Letter of Permit for Disposal of Liquid Waste to the Sea. Wastewater from PT Petrokimia Gresik consists of wastewater parameters, namely: pH, total NH3, TSS, Fluor and PO4. The quality of PT Petrokimia Gresik's wastewater is monitored by an external lab that is certified by KAN every month and reported to the Ministry of Environment and Forestry. According to regulations from the ministry of environment and forestry, each company is required to reduce the burden of wastewater pollution,

in connection with this, an increase in wastewater recovery will be carried out using the Failure Mode Effect Analysis method.

2. LITERATURE REVIEW

The concept of continuous risk assessment in industrial wastewater treatment is very important to determine the causes and consequences of plant failures. The potential risks associated with wastewater that could impede the operation of all manufacturing facilities are currently not adequately determined and are still under research (Trubetskaya et al., 2021). The increasing demand for nutrient compounds for agronomic utilization makes it indispensable to identify technologies capable of recovering nutrients from wastewater streams so as to avoid consumption of natural resources (Siciliano, 2020). The increasing demand for nutrient compounds for agronomic utilization makes it indispensable to identify technologies capable of recovering nutrients from wastewater streams so as to avoid consumption of natural resources (Kristofor et al, 2022). Wastewater, which contains large amounts of nitrogen and phosphorus plays a key role in accelerating the intensity of eutrophication (Preisner et al.,2020), The main direction in preventing eutrophication caused by wastewater discharges is to reduce the nutrient load entering the wastewater receiver (Smol et al.,2020). In general, the technologies used to remove phosphorus are divided into three categories, namely chemical methods, biological methods, and combined chemical-biological methods (Mao et al, 2021). Regarding the chemical phosphorus removal technology, the suggested adsorption method is more promising because the adsorbed phosphate can be recovered for further utilization (Novais et al, 2018).

Failure Mode and Effect Analysis (FMEA) is a method in risk management that can be used in various fields such as manufacturing and service industries, profit and non-profit organizations, private, public organizations, or government organizations (Najwa, 2018). The preparation of FMEA was carried out using online FGDs and the same team as in the fishbone diagram method (Delfian, 2021). From data collection has a strong impact on the way data can be processed and statistically evaluated using various risk assessment tools (Moradi et al., 2020).

3. METHODS

In the first step, data collection was carried out by identifying problems to find out the source of the problem with the high pollution load of wastewater from PT Petrokimia Gresik. The second steps was carried out by looking for several alternative experimental scenarios from the problem of the high pollution load of PT Petrokimia Gresik wastewater using root cause analysis, Failure Mode and Effect Analysis (FMEA), and experiment design of alternative scenarios.

The third step is in the Results Analysis step, the selected repair alternatives are carried out to solve the problem of the high pollution load of wastewater from PT Petrokimia Gresik. The results of the selected improvements are validated, the results of the validation of these improvements are continued to decide that these improvements are feasible to implement by conducting an evaluation analysis of investment (CAPEX) and operational costs (OPEX) in the experimental scenarios that have been carried out. This analysis is to compare the profits in the form of net income generated with the costs of repairs or investments incurred. Investment analysis is determined by the value of ROI (return on investment) and PP (payback period). So that the best alternative scenario is obtained which is able to reduce the load of wastewater pollution at PT Petrokimia Gresik and provide the potential for increasing the utilization of the by-products produced at a feasible cost of repair.

4. RESULTS AND DISCUSSION

4.1. Data Collection and Processing

Secondary data on the WWTP and production data of Plant I - III of PT Petrokimia Gresik are used as data in this study.

Table 4. 1. Types of data collected

No	Data type
1	Production data of Plant IA (Plant Amoniak I, Urea I, ZA I-III)
2	Production data of Plant IB (Plant Amoniak II, Urea II)
3	Production data of Plant IIA (Phosphate Fertilizer I, NPK Phonska I-III)
4	Production data of Plant IIB (NPK Phonska IV, Granulation NPK I-IV,ZK)
5	Production data of Plant IIIA (Sulfuric Acid I, Phosphoric Acid I, *Purified Gypsum* I, dan AlF_3)
6	Production data of Plant IIIB (Sulfuric Acid II, Phosphoric Acid II, and *Purified Gypsum* II)
7	Analysis Result Data of Wastewater with parameters of total NH_3, PO_4, Fluor, pH and TSS at the inlet of wastewater treatment.
8	Waste water discharge data at the wastewater treatment inlet.

Based on Table 4.1 The type of data collected for analysis comes from internal data of PT.Petrokimia Gresik. The data used for the analysis of the high PO_4 Pollution Load at the PT.Petrokimia Gresik is data from January to October 2021.

4.2. Calculation of Waste Water Pollution Load

From the wastewater discharge data, wastewater concentration and total production of PT.Petrokimia Gresik then calculates the load of wastewater pollution in each parameter.

$$BPA = \frac{Q\ x\ C}{production\ total} \quad \ldots\ldots\ldots\

The results of calculating the pollution load can be seen in Table 4.11 below:

Table 4. 2. PT Petrokimia Gresik wastewater Pollution load

Month	NH_3 total kg/ton	TKN kg/ton	Fluor kg/ton	TSS kg/ton	COD kg/ton	PO_4 kg/ton
January	0,87	0,97	0,04	0,03	0,08	0,95
February	0,71	1,02	0,02	0,02	0,02	0,86
March	0,71	0,81	0,02	0,02	0,01	0,54
April	0,47	0,51	0,02	0,17	0,01	1,09
May	0,55	0,66	0,01	0,06	0,01	0,87
June	0,38	0,64	0,04	0,05	0,02	1,12
July	0,44	0,64	0,02	0,03	0,01	0,97
August	0,84	0,62	0,01	0,04	0,03	1,43
September	0,66	0,55	0,01	0,05	0,03	0,69
October	0,91	0,61	0,02	0,16	0,05	0,83
Average	0,62	0,73	0,02	0,05	0,02	0,98

Based on Table 4.2. data on the pollution load of PT. Petrokimia Gresik is used for the analysis of identification of problems causing the high load of wastewater pollution at the WWTP Outlet of PT. Petrokimia Gresik uses Pareto Diagram analysis.

4.3. Identification of Problems Factor causing a high pollution load at the WWTP outlet

Based on the data from the calculation of the wastewater pollution load to identify and determine the priority of the problem of the high pollution load of wastewater at WWTP outlets using a Pareto Diagram.

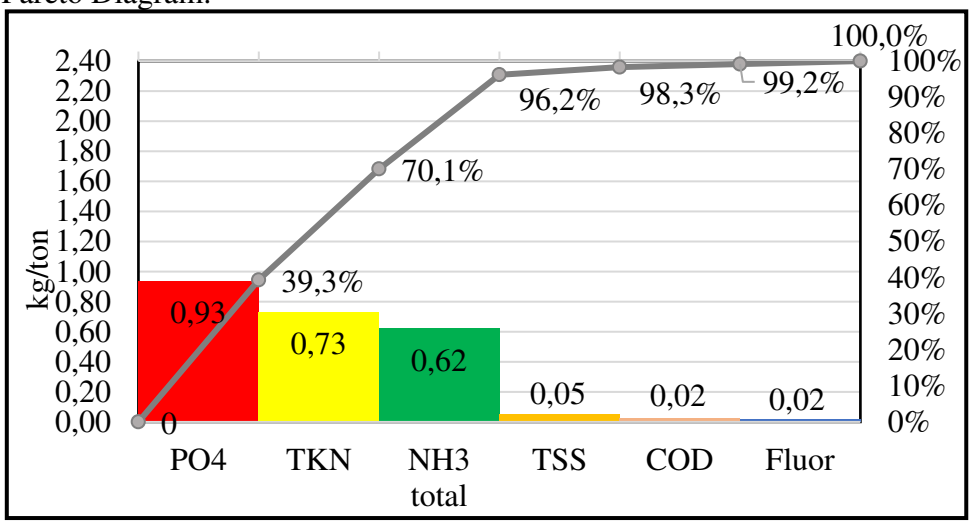

Figure 4.1. Pareto diagram of the problem of wastewater pollution loads

Based on Figure 4.1. Pareto diagram of the problem of wastewater pollution load, it can be concluded that there is a PO_4 pollution load that is the most dominant causing a high pollution load at the WWTP outlet.

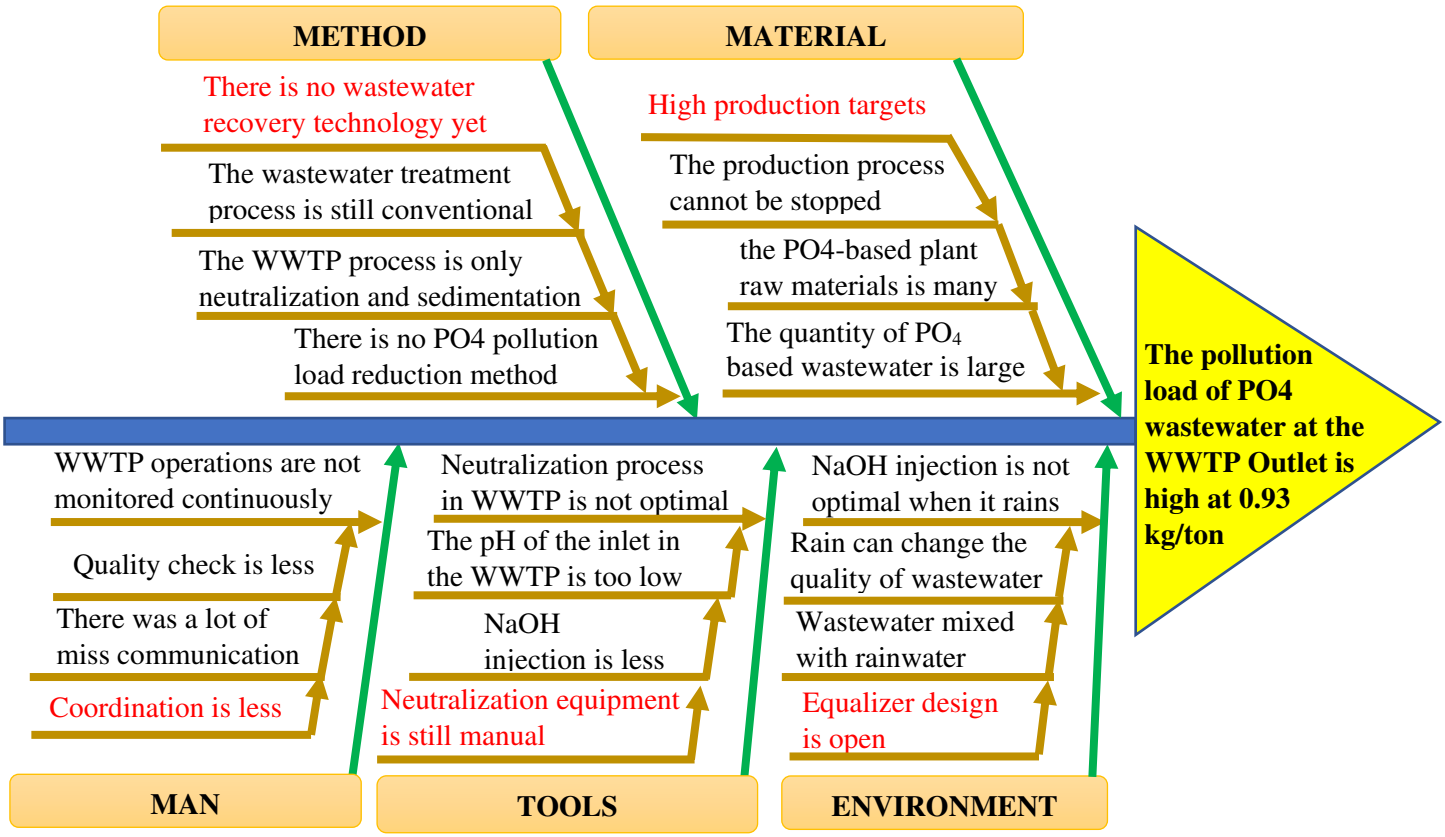

Figure 4.2. Cause & Effect Diagram Analysis

Based on Figure 4.2. the results of the Cause & Effect Diagram analysis obtained 5 root causes that caused the problem of the PO4 pollution load at the WWTP Outlet to be high at 0.93 kg/ton.

FMEA analysis (Failure Mode and Effect Analysis) is a step in the analysis to find the root causes that have been collected from the analysis of cause and effect diagrams. The cause will be given from the level of severity, occurrence and detection. The analysis will produce a priority number of risks from the cause. This priority determines the causes that are the focus for developing improvement scenarios. The FMEA assessment is carried out by distributing questionnaires to parties related to wastewater treatment at PT. Petrokimia Gresik. From the results of distributing the questionnaires, the average value of severity (S), occurrence (O) and detection (D) will be obtained, henceforth the RPN (Risk Priority Number) value will be obtained. Questionnaires were distributed to 8 (eight) respondents who are experts with wastewater treatment processes at PT Petrokimia Gresik. Experts who were the respondents included one person AVP for Water and Air Pollution Control, one person AVP for Utilities II, one person for Utility Supervisor II, one person for Plant Shift Supervisor, one person for Plant Shift II Supervisor, one Plant Shift Supervisor III number of one person and WWTP operator.

Table 4. 3. Failure Mode & Effect Analysis

ID	Potential Failure Mode	Potential effect of failure	Severity(S)	Potential Cause of Failure	Occurrence(O)	Current Design Control	Detection(D)	RPN (S x O x D)
F1	Equalizer design is open	WWTP operations disrupted	6	Rain	6	Equalizer routine drain	5	180
F2	There is no wastewater recovery technology yet	- Polluting the environment - High PO_4 based wastewater	10	There is no *recovery* PO_4	10	Control pH di Unit Netralisasi	10	1000
F3	High production targets	Plant equipment is broken	3	Stream days equipment	4	Make a Turn around (TA) schedule	5	60
F4	Neutralization equipment is still manual	pH Outlet Equalizer is acidic	9	The Control Neutralization Unit is less	10	Adjust the caustic soda valve opening	10	900
F5	Coordination is less	WWPT operations is less optimal	3	The Operator made the wrong decision	4	Coordination meeting every morning	2	24

Based on Table 4.3. the results of Failure Mode & Effect analysis (FMEA) of the 5 root causes of the problem of high PO_4 wastewater pollution load of 0.93 kg/ton, which is then analyzed for the dominant factors that influence these problems.

Based on the data from the calculation of the failure mode and effect analysis to identify and determine the dominant factor of the problem, a high PO_4 pollution load of 0.93 kg/ton uses a Pareto diagram.

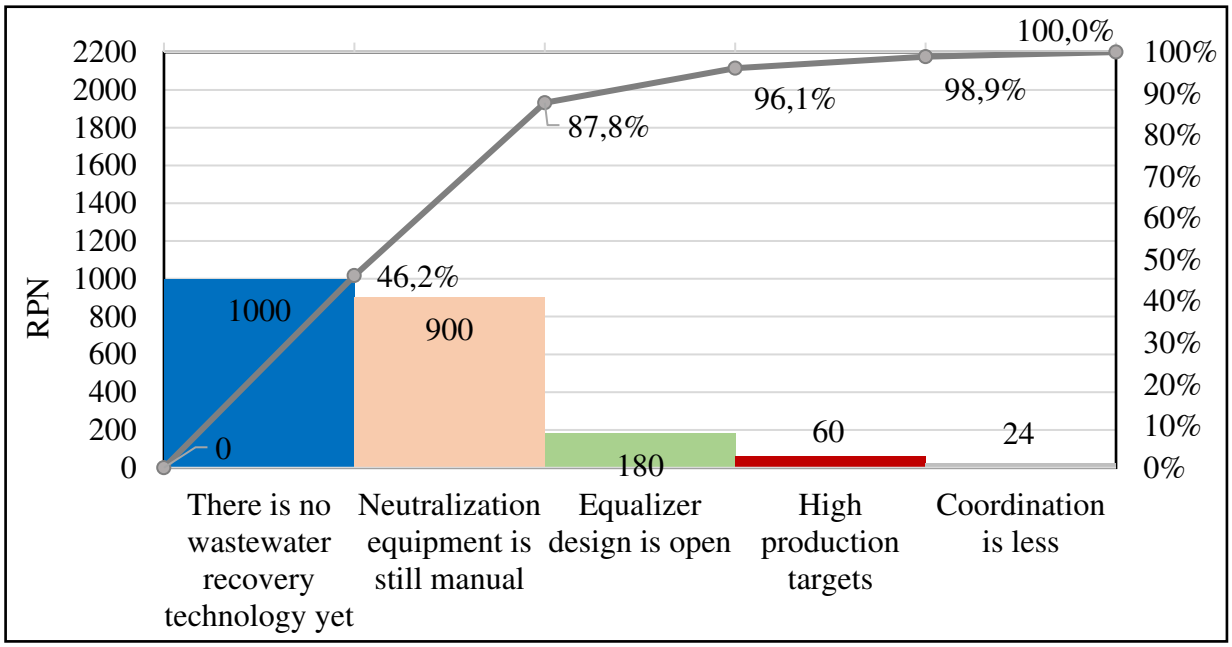

Figure 4. 3 Pareto diagram of the dominant factor for high PO_4 problems

Based on Figure 4.3 and in accordance with the Pareto 80/20 concept, then 80% of problems are solved with 20% of solutions, then the dominant cause of the 5 root causes of the analysis using FMEA is 80% of the total RPN. The causes of the problem of a high PO_4 pollution load of 0.94 kg/ton are as follows:

1. There is no wastewater recovery technology yet.
2. Neutralization equipment is still manual.

4.4. Scenario Development

Analysis of the root causes of the dominant problems found using Cause & effect diagrams, Failure mode & Effect analysis and Pareto diagrams is then carried out to develop scenarios to solve the dominant problems causing a high pollution load at the WWTP outlet of 0.93 kg/ton.

Table 4. 2. Alternative Scenarios

No	Root cause	Repair Scenarios
1	There is no waste water recovery technology	a. Creating a Struvite based Wastewater Treatment Unit b. Creating a Wastewater Treatment Unit with Coagulation and Flocculation technology c. Creating a new Phosphate Recovery Unit
2	Neutralization equipment is still manual	a. Changing WWTP neutralization and operational equipment using automatic methods

Based on Table 4.2. development of alternative scenarios is one of the solutions that can reduce the high PO_4 pollution load at PT. Petrokimia Gresik. Scenario development is based on the root cause of the high PO4 pollution load of 0.93 kg/ton.

4.5. Cost and Benefit Analysis

Comparison of alternatives using cost and benefit analysis in each alternative scenario to compare the benefits or savings generated with the cost of repairs. Cost and Benefit is determined by the value of ROI (Return on investment) and PP (Payback period). So that the best alternative scenario is obtained which is able to provide an effective savings impact on the cost of reducing the PO_4 pollution load at PT. Petrokimia Gresik with a feasible repair cost.

Table 4.3. Comparison of ROI and PP between Alternative Scenarios

Scenarios	Pollution load PO_4 (kg/ton)	Profit (Rp. bilion)	Investment Cost (Rp. bilion)	ROI (%)	PP (years)
Existing Simulation	0,93396	-	-	-	-
Changing WWTP neutralization and operational equipment using automatic methods	0,83422	- 4,453	0,042	-10.602	-0,01
Creating a Struvite based Wastewater Treatment Unit	0,00199	- 29,524	103,062	-28,65	-3,49
Creating a Wastewater Treatment Unit with Coagulation and Flocculation technology	0,00059	- 27,749	75,982	-36,52	-2,74
Creating a new Phosphate Recovery Unit	0,00040	19,785	89,999	21,98	4,55

Based on Table 4.3, it is found that the alternative scenario of the experiment is making a Struvite-based wastewater treatment unit, making a wastewater treatment unit with coagulation and flocculation technology, making a new Phosphate Recovery unit is the best scenario to reduce the PO_4 pollution load in the WWTP outlet wastewater. from the economic evaluation of alternative scenarios Making a new Phosphate Recovery Unit is the result of the best alternative scenario with a PO_4 pollution load at the WWTP outlet of 0.00040 kg/ton, a return on investment (ROI) value of 21.98% in 1 year and a payback period value (PP) of 4.5 years.

5. CONCLUSIONS

Based on the results of the problem analysis using the Pareto diagram, the cause of the high load of wastewater pollution at the WWTP Outlet PT. Petrokimia Gresik due to the most dominant PO_4 waste water pollution load at the WWTP Outlet of 0.93 kg/ton. Through Failure Mode and Effect Analysis (FMEA) analysis of 5 root causes of the problem through distributing questionnaires to related units at PT. Petrokimia Gresik and the pareto diagram produced 2 dominant root causes. To solve these 2 dominant problems, 4 alternative experimental scenarios have been developed which can reduce the load of PO4 wastewater pollution at PT Petrokimia Gresik WWTP Outlets. To reduce the PO_4 pollution load at the PT Petrokimia Gresik WWTP Outlet, the best alternative recommendation is to build a New Phosphate Recovery Unit with a PO_4 pollution load at the WWTP outlet of 0.00040 kg/ton, return on investment (ROI) value of 21.98 % in 1 year and the value of the payback period (PP) is 4.5 years.

Further research development can be carried out by adding several parameters to the treated water, namely pH and Ammonia content so that the treated water can be used as process water at the Phonska NPK Plant, NPK Granulation Plant, Phosphate Fertilizer Plant I and other Plant at PT. Petrokimia Gresik.

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ANALYSIS OF FACTORS AFFECTING THE ACCEPTANCE LEVEL OF THE DIGILEARN LEARNING MODEL USING UNIFIED THEORY OF ACCEPTANCE AND USE OF TECHNOLOGY 2 (UTAUT2)

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ABSTRACT

In an effort to accelerate employee competency improvement, PLN launched Digilearn as a digital-based learning medium. However, the application of digital learning often experiences problems, both in terms of readiness for technology acceptance and behavior (behavioral) of its use.

In this study, researchers used the Unified Theory of Acceptance and Use of Technology 2 (UTAUT2) to identify the factors that influence the level of acceptance of Digilearn technology. Testing this research model will use the Structural Equation Model Partial Least Square (SEM-PLS) method with SmartPLS software. Researchers used a research instrument in the form of a questionnaire to collect data and obtained a total of 84 employees who met the sample criteria. From the results of testing the validity and reliability of the data using the smartPLS software, it shows that the data used is valid and reliable as indicated by the Cronbach's Alpha and Composite Reliability values above 0.7. The results of evaluating the outer model using the PLS algorithm menu in smartPLS show the loading factor value for each exogenous construct with manifest variables or indicators above 0.7 so that it can be said that the research model has a good outer model. Furthermore, the evaluation results of the inner model using smartPLS also show that the R-Square (R^2) value is in the moderate category and even close to strong with an R^2 value of 0.736 or 73.6% of the variation from the endogenous variables can be explained by the exogenous variables.

Testing this hypothesis shows that there are 3 (three) variables that affect employees' desire to use Digilearn (Behavioral Intention), namely Performance Expectation with a p-value of 0.004, Hedonic Motivation with a p-value of 0.046 and Habit with a p-value of 0.000. In addition, it was also found that the facilitating Conditions variable had a direct effect on use behavior with a p-value of 0.004. Even so, from the results of testing the moderating effects of age, gender and experience, it was found that only the moderating effect of age on the relationship between Hedonic Motivation and Behavioral Intention.

Keywords: Digitalization, Digilearn, UTAUT2, SEM-PLS.

1. INTRODUCTION

Regarding the development of learning and training within the PLN environment that is currently being carried out, PLN sees that technological developments and industrial changes have

also changed the way employees learn. The method of learning, which originally had to be face-to-face in class, all day with a limited number of participants, is now starting to switch to being implemented online, with more flexible time and a larger number of participants. Where previously structured and systematic learning was prioritized, now it is more directed at the design thinking abilities of each employee. These things are being scrutinized and trying to apply at PLN as one of the roadmaps for developing the competence of PLN employees so they are not left behind by future technological developments.

In previous research conducted by Lin et. al., (2017) it turns out that compared to traditional learning, digital learning has a positive impact on learning motivation. By combining technology and current teaching trends, researchers can benefit from digital learning to develop practical teaching strategies for teaching effectiveness. However, the implementation of Digilearn is not completely without problems. From the results of preliminary research, it was found that learning students still did not use Digilearn due to the lack of interaction between students and instructors, then unsupportive environmental conditions, such as demands to complete office assignments besides doing training and limited internet quota and facilities such as internet network in several PLN working areas. These findings are in line with the statement expressed by Handayani et al., (2020) that the ineffectiveness of online learning is affected by costs incurred during learning and limited opportunities to interact directly with teachers. In addition, training students also complained that there were several instructors who were still not familiar with the facilities that had been provided, causing learning to be disrupted, they argued that this technology was still new so that there were still many PLN employees who did not fully understand how to use it. This condition is in line with research conducted by Hari et. al., (2015) that one of the biggest obstacles to the failure of the use of technology in the world of learning is due to the inability to absorb technology effectively by both teaching staff and students.

Learning conditions carried out in a company are certainly different from learning carried out on campus, the implementation of learning which is not carried out routinely causes the intensity of using Digilearn to depend on organizational actors according to the awareness and interest in using it. According to Pamugar et. al., (2014) differences in organizational characteristics, business processes, corporate culture and the character of each employee affect the implementation of e-learning. To evaluate the acceptance of learning technology within the PLN environment, in this study, the researcher intends to analyze what factors can influence the acceptance of the Digilearn learning model at PT PLN (Persero). The research methodology model used is the Unified Theory of Acceptance and Use of Technology 2 (UTAUT 2).

According to Sutanto et. al., (2018), the Unified Theory of Acceptance and Use of Technology is a model initiated by Venkatesh et al., (2003) to assist organizations in predicting acceptance and reactions to the use of new technology. The model was then redeveloped by adding several variables to become the Unified Theory of Acceptance and Use of Technology 2 (UTAUT 2) by Venkatesh, et al., (2012). Therefore, through this research it is hoped that factors that influence the acceptance of Digilearn technology will be obtained, especially for training participants at PT PLN (Persero) Makassar Education and Training Implementation Unit.

The Partial Least Square Structural Equation Modeling (SEM-PLS) method will be used as a tool to test the variables that have been determined in UTAUT2, namely 2 dependent variables (use behavioral and behavioral intention), 7 independent variables (performance expectancy, effort expectation, social influence, facilitating condition, habit, hedonic motivation and price value), as well as 3 moderator variables (age, gender, experience).

Based on the description of the existing problems, it is necessary to have a continuous technology development process by taking into account the factors that influence the acceptance

of the Digilearn learning model within PT PLN UPDL Makassar in order to increase the acceptance of Digilearn technology by training participants. This is intended so that Digilearn technology can be properly accepted so that a learning culture and digital mindset are realized in all company employees. This research will focus on discussing the factors that influence the level of acceptance of the Digilearn learning model using the Unified Theory of Acceptance and Use of Technology 2 (UTAUT2).

2. LITERATURE REVIEW

2.1 Digital Learning Application (PLN Digilearn)

The Digilearn application can be accessed at the link: digilearn.pln.co.id through the internet network and the PLN intranet network. The initial page when accessing the Digilearn application is the landing page, which provides information regarding digital application menus, features & functions, FAQs / frequently asked questions and login to access the My Learning menu, Learning Room, Learning on Demand, Learning Support. Wireframe Digital Learning can be seen in Figure 2.1.

Figure 2.1 Overview of the Digilearn Application Features

PLN Digilearn or commonly called Digilearn is an innovative product from the PLN Education and Training Center which was created as a forum to increase competence in PLN employees. Through Digilearn, PLN employees no longer need to do face-to-face learning which requires a lot of money with limited time and capacity. In the Digilearn application, learning materials are summarized in textual form, videos and even virtual reality. Employees can access material according to their position, even one level above their current position. In addition, for employees who want to do learning together, a webinar menu is also provided. And as a form of learning evaluation, the Digilearn application is also equipped with an evaluation menu for the level of understanding of learning outcomes. Employees are greatly helped by this application as the tagline embedded for this application is anytime, anywhere and any device. With this application, PLN can make efficiency in terms of operational costs and also SPPD costs for employees who are conducting education and training.

2.2 Technology Acceptance

The use of information and communication technologies allows us to increase the efficiency and quality of managerial decisions made in the field of human resource management, to preserve and increase their value in the company. In research conducted by Bailey and Pearson (1983) said that the willingness of a group of users to use information technology as intended is called User Acceptance. The principle of user acceptance theory is that the actual use of a technology does not deviate too far from what is predicted by the technology maker, so that each user acceptance can be predicted and modeled (Seuwou et. al., 2016). User acceptance is considered to be the key to the success or failure of an information technology project. Venkatesh et al., (2003) in their research describes the basic concept of user acceptance theory as shown in Figure 2.2.

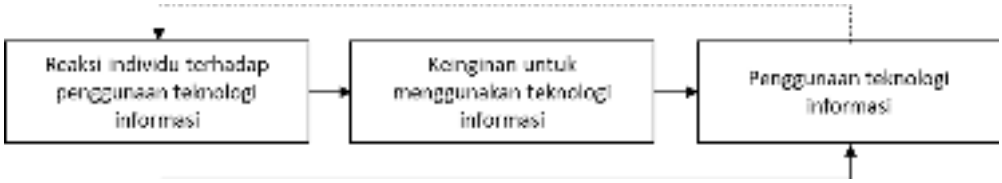

Figure 2.2 Basic Concepts of User Acceptance

2.3 Unified Theory of Acceptance and Use of Technology 2 (UTAUT2)

Venkatesh et al., (2003) conducted research in 2012 to develop a new technology acceptance model or UTAUT which was carried out in 2003 and named it UTAUT2. The UTAUT model itself is a model developed by Venkatesh et al., (2003) to measure acceptance of new technology. According to Venkatesh et al., (2003) in a study conducted by Hamrul et al., (2013) UTAUT is a new technology acceptance construct model developed by combining the concept of technology acceptance from previous models which can be seen in Table 2.1 below:

Table 2. 1 Conception of UTAUT Development

Konsepsi UTAUT	Akar Konsepsi	Model Sumber
Performance Expectancy	*Perceived Usefulness*	TAM *(Technology Acceptance Model)*
	Extrinsic Motivation	MM *(Motivational Model)*
	Job-fit	MPCU *(Model of Personal Computer Utilization)*
	Relative Advantage	IDT *(Innovation and Diffusion Theory)*
	Outcome Expectancy	SCT *(Social Cognitive Theory)*
Effort Expectancy	*Perceived Ease of Use*	TAM (Technology Acceptance Model)
	Complexity	MPCU
	Ease of Use	IDT
Social Influence	*Subjective Norm*	TRA *(Theory of Reasoned Action)* , TPB, C-TAM-TPB
	Social Factors	MPCU
	Image	IDT
Facilitating Condition	*Perceived Behavioral Control*	TPB *(Theory of Planned Behavior)* , C-TAM-TPB
	Facilitating Condition	MPCU
	Compability	IDT

Then to better understand consumer behavior in accepting and using new technology, Venkatesh, et al., (2012) developed the UTAUT theory by adding 3 (three) new variables namely hedonic motivation, price value, and habit and eliminating 1 (one) moderator namely voluntariness of use. This model is then called the Unified Theory of Acceptance and Use of Technology 2 (UTAUT2) or UTAUT 2. There are 3 moderator variables (age, gender, and experience) that are still used in moderating the construct effects of behavioral intention and use behavior in the UTAUT 2 model. constructs in UTAUT2 can be seen in Figure 2.5.

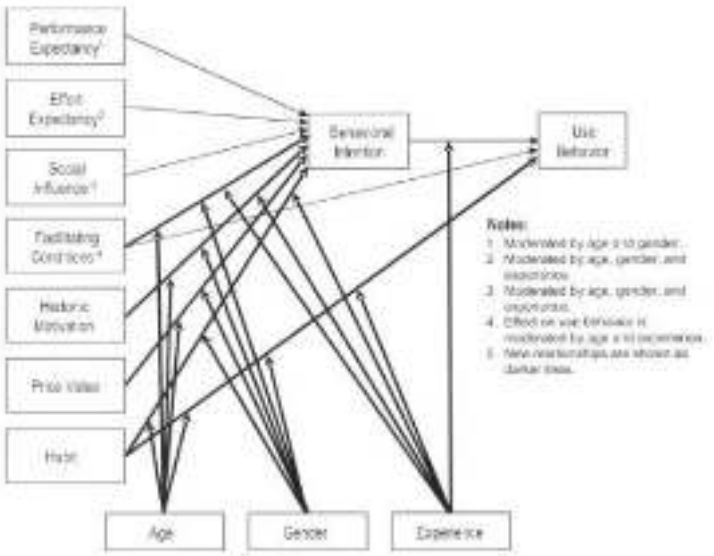

Figure 2.3 UTAUT2 Construct Model

2.4 Partial Least Square Structural Equation Modeling (PLS-SEM)

According to Ghozali (2014) in Anuraga et al.'s research, (2017), the SEM-PLS method or what is commonly called Partial Least Square (PLS) is part of SEM which is more soft modeling. This is because PLS does not impose data assumptions that must be met, such as a normal distribution or a large sample size. According to Hair et al., (2014) the use of PLS is more appropriate for predicting the effect between latent and manifest variables and explaining the relationship between the two variables because indicators in PLS can be formed with 2 (two) types, namely reflective and formative. In implementing PLS, there are process steps that must be followed, namely, ensuring model specifications, then evaluating the inner model or the relationship between the independent variables and the dependent variable, as well as evaluating the outer model, namely the relationship between the variables and their indicators.

3. METHODS

The initial stage of this research methodology is the preparation of a research flowchart. At this stage, the researcher will show the stages of each process in the form of steps or instructions in this research in order to get the intended results. The flow of this research will be divided into 4 main stages, namely:

1) Initial Research Stage

At this stage the researcher determines the topic to be studied, then identifies the problem, research objectives and research scope. Also equipped with a collection of literature studies obtained through observation, interviews, books, journals and articles.

2) Second Stage, namely Observation and Collecting Data

The second stage, researchers identified data needs and data collection techniques through questionnaires and literature studies.

3) The Third Stage, Testing, Analysis and Interpretation of Data

The data that has been obtained in the previous stages will be tested for validity and reliability. After that the researcher will perform data processing using the Partial Least Square Structural Equation Model (SEM-PLS) method with the help of the SmartPLS application, then the results of

data processing will be analyzed with the support of literature studies and interpreted to make it easier for readers to understand the results of data processing.

4) Fourth Stage, Conclusion

After the data is processed and analyzed, the researcher will move on to the next stage, namely drawing conclusions. The conclusion is obtained from comparing the results of the analysis with the initial research hypothesis. From there researchers can provide recommendations for companies and also suggestions for further research.

In general, the steps mentioned above that will be carried out to complete this research are described in Figure 3.1 below:

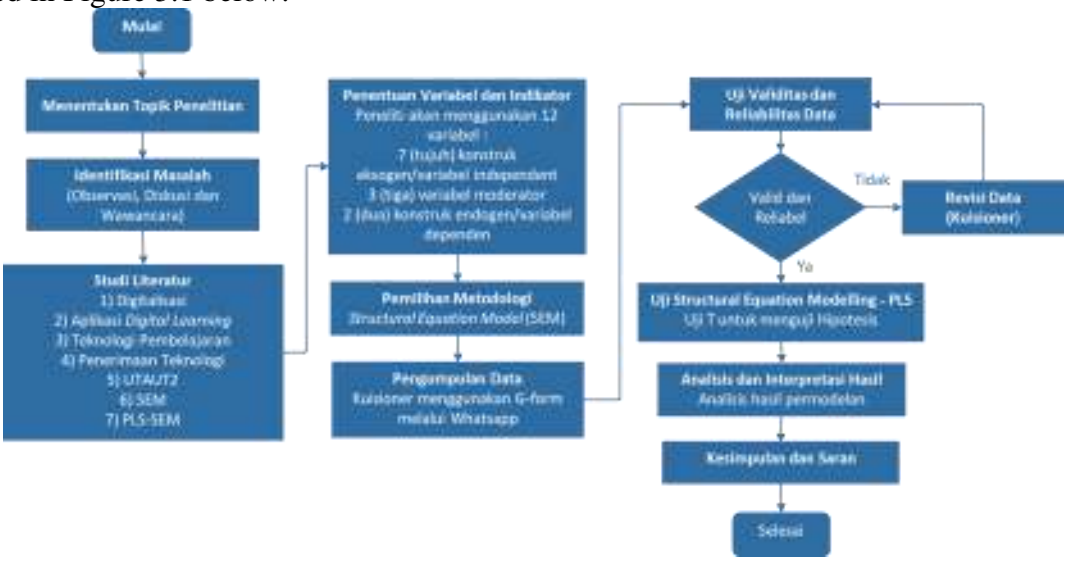

Figure 3. 1 Research Flowchart

In accordance with the research flow diagram above, the researcher began the research with the following steps:

1. Researchers take topics based on issues that are developing in PLN, especially in the education and training units, which are related to the implementation of Digilearn as one of the digital-based learning tools.
2. Then the researchers conducted observations, discussions and interviews with both Digilearn users and facilitators to find out the obstacles faced.
3. The researcher conducted a literature study related to technology acceptance theory as an effort to solve the problems faced.
4. Based on the theory used, the researcher chooses the variables that have been determined as the theory was coined.
5. Then the researcher determines the most appropriate methodology for analyzing this research, namely SEM-PLS. As one of the methods in accordance with the criteria of the research model.
6. After the preparation stage is complete, the researcher carries out the data collection stage which will be carried out through a questionnaire and will be distributed via the WhatsApp short message application until a representative number of respondents is obtained according to the selected sampling technique.
7. The next stage is to test the validity and reliability of the data using the SmartPLS application. At this stage, the data will be processed and assessed for its validity and reliability. If the test results have shown that the data collected is valid and reliable, the researcher will enter the next stage, namely hypothesis testing.

8. Hypothesis testing is done by conducting a T-test. Through this T-test the researcher can determine which hypotheses have a significant influence and which do not.
9. After the data is processed using smartPLS, the researcher will interpret the results and analyze them. From this analysis, the results of the research will be compared with the theories used as well as previous studies.
10. After all stages have been passed, the researcher will draw conclusions based on the findings obtained and provide suggestions for further research.

4. RESULTS

The results of the evaluation of the outer model and inner model in the previous discussion show that the model is said to be fit or good and can be continued for testing the latent variable hypothesis. In this test, it will be seen the level of significance of the influence of exogenous (independent/free) latent variables on endogenous (dependent/bound) variables. This test will look at 2 values, namely the statistical t value (t test) and the p value. According to Ghozali (2014), the independent variable has a significant influence if it has a statistical t value ≥ 1.96. And based on the p value, a variable is said to have a significant influence if the p value ≤ 0.05 with the note that the p value test uses a significance level of α = 5%. This test uses the bootstrapping menu available in the smartPLS software. The results of hypothesis testing using smartPLS can be seen in Table 4.1 and Table 4.2 bellow:

Table 4.1 Results of Hypothesis Testing Using Bootstrapping

Hipotesis	Hubungan Variabel	*T Statistics*	*P Value*
H_1	Performance Expectancy (X1) -> Behavioral Intention (Y1)	2,876	0,004
H_2	Effort Expectancy (X2) -> Behavioral Intention (Y1)	0,520	0,603
H_3	Social Influence (X3) -> Behavioral Intention (Y1)	0,549	0,583
H_4	Facilitating Conditions (X4) -> Behavioral Intention (Y1)	0,705	0,481
H_5	Facilitating Conditions (X4) -> Use Behavior (Y2)	2,858	0,004
H_6	Hedonic Motivation (X5) -> Behavioral Intention (Y1)	2,005	0,046
H_7	Price Value (X6) -> Behavioral Intention (Y1)	0,622	0,535
H_8	Habit (X7) -> Behavioral Intention (Y1)	4,085	0,000
H_9	Habit (X7) -> Use Behavior (Y2)	0,349	0,728
H_{10}	Behavioral Intention (Y1) -> Use Behavior (Y2)	1,186	0,236

From the results of the bootstrapping test with a significance level of α = 5% (0.05) above, it shows that the relationship between the variables Performance Expectancy, Hedonic Motivation and Habit has a significant relationship to the Behavioral Intention variable. Likewise the Facilitating Conditions variable has a significant effect on the Use Behavior variable. In this way the results of the hypothesis test show that H1, H5, H6 and H8 are accepted. While the remaining hypotheses are rejected because the p value is more than α or more than 0.05.

The next stage of this research is to examine the moderating effect (age, gender and experience). Where from the results of this moderating effect test it will be known the significance of the effect of the moderating variable on the relationship between exogenous latent variables and endogenous latent variables. This test still uses smartPLS software with the Multi Group Analysis (MGA) method. This test will only be carried out on exogenous variables which from the results of previous tests show a significant effect on endogenous variables, namely Performance Expectancy, Facilitating Conditions, Hedonic Motivations and Habit.

Table 4.2 Hypothesis Test Results Based on Age Moderation

	Path Coefficie...	p-Value origin...	p-Value new (...
Behavioral Intention (Y1) -> Use Behavior (Y2)	0.188	0.204	0.408
Facilitating Conditions (X4) -> Use Behavior (Y2)	-0.259	0.850	0.300
Habit (X7) -> Behavioral Intention (Y1)	0.334	0.095	0.189
Hedonic Motivation (X5) -> Behavioral Intention (Y1)	-0.408	0.989	0.022
Performance Expectancy (X1) -> Behavioral Intention (Y1)	0.063	0.367	0.735

The results above show that the moderating variable age has a significant effect on the relationship between the exogenous variable Hedonic Motivation and the endogenous variable Behavioral Intention.

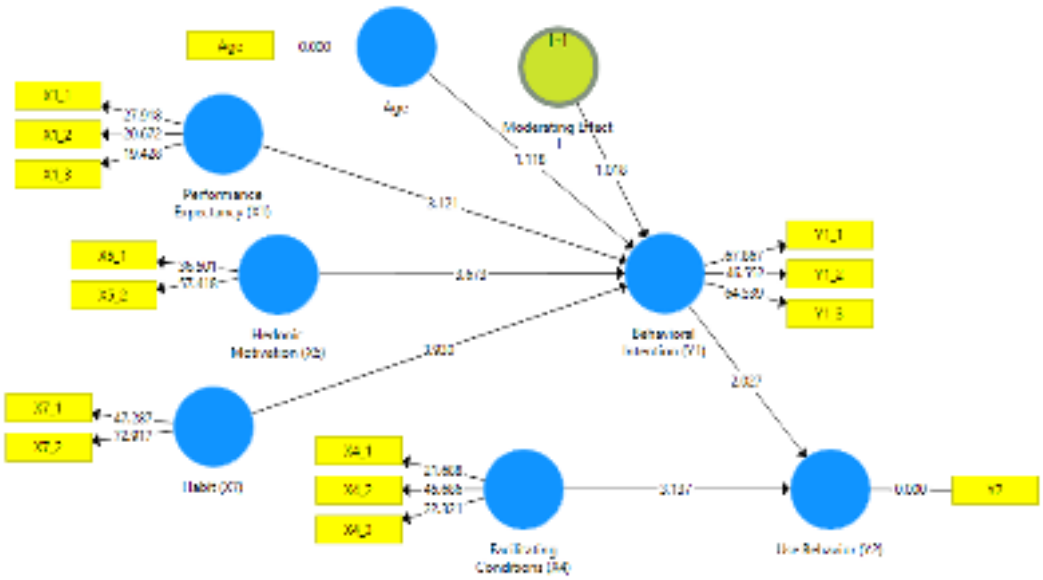

Figure 4. 1 Research Models with Age Moderating Variables

Figure 4.11 shows the relationship between the exogenous latent variable Hedonic Motivations and the endogenous latent variable Behavioral Intention which was successfully moderated by the age variable. Meanwhile, the moderating variable gender (gender) and the moderating variable experience (experience) were not included in the final model of the study because they did not have a significant effect on the relationship between latent variables.

5. CONCLUSIONS

Researchers have conducted research to analyze what factors influence Digilearn acceptance using the unified theory of acceptance and use of technology 2 (UTAUT2) model approach and using the partial least square structural equation modeling (SEM-PLS) analysis method. From the results of this study it can be concluded as follows:

1. Researchers used a research instrument in the form of a questionnaire to collect data and obtained a total of 84 employees who met the sample criteria. From the results of testing the validity and reliability of the data using the smartPLS software, it shows that the data used is valid and reliable as indicated by the Cronbach's Alpha and Composite Reliability values above 0.7.

2. The results of evaluating the outer model using the PLS algorithm menu in smartPLS show the loading factor value for each exogenous construct with manifest variables or indicators above 0.7 so that it can be said that the research model has a good outer model.
3. The evaluation results of the inner model using smartPLS also show that the R-Square (R2) value is in the moderate category and even close to strong with an R2 value of 0.736 or 73.6% of the variation from the endogenous variables can be explained by the exogenous variables. Testing the inner model with cross-validated redundancy (Q2) to determine the relative effect of the inner model on the measurement of endogenous variable observations also shows a fairly high value of 0.611 or 61.6%.
4. Testing the hypothesis using the SEM-PLS analysis model shows that of the 7 (seven) exogenous variables, there are 4 (four) variables that have a significant influence on Digilearn acceptance. These variables are performance expectancy, hedonic motivation, facilitating conditions and habits. Meanwhile, the remaining 3 (three) namely effort expectancy, price value and social influence have no significant effect on Digilearn acceptance.
5. Based on the factors that have a significant influence on acceptance of Digilearn, it shows that the higher the employee's expectations (performance expectancy) for the benefits of Digilearn will increase the desire of employees to use Digilearn. Then, the higher the satisfaction that employees will get (hedonic motivation) when using Digilearn will encourage their desire to use Digilearn. Besides that, employee habits (habit) and the availability of supporting facilities (facilitating conditions) have also proven to influence the use of Digilearn.
6. The results of testing the moderating effects of age (age), gender (gender) and years of service (experience) show that there is a moderating effect of age (age group $\leq$ 30 and age group > 30 years) on the relationship between hedonic motivation and behavioral intention. The remainder for the moderating variables of gender and years of service did not show any moderating effect on the relationship between exogenous and endogenous variables.
7. The variables effort expectancy, price value and social influence show insignificant results so that it can be said that the ease of use, the influence of the people around, and the costs incurred to use this technology do not have a significant effect on the acceptance of Digilearn.
8. The strategy that the researcher recommends to increase Digilearn acceptance is first, maximizing the features (value added) that exist in Digilearn so that through this technology, employees' needs for self-competence improvement can be fulfilled. Second, provide rewards, points and include them as one of the assessments for promotional needs. Third, give regular assignments to familiarize employees with using Digilearn. And fourth, providing facilities, modules and officers who can support the use of Digilearn.

In this study, researchers especially in testing the moderating effect only found the variable age (age), which has a moderating effect on the relationship between exogenous variables and endogenous variables. However, from the multi-group analysis on the moderating variable of tenure as an experience variable, it has a p-value of 0.096, which can be said to be significant at a significance level of $\alpha = 0.1$ or 10%. Therefore, the researcher suggests that in the next similar research those who wish to research similar topics are advised to use work experience as a variable.

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RISK ANALYSIS ON CHANGE OF CARGO QUANTITY DUE TO DEVIATION OF BERTHING PORT FROM TANJUNG PRIOK PORT TO PATIMBAN PORT

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ABSTRACT

Tanjung Priok Port as one of the busiest ports with the transportation of cargos that occurred during 2020 reached 40.5 million tons. The government implement a strategy of moving cargo shipping activities from the Tanjung Priok Port to the Patimban Port at the end of 2021. The purpose of this research is to mitigate the reduction in the amount of cargo due to port deviation to Patimban. The implementation of the House of Risk (HoR) method is used to be identified the risks that arise in the process of deviation port. The risk assessment process is used to determine risk priorities that must be mitigated so that can be controlled and monitored in the future. After risk identification & analysis, there are 13 out of 25 risk agents that frequently occurs and have high severity. So the mitigation needs to be done in the form of preparing ships back up / ship charters, port agent training and preparing more than one vendor agent, implementing an outsourcing/ work shift system, implementing digitization and standardization of documents, preparing and renting loading and unloading equipment from third parties and installing applications for fastest route selection on trucking.

Keywords: Cargo, House of Risk, Port, Risk, Transportation Management

1. INTRODUCTION

According to data from the Badan Pusa Statistik (BPS) 2022, demonstrated in Figure 1. 1, the number of items transported at Tanjung Priok Port in 2020 reached 40,5 million tonnes. Tanjung Priok Port has a high loading and unloading process since it is the only Jakarta port capable of serving domestic and international shipping activity. Tanjung Priok Port is the only port managed by PT. Indonesia Kendaraan Terminal (IKT) for loading and unloading ships, specifically for carrying vehicles and heavy equipment.

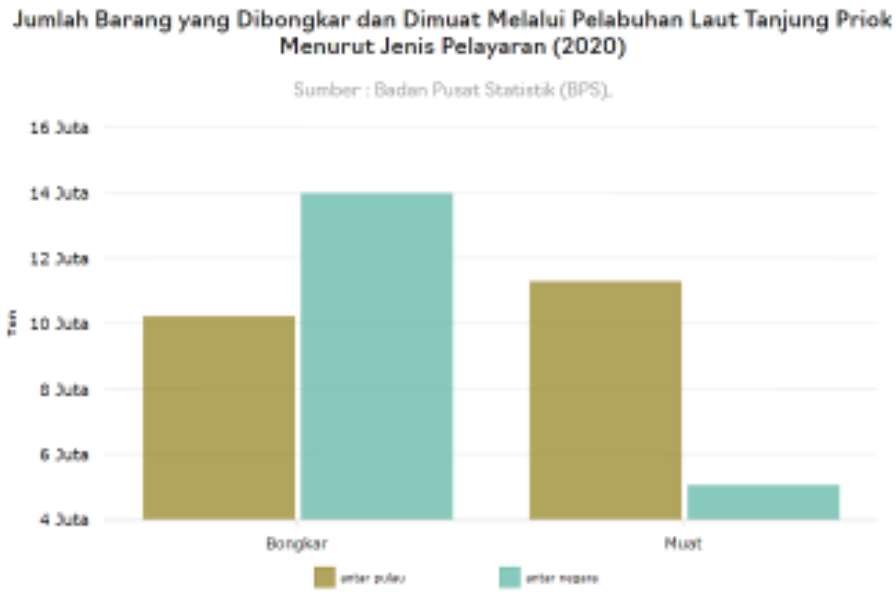

Figure 1. 1 Number of Unloaded and Loaded Cargo at Tanjung Priok Port

In 2020, the Ministry of Transportation issued Decree Number KM 318 of the Ministry of Transportation regarding establishing Patimban Port in Subang Regency as a public port open to foreign and domestic trade. This is part of the government's strategy to alleviate the congestion and overburden at Tanjung Priok Port during the loading and unloading. The Minister of Transportation inaugurated Patimban Port in October 2021. In Patimban Port, the trial phase of berthing all cargo ships specifically for delivering domestic and international vehicle cargo was carried out in stages. Consequently, it is necessary to identify potential risks and implement mitigation or preventative measures (Triatmodjo,2018).

2. LITERATURE REVIEW

Previous research has identified the potential risks associated with ship service at Tanjung Perak Port. The identification process utilises the fault tree analysis method to determine what causes the risks emerging from each activity. Risk evaluation will be conducted using failure mode effects and criticality analysis, which will classify risks into a risk map based on each risk's severity and occurrence value. The subsequent review phase will mitigate corrective action-required risks. The findings on risk identification revealed 62 risks associated with the ship service process. During the risk evaluation, 17 risks necessitating corrective action and 45 risks not necessitating corrective action were identified (Sebayang, 2016).

In addition, past research was utilised to analyse the construction of new ports in industrial areas surrounding West Java, potential shifts in container transport, market share, and the cost of container transportation from the coast and hinterland. Five nations shipped containers, including Singapore, China, South Korea, Thailand, and Malaysia. Shipping containers through the hinterland and the foreland to Karawang and Bekasi is more effective through Tanjung Priok, expensing Rp. 3.6 million and Rp. 2.8 million; on the other hand, shipments to Subang, Indramayu, Bandung, Tasikmalaya and Purwakarta are more effective through Patimban, expensing IDR 2.7 million, IDR 3.4 million, IDR 4.9 million, IDR 6 million and IDR 3.7 million via Patimban (Arira, 2018).

3. METHODS

This study will identify risks that will occur and be caused by the relocation or deviation of the berthing port from Tanjung Priok Port in Jakarta to Patimban Port in Subang using the House of Risk (HoR) method. Yuda (2019) said, The House of Risk stage consists of two parts; the first is risk identification, which aims to determine risk events and agents in each business process. The following is the risk analysis process, in which the severity and occurrence values of the existing risks are analysed to be mapped into the risk matrix based on the Aggregate Risk Potential (ARP) value (Prabowo,2018). After obtaining the ARP value, the agent with the highest potential risk is chosen. Based on Purwadono (2010), a risk evaluation is performed on the list of risk agents with the most potential to determine risk treatment and mitigation for each current risk agent. At the phase 2 stage of the house of risk, existing preventive or risk mitigation actions are conducted to determine which should be performed first (Cahyani, 2016).

4. RESULTS

4.1 House of Risk Fase 1

Identification data is collected on risk events and agents during the cargo delivery and risks due to the berthing port transfers. Identifying risk events and agents is separated into the transportation and port business processes. Where the risk agent can affect several risk events, multiple risk agents can affect a single risk event. In this study, interviews with parties involved in cargo delivery were performed to collect data to identify risk event variables and agents. The data on risk events and agents is demonstrated in **Table 4.1**

Table 4.1 Risk Event & Risk Agent Identification

Kode	*Risk Event*		Kode	*Risk Agent*
Transportasi			Transportasi	
Administrasi			Administrasi	
E1	Kesalahan Delivery Order		A1	Kesalahan Input Data di Sistem DO
E2	*Trucking* tidak kebaca		A2	Tidak terinputnya/ data dokumen
E3	Dokumen pengiriman tidak lengkap		A3	Tidak disiapkannya dokumen
E4	*Missing approval* pengambilan kargo		A4	Dokumen lupa ditandatangani
Operation			*Operation*	
E5	Kargo rusak		A5	Trailer dan fasilitas tidak layak pakai
E6	Kargo terjatuh		A6	lashing dan pengikatan tidak benar
E7	Kesalahan area pengiriman		A7	Perubahan lokasi
E8	Keterlambatan penjemputan kargo		A8	kesalahan pemilihan rute
Manajemen			*Manajemen*	
E9	Data Sistem dan Dokumen tidak match		A9	Gangguan Sistem IT
Eskternal			*Eskternal*	
E10	Keterlambatan Pengiriman		A10	*Traffic Jam*
E11	Tidak kebawanya kargo		A11	Kurangnya komunikasi dengan eskternal
Kepelabuhanan			Kepelabuhanan	
Administrasi			*Administrasi*	
E12	Delivery Order tidak sesuai		A12	Delivery order tidak keupdate
E13	*Invoice tidak sesuai*		A13	Sistem invoicing tidka keupdate
E14	Dokumen pengantaran tidak lengkap		A14	Dokumen belum terupdate
E15	*Missing approval* pengantaran kargo		*Operation*	
Operation			A15	*Man Hour* yang kurang
E16	Lamanya proses muat		A16	Kondisi pelabuhan yang padat
E17	Kargo rusak saat *cargodoring*		A17	Fasilitas *Cargodoring* kurang memadai
E18	Kargo rusak saat *stevedoring*		A18	Fasilitas *stevedeoring* kurang memadai
E19	Kargo tertukar		A19	Bill of lading tidak sesuai
E20	Kargo tertinggal di lapangan		A20	Agen pelabuhan yang kurang kompeten
Kepelabuhanan			*Kepelabuhanan*	
E21	Data Jadwal, Kargo dan manifest yang berbeda di sistem		A21	Gangguan Sistem Kepelabuhan
E22	Keterlambatan kapal datang		A22	Perubahan *schedulle kapal*
Shippinglines			*Shippinglines*	
E23	Gagal Muat		A23	Kapal tidak jadi sandar
E24	Delay/ ganti jadwal sandar		A24	Area sandar penuh
E25	kerusakan saat lashing di kapal		A25	lashing di kapal kurang memadai

After distributing the questionnaires, ARP calculations were carried out in the House of Risk phase 1 (HOR phase 1). The mapping was determined following the standard 5x5 severity and occurrence rates matrix and placed under the ARP values. Mapping is performed by obtaining the ARP value by multiplying the risk event's severity and occurrence, where the ARP number indicates the risk event's position in the risk matrix level column. In **Figure 4.2,** there is one risk with highly high criteria, four risks with high criteria, and 16 risks with medium criteria.

Occurrence		Severity: Tidak signifikan 1	Minor 2	Medium 3	Mayor 4	Critical 5
Sangat besar	5				E22	
Besar	4		E3,E4,E9,E13, E14,E15,E21	E10,E12	E8,E16	
Sedang	3		E2,			
Kecil	2		E1		E7,E17,E19, E25	E5,E6,E11,E18 ,E20,E24
Sangat kecil	1					E23

Figure 4.2 Risk Matrix on Risk Event

The following are the results of the Pareto diagram depiction for HOR phase 1 results: The bar chart in **Figure 4.3** represents the ARP value of the risk agent, which consists of two colours: yellow indicates that the risk agent has not been eliminated. The red indicates that the risk agent has been eliminated. On the other hand, the line chart represents the cumulative percentage of each risk agent. The outcome of calculating the cumulative percentage of ARP is greater than 80%, indicating that the risk agent variables account for 20% of the possibility of the cargo delivery procedure to Patimban triggering the risk. In addition, variables with an accumulation percentage over 80% to 100% will be excluded from preventative action planning.

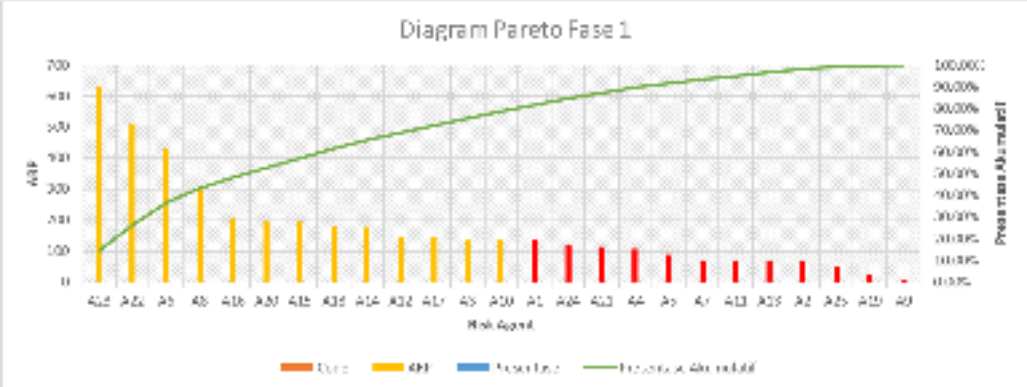

Figure 4. 3 Pareto Diagram

Table 4. 2 *Preventif Action*

Priority Rank	Code	*Risk Agent*	*Risk Treatment*	*Preventif action*
1	A23	Kapal tidak jadi sandar	avoid	*back up* kapal cadangan
2	A22	Perubahan schedulle kapal	avoid	*back up* kapal cadangan
3	A6	lashing dan pengikatan tidak benar	mitigasi	sewa perlengkapan & peralatan cargodoring ke pihak ketiga
4	A8	kesalahan pemilihan rute	mitigasi	instalasi aplikasi pemilihan rute tercepat
5	A16	Kondisi pelabuhan yang padat	mitigasi	retraining agen & menyiapakan lebih dari 1 vendor agen kepelabuhanan
6	A20	Agen pelabuhan yang kurang kompeten	mitigasi	retraining agen & menyiapakan lebih dari 1 vendor agen kepelabuhanan
7	A15	Man Hour yang kurang	mitigasi	menerapakn sistem outsouring & shift
8	A18	Fasilitas stevedeoring kurang memadai	transfer	sewa perlengkapan & peralatan cargodoring ke pihak ketiga
9	A14	Dokumen belum terupdate	mitigasi	menerapkan sistem SOP dan standard dokumen
10	A12	Delivery order tidak keupdate	mitigasi	menerapkan sistem SOP dan standard dokumen
11	A17	Fasilitas Cargodoring kurang memadai	transfer	sewa perlengkapan & peralatan cargodoring ke pihak ketiga
12	A3	Tidak disiapkannya dokumen	mitigasi	menerapkan sistem SOP dan standard dokumen
13	A10	Traffic Jam	mitigasi	instalasi aplikasi pemilihan rute tercepat

Furthermore, there is a correlation between the outcomes of risk events and risk agents. This relationship also involves the risk event's severity and the risk agent's occurrence. This relationship generates an Aggregate Risk Potential (ARP) value from the risk agent to determine mitigation. Based on **Table 4.2**, 13 agents must be determined, and several preventative actions can be performed to minimise the occurrence of risk agents. Based on the preparation of preventive actions, several preventive actions are similar and can be employed to prevent several risk agents.

4.2 House of Risk Fase 1

The outcomes of the preventive action identification in Table 4.2 are then utilised in phase 2 of the House of Risk (HOR) model, together with the degree of difficulty received from the group discussion forum and presented in **Table 4.3.**

Table 4.3 Preventif Action based on Difficultyof Performing Action.

Code	*Preventif action*	*Dk*
PA1	*back up* kapal cadangan	5
PA2	retraining agen & menyiapakan lebih dari 1 vendor agen kepelabuhanan	4
PA3	menerapakn sistem outsourcing & shift	3
PA4	menerapkan sistem SOP dan standard dokumen secara digital	4
PA5	sewa perlengkapan & peralatan ke pihak ketiga	4
PA6	instalasi aplikasi pemilihan rute tercepat	4

Six preventive actions were acquired and will be processed during phase 2 of the House of Risk. In addition, based on the questionnaire findings, the correlation value between the existing preventative intervention and the risk agent is calculated. In addition, a ranking of preventative actions must be performed by considering each preventive action's difficulty level and effectiveness, as revealed in **Table 4.4.**

Table 4.4 House of Risk fase 2

Risk Agent (Aj)	*Preventive Action* (PAk)						ARP *Risk*
	PA1	PA2	PA3	PA4	PA5	PA6	*Agent*
A23	9	1	0	1	1	0	630
A22	9	1	1	1	1	0	512
A6	0	9	0	9	9	0	432
A8	0	0	0	0	0	9	300
A16	0	0	9	0	1	0	210
A20	0	9	9	3	3	0	198
A15	0	3	9	1	1	0	195
A18	0	9	1	3	9	0	180
A14	0	0	0	9	0	0	175
A12	0	0	0	9	0	0	145
A17	0	0	1	3	9	0	144
A3	0	0	3	9	0	0	140
A10	0	0	0	0	0	9	140
Difficultyof performing action k (Dk)	5	3	3	4	4	4	
Total effectiveness of proactive action k (TEk)	10,278	9,017	6,683	10,931	8,945	3,960	
Effectiveness to difficulty ratio of action k (ETDk)	2,056	3,006	2,228	2,733	2,236	990	
Rank of proactive action k (Rk)	5	1	4	2	3	6	

5. CONCLUSIONS

Identifying risks that emerge in port relocation from Tanjung Priok Port to Patimban Port, where 13 out of 25 risk agents frequently occur and have high severity, such as ships not berthing, changes in ship docking schedules, lashing and improper ship binding, route selection errors, congested port conditions, incompetent port agents, insufficient number of working hours, inadequate facilities, documents that are not up-to-date, inappropriate delivery, unprepared documents, and congestion in cargo delivery.

Mitigation of risks stemming from the relocation of the port from Tanjung Priok to Patimban, among other things, by preparing backup vessels/ship charters, training port agents and preparing more than one agent vendor, implementing an outsourcing/work shift system, implementing digitisation and document standardisation, preparing and renting loading and unloading equipment from third parties, and installing the quickest route selection application for trucking.

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Digital Transformation 4.0 Implementation in Petrochemical Company

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ABSTRACT

PT. XYZ was hit hard by the increase in crude oil prices which increased significantly in March 2022. Geopolitical tensions caused crude oil prices to jump more than US$100 per barrels compared to 2021. This caused Q1 2022 EBITDA to drop by 83% compared to 2021, hence a strategy is needed to improve the performance of companies based on digital technology 4.0. In this study will discuss strategies related to the performance management system. The data processing process starts from the business mapping stage using Business Model Canvas (BMC) current state which later INDI 4.0 improvisation and redesigned BMC, integrating BMC into Balanced Scorecard (BSC) through expert judgment with semi-structured interviews.

Performance management system is in accordance with the proposed research analysis, namely mapping the business with BMC and increasing the value of INDI 4.0 from 3.07 to 4.0 by integrating BMC into Balanced Scorecard (BSC) generated a 3 million dollars' efficiency for the PT. XYZ

Keywords: Digital Transformation 4.0, INDI 4.0, BMC, BSC, efficiency

1. INTRODUCTION

The war between Russia and Ukraine that occurred in February 2022 which very significantly hit the world economy. The war between the two countries had a serious impact on the world, affecting price sharp hikes in the energy sector and the food sector, due to a lack of supply chains from these countries. PT. XYZ, which is Indonesia's premier petrochemical producer with an integrated plant. The geopolitical tensions due to the war Russia and Ukraine triggered crude oil price to spike to more than US$100 per barrel, which is about 25% higher quarter-on-quarter vs Q4 2021, and around 66% higher vs the comparable quarter in Q1 2021.

The crude oil price surge has increased naphtha input prices considerably. Naphtha is main raw material that be used by PT. XYZ to produce Ethylene, Propylene, Butadiene. Below is graphic of naphtha price

Figure 1. Naphtha Price 2020-2022

Refer to figure 1 that naphtha price in 2022 has dramatically increased up to 60% compared to 2021. Even more, on March 2022 the price reached almost double compared to March 2021. the Q1 2022 EBITDA has plunged up to 83% and cost of revenue has surged 45% compared to Q1 2021 due to naphtha price impact.

Kemeperin has launches Industri 4.0 Readiness Index is called INDI 4.0. INDI can be used to assess the level of industry readiness in Indonesia in applying industrial era 4.0 technology. INDI 4.0 assessment uses the company's self-assessment mechanism by measuring five pillars, namely management and organization, people and culture, products and services, technology, and plant operations. (Kemenperin, 2018).

PT XYZ is a largest integrated Petrochemical producer in Indonesia which are produce Ethylene, Polyethylene, Polypropylene, Butadiene, Styrene Monomer, MTBE and B-1 plants and located in Cilegon, Banten. The roadmap Digital Transformation 4.0 was developed by PT. XYZ for dealing with Industry 4.0. This is in line with the business strategy of PT. XYZ to maintain and improve world-class operating standards, cost efficiency, SHE (safety, health, and environment) and the competence and ability of employees to take advantage of digital transformation. PT. XYZ is using digital technology as an enabler for sustainable operational and competitive advantage. PT. XYZ has also formed a digital transformation committee as a task force to make happen in digital transformation journey. Our digital transformation core mission are people culture, process optimization, and technology update". PT XYZ won the 2021 INDI 4.0 award for the Aggressive Digitalization category with a value of 3.07. Aggressive Digitalization category given to companies that significantly and aggressively developed digital technology in business processes to increase competitiveness and productivity in companies as well as efficiency in production processes.

Based on the problems described above, this study intends to establish a performance management system strategy that is in accordance with the proposed analysis to continue and increase the INDI 4.0 score from 3.07 to 4.0 and improve operational efficiency and reliability of PT. XYZ because of the company's EBITDA which fell by 83%.

2. LITERATURE REVIEW

According to Klaus (2016) in a book entitled "The Fourth Industrial Revolution" explained that digital transformation 4.0 is not only related to machines and systems but also advances technologies in the fields of nanotechnology, renewable energy and quantum computing. The interactions between these three components physically, digitally and biologically make the 4th industrial revolution phase totally different from the previous three phases. According to Manarep and Albert (2020), there are many benefits that companies that have implemented digital transformation will receive, namely production flexibility, speed in making prototype products, reduced down-time machines, and increased quality of the products. Digital transformation 4.0 is characterized by rapid development, growth, innovation and disruption. Companies that want to survive must be ready to adapt to the new digital landscape. The digital transformation process is much more than implementing new technology, or enhancing existing systems, but investing in people as well.

Referring to INDI 4.0 (2018), Indonesia is starting to implement assessment INDI 4.0 in 2018. Instruments Assessment INDI 4.0 used by industry and the government is a reference index to measure how prepared an industry is to face Industry 4.0. INDI 4.0 uses five pillars namely: management & organization, people & culture, products & services, technology, and plants operations.

A common instrument used to show clearer business mapping is known as Business Model Canvas (BMC) (Fritscher & Pigneur, 2014). Business mapping is obtained through a clearer picture of business activities that are being carried out in nine elements. According to Osterwalder & Pigneur (2010), the nine elements are customer segment, value proposition, channels, customer relationship, revenue streams, key resources, key activities, key partnership and cost structure. Some research related BMC, that BMC can be used for all corporate businesses, because it can map all businesses in helicopter view perspectives, such as applying BMC to oil and gas companies, namely BMC at Pertamina (Vitalino, 2019) and BMC for chemical companies, namely BMC at PT. Timuraya Tunggal (Handling, 2020).

Balanced Scorecard is a strategic evaluation and control tool for companies to address the limitations of traditional evaluation systems that depend on historical financial reports and the shortcomings of the current system (Madsen & Steinheim, 2015). This instrument was first introduced by Professors Robert Kaplan and David Norton in 1992, Balanced scorecard has 4 perspectives such as financial, customer knowledge, internal business and learning & growth. Balanced Scorecard used to measure the level of performance that does not only focus on the financial perspective only in modern companies (Niven, 2003). Kaplan and Norton did research case for the BSC implementation in several companies that engaged in the chemical sector such as the Company Chemico's which is a leading chemical company, Tata Chemical is a company under the Tata group located in India, and Acme Chemical which is a company from Singapore which is a company engaged in the special chemical product sector (Kaplan & Norton, 2004). The concept of integration between Business Model Canvas (BMC) and Balanced Scorecard (BSC) Richardson (2014) suggested to achieve the company's vision, mission and goals are evaluated and improved from the most basic perspective, Learning and Growth, then proceed with the internal process.

3. METHODS

The research method used in this study is a qualitative research method. Data collection is taken by direct observation and semi structured interview by expert judgements. Expert judgement

came from employees of PT. XYZ company with middle up managerial positions. Expert judgement has important role for this research due to problem existed in company can be identified and observed such BMC existing that required to redesign.

Analysis data was conducted to determine strategy implementation required to face obstacles. From this analysis, the researchers analyzed the strategy formulation for creating a performance management system strategy through BMC analysis, increasing INDI 4.0 scores and BSC integration.

4. RESULTS

Based on the results of the interview, PT. XYZ already had BMC existing condition. Here is the BMC as follows:

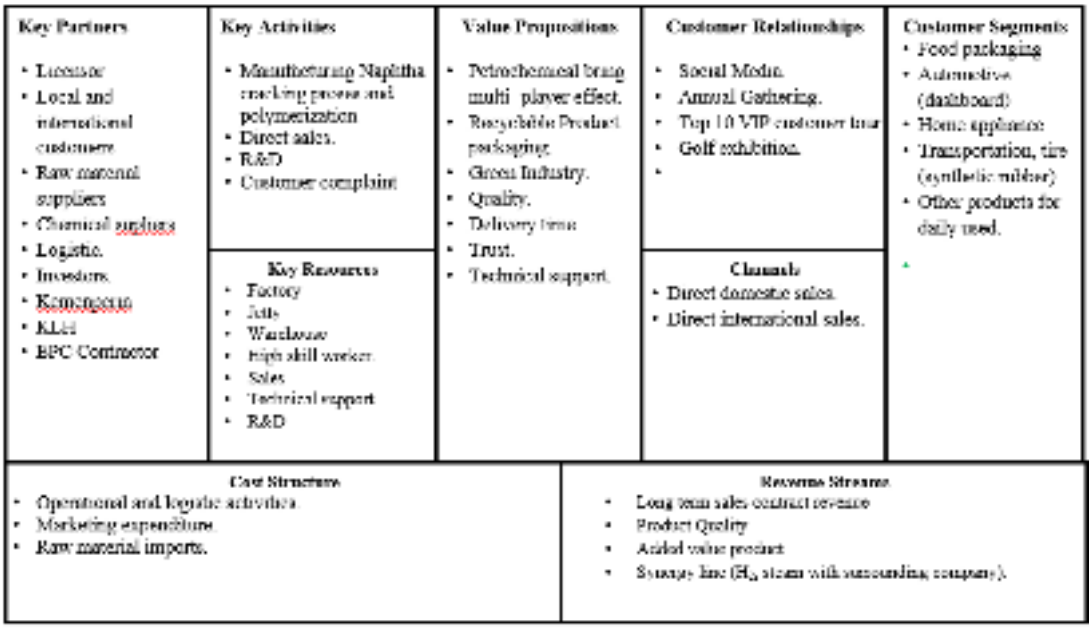

Figure 2. BMC Existing

Strategy to enhance the level that is still in mature readiness position (level 3.0) towards completed Industry 4.0 implementation stage (level 4.0) in all pillars of INDI 4.0 in the company PT. XYZ. The researcher conducted an assessment with expert judgment who was assigned as task force team. The assessment which covered 5 pillars and 17 areas of INDI regarding challenges and strategies to increase the score value across all pillars using the assessment guidelines from INDI 4.0.

Table 1. INDI scoring Improvement

Pillars	Weighting Factor	Average Score	Score
Management & Organization	17.5%	4.00	0.7
People & Culture	30.0%	3.67	1.10
Product & Services	17.5%	3.50	0.61
Technology	17.5%	3.63	0.64
Factory Operation	17.5%	3.56	0.62
Total Scores			3.67

Assessment result shown in Table 1 that there are enhancements in INDI score from 3.07 to 3.67. The result can be obtained by focusing enhancement steps INDI 4.0 for both 5 pillars and 17 areas. improvisational steps such as implementing technology in the field of supply chain, RPA, HR aggressive digitalization and focusing on the Implementation of Integrated Digital Technology systems. Referring assessment guidelines from INDI 4.0 scoring as seen on Table 2, that 3.67 scores is at level 4 and equal with 3 million dollars' efficiency for the PT. XYZ.

Table 2. INDI Scoring

Score Range	Level	Categories
0-0.50	0	Company **NOT YET** ready Industry 4.0 Implementation
0.51-1.50	1	The company is in **BEGINNING** Industry 4.0 implementation stage
1.51-2.50	2	The company is in **ON GOING** Industry 4.0 implementation stage
2.51-3.50	3	The company is in **MATURE** Industry 4.0 implementation stage
3.51-4.00	4	The company is in **COMPLETED** Industry 4.0 implementation stage

Source: INDI, 2018

BMC redesign was carried out to meet and adjust to the digital transformation 4.0 which is expected from a position of mature readiness (3.0 level) to completed implementation (4.0 level), hence the INDI 4.0 improvisation score increased significantly. Below is figure 3 that show BMC redesign.

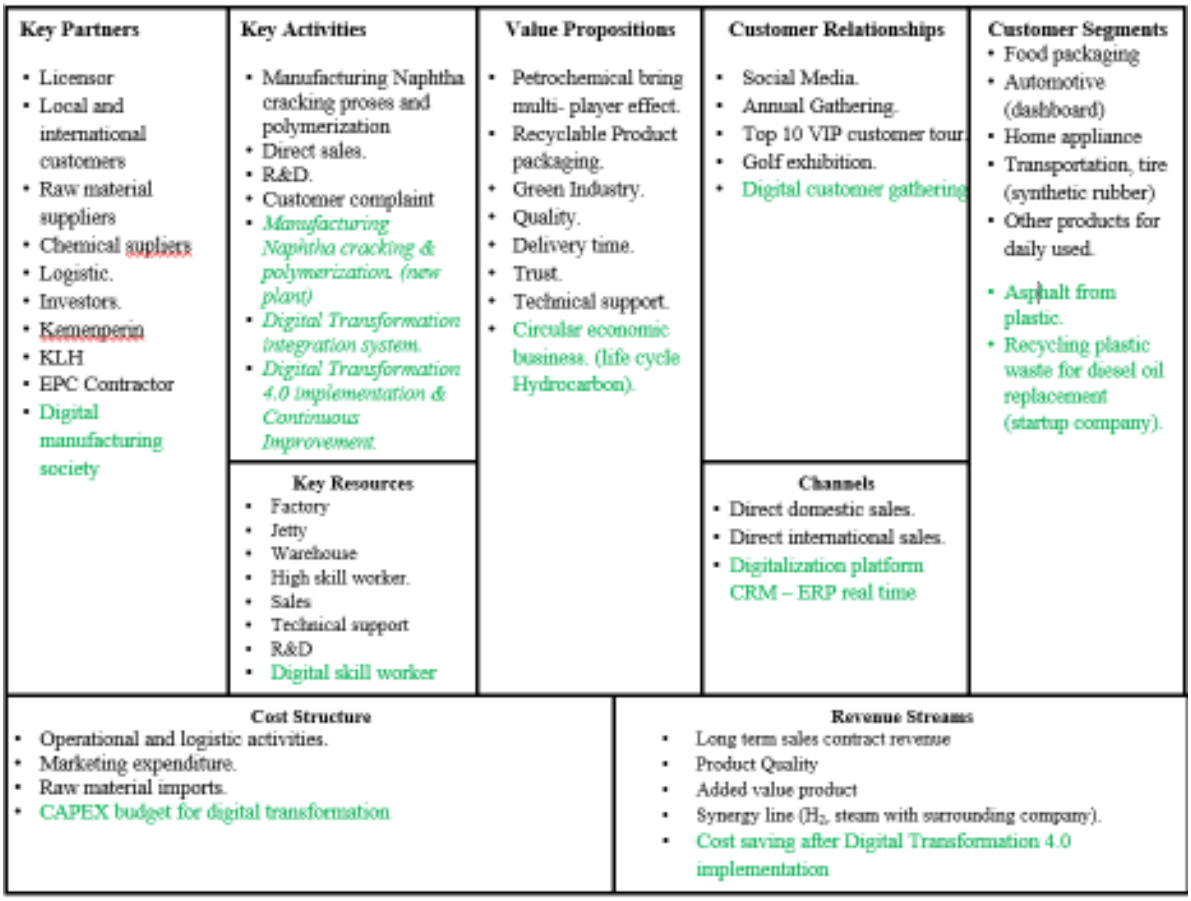

Figure 3. BMC Redesign

BMC can be integrated into the concept of performance measurement in BSC by developing opportunities captured by the company. BMC is able to describe a broad picture of the company and can assist in the formulation of objective strategies in the BSC. The determination of strategic themes and strategic objectives is based on the need to increase the digital transformation score 4.0 in PT. XYZ. There were 13 identified objective strategies, namely 2 strategic objectives in financial perspective, 2 strategic goals in customer perspective, 5 strategic goals in internal business process perspective, and 4 strategic goals in learning and growth perspective. internal business process perspective with learning and growth perspectives drives how the company will implement its strategy. Effective and sustainable processes determine how value can be created and maintained. While financial and customer perspectives describe the results that the organization expects to achieve, such as increased shareholder value (Long-Term Shareholder Value) through increased income and increased productivity. Shareholder value can make it simplify by using map strategy as seen on Figure 4.

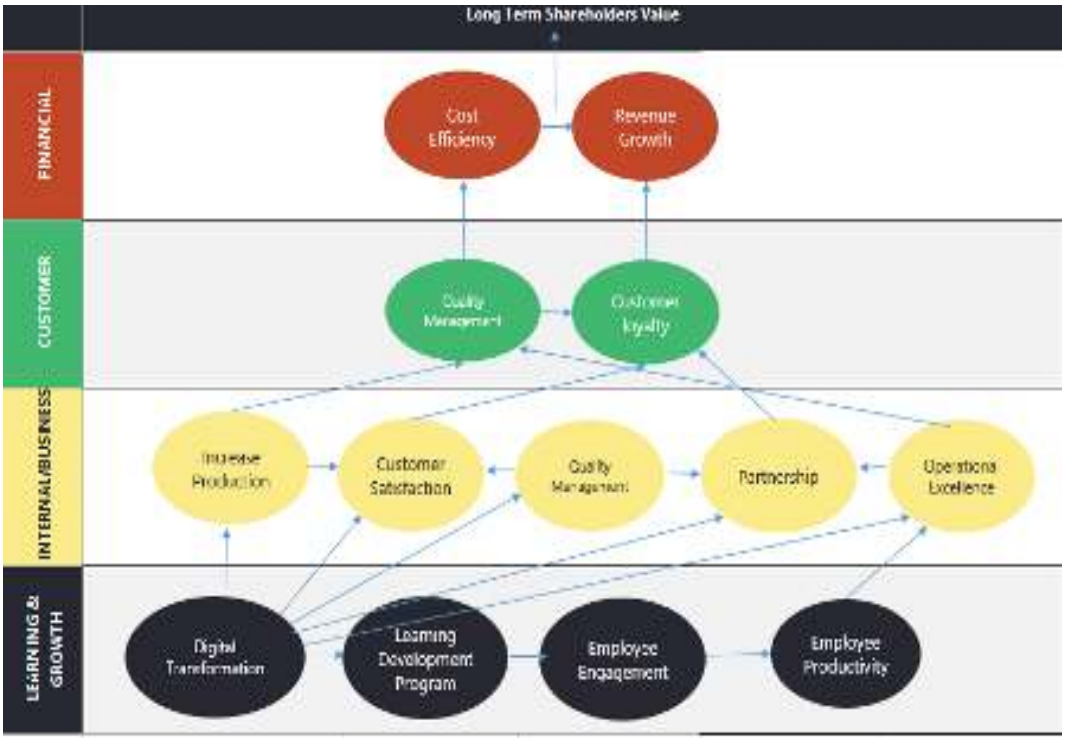

Figure 4. Map Strategy

5. CONCLUSIONS

Performance management system is in accordance with the proposed research analysis, namely mapping the business with BMC and increasing the value of INDI 4.0 from 3.07 to 4.0 by integrating BMC into Balanced Scorecard (BSC) generated a 3 million dollars' efficiency for the PT. XYZ.

Digital transformation is a series of projects that will continue, hence top management needs to consider the investment and make a roadmap and design a performance management strategy that is in line with the company's vision and mission based on the pain point priority of each company. In this business model canvas and balanced scorecard methods can be a reference for all industrial sectors, especially for the chemical industry sector.

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IMPLEMENTATION OF TOPSIS METHOD TO DETERMINE PRIORITIES FOR DESIGN SELECTION OF MULTI POWER PLANT SYSTEMS

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ABSTRACT

PT XYZ as the operator of the Mahakam block is one of the main oil and gas producers in Indonesia. One of the oil and gas processing site owned by PT XYZ is site-A. Site-A has 3 units of turbine generators (TG) to meet its electricity needs. To maintain the reliability of the electricity supply, the company requires that at least 2 TGs must operate. With 2 turbine generators operating, the capacity that can be produced is 18 MW. The average load that must be supplied is 5 MW. With a load of 5 MW, the use of the current TG needs to be re-evaluated because each turbine generator is only loaded with 27% of its capacity. Under these conditions, the researchers believes that the company still has the opportunity to reduce the cost of electricity and CO_2 emissions, but the reliability of electricity supply is still maintained by adding a new source of electrical energy which will be paralleled with the company's TG. For this reason, a new multi-power system alternative design priority will be determined using the TOPSIS method. Based on the results of data processing using the TOPSIS method, alternative-5 was selected as rank-1st with a preference of 0.747.

Keywords: CO_2 emissions, TOPSIS, Turbine generator

1. INTRODUCTION

Site-A has 3 unit Turbine Generators (TG) to meet its electricity needs. Each TG can generate 9 MW. To maintain the availability of electricity supply, the company requires that a minimum of 2 unit TGs must operate, which means that 18 MW of electrical power can be generated. The average consumption of electricity is 5 MW. With an average electricity load of 5 MW, it can only be supplied with 1 unit TG. The use of 1 unit TG and 2 unit TGs have a different impact. The positive side of operating 1 unit TG will be extending the maintenance time. The negative side of operating 1 unit TG, when 1 unit TG shutdown, it will cause stop production in site-A. Operation of 2 unit TGs will improve the reliability of the power supply. The negative side of operating 2 unit TGs is that each TG is only loaded with 27% of its capacity and cannot save on maintenance costs. Under these conditions, the researcher believes that the company still has the opportunity to reduce the cost of electricity and CO_2 emissions, but the reliability of electricity supply is still maintained by adding a new source of electrical energy which will be paralleled with the company's TG. For this reason, a new multi-power system alternative design priority will be determined using the Multiple criteria decision making (MCDM). Multiple criteria decision making (MCDM) is a branch of operational research dealing with finding optimal results in

complex scenarios including various indicators, conflicting objectives and criteria. This tool is becoming popular in the field of energy planning due to the flexibility it provides to the decision makers to take decisions while considering all the criteria and objectives simultaneously (Kumar et al. 2017). The following factors must be considered when designing a power plant: design simplicity, low capital costs, low energy generation costs, high efficiency, low maintenance costs, low operating costs, reliability of power supply and minimizing emissions (Al-ani 2021). If energy saving is successful, it will have a significant impact on the costs that must be spent on energy purchases (Rizkani and Ciptomulyono 2012). Below is a single line diagram at site-A.

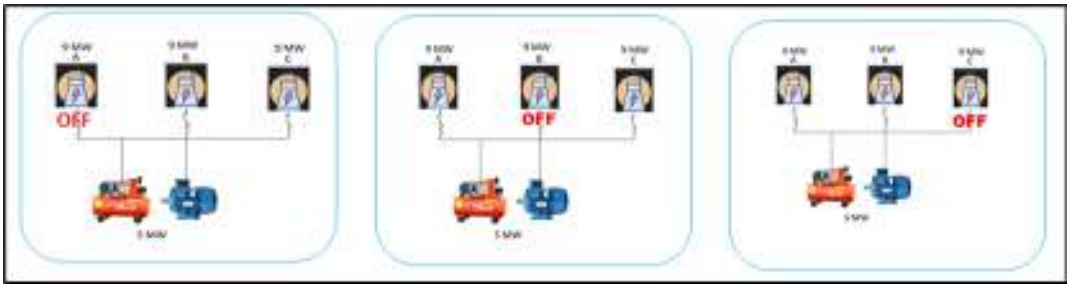

Figure 1. Single line diagram

Configurations that can be made at the current power plant operation are: TG-B and TG-C operate and TG-A stop/ TG-A and TG-C operate and TG-B stop/ TG-A and TG-B operate and TG-C stop.

2. LITERATURE REVIEW

A multi-generation system is a power generation system that combines two or more energy sources that aim to supply reliable energy and have good power quality (Machrafi 2012). The configuration of a multiple power generation system can be a combination of various types of energy sources, either in the form of a combination of renewable energy with conventional energy or entirely renewable energy or all conventional energy.

Turbine Generator (TG) is one type of power plant that uses a turbine as its prime mover with gas as its working fluid, with an internal combustion process. Compared to other power plants, a gas turbine is a simple generator consisting of four main components, namely a compressor, combustion chamber, gas turbine and generator.

Photovoltaic (PV) have a vital function to convert solar radiation into electricity directly. To perform its function satisfactorily, the solar cell must have the highest possible conversion efficiency (Imene Yahyaoui 2018).

Battery Energy Storage System (BESS) is an Energy Storage System (ESS) that captures electrical energy from various sources, accumulates this energy, and stores it in a rechargeable battery for later use. When needed, electrochemical energy is removed from the battery and supplied to homes, electric vehicles, industrial and commercial facilities (Baloyi and Chowdhury 2021).

TOPSIS is one of a multicriteria decision-making method that was first introduced by Yoon and Hwang in 1981. TOPSIS uses the principle that the chosen alternative must have the shortest distance from the positive ideal solution and the farthest from the negative ideal solution from a geometric point of view by using the euclidean distance for determine the relative proximity of an alternative to the optimal solution (Pratiwi and Suharsono 2020). The positive ideal solution is defined as the sum of all the best values that can be achieved for each attribute,

while the negative-ideal solution consists of all the worst values that can be achieved for each attribute (Chakraborty 2022). TOPSIS considers both the distance to the positive ideal solution and the distance to the negative ideal solution by taking the relative proximity to the positive ideal solution (Yoon and Hwang 1995). The TOPSIS method can be explained as a set of stages shown below (Chakraborty 2022) :

1. Calculate the normalised performance ratings.

$$x_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}}$$

2. Integrate weigh with ratings

$V_{ij} = X_{ij} \cdot w_j$

3. Find positive and negative ideal solutions

$$A^+ = (v_1^+, v_2^+, \dots, v_n^+) = \left[\left[{}^{max}_{i} v_{ij} | j \in I\right], \left[{}^{min}_{i} v_{ij} | j \in J\right]\right]$$

$$A^- = (v_1^-, v_2^-, \dots, v_n^-) = \left[\left[{}^{max}_{i} v_{ij} | j \in I\right], \left[{}^{min}_{i} v_{ij} | j \in J\right]\right]$$

4. Obtain the separation values

$$d_i^+ = \left[\sum_{j-1}^{n} \left(V_{ij} - V_j^+\right)^p\right]^{\frac{1}{p}}, i = 1, 2, \dots, m$$

$$d_i^- = \left[\sum_{j=1}^{n} \left(V_{ij} - V_j^-\right)^p\right]^{1/p}, p \geq 1$$

5. Calculate the overall preference score

$$R_i = \frac{d_i^-}{d_i^- + d_i^+}$$

3. METHODS

This study uses the TOPSIS method to determine the ranking alternative designs of multiple power plant systems in site-A. The TOPSIS method was chosen because :

1. This study has several conflicting criteria
2. This study has several choices of alternative decision solutions
3. This study have qualitative criteria and quantitative criteria
4. There are subjective factors for decision making

TOPSIS is a multi-criteria decision-making method that uses the basic mathematical approach to find the optimal alternative. TOPSIS method is widely used for solving real-life problems. With efficient computation and the caliber to calculate the relative performance of decision options, it is a straightforward technique.

Selection of criteria for sources of electrical energy can be done by referring to previous research or existing journals (Artana Fadilla Indrayuni 2014). In this study, the selection of criteria was determined by the researcher by referring to previous research or existing journals and adjusted to the operational needs of PT XYZ. The selected criteria are: Reliability (C_1), Ease of

installation (C_2), Installation time (C_3), Lifetime (C_4), Investment costs (C_5), Operational costs (C_6), Operating costs (C_7), CO2 reduction (C_8).

In determining the criteria weight, a questionnaire survey will be carried out to determine the appropriate preference weight for each criteria. Primary data collection is carried out by conducting interviews or the results of filling out questionnaires with consultants or practitioners who are considered experts (Ponto 2015). For secondary data collection, this study uses secondary data from company data for 1 year. Furthermore, an empirical approach will be carried out. The results of the preferences criteria will be used as a decision matrix.

4. RESULTS

Table 1 below is the decision matrix resulting from empirical calculations and the results of the questionnaire that will be used in the next stage.

Table 1. Decision matrix

	Kriteria							
	(C_1)	**(C_2)**	**(C_3)**	**(C_4)**	**(C_5)**	**(C_6)**	**(C_7)**	**(C_8)**
Alternatif								
A_1	3,0	3,5	4	3,5	5,25 M	36,94 M	10,50 M	70 %
A_2	5,0	3,5	4,5	4,5	32,77 M	86,46 M	10,95 M	0 %
A_3	3,5	3,5	3,5	4,0	61,50 M	25,25 M	11,10 M	99 %
A_4	5,0	4,5	4,5	5,0	89,02 M	62,56 M	11,55 M	25 %
A_5	4,5	3,5	3,5	4,5	38,02 M	45,76 M	0,45 M	100 %

Code	Description	Code	Description
A_1	Alternative-1 (TG-A,PLN)	C_2	Ease of installation
A_2	Alternative -2 (TG-A,BESS)	C_3	Installation time
A_3	Alternative -3 (TG-A,PLN,PV)	C_4	Lifetime
A_4	Alternative -4 (TG-A,PV,BESS)	C_5	Investment costs
A_5	Alternative -5 (TG-A standby,PLN,BESS)	C_6	Operational costs
M	Billion Rupiahs	C_7	Operating costs
C_1	Reliability	C_8	CO_2 reduction

Based on table 1, there are a conflict of interest and a trade off between each criteria. Alternative-1 is low investment costs, but it's reliability also low. Alternative 4 has the best reliability, but the investment and operational costs are the highest. Through the TOPSIS method, alternatives will be obtained that can cover the criteria as a whole. After calculating using the TOPSIS steps, an alternative ranking is obtained as shown in Table 2 below:

Table 2. Alternative ranking

Alternatif	Nilai preferensi	Peringkat
A_1 (TG-A, PLN)	0,588	2
A_2 (TG-A, BESS)	0,379	4
A_3 (TG-A, PLN, PV)	0,535	3
A_4 (TG-A, PV, BESS)	0,275	5
A_5 (TG-A standby, PLN, BESS)	0,756	1

Based on these results, the value of the ideal solution with the greatest preference is Alternative-5 which uses PLN and BESS, while TG-A is in standby. So, with this calculation, the use of PLN and BESS, while TG-A standby can be recommended in principle as an alternative to the selected decision. To find out the robustness of the selected alternative, a sensitivity analysis will be carried out by changing the weight of the dominant criteria. Chart of sensitivity analysis results can be seen in the Figure 2 :

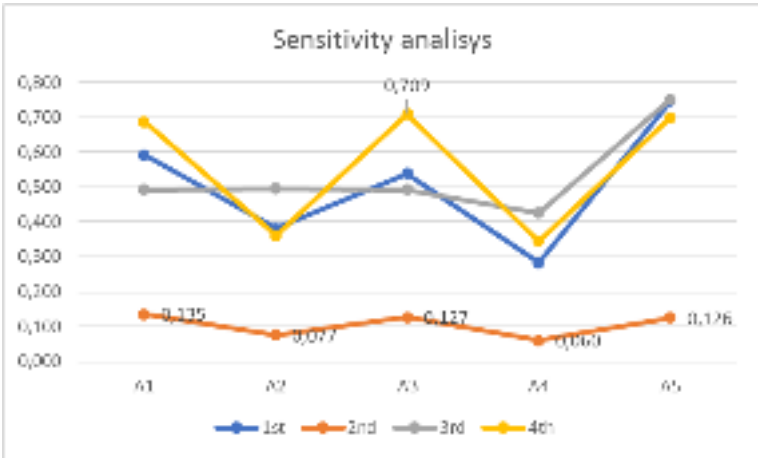

Figure 2. Sensitivity analysis chart

6. CONCLUSIONS

This study has provided a mathematical evidence-based simulation using the TOPSIS method. The topsis method was used to determine the priority scale of alternative multi-generation system designs in the site-A. There are 5 alternative proposals with 8 criteria. Based on the results of the to TOPSIS method calculation, the best alternative is alternative-5 (TG-A standby, PLN, BESS) is ranked 1st with a preference value of 0.756.

The selected alternative implementation will certainly have an impact on the company's managerial and is expected to provide benefits for PT XYZ in the site-A, including**:**

1. PT XYZ can reduce operational costs, annual maintenance costs, five-year maintenance costs and reduce CO_2 emissions produced by the company's power plants
2. PT XYZ can benefit financially from savings in operating costs and maintenance costs
3. Implementation of selected alternatives can be used for recertification of ISO 50001, namely standards for energy use, cost reduction and reduction of greenhouse gas emissions
4. The selected alternative implementation can be used to increase the achievement of PROPER certification from green PROPER to gold PROPER with a significant reduction in CO_2 emissions. PROPER is a Company Performance Rating Program in Environmental

Management developed by the Ministry of Environment since 1995, to encourage companies to improve their environmental management

5. PT XYZ can use manhours of annual and five-year TG maintenance work to carry out maintenance on other equipment. Currently, a lot of equipment has delayed its maintenance schedule due to limited man hours.

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PROJECT SCHEDULING CONCEPTS FOR ACTIVITIES OF AN EVENT ORGANIZER

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ABSTRACT

Project scheduling is the activity of determining the timeframe for project activities to be completed, raw materials, labor and time needed by each activity. The benefits of scheduling for the project owner include: the project owner gets an overview of the start and finish times of the project, the project owner can evaluate and assess if there is a change in the time and cost of the project, the project owner can plan cash flow. Limited resources are one of the reasons why scheduling is necessary. Scheduling is intended so that project implementation can continue, by optimizing the use of these limited resources, which is also attempted so that the duration of the project does not become too slow. The purpose of this case study is to find out the relationship between activities, both selecting and participating; know the duration of each activity and the duration of all activities; Know the start time and end time of an activity. The analysis technique uses descriptive methods and compares several project scheduling methods including Gantt Charts, Precedence Diagram Method (PDM), Critical Path Method (CPM), Program Evaluation Review Technique (PERT), Graphical Evaluation Review Technique (GERT), Linear Scheduling Method (LSM) which is most appropriate to the object of research. Compilation of case study reports is complemented by bibliographical methods and conducting interviews with respondents. The results of this case study are expected to answer the existing objectives.

Keywords: project scheduling, activities, time duration

1. INTRODUCTION

According to the Association for Project Management, a project is a unique and temporary job. The project is carried out to achieve the planned goals and produce the desired results or benefits (output). Time and cost are the main ingredients of a project. Project features: A. Has a specific goal in the form of the final work B. It is temporary because the project cycle is relatively short C. In the process of implementation, the project is constrained by the schedule, budget costs, and the final outcome. Scheduling is allocating the time available to carry out each work in order to complete a project until optimal results are achieved taking into account the existing limitations. Project scheduling is the activity of determining the timeframe for project activities to be completed, raw materials, labor and time needed by each activity. The benefits of scheduling for project owners include: 1. The project owner gets an overview of the start and finish times of the project 2. The project owner can evaluate and assess if there is a change in the time and cost of the project 3. Project owner can plan cash flow. Limited resources are one of the reasons why scheduling is necessary. Scheduling is intended so that project implementation can continue, by optimizing the use of these limited resources, which is also attempted so that the duration of the project does not become too slow.

2. LITERATURE REVIEW

Project management is the process of planning, organizing and managing tasks and resources to accomplish a defined objective, usually within constraints of time, resources and cost. A project plan can be as simple as a list of tasks and their start and finish dates written on a notepad, or it can be as complex as one involving thousands of tasks and resources and a budget of millions of dollars.

In a gantt chart, each task takes up one row. Dates run along the top in increment of days, weeks, or months, depending on the total length of the project. The expected time for each task is represented by a horizontal bar whose left end marks the beginning of the task and the right end marks the completion of the task.

Henry Laurence Gantt developed gantt charts in the second decade of the 20th century. Gantt charts were and are used as a visual tool to show scheduled and actual progress of projects. (Kumar, 2005)

The precedence diagram method is well-known in scheduling activities within projects. With this method, projects are described as activity-on-node network (ANN) diagrams consisting of time-consuming activity nodes and directed edges specifying the execution sequences. Based on an activity's duration, the precedence diagram method allows users to calculate the minimum project execution time and buffer times during which concurrent activities can be postponed without delaying the whole project. (Hofmann et al., 2015)

Critical Path Method (CPM) uses a network to coordinate activities, develop schedules and monitor progress of the projects. In fact, it is a step-by-step project management technique that identifies activities on the critical path. It is an approach to project scheduling that breaks the project into several work tasks, displays them in a flow chart and then calculates the project duration based on estimated durations for each task. It defines tasks that are critical, time-wise, in completing the project. CPM has been used extensively to calculate operation parameters including earliest starting time, latest starting time, earliest finish time, latest finish time, maximum available time and slack time. (Zareei, 2018)

Program Evaluation Review Technique (PERT) is a probabilistic method which is based on the assumption that one path determines the duration of the project, but the duration of each activity is characterized by a probability density function. The project duration can be calculated by the sum of the "expected" durations of each activity in critical path. According to the central limit theorem, the project duration can be shown to follow a normal distribution, uniquely defined by the parameters computed from each activity parameters. The concept of PERT is based on the assumption that the duration of each activity is a random variable that behaves according to some known and identical probability distribution. (Liu, 2013)

Graphical Evaluation Review Technique (GERT) is a stochastic network analysis technique that allows for conditional and the probabilistic treatment of the logical relationships between the project's activities following randomly determine sequence of observations. The logical relationships between the project's activities are primarily based on the dependency between the two project activities or the dependency between a project activity and milestone. The key objective of the GERT is to evaluate on the basis of the network logic and estimated duration of the activity and derive inference about some activities that may not be performed. GERT essentially outdoes limitations associated with PERT/CPM and allows loops between tasks. GERT is useful particularly in experiments which demand higher degree of pre-planning and rescheduling capabilities to maximize the return from the experimental facilities available. The

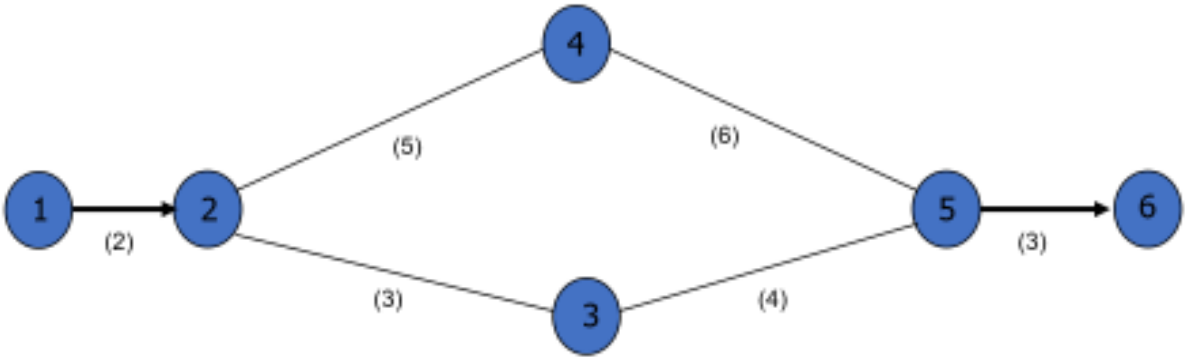
GERT network appears to be an excellent launching pad for carrying out the data visualization and categorization of data and modeling and analysis of the complex networks. (Ramani et al., 2014)

3. METHODS

The research already conducted in end of years 2022 in the event organizer sector. The method used in this research is descriptive method. The population of this study is the small business sector in the field of event organizers, where the meaning of the population itself is the whole group of people, events, or something interesting to study. While the sample used in this study is the daily organizers in the event organizer sector where the meaning of the sample is part of the population to be studied and has the same characteristics as the population. In addition, this study also used secondary data, namely supporting data primary data needs such as books, literature and reading materials relating to and supporting research. The preparation of the research report was carried out by the author collecting data obtained from books, companies, records and literature related to the topics made and conducting interviews with respondents.

4. RESULTS

From the several existing project scheduling methods, finally we determine which method is most suitable to be applied to the organizers of the event with the following discussion



Kegiatan			Durasi waktu	Paling awal	
i	j	Nama		Mulai (ES)	Selesai (EF)
1	2	A	2	0	2
2	3	B	3	2	5
2	4	C	5	2	7
3	5	D	4	5	9
4	5	E	6	7	13
5	6	F	3	13	16

Kegiatan			Durasi waktu	Paling awal		Paling akhir	
i	j	Nama		Mulai (ES)	Selesai (EF)	Mulai (LS)	Selesai (LF)
1	2	A	2	0	2	0	2
2	3	B	3	2	5	6	9
2	4	C	5	2	7	2	7
3	5	D	4	5	9	9	13
4	5	E	6	7	13	7	13
5	6	F	3	13	16	13	16

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SUPPLIER SELECTION AND INVESTMENT ANALYSIS OF PALLETIZATION ROBOT : A CASE STUDY

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ABSTRACT

This paper presents the supplier selection process for palletization robot and its investment analysis. The palletization robots are aimed to improve productivity in the final stage of production process in the case company. The selection of the supplier begins with setting the selection criteria through focus group discussion. The analytical hierarchy process is used to determine the weight of each criterias. The investment analysis is used to evaluate whether the implementation of the robots is financially feasible. The investment analysis considers the investment cost of the robot, operating and maintenance cost, increased productivity, and salvage value. Using Net Present Value (NPV), the analysis evaluate whether the investment of palletization robots is financially feasible compared to the manual system.

Keywords*: palletization, automation, supplier selection, AHP*

1. INTRODUCTION

The palletizing system is an internal logistics part that plays an important role because it connects production output with transportation. A palletizing system is a method of stacking finished goods using one or more patterns, to assist product handling, storage, and other logistics-related activities (Moura, 2018)

The palletization process itself is an internal logistics process that is carried out by stacking boxes containing finished products on a pallet to facilitate the process of moving products from the factory to the finished product warehouse location. This process can be done manually by human labor by sorting products manually from the main conveyor to be stacked on a pallet with other similar products. This system is prone to errors due to the similar cardboard design between products and fatigue and ergonomic factors which have the potential to cause errors when palletizing.

Currently, the company is still implementing a manual palletizing system that requires human labor. In the implementation of the manual palletizing system in the company, product mix-up on the pallet (cross-contamination) were still found. During 2021 there were 124 incidents of mixed products in 1 pallet and 13 incidents of products lacking in 1 pallet. This then encourages companies to look for alternative pallet systems, namely by using automatic pallet methods with programmed robots.

In addition to the benefits of improving product quality, automated palletizing systems are expected to have financial benefits for companies. To carry out the manual palletizing process, a workforce of 36 people is needed to fulfill the pallet needs of twelve manufacturing lines for three

shifts. Based on the calculation results, the use of pallet robots can save up to 65% in operational costs.

The automatic palletizing process relies heavily on the capacity of the automation tool and the appointed pallet robot supplier. In determining the capacity of the automation device to be used, it is necessary to map the capacity of the packaging line to the pallet robot using the path balancing method or Line Balancing. Meanwhile, to objectively determine the best supplier selection, the Analytical Hierarchy Process (AHP) method will be used, which is a decision-making method that involves a number of criteria and alternatives that are selected based on consideration of all relevant criteria (saaty, 1988).

2. LITERATURE REVIEW

2.1 Analytic Hierarchy Process (AHP)

The Analytic Hierarchy Process (AHP) is a multiple criterion decision analysis method developed by Saaty. Modeling the design problem by breaking it down into a hierarchy of interrelated decision elements, decision criteria, and sub criteria; After the decision problem is modeled hierarchically, the decision maker must develop a set of comparison matrices that numerically determines the relative preference of each decision alternative with respect to each criterion and also the relative importance of each criterion (El-Sawalhi, 2007). The stages in AHP includes (Setiyaningsih, 2015; Saaty and Kearns, 1985; Saaty, 1988; Bhushan and Rai, 2004) Defining goals; developing a Hierarchical structure; create a pairwise comparison matrix; test the consistency of the paired matrices; determination of global weight; selection of alternatives

2.2 Line Balancing

Line balancing is an assignment of a number of jobs to work points that are interconnected in one line or production line that functions to create a balanced work path. The execution point has a time that does not exceed the cycle time and processing point. The main objective of track balancing is to minimize idle time on the track which is determined by the slowest processing time (Baroto, 2002) and can be used to determine the exact number of processing points.

The data needed is in the form of information about the time needed for each production line and the relationship that precedes between work points, the production rate per day adjusted to the level of total demand, then divides it into available productive time per day. The result will be obtained in the form of a cycle time which is the time the product is available at each processing point (Baroto, 2002) which is explained in the following formula.

$$Cycle\ time\ (C) = \frac{Production\ time}{Output\ target} \quad (1)$$

Selain *cycle time,* ditentukan juga jumlah terkecil titik pengerjaan agar tercapai efisiensi lini produksi dengan rumus sebagai berikut

$$Minimum\ work\ station\ (Nt) = \frac{Total\ working\ time\ (T)}{Cycle\ time\ (C)} \quad (2)$$

2.3 Palletizer Robot Capacity Calculation

The first step that must be taken to determine the optimal number of pallet robots is to collect data on the number and capacity of production machines from the designed speed data and because in one production line various SKUs can be produced, the SKU data with the highest production speed is taken for this purpose to prevent future overloading of palletizing robots.

After knowing the specifications of the packing line, the next step is to calculate the packing speed in boxes per minute based on the output of the printing machine every minute divided by the amount of product in each box.

$$Outer\ case\ output\ per\ minute = \frac{Soap\ output\ per\ minute}{Soap\ per\ outer\ case} \quad (3)$$

2.3.1 Pallet pattern and Pickup Average

The pallet pattern and number of cardboard boxes in each pallet layer is needed to be able to find out the amount of picking made on each pallet layer and the average picking. The formula for the average pickup for each layer of pallet is as follows

$$Pickup\ average = \frac{number\ of\ outer\ case\ per\ pallet\ layer}{number\ of\ pick\ up\ per\ pallet\ layer} \quad (4)$$

The amount of picking per pallet layer itself is determined based on the pallet arrangement pattern and the arrangement by the pallet robot. The pallet arrangement pattern is determined based on the size of the carton and the total weight of the cardboard in one pallet which must not exceed the weight capacity of the pallet. The determination of the pallet arrangement pattern is done with the help of software

2.3.2 Work Cycle per Time

After obtaining data on cardboard packing capacity per minute and average pick up, cycles are calculated per time unit (minutes) with the following formula

$$Cycle\ per\ minute = \frac{Outer\ case\ output\ per\ minute}{Pickup\ average} \quad (5)$$

From the equation above, cycles per minute are then calculated to be adjusted to the cycles per minute of the pallet robot specifications set by the company so that the ability of each pallet robot to handle a number of packaging lines can be defined.

2.4 Net Saving

The savings arising from the investment are the value obtained from the costs that can be eliminated as a result of the investment made, minus the costs incurred from procuring the investment. Meanwhile, after-tax savings are net savings before taxes plus tax costs to be paid so if it is formulated it will be as follows

$$Tax\ Paid = (saving\ before\ tax - depreciation) \times \%tax \quad (6)$$

$$Net\ saving\ after\ tax = saving\ before\ tax - tax\ paid \quad (7)$$

2.5 Net Present Value

Net Present value (NPV) is the difference between total present value and total present value of costs, or the total present value of additional net benefits over the life of the business (Nurmalina, 2010). Freddy Rangkuti (2012) states that the net present value has advantages in describing the profitability of an investment, such as:

a. Predicting current value of present currency compared to the future value
b. Considering the entire cash flow value of an investment
c. Objective due to using clear measures, namely estimated cash flows and discount rates
d. The NPV method is always consistent with the goal of maximizing the value of an investment

If the net present value is greater than zero, then the investment made by the company is acceptable and feasible to continue, whereas when the NPV of a company is lower than zero or negative, then the investment is not recommended to be continued. To determine the NPV value, the following equation is used

$$NPV = \frac{Rt}{(1+i)^t} \quad (8)$$

With Rt is the net cash flow at time t, i is the discount rate, and t is the cash flow time.

2.6 Payback Period

The payback period (PBP) is the time it takes for the cumulative net cash flow from the start of the investment to reach a point equal to a fixed amount that can be depreciated by depreciation. The payback period is generally measured as the time from the start of production to the recovery of capital investment.

Another definition of payback period is the number of years it takes to recover the initial cash investment. In other words, it is the period of time during which a machine, facility or other investment has generated sufficient net income to cover the cost of the investment. If P is the payback period in several years, NCF is the difference between incoming and outgoing cash and 1 is the rate and cash flow each year is not uniform, then we can get the following equation Discounted, i 0%; NCF t varies annually: $-\mathrm{P} + \sum_{t=1}^{t=n} NCF_t \ (\mathrm{P/F}, i, t)$ (9)

2.7 Internal Rate of Return

Internal Rate of Return or rate of return is the amount paid on the unpaid loan balance or the rate obtained from the investment balance that has not been recovered so that the final payment or receipt can bring the balance exactly to zero considering interest. Sullivan (2015) stated that the IRR method is a method commonly used to display economic returns. By applying the IRR method, companies can calculate profits or losses that may occur.

Return of Investment (ROI) ROI is a simple calculation that shows the amount of return on investment compared to the amount of the initial investment. IRR, on the other hand, provides an estimate of the annual rate of return for an investment over time and offers a "hurdle rate" for comparing other investments with different cash flows.

ROI and IRR are two metrics that can help investors and businesses evaluate investments. IRR tends to be useful when budgeting capital for a project, whereas ROI is useful in determining the overall profitability of an investment expressed as a percentage.

2.8 Salvage Value

Salvage Value is an estimated value at the end of the expected lifetime or the end of its useful lifetime. The salvage value is zero if there is no expected salvage value and the salvage value is negative if it costs money to write off the asset (Blank, 2012).

The salvage value of an asset is obtained by calculating the depreciation cost. Salvage value is used as an estimated value so that the company can calculate the amount of depreciation. If the book value of the machine depreciation percentage has been determined by the company, then the salvage value can be obtained through the known depreciation value.

According to Blank, 2012 Depreciation calculation method can be divided intothree method:

1. Straight-line depreciation is the most widely used method for calculating depreciation expense. This method focuses on depreciation as a function of time rather than usage. The formula for this method is as follows

$$Yearly\ depreciation = \frac{Investment - Salvage\ value}{recovery\ period} \quad (10)$$

2. The balance depreciation method is also known as the fixed percentage or uniform percentage method. Depreciation on balances accelerates the write-off of asset values because the annual depreciation is determined by multiplying the cash value at the beginning of the year by a fixed percentage because the depreciation amount decreases each year

$$implied\ salvage\ value = B(1 - d)^n \quad (11)$$

With :
B : Investment
d : depreciation percentage
n : lifetime
Equation 11 implied salvage value

3. The modified accelerated cost recovery system (MACRS), automatically converts the depreciation balance to a straight line and calculations using this method always depreciate to zero so that the residual value is always assumed to be zero. In this method the payback period is determined by the property class which is calculated with the actual payback period being 1 year longer as a result of the half year convention that applies.

3. METHODS

3.1 Data Collecting

At this stage, the data collection needed for the research includes company regulatory data, manual pallet work analysis data, production speed data, production robot capacity and speed data, required automatic pallet robot specifications, robot supplier data

3.2 Auto-Palletizer Robot Determination

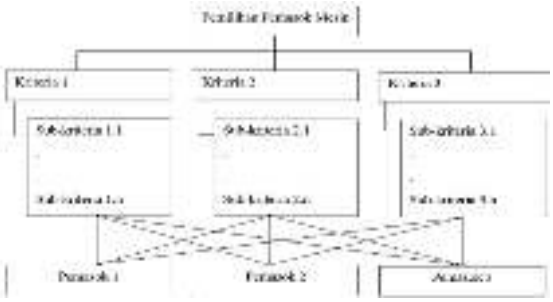
The number of auto-palletizing robots must be determined precisely to calculate a sufficient number of robots, to serve the palletizing process of all packing line operating in the factory. Determination of the number of auto-pallet robots is based on:

a. Data on the number of packing line operating in the factory as well as the production capacity per minute of each of these lines to determine the potential load to be handled by the palletizing robot.
b. The pattern arrangement cardboard on a pallet which includes the number of boxes for each pallet which will affect the cycle time of the pallet robot to carry out the arrangement from the input of each robot to the pallet and the number of pallet robots
c. The capacity of the palletizing robot uses line balancing method by considering the two factors above.

3.3 Robot Supplier Determinaton

3.3.2 Supplier Selection Methods Development

The supplier selection stages are shown in the flowchart in Figure 3.2. The first stage is collecting the data needed to select a supplier including the required robot specification data and the bidding data provided by the supplier. Furthermore, the formulation of supplier selection criteria was carried out through a Forum Group Discussion (FGD) with the company's project team and production operations team. The criteria that have been formulated are then weighted using the AHP method. Offers given by suppliers are then evaluated based on weighted criteria using a scoring method to obtain the supplier with the best value as the selected supplier.



Picture 1. Supplier Selection Stages

3.3.3. Criteria Weighing

Pairwise analysis is the first step to determine priority (weight). The value used is from 1 to 9 and the score is the opposite value. After creating a pairwise comparison matrix, the weight of each criterion was determined using the Focused Group Discussion method. From the pairwise comparison matrix, a matrix consistency test and validation and calculation of the global weight of each criterion are carried out according to the formula

To determine the criteria used in supplier selection, a focused group discussion was conducted with the project, engineering, and production divisions and obtained 3 selection criteria, namely company operations, robot quality, and post-purchase service.

3.4 Supplier Evaluation

The next stage is to evaluate suppliers against the criteria that have been determined using AHP. First, a paired matrix is created which contains predetermined supplier selection criteria. Then for each criterion is given a weight with numbers 1 to 9 according to the AHP weighting table. From the pairwise comparison matrix, a matrix consistency test and validation and calculation of the global weight of each criterion are carried out according to the formula.

After obtaining the weight value for each criterion, then the supplier with the highest criterion value will be obtained. The supplier will then become the selected supplier. Meanwhile, other suppliers will still be stored in the database as supplier options if needed in the future and/or as a backup for selected suppliers

4. RESULTS

4.2.1 Criteria weighing with AHP method

At this stage, the weight of supplier selection criteria is calculated using the AHP method. The results of the Focused Group Discussion (FGD) are used to retrieve preference data from decision makers against predetermined supplier selection criteria. In this study, the decision makers in question are the Engineering Department and the Production Department.

Furthermore, the results of the discussion regarding the criteria agreed upon by all decision makers are then processed according to the stages in AHP. This data processing is done with the help of Microsoft Excel software. This calculation then produces a local weight at each level of the hierarchical structure which is then multiplied by the sub-criteria local weight to get a global weight. Table 4.1 below shows the weighting results that have been carried out using the AHP method.

Table 1 Global Weight Supplier Selection Criteria

No.	Criteria	Local weight	Sub-Criteria	Sub-Criteria local weight	Global weight
1	Machine Quality	0,591	Robot agility	0,608	0,359
			Spare part availability	0,120	0,071
			User interface	0,272	0,161
2	Aftersales service	0,334	Repair/maintenance quality	0,620	0,207
			Installation service	0,224	0,075
			Operational and maintenance training	0,156	0,052
3	Company Operational	0,075	Monetary capability	0,633	0,048
			Company experience	0,260	0,020
			Company legal aspect	0,106	0,008

Based on the results of the AHP calculation in table 1 above, machine quality has the highest weight of 0.359 followed by after-sales service criteria with a weight of 0.207 and the lowest global weight is owned by the Company Legality sub-criteria of 0.008.

4.2.2 Supplier Quotation

A Quotation is a document submitted by the supplier during tender process between the company and potential machine suppliers. Quotation document generally describe the supplier's capability for company assessment whether it is in accordance with the company's needs. These offers are then assessed based on a scoring method to determine the best supplier.

The results of the assessment of potential robot palletizer suppliers are presented in table 2. Each supplier is given a value according to the criteria then the value obtained for each criterion is multiplied by the weight of the criterion and then added together to obtain a total value for the supplier.

Table 2 Supplier evaluation result

Criteria	Sub Criteria	Bobot Global	Supplier A		Supplier B		Supplier C	
			Value	Weighted value	Value	Weighted value	Value	Weighted value
Machine quality	Robot agility	0,359	5	1,797	5	1,797	5	1,797
	Sparepart availability	0,071	5	0,355	4	0,284	5	0,355
	User interface	0,161	4	0,643	4	0,643	4	0,643
	Total value of Machine Quality Criteria		2,795		2,724		2,795	
Aftersales service	Repair/maintenance quality	0,207	4	0,828	1	0,207	2	0,414
	Installation service	0,075	5	0,375	5	0,375	4	0,300
	Operational and maintenance training	0,052	5	0,261	4	0,208	5	0,261
	Total value of Aftersales service Criteria		1,463		0,790		0,974	
	Monetary capability	0,048	4	0,190	4	0,190	5	0,238

Company Operational	Company experience	0,020	4	0,078	4	0,078	5	0,098
	Company legal aspect	0,008	5	0,040	5	0,040	5	0,040
	Total value of Company Operational Criteria		0,308		0,308		0,375	
Total value			4,566		3,822		4,144	
Rank			1		3		2	

From the results of the supplier assessment in table 3, the supplier with the highest score was Supplier A with total score of 4.566, Supplier B with total score of 3.822, and Supplier C with a total score of 4.144. Detailed supplier assessment results are shown in table 3

Furthermore, an evaluation of the price offers from the three suppliers is carried out. From the bid prices from the three suppliers shown in table 4.4, it is known that Supplier A does not have the lowest bid price but has the most complete installation service, so it was decided to use the services of Supplier A.

Table 3 Quotation value of automatic pallet system

	Supplier A (Rupiah)	Supplier B (Rupiah)	Supplier C (Rupiah)
Robot Paletizer	4.574.100.000	4.292.000.000	4.100.000.000
Pallet System and central conveyor	9.054.200.000	7.510.000.000	9.306.000.000
Barcode Reader & Sorting System	1.492.900.000	4.500.000.000	-
Check Weigher	378.800.000	898.000.000	1.344.000.000

4.3.2 Numbers and Capacity of Packing Line

The first step that must be taken to determine the number of pallet robots is to collect data on the number and capacity of production machines from the designed speed data and then calculate the packing speed in cartons per minute based on Equation XX

The capacity of the production machine on the packing line for the products with the largest number of outputs for each packing line and the output calculation results for each box are as follows

Table 4 Packing Line capacity

Packing Line	product/minute	Product	product/ outer case	Outer Case/ minute
A	450	1	72	6,3
B	450	2	72	6,3
C	450	3	144	3,1
D	450	4	96	4,7
E	350	5	96	3,6
F	320	6	96	3,3
G	325	7	96	3,1
H	325	8	36	9,0
I	300	9	144	2,3
J	550	10	144	2,1
K	550	11	144	3,8
L	550	12	144	3,8

4.3.3 Pallet Pattern and Pickup Average

Based on the average collection formula and referring to the product arrangement pattern on the pallet, the average collection data for each packaging line is as follows

Table 5 Pickup Average

Lini pengemasan	Kardus/lapisan palet	Jumlah pengambilan	Rata-rata pengambilan
A	14	5	2,8
B	14	5	2,8
C	13	7	1,9
D	12	8	1,5
E	10	4	2,5
F	12	8	1,5
G	12	8	1,5
H	19	7	2,7
I	16	5	3,2
J	13	7	1,9
K	13	7	1,9
L	13	7	1,9

4.3.4 Cycle per Minute

After obtaining data on outer case packing capacity per minute and average picking, cycles per unit of time (minute) are calculated according to Equation 2.9. Cycles per minute are calculated and compared to cycles per minute from the palletizer robot specifications. From the calculations, the cycles per minute data from each packing line are as follows:

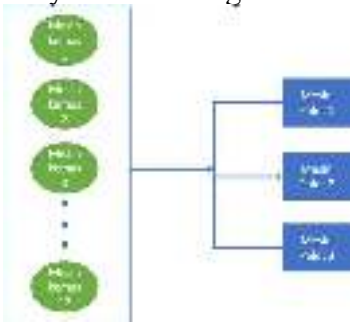
Tabel 6 Cycle per minute

Packing Line	Pickup Average	Machine capacity (outercase/minute)	Cycle/minute
A	2,8	6,3	2,2
B	2,8	6,3	2,2
C	1,9	3,1	1,7
D	1,5	4,7	3,1
E	2,5	3,6	1,5
F	1,5	3,3	2,2
G	1,5	3,1	2,1
H	2,7	9,0	3,3
I	3,2	2,3	0,7
J	1,9	2,1	1,1
K	1,9	3,8	2,1
L	1,9	3,8	2,1

4.3.5 Penghitungan Jumlah Robot Palet

To calculate the optimal number of robot palletizers, apart from the capacity of the packaging machine, the capacity of the robot palletizer must also be considered. The capacity of the robot palletizer is 18 cartons per minute, taking into account the average number of boxes taken and the number of cartons per pallet layer, the pallet machine cycle time is 8.7 cycles per minute. With a total cycles per minute of 12 packaging lines are 24.3 cycles per minute, 2.8 pallet robots are needed

which are rounded up to 3 robots with each robot handling 4 packaging lines with a total of 8 cycles per minute so that it can be illustrated by the flow diagram as follows



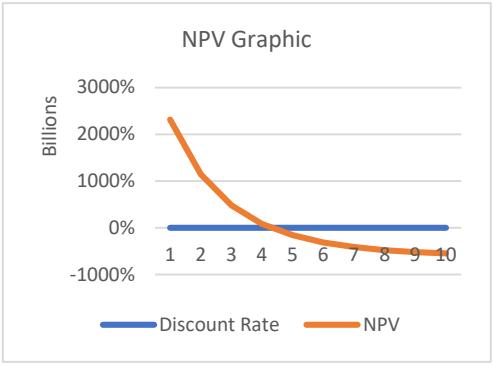
Picture 2 Balanced line diagram

4.3.6 Net Savings and Net Present Value

To determine whether this palletizer robot investment is feasible, the Net Present Value (NPV) of this investment is calculated. To calculate the net savings, calculations are carried out according to equation 7. The total savings figure came from manpower palletizer of 36 people (to handle 12 packing lines for 3 operational shifts), reconditioning costs due to mixed up outer case in pallets of 3 people and return transport costs from the warehouse to deliver pallets that must be sorted 4 times in 1 month. While the expenses resulting from the pallet robot investment consist of 3 additional technicians, palletizer robot routine maintenance costs, utility costs for palletizer robot (electricity, compressed air), manpower to handle rejected products by the check weigher system due to uncomplete count of finished goods in boxes. The cost of net savings from year 0 has not been deducted by the tax that must be paid by the company on these investment assets. With the cost details mentioned above, we get a net savings figure of 2,529,000,000.00 Rupiah per year.

In addition to the net savings figure, a payback period calculation is also carried out to find out how long it will take for the investment costs to be recovered according to equation 9. From the calculation results, the required payback period is 6.41 years.

As for the NPV calculation, machine lifetime must be determined in advance, which is agreed upon by the company for 14 years. Furthermore, the calculation of cash flows for 14 years takes into account inflation of 4% for non-manpower and 8% inflation for manpower each year and an IRR of 12% which has been determined by the company. The NPV calculation was carried out with the help of the excel program and the positive NPV figure was 2,964,135,801 Rupiah. By referring to the NPV figure, it can be concluded that this investment is feasible to run.



Picture 3. NPV Graphic

Labour inflation	7%	7%	7%	7%	7%	7%
Utility/others inlfation	4%	4%	4%	4%	4%	4%

Description	Year 1	Year 2	Year 3	Year 4	Year 5	Year 14
SAVING FTE	IDR 3.144.960.000	IDR 3.365.107.200	IDR 3.600.664.704	IDR 3.852.711.233	IDR 4.122.401.020	IDR 7.578.866.132
SAVING NON-FTE	IDR 405.600.000	IDR 421.824.000	IDR 438.696.960	IDR 456.244.838	IDR 474.494.632	IDR 675.353.815
UTILITY	IDR (234.000.000)	IDR (243.360.000)	IDR (253.094.400)	IDR (263.218.176)	IDR (273.746.903)	IDR (389.627.201)
REPAIR & MAINTANCE	IDR (124.800.000)	IDR (129.792.000)	IDR (134.983.680)	IDR (140.383.027)	IDR (145.998.348)	IDR (207.801.174)
TEKNISI DAN TENAGA SORTIR	IDR (561.600.000)	IDR (584.064.000)	IDR (607.426.560)	IDR (631.723.622)	IDR (656.992.567)	IDR (935.105.282)
NET SAVING	**IDR 2.630.160.000**	**IDR 2.829.715.200**	**IDR 3.043.857.024**	**IDR 3.273.631.246**	**IDR 3.520.157.833**	**IDR 6.721.686.290**

Project Title : Auto - Palletizer

INVESTMENT YEAR	0	1	2	3	4	5	14
INFLATION INDEX	1,00	1,04	1,08	1,12	1,17	1,22	1,73
CASH INFLOW (IDR Mio):	**2.529.000.000**	**2.630.160.000**	**2.829.715.200**	**3.043.857.024**	**3.273.631.246**	**3.520.157.833**	**6.721.686.290**
a. Profit Before Indirect (PBI)	-	-	-	-	-	-	-
b. Additonal Saving	2.529.000.000	2.630.160.000	2.829.715.200	3.043.857.024	3.273.631.246	3.520.157.833	6.721.686.290
CASH OUTFLOW :	**-15.500.000.000**	**-386.290.000**	**-436.178.800**	**-489.714.256**	**-547.157.812**	**-608.789.458**	**-1.409.171.570**
a. Investment Cost							
- Equipment	-15.500.000.000						
b. Tax		-386.290.000	-436.178.800	-489.714.256	-547.157.812	-608.789.458	-1.409.171.573
NET CASH FLOW Current Money	(12.971.000.000)	2.243.870.000	2.393.536.400	2.554.142.768	2.726.473.435	2.911.368.375	5.312.514.721
NET CASH FLOW Constant Money	(12.971.000.000)	2.157.567.308	2.212.958.950	2.270.623.620	2.330.600.919	2.392.932.585	3.067.844.878
TAX CALCULATION							
Profit Before Indirect (PBI)		2.630.160.000	2.829.715.200	3.043.857.024	3.273.631.246	3.520.157.833	6.721.686.290
Depreciation Equipment	7%	(1.085.000.000)	(1.085.000.000)	(1.085.000.000)	(1.085.000.000)	(1.085.000.000)	(1.085.000.000)
Taxable Earning		1.545.160.000	1.744.715.200	1.958.857.024	2.188.631.246	2.435.157.833	5.636.686.290
Tax payable at final	25%	(386.290.000,00)	(436.178.800,00)	(489.714.256,00)	(547.157.811,52)	(608.789.458,23)	(1.409.171.572,56)
Salvage Value		14.415.000.000	13.330.000.000	12.245.000.000	11.160.000.000	10.075.000.000	310.000.000
FINANCIAL RESULT							
Payback Period (Years)	**6,41**		**NPV at 12%**	**2.964.135.801**			

Table 7 Investment Analysis

5. CONCLUSIONS

By using multi-criteria method and weighing with AHP and evaluating suppliers using the scoring method, Supplier A was chosen as the selected supplier with the consideration of being able to provide the best machines and aftersales services.

From the calculation results using the line balancing method, the optimal number of palletizer robots to handle a total of 12 packing lines are 3 palletizing robots. The results of this calculation apply to conditions where all packaging lines operate at the maximum capacity of each line. If a number of packaging lines experience a decrease in production capacity to the point where they don't produce at all, and there is a condition where the pallet machines work far below the planned capacity, the pallet machines will be turned off and assets transferred to the PT factory. other X.

From the calculation of saving on the pallet robot investment, a net savings of 2.5 billion rupiahs, a payback period of 6.1 years, and a positive Net Present Value of 2.964 billion Rupiah

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SUPPLIER SELECTION AND DETERMINATION OF COAL CAPACITY AT PT. SEMEN GRESIK REMBANG PLANT

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ABSTRACT

One of the routine materials that are needed by PT. Semen Gresik in running the production process is the purchase of coal. For domestic needs, coal becomes a rare item. The daily stock of coal at PT. Semen Gresik Rembang Plant from August to December 2021 is always below the minimum stock needed. The estimated monthly needs requires coal of 51,000 tons. In the span of 2020, there are seven coal suppliers who actively distribute activities to PT. Semen Gresik. The selection of coal suppliers will be carried out with the Analytical Hiearchy Process that determining the hierarchical structure, then determining the weight of criteria and subcriteria. A consistency test is carried out until a consistency ratio value <=0.1 is obtained. A sensitivity analysis was carried out which finally obtained the three best suppliers who were prioritized to supplies the coal needs. The coal capacity of each selected supplier will be determined using linear programming. Based on the AHP study, three selected suppliers are IMK with 0.2174 point; DBM with 0.1677 point; and SAE with 0.1501 point. Each of these suppliers supplies coal in the amount of: IMK of 8,222 tons, DBM of 7,688 tons, and SAE of 35,090 tons.

Keywords: Supplier Selection, Capacity Determination, Analytical Hierarki Process, Linear Programming

1. INTRODUCTION

The procurement process of goods and services is a vital thing that needs more attention because it will affect everything that happens in the future. If the selected vendor or supplier is less responsible for fulfilling demand, it will cause a stockout and a lead time that is longer than agreed (Brisky Musyahidah, 2018). If the decisions to be made are complex and have high risks, scientific, logical, and structured tools are needed. Choosing the right supplier is key to the purchasing process and a key opportunity for companies to reduce costs (Kumar et al., 2018).

PT. Semen Gresik is one of the operational companies of PT. Semen Indonesia (Persero), Tbk, a multinational state-owned company owned by the State of Indonesia that is bound to the SOE Regulation. Of course, a company of this size really needs a variety of vendors and suppliers to meet its procurement needs for goods and services. It is necessary to evaluate the number of vendors and suppliers in order to find the right vendor or supplier for the work plan to be carried out. One of the routine materials that is indispensable for PT. Semen Gresik in carrying out its production process is the purchase of coal. Coal has an important role because it is the material

with the largest percentage used to burn in the production process. Meanwhile, for domestic needs, coal is a rare item. The daily stock of coal from PT. Semen Gresik starting in August to December 2021 is always below the minimum stock needed. It is very far from ideal conditions for a smooth production process. This condition is also exacerbated by the large number of coal supply companies that are reluctant to meet domestic market obligations of 25% of total production. Considering that the condition of coal supply for national purposes is vulnerable because many coal producers prefer to sell exports, PT. Semen Gresik must create a strategy that can secure its coal supply. The daily coal requirement for one factory line is 1,700 tons. The estimated monthly needs of this Rembang plant require 51,000 tons of coal. There are seven coal suppliers who actively carry out distribution activities for PT. Semen Gresik, among them PT. BIS, PT. DBM, PT. IMK, PT. PEU, PT. RBA, PT. SAE, and PT. SMA. It is necessary to conduct a further analysis of the performance history of each supplier with several considerations in order to obtain the right quality, timely, and competitively priced coal.

Supplier selection is a multi-objective decision that looks for the value of purchasing cost minimization, quality maximization, and service performance simultaneously (Xia & Wu, 2007). Multiple sourcing is intended to protect (hedge) buyers against supply risks such as supply shortage (Constantino & Pellegrino, 2010). Companies must first determine the number of suppliers to be selected before implementing the policy of using multiple suppliers. Furthermore, the company can determine the number of orders from each supplier. Order allocation is influenced by several factors, such as cost, quality, delivery, service, and so on (Pan & Wang, 2014). The selection of suppliers for critical materials for the company is a multi-criteria problem. While the criteria that affect it themselves are quantitative and qualitative. So a method is needed that can solve problems with such conditions. One method that can be used is the Analytical Hierarchy Process (AHP). It is necessary to carry out an advanced analysis aimed at determining the required order quantity. In this case, the determination of the quantity for each supplier uses Linear Programming. The AHP method is used to determine the priority factors that affect supplier selection as well as get the 3 best suppliers for PT. Semen Gresik to avoid uncertainty and a potential lack of supply. The analysis was then continued by using linear programming to map the number of orders that must be fulfilled by PT. Semen Gresik to selected suppliers.

2. LITERATURE REVIEW

Supplier Selection

To carry out the company's operational processes, spare parts and materials are needed, which are, of course, supplied by suppliers. Improper supplier selection can interfere with the company's operating activities (Onut et al., 2009). The selection of suppliers will be very critical again when faced with the need to procure the main material, where it is expected that there will be no stockouts, such as coal materials. Supplier selection problems can be in the form of single-sourcing problems, where one supplier meets the needs of all orders, or multiple-sourcing problems, where more than one supplier is selected to fulfill orders (Hamdan & Cheatiou, 2017). The problem that occurs is how to evaluate and select the best or most feasible suppliers for the company based on the capabilities of varied suppliers (Jolai et al., 2011).

Multi-Criteria Decision Making (MCDM)

This multi-criteria decision analysis aims to evaluate various conflicting criteria in decision-making. Multi-Criteria Decision Making (MCDM) consists of several interrelated steps as a decision support system that can help get the optimal solution. The procedure is as follows:

(1) determining characteristics and problems, (2) obtaining criteria, (3) filtering alternatives, (4) determining preferences for evaluation criteria, (5) choosing the MCDM method, (6) evaluating the MCDM method, (7) using the MCDM method, and (8) knowing the results and evaluation of the evaluation (Singh and Sanjay, 2014). There are at least 6 methods that can be used in solving problems in MCDM (Gayatri and Chetan, 2013), but this study will focus on AHP.

Analytical Hierrarchy Process (AHP)

The Analytical Hierarchy Process (AHP) is a decision-supporting model developed by Thomas L. Saaty (1990). This method explains multifactor or multicriteria problems so that they become a hierarchy or unity. Hierarchy is a representation of complex problems in a single multilevel structure consisting of a goal level, factor level, criterion level, sub-criterion level, and the last level of existing alternatives. Hierarchy allows a complex problem to be decomposed into groups, resulting in a more structured and systematic problem (Saragih, 2013). AHP is considered a simple, flexible method that houses creativity to solve a problem (Herjanto, 2008). AHP is closely related to human judgment (Xia & Wu, 2007).

Linear Programming

Linear programming is a tool for solving optimization problems (Winston, 2004). In linear programming problems, there are characteristics including decision variables, objective functions, and constraints. The decision variables should be appropriate for describing the decision to be made. The decision-maker will maximize or minimize a function of the decision variable. This maximized or minimized function is called the objective function. In linear programming modeling, there are limitations that must be met, such as capacity, budget, resources, and so on. Choudhary & Shankar (2013) developed a model of combining joint decisions in the determination of purchase lot sizes, supplier selection, and mode of transportation that have the potential to reduce the total cost of purchase.

3. METHODS

Development of AHP Model

Hierarchy model being developed by AHP must meet the goal behind it. Initial steps taken is conducting problem identification and determining the desired solution. At this stage, the researcher will determine the problem to be solved in detail. Furthermore, the determination of solutions that are in accordance with the existing problem is carried out. Create a hierarchical structure. At this stage, the main goal of problem solving is determined in advance as the top level in the hierarchy. Then the hierarchy level is arranged below it according to the criteria that are considered suitable for assessing existing alternatives.

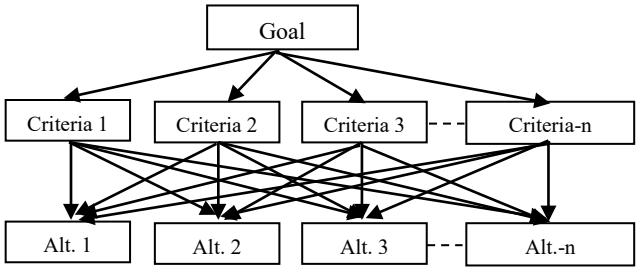


Figure 1. Hierarchical Structure on AHP

Create a pairwise comparison matrix. Its purpose is to describe the relative contribution or influence of each element over goals or criteria on one level above it. The matrix approach reflects a dual priority aspect, namely dominating or dominating. The result of the comparison of each element shows the degree of comparison of that element, written in numbers from 1 to 9. And if an element in the matrix is compared with the element itself, then the comparison value obtained is 1. In determining the average of the assessments given by respondents, it is carried out using geometric averages. Here is the scale of pairwise comparison introduced by Saaty (1987):

Table 1. Comparison Scale

Score	Information
1	Both elements are equally important, and two elements have an equally great influence.
3	One element is slightly more important than the other, so experience and judgment slightly favor one element compared to another.
5	One element is more important than another, so very strong experience and judgment can support one element over another.
7	One element is of greater absolute importance than another, so that one strong element is supported and more dominant in practice.
9	One factor is unquestionably more important than another.
2,4,6,8	values between two adjacent considerations

Then calculate the eigenvalue and perform a consistency test. If the test results show inconsistency, the data collection process is repeated, or the assessment is improved because it shows inconsistencies in the provision of judgment. Calculating the consistency ratio (CR) with the following formula:

$CR = CI/RI$

where,

CR : Consistensy Ratio
CI : Consistensy Index
RI : Random Index

The random index value is obtained using the following random consistency table:

Table 2. Random Index Value

n	1	2	3	4	5	6	7	8	9	10
RI	0	0	0,58	0,9	1,12	1,24	1,32	1,41	1,45	1,49

Sensitivity Analysis

A sensitivity analysis is carried out to determine the degree of influence on the arrangement of alternative decisions if the value of the criterion weight changes. The results obtained are to find out which component of the hierarchy structure is most sensitive to changes in weight, so that it can be known which factors are most influential in the assessment.

Development of LP Model

The steps taken at this stage include determining decision variables, determining the function of goals, and determining boundaries. Decision variables are used to outline the decisions to be made. The goal function is to perform minimization or maximization. The necessary boundaries must be determined at the beginning. The above conceptual framework is used to compile mathematical models. The preparation of mathematical models starts with defining the index, determining parameters, determining decision variables, compiling the goal function, and finally compiling the limiting function.

4. RESULTS

Data collection is carried out by submitting a request to PT. Semen Gresik is related to coal needs and specifications needed, as well as data on suppliers who have become partners and have coal contracts with PT. Semen Gresik. Thus, with data on what is possible for the weighting process and expected supplier criteria, The data was obtained by interviewing several employees of PT. Semen Gresik.

Table 3. Criteria and Subcriteria

Criteria	Subcriteria
Quality	Calorific Value (CV)
	Moisture
	Ash
	Sulfur
	Hardgrove Grindable Index (HGI)
Price	-
Capability	Delivery Time
	Capacity
	Communication

Table 4. Suppliers Spesification

No	Supplier	CV	Moisture	Ash	HGI	Sulfur	Price (Rp/ton)	Delivery time (day)	Average volume
1	BIM	3741	36,36	8,06	57,00	0,23	850.000	12	7727,05
2	DBM	3931	36,47	3,17	54,00	0,11	528.750	8	7687,26
3	IMK	4192	33,66	4,33	56,50	0,46	760.000	6	8221,89
4	PEU	3735	39,95	4,12	57,08	0,14	666.667	7	7690,46
5	RBA	3640	42,95	3,38	57,00	0,16	840.000	9	7552,12
6	SAE	3810	38,52	3,68	55,60	0,38	525.000	7	7656,59
7	SMA	3833	37,48	3,74	56,10	0,13	572.857	7	7535,82

After obtaining the necessary data, continue processing according to the order of the AHP, starting with pairwise comparison and moving on to consistency testing of the modeled hierarchy. Until the processing results are obtained, they are as follows:

Table 5. Preference Index of Criteria and Subcriteria

Criteria	Subcriteria	Score
Quality	Calorific Value (CV)	0,1671
	Moisture	0,0216
	Ash	0,0326
	Sulfur	0,0666
	HGI	0,0229
Price	-	0,2280
Capability	Delivery Time	0,1821
	Capacity	0,1440
	Communication	0,1350

Weight is obtained from each of the criteria and subcriteria that influence the selection of existing alternatives. Referring to the table, it can be seen that the order of the most influential criteria is capability, quality, and price.

Table 6. Prioritization of Alternatives for supply of coal

Altervatives	Ideal	Normal
PT.BIS	0,3772	0,0825
PT.DBM	0,7692	0,1682
PT.IMK	1,0000	0,2187
PT.PEU	0,5991	0,1310
PT.RBA	0,4649	0,1017
PT.SAE	0,6851	0,1498
PT.SMA	0,6774	0,1481

AHP processing results obtained an alternative order for suppliers registered as PT. Semen Gresik, which corresponds to Table 6. PT. IMK was ranked first with a value of 0.2187 and was followed by PT. DBM and PT. SAE in second and third with values of 0.1682 and 0.1498. Furthermore, PT. SMA has a score of 0.1481, PT. PEU has a value of 0.1310, PT. RBA has a value of 0.1017, and PT. BIS has a value of 0.0825.

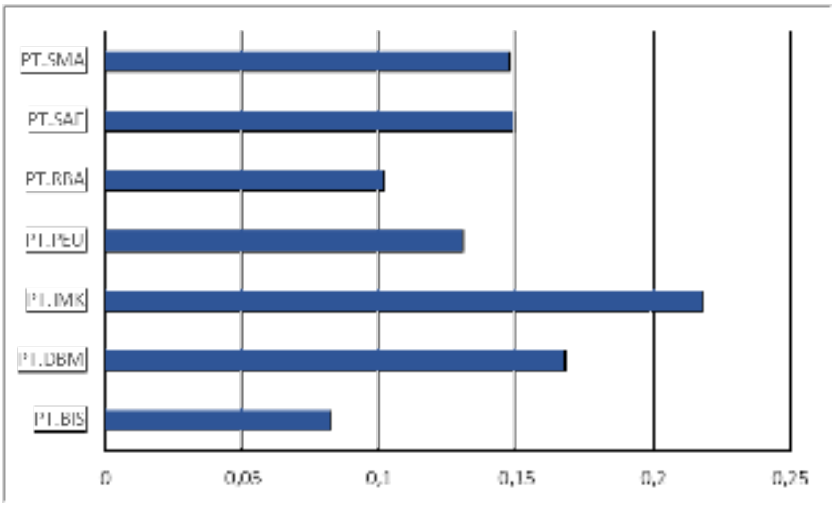
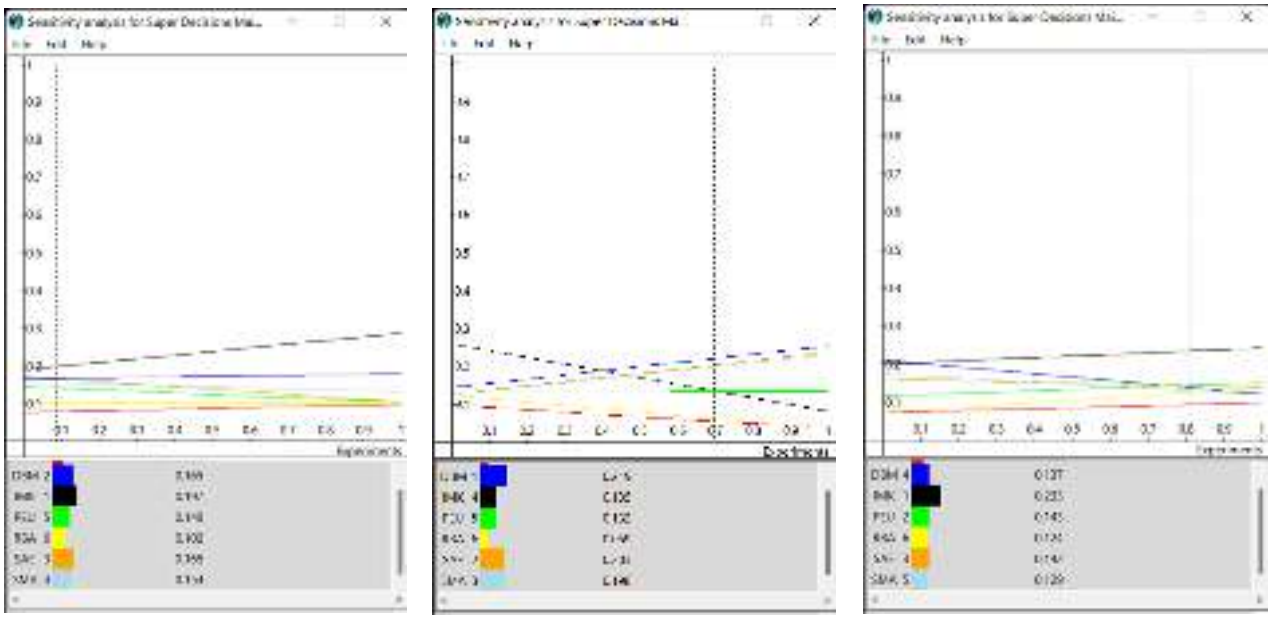


Figure 2. Final normal values of alternatives

The top three orders selected to supply coal consist of the following suppliers are PT. IMK, PT. DBM, and PT.SAE. These three suppliers were chosen to supply coal to PT. Semen Gresik. However, to see what will happen with the results of AHP processing if there is a change in the size of the weight of the criteria, a sensitivity analysis will be carried out.



(a) (b) (c)

Figure 3. Sensitivity analysis for quality (a), price (b), capability (c)

Testing is carried out using sensitivity analysis to see which criteria are sensitive to changes in weight. The results of the sensitivity analysis carried out show that changes in the weight of quality criteria are insensitive to changes in supplier selection ratings. Meanwhile, changes in the weight given to price criteria and capability criteria are sensitive to influencing changes in supplier selection ratings.

After calculations are carried out using the AHP method to obtain alternative suppliers who will supply coal, the next step is to calculate the allocation of supplies from each supplier using linear programming. The model used in this study can be seen in the following explanation:

Index

t *time period,* $t \in T$

i *suppliers,* $i \in I$

Parameters

H_i *purchase price of coal at supplier i (Rp/ton)*

D_t *coal demand in each period t (ton)*

C_t *capacity of modes of transport in the period t (ton)*

N_t *many modes of transportation are required during time period t*

R_{ti} *minimum requirements for each supplier in the period t (ton)*

HA_t *number of days in a period (day)*

DU_t *duration of delivery for each supplier*

Decision variable

Q_{ti} *coal purchases from each supplier in the period t (ton)*

Objective function

$$\min z = \sum_{t=1}^{T}\sum_{i=1}^{I} H_i Q_{it} \quad \text{..... (1)}$$

Eq. (1) the purpose of this study is to reduce the cost of coal procurement.

Constraints

$$\sum_{i=1}^{I} Q_{it} \geq D_t \; ; \; \forall t \quad \text{..... (2)}$$

Eq. (2) show demand fulfillment restrictions ensure coal demand is met in each planned time period.

$$Q_{it} \leq C_i N_{it} \; ; \; \forall t, \forall i \quad \text{..... (3)}$$

$$N_{it} \leq (Q_{it}/C_i) + 1 \; ; \; \forall t, \forall i \quad \text{..... (4)}$$

$$N_{it} \leq (HA_i/DU_i) \; ; \; \forall t, \forall i \quad \text{..... (5)}$$

Eq. (3) to (5) capacity search restrictions ensure that the number of orders placed does not exceed the capacity of the mode of transportation and also determine the number of modes of transportation needed. The chosen mode of transport is a barge with a capacity of 10.000 tons.

$$Q_{it} \geq R_{it} \; ; \; \forall t, \forall i \quad \text{..... (6)}$$

Eq. (6) supplier requirement restrictions ensure that the number of orders placed exceeds the specified minimum order level.

$$Q_{it} \geq 0 \; integer \quad \text{..... (7)}$$

$$N_{it} \geq 0 \; integer \quad \text{..... (8)}$$

Eq. (7) & (8) non negativity, integer constraints

After inputting constraints and destination functions, the next step is to find the optimal solution for the model that has been created. The analysis of the results here is the result of the search for the most optimized solution from the research being carried out. Obtained is the distribution of coal allocations that must be sent by each supplier to PT. Semen Gresik, which corresponds to the following table:

Table 7. Coal supply allocation for January, March, May, July, August, October, and December

Supplier	Supply Allocation	Price (Rp/ton)	Number of barges
PT.IMK	8.222	760.000	1
PT.DBM	7.688	528.760	1
PT.SAE	36.790	525.000	4

In January, March, May, July, August, October, and December, coal needs as much as 52,700 tons. The distribution of coal allocation from PT. IMK suppliers was 8,222 tons, PT. DBM was 7,688 tons, and PT. SAE was 36,790 tons. So, using the coal allocation composition obtained, the costs incurred in each month mentioned above are IDR 29,628,576,880,-.

Table 8. Coal supply allocation for February, April, June, September, and November

Supplier	Supply Allocation	Price (Rp/ton)	Number of barges
IMK	8.222	760.000	1
DBM	7.688	528.760	1
SAE	35.090	525.000	4

In February, April, June, September, and November, coal needs as much as 51,000 tons. The distribution of coal allocation from PT. IMK suppliers was 8,222 tons, PT. DBM was 7,688 tons, and PT. SAE was 35,090 tons. So, using the coal allocation composition obtained, the costs incurred in each month mentioned above are IDR 28,736,076,880,-.

5. CONCLUSIONS

Supplier selection is very important because supplier performance will affect company performance. The main factors for selecting suppliers that must be considered are the criteria and subcriteria that are in accordance with the purpose of the selection. The order of criteria according to existing case studies of the most important is capability, quality, and cost. This criterion has accommodated all stakeholders' interests. The suppliers selected according to the assessment design are PT. IMK, PT. DBM, and PT. SAE, which correspond to the specified supply allocation.

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CRITICAL SUCCESS FACTORS AND BARRIERS ANALYSES ON THE IMPLEMENTATION OF INDONESIAN MINING SAFETY MANAGEMENT SYSTEM: CASE STUDY A NICKEL MINE & PROCESSING COMPANY

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ABSTRACT

Implementation of an occupational health and safety management system is an absolute must, especially for mining companies that have very high work risks. Mining safety is a critical issue because it affects the company's reputation, performance, and sustainability. The Republic of Indonesia's government, through the Ministry of Energy and Mineral Resources (MEMR), has established laws mandating the Mineral and Coal Mining Safety Management System (SMKP MINERBA) to be implemented, as described in MEMR Regulation No. 26 of 2018 and its derivatives. However, the implementation of SMKP MINERBA is still inadequate, as evidenced by increased mining accidents resulting in injuries, lost work hours, and even death. Critical success factors (CSFs) for a system management well recognized as very useful in improving OHS performance. Therefore, this study will analyze CSFs and barriers to their application in PT. XYZ, including Mining Service Companies within it. Research variables resulted from reviews and consultations with experts then Exploratory Factor Analysis (EFA) was used to analyze questionnaire data from 357 respondents. The study concluded that the seven factors – SMKP good governance; strong organizational safety culture; organizing and resource availability; Specific - Measurable - Attainable - Relevant - Time Bound (SMART) planning and periodic monitoring; management commitment and strategy, effective Occupational Health & Industrial Hygiene (OH-IH) management; and compliance and safety leadership – could be used to categorize the existing CSFs. Meanwhile, the barriers can be divided into three categories, i.e.: low SMKP management commitment, poor safety leadership, and weak OHS planning and execution. Rankings of CSFs and Barriers were also created based on Relative Importance Index (RII) calculation and the ratings could be used by Management for further SMKP MINERBA improvement at the company. Thus, the results and the proposed solutions are also valuable to the industry since they may improve practitioners' comprehension and assist them expand their adoption in businesses.

Keywords: Critical Success Factors, Factor Analysis, Mining Occupational Health and Safety Management System, Relative Importance Index, SMKP MINERBA, Strategic Management

1. INTRODUCTION

The mining sector, which differs in nature and features from other industries, is one of the most crucial sectors for a country's economic growth. The mining sector necessitates a high investment cost (capital intensive), technology-intensive, long term, risky (both high and specific),high unpredictability, and dynamic circumstances (hazard & switched risk). The presence of these traits, along with efforts to boost output to satisfy high demand, might have undesirable repercussions, such as a rise in work accidents owing to pressure on production objectives. In Indonesia the mining sector is still the most dangerous work sector, according to data from the Directorate General of Mineral and Coal, Director of Engineering and Environment (DTEMC) of Ministry of Energy and Mineral Resources (MEMR) (2022), in a decade there were 1642 reports of mining accidents with various categories, from mild to fatalities. Mining accident statistics between 2012 - 2021 are shown in Figure 1. As many as 883 people were seriously injured and 224 mining workers died. This does not include cases that may have been hidden or not reported. Based on report data from the Indonesian Mining Safety Professional Association (2022),there was also an increasing trend of working accidents in Indonesia's mining sector resulting in serious injuries and or death for last five years. As a nickel mining and processing company, the statistical description before is reflected also in what was experienced by PT. XYZ. The company's internal data (2022), shows that since 2018 there has been a signal of a gradual up reversal of the Total Recordable Injury Frequency Rate (TRIFR) curve in Figure 1. The TRIFR statistic refers to the frequency of work-related injuries or illnesses that can be recorded for every 1 (one) million hours worked. In the end, 1 fatality case happen in 2022 involving a contractor's employee. This figure indicates that there is a failure of the line of defense of a management control system so that there is a continuous increase in resulting mining accidents.

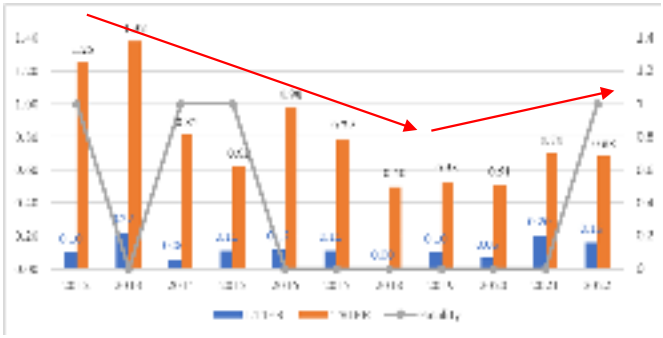

Figure 1. TRIFR vs Fatality 2012 – 2022

Mining accidents that occur certainly cause huge losses to employees and companies, both directly and indirectly. Hazards and risks should be managed and controlled to reduce work- related accidents. Efforts to control hazards must be carried out by identifying potential risks in the workplace (Suma'mur, 2011). Work accidents will have a direct impact on time, loss of productivity, and every individual involved in work. So, improving safety standards that are better will result in good finance (Delfani, 2018). Although proper safety management is essential, the facts show that safety is not sufficiently considered in many developing countries (Durdyev et al., 2017). Sutawijaya et al. (2017), implementation of the Occupational Health and Safety Management System (OHSMS) in Indonesia is still not maximally implemented, due to the poor of safety culture in society. On the other hand, global market competition requires an industry to further develop its business by improving its OHSMS, because the OHSMS is the management of occupational health and safety by a management system approach to implement effective results in preventing accidents and other adverse effects (Ramli, 2010). MEMR encouraged Mining Companies to adopt best practices to create favorable conditions for sustainable mining. SMKP MINERBA is part of the company's management system as a whole part of the management system in the framework of controlling mining safety risks (MEMR Regulation No. 26, 2018). As an OHSMS in the mining industry, SMKP MINERBA is believed right now to be the best defense against mining accidents that resulted in injuries and fatalities. This system is also directed at the integration of the Mining Occupational Health and Safety (K3) management system and Mining Operational Safety (KO) and the environment in mining (Sumarno, 2018).

Efforts to support mining to remain safe and comply with safety regulations describe the core activities that must be carried out to maintain workplace safety (Neal & Griffin, 2012). However, after 3 years new SMKP MINERBA regulation was published, the effectiveness of SMKP MINERBA implementation is remained to be challenging. Nationally, a trend of SMKP MINERBA fulfillment tends to decrease, in 2021 the national average is only 51% (DTEMC, 2022). Likewise, those conditions are reflected also in the internal area of PT. XYZ. The results of the SMKP Audit evaluation also showed an unsatisfactory score, especially for mining services contractors within PT. XYZ which has a range of 30 – 70%. It can be concluded that the implementation of SMKP MINERBA is still in a low condition because the average compliance is still below 60%. Anggoro & Simorangkir (2019), Barriers that are often faced by companies implementing SMKP MINERBA mostly comes from: 1) internal company factors include: lack of understanding, lack of management support, and an unstable workforce; 2) Difficulties in managing a mining service company); 3) Nature of the Company: lack of resources, lack of familiarity with the system concept; and 4) Not optimal audit implementation.

Critical success factors (CSFs) for management systems have been recognized as useful in improving OHS performance. CSF is an area in the organization, which can determine the success of the performance of the strategy carried out by the organization if the area can be implemented and appropriately fulfilled (Rockhart, 1979). CSF is a concept that can systematically identify a limitation that requires more attention from management to meet performance objectives (Corkindale, 2013). Thus, it is essential to consider the many obstacles faced in implementing a safety management system because they have not identified and implemented CSF properly (da Silva & Amaral, 2019). The CSF is a key success factor that is important and must be considered by the company so the implementation of the strategy design can run well (Buniya et al, 2021). This research is expected to contribute to solving challenges in the implementation of SMKP MINERBA which has not been maximized, so it is necessary to evaluate critical success factors and barriers that have a strong contribution to the successful implementation of SMKP MINERBA in companies.

2. LITERATURE REVIEW

A review of literature and research journals in accordance with the object of research was carried out to collect initial data. Not much literature specifically discusses SMKP MINERBA, especially in nickel mining and processing in Indonesia. Data collection was carried out to determine various variables which were categorized as CSFs and Barriers to the implementation of SMKP MINERBA in mining companies and mining service contractors. Literature collection with OHSMS research in other fields was also carried out, because activities at PT. XYZ also has a variety of activities from upstream to downstream which include exploration, construction, excavation, transportation, processing, port (logistics), and soon.

From the previous research review, 35 CSF variables can be synthesized from selected 25 national and international journals and 29 barriers variables also synthesized from 23 selected national and international journals. Barrier's variables to the implementation of SMKP MINERBA. All those variables are reviews and screened by consultations with experts in the first phase. Variables/items predictor of CSFs to the implementation of SMKP MINERBA can be seen in Table 3 and for Barriers shown in the Table 4.

Since there are only a few studies and theories that discuss the implementation of SMKP MINERBA, there is a need for a comprehensive study to develop a model for implementing an occupational safety and health management system, particularly in nickel mining and processing companies in Indonesia. One of the research methods that has been widely used in previous similar studies and considered suitable and appropriate is factor analysis. Factor analysis is a data reduction procedure as well as a tool for testing measuring instruments in the multivariate statistical method (Watkins, 2018). In this study, the Exploratory Factor Analysis (EFA) approach was chosen since it is well-known and very simple. In most cases, the data submitted are measurements with a lot of variables. The data gathered from the survey was evaluated using the EFA approach, which also helped to limit the number of factors and create correlations between variables (Hair et al., 2010).

3. METHODS

To answer the proposed research questions, the researcher develops Research Framework as seen on Figure 2.

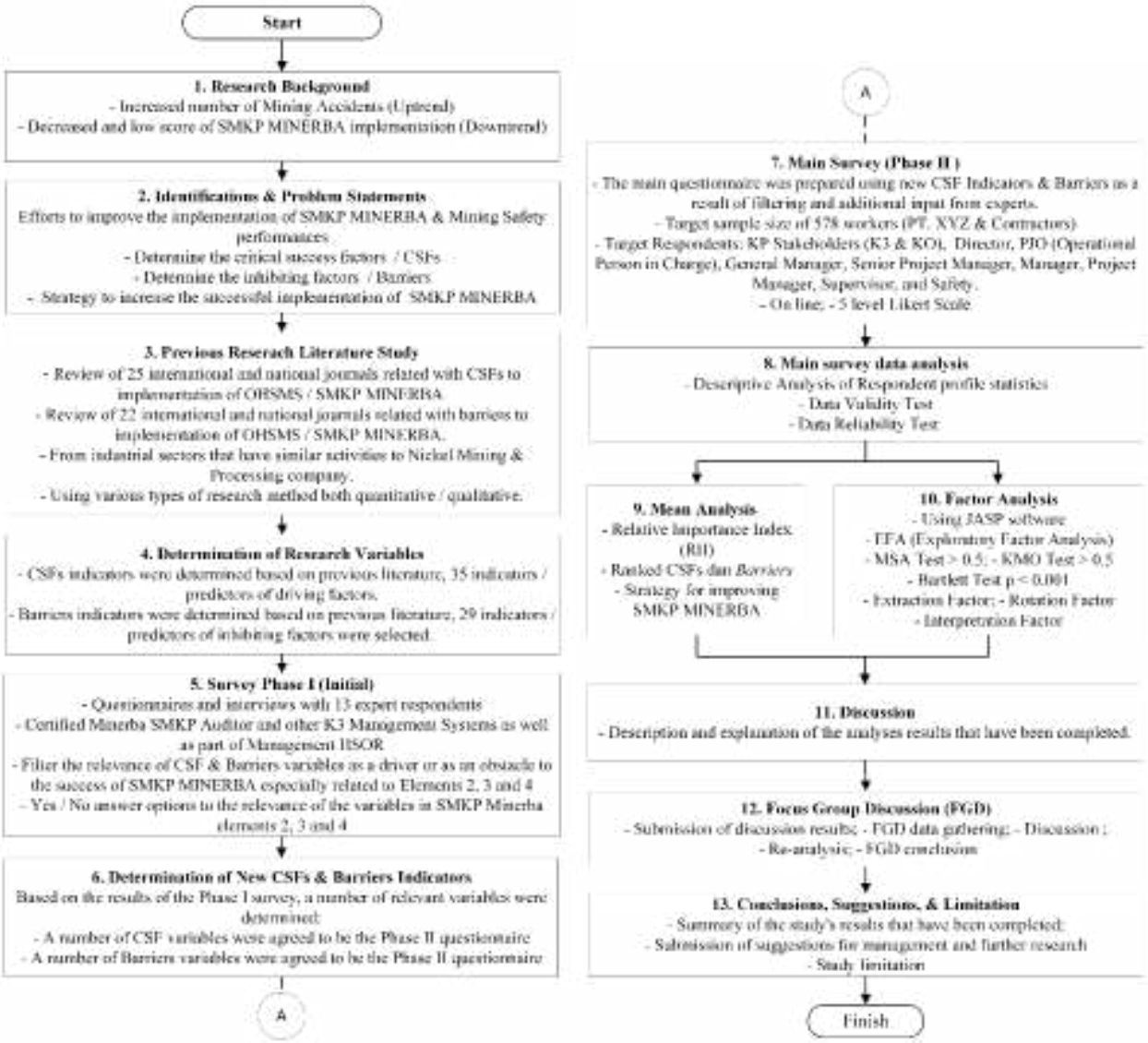

Figure 2. Research Framework

Based on the results of completing the questionnaire in stage II that has been carried out, it can be analyzed using the Relative Importance Index (RII) method so that it can be seen which factors are the most supporting and inhibiting the implementation of SMKP MINERBA. RII determines the ranking based on the weight of the Likert scale values that have been carried out bythe Respondents. The RII formula is calculated by the following equation:

$$RII = \Sigma W/(A \times N)$$

Where:

- RII = Relative Importance Index
- W = Weight (Number of answers on Weight with a range of 1 to 5 according to theLikert Scale * weight)
- A = highest weight (5)
- N = total respondents

FGD were also conducted to strengthen the results of the study, especially to ranking of CSFs and

Barriers where the results will provide managerial implications for the successful implementation of SMKP MINERBA in the future. The FGD session was attended by experts/respondents who have competencies as SMKP MINERBA Auditors and the Health, Safety & Risk Management of PT. XYZ. In this study, FGD was used as a secondary method of data collection as well as being used as a form of the triangulation method technique so that it can be ensured that the data obtained is valid data by re-comparing the degree of trust in information from different sources (Moleong, 2014).

4. RESULTS

4.1 Analysis Factor of CSFs & Barriers

Several value criteria are to be interpreted and meet the requirements to be declared area valid and suitable for further analysis. The first-factor analysis assumption is the Bartlett Test of Sphericity. The calculation results with $p < 0.001$. This shows that the data tested are correlated data and meet the requirements for factor analysis because the significance is below 0.05 (5%). The second-factor analysis assumption is: Kaiser Meyer Olkin Measure of Sampling (KMO) is an index of the comparison of the distance between the correlation coefficient and its partial correlation coefficient. The KMO value is considered sufficient if it is more than 0.5. KMO results for overall MSA CSFs indicators are 0.874. and KMO result for overall MSA of Barriers indicators area are 0.88.

Furthermore, factor analysis was carried out by Exploratory Factor Analysis (EFA) using JASP software to identify how many factors were formed from a measurement device consisting of several questionnaire items. EFA has the same purpose and function as Principal Component Analysis (PCA) but has a different algorithm mathematically. In addition to the assumptions and requirements such as the KMO-MSA and the Bartlett Test above, the method used to reduce the initial group of variables to simpler factors also uses the Eigenvalues and Scree Plot criteria, as shown in Figure 3. In figure 3, the formation of the number of factors will be confirmed by the Scree plot based on the Eigenvalue, illustrated by subtracting the curve until it is sloping and still above the Eigenvalue = 1 line.

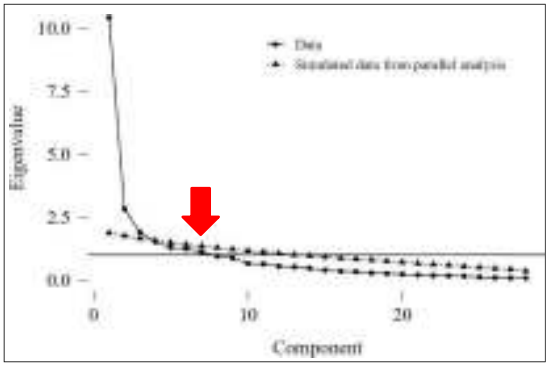

Figure 3. Scree Plot Factor Analysis CSFs of SMKP MINERBA

Thus, if we count the number of points starting from the left side, then there are only 7 (seven) points indicating the number of factors formed. The results of the analysis get 7 different factors, with groupings based on the relationship of the loading factor value on each question item. Setting the default loading value above 0.4, but researchers may adjust according to the assumptions used respectively, whether it is more stringent, or the minimum uses the number 0.3 which as seen in the Table 3.

Table 3. CSFs Analysis Result of SMKP MINERBA

Factor	Name	Variable		Factor Loading
1	*SMKP Good Governance*	X12	Implementation of completed SMKP MINERBA Audit versus adequate plans and follow-up of SMKP MINERBA Audit results	0.848
		X13	Regular Mining Safety meetings	0.847
		X6	Award incentives and innovations related to the Mining Safety Award	0.841
		X5	Determination of Mining Safety Policies and Mining Safety Procedures, technical	0.786

Factor	Name	Variable		Factor Loading
			standards, and Special Work Permits related to work.	
		X34	Socialization of SMKP MINERBA to Top Level Management of the Company;	0.647
2	Strong Organizational Safety Culture	X20	Risk Management and Emergency Response Plan (ERP)	0.79
		X22	Minerba SMKP work plan and implementation program	0.781
		X21	OHS Inspection and Equipment Feasibility Test (KO)	0.772
		X19	Strong organizational safety culture	0.732
		X17	There are clear Goals, Targets, SMKP MINERBA Programs	0.501
3	*Organizing and Resource availability*	X14	Contractor Safety Management System (CSMS) as part of SMKP MINERBA	0.838
		X8	Adequate organizational planning and resources, including the formation of a Mining Safety Committee which plays an active role in the management of SMKP MINERBA	0.827
		X35	Determination of Minerba SMKP Implementation Minimum Criteria for Mining Service Companies	0.735
		X15	Reporting, recording, and working accident investigations and follow-up repairs. (Including dangerous/near misses)	0.458
		X9	Management of good SPIP (Facilities, Infrastructure, Installation, Equipment).	0.479
4	*SMART Planning & Monitoring*	X3	Promotion, communication, information, and socialization regarding activities related to SMKP MINERBA	0.810
		X18	Adequate Investment and Budget of SMKP MINERBA	0.779
4	*SMART Planning & Monitoring*	X33	Supervision and Guidance from Mining Inspectors (Government)	0.740
		X2	Fulfillment of Training and Competency needs of SMKP MINERBA	0.474
		X4	Hazard Identification and Risk Assessment of Business and Work Processes	0.359
5	*Management Commitment & Strategy*	X1	Management commitment and support for the implementation of SMKP MINERBA	0.669
		X30	Selection and placement of personnel	0.553
		X32	Use of information technology and operation technology in SMKP MINERBA	0.432
6	*Efficient OH-IH Management*	X16	Adequate Occupational Health Management	0.953
		X10	Availability of an IH team that periodically tests the safe working environment and ergonomics	0.631
7	*Compliance & safety leadership*	X29	Compliance with standards and timeframe for providing personal protective equipment (PPE) to employees;	0.759
		X28	Review applicable laws and government regulations to become an integral part of SMKP MINERBA	0.745
		X23	KTT and PJO Leadership (including Delegation, Authorities, and Responsibilities)	0.491

Barriers factor analysis to the Implementation of SMKP MINERBA also confirmed by the Scree plot based on the Eigenvalue, illustrated by subtracting the curve until it is sloping and above the Eigenvalue = 1 line. Thus, if we count the number of points starting from the left side, then there are only 3 (three) factors that are formed. (The fourth point of the eigenvalue is <1) as shown in Figure 4. The results of the analysis get 3 different factors, with groupings based on the relationship between the factor loading values. The default loading value setting uses thenumber 0.36 to appear all loading factors. The grouping of factors that are formed and the members of each factor are as shown in Table 4.

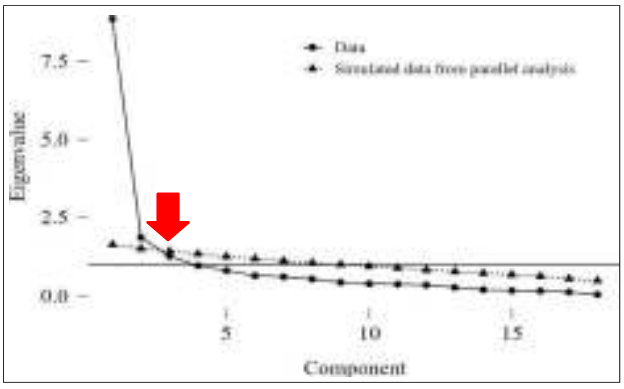

Figure 4. Scree Plot of Factor Analysis of Barriers to SMKP MINERBA

Table 4. Barriers Factor Analysis Results of SMKP MINERBA

Factor	Name	Variable		Factor Loading
1	Low Management Commitment	B13	Failure in Risk Analysis and Improper Decision Making in the implementation of SMKP MINERBA	0.793
		B12	Difficulties in managing Contractors / Mining Service Companies in implementing SMKP MINERBA	0.764
		B2	Lack of Management Commitment and Participation in the Implementation of SMKP MINERBA	0.761
		B1	Lack of understanding and training related to the Implementation of SMKP MINERBA	0.736
		B16	The management review has not been carried out, so it is difficult to define appropriate management indicators in the application of SMKP MINERBA	0.671
		B10	Difficulties in reviewing laws and regulations so they are not implemented consistently.	0.67
		B22	No/no Mining Safety Committee has been established	0.56
		B19	Lack of communication and information related to the implementation of SMKP MINERBA	0.363
2	*Poor Safety Leadership*	B30	Mining Safety Incentives and Awards are inadequate	0.833
		B24	Lack of sanctions/law enforcement against SMKP MINERBA violations	0.784
		B28	Resistance to change and obstacles to the use of technology integration in the implementation of SMKP MINERBA	0.756
		B15	Unfamiliarity and lack of readiness to adopt the SMKP MINERBA management system	0.692
		B18	Lack of Standard Procedures and their integration into SMKP MINERBA	0.66
		B27	Not optimal implementation of studies and audits of SMKP MINERBA	0.599
		B3	Limited costs or lack of budget and implementation costs for SMKP MINERBA	0.599
3	Weak Planning & Execution	B26	The follow-up and evaluation/audit results of SMKP MINERBA have not been implemented	0.805
		B20	Weak procurement strategy and lack of Contract Clauses to apply management systems to contractors	0.758
		B4	Lack of experts / limited SMKP MINERBA resources	0.691

4.2 Relative Importance Index (RII) & Focus Group Discussion (FGD)

The results of the RII survey and RII FGD calculations were compared. There were differences in ranking between the RII Survey and RII FGD in terms of both CSFs (Table 5) and barriers (Table 6). Several variables still have the same rank or have shifted only slightly, but the other have huge differences. Based on FGD, the results of the RII Survey emerged based on the assumed weight of "Important" either as a CSF or as a barrier, while the results of the RII FGD with experts emerged with an additional sense of "Urgency" which must be followed up immediately. Through the results of an exciting discussion with Management and experts during the FGD, a decision was made to "cross" the RII to produce a new ranking and when plotted it waslike the Eisenhower Matrix. The results of the FGD decisions for ranking RII calculations on CSF for the implementation of SMKP MINERBA can be seen in Figure 5 and for barriers are shown in Figure 6.

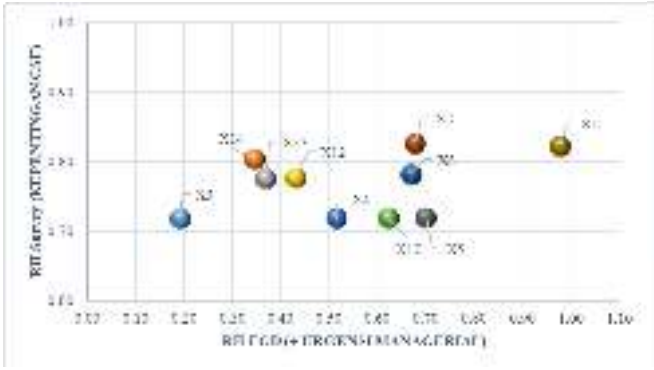

Figure 5. Bubble Plot Diagram of RII CSF SMKP MINERBA at Final Stage

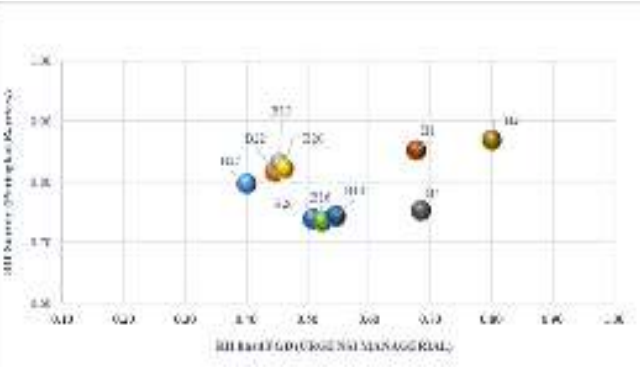

Figure 6. Bubble Plot Diagram of RII Barriers SMKP MINERBA at Final Stage

Furthermore, to get the final RII ranking for the implementation of SMKP MINERBA, it is done by multiplying the RII values from the survey results and the RII from the FGD results. This circumstances are

applicable both for CSFs and Barriers analysis. For example, based on the data from Table 5, the results obtained for variable X2 ~ Fulfillment of Training and Competency needs of SMKP MINERBA, namely with an RII Survey of 0.825 and an RII of FGD of 0.677, the results of the Final RII score for variable X2 = 0.825 x 0.677 = 0.558. Thus, this formulation was applied to obtain the top 10 scores of the Final RII and the Final Ranking of the CSF variables. Final score results for the top 10 RII CSFs and the final CSF rankings of SMKP MINERBA after the FGD, as shown in Table 5.

Table 5. Final Score and Ranking of RII CSF to the Implementation of SMKP MINERBA

Code	Description	RII Survey	Rank Survey	RII FGD	Rank FGD	RII Final	Rank Final	Management Strategy
X1	Management commitment and support for the implementation of SMKP MINERBA	0.821	2	0.977	1	0.802	1	Must Do Immediately
X2	Fulfillment of Training and Competency needs of SMKP MINERBA	0.825	1	0.677	3	0.558	2	
X8	Adequate organizational planning and resources, including the formation of a Mining Safety Committee which plays an active role in the management of SMKP	0.781	4	0.669	4	0.523	3	
X5	Determination of Mining Safety Policies and Mining Safety Procedures, technical standards, and Special Work Permits related to work.	0.718	7	0.7	2	0.503	4	
X17	clear Goals, Targets, SMKP MINERBA Programs	0.718	8	0.623	5	0.447	5	
X4	Hazard Identification and Risk Assessment of Business and Work Processes	0.718	8	0.515	6	0.37	6	Scheduled ASAP (As Soon As Possible)
X12	Implementation of completed SMKP MINERBA Audit versus adequate plans and follow-up of SMKP MINERBA Audit results	0.775	5	0.431	7	0.334	7	
X33	Supervision and Guidance from Mining Inspectors (Government)	0.774	6	0.369	8	0.286	8	
X14	Contractor Safety Management System (CSMS) as part of SMKP MINERBA	0.803	3	0.346	9	0.278	9	
X3	Promotion, Communication, Information, and Socialization regarding activities related to SMKP MINERBA	0.717	10	0.192	10	0.138	10	

Table 6. Final Score and Ranking of RII Barriers to the Implementation of SMKP MINERBA

Code	Description	RII Survey	Rank Survey	RII FGD	Rank FGD	RII Final	Rank Final	Management Strategy
B2	Lack of Management Commitment and Participation in the Implementation of SMKP MINERBA	0.869	1	0.8	1	0.695	1	Must eliminate immediately
B1	Lack of understanding and training related to the Implementation of SMKP MINERBA	0.852	2	0.677	3	0.577	2	
B4	Lack of experts / limited SMKP MINERBA resources	0.752	7	0.685	2	0.515	3	
B13	Failure in Risk Analysis and Improper Decision Making in the implementation of SMKP MINERBA	0.743	8	0.546	4	0.406	4	Review & Scheduled (As soon as possible)
B16	The management review has not been carried out, so it is difficult to define appropriate management indicators in the application of SMKP MINERBA	0.735	10	0.523	5	0.384	5	
B20	Weak procurement strategy and lack of Contract Clauses to apply management systems to contractors	0.822	4	0.462	7	0.379	6	
B12	Difficulties in managing Contractors / Mining Service Companies in implementing SMKP MINERBA	0.83	3	0.454	8	0.377	7	
B26	The follow-up and evaluation/audit results of SMKP MINERBA have not been implemented	0.739	9	0.508	6	0.375	8	
B22	Mining Safety Committee hadn't been established	0.817	5	0.446	9	0.364	9	
B27	SMKP MINERBA review and audit is not optimal	0.797	6	0.4	10	0.319	10	

5. CONCLUSIONS

The conclusions of this study provide answers to the formulation of the problem and research objectives. The factor analysis in this study concluded that from the identification of 28 predictor items that were driving the successful implementation of SMKP MINERBA, can be grouped into 7 (seven) main

factors, including: 1) SMKP Good Governance; 2) Strong Organizational Safety Culture; 3) Organizing and Resource availability; 4) SMART (Specific - Measurable - Attainable - Relevant - Time Bound) Planning & Monitoring; 5) Management Commitment & Strategy; 6) Efficient IH- OH Management; 7) Compliance & Safety Leadership. Meanwhile, from the 17 item predictors of success obstacles / Barriers to the implementation of SMKP MINERBA, can be grouped into 3 (three) main factors, namely 1) Low SMKP management commitment; and 3) Poor Safety Leadership, and 3) Weak Planning and Execution.

Using the results of the final analysis of the Relative Importance Index (RII) and strengthened by discussions / FGDs with HSE experts and Management, the top 10 rankings are obtained from Critical Success Factors and the top 10 rankings are the main obstacles to the successful implementation of SMKP MINERBA in the scope of mining companies and nickel processing PT. XYZ. All combined into several recommendation to produce corrective steps to increase the success of the SMKP MINERBA implementations in companies and mining service business contractors at PT. XYZ in the years to come. The recommendations are: 1) X1 & B2 ~ Strengthening commitment and support, as well as Management's participation in the implementation of SMKP MINERBA; 2) X2 & B1 ~ Organizing Training and Competency Tests for the needs of SMKP MINERBA to increase understanding regarding the Implementation of SMKP MINERBA using trusted instructors; 3) X8 & B4 & B22 ~ Carry out adequate management of mining safety organizations and resources, including reviving the Mining Safety Committee which plays an active role in the management of SMKP MINERBA while at the same time closing the shortage of experts / limited auditor resources of SMKP MINERBA; 4) X5 ~ Establish and carry out re-socialization of Mining Safety Policies and Mining Safety Procedures, Technical Standards, and Special Work Permits related to mining and processing activities by optimizing the various internal communication media that they already have; 5) X17 ~ Convey clear goals, objectives, SMKP MINERBA programs to all levels of workers and make them KPIs (Key Performance Indicators) in fulfilling them both individually and as a team (Department)

Nevertheless, this study has some limitations that need to be considered and understood. The following are some of the study's limitations: 1) The research is limited to a few SMKP MINERBA elements, notably Element 2 (Planning), Element 3 (Personnel and Organization), and Element 4. (Implementation of SMKP MINERBA). The results likely do not represent all the SMKP MINERBA's components. However, the interrelationships between the elements that are usually always present in almost every Management System, most likely allow the representation to be fulfilled. Further study is advised. 2) The online data collections, as well as the perspectives of employees and contractor workers on the present implementation of SMKP MINERBA, do not always reflect the genuine viewpoint of respondents. This occurs because each respondent may have different beliefs, assumptions, and understandings, as well as other criteria such as honesty and objectivity in delivering comments. This scenario can lead to information bias, hence confirmation via FGD is used to eliminate bias, boost validity, and reinforce study results. 3) Data analysis is only performed in entirety and not for each Company, which should've allowed for more thorough and deep analysis and discussion findings. Nonetheless, this research gives vital preliminary information to the company's management in general about the areas of driving and inhibiting forces in the current implementation of SMKP MINERBA, as well as recommendations to increase the success of its future implementation.

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DESIGNING BUSINESS MODEL CANVAS WITH BLUE OCEAN STRATEGY APPROACH FOR SME HOMESTAY

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ABSTRACT

Covid-19 outbreak in Bukittinggi West Sumatera had a significant impact to tourism occupancy rate in many Hotels & Homestays. This low rate of tourism occupancy during Covid-19 outbreak had a significant domino effect to regional income in Bukittinggi that most of their income come from tourism industry. One oh homestay industry in Bukittinggi that labeled as SME industry is Rumah Liessa Bukittinggi, located in Aur Birugo Tigo Baleh, Rumah Liessa had a significant decreased in their revenue during 2020. This anomaly situation forced Rumah Liessa to think how to innovate their business model to compete and win with the future tourism industry situation in Bukittinggi. The purpose of this study is to redesign current Rumah Liessa business model using SWOT analysis, servqual method, business model canvas, and blue ocean strategy to create new business model by bringing value added from customers. The research method used is descriptive qualitative method through the SWOT analysis, servqual method, business model canvas, and blue ocean strategy approach. The result of this study found that Rumah Liessa can create innovative new business model using business model canvas with blue ocean strategy as guidance to innovate by making valuable improvement in customer relationship, channels, value proposition, cost structure, and revenue streams. To strengthen this innovation purpose, this study used benefit cost ratio approach to see if this innovation improvement has a positive impact to future business plan. By making future forecasting cashflow, found that this innovation business model with blue ocean strategy gets 1.17 points from benefit cost ratio approach. From this we conclude, this new business model is recommended to be realized for Rumah Liessa business continuity.

Keywords: business model canvas, blue ocean strategy, tourism, small medium enterprise

1. INTRODUCTION

The Tourism industry in Bukittinggi West Sumatra had a significant impact on regional income. Since the tourism industry in Bukittinggi as the backbone of regional income for many years, Bukittinggi had an economy ecosystem that involves many businesses, especially in the tourism sector. But, since the covid-19 outbreak hit the tourism sector in Indonesia, Bukittinggi, which depends on most of their regional income in tourism sector, had a big impact on this situation. In 2020 from the Bukittinggi BPS Statistik report (2022), foreign tourists had a significantly decrease from 32.653 in 2019 to 2.337. This declining had a domino effect on many small and

medium enterprises that relate to the tourism sector in Bukittinggi, one of which being homestay sector in Bukittinggi. With tourist visitors decreasing, many homestays had a lower occupancy rate during a covid-19 outbreak in 2020, one of them is Rumah Liessa, a homestay in Aur Birugo Tigo Baleh Bukittinggi.

The Declining occupancy rate in the Bukittinggi tourism industry had a significant impact on Rumah Liessa revenue in 2020; from Rumah Liessa financial report (2022) average revenue for Rumah Liessa in 12 months is just Rp20.000.000, -. This situation forced Rumah Liessa to improve their business model to creating a new business model that has a unique value proposition that fits with their customers. Too bring a new unique value proposition to their customers, Rumah Liessa used several methods like SWOT analysis, service quality (servqual), and business model canvas, and to generate innovation, Rumah Liessa also used the blue ocean strategy and benefit-cost ratio to calculate their cost for innovation. Leavy (2018) mentioned the blue ocean strategy focuses on value innovation that uncovers new aggregate demand by redefining the category. With this purpose, the blue ocean strategy can strengthen Rumah Liessa business model canvas to win the tourism market in Bukittinggi by discovering new value propositions to satisfy the target market. This paper aims to find a new business model canvas for Rumah Liessa using the blue ocean strategy to create innovation in their business model.

2. LITERATURE REVIEW

Strategic management the first time is defined by David (2017) as the science of planning and directing large-scale military operations, of maneuvering precisely into the most advantageous positions before actual engagement with the enemy; from this military term, management strategy evolves into art and science of formulating, implementing, and evaluating cross-functional decisions that enable an organization to achieve its goals. From this statement David (2017) concludes that strategic management focuses on integrating the functions of management, marketing, finance, accounting, production, operations, development & research, and lastly, information systems to achieve large organizational goals.

Before the strategic plan, knowing internal and external strengths using SWOT analysis can help to identify internal capability and possible interfering external factors; David (2017) mention that having compatibility with the external factors that will be faced by the internal aspects of the organization owned, is an essential factor in developing possible alternative strategies to do. To develop possible alternative strategies, SWOT analysis develops TOWS analysis to seek possible strategies that tackle several challenges in SWOT analysis, like Strengths-Opportunities strategies, Weakness-Opportunities strategies, Strengths-Threats strategies, and Weakness-Threats strategies.

After identifying internal factors, Rumah Liessa used servqual (service quality) method to determine what consumers feel about the overall services they felt. Tjiptono (2018) said in the service industry, product/service quality contributes significantly to customer satisfaction, customer retention, word-of-mouth communication, repurchase, customer loyalty, market share, and profitability. This is reinforced by the result of several studies which show that market share, return on investment, stock returns, and return on the asset are closely related to perceptions of the quality of a company's goods and services. Tjiptono (2018) explained to calculate service quality, Parasuraman, Zeithaml, & Berry developed the Servqual Method that measures five gaps using customer point of view to evaluate based on the service that has been received. First, using knowledge gap (measure the gap between customer expectations and management perception), standards gap (measure the gap between management perception and costumer expectations against service quality specification), delivery gap (measure the gap between service quality specification

and service delivery), and last using service gap (measure the gap between service perception and expected service).

Osterwalder & Pigneur (2010) said that business model canvas is used to develop value propositions in the business models using customers' perspectives. A business model canvas is used to explain, visualize, assess, and change a business model, to produce more optimal performance. Business model canvas is very helpful accelerating the process of analyzing of business strengths and weaknesses. Using nine different blocks, from customer segments, value propositions, channels, customer relationships, revenue streams, key resources, key activities, key partnerships, and cost structure, can identify the business aspects that can be improved from the future model business. Blue ocean strategy is used to generate innovative aspects in the business model canvas, blue ocean strategy is used for. Blue ocean strategy can help by providing a big visual picture that helps researchers and business owners understand how changes to one part of the business model affect another. Kim & Mauborgne (2005) defined related tools that can be used by specifying a four-action framework, first Reduce (which factors should be reduced well below the industry standard?), Eliminate (which of the factors that the industry takes for granted should be eliminated?), Raise (which elements should be raised well above the industry standard?) and finally, Create (which elements should be created that the industry has never offered?). In addition to using blue ocean strategy support in formulating a business model with a business model canvas, in this study the results of innovation in this form of planning will be analyzed using a cost benefit ratio, to find out whether this projected innovation in the future will generate profits for Rumah Liessa or not by looking at the results this calculation. If the calculation shows more than 1.0, then the proposed project expects of benefiting the company if realized; if it is less than 1.0, then it will have the opposite implication so that the results of innovation can be known as sustainability.

3. METHODS

This section describes the method used in this research, including the data collection method. This research is using descriptive analysis method uses descriptive analysis methods that combine literature studies and interviews with Rumah Liessa management about SWOT analysis, business model canvas, and blue ocean strategy. Also, using a questionnaire about service quality to 56 Rumah Liessa guests.

Initial observations made in this study were to collect initial information regarding the performance of Rumah Liessa and the constraints found in daily business operational activities. The collection of this information was carried out by conducting interviews with the management of Rumah Liessa. From this initial interview, information was obtained to form the SWOT matrix (Strengths, Weakness, Opportunity, Threats) and elements of the Business Model Canvas currently owned by Rumah Liessa. In terms of data processing and analysis related to this research, it will be carried out as follows.

First, a description of the vision and mission of Rumah Liessa. In solving a problem in an organization, it is essential to know the purpose of running the organization. So, by knowing the goals of the running of the organization, the solutions offered can be better because they are by the company's pathway.

Second, service quality analysis. In the service quality component, interviews with customers of Rumah Liessa will be conducted based on predetermined dimensions so that the questions asked to customers are by service quality theory. As with the Physical Evidence dimension, the question will focus on how consumers see the physical conditions where the service takes place compared to the consumer's satisfaction when enjoying the service. After all service

quality components have been answered, it can be concluded whether the benefits of the relevant companies have met consumer expectations. In this discussion, the role of service quality is not only as an analysis of quality from the consumer's point of view, but service quality can also act as an amplifier in SWOT analysis, establishing a business model that prioritizes customer perceived value and forming an innovation component in a blue ocean strategy that considers the perspective of point of view from the customer.

Third, SWOT analysis. Analysis of the SWOT matrix was obtained from the results of interviews with the management of Rumah Liessa to obtain information regarding the constituent components of the SWOT matrix itself, both from Internal (Strengths and Weaknesses) and External (Opportunity and Threats) aspects. The Strengths aspect, it will be examined from the results of interviews about what are the components that make up the strength of the company internally to be able to compete in the current tourism market, from the opportunity aspect, it will be seen what opportunities the company can get against the conditions of the tourism market Bukittinggi today.

Fourth, business model canvas analysis. The business model canvas component relies on the results of interviews conducted with the management of the Rumah Liessa to find out the explanation based on the block components in the business model canvas. As with the customer segments component, questions will lead to what customer segments are the target market for Rumah Liessa and which can be used as opportunities in the future. Furthermore, there is also the cost structure component, where questions will be explored regarding what cost components make up the company's current expenses and what components can be minimized in the future. After all components of the business model canvas are completed, it will be possible to see what business model is currently running at Rumah Liessa and the innovation opportunities for a better direction.

Finally, blue ocean strategy analysis. To create a new value proposition in the business model, a study using the blue ocean strategy is used to design the business model canvas of Rumah Liessa. In this analysis, the study will rely on questions and discussions with management regarding what factors can be reduced in the company's operational activities below the homestay industry average, what factors can be created in the development of Rumah Liessa that are not yet owned by competitors similar, what elements can be improved far beyond what is in the current homestay market conditions, and several other questions to produce innovations to form new market segments for the company. Furthermore, to strengthen the innovation component through the blue ocean strategy, a benefit-cost ratio calculation is also added to see whether the innovations carried out will provide economic benefits to Rumah Liessa.

4. RESULTS

Rumah Liessa was founded in June 2019 by two founders, namely Ms. Remisi the CEO and Mr. Sabaruddin the Director of Operations. Rumah Liessa itself is a business engaged in the tourism industry with a product focus on lodging services based on cottages/homestays located in Aur Birugo Tigo Baleh, Bukittinggi, West Sumatra. In the first phase of sales, Rumah Liessa used the Airbnb application to sell products to Bukittinggi tourists, but over time management also used Google Maps, Traveloka and Tiket.com to sell its products. With strategic location, which is only 2.1 kilometers from the Bukittinggi Clock Tower, Rumah Liessa has its charm for local tourists who visit Bukittinggi and want to rest with their families. This can be seen from most customer visits from 2019 to 2021, dominated by customers who brought their extended family, considering that the Rumah Liessa has a large enough capacity to accommodate guests, which can reach 10-20 people in one house. So, with the condition that the house is large enough to accommodate many people and the distance to the city center is quite close, the Rumah Liessa is still quite superior in

accommodating customers who bring their extended family to go on trips to Bukittinggi, West Sumatra. In its business activities, Rumah Liessa up to now has one type of product without any additional extra services. This product is a rental place to stay by renting out a house and its contents to customers.

In obtaining information to achieve the objectives of this study, the researchers determined informants who could provide answers to several questions based on the theories used in this study, including the SWOT Matrix, Business Model Canvas, Blue Ocean Strategy, and Service Quality. For informants related to interviews in addition to discussing service quality theory, researchers will conduct interviews with two management boards of Rumah Liessa, namely Mrs. Remisi as CEO, and Mr. Sabaruddin, as Director of Operations. For informants related to the questionnaire on the explanation of service quality, the researchers used guests who had stayed at the Liessa House from 2019 to 2019. 2021 as many as 56 orders.

Service quality identification, in this section we identified five dimensions that build service quality analysis to Rumah Liessa guests. First, reliability itself is a measure of the ability of Rumah Liessa to provide the services it promised to its customers/guests. Found that most respondents 85.70% said Strongly Agreed regarding the question, *"The service I received was by the initial explanation when ordering the Rumah Liessa"* and *"The service I received was by the promises made by the management of Rumah Liessa"*. Second, responsiveness itself is a measurement of whether the staff at Rumah Liessa help customers and provide responsive service or not. Found that most respondents at 71.40% said Strongly Agreed regarding the question, "*If there are problems during your stay, the management of Rumah Liessa resolves the problem quickly*" and "*During the stay, the management of Rumah Liessa is willing to answer questions from me as a customer*". Third, assurance is a way to measure whether the staff of Rumah Liessa have competence, knowledge, courtesy, and can be trusted and are free from danger, risk, and doubt. Many respondents 57.10% and 71.40% said Strongly Agreed regarding the question, "*Rumah Liessa management has good service quality*" and "*Rumah Liessa can be trusted as a provider of homestay accommodation services*". Fourth, empathy itself is used to measure whether the staff at Rumah Liessa easily establish relationships with their customers, have good communication, have personal attention to customers and understand the individual needs of their customers. Found that, most respondents at 71.40% said Strongly Agreed regarding the question, "*Rumah Liessa Management is always polite and well-spoken*" and "*Rumah Liessa can be trusted as a provider of homestay accommodation services*". The last is physical evidence, itself functions to see whether the Liessa House has physical facilities, equipment, employees, and means of communication that satisfy its customers. Most respondents by 42.90% and 71.40% said Strongly Agreed regarding the question, "*Rumah Liessa has good and satisfactory accommodation facilities*" and "*Rumah Liessa has a clean interior and exterior condition*".

SWOT analysis identification, in this section, we identified four components of SWOT by interviewing Rumah Liessa management. First strength component, strength is the first component in the SWOT matrix which explains the strengths contained within the internal organization/company. In this explanation, strength will be focused on the strength components within the Rumah Liessa. Rumah Liessa identified several features of internal strength in the company, which management felt were quite superior to some of its competitors in the homestay industry. Rumah Liessa offers villa conditions that are spacious above the average one-house homestay in the Bukittinggi area, so this condition gives Rumah Liessa the capacity to accommodate guests at one stay which can reach 20 guests; this makes Rumah Liessa have most guests coming from a big family. Another supporting factor is the distance between Rumah Liessa and the landmark city of Bukittinggi, namely Jam Gadang, which is only 2.1 KM away, which only takes

eight minutes by motorized vehicle. Weakness is the second component in the SWOT matrix which explains the weaknesses that exist within the internal organization/company. In this explanation, weaknesses will be focused on weaknesses found in Rumah Liessa. In its business activities for approximately three years, Rumah Liessa has identified several weak points in the operations and management of Rumah Liessa itself, the first is the lack of marketing activities carried out by management, both offline and online marketing. Where the current condition of Rumah Liessa only relies on searching for tourists through Google Maps and word of mouth alone, without social media and advertising activities carried out by management. Furthermore, this condition is also exacerbated by telecommunications equipment that does not support management operations, such as laptops which often experience problems, and cellphones which sometimes experience these problems coupled with the age of the management who runs the operational business of Rumah Liessa no longer young, thus hindering the adaptation of technology to support Rumha Liessa business activities. Opportunity is the third component in the SWOT matrix which explains the opportunities in the external environment of the organization/company. In this explanation, opportunities will be focused on the components of opportunities outside Rumah Liessa in the tourism market environment in Bukittinggi. At the end of 2022, the management of Rumah Liessa identified several opportunities that could be exploited to increase the potential for business acquisitions for Rumah Liessa, including the post-covid-19 conditions which made tourism conditions and outdoor gathering activities increasingly relaxed by the Indonesia government, making it easier the public to visit tourist destinations, then also the potential for Christmas and New Year 2023 as well as Eid al-Fitr 1444 H which will fall in April 2023 makes the Indonesian people prepare holiday agendas with their respective families which causes an increase in demand for rooms in several lodging places. The threat is the fourth component in the SWOT matrix which explains the threats in the external environment of the organization/company. In this explanation, threats will be focused on the threat component that is outside the Rumah Liessa in the tourism market environment in Bukittinggi. During its business for approximately three years, the management of Rumah Liessa has detected several threats that could threaten the business continuity of Rumah Liessa itself, including the emergence of several new homestays which are additional competitors for Rumah Liessa in the Bukittinggi homestay industry. In addition to the addition of the number of new homestays, there has been quite a variety of price diversification at several homestays in Bukittinggi, resulting in quite a tight price competition between homestay players in Bukittinggi. Apart from competition between homestay players, the threat of weakening purchasing power of the Indonesian people in 2023 also overshadows the homestay industry, because not all Indonesians make holidays their priority agenda, of course with rising prices the Indonesian people will prioritize their spending on purchases that are quite important for their needs daily.

Business model canvas identification, in this phase, the results of interviews conducted by researchers with the management of Rumah Liessa Bukittinggi, namely Mrs. Remisi as the CEO, and Mr. Sabar as the Director of Operations related to the Business Model Canvas component, which includes customer segments, customer relations, channels, values, will be explained. proposition, revenue streams, key partners, key activities, key resources, and cost structure. Customer Segment is the first component in the Business Model Canvas which explains the group of people targeted by Rumah Liessa as its target customers, so that it will be described who the intended people could become guests/customers of Rumah Liessa.

In the results of interviews with the management of Rumah Liessa, several customer segments have been the focus of Rumah Liessa in its business operations for almost three years. First, customers who place orders with their extended family, second mothers who join a Majlis Ta'lim, third employees who want to do gatherings; and finally, school children. Customer Relations is the second

component of the Business Model Canvas which describes the types of relationships a company currently has with specific customer segments. In this case, this is the current relationship between Rumah Liessa and its customers. In the results of the interviews that have been conducted, based on business activities for the last three years, Rumah Liessa in terms of acquiring customers and maintaining customer retention uses only two events, using WhatsApp – regarding customer acquisition and retention and SMS – related to customer acquisition and retention. Channels are the third component in the Business Model Canvas that describes how a company communicates with and reaches its customer segments to provide value propositions that are felt to be worthwhile. In this case, how does Rumah Liessa carry out communication activities to reach its customer segments to inform the products/services offered. In the results of the interviews that have been conducted, based on business activities that have been running up to now, Rumah Liessa uses four channels to reach its customer segments, through travel commerce (Airbnb, Traveloka, Tiket.com, and PegiPegi), google maps, direct calls, and previous customer recommendations. The Value Proposition is the fourth component in the Business Model Canvas which describes several products and services that create value for specific customer segments. In this case, what types of products and services are provided by Rumah Liessa to its customers which have been identified in the customer segment. In the interviews that have been conducted, there are value propositions identified during the three years of ongoing business activity: location close to the city center, the location is close to a culinary center and a major city hospital, location close to the large wholesale center of West Sumatra, spacious villa conditions and lots of plants, complete and clean guest facilities, and the location of the villa is safe and comfortable from noise. Revenue streams are the fifth component in the Business Model Canvas which describes the revenue streams generated from each customer segment currently owned by Rumah Liessa. It's like the question of how Rumah Liessa got its revenue stream in the past three years. In the interviews that have been conducted, there are four types of revenue streams identified during the three years of business activity: villa rental as a core product, villa rental with additional meals, entertainment equipment rental, and last ordering typical Bukittinggi souvenirs. Key Partners is the sixth component in the Business Model Canvas which explains which parties are partners and collaborate with Rumah Liessa to achieve its business goals. In the results of interviews with the management of Rumah Liessa, several main key partners were obtained to achieve Rumah Liessa's business goals: provider of bottled water, LPG gas supplier, laundry service providers, and food service providers. Key Activities is the seventh component in the Business Model Canvas which describes a series of the most important activities that must be carried out by Rumah Liessa to create, provide value for its customers, and most importantly carry out its current business activities. From the results of the interviews that have been conducted, several key activity components are obtained to keep the business operations of Rumah Liessa running well: overall cleaning activities of the property, overall cleaning activities for guest equipment, interior and exterior decoration activities, an finally replenishment activities for all guest needs: Key Resources is the eighth component in the Business Model which describes the most important assets needed for a business model to work properly. In this case, what key resources are needed by Rumah Liessa to continue carrying out its business activities. In an interview session with the management of Rumah Liessa, the following key resources were obtained: villa buildings both interior and exterior along with plants, technology components to support operational activities (laptops, cell phones, etc.), qualified human resources in homestay management, owned trademark in the form of Rumah Liessa brand. Cost Structure is the last component in the Business Model Canvas which looks at all the cost components that are formed from all business model activities. This block describes the most important components in a business model, because Rumah Liessa can see the costs incurred because of activities maintaining relationships with customers, the process

of creating and delivering value propositions to its customers. From the interview results, the cost structure is obtained as follows: Fix Cost (HR costs, Monthly operational costs, Land Building Tax) and Variable Cost (plant maintenance costs, the cost of maintaining the interior and exterior of the villa, refill fees for basic guest needs, cost of marketing activities).

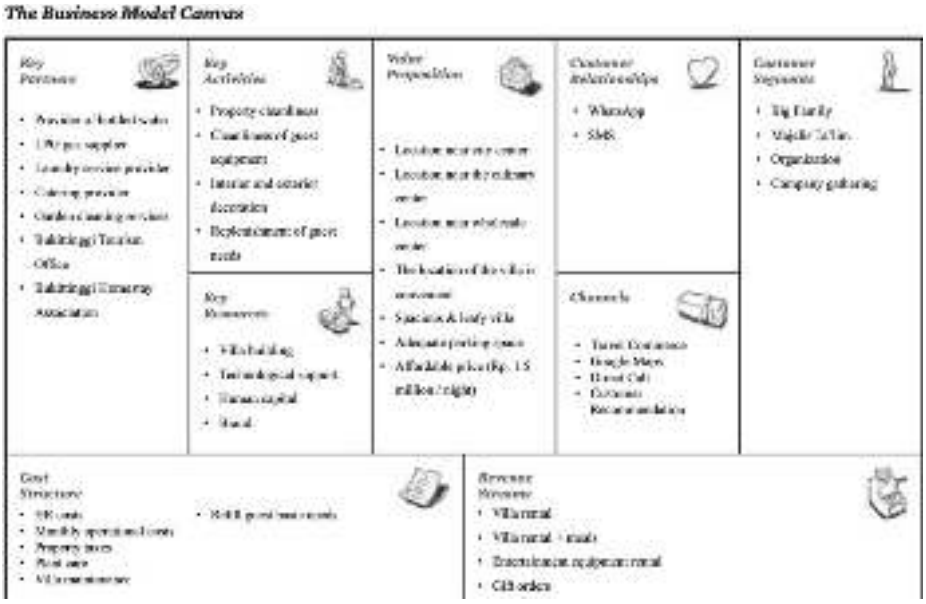

Figure 1. Rumah Liessa Curent Business Model Canvas

After identifying Rumah Liessa current business model, we will describe the results of interviews regarding the 4-step framework component in the Blue Ocean Strategy to reformulate the business model components for future innovations at Rumah Liessa. Where the explanation is as follows. First Reduce: "What factors should be reduced so that it is slightly below the homestay industry standard?" – Revenue Streams (In the results of the interviews, the provision of amenities for guests such as gas for cooking needs and towels needed for guests can be changed to be available at an additional cost), second is Create: "What factors must be created that are currently not offered in the homestay industry?" – Revenue Streams (villa rentals and tourist destination visit packages, BBQ party package, provision of extra beds including towels per person, provision of room rates that include breakfast and dinner, provision of thematic programs according to the trend of community needs), third is Reduce: "What factors must be raised far above the standard of the homestay industry in general?" – Value Proposition (Standardization of hospitality and guest services needs to be improved in the services of Rumah Liessa, considering that the service and hospitality component is one that is remembered by guests based on the questionnaire that has been asked) and Channels (Marketing activities through digital media also need to be increased by Rumah Liessa, considering that for the past three years digital marketing activities have been very passive), and the last is Eliminate: "What factors are considered normal by the Bukittinggi homestay industry and should be eliminated?" – From the results of interviews, from Rumah Liessa there are no components that must be eliminated right now.

Finally, after we conclude the blue ocean strategy aspect based on interview with Rumah Liessa management and finding out what current business model looks like using business model canvas, we can re-create future business model using business model canvas based on result from blue ocean strategy process. Which can be seen with the following results:

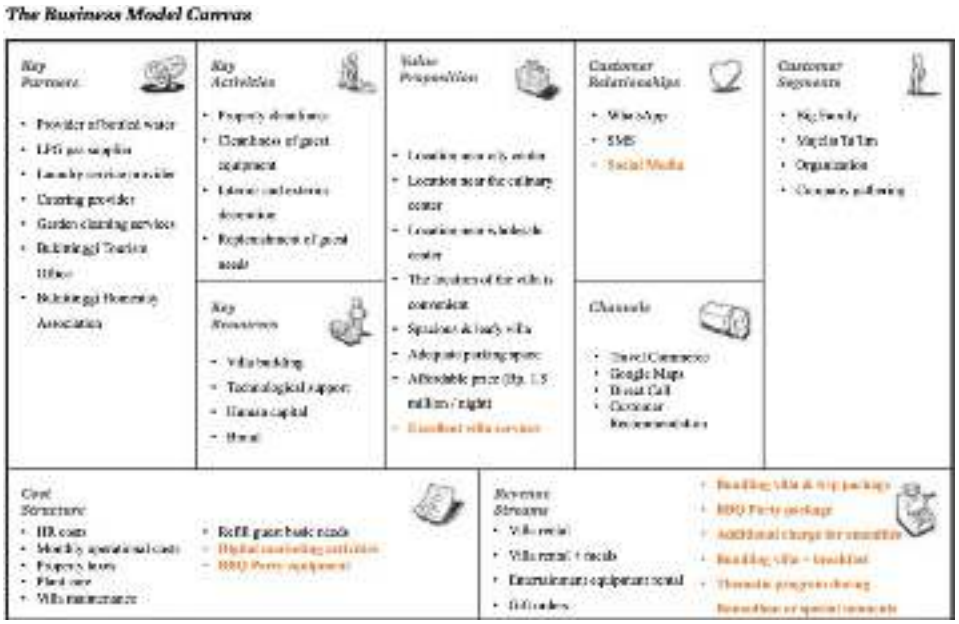

Figure 2. Rumah Liessa Business Model Canvas Using Blue Ocean Strategy Approach

After identifying the SWOT matrix, business model canvas, blue ocean strategy, and redesigning the Rumah Liessa business model for future strategies based on the results of the blue ocean strategy, it is important to know the cost benefit ratio of the new components created in the Rumah Liessa business model. The search for the cost benefit ratio is necessary to find out whether the value of the investment to be made is quite profitable when compared to the results/income that will be obtained based on the investment in the innovation. So, it is important to know whether the investment in the business is quite profitable or vice versa. If based on the innovation component carried out in the business model from the results of the blue ocean strategy approach, the cash flow forecasting for 2023 (1 year period) is as follows:

CASH FLOW FORECAST

KETERANGAN	Balance	Januari	Februari	Maret	April	Mei	Juni	Juli	Agustus	September	Oktober	November	Desember
Initial Cash Capital	10.801.200	10.801.200	3.262.400	3.262.400	3.262.400	6.271.400	3.262.400	7.324.000	6.730.400	3.262.400	3.262.400	6.810.400	3.858.000
Incoming Cash:													
Services Revenue		3.262.400	3.262.400	3.262.400	6.271.400	3.262.400	7.324.000	6.730.400	3.262.400	3.262.400	6.810.400	3.858.000	7.464.000
Total Incoming Cash	10.801.200	3.262.400	3.262.400	3.262.400	6.271.400	3.262.400	7.324.000	6.730.400	3.262.400	3.262.400	6.810.400	3.858.000	7.464.000
Cash Out:													
Operational Expense		10.540.200	3.251.000	3.251.000	4.330.000	3.251.000	4.406.000	4.406.000	3.251.000	3.251.000	4.406.000	3.251.000	4.506.000
Loan Principal + Interest													
Total Cash		(10.171.800)	(289.200)	(289.200)	2.161.400	(289.200)	3.017.400	2.324.400	(289.200)	(289.200)	2.404.400	(3.858.600)	2.957.400
Depreciation Asset		(40.000)	(3.958)	(3.958)	108.29	(3.958)	12.567	13.619	(3.958)	(3.958)	12.519	(9.419)	12.767
Net Profit		(10.210.800)	(287.242)	(287.242)	2.161.671	(287.242)	3.002.833	2.310.781	(287.242)	(287.242)	2.391.881	(3.874.181)	2.943.633
Total Revenue (Forecast 2023)	67.924.800												
Total Expense (Forecast 2023)	57.924.800												
Benefit Cost Ratio	1,17												

Figure 3. Rumah Liessa Benefit Cost Ratio Based on Latest Business Model

From the calculation of the benefit cost ratio that has been carried out above, it can be found that the result of the calculation is at 1.17, where this result is more than 1.0, so it can be concluded that the proposed innovation plan can be recommended to be continued at the realization stage to benefit Rumah Liessa upcoming. However, what needs to be given special attention and consideration to the management of Rumah Liessa is that the points earned are only 0.17 points more than the minimum score, which is 1. It is observed how the ability of Rumah Liessa to increase the number of orders through marketing activities. This is done so that Rumah Liessa does not only rely on operational cost efficiency, but also relies on incoming cash from the services offered.

5. CONCLUSIONS

From this analysis we have found SME industry can also using strategic business approach to eliminate challenge they faced in current industry, especially in tourism industry like Rumah Liessa. By using blue ocean strategy approach in Rumah Liessa business model canvas, we create five new components to bring a new value added for make Rumah Liessa business model still relevant in Bukittinggi tourism industry competition and help Rumah Liessa management predict what can their future business model impact the future revenue in 2023 by using benefit cost ratio approach. So, with several method in term of strategic management we can help SME to create more value added to make their products/services always relevant in their current industry.

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COMBINATION OF FMEA AND AHP-TOPSIS FOR ANALYSIS OF MAINTENANCE STRATEGY AT OIL AND GAS PRODUCTION FACILITIES

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ABSTRACT

In carrying out maintenance activities for gas compressors, an appropriate strategy is needed so that it can be realized within a predetermined budget. A study is needed to provide measurable information on the maintenance strategy for production facilities at PT PHSS. This study discusses the factors causing the high maintenance cost at PT PHSS in choosing an overhaul strategy so that it can run well according to a predetermined budget. Pareto diagrams and cause and effect diagrams are used to find the source of problems, NGT and FMEA are used to identify alternative solutions and criteria for decision making, and the AHP-TOPSIS combination is used to choose the best alternative strategy. Based on the results of the analysis and discussion conducted, it is concluded that the main cause of the overbudget is the overhaul implementation method carried out by a third party with the Time Between Overhaul (TBO) which refers to the OEM. Taking into account the criteria for cost, warranty, number of overhauls until 2038, flexibility of work, and availability of resources, the best alternative for this problem is to carry out an overhaul by a third party but by extending the TBO with a preference value of 65.23%.

Keywords: Maintenance strategy, FMEA, AHP-TOPSIS.

1. INTRODUCTION

Oil and natural gas is important sources of energy and economic commodities in the world today, its presence can affect a country's growth and development plans (Choudbury,2016). Oil and gas industry in Indonesia consist of upstream and downstream sector. Upstream oil and gas activities basically consist of two main activities, exploration and exploitation/production. Exploration activities is the initial stage of a whole series of upstream oil and gas activities, which aim to find oil and gas reserves. In general, exploration activities include geological studies, geophysical studies, seismic surveys, and exploratory drilling. Downstream oil and gas business activities include processing, transportation, storage and trading.

Production activities in the upstream oil and gas business sector involve a series of mechanical equipment used for drilling operations, pumping liquid from wells to processing facilities, gas compressors used to increase gas pressure so that it can be channeled to its destination, and also supporting equipment such as fire systems, instruments air compressor for instrumentation purposes in the field. These equipment must be properly maintained in order to operate properly. Butcher (2008) suggested that maintenance is a combination of all related administrative and

technical actions intended to maintain an item or return it to a condition where it can perform its required function. Equipment that is not being used either because it is still waiting for the installation process or for spare parts needs to be maintained (Gulati, 2013).

This research takes a case study at PT Pertamina Hulu Sanga Sanga which operates very mature oil and gas field in East Kalimantan. Time by time gas pressure from well become lower and lower, so it needs gas compressor to deliver natural gas to liquefaction plant in Badak NGL Bontang. Compression diagram shown at Figure 1.

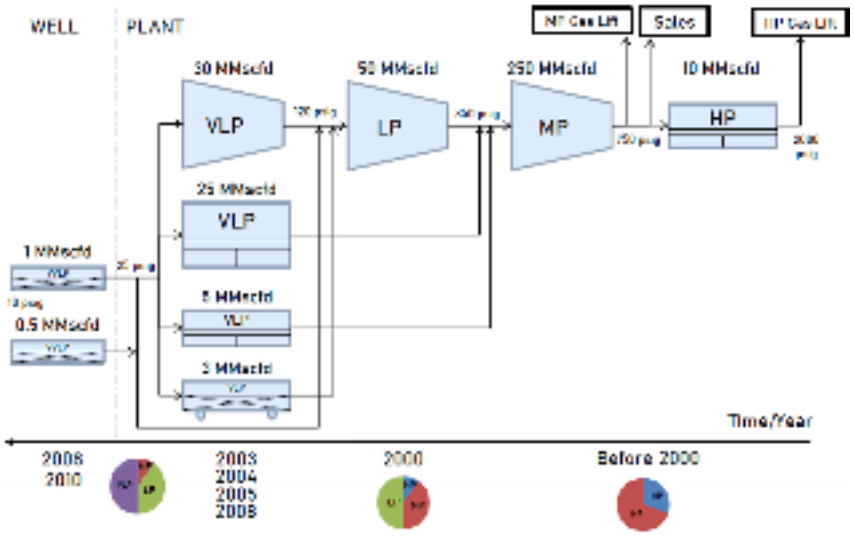

Figure 1. Compression system PT PHSS

Based on above compression system diagram, it can be seen that the role of this gas compressor is very vital to the operations of PT PHSS (PHSS, 2021). As a mechanical equipment, the compressor requires periodic maintenance. One type of periodic maintenance is overhaul. Overhaul is a series of engine disassembly work to check internal parts and replace certain parts as recommended by the OEM (Stewart, 2019).

2. LITERATURE REVIEW

An overview of maintenance strategy developed to date has been done in Deighton (2016), in general, strategies for carrying out equipment maintenance activities can be divided into two, proactive maintenance and reactive maintenance. The reactive maintenance strategy is the first maintenance strategy that is widely used in the industry, this strategy only performs equipment maintenance activities in response to equipment failure. Proactive maintenance is an equipment maintenance strategy that is carried out before the equipment needs it, what can be done is to detect the condition of an equipment and correct conditions that can cause equipment damage. Whatever is the motivation behind the development of a maintenance strategy (regardless of priority criteria: economic or operational safety) the final goal remains the same. It aims to develop an optimal maintenance strategy, Katarzyna, et al (2021) suggested that a decision from a leader can lead an organization to achieve success or even lead an organization to failure. Pricopie, et al (2020) developed preventive maintenance strategy for an actuator using Markov models. Hakkı Bağan,et al (2019) suggested to use of a nominal group technique in the exploration of safety hazards arising from the outsourcing of aircraft maintenance, by this technique he elaborated hazard source on aircraft maintenance.

Ouyanga, et al (2022) suggested that FMEA is primarily employed to track and eliminate feasible faults and failures. Because of the effectiveness and simplicity to apply, it has been broadly

utilized in various domains including manufacturing, healthcare, aviation and so on. Besides producing RPN to identify the level of risk, FMEA also produces action recommendations for improvement. So that we can get suggestions for improvement by exploring each potential failure mode and failure effect. Wang, et al (2020) combined FMEA approach based on extended matter element model and AHP is developed to evaluate and determine the risk priority of failure modes by using conventional crisp value evaluation information. In addition, the AHP is used to determine the weights of risk factors considering their different effects for failure modes, and the extended matter-element model incorporating the relative importance of risk factors is established to determine the risk priority of failure modes. Li, et al (2021) combined FMEA-AHP to analyze a failure analysis of floating offshore wind turbines. To identify alternative solution, Bagan (2019) suggested to utilize Nominal Group Technique (NGT) method.

Analytical Hierarchy Process widely use together TOPSIS. Patil, et al (2014) used combination of AHP and TOPSIS framework for ranking the solutions of knowledge management adoption in Supply Chain to overcome its barriers. Amiri (2010) combined AHP and TOPSIS for project selection purpose for oil-fields development. Gumus (2009) Evaluate of hazardous waste transportation firms by using a two steps fuzzy-AHP and TOPSIS methodology considered various criteria such as: Hygiene and safety, Quality of service, Complementary service; Economic factors, Service time, Taking care of the human health and environmental protection standards, Problem solving ability, and The owned vehicle fleet.

3. METHODS

To explore the causes of high maintenance costs, Pareto method is used because this method is an analysis based on identification on category, product, or type of damage or discrepancy (Montgomery, 2013). By applying the Pareto method, it will be known which expenditure items are the biggest contributor to the problem of maintenance costs for production facilities that exceed the predetermined budget. After identifying a damage or problem, then we must analyze the potential causes of these unwanted conditions. Cause and effect diagram is a formal tool that is often used to uncover potential causes (Montgomery, 2013).

After identify the potential causes, the next step is to analyze the risk of each failure mode. looking for various alternatives that can be done for improvement steps. FMEA is an analytical technique for defining, identifying, and eliminating known and/or potential failures, problems, errors, and so on from systems, designs, processes, and/or services (lay, 2013). FMEA also produces suggestions for improvement that can be used as alternatives that can be taken for corrective measures. The various improvement alternatives will then be selected which is the best based on various criteria. Shyur, et al (2019) suggested that various method of Multi Criteria Decision Making (MCDM) could be combined. Saaty (1987) explained detail calculation for AHP, while Lay, et al (1994) explained about TOPSIS. Patil, et al (2014) suggested to combine AHP with TOPSIS for ranking the solution. The combination of AHP and TOPSIS can complement each other's weakness. AHP is used to determine the weighting of the existing criteria, while TOPSIS is used to determine the ranking of the alternatives after taking into account the weight of the criteria obtained from the AHP.

4. RESULTS

4.1 Determining the Source of Problems Causing Maintenance Costs to Exceed the Predetermined Budget, Using Pareto Diagrams.

To identify the problems that cause maintenance costs at PHSS in 2021 to exceed the budget, we must first know the cost structure in maintenance. Based on the data obtained, maintenance costs

can be divided into 5 budget groups, the budget for overhaul, the budget for reactive maintenance materials, the material budget for preventive maintenance, the budget for labor costs for reactive maintenance work, and labor costs for preventive maintenance. Figure 2 is a pareto diagram of maintenance costs at PHSS in 2021. It shows that

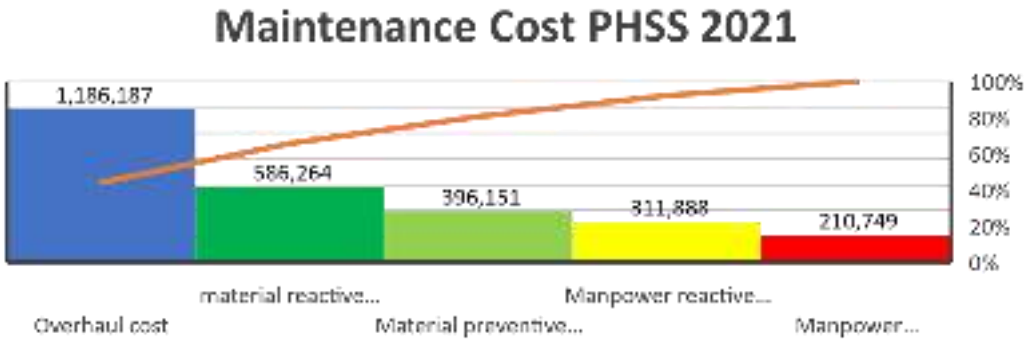

Figure 2. Pareto Maintenance Cost PT PHSS 2021

Based on the information obtained from Figure 2 above, it can be concluded that overhaul costs are the most dominant budget item of the overall maintenance costs at PHSS, namely USD 1,186,187. Further analysis is needed of the factors that influence the cost of overhauling PHSS in 2021

4.2 Identify the Factors that Cause the Occurrence of Problems that Cause Maintenance Costs to Exceed the Budget that Has Been Determined by Using a Cause and Effect Diagram.

After we identify the budget items that are the dominant contributor to high maintenance costs, the next step is to explore the causes, why this happened. The Ishikawa diagram is used as a tool to find out the source of the cause, the fish head is the result of a previous Pareto analysis, namely the high cost of overhaul which reached USD 1,186,187. Through the Ishikawa diagram, an analysis of the influencing aspects will be carried out so that the dominant cause appears, in this case an evaluation of the factors that may contribute, including human factors, materials, environment, methods and equipment. Figure 3 below is a cause and effect diagram of the high 2021 overhaul costs at PHSS.

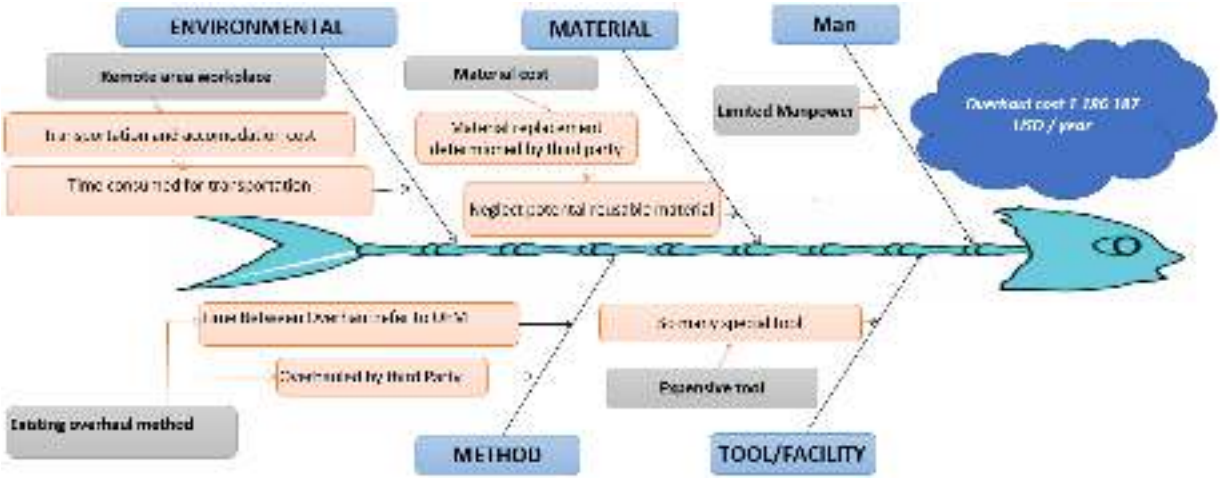

Figure 3. Cause and effect diagram overhaul cost PT PHSS 2021

Based on the information obtained from Figure 3 above determined that many contributing factor for overhaul cost, consist of existing overhaul method which is overhauled by third party and performed based on TBO refer to OEM, human factors, materials, environment, and tools. However, at this stage it is not yet known which factors have the most potential to cause overhaul costs.

4.3 Identifying the Risk Level of the dominant causes and Identifying Alternative Solutions Using the Failure Mode and Effect Analysis (FMEA) Method.

After we identify the factors that cause the problem of high overhaul costs at PT PHSS in 2021 which will reach USD 1,186,187, then we will analyze the risk level of these factors using the Failure Mode and Effect Analysis (FMEA) method. In FMEA, the level of risk of a potential failure (failure mode) can be identified. This level of risk can be determined by calculating the value of the Risk Priority Number (RPN). The higher the RPN value indicates a failure, the more problematic it is. Determination of the value of S, O and D is obtained based on predetermined scoring. Table 1 shows a recap of the FMEA assessment that was carried out.

Table 1. FMEA Score

Contributing factor of high overhaul cost	***Severity* (S)**	***Occurance* (O)**	***Detection* (D)**	**RPN**
Existing overhaul method	9	9	8	648
Material cost	5	7	6	210
Tool and equipment cost	3	5	4	60
Limited manpower	3	3	2	18
Remote working area	2	3	2	12

Table 1 shows that existing overhaul method is the most contributing factor for overhaul cost. After we identify the risk level of the causal factors that result in high overhaul costs at PT PHSS, then we will explore the main factors and get suggestions for improvements that we can identify as alternative of improvement that can be carried out. The FMEA framework is used to explore failure modes, potential causes, potential consequences of a failure, control processes, and recommendations. The recommendations obtained in this analysis will then become alternative solutions for improvement. In this evaluation, there is no RPN assessment because the selection of solutions and ranking will be carried out using the AHP-TOPSIS method.

Through the Focus Group Discussion (FGD) forum, it was found that alternative improvements that could be made were two recommended action items obtained from These alternatives include:

1. Performing inhouse overhaul, interval time between overhaul refer to OEM (Alternative 1 / A1).
2. Overhaul by third party, extend time between overhaul (Alternative 2 / A2).
3. Performing inhouse overhaul, and extend time between overhaul (Alternative 3 / A3).

4.4 Identifying Criteria and Sub-criteria in Decision Making with the Nominal Group Technique (NGT) Method.

After we have alternative improvements that can be made to fix the problems faced by PT PHSS, which is the high cost of overhaul. To determine which alternative is the best, it is necessary to have the criteria needed to make a decision. To determine the criteria, discussions were held using the Nominal Group Technique (NGT) method was held on November 21, 2022 in the PT PHSS Office in Muara Badak, East Kalimantan. The discussion involved permanent employees in the PT PHSS maintenance section with the positions of Supervisor, Senior Supervisor, and Maintenance Section Head. To add to the point of view, a Surface Facilities Engineer from Pertamina Subholding Upstream, was also involved.

Nominal group interviews and brainstorming were conducted to collect data. Beginning with an explanation of the purpose of the discussion and the problems encountered, then each participant was asked for opinions related to the criteria in decision making. Advice from participants was discussed to produce criteria that could be taken into consideration in selecting an overhaul strategy at PT PHSS. The following are the criteria for selecting an overhaul strategy:

1. Cost (Criteria 1/ C1).
   A recapitulation of overhaul costs for gas compressors at PT PHSS will be carried out until July 2018, according to the Field Development Operations (OPLL) document.
2. Number of overhaul activity (Criteria 2 / C2).
   One alternative that appears in the FMEA is to extend the Time Between Overhaul (TBO), this will certainly affect the number of overhaul activities up to July 2038. Discussion participants consider this to be a worthy criteria due to its association with the inherent risks of each overhaul activity.
3. Job Warranty (Criteria 3 / C3).
   Discussion participants also considered job guarantees to be worthy of being included as a criteria in decision making.
4. Time Flexibility (Criteria 4 / C4)
   This is one of the differentiating things from the existing method because if the overhaul is performed in-house then coordination with the operations team is easier than if it is performed by a third party, this becomes less flexible because related to the mobilization of workers, materials, and equipment.
5. Resource availability (Criteria 5 / C5)
   The availability of resources in question is the availability of the number of workers and also materials needed in the overhaul.

4.5 Ranking Alternative Solutions Using the AHP-TOPSIS Method.

First step of AHP-TOPSIS is To find out the weight of the importance level of one criteria with another criteria, data collection was carried out through a questionnaire on predetermined respondents. There were eight respondents, the opinions of the respondents were then carried out by geomean calculations to find out the average measurement. Geomean can be calculated by the following equation:

$$G = \sqrt[n]{X1X2X3 \dots \dots Xn} \quad \dots\dots(1)$$

Table 2. Pairways comparison between criteria

Responden	C1 Vs C2	C1 Vs	C1 Vs	C1 Vs	C2 Vs	C2 Vs C4	C2 Vs C5	C3 Vs C4	C3 Vs C5	C4 Vs
R1	0.250	0.200	5.000	4.000	0.250	6.000	5.000	7.000	4.000	0.250
R2	0.125	0.143	6.000	0.167	0.333	7.000	2.000	8.000	2.000	0.143
R3	7.000	2.000	0.167	0.143	0.250	0.167	0.167	7.000	3.000	0.143
R4	0.143	0.167	5.000	0.125	0.250	0.200	0.333	6.000	2.000	0.143
R5	7.000	0.333	7.000	0.143	0.143	0.167	0.143	7.000	6.000	0.143
R6	3.000	0.167	8.000	4.000	0.200	7.000	3.000	4.000	2.000	0.200
R7	0.143	0.125	7.000	7.000	0.125	7.000	8.000	9.000	9.000	0.143
R8	3.000	0.200	7.000	4.000	0.200	8.000	3.000	4.000	2.000	0.167
Geomean	0.853	0.246	4.023	0.813	0.210	1.759	1.243	6.264	3.177	0.163

Table 2. shows pairways comparison among criteria based on questionnaire and also result of geomean calculation. The geomean data then processed both of manually and using Super Decision software to obtain the weighting value for each criteria.

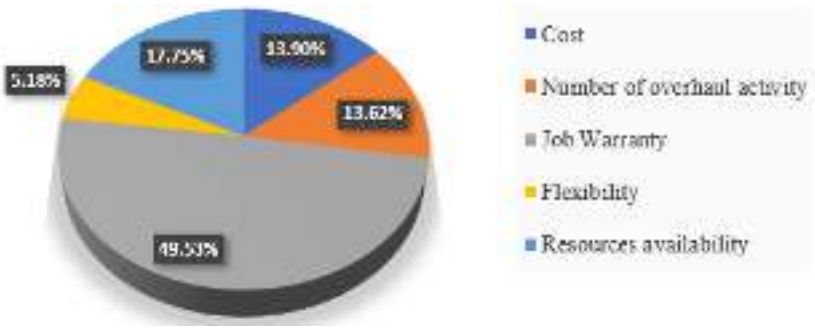

Figure 4. Criteria weight

After we have criteria weight, we have to find out the weight of the importance level of criteria to alternative, data collection was carried out through a questionnaire on predetermined respondents to obtain C3,C4,and V5 . Criteria cost (C1) and Number of job (C2) is obtained from the exploded overhaul program until 2038 according to the PSC contract. Table 3 below is the value of each criteria for the alternative solutions.

Table 3. Matrix assessment of criteria against alternatives solution

Alternative	Criteria				
	Cost (C1)	No. of Job (C2)	Job Warranty (C3)	Flexibility (C4)	Avaability (C5)
A1	$32.089.750	595	5,4744618	5,38056657	4,5707797
A2	$61.206.400	379	6,0061507	4,84253449	7,5287011
A3	$25.748.296	379	4,0187920	5,93924811	4,8721582

Table 3 shows that the value of criteria has different dimensions, for this reason it is necessary to normalize them so that they have the same dimensions. Matrix normalization can be calculated through the following equation

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \quad \ldots\ldots\ldots\

After having a weighted value matrix, the next step is to find a positive ideal solution matrix and a negative ideal solution matrix. Criteria 1 (C1) and criteria 2 (C2) were identified as having negative polarity, meaning that the lower the score, the better, while criteria 3 (C3), criteria 4 (C4), and criteria 5 (C5) were identified as having positive polarity, meaning the more the higher the better. The calculation can be done using the following formula:

$$A^+ = (y_1{}^+, y_2{}^+, y_3{}^+, \dots, y_n{}^+) \quad \dots\dots(4)$$

$$A^- = (y_1{}^-, y_2{}^-, y_3{}^-, \dots, y_n{}^-) \quad \dots\dots(5)$$

Table 6. Ideal Solution Matrix

Alternative	Kriteria				
	Cost	No. of	Job	Flexibility	Resource
Code	C1	C2	C3	C4	C5
Positif	0,048529493	0,064458965	0,328128375	0,032856597	0,132766799
Negatif	0,115359694	0,101195473	0,219554882	0,026789453	0,080604579

After having positive and negative ideal solution values, the next step is to calculate the distance between the values of each alternative with positive ideal solutions and negative ideal solutions. Alternative distances with positive and negative ideal solutions will be directly related to the calculation of the preference value for each alternative. The calculation of the positive and negative ideal solution distance values can be done with the following equation:

$$D_i^{+/-} = \sqrt{\sum_{j=1}^{n} \left(y_i^{+/-} - y_{ij}\right)^2} \quad \dots\dots(6)$$

Table 7 Alternatives distance to ideal solution

Ideal Positif (D^+)	A1	0,071
	A2	0,067
	A3	0,118
Ideal Negatif (D^-)	A1	0,097
	A2	0,126
	A3	0,023

The last step in working on the TOPSIS method is to calculate the preference value of each alternative. The larger Vi value indicates the alternative value Ai is preferred. The preference value of Vi can be calculated through the following equation:

$$V_i = \frac{D_i^-}{D_i^- + D_i^+} \quad \dots\dots(7)$$

Table 8 Alternatives distance to ideal solution

Alternative	Preference score	Rank
Inhouse overhaul, TBO standard manufacturer (A1)	0,57592	2
Overhaul by third party, extend TBO (A2)	0,65237	1
Inhouse overhaul, extend TBO (A3)	0,16397	3

4.6 Sensitivity Check

After obtaining the best solution through AHP-TOPSIS analysis, then it is necessary to carry out a sensitivity test to ensure that the choice is robust. Sensitivity test is done by changing the weight of each criteria in a variety of ways. Table 9 below explain the sensitivity test calculations.

Table 9 Weight variation

	Criteria				
Alternative	C1	C2	C3	C4	C5
A1	$32.089.750	595	5,47446	5,380566	4,570779
A2	$61.206.400	379	6,00615	4,842534	7,528701
A3	$25.748.296	379	4,01879	5,939248	4,872158
Weight variation					
Calculation by AHP-TOPSIS	13,90%	13,62%	49,53%	5,18%	17,75%
Sensitivity check 1	0,00%	18,00%	49,00%	10,00%	23,00%
Sensitivity check 2	17,00%	0,00%	51,00%	10,00%	22,00%
Sensitivity check 3	26,00%	25,00%	0,00%	17,00%	32,00%
Sensitivity check 4	16,00%	15,00%	49,00%	0,00%	20,00%
Sensitivity check 5	16,00%	22,00%	51,00%	11,00%	0,00%

The results of the sensitivity test show that the second alternative (A2) consistently ranks first, so that the results of the ranking analysis carried out using the AHP-TOPSIS combination method confirm that the second alternative (A2) is indeed the best alternative to overcome the overbudget problem that occurred at PT Pertamina Hulu Sanga Sanga in 2021. Figure 5 below is a graph of the sensitivity test results.

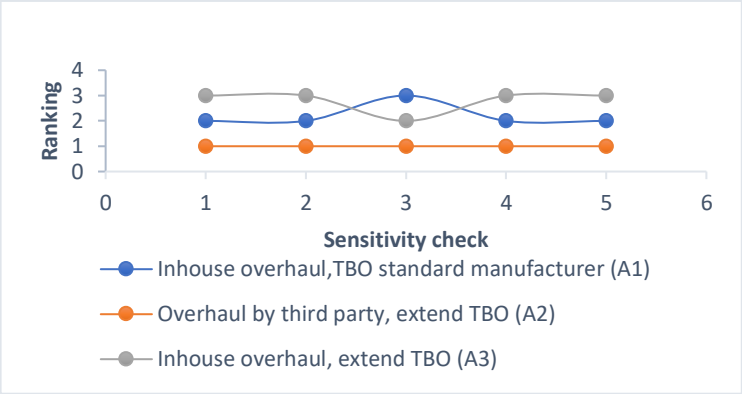

Figure 5. Sensitivity Check

6. CONCLUSIONS

From the analysis carried out above, it was found that the second alternative (A2), namely the implementation of the overhaul was carried out by a third party but by extending the Time Between Overhaul (TBO). If this strategy is implemented at PT PHSS, the total overhaul cost required is USD 61,206,400. there was a saving of USD 20,506,331 when compared to the existing method implemented at PT PHSS. In addition to significant cost savings, this method is feasible to be the choice of gas compressor maintenance strategy because it has considered other factors such as job guarantees, work flexibility, availability of human resources as well as equipment and materials.

As explained in sub-chapter 4.5.1 that the third criteria regarding job guarantee has a very large weight, namely 49.53%, this is the main strength of alternative 2 because the job guarantee criteria has the highest value. Alternatives 1 and 3, although they offer much greater savings, are not selected as the best alternative because the weight for the cost criteria is only 13.90%. From these data it can be seen that from the perspective of the respondents who are employees in the maintenance section of PT PHSS that job guarantees are very important in the implementation of gas compressor maintenance.

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THE BEHAVIORAL INTENTION TO USE PLN MOBILE TO OBTAIN ELECTRICITY SERVICES WITH A MODIFIED UTAUT2 MODEL

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ABSTRACT

PT.PLN (Persero) implements digital innovation in the consumer service section by launching the PLN Mobile application. This application aims to improve the quality of customer service that is easily accessible anywhere and anytime. The benefits of using this application have not been felt by all PLN consumers, therefore it is necessary to conduct research related to consumer behavior in using the PLN Mobile application. This study uses the UTAUT2 (Unified Theory of Acceptance and Use of Technology2) model which has added the Information Quality and Trust variables by involving a number of 162 respondents. In data analysis using the SEM-PLS method and the software Smartpls 3.2, the results showed that the variables Performance Expectancy (PE), Price Value (PV), Information Quality (IQ) and Trust (TR) had a positive and significant effect on Behavioral Intention to Use (BI) on the use of the PLN Mobile application.

Keywords: PLN Mobile, Structural Equation Modeling (SEM), Information Quality, Trust, UTAUT2

1. INTRODUCTION

Mobile apps is software that can be run on mobile devices such as smartphones, tablets, PDAs. Mobile devices have various kinds of operating systems, Currently there are three types of operating systems that are Android, iOS and Windows Phone. Each operating system has official application provider services such as: Google Play as a service provider for the Android operating system software, the App Store which is the official application provider for the iOS operating system and the Windows Phone Store which provides official software for Windows Phone devices (Novac et al., 2017).

Applications mobile provided to increase productivity, facilitate daily life, entertain, broaden friendships and help maintain health (Chang et al., 2012). Likewise the PLN Mobile Application is an application made by PT. PLN (Persero) as an application self-service for PLN electricity consumers. The PLN Mobile application is available for the Android and iOS operating systems, so the existence of this application aims to make it easy for PLN electricity customers to get service without come to the PLN office.

The PLN Mobile application can provide payment of electricity bills, purchase of electricity tokens, history of usage/purchase of electricity, changes in power, temporary lighting, new installations, self-meter reading, reporting of electricity complaints / disturbances and important information related to PLN, electricity rates and power outages. Benefits that customers

can experience directly if they choose to use the PLN Mobile application include not being charged credit fees, not having to incur transportation costs, not taking a long time and relatively cheaper prices.

PLN understands that the PLN Mobile application makes everything about electricity easy for consumers, but data from PT. PLN (Persero) East Java Main Distribution Unit (UID) shows that PLN Mobile application users in the PLN Babat area are 27,132 out of a total of 155,040 customers or only around 17.5%. of the total number of customers in the working area of PLN ULP Babat.

Many research models have been conducted to identify consumer behavior in the acceptance and use of new technology, one of which uses a model Unified Theory of Acceptance and Use of Technology (UTAUT2), as in the study (Parhamnia, 2022) to identify the behavior of users of academic library services using UTAUT2 and research conducted by (Schmitz et al., 2022) use UTAUT2 to describe predictors that influence society in adoption telemedicine. Therefore, it is necessary to conduct research to determine the factors that influence consumers in using the PLN Mobile application.

2. LITERATURE REVIEW

Model Unified Theory of Acceptance and Use of Technology 2 (UTAUT2) is a development of the UTAUT model. The UTAUT model includes four predictors such as: Performance Expectancy, Effort Expectancy, Social Influence and Facilitating Conditions to determine the level of acceptance and use of technology by consumers (Venkatesh et al., 2003). Meanwhile, UTAUT2 has added three predictors from UTAUT, namely: Hedonic Motivation, Price Value and Habits (Venkatesh et al., 2012)

The degree to which a person believes that using technology will result in better productivity or performance is called Performance Expectancy (Venkatesh et al., 2012), Performance Expectancy significant positive effect on the desire to use e-money technology (Gunawan et al., 2019). Other research (Priyadi et al., 2017) prove that Performance Expectancy is a significant influence on Behavioral Intention to Use system Digital Office to bank employees.

H1: Performance Expectancy significant effect on Behavioral Intention to Use

The degree to which aspects of the ease that a person feels in using technology is called Effort Expectancy (Venkatesh et al., 2012). According to (Hoque & Sorwar, 2017), Effort Expectancy is one of the factors that influence the behavioral intention of users to use the service m-Health. Effort Expectancy also influence the behavioral intention to apply Learning Management System (Al-Mamary, 2022).

H2: Effort Expectancy significant effect on Behavioral Intention to Use

The degree to which a person believes that influential people who are considered important believe they need to use technology is called Social Influence (Venkatesh et al., 2012). The best predictor of behavioral intention to use technology covid-19 digital tackling is Social Influence (Akinnuwesi et al., 2022) As well as Social Influence acceptable as the influence of the user's intention to use the system M-payment (Al-Saedi et al., 2020).

H3: Social Influence significant effect on Behavioral Intention to Use

The degree to which a person believes that the conditions of the facility and organization can support the use of technology is called Facilitating Conditions (Venkatesh et al., 2012). According to (Patil et al., 2020) in his research confirms that Facilitating Conditions to be a significant positive predictor of consumers to use mobile payments.

H4: Facilitating Conditions significant effect on Behavioral Intention to Use

The degree to which a person believes that the costs and benefits obtained have an influence on the use of technology Price Value (Venkatesh et al., 2012). Other research proves that Price Value significantly affect the behavioral intention to use scooters (Öztaş Karlı et al., 2022). As well as, (Kapser & Abdelrahman, 2020) validates that behavioral intention to use autonomous delivery vehicles greatly influenced by Price Value.

H5: Price Value significant effect on Behavioral Intention to Use

The degree to which a person feels happy when using technology is called Hedonic Motivation and the extent to which consumers tend to use technology due to the formation of automatic behavior patterns due to experience is called Habits (Venkatesh et al., 2012).

Hedonic Motivation and Habits has been investigated to be a significant factor in game use on line (Ramírez-Correa et al., 2019), and user intent in shopping ate-commerce (Zhou et al., 2021). Although many studies have proven that Hedonic Motivation and Habits has a positive and significant effect on the intention to use / accept new technology. however, the authors omit this predictor because it is less relevant to the application in this study and generally these two predictors are used for Entertainment apps or Shopping apps.

Information quality based on accurate and useful information resulting from the use of the system / technology (Zhao, 2019). Information quality has been widely studied to analyze the influence on users to use management systems E-learning, it was found that the variable quality of information has a significant effect on interest in the use and continuous use of the system (Zwain, 2019). Information Quality has also been investigated for government service type applications. The results of the study stated that variable Information Quality is one that influences people's interest in using the application (Berlilana et al., 2017).

H6: Information Quality significant effect on Behavioral Intention to Use

Consumers' willingness to use technology is proportional to trust (Trusts) about the ability, fairness and integrity presented through technology so that they feel they need this technology (Alalwan et al., 2017) Trusts has been extensively studied in application mobile banking, found significant results on the effect of interest in using the application mobile banking (Hanafizadeh et al., 2014) Trust has also been investigated for the application e-commerce. Similar results show that variable Trust also has a significant effect on interest in using the application e-commerce (Arsyadani, 2021).

H7: Trust significant effect on Behavioral Intention to Use

3. METHODS

The target population in this research is the PLN consumers who have used the PLN Mobile apps, specifically in Babat Lamongan area. This area has 27,132 PLN customers who have used it, or only about 17.5% of the total customers. The minimum number of sample size suggested by (Hair et al., 2019) is 100 respondents. 162 respondents were involved in this research, so the number of respondents was above the minimum sample size.

The data collection technique was a survey using a online questionnaire that provided by google forms. The link for online questionnaire was sent in two different ways: first, field officers directly provide a survey link to the customer that match the criteria target respondent. Second, the survey link send through the WhatsApp number's target respondent.

Structural Equation Model - Partial Least Square (SEM-PLS) was used in this research for estimating relationship between variables with combination of statistical methods. SEM-PLS has two stage for this research: first, assessment a measurement model (Outer Model). Second, assessment a structural model (Inner Model) (Hair et al., 2019). The data in this research was analyzed using Smartpls 3.2, the authors' conceptual framework as described on Figure 1.

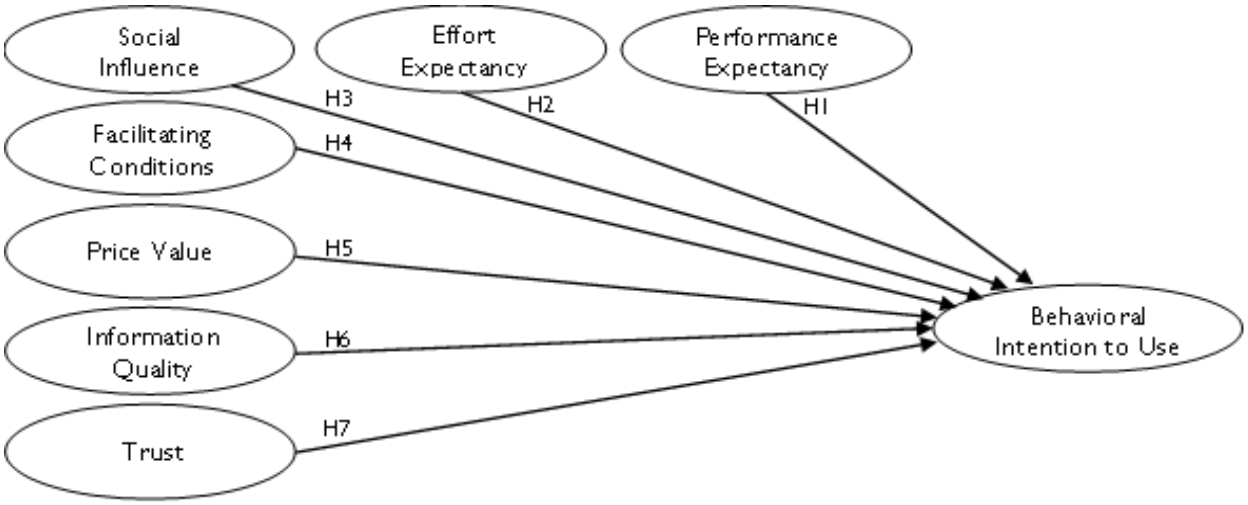

Figure 1. Conceptual Framework

4. RESULTS

This study involved 162 respondents to the PLN Mobile application customers in the PLN ULP Babat area, 86.42% of the respondents were male and 67.28% of the respondents had a high school educational background. the majority of respondents use the PLN Mobile application for the purpose of reporting electricity complaints / disturbances.

Measurement model testing (Outer Model) to determine the level of reliability and validity of a measuring instrument. Criteria on Outer Model, as: Factor Loadings, Construct Reliability, Convergent Validity and Discriminant Validity have been tested in this study. All

items in this study have achieved Factor Loadings threshold value (FL ≥ 0.708), all variables in this study have exceeded the minimum level of construct reliability (CR ≥ 0.7 and Cronbach's Alpha ≥ 0.7), all variables. in this study has exceeded the criteria Convergent Validity hose value is acceptable (AVE ≥ 0.5), and all variables in this study are in accordance with the criteria Discriminant validity (HTMT < 0.90) as recommended by (Hair et al., 2019). So that the measurement model test (Outer Model) meets the criteria of validity and reliability.

Table 1. Hypothesis testing

Hypotheses	**Variables**	***T Statistics***	***P Values***	**Relationship**
H1	Performance Expectancy -> BI	3.772	0.000	Significant
H2	Effort Expectancy -> BI	0.054	0.957	Not-Significant
H3	Social Influence -> BI	1.123	0.262	Not-Significant
H4	Facilitating Conditions -> BI	0.190	0.849	Not-Significant
H5	Price Value -> BI	2.136	0.033	Significant
H6	Information Quality -> BI	5.024	0.000	Significant
H7	Trust -> BI	2.033	0.042	Significant

Based on Table 1, the Performance Expectancy (PE) has a significant effect on Behavioral Intention to Use (BI), this is supported by a T-Statistic value of 3.772 (> 1.96) and a p-value of 0.000 (< 0.05) thus H1 is accepted. Effort Expectancy (EE) has no significant effect on Behavioral Intention to Use (BI), this is supported by a T-Statistic value of 0.054 (< 1.96) and a p-value of 0.957 (> 0.05) thus H2 is rejected. The Social Influence (SI) has no significant effect on Behavioral Intention to Use (BI), this case supported by a T-Statistic value of 1.123 (< 1.96) and a p-value of 0.267 (> 0.05) thus H3 is rejected. Facilitating Conditions (FC) has no significant effect on Behavioral Intention to Use (BI), this is supported by a T-Statistic value of 0.019 (< 1.96) and a p-value of 0.849 (> 0.05) thus H4 is rejected. Price Value (PV) has a significant effect on Behavioral Intention to Use (BI), this is supported by a T-Statistic value of 2.136 (> 1.96) and a p-value of 0.033 (<0.05) thus H5 is accepted. Information Quality (IQ) has a significant effect on Behavioral Intention to Use (BI), this is supported by a T-Statistic value of 5.024 (> 1.96) and a p-value of 0.000 (< 0.05) thus H6 is accepted. Trust (TR) has a significant effect on Behavioral Intention to Use (BI), this is supported by the T-Statistic value of 2.033 (> 1.96) and the p-value 0.042 (< 0.05) thus H7 is accepted.

The research results show that the Path Coefficient values for all hypotheses are positive. This indicates that all exogenous variables have a positive relationship with the endogenous variables. The R^2 value is 0.775 or 77.5% which indicates a strong influence of exogenous variables on endogenous variables in this study.

Based on the research result, the final research model for this study as shown in Figure 2.

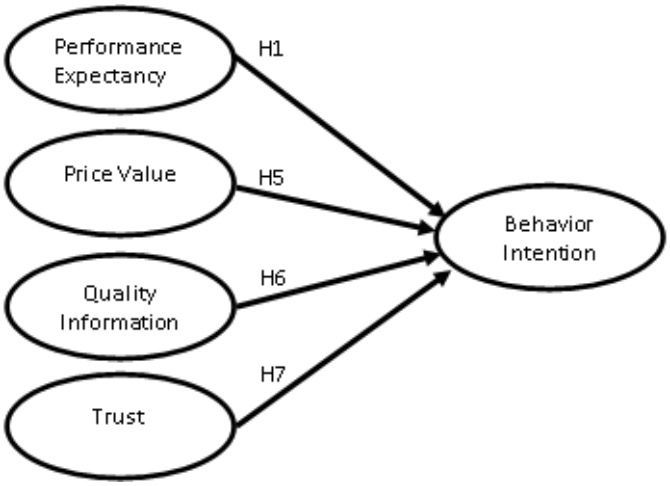

Figure 2. Final Research Model

5. CONCLUSIONS

Performance Expectancy (PE), Price Value (PV), Information Quality (IQ) and Trust (TR) have a positive and significant influence on Behavioral Intention to Use (BI) on PLN Mobile application users at PLN ULP Babat. Based on the results of Performance Expectancy (PE), users of the PLN Mobile application like the ability of this application because it can increase productivity in their lives, so service providers must continue to improve the performance of the application so that they retain users in using the PLN Mobile application. Based on the results of Price Value (PV), users of the PLN Mobile application like the price offered in the application because it is cheaper than other payment method, so service providers must continue to look for strategies so that the price offered in the application retains users in using the PLN Mobile application. Based on the results of Information Quality (IQ), users of the PLN Mobile application like the quality of the information contained in the application because the information displayed is the latest and most reliable information, so service providers must continue to improve the quality of the information displayed on the application in order to retain users using the PLN Mobile application. Based on the results of Trust (TR), users of the PLN Mobile application use the application because they trust the system built by service providers, so service providers must continue to improve and innovate the PLN Mobile application system so that users continue to use the PLN Mobile application.

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SHIPYARD SELECTION IN THE PROCUREMENT PROCESS OF WARSHIPS USING FUZZY ANP METHOD

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ABSTRACT

Shipyard Selection is very important in the warship procurement process. Warships have special designs in the platforms and sewaco (sensors, weapons and command) according to their operational requirement. This study aims to select shipyards as part of the procurement process for warships at the Ministry of Defense of the Republic of Indonesia. The method proposed for this decision is the Fuzzy Analytic Network Process. The combined method of Fuzzy and ANP is applied because it has advantages in considering dependencies between criteria, and can reduce uncertainty and inaccuracy in assessing the level of importance of each criterion/sub-criteria. The research process starts from the process of determining criteria/sub-criteria and alternatives. Dependence and pairwise comparisons between criteria/sub-criteria were determined through a questionnaire by experts. Shipyards that are used as alternatives are shipyards that have submitted worthiness certification to the Worthiness Center of the Ministry of Defense of the Republic of Indonesia. The results of this study obtained a priority ranking of criteria/sub-criteria and alternatives. The sensitivity analysis and validation of the results that have been carried out show that the application of Fuzzy ANP is practically feasible and can be applied to the selection of shipyards in the warship procurement process.

Keywords: Shipyard selection, Warships, Fuzzy, ANP.

1. INTRODUCTION

The Defense Equipment Tool Center of ministry of defence has the task of carrying out the procurement of goods and services maintenance of Defense Equipment Tool repairs from within and outside the country. One of the goods and services procurement activities carried out is the procurement of warships which are carried out by shipyards from within the country and abroad. The selection of shipyards carried out by the Ministry of Defense currently follows the Regulation of the Minister of Defense of the Republic of Indonesia Number 16 of 2019 concerning Implementation of Procurement of Defense and Security Equipment Equipment within the Ministry of Defense and the Indonesian National Armed Forces. According to Pujawan and Er (2017) that one of the tasks in procurement activities is to provide inputs of goods and services needed in production activities or other activities. There are tasks in the procurement department from designing the right relationship with suppliers to purchasing. The problems that occur in the procurement of warships at the Ministry of Defense include: the construction of warships that are not completed, the construction of warships that are not completed on time and the quality of products that do not meet the required standards.

Prakoso & Apriyani (2017) argues that the construction of warships requires design expertise, mastery of platforms and sewaco (sensors, weapons and command) as well as special teams compared to building commercial ships in general. Warships are ships used for military or naval purposes, so they need to be equipped with special equipment compared to commercial ships. Thus it is necessary to carry out the selection of shipyards that have good facilities, human resources and management in the construction of warships. Kafali and Ozkok (2015) argue that if the shipyard is not chosen correctly, it is possible to have negative impacts, such as delays in delivery or bad work which results in a large loss of return on investment. Therefore, in the selection of shipyards, ship owners must consider various parameters or appropriate criteria. Arabadzhiev (2020) has compiled shipyard assessment documents covering several areas including: assessment of shipyard facilities and shipbuilding strategies, assessment of production capacity and worker qualifications as well as performance data from ships that have been built in the same shipyard.

Many studies on shipyard selection criteria have used Multi Criteria Decision Making (MCDM). Kafali & Ozkok (2015) conducted research on the evaluation of shipyard selection criteria from the ship owner's point of view using the Fuzzy AHP method. In this study, a number of 5 criteria and 31 sub criteria were determined. The selection of shipyards in international container shipping is specifically carried out by evaluating critical factors through the AHP method carried out by Lirn (2011) using 4 main criteria and 15 sub criteria. Another research related to Fuzzy AHP was conducted by Sahin et al (2021) which related to the selection of shipyards, which is more specific in making improvements to fuzzy AHP based on game-theoritic models in shipyard selection.Several studies using multi-criteria decision making are used to select the best shipyard location. Research on selecting a new shipyard location by combining the DEMANTEL and ANP methods has been carried out by Sukisno & Singgih (2019) by determining 7 main criteria and 18 sub criteria. The Fuzzy ANP method was used by Gunery et al (2009) in selecting the best shipyard locations in Turkey by considering 6 main criteria and 15 sub criteria. The selection of the shipyard location in Iskenderun bay using the raster calculation method and AHP was carried out by Caner and Aydin (2021) to select the shipyard location considering 17 criteria. In other fields the Fuzzy ANP method is applied to supplier selection by considering aspects of organizational management by Imran et al (2020) by determining 6 criteria and 18 sub criteria.

Based on the background of the problems above, the researcher is interested in applying the Fuzzy ANP method in the selection of shipyards for the construction of warships at the Ministry of Defense of the Republic of Indonesia. The process carried out in Fuzzy ANP consists of four main stages, namely the process of determining the criteria and sub-criteria for selecting shipyards, the process for determining dependencies between criteria and sub-criteria, the process for weighing criteria/sub-criteria, and the process for selecting shipyards. The result of the Fuzzy ANP method is to obtain a shipyard ranking order in a warship procurement process.

2. LITERATURE REVIEW

Selection of goods/services suppliers is an activity to determine the goods/services suppliers to be appointed to carry out the work. Selection of the best shipyard is one of the most important decisions for ship buyers. According to Kafali and Ozkok (2015) selecting the right shipyard can determine the quality of workmanship and the time to complete the ship. From the point of view of the ship owner, the timely completion of the ship construction and the quality of the ship in accordance with the technical specifications is very important. Sucofindo, (2018) has suggested that selecting the right shipyard in accordance with industry capabilities is intended to meet quality requirements, delivery times and competitive prices.

The selection of shipyards in the process of procuring warships within the Ministry of Defense of the Republic of Indonesia currently follows the Regulation of the Minister of Defense of the Republic of Indonesia Number 16 of 2019 concerning Implementation of Procurement of Defense and Security Equipment Equipment within the Ministry of Defense and the Indonesian National Armed Forces. Based on the Minister of Defense of the Republic of Indonesia No. 16 of 2019 article 44 it is stated that the supplier selection stage includes: Supplier selection mechanism, Determination and notification of suppliers and Resignation.

Kafali & Ozkok (2015) have suggested several important things in shipyard selection in general from the perspective of ship owners divided into 5 main criteria and 31 sub criteria. Sucofindo (2018) has divided the criteria for assessing shipbuilding capabilities into two aspects, namely technical aspects and non-technical aspects. From the criteria/sub-criteria considered in some of the literature, there are many similarities in determining the criteria and sub-criteria. In this study, the proposed criteria and sub-criteria were determined in selecting the best shipyard.

Fuzzy logic was first developed by Lotfi A. Zadeh, an Iranian American scientist from the University of California at Berkeley. This theory is widely applied in various fields, including representing the human mind into a system. "Fuzzy logic is an appropriate way to map an input space into an output space" (Kusumadewi & Purnomo, 2004). In the conventional AHP and ANP methods, the scale used in pairwise comparisons to find alternative selection purposes is a linguistic scale with a value of 1 to 9 where the scale is not sufficient to make the right decision-making requirements. This problem can be solved by adding Fuzzy logic which can provide a more accurate description of the decision-making process (Slamet, Arkeman, Udin & Marimin, 2010).

According to Kusumadewi (2004) there are several reasons for using Fuzzy Logic, including:

- Fuzzy logic is very flexible.
- Fuzzy logic has tolerance for imprecise data.
- The concept of Fuzzy logic is easy to understand. The mathematical concepts underlying Fuzzy reasoning are very simple and easy to understand.
- Fuzzy logic is capable of modeling very complex nonlinear functions.
- Fuzzy Logic can build and apply the experiences of experts directly without having to go through the training process.
- Fuzzy logic can work with conventional control techniques.
- Fuzzy logic is based on natural language.

ANP is a development of the AHP method which takes into account more dependencies between hierarchical elements. Many decision problems cannot be structured using a hierarchy because hierarchies take into account the dependence of elements higher in the hierarchy on lower level elements. Meanwhile, ANP which is represented by a network, not a hierarchy can overcome this problem. ANP is a logical way to deal with the problem of dependency on higher elements (Saaty, 2008). Like the AHP method, the ANP method can also be combined with Fuzzy logic. One of the previous studies in the field of shipping used the Fuzzy ANP method, namely the Fuzzy ANP approach for selecting shipyard locations by Guneri et al (2009). The ANP method can correct the deficiencies of the AHP method where its ability can accommodate the interrelationships between criteria or alternatives (Saaty, 2005). By looking at each criterion it can be considered to be at the same level or hierarchy. These conditions make the problem structured based on hierarchical levels with objectives at the top level and criteria at the second level and alternatives at the next level (Govindaraju & Sinulinga, 2017). According to Ascarya (Tanjung and Dewi, 2013) there are three main functions of ANP, including: Structuring Complexity, Measurement in Ratio Scale and Synthesis.

3. METHODS

The research started from a literature study conducted with the intention of obtaining theories and methods related to the criteria in selecting a shipyard to build a warship. At the stage of identification and analysis of research problems, the problems are adjusted to the research objectives proposed to be solved using the Fuzzy ANP method. The ANP structure consists of goals, criteria/sub-criteria and alternatives. The criteria/sub-criteria from some of the literature above can be combined and selected to become the relevant criteria/sub-criteria for the construction of warships. In this study, the proposed criteria and sub-criteria were determined in selecting the best shipyard. The proposed criteria and sub-criteria are then tested or validated through interviews with respondents (stakeholders) in filling out the research questionnaire. A research method was developed that was arranged in a structured manner so as to make it easier for writers and readers to understand the research being conducted. Figure 1 shows the steps used in this study. The Flow chart of fuzzy ANP in this study was carried out systematically so that it fits the research objectives.

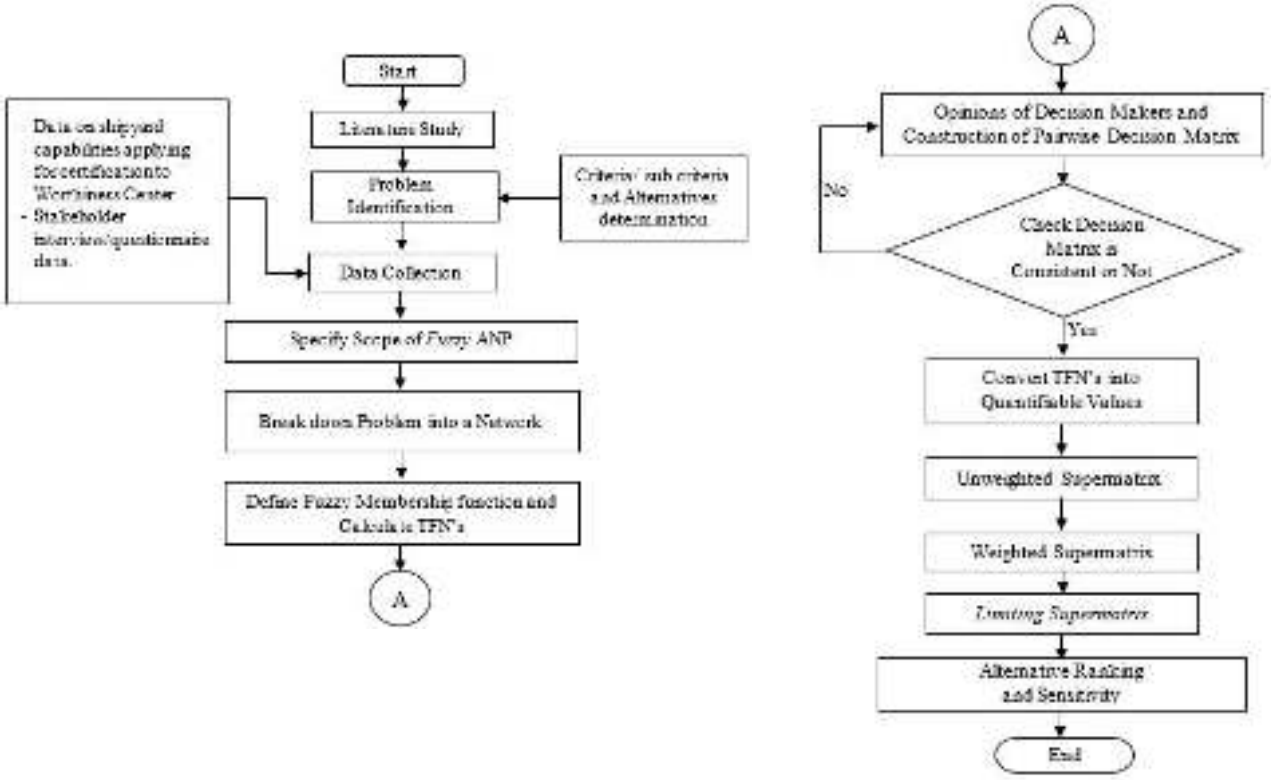

Figure 1. Flow chart of fuzzy ANP

In the problem identification stage, identification of the criteria taken from several literatures is carried out. The identified criteria can be grouped into two, namely the main criteria and sub criteria. The criteria contained in the case of shipyard selection are qualitative and quantitative. The specified criteria can describe the overall shipyard capability and are strengthened by data and studies in other literature studies. The alternative shipyards are shipyards that have submitted capability certification to the Indonesian Ministry of Defense Worthiness Center for the period 2020 to 2022. There were 15 shipyards that applied for a Certificate of Approval, of the 15 shipyards it was determined that the 5 best shipyards had relatively balanced values which would then be used as an alternative in this study.

Specify Scope of *Fuzzy* ANP. The Fuzzy ANP method was used for the selection of shipyards in the procurement process for warships at the Ministry of Defense of the Republic of Indonesia. The criteria and sub-criteria used were determined from a literature study on previous similar studies and guidelines owned by the Ministry of Defence. The alternative is determined from the initial studies that have been carried out on shipyards that have submitted a certification process at the Ministry of Defense of the Republic of Indonesia. Thus in this study determined 5 (five) criteria, 17 (seventeen) sub criteria and 5 (five) alternatives.

Break down Problem into a Network. Analytic network framework is made to show interdependencies (interdependence) between nodes or elements. Creating a network requires interrelationships between sub-criteria input from questionnaire/interview respondents. To assist in determining the interrelationships between criteria, a questionnaire filled in by the respondents is required, then a resume is made from the interview results into a decision on the linkages between the sub-criteria (Figure 2). Furthermore, from the table further analysis is carried out to determine inner dependencies and outer dependencies.

Define Fuzzy Membership function and Calculate TFN's. The membership function is a curve that shows the mapping of input data points into their membership values (often referred to as membership degrees) which have an interval between 0 and 1. Triangular Fuzzy Number is a Fuzzy set theory that can assist in measurement related with human subjective judgments using language or linguistics which can be described in the TFN membership function.

Opinions of Decision Makers and Construction of Pairwise Decision Matrix. The opinions of stakeholders in each comparison between two things (criteria/sub-criteria) will be carried out on geometric mean. Weighting is done after obtaining pairwise comparisons between criteria/sub-criteria and alternatives into a comparison matrix previously obtained from respondents (questionnaire/interview). The weighting stage is carried out to determine the weight on the criteria/sub-criteria that have been determined. Pairwise comparisons between criteria/sub-criteria were carried out to determine the importance of the inter-criteria/sub-criteria and alternatives using the importance rating scale.

Check Decision Matrix is Consistent or Not. The data from the assessment results provided by respondents are in the form of numeric, so that each assessment needs to be tested for consistency by looking for the value of λmax, Consistency Index and Consistency Ratio. The stages in testing consistency include:

- Multiplies each value in the first column by the relative priority of the first element and so on for as many times as there are elements.
- Add up each row and divide the results by their relative priority.
- The results of the division are added up to find λ max, as shown in equation (1).

$$\lambda\ max = \frac{total\ Sum\ Matrix}{Number\ of\ criteria} \quad (1)$$

- Calculate CI and CR**.** The Consistency Index (CI) value is obtained from the formula:

$$CI = \left(\frac{\lambda \max - n}{n-1}\right) \quad (2)$$

Where:

n = number of elements

λ max = the sum of the results of multiplying the number of columns by the eigenvectors

If CI = 0, denotes a consistent matrix

The inconsistency limit set by Saaty is measured using the Consistency Ratio, which is a comparison of the Consistency Index (CI) with the Random Consistency Index (IR). The IR value depends on the order of the matrix n. IR values are shown in Table 1.

$$CR = \frac{CI}{IR} \quad (3)$$

Table 1. *Random Indeks*

n	1	2	3	4	5	6	7	8	9	10
RI	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

Convert TFN's into Quantifiable Values. After the comparison matrix derived from the respondent's assessment is consistent, then this value can be converted into a TFN value. The fuzzy number for TFN which is the relative importance scale of ANP with different importance levels can be seen in Table 2. The table shows the grade, level of importance, TFN scale and Inverse TFN scale. The grade is determined by a value of 1 to 9, each of which has further information or meaning on the TFN scale, which is a value that represents lower (l), middle (m) and upper (u) values. While the Inverse TFN scale is the opposite of the TFN Scale value.

Table 2. Triangular Fuzzy Number Scale

Grade	Meaning	Triangular fuzzy expression	Inverse expression
1	Element a is equally as important as element b	(1, 1, 1)	(1, 1, 1)
2	Slightly less important	(1, 2, 3)	(1/3, 1/2, 1)
3	Slightly important	(2, 3, 4)	(1/4, 1/3, 2)
4	Between slightly important and more important	(3, 4, 5)	(1/5, 1/4, 3)
5	More Important	(4, 5, 6)	(1/6, 1/5, 4)
6	Between more important and very important	(5, 6, 7)	(1/7, 1/6, 5)
7	Very important	(6, 7, 8)	(1/8, 1/7, 6)
8	Between very important and extremely important	(7, 8, 9)	(1/9, 1/8, 7)
9	Extremely important	(8, 9, 10)	(1/10, 1/9, 8)

Super Matrix. This step involves the construction of a super matrix, which is the result of priority vectors derived through pairwise group comparisons, and includes goals, criteria, sub criteria, and alternatives. Each ratio scale shows the comparison of interests between elements in a component with elements outside the component (outer dependence) or also within the elements themselves which are in the inner component (inner dependence). The supermatrix consists of 3 (three) stages, including: unweight supermatrix, weighted supermatrix and limit supermatrix.

Calculation of the final priority weight and ranking. The calculation of the final priority weight is used to determine the final weight/importance level of each criterion and each sub-criterion. The final weight of the criteria and sub-criteria is obtained from the initial weight obtained from pairwise comparisons between criteria and sub-criteria which are then processed through the Fuzzy ANP method which considers the relationship between criteria, sub-criteria and alternatives. Alternative final weights are obtained after experiencing a series of Fuzzy ANP processes.

4. RESULTS

Validation of shipyard selection criteria/sub criteria. Validation was carried out by the respondents against the criteria/sub-criteria previously determined through a literature study from several sources that had been studied. The purpose of carrying out validation in this study is to ascertain and find out how far the criteria/sub-criteria are needed for the selection of shipyards in the procurement of warships. From the results of the distributed questionnaires, no addition or subtraction of the criteria/sub-criteria was found for the respondents, but several respondents provided additional, broader understanding of the proposed sub-criteria.

Arrange of network structures. In the second material questionnaire, the respondents gave opinions about the relationship between sub-criteria within one criterion or between sub-criteria outside the main criteria. The linkages between sub-criteria within one criterion (between nodes in one cluster) are called inner dependencies, while the linkages between sub-criteria outside of these criteria (between nodes outside one cluster) are called outer dependencies. The network structure manually is shown in Figure 2.

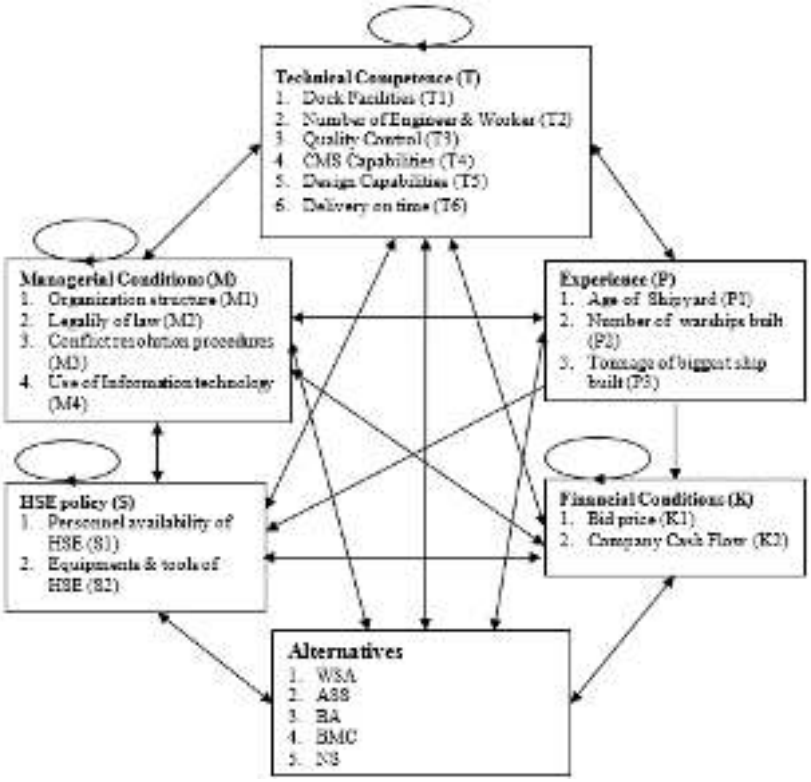

Figure 2. Network structure of shipyard selection

Figure 2 shows that all criteria are related to other criteria (outer dependence) so that they are indicated by two-way and two-way arrows. One-way arrows indicate that only one criterion affects the other criteria and does not occur the other way around. While the two-way arrows indicate the interdependence between criteria. Inner dependence occurs in the sub-criteria Managerial Conditions, Technical Competence, HSE Policy and Financial Conditions indicated by a loop sign which means there is a relationship between the sub-criteria on different criteria.

Calculation of weights between criteria/sub criteria. Pairwise comparison matrices between criteria are prepared based on the values obtained from the resume results of the pairwise comparison questionnaire between criteria as shown in Table 3 below:

Table 3. Pairwise comparison matrix between criteria

	Managerial Conditions	Technical Competence	Experience	HSE policy	Financial Conditions
Managerial Conditions	1,00	0,50	1,00	2,00	1,00
Technical Competence	2,00	1,00	2,00	2,00	1,00
Experience	1,00	0,50	1,00	2,00	1,00
HSE policy	0,50	0,50	0,50	1,00	0,50
Financial Conditions	1,00	1,00	1,00	2,00	1,00

Table 4.Ordinat defuzzifikasi value between criteria

	Ordinat Defuzzifikasi Value	Normalized
V(M1≥M2,M3,M4,M5)	0,65	0,196
V(M2≥M1,M3,M4,M5)	1,00	0,300
V(M3≥M1,M2,M4,M5)	0,65	0,196
V(M4≥M1,M2,M3,M5)	0,34	0,103
V(M5≥M1,M2,M3,M4)	0,69	0,206

Based on Table 4 in the last column, it shows that the value of the fuzzy vector weight (W) for each criterion is as follows: managerial conditions (0.196), technical competence (0.300), experience (0.196), HSE policy (0.103) and financial condition (0.206).

Calculation of weights between alternatives. Alternative weights are determined from the assessment of each alternative against all sub-criteria in each criterion. Determination of alternative weights is obtained through assessment and shipyard certification data. Shipyard certification at the Ministry of Defense of the Republic of Indonesia is carried out Indonesia Defense Seaworthiness Authority at the Worthiness Center. Because the results of the assessment are confidential, they cannot be written down in detail, but the assessment is carried out in real terms using actual data.

Supermatrix. The criteria and sub-criteria weights were obtained from pairwise comparisons on the questionnaires/opinions of the respondents through direct interviews. Questionnaire data is processed using fuzzy techniques so as to get priority weight of criteria and sub criteria. Meanwhile, the alternative weights for the sub-criteria were obtained from a direct assessment of the results of airworthiness certification at the Indonesian Ministry of Defense's Feasibility Center because the shipyard data that became an alternative was complete and the results had been validated by the Indonesian Defense Seaworthiness Authority Team.

Final weight of priority criteria/sub-criteria and ranking of alternatives. The ultimate goal of selecting a shipyard is to obtain alternative rankings after carrying out an analysis using Fuzzy ANP. The final priority weight is automatically displayed on the Super Decision because the network structure and input weights entered are complete. The final priority weight displayed on the Super Decision is shown in Figure 3.

Figure 3. Alternative Final Priority Weight

Sensitivity analysis and validity of research results. Sensitivity analysis was carried out to find out how sensitive changes in the weight of the criteria and sub-criteria will affect the shipyard selection rating. An alternative sensitivity analysis graph has been provided in the Super Decision shown in Figure 4.

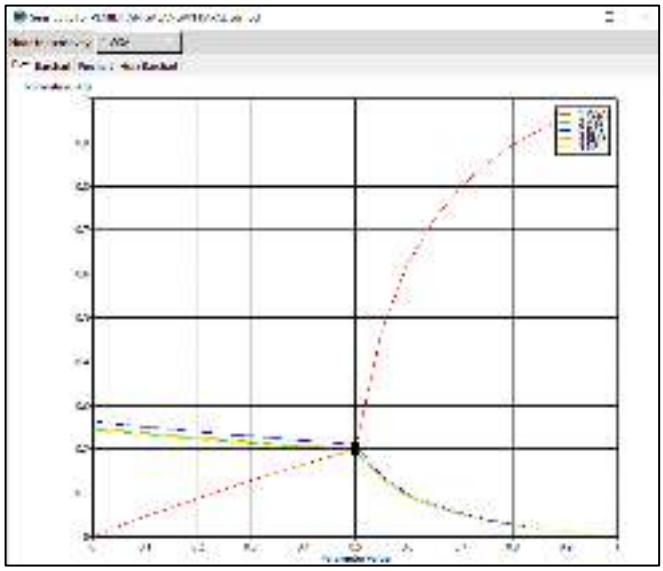

Figure 4. Sensitivity Plot Graph for WSA alternative

Validation of research results has also been carried out on respondents in the form of comments and statements on the final results of the criteria, sub criteria and alternative weights. In their statements, the respondents said that the Fuzzy ANP method could be applied to the selection of warships in the process of procuring warships at the Indonesian Ministry of Defense.

6. CONCLUSIONS

The process of determining the weight of the criteria and sub-criteria is obtained from a pairwise comparison of criteria/sub-criteria from the respondents through a questionnaire which is then carried out by the Fuzzy ANP analysis process. From the final results of the calculation, the highest criterion weight is financial condition (0.281), the highest managerial condition sub-criterion weight is workload (0.366), the highest technical competence sub-criteria weight is dock facilities (0.264), the highest experience sub-criteria weight is the largest ship tonnage ever built (0.349), the highest HSE policy competence sub-criterion weight is personnel availability (0.547) and the highest financial condition sub-criteria weight is company cash flow (0.71). The alternative

ranking results are obtained by inputting the weight value of the criteria vector, the weight of the sub-criteria vector and the alternative weight of the sub-criteria into the Super Decision. From the final results of the calculation, it is known that the alternative ranking order from top to bottom is: BAB (0.21086), BMB (0.19969), WSA (0.19915), ASS (0.19627) and NSL (0.19403). The ranking of shipyard selection may change with changes in the weight of the criteria and sub criteria through sensitivity analysis. Sensitivity analysis has been provided in Super Decision in the form of visualization of parameter changes followed by changes in sensitivity graphs.

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DATA ANALYSIS ON COLLECTABILITY TO THE CURRENCY OF RETAIL CREDIT PRODUCTS AT BANK XYZ

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ABSTRACT

Bank has the instinct to minimize the risk of a customer default by trying to classify previous customers to predict future customers. The researcher wants to classify customer collectability based on customer profiles and financial information by using several classification methods using machine learning, namely Naïve Bayes, Random Forest, Light Gradient Boosting Machine (LGBM), and catboost. Based on the classification results, it is known that the random forest and LGBM method has the highest AUC score, which is 0.999, but for feature importance, the Light Gradient Boosting Machine method has a much higher feature importance score than other methods, although the AUC score was same as Random Forest, which is 0.999. As well as providing several inputs regarding consideration for each legacy in providing credit access which is expected to reduce the number of non-performing loans that can harm the bank.

Keywords: Credit, Classification

1. INTRODUCTION

Credit is a bank asset that is given to the public. Credit is a bank's most enormous income when compared to other sources of income. By providing credit to the public, banks will get additional income, such as credit provisions and credit administration income. Credit can be given by anyone who can pay, with a debt agreement between the lender and the recipient of the funds. After the agreement is agreed, the funder must deliver the money according to the agreement to the recipient of the fund, with the right to receive the money-back from the recipient of the fund according to the payback period stated in the agreement, accompanied by interest agreed by both parties. As long as both parties carry out their rights and obligations under the agreement, there will be no problem with loans (Simorangkir, 1991). The interesting thing to note is that when the business prospects of the recipient of funds are still promising profits and the recipient of the funds is willing to be transparent and cooperative, the bank will not hesitate to provide access to credit and provide convenience if there are obstacles in routine payments.

Quality in credit or financing is an assessment of the smoothness of the borrowers of funds in regular payments under the agreement between the borrower and the lender. The quality of credit determines the performance of a borrowing institution (Kurniawan, 2022). So, according to the regulation of the Financial Services Authority (POJK) no. 40/POJK.03/2019 concerning the assessment of the Asset Quality of Commercial Banks, which explains that banks are required to manage credit assets based on prudent principles by observing, monitoring, and taking the necessary

steps in safeguarding bank assets. Based on this regulation, credit quality is ranked based on collectability scores, from 1 to 5 (Otoritas Jasa Keuangan, 2019).

Table 1. Collectability Categories from POJK no.40/POJK.03/2019

Collectability Score	Description
1	Current (the borrower always pays in installments on time)
2	In Special Mention (borrowers are 1-90 days in arrears)
3	Substandard (borrowers are 91-120 days in arrears)
4	Doubtful (borrowers are 121-180 days in arrears)
5	Default (debtors in arrears for more than 180 days)

Non-performing loans arise if the recipient of the funds is negligent in returning the loan money within the agreed time limit. Fast handling is needed by the bank because it will affect the soundness of the bank. So that the amount of credit is regulated in Bank Indonesia Regulation No. 8/13/PBI/2006 concerning the maximum limit for a lending (Bank Indonesia, 2022). With the increasing realization of credit disbursement, the bank must tighten the protocol in applying for credit. It is crucial for the bank to classify customers who apply for credit, so there is no default and as the main protocol in sorting out borrowers. The bank needs to classify customers who apply for credit, so there is no default and as the main protocol in sorting out borrowers. So, researchers want to classify customer collectability based on customer profiles and financial information by using several classification methods using machine learning, namely Naïve Bayes, random forest, Light Gradient Boosting Machine (LGBM), and Catboost.

2. LITERATURE REVIEW

Research conducted by Yusril Izzi Arlisa Amiri (2017) on debtor classification to predict the feasibility of applying for credit in the Jaya Sekarputih Bondowoso village cooperative unit uses the binary logistic regression method and classification tree. In that study, it was found that the classification tree method produced higher accuracy, sensitivity, and specificity values, namely 61.5897%, 57.1429%, and 65.8333%. So the classification tree method is better at explaining debtor data in KUD Jaya. Research from Tiara Fajrin (2018) entitled Application for Predicting Credit Collectability of Prospective Debtors Using the Dynamic K-Nearest Neighbor and Distance and Attribute Weighted Algorithms. Based on the method used, it is known that by using 240 old customer data, the order of the importance level of the attributes determined by the domain expert and 10¬-fold cross validation produces the highest accuracy, of 65.83% with a precision value of 56.10%, and a recall of 50% for k=3. By using correlation attribute evaluation, it produces a higher recall value, namely 54.35% for k = 5.

Research from Mohammad Ali (2015) entitled Performance of Three Classification Techniques in Classifying Credit Application into Good Loans and Bad Loans: A Comparison. The methods used in this research are logistic regression, classification tree, and random forest. Of the three methods, none of the classification methods has high accuracy. So that in this study there is no single method that can classify credit application data. In the research from Armin Lawi and Firman Azis in 2018 entitled "Classification of Credit Card Default Clients Using LS-SVM Ensemble", this study explained that SVM Ensemble Least Squares can improve prediction classification accuracy or reduce misclassification in SVM and SVM Least Square. The SVM Least Square ensemble method has the highest percentage with a difference of 1.7% from SVM and 0.6% from Least Square SVM. So that the SVM ensemble method is better at classifying.

Research from Dr. K. Chitra and Mrs. B. Subashini in 2013 entitled "Automatic Credit Approval Using Classification Method", explained that automatic credit approval is important for

efficient credit application processing. To increase the security of an automated and effective credit approval system, building an accurate and efficient credit approval system is one of the main tasks of financial institutions. In this study, four classification methods are used to build a fraud detection model. The work demonstrates the advantages of applying data mining techniques including classification trees, SVM and Logistic Regression to automated credit approval problems for the purpose of reducing bank risk. The results show that the proposed CART classifier is superior in solving the problem under investigation. Based on research from Fernanda Assef, Maria Teresinha Steiner, Pedro Jose Steiner Neto, and David Gabriel de Barros Franco in 2019 entitled "Classification Algorithms in Financial Application: Credit Risk Analysis on Legal Entities", explained that by using several machine learning methods, such as Artificial Neural Networks (ANN) more specifically, namely Multilayer Perceptron (MLP) and Radial Basis Functions (RBF) and also the Logistic Regression statistical model, it was found that the default client is easy to identify, but for temporarily absent clients it will be difficult to classify, which shows that they are not so discriminative. This work provides new insights into research on credit risk assessment demonstrating the possibility of different classifications and codifications of clients, which allows different types of studies to be conducted.

In research from Daniela Saavedra Lopez in 2020 entitled “SME Credit Application”, it was explained that this project presents an approach for constructing a recommendation text classification model for SME credit applications and for providing analytical solutions to credit risk in an area. The solution of classifying all recommendation texts into one of three categories had to be developed in two steps. The first is to classify all text via regular expressions that are displayed in the initial data analysis. Then the remaining text will be classified based on the sentence-bert neural network classification model. The second group, it is expected to have an accuracy of 68.16%; which will give a misclassification rate of 31.84% from the 50% database. However, it represents 15.92% of the entire database which will represent a high positive impact on the business.

3. METHODS

Using secondary data, with as many as 25 independent variables and 1 dependent variable that using 1032151 client credit data. Features used in the experiment are given in Table 2.

Table 1. Variabel yang Digunakan

Variable	Name	Type
X_1	Legacy	Nominal
X_2	Current Date	*Date*
X_3	Area	Nominal
X_4	Division	Nominal
X_5	Types of payment receivables	Nominal
X_6	Collectability CIF Last Month	Ordinal
X_7	Daily Mutation	Ordinal
X_8	Disbursement Date	*Date*
X_9	Due Date	*Date*
X_{10}	DPD	Ratio
X_{11}	Principal Disbursement	Ratio
X_{12}	Margin Disbursement	Ratio
X_{13}	CKPN_Last	Ratio
X_{14}	OS_Principal_Current	Ratio
X_{15}	OS_Margin_Current	Ratio
X_{16}	Principal Installment	Ratio

Variable	Name	Type
X_{17}	Margin Installment	Ratio
X_{18}	Principal_Arrear_Current	Ratio
X_{19}	Margin_Arrear_Current	Ratio
X_{20}	Flag Arrear	Ordinal
X_{21}	Gender	Nominal
X_{22}	Job	Nominal
X_{23}	Restructuring frequency	Ratio
X_{24}	Disbursement Status	Nominal
X_{25}	Payment Term	Ratio
Y	Collectability CIF System	Ordinal

Based on the data used, the following are the steps of this research.

1. Pre-Processing Data. Manage data from outliers, missing values, and several duplications and writing errors from retail credit collectability data at XYZ bank. Customer names and bank names have been intentionally disguised for privacy reasons
2. Conduct exploratory data analysis on predictor variables that affect credit collectability. So that the characteristics of the predictor variables are obtained.
3. Divide the data into training data and testing data. Because the data used is very large, and the majority are current loans, the researcher wants to use a proportion between training and testing data of 70: 30 with a random purposive sampling method so that the proportion of the five categories of the dependent variable is available in the training and testing data.
4. Classify retail credit defaults using the random forest, light gradient boosting machine, and catboost method
5. Evaluate the performance of the analysis results using AUC scores. In the last stage, several recommendations were obtained based on the method that had the highest AUC score and feature importance.

4. RESULTS

Classification can be performed for each method to obtain the method with the highest AUC score and F1 Score. The following is the AUC and F1 score for 5 Category.

Table 2. AUC and F1 Score for 5 Category

Classification Methods	AUC Score	F1 Score	
		Training	Training
Random Forest (SMOTE)	0.999	0.999	0.999
Light Gradient Boosting Machine	0.999	0.999	0.999
Random Forest (*Under Sampling*)	0.996	0.992	0.991
Catboost	0.995	0.988	0.993
Naïve Bayes (*Under Sampling*)	0.982	0.849	0.971
Naïve Bayes (SMOTE)	0.974	0.308	0.941

Based on the AUC score table for each classification method, it is known that the random forest method using SMOTE has the same AUC score as the Light Gradient Boosting Machine method. In contrast, the Naïve Bayes method has the lowest AUC score of the four methods used. The following is the F1 score for training and testing data. It is known that the highest F1 score was achieved by the random forest method with SMOTE and LGBM with the same score. So that both ways can predict the training data well. Underfit occurs for the Naïve Bayes method because the f1 score for training data is relatively low, but for F1 the score for data testing is high. The following is the Feature Importance of the 2 methods with the highest AUC scores.

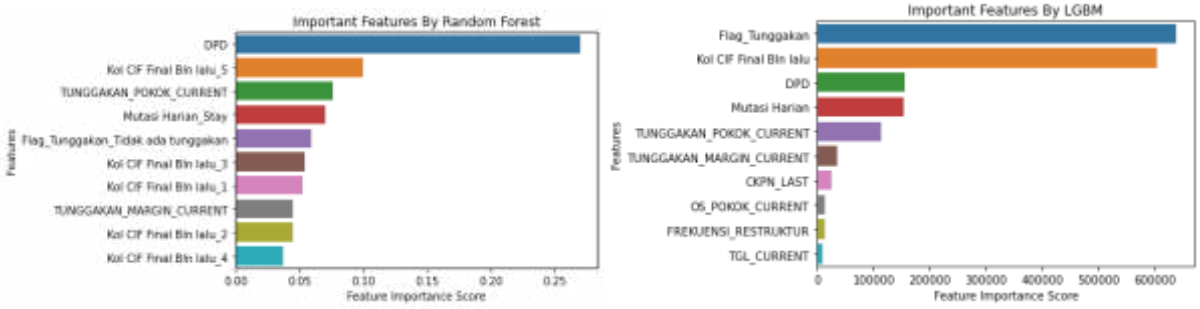

Figure 1. *Feature Importance uses Random Forest with SMOTE for 5 categories*

It can be concluded that with the random forest method using SMOTE, the variables considered in the classification are DPD values, Last Month's Final CIF Col, Current Principal Arrears, and Daily Movements. The following is the feature importance score from the Light Gradient Boosting Machine method. With the Light Gradient Boosting Machine method, the variables considered in the classification are the value of the Arrearning Flag, last month's CIF column, DPD, and Daily Movements. The following is the result of the classification using the Light Gradient Boosting Machine method.

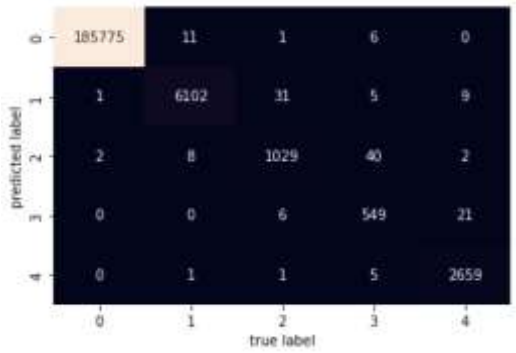

Figure 2. Classification results using the Light Gradient Boosting Machine (LGBM) method for 5 categories

The LGBM method produces a classification that minimizes false positives. It can be seen that from around 1 million samples there were only 63 false positives (total from the top diagonal). Because in credit, banks minimize the occurrence of errors that provide loans to people who are unable to repay loans, which is statistically a false positive hypothesis. On credit, a false positive hypothesis is very dangerous because it can result in losses for the bank. The following is the result of a classification with 2 categories of response variables.

Table 3. AUC and F1 Score for 2 Category

Classification Methods	AUC Score	F1-Score	
		Training	Training
Random Forest (SMOTE)	0.999	1	0.999
Random Forest (*Under Sampling*)	0.999	0.999	0.999
Light Gradient Boosting Machine	0.997	0.999	0.999
Catboost	0.995	0.997	0.998
Naïve Bayes (*Under Sampling*)	0.717	0.723	0.973
Naïve Bayes (SMOTE)	0.690	0.684	0.975

Based on the AUC score table for each classification method, it is known that the random forest method using SMOTE has a higher AUC score than other methods. Meanwhile, the Naïve Bayes method using SMOTE has the lowest AUC score of the four methods used. The following is the F1 score of each method. The random forest method with undersampling on the training data has a perfect score, namely 1. An ideal score is obtained if there are no errors in the classifier. The Naïve Bayes method is underfitted because the F1 data training score is much lower than the F1 data testing score.

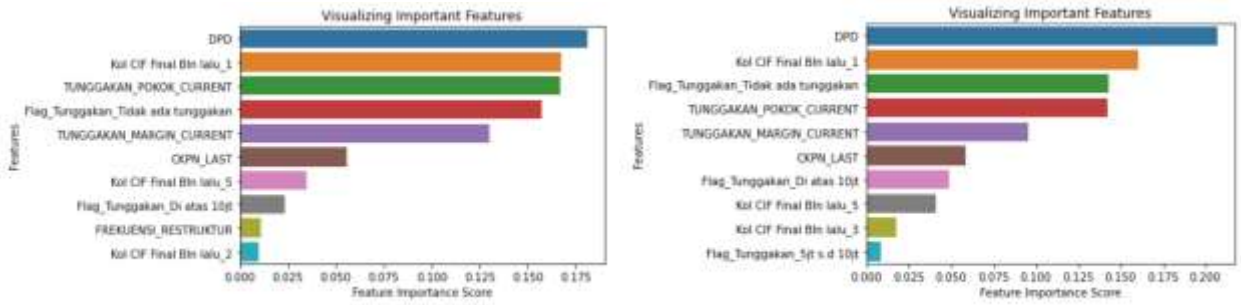

Figure 3. Feature Importance uses Random Forest with SMOTE (left) and Undersampling for 2 categories

It can be concluded that with the random forest method using SMOTE, the variables considered in the classification are DPD values, Last Month Final CIF Col, Current Principal Arrears, and Arrear Flags in the category of no arrears. Also with the random forest method using under-sampling, the variables considered in the classification are DPD values, Last Month's Final CIF Col, arrears flags, and current principal arrears. A comparison of the two feature importances of the random forest method using SMOTE and Undersampling shows that the random forest method using SMOTE produces a high AUC score. So the random forest method using SMOTE is used in this study. Following are the results of the random forest classification method with SMOTE.

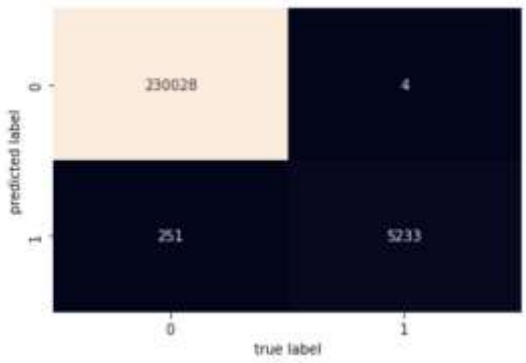

Figure 4. Classification results using the Random Forest method with SMOTE for 2 categories

The random forest method produces a classification that minimizes false positives. It can be seen that from around 1 million samples there were only 4 false positives (total from the top diagonal). Because in credit, banks minimize the occurrence of errors that provide loans to people who cannot repay loans, which is a statistically false positive hypothesis. On credit, a false positive

hypothesis is very dangerous because it can result in losses for the bank. So that method is used in this research. The following is a discussion regarding the classification results obtained.

From the feature importance chart, it was found that several variables had the highest feature importance scores of the three classification methods used, namely DPD, last month's CIF Final COL, Principal_Current Arrears, Overdue_Flags, and Daily Movements. The researcher uses the variable that has the highest feature importance value to make some conclusions and suggestions based on tables or graphs of each variable on legacy as follows.

Table 4. DPD Characteristics for Each Legacy

Legacy	count	mean	std	min	Max
X	581438.0	8.234	75.344	0.0	3208.0
Y	52650.0	22.178	124.457	0.0	1284.0
Z	150965.0	20.815	131.722	0.0	3177.0

It is known that companies X and Z have customers who are in arrears of up to about 3000 days (about 8 years). Company Y has a much lower DPD than the other two companies. But on average, company X has less DPD. So it can be seen that company Y is better at dealing with customers who experience default, and Company X is better at screening potential debtors so that the average DPD becomes smaller than companies Y and Z. The following is COL CIF last month for each company.

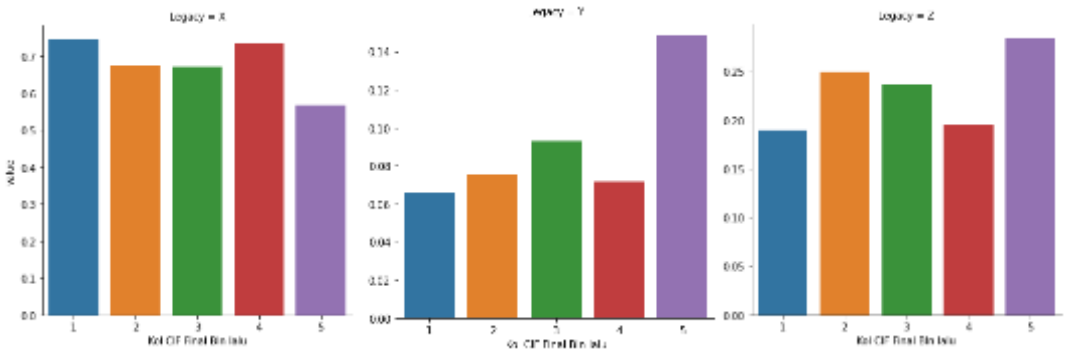

Figure 5. Kol CIF Final Month for Legacy X, Y, dan Z

Overall, it is known that company X tends to get customers in the current category. This indicates a fairly healthy credit because the percentage of current customers is higher than the percentage of default customers. After all, banks must make every effort to minimize risk. However, for Y and Z companies, the percentage of defaulting customers is quite high, and the resulting percentage is even higher than current customers. So the researchers hope this research can minimize losses due to default customers. Below are the daily mutations for each company.

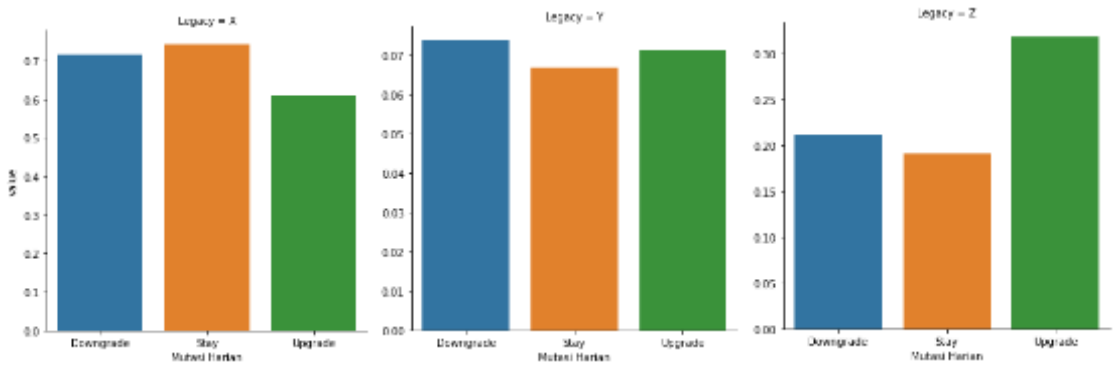

Figure 6. Daily Mutation Legacy for X, Y, dan Z

Overall, it is known that companies X and Y tend to be stable (balanced between Upgrades and Downgrades). This can be indicated that companies X and Y prefer to be conservative in maintaining bank finances and anticipating customer default after upgrading. Meanwhile, company Z tends to play aggressively by providing more Upgrade services than Downgrade or Stay. So, company Z is expected to remain cautious and anticipate defaults from customers who upgrade. Because legacy X has customers who tend to be in the Stay category and have a high level of smoothness of payments, which indicates that legacy X has good credit smoothness. Here are the Overdue Flags in each Legacy.

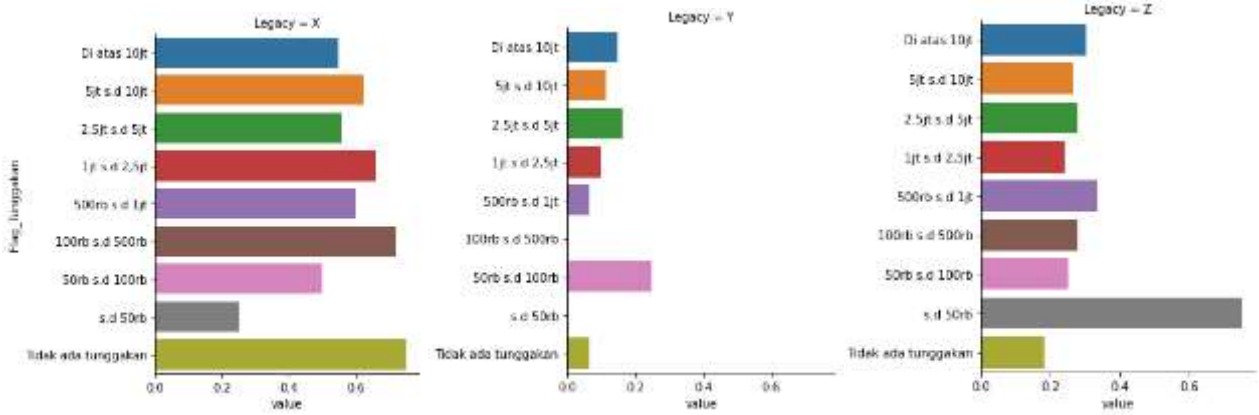

Figure 6. Flag Arrear for Legacy X, Y, dan Z

Legacy X has customers who tend not to have arrears, which can be seen that almost 80% of customers are not in arrears in Legacy X. However, there are also many customers who are in arrears, ranging from 50 thousand to over 10 million Rupiah. So even though there are many customers who are not in arrears, legacy X still gets problems from customers who are in arrears. In legacy Y, there are customers who tend to have arrears, and it can be seen that only about 6% of customers are not in arrears in legacy Y. However, the most frequent arrears range from units of 50 thousand to 100 thousand Rupiah, so even though in legacy Y many customers are in arrears, at least only dominated by arrears of 50 thousand to 100 thousand. In legacy Z, there are customers who tend to have arrears, which can be seen that only about 20% of customers are not in arrears in legacy Z. However, the most frequent arrears range from units of less than 50 thousand Rupiah, so even though in legacy Z many customers are in arrears, at least only dominated by arrears of less than 50 thousand Rupiah.

Overall, it is known that all legacy customers are in arrears. It can be seen that the number of customers who do not have arrears is no more than the number of customers who have arrears. So that every company is expected to be able to minimize customers who are in arrears so that the bank does not experience losses at once.

5. CONCLUSION

This study aims to explore, analyze, and develop several classification algorithms to correctly identify whether a certain category has a high probability of creating problem loans. Based on the classification results, it was found that using the SMOTE and Undersampling methods represented by random forest with the Boosting method represented by Light Gradient Boosting Machine (LGBM) produced a very high AUC (almost close to 1). So it can be concluded that the SMOTE, Undersampling, and Boosting methods can overcome data imbalance and obtain very high accuracy scores, even though using 5 categories or 2 categories on the response variable. The best method for handling XYZ bank collectability data is the Random Forest method with SMOTE or Undersampling, and the Light Gradient Boosting Machine method which produces an AUC score close to 1.

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STUDY OF ENTERPRISE CONTRACTS USING DESIGN THINKING IN THE MYTENS CASE

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ABSTRACT

The enterprise contract is a critical issue that affects most businesses in various industrial sectors. Therefore, businesses must implement digital transformation to address the high cost and high time requirement issues on enterprise contracts. People, process, policy, and technology are four business process management aspects that influence the success of the digital transformation process. The digital transformation process is high-risk and complex, therefore it is critical to use the proper method to ensure that the innovation process runs smoothly. Design thinking approach is used in this study to identify problems and formulate solutions to enterprise contract issues in a complex situation. Design thinking includes five stages of convergent and divergent thinking that consist of empathize, define, ideate, prototype, and test. The divergent process was applied to identify problems using in-depth interviews with 15 respondents of internal company users and customers. The result is 148 ideas discovered from the brainstorming process to solve 13 pain points that have a significant effect on business processes. The solution was e-contract features applied on MyTEnS as a digital touch point to support enterprise business processes. The e-contract application was validated by heuristic evaluation and proposing a supporting policy for people, process, and policy aspects.

Keywords: Enterprise Contract, Digital Transformation, Design Thinking, User Experience, Heuristic Evaluation

1. INTRODUCTION

The concept of enterprise contract management is directly related to business performance (Muhammad, et al., 2019). Because of the high cost and lengthy processing time, it frequently becomes a problem for businesses (Angelove & Grefen, 2003). As one of the goals of enterprise companies is to become operational quickly, the time consumed by the contract's set-up phase must be reduced to a minimum (Quirchmayr, et al., 2022). At the same time, it has to be guaranteed that the outcome of this phase leads to a formally correct and executable agreement (Palanisamy, 2015). As a result, many businesses choose to initiate digital transformation to address this issue.

Digital transformations cause significant changes in many companies by introducing new processes and mechanisms that can affect fundamental aspects of how companies run business. The primary goal of digital transformation is to address issues of efficiency and effectiveness (Heavin & Power, 2018). However, the digital transformation process has many risks and challenges. Previous research has shown that change is difficult to implement in large companies (Decline, 2018), with up to 70% of large companies' transformation efforts failing (Barrett & Stephens, 2017).

People, process, policy, and technology are four business process management factors that influence the success of digital transformation initiatives in the public sector and enterprise companies having rigid characteristics and prioritizing compliance (Bessick, 2016). Because the digital transformation process will be high-risk and complex (Jöhnk, et al., 2022), it is critical to use the proper method to ensure that the innovation process runs smoothly.

To ensure that digital transformation runs smoothly, a bottom-up approach that can identify specific user needs is required (Budde, et al., 2022), so that design thinking becomes a potential framework to be applied (Vendraminelli, et al., 2022). Design Thinking is expected to provide insight into user pain points in order to find effective solutions, such as developing user experience on the MyTEnS application, a digital touch point that aids business processes from pre-sales, sales, after-sales, and billing-payment activity in one of Indonesia's enterprise companies. MyTEnS was chosen due to its massive usage by thousands of users spanning from operational to high management levels to run businesses across the country. MyTEnS has characteristics that change in response to supporting changes in people's behavior, processes, and policies, which can significantly increase efficiency and effectiveness, one of which is in corporate contract management. This bottom-up and user-centric approach distinguishes MyTEnS from similar applications, particularly global Enterprise Resource Planning (ERP) applications with limited customization. The user experience aspect will be considered when designing solution ideas to create memorable interactions for users (Mootee, 2013)and to meet the usability, usefulness, and emotional impact aspects (Hartson & Pyla, 2012). During the testing phase, the heuristic evaluation method will be used to assess the solution's usability and impact on the business.

2. LITERATURE REVIEW

Existing references have identified several methods to implement digital transformation. The study (Vendraminelli, et al., 2022) explained that the digital transformation process can be divided into three stages: Understanding reality, defining a digital transformation strategy, and converting the digital transformation strategy into a digital project using a human-centered design (HCD) approach. The HCD's application for innovation is driven by design thinking to overcome various challenges (Mike, 2016). The Design Thinking method is a comprehensive method of creative problem-solving that involves the user in a thought process and prioritizes the user's perspective in the problem-solving process (Brown, 2008). Design thinking is a significant organizational breakthrough that has become widely accepted as one of the most effective approaches to solving complex problems (Mount, 2020).

In the design field, (Darmawan, et al., 2022) combine design thinking and user experience design methods in developing information systems that consider user experience aspects. In common practice, IBM has developed design thinking into iteratively better product development (Eickhoff, et al., 2018). User Experience is all the effects felt by users when interacting with a product (Mejtoft, et al., 2019). Another opinion states that User Experience (UX) increases user satisfaction, pleasure, needs, and engagement with the interaction of a product. User Experience (UX) is concerned with studying, designing, and evaluating the experiences by using or encountering a system (Roto, et al., 2011). However, due to the influence of the user's personal opinion, it is necessary to involve field studies using the usability method and testing real users to improve the user experience (Ritter & Winterbottom, 2017). There are perspectives from different users that support the relation between user experience and usability and produce four points of view: (1) usability is part of the user experience, (2) usability is a measure of user experience, (3)

usability is part of usability satisfaction, and (4) user experience and usability complement each other (Hassan & Galal-Edeen, 2017).

Other related works from Thyvalikakath compare heuristic evaluation and usability testing methods. The result describes heuristic evaluation identified an average of 50% of empirically determined usability problems. The most prominent usability metrics have been derived from the ten usability heuristics for user interface design developed by Nielsen (Nielsen, 1994) (Nielsen, 2005). Nielsen's heuristics include ensuring "Visibility of system status; Match between the system and the real world; User control and freedom; Consistency and standards; Error prevention; Recognition rather than recall; Flexibility and efficiency of use; Aesthetic and minimalist design; Helping users recognize, diagnose, and recover from errors; Help and documentation" (Nielsen, 1995). Heuristic evaluation is difficult to perform with a single evaluator because one person cannot identify all usability issues in an interface. Therefore, 3-5 experts should be used as evaluators to achieve optimal results (Molich & Nielsen, 1990). The agreement rate from real end users with the HE's results was at a medium level. Therefore, in some areas, the evaluator's perception while using this method is not consistent with the user experience with a system (Khajouei, et al., 2018).

3. METHODS

In this research, we chose a qualitative-empirical approach to investigate the interactions of multiple users and stakeholders during digital transformation in enterprise contracts. Generally, qualitative-empirical research helps to develop a more in-depth understanding, generating new insights into emerging phenomena (Bettis, et al., 2014). This study was conducted at one of the largest state-owned enterprises and telecommunication companies in Indonesia which is listed on the IDX and NYSE. This company provides consumer, enterprise, and wholesale services throughout Indonesia. This research focuses on enterprise contract issues at these companies using a design thinking approach. The five stages of Hasso-Plattner's Design Thinking model were used in this study: empathize, define, ideate, prototype, and test (Hasso, 2010) combined with other methods shown in Figure 1.

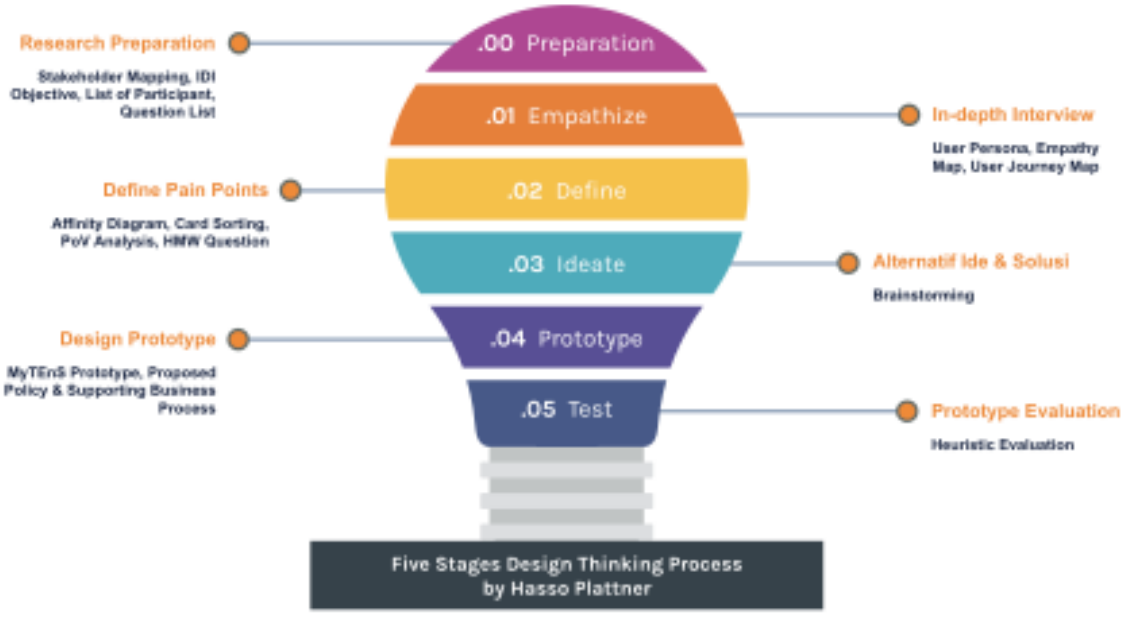

Figure 1. Research Methodology

At the empathize stage, qualitative data is collected through in-depth interviews with previously identified users and stakeholders involved in the enterprise contract process. In-depth interview results are visualized in user personas that represent users (Tonkinwise, 2017), empathy maps to identify user needs and gain new insights about users (Beims, 2021), and user journey maps to view user activities at various points in time (Liedtka, 2014). At the define stage, the previous process's information on pain points, gains, and user needs was synthesized and formulated into the How Might We Question. A brainstorming process is carried out during the ideation stage, after which a prototype of a feasible idea is created. The prototype's usability level was evaluated using a heuristic evaluation involving three experts during the testing stage (Nielsen, 2005).

4. RESULTS

The first stage in design thinking is empathy, which is the stage in the data collection process that involves exploring the problems and behavior of users and stakeholders involved in the company's contracting process through an in-depth interview process. The results from in-depth interviews will be visualized into user personas, empathy maps, and user journey mapping. Of the 15 respondents involved in the in-depth interview process, the authors synthesized and grouped them into several types of user personas including Account manager (AM), Administration Support, Legal Team, Management, and Customer as shown in Table 1.

Table 1. User Persona and Empathy Map

User Persona	Empathy Map
Persona 1 (Indra) is a 37-year-old account manager with ten years of work experience. His job as account manager is to build relationships with customers and meet customer needs. The goal in the contract process is to meet sales targets, so he gets a performance bonus.	Indra believes that the contract is an important step toward meeting the sales target. He was frustrated because there were frequent changes to contract templates without notification, old contracts were not well documented, reviews and signatures took approximately two weeks to three months, and Unable to monitor review progress. As a result, rather than receiving customer complaints, Indra frequently helps to follow up with the internal team. Meanwhile, he feels supported by the existing support team, and the high-value contracts handled allow him to meet the sales targets. He hoped the contracting process would be simple, quick, and transparent.
Persona 2 (Odi) is a 30-year-old Administration Support with six years of experience. As administration support, she has a responsibility to help AMs and segments to solve administration issues such as contract drafting and contract review follow-up.	Odi is motivated to ensure that work runs smoothly and completes documents on time. She felt confused by the rigid internal policies. Furthermore, she was annoyed by the lengthy review process, especially since AMs was bombarding him with questions. He feels the current communication is ineffective, so he has many private WhatsApp and Telegram groups to discuss contract issues. She also often has difficulty finding master contract documents to refer to because they are not stored properly. Odi is pleased that she can easily reach AMs and the legal team. She hopes that contract documents and their supporting materials can be managed properly through digital repositories and that the company should provide an official media to facilitate the contract communication process.

User Persona	Empathy Map
Persona 3 (Lala) is a 38-year-old legal manager. Lala is known as a conscientious and critical person. As a legal, she focuses on compliance and company policies. She has goals to maintain the effectiveness and compliance of enterprise contracts, especially with customers.	Lala is motivated to establish contracting standards and proportional policy proposals. She is frustrated because the revenue earned is frequently corrected during audits because the contract documentation is still a mess. She and the legal team also struggled to review custom contract documents quickly because the team was already overloaded, while legal needed to provide an analysis of the risks associated with each contract reviewed. From the existing process, high-value contracts contribute significantly to the company's revenue. Lala hopes to get an additional team to speed up the review process, and policy support from the directorate and management to simplify the contract process while still meeting compliance.
Persona 4 (Yudi) is a 42-year-old management in the enterprise directorate. He and the team have a task to formulate the right policies in the company's digital transformation efforts by maintaining compliance and prioritizing risk mitigation.	Yudi is concerned about increasing the profitability of every transaction made by the company in the contract process. Because many of the profitability problems facing enterprises today are caused by misunderstandings in contract documents, Yudi and his teams are concerned about creating a new mechanism to increase transparency, efficiency, and contract compliance. He feels frustrated because the current regulations are very rigid, and it takes a long time to formulate a new policy because it requires approval from various parties. He also found obstacles to implementing new policies with change management activities. However, he is optimistic about the support from directors and the government for the company's transformation efforts. He hopes to get a lot of input from the operational level to implement policy innovations and supporting tools in accordance with the ongoing business processes and policies.
Persona 5 (Fitri) is a 46-year-old stakeholder on the customer side who is a state-owned company in the property sector. Her job is to find partners who have solutions and services according to the company's business.	Fitri is motivated to get contracts on time to meet corporate needs provided by partners quickly. She was frustrated during the contract process because the contract process at PT XYZ was long and rigid. Furthermore, there are numerous revision processes and requirements from PT XYZ. She also regretted the service suspension because there was no notification when her contract would expire. However, she was lucky because he had excellent communication with PT XYZ's account manager so she could carry out the parallel installation process with the contract process. He hopes that the contract process will go faster and get guarantees from PT XYZ regarding the delivery process and service quality.

Five key personas are involved in the enterprise contract process, according to the user persona and empathy map in Table 1. Figure 2 visualizes a user journey map that contains the sequence of activities performed by each user personas during the contract process, which includes the stages of preparation, review, signing, and post-contract.

Figure 2. User Journey Map

At the define stage, we collect information at the empathize stage and synthesize the paint point, gain, and user needs. The synthesis process results in 13 How Might We (HMW) questions from the user's perspective, as shown in Table 2.

Table 2. Point of View and HMW Question

No	Paint Point	Point of View (User Needs)	HMW Question
1.	The review process is long (approximately a month) because the process is still serial and there is no progress information.	A fast, easy, and transparent review process.	How to make a fast, easy, and transparent review process?
2.	Contract signing process takes a long time (around two weeks to a month).	Transparency of the signature process, fast and simple signature mechanism.	How to provide a fast, simple, and transparent signature process?
3	Internal rules are rigid, and difficult to implement new policies.	simple, easy, and compliant contracting policies.	How to implement simple, compliant, and easy policies in the contract process?
4	Communication during the contact process uses personal media (WA/Telegram), so personal media is mixed up with work tasks	Centralized and documented media of communication during the contract process.	How to provide easy and documented centralized communication during the contract process?
5	Old contract document data is not well documented, making it difficult to find in contract amendments or audits.	digital contract documents repository that can be accessed by specified AM or legal team.	How to provide a repository of digital contract documents that can be accessed by AM and legal teams?
6	AM and customers don't know the contract will expire, so the service is isolated/still active when the contract expires.	The end of contract information can help customers to reduce service termination, and minimize company losses when	How to provide information to AM and the customer when the customer's contract is about to expire?

No	Paint Point	Point of View (User Needs)	HMW Question
		services are still active after contract has expired.	
7	The contract numbering system is inaccurate, and the process is still manual.	A simple and centralized numbering process is required.	How to make the contract numbering process simple and centralized?
8	During an audit, revenue is frequently subject to correction.	Contracts are one of the audit documents that often cause corrections to revenue recognition.	How to mitigate and minimize corrections during an audit of contract documents?
9	The standard contract templates change frequently and aren't well-informed to AMs.	Updated Contract template information according to the required format during the drafting process.	How to provide up-to-date contract template information during the drafting process?
10	The custom contract process is time-consuming and requires considerable review and communication efforts.	High-value contracts often require customization.	How does the contract customization process be streamlined so that it can run smoothly and quickly?
11	The drafting process requires a little more time than usual.	AM and administration support can complete the drafting process quickly.	How to make the contract drafting process easy and fast?
12	The staffing index is unbalanced, and the region's coordination flow lacks awareness from the head office.	Enterprise functions in the region are not directly in the enterprise directorate, but only using the coordination line.	How to set up an effective organization for enterprise functions in the region?
13	AMs are unaware of any changes in standard service rate which are highly dynamic and vary greatly across regions and locations.	Information on standard service rates when drafting contracts and service configurations in multiple locations.	How to provide standard service rate information and service configurations in multiple locations on contract drafting?

The ideate stage produces 158 ideas divided into various aspects of business process management. Ideas that fall into the technology category are compiled into prototypes of MyTEnS features, while those that fall into the people, process, and policy categories will be included in the policy proposals. Some examples of prototype designs are shown in Figure 3.

(a) Document & Review process tracking

(b) Review Information and Notification

(c) Chat on specified contract

(d) Final document using e-sign & e-seal

Figure 3. Prototype Design Illustrations

To use the e-contract feature prototype designed in the MyTEnS application running optimally, several changes to business processes are required, which the authors believe are necessary to submit to management. Due to MyTEnS being used following relevant business processes and policies, we propose several policy and business processes changes as follows:

a. Use of digital contract documents by utilizing e-signs and e-seal
b. Implementing digital document history for audit transparency
c. Standardize the contract review process in the region to involve a team from the head office
d. The collaborative review process replaces the tiered review mechanism.
e. MyTEnS as a single app to generate contract numbers.

During testing, heuristic evaluation was used to make decisions on more than 100 prototypes while evaluating three experts with the results shown in Table 3.

Table 3. Heuristic Evaluation Result

10 Usability Heuristic	Total Finding	Severity Rating
1. Visibility of system status	5	2
2. Match between system and the real world	0	0
3. User control and freedom	2	3
4. Consistency and standards	5	2
5. Error prevention	2	2
6. Recognition rather than recall	0	0
7. Flexibility and efficiency of use	7	3
8. Aesthetic and minimalist design	6	2
9. Help users recognize, diagnose, and recover from errors	0	0
10. Help and documentation	2	2

The heuristic evaluation results in Table 2 show that the MyTEnS e-contract feature has a minor severity problem in terms of visibility of system status, consistency and standards, and aesthetic and minimalist design. Furthermore, there are several major issues with the principles of user control and freedom and flexibility and efficiency of use that must be solved immediately.

6. CONCLUSIONS

In this study, we discovered five key personas with unique needs and behaviours based on each job to be done. According to the observations, 13 critical issues were discovered, with the long time and invisible review process, manual signature process, and rigid internal regulations being the top three pain points that need to be solved. As a result, we propose design solutions such as document tracking and review processes, review deadline information, chat features for centralized communication, periodic notifications, digital document with e-sign, proposals policies on the use of digital documents, and collaborative review were designed. During the testing stage using heuristic evaluation, the e-contract feature on MyTEnS as a tool for the enterprise contract process obtained an average severity of 2 (minor problem). These results show that the designed prototype met the needs of the user, but some minor improvements should be created in the next iteration. The ideas and solutions generated in the design thinking process related to enterprise contracts in the MyTEnS case can be widely applied, especially in cases that require an effective review process. We also underline that research using the design thinking method requires high flexibility to accommodate the insights obtained during the research process. Researchers should avoid making a lot of assumptions because solutions are frequently unpredictable.

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ANALYSIS CONTROL OF SPARE PARTS INVENTORY IN HEAVY EQUIPMENT REPARATION COMPANIES

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ABSTRACT

The control of spare parts in a repair company, especially spare parts, is not the same as that of a manufacturing company in general, it needs a separate approach according to the existing problems. In the initial observation and data collection, the phenomenon of out of stock, especially in the electrical and instrumental categories, often occurs and significantly affects maintenance activities. The purpose of this research is to be able to determine the optimal number of order quantities and reorder points and provide recommendations for improvements to reduce stock outs and/or reduce the cost of spare part inventory. In this study, the selection of spare parts was carried out using the ABC method, then the data was calculated by ADI-CV to determine the demand pattern matrix that occurred. The periodic review (R,S) method policy was chosen to determine the order quantity, reorder point (ROP) and total inventory cost. In calculating the Monte Carlo simulation approach can't be used to analyze inventory performance, then in this study using the Croston method for recommendations for inventory improvement. The main result of this study is to determine corrective actions for spare part inventory in order to reduce stock out and or inventory costs. Based on the results of spare part inventory control calculations in heavy equipment repair companies using the periodic review method, the service level value is 50% higher than the existing condition.

Keywords: Periodic review (R, S), ABC classification, Monte Carlo simulation, Croston Methods, Inventory control of spare parts, *Service level.*

1. INTRODUCTION

Inventory is one of the fundamental problems in company. Even in a trading company trade or reparation company services, inventory is a significant portion from flowing asset on a wide range of business (Rajeev, N. 2008). Inventory is one of the factors that determine the cash flow of some company. Cost of goods in inventory ranging from 20 to 40 percent owned by the company (Atkinson, C. 2005).

In the era of the Covid-19 pandemic, many companies got bankrupt because existed regulation from government with lockdown and limit of movement. This phenomenon resulted the companies to bankrupt because they have no capable to increase the quality company and look after the stability of cash flow in company.

PT. X is a company in MRO (Maintenance, Repair and Overhaul*)* business. In an effort maintenance, happens often a hidden cost which if no quick respond to handle, it could lower the profit gained by the company. Some example phenomenon cost maintenance becomes hidden costs is an activity procurement spare parts increase rapidly, however profit acquired by the company is not increased as well. This phenomenon often happens in business maintenance because if there is an over stuff, it could cause some high cost in storage (holding cost) meanwhile often happen the lack or *stockout* could have negative impact to quality performance operational companies (Porras & Dekker, 2007).

This research focusses on inventory control of spare parts with considering the ABC classification model at PT. X. The ABC classification model was used to get priority level from spare parts. Inventory control is using the continuous reviews (s,Q) method and periodic review system (R, T). It is hoped that the output of this research can minimize the unavailability of MRO (Maintenance, Repair, Overhaul*)* heavy spare parts supplies so as to minimize the total cost of inventory at PT. X

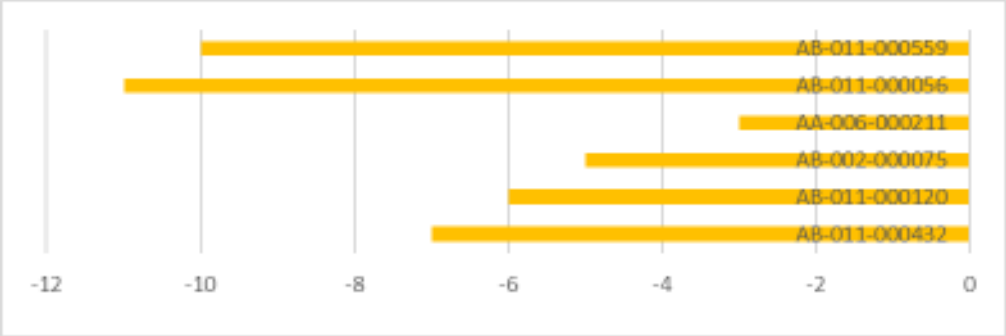

Figure 1. Actual Condition (Stock Out) for Electrical and Instrumentation Spare Part

2. LITERATURE REVIEW

Arismawati, and partners (2016), conducted research on companies engaged in distribution, after sales service and motor vehicle retailers. The problem that occurs is the high demand for material accessories for the period of June 2014 - January 2015 but it is not balanced by material inventory in the warehouse which causes stockouts in the warehouse. The stockout problem occurs because there is no inventory policy, including the absence of determining the amount of safety stock to dampen fluctuations in demand. In her research, she developed an inventory policy for the company. This includes calculating the total cost of inventory and the amount of safety stock. The method used is periodic review (R,s,S).

Research conducted by Hanissa & Aini (2019) and Imran & I. Vanany (2020) is the basis for supply planning in this study where demand is intermittent or lumpy and requires a separate approach. This research discusses from the point of view of a distributor company with several product items that must be ordered from suppliers to meet customer demand.

3. METHODS

The first step doing a literature study, this is used as a reference for concepts and theories that are relevant and can be used to solve problems and achieve research objectives. For literature studies, a literature search related to research is carried out either through books, journals, or research that has been done before, especially regarding spare part inventory control.

Then a field study was carried out. Where for field studies carried out direct observation at PT. X. Observations made are observing and understanding the process of procurement and

management of spare parts in the company. After the problems within the company are identified, then data collection is carried out which will later be used in research. Data collection was carried out by obtaining secondary data in the form of historical data on the supply of electrical spare parts and data in the form of interviews with PT. X.

In the first data processing is done by intermittent demand method. After all planning calculations have been carried out, the next step is to analyze the appropriate planning policies. This analysis was carried out with several schemes to see whether the EOQ calculations and the correct SS and ROP determinations could be carried out by PT. X.

Furthermore, general conclusions are drawn from the results obtained or the process of solving the problem, which is accompanied by suggestions for further research development in the future.

4. RESULTS

This chapter will explain the collection and processing of data from the use of electrical & instrumentation spare parts, the classification of spare parts using the ABC method, the calculation of inventory costs using the periodic review (R,S) method, the calculation of total costs and service level.

The calculation is started from collecting real condition of electrical and instrumentation spare part demand for 36 months (January 2017 - December 2019). Furthermore, this data becomes an input for inventory control policy makers using the periodic review (R, S) calculation method. Meanwhile, for the type of instrumentation found there were 20 items spare part category

Table 1. Classification of spare parts at PT. X

		REPORT INVENTORY					
		Warehouse : A	2019/01/01 s/d 2021/12/31				
No	**Code**	**Name**	**Location**	**Qty**	**UoM**	**Price (Million)**	**Klasifikasi**
1	AB-011-000432	SIEMENS;ENCODER INCREMENTAL TROLLEY;1XP8001-1	A	41	PCS	23	A
2	AB-011-000056	EMERGENCY STOP	A	36	PCS	15	A
3	AA-013-000027	BROMMA;CHAIN LOCK DUPLEX 1 1/2IN;BR71520	A	150	PCS	1	C
4	AB-011-000120	SICK;PROXIMITY;IM30-10BPS-ZC1	A	24	PCS	25	A
5	AB-011-000559	BROMMA;SENSOR SLACK ROPE;BR1702972	A	16	PCS	10	A
19	AB-001-000035	STAMFORD;AVR;MX 341	A	300	PCS	3	C
20	AB-004-000211	NMB;FAN;4715VL-05W-B76;24VDC 1.20A	A	171	PCS	0,23	C

Then classify the selected spare part samples based on the ADI – CV values, the results obtained from the ADI – CV calculations will determine whether the inventory calculation policy can use the periodic review method (R,S) or not. Calculation of ADI-CV can be done with the following formula:

$$ADI = \frac{\sum_{N}^{i=1} D_i}{N} \quad \text{.....(1)}$$

$$CV = \frac{\sigma}{\mu} \quad \text{.....(2)}$$

After obtaining the data on the classification of spare parts, the calculation of the ordering cost for each spare part is carried out. The calculation results of order cost calculations can be seen in Table 2.

Table 2. Calculation Cost Order at PT. X

No	Component	Total Cost/Bulan (Rp)
1	Asset	49.800.000
2	Man Power	40.600.000
3	Operational Cost	8.700.000
Total biaya per bulan (Rp)		99.100.000
purchase order/bulan		135
Cost order		734.074

Then the next stage is to calculate the holding costs for each spare part. The calculation results of holding cost calculations can be seen in Table 3.

Table 3. Calculation Holding Cost at PT. X

No	Kode Material	Salary per month (Rp)	Depreciation Asset per bulan (Rp)	Cost of Capital (7%)	Total (Rp/Year)
1	AB-011-000432	14.059	195	1,610,000	19.491.048
2	AB-011-000120	14.059	195	1,750,000	21.171.048
3	AB-002-000075	14.059	195	1,330,000	16.131.048
4	AA-006-000211	14.059	195	2,730,000	32.931.048
5	AB-011-000056	14.059	195	1,050,000	12.771.048
6	AB-011-000559	14.059	195	700,000	8.571.048

Then, calculate the shortage costs for each spare part. The calculation results of shortage cost calculations can be seen in Table 4

. **Table 3**. Calculation Shortage Cost at PT. X

No	Kode Material	Lead Time Average (hari)	Shortage Cost (Rp)
1	AB-011-000432	90	2.160.000.000
2	AB-011-000120	180	4.320.000.000
3	AB-002-000075	120	2.880.000.000
4	AA-006-000211	150	3.600.000.000
5	AB-011-000056	210	5.040.000.000
6	AB-011-000559	90	2.160.000.000

The following is an example of an existing condition calculation performed on a SIEMENS spare part; ENCODER INCREMENTAL TROLLEY; 1XP8001-1 (Material Number AB-011-000432).

$$\text{Holding Cost} = \text{Total Stock} \times \text{Holding Cost}$$

$$= 149 \times 19.491.048$$

$$= 2.904.166.152$$

Cost Order = Total Order (history order) × Order Cost

= 5 × 734.074

= 3.670.370

Purchase Fee = Qty Order × Cost Material

= 41 × 23.000.000

= 943.000.000

Total Cost = Holding Cost + Cost Order + Purchase Fee

= 2.904.166.152 + 3.670.370 + 943.000.000

= 3.850.836.522

$$\text{Service level} = \frac{\text{Total Demand} - \text{Total Shortage}}{\text{Total Demand}} \times 100\%$$

$$= \frac{48 - 12}{48} \times 100\%$$

$$= 75\%$$

The following is the calculation result for inventory cost and service level from six sample data on existing conditions.

Table 4. Inventory Cost Calculation Results and Service Level Existing Conditions

No	Material Code	Holding Cost (Rp)	Cost Order (Rp)	Purchase Fee (Rp)	Total Cost (Rp)	Service Level
1	AB-011-000432	2.904.166.152	3.670.370	943.000.000	3.850.836.522	75%
2	AB-011-000120	2.477.012.616	2.202.222	600.000.000	3.079.214.838	73%
3	AB-002-000075	64.524.192	3.670.370	247.000.000	315.194.562	11%
4	AA-006-000211	32.931.048	4.404.444	351.000.000	388.335.492	6%
5	AB-011-000056	638.552.400	3.670.370	540.000.000	1.182.222.770	29%
6	AB-011-000559	128.565.720	2.202.222	160.000.000	290.767.942	19%

Furthermore, inventory calculations for repair conditions are carried out with periodic review policies (R, S). Calculation of inventory policy using periodic review (R, S) method, formula to use:

$$T = \sqrt{\frac{2 \times S}{D \times H}} \quad \text{.....(3)}$$

$$\alpha = \frac{T \times H}{C_u} \quad \text{.....(4)}$$

$$R = D(T + L) + Z_\alpha \sqrt{T + L} \quad \text{.....(5)}$$

$$N = \alpha D \sqrt{T + L} \left(f(z_\alpha) - (z_\alpha \times \omega z_\alpha) \right) \quad \text{.....(6)}$$

$$R' = D(T + L) + Z_\alpha \sqrt{T + L} \quad \text{.....(7)}$$

Description:

T = time interval between orders
S = cost order for each order
D = demand
H = holding cost
C_u = shortage csot
L = lead time

Z_α = deviasi normal
σ = standard deviation
μ = mean
$f(z_\alpha)$ = cumulative distribution function
ωz_α = probability distribution function

First step of this simulation is to generate random number with Monte Carlo approach. The step
to generate random number are as follows [9]:
- Observe the parameter to be modeled
- Calculate the frequency of each parameter
- Calculate the cumulative frequency distribution and cumulative probability distribution
- Pair the class value of each parameter with random number in the range 1 – 100
- Drag a random number using generate random in Microsoft excel application
- Get the appropriate parameter value by pairing the generate random number

Table 5. Generate Random Number Result for Material No. AB-011-000432

No	R1		R2		R3		R4		R5		R6	
	Random Number	Replica 1	Random Number	Replica 2	Random Number	Replica 3	Random Number	Replica 4	Random Number	Replica 5	Random Number	Replica 6
1	4	0	3	0	80	0	62	0	50	0	23	0
2	39	0	33	0	64	1	50	0	9	0	47	0
3	43	0	42	0	45	0	43	0	47	0	51	0
4	81	3	15	0	83	6	14	0	77	2	18	0
5	56	0	13	0	30	0	95	7	89	3	57	0
6	52	0	82	3	20	0	82	3	67	2	97	7
…	…	…	…	…	…	…	…	…	…	…	…	…
35	55	0	96	7	7	0	5	0	19	0	7	0
36	58	0	82	3	93	7	9	0	79	3	88	3

Next, it is necessary to do a t-test to validate that demand data that have been raised previously in this simulation to check whether or not it is already approaching the real condition. The following are the t-test result.

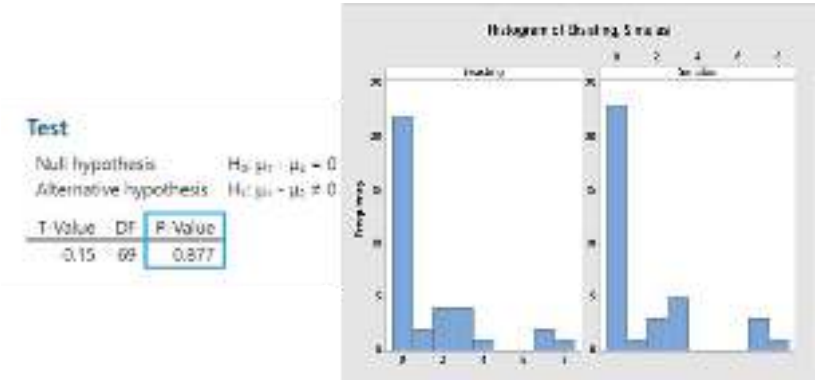

Figure 2. AB-011-000432 spare part validation results

From the results of the Figure 2 above it can be seen that there is a discrepancy that occurs. So the Monte Carlo approach cannot be used. So the next recommendation is to use the intermittent demand approach using the Croston method. The Croston method equation can be done using the following equation:

i. If $Z_t = 0$

$$Z_t = Z_{t-1}, \quad \text{.....} \quad (8)$$

$$P_t = P_{t-1}, \quad \text{.....} \quad (9)$$

ii. If $Z_t \neq 0$

$$Z_t = \alpha D_t + (1 - \alpha) Z_{t-1} \quad \text{.....} \quad (10)$$

$$P_t = \alpha T + (1 - \alpha) P_{t-1}, \quad \text{.....} \quad (11)$$

The combination of the size of the demand quantity and the demand occurrence interval per period can be written using a formula

$$F_t = \frac{Z_t}{\bar{P}_r}, \quad \text{.....} \quad (12)$$

Table 6. Forecasting Value Calculation Results with the Croston Method on Spare Part AB-011-000432

No	Periode	*Demand Aktual*	*Actual Interval*	0.5			*Abs. Scaled Error*	*Squared Error*
				Z_t	P_t	F_t		
1	Jan-19	3	N/A	N/A	N/A	N/A	N/A	N/A
2	Feb-19	2	1	3.00	1	3	1	1
3	Mar-19	2	1	2.50	1.00	3	1	0
4	Apr-19	0	0	2.50	1.00	3	3	6
5	May-19	0	0	2.50	1.00	3	3	6
6	Jun-19	7	3	4.75	2.00	2	5	21
...	...	...	...	...	...	...	...	...
34	Oct-21	0	0	5.06	4.25	1	1	1
35	Nov-21	7	4	6.03	4.12	1	6	31
36	Dec-21	3	1	4.52	2.56	2	1	2

Then do a comparison of the calculation of the level of accuracy on each spare part by changing the alpha value. After obtaining the maximum Croston results, data validation is carried out to find out that the Croston results can be applied. In Syntetos' research (2016) to determine

the accuracy of the Croston method's forecasting, training data and experimental data are needed to determine whether forecasting can be used or not. The steps in validating the Croston method are as follows:

1. Data demand results from Croston are divided into 2 parts, where the training data has an amount of 80% of the distribution of data demand results of Croston and trial data has an amount of 20% of the distribution of data demand results of Croston.
2. On the training data that has been formed, look for the optimal smoothing constant first using the solver menu in the excel application, and calculate MAD and MSE.
3. The optimal constants obtained from the training data are then used for forecasting experimental data, then calculating MAD and MSE
4. If the MAD or MSE of the experiment is greater than that of the exercise, there is an indication of overfitting, then return to determining the smoothing constant. The chosen constant must provide a greater MAD or MSE value for practice than the experiment and the value is not much different between practice and experiment.

Table 7. Results of the Croston Method Modeling Validation on AB-011-000432 spare parts

	MAD		MSE	
	Data Training	Data Testing	Data Training	Data Testing
initiation (0.3)	0.825996166	0.242857143	1.029355993	0.212857143
Optimal (0.124362)	1.077970555	0.267948292	1.511215879	0.252391712

In Table 7 it can be seen that the MAD or MSE in the training data is greater than the experimental data and the results are not much different. So it can be said that the results of the Croston method on AB-011-000432 spare parts are valid.

Recommendations for improvements that will be submitted to the company later carried out using a combination of R and S values. By using the stochastic method and periodic review. The spare parts that will be used in this simulation include the 36 data generated with the Monte Carlo simulation method with 6 replications. This simulation aims to evaluate the proposed policy so that later results will be obtained in the form of inventory parameters, total costs, and service level value. Later, the simulation results of this calculation will be compared with the existing one policies and analyze which policy is better in terms of service level value and total cost. Table 8 shows the calculation results for Material No. AB-011-000432. By performing simulation calculations using the combination of input parameter values (R and S) from Croston's best results is obtained on equivalent parameters value s=9 & S= 16.

Table 7. Results of the Croston Method Modeling Validation on AB-011-000432 spare parts

Percobaan	S	S	Total Cost (Rp)	Service Level
Eksisting	-	-	3.850,836,522	75%
1	7	16	5.871.588.510	90%
2	7	18	6.946.371.028	91%
3	7	14	5.160.852.074	90%
4	9	16	6.163.476.090	91%
5	6	16	5.084.450.546	90%
6	4	16	5.942.418.074	73%

With the same method, for other material result for recommendation of improvement can be seen in Table 8 below.

Table 8. Resume Scenarios for Recommendation for Improvement At PT. X

No.	Kode Material	s		S		*Total Cost* (Rp.)		*Service Level*	
		Existing	*Simulation*	*Existing*	*Simulation*	*Existing*	*Simulation*	*Existing*	*Simulation*
1	AB-011-000432	-	9	-	16	3,850,836,522	6,163,476,090	75%	91%
2	AB-011-000120	-	8	-	14	3,079,214,838	5,132,758,804	73%	88%
3	AB-002-000075	-	2	-	7	315,194,562	2,067,355,406	11%	93%
4	AA-006-000211	-	2	-	5	388,335,492	2,513,395,346	6%	67%
5	AB-011-000056	-	15	-	25	1,182,222,770	3,701,422,096	29%	87%
6	AB-011-000559	-	3	-	8	290,767,942	1,447,864,750	19%	93%

From the above simulation Table 8 above it can be seen that the result show an increase in service level from existing condition. Total cost also raises as result of increasing the service level.

6. CONCLUSIONS

The results of this study indicate that the periodic review simulation value is not only higher service level than the service level in the existing conditions on six electrical and instrumentation spare parts at PT. X, but also an increase in total cost due to an increase in the number of orders and the amount of stock to reduce shortages. The limitation of this research is that this research does not take into account the age of the equipment as well as major maintenance periods. Therefore, future research can take into account the age of the equipment and consider the main maintenance period of the company was scheduled annually.

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INVENTORY MANAGEMENT FOR STEEL MATERIAL AT SHIPYARD REPAIR COMPANY

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ABSTRACT

In the ship repair industry, fulfilment schedule repair is very important because ships operations stop temporarily during repair. The repair process based on scope of work requires the availability of steel raw materials to reach target repair time. PT.BGN is a ship repair shipyard that focuses on barges and tugboats, therefore steel material is one of the critical materials in shipyard inventory. Existing material management with the material replenishment system used in the previous project was not sufficient to meet the steel material needs. Delays in project completion due to material delays have contributed 19% of the total project during 2021. Forecasting is carried out in this study to get the amount needed in the future. Considering demand in ship repair industry does not influence trend and unseasonal, forecasting time series methods, weighted moving average and exponential smoothing were chosen in this study by using the historical use of steel material as the data that is processed in forecasting. The results of the forecasting are then carried out by calculating the Economic Order Quantity to get the optimum amount of steel material purchases and avoid stockout. This research produces an optimal inventory strategy in shipyard repairs that focuses on construction.

Keyword: Economic Order Quantity, Forecasting, Inventory management, Shipyard repair.

1. INTRODUCTION

In the shipping industry, shiprepair is one of the matters that cannot be separated in that it has an important role in supporting the smooth maritime supply chain. The shiprepair industry on the Barito River is mostly focused on repairing the construction of barges and tugboats so that the need for steel material becomes one of the main ingredients in the ship repair business. The operational condition of coal barges which are prone to collisions and corrosive environments makes most of the repair work for barge-type vessels in the construction sector. In the process of obtaining steel materials, shipyard repair is faced with uncertainties in the amount of material that must be stored and lead times which can be disrupted due to geographical factors. Uncertainty in the procurement process is one of the reasons for the need for a procurement and storage strategy for steel materials to minimize costs incurred.

It is difficult to precisely estimate the parts of the construction that require repair in underwater areas, so forecasting needs to be done to estimate the material requirements used for underwater construction. To carry out ship repairs requires various types of materials and components, the demand for these materials occurs when repairs are carried out on ships at the docks in ship repair yards, that is, in general, at random times. Petrov (2019).

Research on optimization in the management of material or spare parts inventories has been carried out, including by Pang, H.E et al (2019) and Roslin, E.N (2015) with the forecasting method and Economic Order Quantity, namely an approach method that calculates the number of fixed orders with a minimum total cost . Research on steel materials in the shipyard industry has not been carried out in previous studies so that through this research it is hoped that it can become a research object that can contribute to the ship repair industry.

2. LITERATURE REVIEW

2.1 Inventory at Ship Repair Yard

Shipyard operations are very dynamic where the scope of repair work is often uncertain, repair work is not known from the start and many repair items are identified during shipyard inspections (Makris et.al, 2005). Uncertainty in the scope of work means that the demand for a constituent material for ship repair can be said to be uncertain. Ship repair yards that focus on construction improvements have challenges in managing steel materials as the main constituent material.

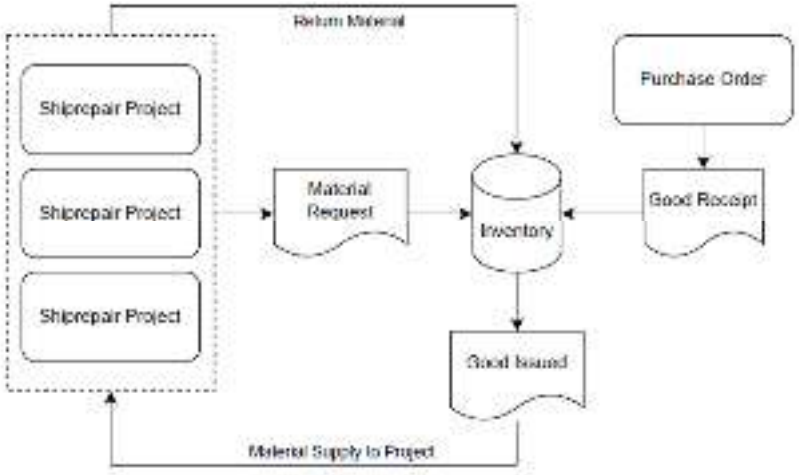

Figure 1. Flowprocess steel inventory in ship repair project

2.2 Forecasting

Decisions in ordering materials are often made without knowing what will happen in the future so that orders made have the risk of not being able to meet demand or storage that has accumulated. Efforts made to minimize the risk of overordering which can lead to stockpiling or failure to meet demand are always made by decision makers within the company. forecasting demand is one of the efforts to estimate how much demand will be in the future.

2.2.1 Weighted Moving Average

The weighted moving average model, like the moving average model, has an advantage over other forecasting models in that it does smooth out peaks and troughs (or valleys) in a set of observations. It is not all that useful as a medium-long range forecasting tool. It can only reliably be used to forecast a few periods into the future (Kapgate,2014)

$$WMA_n = \sum_{i=1}^{n} W_i \, x \, D_i \qquad (1)$$

Where:

W_i = *Weighted* at period *i*
D_i = *Demand* at period *i*
n = number of periods

2.2.2 Exponential Smoothing

Exponential smoothing is is most widely used of all forecasting techniques to forecast the immediate future. This popularity can be attributed to its simplicity, its computational efficiency, the ease of adjusting its responsiveness to changes in the process being forecast, and its reasonable accuracy (Ostertagova & Ostertag, 2012). exponential smoothing is a simple and pragmatic approach to forecasting.

the exponential smoothing equation takes the form of :

$$F_t = \alpha \, . D_{t-1} + (1 - \alpha) \, . F_{t-1} \quad (2)$$

Where :

F_t = Forecast next period
D_{t-1} = Actual Demand
F_{t-1} = Predetermined forecast for the current period
α = Weighting factor / smoothing constant / level smoothing parameter

2.2.3 Error measurement

There are two common measures to summarize the historical error used in this study, MAD and MSE :

1. *Mean Absolute Deviation* (MAD)

$$\text{MAD} = \frac{1}{n} \sum_{t=1}^{n} |X_t - F_t| \quad (3)$$

2. *Mean Squared Error* (MSE)

$$\text{MSE} = \frac{1}{n} \sum_{t=1}^{n} (X_t - F_t)^2 \quad (4)$$

Where :

X_t = Actual at t period
F_t = Forecast at t period
n = Numbers of data ,n = 1,2,3,4, …
t = Period

2.2 Economic Order Quantity

Determining how much material must be purchased to meet the production plan is one of the problems in carrying out inventory management. Purchasing in large quantities will certainly make the inventory value high and uneconomical. Meanwhile, if the purchase in small quantities and in high frequency causes procurement costs to swell.

In using the Economic Order Quantity method, the following assumptions apply:

1. Number of Requests is known, constant and independent.
2. Lead Time (time between ordering and receiving) is known and is constant.
3. Inventory received immediately and completely finished. In other words, ordered supplies arrive one batch at a time.
4. Order Cost is known and has no effect on the number of orders (Constant).
5. Costs incurred only consider the Order Cost and Holding Cost.

EOQ model calculated by :

$$\text{EOQ} = \sqrt{\frac{2D.S}{H}} \quad (5)$$

Where:

D = Demand in one period
Q = The number of units in each order
Q* = Optimum order
S = Order Cost
H = Holding Cost

2.3 Safety Stock & Reorder Point

In managing inventory, we are often faced with uncertainty. Uncertainty does not only come from demand but also supply uncertainty. The uncertainty that arises will affect the amount of safety stock that must be managed by the company. Safety stock's problem is how to find the right time for replenishment of safety stock and setting the appropriate delivery date for replenishment (Caridi & Cigolini, 2011)

The amount of safety stock determined by demand uncertainty is generally formulated as follows:

$$Safety\ Stock = Z\ x\ \sigma\ x\ \sqrt{LT} \quad (6)$$

Where :

Z = *Service level*
σ = *Standard Deviasi*
LT = *Lead Time*

The goal of the reorder point model is to ensure that the request for new inventory items materialises before the current inventory level drops to zero.(Inegbedion et al,2019)

3. METHODS

Steel demand is collected from the 2020-2021 period and then forecasted using two methods, namely weight moving average and exponential smoothing. Forecasting results are calculated error rates and the smallest error is taken to calculate the EOQ value.

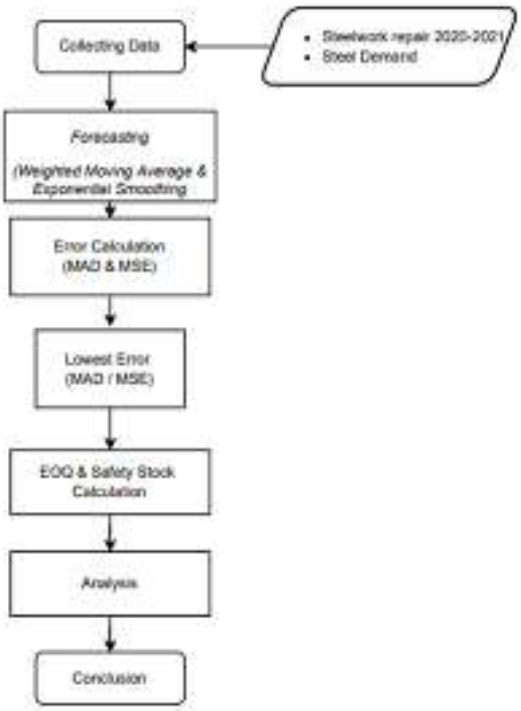

Figure 2. Research methodology

The safety stock value is calculated to be compared with the safety stock value currently used in the company. Inventory costs are taken from the costs borne by the company in maintaining its safety stock. Analysis is carried out on the results of forecasting, which forecasting method gives a small error value and what is the impact of using safety stock based on the calculations in this study.

4. RESULTS

The results of forecasting are not always accurate, in this research shows that forecasting results have different errors for each material. The results of forecasting with both methods were smaller errors for AB 150x90, AB 100x100, AB 80x80, PL 8MM, PL 10MM materials with smaller errors with the weight moving average, while the AB 150x150, AB 120x120 and PL 12MM materials are smaller with exponential smoothing.

Table 1. Forecasting using Weight Moving Average and Exponential Smoothing

Material	Weighted Moving Average		Exponential Smoothing		Error Minimum
	MAD	MSE	MAD	MSE	
AB 150x90	9.295	191.585	9.303	171.013	WMA
AB 150x150	10.345	191.046	8.780	151.095	ES
AB 120x120	13.275	268.706	11.361	218.680	ES
AB 100x100	21.880	767.483	23.383	871.037	WMA

AB 80x80	9.210	211.564	10.068	211.505	WMA
PL 8MM	4.415	30.404	4.502	31.185	WMA
PL 10MM	7.570	128.319	7.929	120.871	WMA
PL 12MM	12.780	276.211	12.628	262.245	ES

Table 2. EOQ Calculation

Material	Unit Cost	Holding Cost	Demand (F)		EOQ
			Total	Average	
AB 150x90	Rp 2,459,896.46	Rp 737,968.94	318	16	29
AB 150x150	Rp 2,460,000.00	Rp 738,000.00	286	12	28
AB 120x120	Rp 1,439,697.31	Rp 431,909.19	536	22	50
AB 100x100	Rp 1,052,715.82	Rp 315,814.75	879	44	75
AB 80x80	Rp 738,752.52	Rp 221,625.76	240	12	46
PL 8MM	Rp 11,606,922.51	Rp 3,482,076.75	99	5	8
PL 10MM	Rp 13,125,171.09	Rp 3,937,551.33	245	12	11
PL 12MM	Rp 15,680,183.37	Rp 4,704,055.01	541	27	15

Table 3. Comparison of Inventory cost

Material	SS *Existing*	SS (F)	ROP (F)	Inventory Cost		*Saving* %
				Existing	ROP	
AB 150x90	125	19	33	Rp 399,733,175.25	Rp 104,310,212.67	73.91%
AB 150x150	150	20	32	Rp 479,700,000.00	Rp 101,331,062.40	78.88%
AB 120x120	150	26	49	Rp 280,740,975.75	Rp 90,871,082.03	67.63%
AB 100x100	200	47	84	Rp 273,706,113.96	Rp 114,410,092.67	58.20%
AB 80x80	50	23	33	Rp 48,018,913.80	Rp 31,635,223.41	34.12%
PL 8MM	20	7	12	Rp 301,779,985.33	Rp 174,785,133.71	42.08%
PL 10MM	60	16	26	Rp 1,023,763,344.90	Rp 446,736,584.54	56.36%
PL 12MM	60	25	48	Rp 1,223,054,302.95	Rp 973,241,798.51	20.43%
				Rp 4,030,496,812	**Rp 2,037,321,190**	49.45%

The results of the calculation produce a lower cost value for all materials with a value for AB 150x90 material, the savings obtained are 73.91% while for AB 150x150 material you can save 78.88%, for AB 120x120 material you can save 67.63%, for AB 100x100 material can save up to 58.20%, for AB 80x80 material you can save up to 34.12%, for PL 8MM material you can save up to 42.08%, for PL 10MM material you can save up to 56.36%, and PL12MM can save up to 20.43%.

4. CONCLUSIONS

From this research it can be concluded that forecasting helps in predicting future needs. The result of forecasting still needs to be reviewed continuously to improve the accuracy of forecasting. Earlier demand information can help the planning department in the company to respond to forecasting results. Using EOQ, safety stock and ROP shows savings in the value of steel material inventories. Further research on inventory management with the object of the ship repair industry is still needed and possible to develop. The use of software in inventory management is expected to be part of further research.

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SELECTION OF PRIORITIES FOR TOURISM DEVELOPMENT USING ANP AND TOPSIS

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ABSTRACT

PT ABC is a State-Owned Enterprise engaged in the development and management of Tourism Areas. The problem faced by the company is not having yet a decision-making method for select priority tourism areas to develop. This study aims to identify and determine the criteria and sub-criteria and to select the best alternative. A Combination of the ANP and TOPSIS methods is used. Questionnaires were distributed to several respondents, and the data was used to calculate the weight of each criterion using the ANP method assisted by Super Decision Software, while calculating the ranking of alternatives was conducted using the TOPSIS method. There are 8 Criteria and 15 sub-Criteria. The criteria and the weight of each criterion are Social, Geographical Conditions, Characteristics, and Image (0.201), Proximity to Public Facilities criteria (0.031), Basic Infrastructure (0.141), Tourist Attraction (0.157), Accessibility and Cost (0.136), Development Impact on the Environment (0.085), Competitor (0.082), and Project Cost (0.133). Based on the weight of each criteria and sub-criteria, an alternative ranking was carried out using the TOPSIS method and the results are the priority is Tana Mori, West Manggarai Regency (0.895), the second is Likupang in North Sulawesi (0.406), and the third Menjangan in North Bali (0,124).

Keywords: Tourism Area, ANP, TOPSIS.

1. INTRODUCTION

Tourism is a major growth industry in the world. Worldwide, tourism employs more people than any other single industry sector and makes a significant contribution to the economy of nearly every country, Ioppolo. et al. (2013). With more than 17,000 islands, the second longest coastline in the world, 300 ethnicities, 250 languages, and a tropical climate all year round, Indonesia is one of the main tourist destinations for foreign tourists. With these natural resources, the tourism sector is an important element of the Indonesian economy and an important source of foreign exchange.

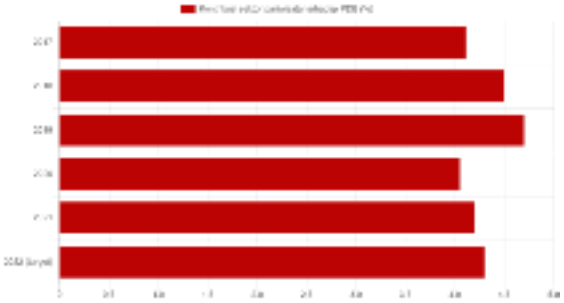

Figure 1. Tourism sector contribution to GDP (Ministry of Tourism and Creative Economy, 2021)

Currently, the government wants to maximize the potential of the tourism sector because it not only contributes to foreign exchange but also improves the standard of living and welfare of the surrounding community to provide benefits for tourism development companies in developing their business. PT ABC is a State-Owned Enterprise (BUMN) engaged in the development and management of tourism areas. The tourism area currently being developed by PT ABC is based on an assignment given by the government of the Republic of Indonesia. Referring to PT ABC's new Mission, namely "Synergizing with the Government, SOEs, and other agencies in developing tourism destinations at home and abroad", and currently PT ABC does not yet have a decision-making approach method for selecting alternative tourism areas, it is necessary to think about an appropriate decision-making method if simultaneously there are several tourism areas proposed by the government, BUMN, or other agencies to be developed, so that which tourism areas can be prioritized which will be developed first.

The ANP method was chosen in this study because it can be applied to multi-criteria problems in which there are interdependence and outer dependence relationships. ANP allows for feedback that cannot be done in the Analytical Hierarchy Process (AHP) and can model a system with feedback where one level may dominate or be dominated, either directly or indirectly. The TOPSIS method is an approach to solving multi-criteria problems. This method assumes that each attribute has a monotonic increase or decrease in utility. This makes it easier to find the ideal solution and the negative solution. The TOPSIS method is used in this study because ranking with the TOPSIS method will be easier when compared to the ANP method which requires a large number of pairwise comparisons if there are also many alternative input data.

2. LITERATUR REVIEW

Decision Making

In the decision-making analysis process, criteria are needed before deciding on a choice from the various available alternatives. Criteria show the problem definition in a concrete form and are sometimes considered as goals to be achieved. The decision-making method used is known as MCDM. Multi-criteria decision-making (MCDM) is a decision-making method for determining the best alternative from several alternatives based on certain criteria. The implementation of the MCDM method has been widely used both in studies that are policy formulation and strategy formulation or at the operational scale policy level such as the selection or evaluation process, supply chain management, and performance measurement including in the tourism industry. Morteza. et al. (2016) conducted research regarding the selection of optimal tourist sites on Qeshm Island within the Integrated Coastal Zone Management framework using a combination of ANP and Fuzzy TOPSIS methods. ANP is used to analyze the structure of the tourist location selection problem and determines the weight of the criteria, while the Fuzzy TOPSIS method is used to get the final priority of the alternative. From the research conducted, it was concluded that the combination of ANP and Fuzzy TOPSIS methods has significantly increased efficiency in the decision-making process. This study also explained that researchers are advised to use modern scientific methods such as a combination of ANP and TOPSIS. Another research is Hamurcu. et al (2018) used a combination of the ANP and TOPSIS methods in selecting or getting the best monorail route out of 8 alternative routes. ANP is used to get the weight or level of influence of the criteria, and TOPSIS is used to get the best ranking of the available alternatives. The results of this

study indicate that the combination of ANP and TOPSIS can be used to select the best route and determine the relationship between the criteria used to select the best route. The combined application of the ANP and TOPSIS methods Together provides several important advantages such as building relationships, evaluating various factors at the same time and using tangible and intangible criteria.

Criteria and sub-Criteria for Priority Selection for Tourism Area Development

The first step is to identify the criteria and sub-criteria used in the selection of priority areas to be developed. The criteria depend on the company's strategy and developing tourism areas. The criteria were determined from a literature review and discussion with experts. In this study eight criteria and fifteen sub-criteria were obtained, as shown in **Table 1** below:

Table 1. Criteria and sub-Criteria for Priority Selection for Tourism Area Development

No	Criteria	Sub-criteria	Information
1	Social, Economic, Geographical Conditions, and Image of Tourism Areas	Social Conditions	Related to social conditions, geographical conditions, local economic environment, characteristics of tourist sites, and regional image
		Geographical Conditions	
		Characteristics of tourist sites	
		Tourism Area Image	
2	Proximity to Public Facilities		Access and proximity to public facilities such as hospitals, malls, and other public facilities.
3	Basic Infrastructure	Availability of clean water network	Availability of clean water networks, electricity networks, and telecommunications.
		Availability of electricity network	
		Availability of telecommunications and ICT networks	
4	Tourist attraction	Natural object tourist attraction	Mountains, beaches, islands, docks, etc. (Nature). Culturally made: Temples, and others. Artificial tourism: Agrotourism, and others
		Artificial Tourist Attraction	
5	Accessibility and Cost	Distance to nearest Airport	various transportation alternatives, distance to airports, freeways, and bus stations, communication meetings between traffic facilities, ease of traffic routes, parking areas, and costs incurred to reach tourist areas
		Number of Tourist Destinations Around	
		Availability of Transportation (Public Transport)	
		Road Conditions	
		Dock Availability and Conditions	
		Cost	
6	Impact of Development on the Environment		The impact of development on the environment and society

7	competitors		Availability of other tourist destinations in the vicinity, availability of other tourism services.
8	Project Cost		land costs, labor costs, operating costs, transportation costs

3. METODOLOGI

This research was conducted to select priorities for the development of tourism areas. This study used two Multi-Criteria Decision-Making (MCDM) methods, namely the ANP and TOPSIS methods. The ANP method is used to calculate the weight of each criterion and sub-criteria, while the TOPSIS method is used to calculate the ranking of each of the alternatives. From the results obtained, a Sensitivity Analysis was carried out to determine the impact of changing the weight of the criteria on the final result of the calculation. Changes in ranking will be analyzed to then conclude on whether there are sensitive variables that can change the final result of the calculation. Each criterion has its weight value changed so that you can see the changes that have occurred. More detail regarding the flow of this research process is shown in **Figure 2**. The decision-makers (respondents) of this study were company internal and external officials who have appropriate backgrounds and experience in the field of tourism area development and understand the three alternative tourist destinations.

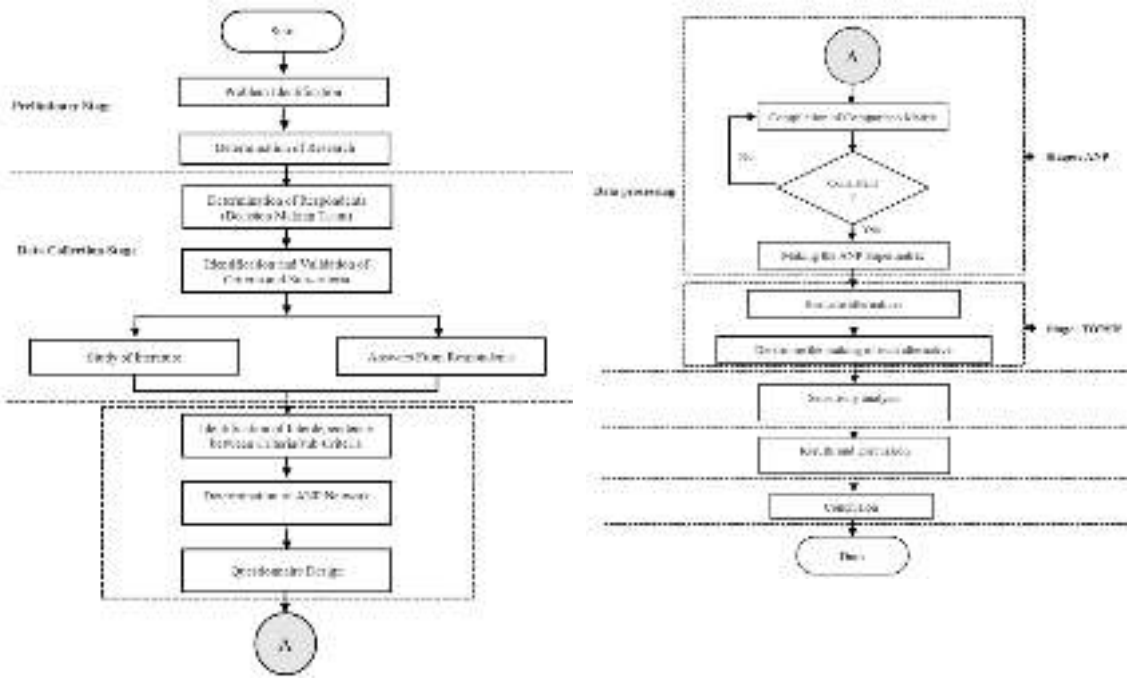

Figure 2. Research Scheme

4. RESULTS

Interdependence between Criteria and sub-Criteria

The relationship between Criteria and sub-Criteria (second questionnaire) shows that there is a dependency between elements. The number of respondents involved in filling out the questionnaire to determine the relationship between the Criteria and sub-Criteria is 5 people, so if in one cell the number of respondents chooses more than 2, then the Criteria and sub-Criteria

are considered related. **Table 2** shows the results of the recapitulation of the respondents' assessments.

Table 2. Recapitulation of Linkage Questionnaire between Criteria and Sub-criteria

Criteria & sub-Criteria			Influenced																	
			A				B	C			D		E						F	G	H
			A1	A2	A3	A4		C1	C2	C3	D1	D2	E1	E2	E3	E4	E5	E6			
Influencing Variables	A	A1	0	0	3	5	1	0	0	0	0	0	0	0	0	0	0	0	1	0	3
		A2	0	0	4	0	0	3	2	2	4	1	0	0	0	1	0	0	0	0	5
		A3	0	0	0	3	0	0	0	0	0	1	1	1	1	0	0	1	0	4	3
		A4	0	1	1	0	1	1	0	0	1	1	0	0	0	0	0	0	1	4	1
	B		0	0	1	3	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1
	C	C1	0	1	1	4	1	0	0	0	0	0	0	0	0	0	0	0	0	1	4
		C2	0	1	1	4	1	0	0	0	0	0	0	0	0	0	0	0	0	1	4
		C3	0	1	1	4	2	0	0	0	0	0	0	0	0	0	0	0	0	1	3
	D	D1	1	0	0	4	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
		D2	1	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	E	E1	1	0	0	4	1	0	0	0	0	0	0	0	0	0	0	4	0	0	2
		E2	1	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
		E3	1	0	0	4	2	0	0	0	0	0	0	0	0	0	0	3	0	0	1
		E4	1	0	0	4	1	0	0	0	0	0	0	0	0	0	0	1	0	0	3
		E5	1	0	0	4	0	0	0	0	0	0	0	0	0	0	0	4	0	0	4
		E6	1	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	F		1	1	1	3	0	0	0	0	1	1	0	0	0	0	0	0	0	1	1
	G		0	0	3	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	1
	H		0	0	1	1	0	2	2	2	1	1	1	1	1	1	1	1	1	1	0

Table 3. Interdependence between criteria and sub-criteria

Clusters	nodes	Innerdependency	Outer dependency
goal			
Social, Geographical Conditions, Characteristics of tourist sites, and Image of Tourism Areas	A		
Social Conditions	A1	A3, A4	H
Geographical Conditions	A2	A3	C1, D1, H
Characteristics of tourist sites	A3	A4	G, H
Tourism Area Image	A4	-	G
Proximity to Public Facilities	B	-	A4
Basic Infrastructure	C		
Availability of clean water network	C1	-	A4, H
Availability of electricity network	C2	-	A4, H
Availability of telecommunications and ICT networks	C3	-	A4, H
Tourist attraction	D		
Natural object tourist attraction	D1	-	A4
Artificial Tourist Attraction	D2	-	A4
Accessibility and Cost	E		

Distance to nearest Airport	E1	E6	A4
Number of Tourist Destinations Around	E2	-	A4
Availability of Transportation (Public Transport)	E3	E6	A4
Road Conditions	E4	-	A4, H
Dock Availability and Conditions	E5	-	A4, E6, H
Cost	E6	-	A4
Impact of Development on the Environment	F	-	A4
competitors	G	-	A3
Project Cost	H	-	-

ANP Network

The three types of network in ANP are innerdependence, outer dependency, and feedback. **Figure 3** indicates the existence of innerdependence and outer dependence. An example of innerdependence is the sub-Criteria of Distance to the nearest Airport with the sub-Criteria of Cost, according to the respondents, the distance to the nearest airport will affect the travel costs incurred by tourists. Outerdependence linkages occur in several sub-Criteria, one of which is the Geographic Conditions sub-Criterion with the Project Cost sub-Criterion, geographical conditions in the form of land contours, and others will affect the costs to be incurred to build a tourism area. Figure 3 below, shows the ANP network from the selection of tourism area development priorities.

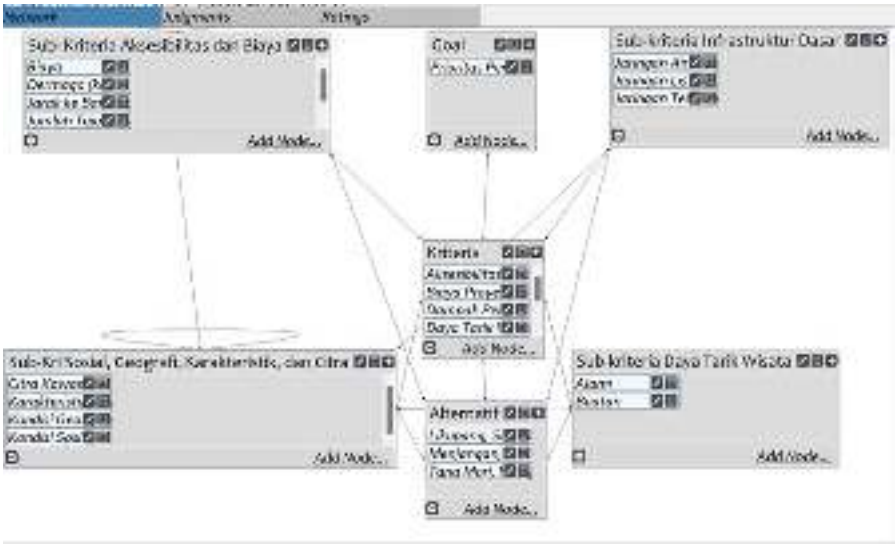

Figure 3. ANP network model with Super Decision Software

Calculation of weight of criteria and sub-criteria with ANP

Comparison value obtained from questionnaire survey to 5 respondents. The questionnaire will first be processed per each respondent. The data processed from each of these respondents produces three matrices that provide a priority order of the most important aspects of the criteria and sub-criteria. To obtain these results, from five (5) respondents in one group the average and mode were calculated. The average value and/or mode are used to determine the order of priority. In carrying out pairwise comparisons, it is necessary to have consistency in the answers of the respondents in filling out the questionnaire where the maximum allowed inconsistency value is 0.1 (Saaty, 2001). The weight of each criterion and sub-criteria are shown in the following **Table 4** following:

Table 4. Bobot Kriteria dan sub-Kriteria

NODE	CRITERIA AND SUB-CRITERIA	WEIGHT
A	Social, Tourism Characteristics, Geographical Conditions and Regional Image	0.201
A1	Regional Image	0.636
A2	Tourism Characteristics	0.201
A3	Geographical Conditions	0.066
A4	Social Conditions	0.090
B	Proximity to the Needs of Public Facilities	0.031
C	Basic Infrastructure	0.141
C1	Clean Water Network	0.393
C2	Electric network	0.349
C3	Telecommunications and ICT Networks	0.248
D	Tourist attraction	0.157
D1	Experience	0.721
D2	Artificial	0.258
E	Accessibility and Cost	0.136
E1	Distance to Nearest Airport	0.221
E2	Number of Tourist Destinations Around	0.106
E3	Public Transport Transportation (Availability)	0.099
E4	Road Conditions	0.167
E5	Pier (availability and conditions)	0.101
E6	Cost	0.260
F	Impact of Development on the Environment	0.085
G	Competitors	0.082
H	Project Cost	0.133

The **table 4** above shows that in choosing a tourism area, the most important aspects or criteria that must be considered are the criteria for Social, Economic, Geographical Conditions, and Regional Image with sub-criteria Regional Image. Regional Image is an aspect related to reputation, image, and popularity, safety and comfort, health and cleanliness, price, cuisine, nightlife, diversity of activities, and recreation. This is following research conducted by Onder. et al (2013) integrated the AHP and TOPSIS methods to evaluate tourism destinations in Turkey and obtained the results that safety and comfort factors, health and hygiene factors, price factors, reputation factors, image, and popularity, and the cooking factor gets the highest weight and is the most influential factor compared to 26 other factors. In addition to the Regional Image sub-criteria, the Natural Tourism Attraction sub-criteria is an aspect that must be considered in choosing a tourism area. The uniqueness and natural beauty that is owned will have a major impact on the progress of a tourist destination. This is also following research conducted by Pratama (2016) that one of the influential factors in the development of a tourist destination is the Attraction to Natural Objects in the form of natural beauty. The uniqueness and natural beauty that is owned will have a major impact on the progress of a tourist destination.

Alternative Ranking with TOPSIS

Figure 4 Explaining the percentage of preferences for the assessment of tourism areas based on TOPSIS. Three alternative tourism areas are assessed based on 8 criteria and 15 sub-criteria. Based on the assessment, the Tana Mori tourism area which is located in West Manggarai has the highest level of preference compared to the other two alternative areas.

These results show that the integration of ANP and TOPSIS is effectively used in selecting priorities for the development of tourism areas.

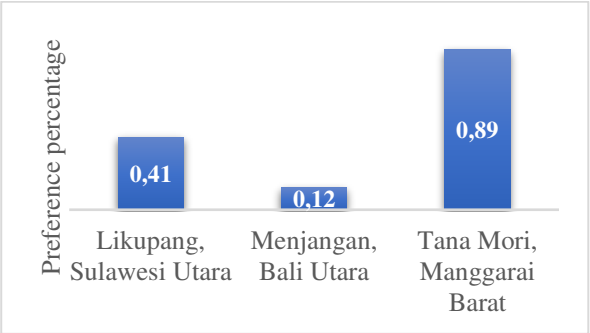

Figure 4. Preference Percentage of each regional alternative

Sensitivity Analysis

From the results of the sensitivity analysis carried out, it was found that changes in the weight values on the criteria and sub-criteria cause changes in alternative preference values, but not all of these changes cause changes in the ranking of the best alternative or alternative. Changes in the weight of the Availability and condition of the wharf sub-criteria, the Distance to the Nearest Airport sub-criterion, the Cost sub-criteria, and the Telecommunication Networks and ICT sub-criteria cause changes in the ranking of the alternatives but do not change the results for the best alternative. Significant changes occur when weight changes are made to the Distance to the Nearest Airport sub-criteria, Road Conditions sub-criteria, Availability of Public Transport sub-criteria, and Proximity to Public Facilities criteria. Change in weight on the Road Conditions sub-criteria to 0.4, 0.6, 0.8, and 1 cause changes to the best alternative produced, namely Menjangan. This is certainly appropriate because the condition of the road that connects the Menjangan area with public facilities is relatively good compared to the other two alternatives. The same thing is also obtained when weight changes are made to the sub-criteria for the availability of public transport and the criteria for Proximity to Public Facilities cause changes in the ranking of alternatives and the best alternative produced. This is because the value obtained by Menjangan in terms of the availability of public transportation and proximity to public facilities is higher than the other two alternatives.

5. CONCLUSION

This study aims to integrate the ANP method and the TOPSIS method into the assessment of tourism area development priorities. The eight criteria used in the assessment and the weight of each criterion are the criteria for Social, Geographical Conditions, Characteristics of tourist sites, and Image of Tourism Areas (0.201), Proximity criteria to Public Facilities (0.031), Basic Infrastructure criteria (0.141), Power criteria Tourism Attraction (0.157), Accessibility and Cost criteria (0.136), Development Impact criteria on the Environment (0.085), Competitor criteria (0.082), and Project Cost criteria (0.133). Fifteen sub-criteria were selected to assess tourism area development priorities. The Regional Image sub-criteria and the Natural Tourism Attraction sub-criteria are the sub-criteria with the highest weight compared to the other sub-criteria. The alternative ranking results with TOPSIS show that the Tana Mori area in West Manggarai gets the highest preference value (0,895), followed by Lukupang, North Sulawesi (0,406), and Menjangan North Bali (0,124). From the sensitivity analysis conducted, the Tana Mori tourism area is still the best choice for development. Furthermore, to avoid future investment risks, it is necessary to repair or increase the access

road to Tana Mori. Apart from that, it is necessary to build public facilities to support the area and also to improve public transportation facilities to and from the Tana Mori area. Companies also need to monitor the selected alternatives to ensure that the selected alternatives can function properly in the long term. These results show that the integration of ANP and TOPSIS is effectively used to assess tourism area development priorities.

This assessment has limitations in terms of criteria and sub-criteria, so it is necessary to conduct a study of more literature so that more Criteria and sub-Criteria are obtained. In addition, integrating other decision-making methods needs to be developed to provide a better solution.

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THE EXPLORATION OF EFFECTIVENESS SCENARIOS OF IMPLEMENTING CONSIGNMENT NOTES (CN) FOR IMPORTED GOODS SHIPMENTS OF INDONESIAN MIGRANT WORKERS THROUGH POSTAL SERVICES WITH THE ANALYTICAL HIERARCHY PROCESS (AHP) METHOD

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ABSTRACT

The process of sending goods for Indonesian migrant workers (PMI) are hindered by several factors, including the lack of quality human resources, and the absence of streamlined regulations that make it easier for PMI to send their goods. These issue range from the criteria for the goods sent, to logistics and customs costs that PMI should bear, and lack of integration in the system from the country of origin to Indonesia. Therefore, this study aims to examine factors affecting the implementation of policies related to PMI shipments. The method used was the analytic hierarchy process (AHP), which determines the overall weighting level of economical, operational, and legal factors including its derived sub-factors. This is followed by the proposed policy-making process and potential solution such as the implementation n of CMR technology and data digitalization, customer education for PMI, and the harmonization of various regulations in relation to consignment notes. The study concludes that international harmonization of shipping policies, particularly concerning the distribution countries of PMI, is necessary for the ultimate benefit of the consignment notes implementation and supply-chain players involved in postal services

Keywords: Consignment notes (CN), Indonesian migrant workers, logistics costs, shipments.

1. INTRODUCTION

The import of consignment goods is governed by Regulation of the Minister of Finance Number 199/PMK.010/2019 which stipulated that imports should new conditions and accompanied by a consignment notes document. However, most goods sent by Indonesian Migrant Workers (PMI) are used products that are not for sale. This presents a challenge as the Organizers of PMI Shipments in the country of origin often have limited knowledge of customs regulation and proficiency in communication technology. This can impede the smooth distribution of the supply chain for consignment goods. The process of importing this shipment from the country of origin requires a complex communication procedure and proficient understanding of the information technology by the organizers. This includes reporting documents to the shipping line and Customs in the country of origin for transportation and departure, as well as technical communication of goods documents notified to the Consignee (recipient).

This research addresses the issue of PMI shipments, which according to the Regulation of the Minister of Trade of the Republic of Indonesia Number 20 of 2021. Specifically, Article 18 paragraph (1) stated that goods should be imported in new condition. However, it is possible to send used products, but this requires obtaining various permits and meeting certain requirements. This research aims identify the obstacles encountered in formulating policies related to PMI and its shipments, which can be quite burdensome in obtaining permits, and by overcoming the main problems in policy formulation. By addressing these primary problems in policy formulation, a solution for PMI shipments that can be sent in used condition without the need for obtaining multiple permits, should be proposed.

Given the above issue, this research aims to discover solutions to the problems faced by PMI, specifically concerning the nature of their shipments, limited knowledge of customs, and mastery of technology. The primary focus is on improving the smooth distribution of the supply chain of PMI shipments. To achieve this, it is crucial to synchronize the policies that will be produced in this research with the realization of the shipments services. As Indonesia has adopted an online system for submitting good, called CEISA, the consignments of individuals, companies, and PMIs, are differentiated to facilitate the sending of used goods that are not for sale.

2. LITERATURE REVIEW

According to the PMK No. 199/PMK.010/2019, a consignment notes is a document with code CN2/CN-23 or something of similar nature containing an agreement for the delivery of goods between the sender and the postal operator. These notes are only applicable to shipments valued at less than USD 1500 which can be removed from the Customs area or other places that are treated as TPS (Temporary Storage Places) for import after the postal operator submits a consignment document to the customs official handling the goods. The certain procedures that should be followed during importations, include the submission of a consignment notes (Ministry of Administrative Reform and Bureaucratic Reform, 2022):

Figure 1. Shipment Goods Delivery Procedures

Inhibiting factors are determined based on several previous studies that discuss problems in importing goods. The following is a diagram of several previous studies that represent each factor.

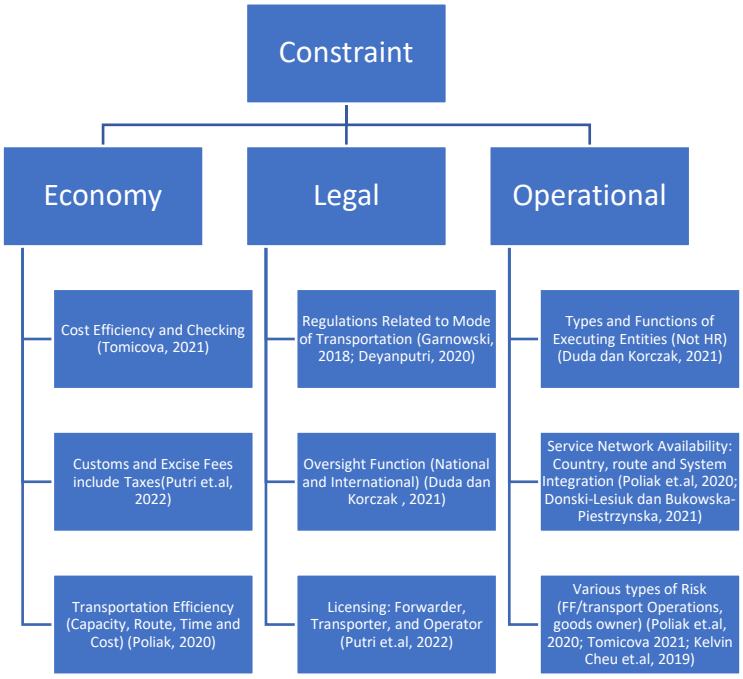

Figure 2. Three major factors as proposed by literature

Economic (commercial) factors were considered to determine the next steps in implementing specific policies for PMI's shipments. According to previous research, several aspects are taken into account when implementing these policies, namely, cost efficiency, customs and excise costs, taxes imposed on consignments, as well as transport efficiency, such as modal capacity, shipping route, delivery time, and shipping costs. delivery. The role of economic factors as an obstacle in determining policy is supported by Poliaka (2020) research titled "Identification of Risks Associated with Neutralization of Consignment Notes." It stated that senders, transporters, and recipients of goods coordinate with each other to secure consignment notes, regardless of status of the orders to neutralize (Putri et.al, 2022).

In addition to Economic factors, there are legal factors plays a role in determine the steps in implementing a special policy for PMI shipments. Previous research has stated that several aspects are taking into account when implementating these policies, including regulations regarding the modes of transportation used to deliver goods, supervisory functions from national and international parties, and permits required before sending goods, such as from forwarders, transporters, and delivery operators. The role of legal factors as an obstacle in policy-making is supported by Garnowski (2018) research titled "Special responsibility for consignment notes." It recommends that legal presumptions should be based on the assumption that the information in the consignment notes comes from the sender who can be held liable on the same terms as the carrier.

Operational factors, which pertain to the practical implementation of sending goods abroad, are also crucial considerations when formulating policies. Previous research have stated that several aspects are taken into account, including the Type and Function of the Implementing Entity, the availability of service networks provided by the country concerned, as well as delivery routes and data integration between goods senders and recipients, Also, various types of risks can be experienced during deliveries, such as those associated with FF/transport operations and the ownership of goods. According to the journals of Donski-Lesiuk and Bukowska-Piestrzynska (2021), CIM/SMGS consignment notes are crucial for dealing with international flows, and are implemented to varying degree. The study recommend that creating a common legal regime for rail

traffic in Asia and Europe, including countries, such as Armenia, Iran, Pakistan, Serbia, Uzbekistan, and Turkey, would increase the coverage of CIM/SMGS shipment documents on Trans-Eurasian Logistics Chain. It can be inferred that the solution of a unified transport document properly implemented into the legal system, which serves as a tool for providing fast logistics services anywhere with the recognition of the parties involved, will increase the effectiveness of international exchanges, despite any political obstacles.

3. METHODS

The analytic Hierarchy Process (AHP) method was used in this study for scenario analysis. This general measurement theory derives ratios from discrete and continuous pairwise comparisons, which can be drawn from measuring scales that reflect trends. The approach focuses on deviations from consistency, such as measurement and dependability within and between groups of structural elements. The population in this study is customs and excise experts in each country, while the samples are selected from Indonesia. The factors used in AHP analysis include economic, legal, and operational factors. Data were obtained from various literature related to customs and excise, as well as interviews with experts in Indonesia. The followings are indicators for each factor.

Table 1. Used Factors and Indicators

No	Faktor	Indikator
1.	Economy	• Check Cost Efficiency • Customs and excise fees • Goods Transportation Efficiency
2.	Legal	• Regulation • Supervision • Licensing
3.	Operational	• Executing Entities • Accessibilities • Risk

As shown in Table 1, the factors and subfactors were derived from literature studies and previous research related to customs. The policy emphasizes the economic aspect, such as customs and excise costs, and efficiency in checking and transporting goods sent from abroad. They also coordinate several regulations related to insurance and permits during the delivery of shipments. Operations are also considered when formulating policies as they are directly related to checking consignments, including human resources, accessibility of customs posts, and potential risks involved in handling goods. The executing entities oversee every shipment of goods sent abroad, including the Ministry of Administrative and Bureaucratic Reform, the Ministry of Trade, BP2MI, and the Director General of Customs and Excise. Finally, the following is the scheme of this research.

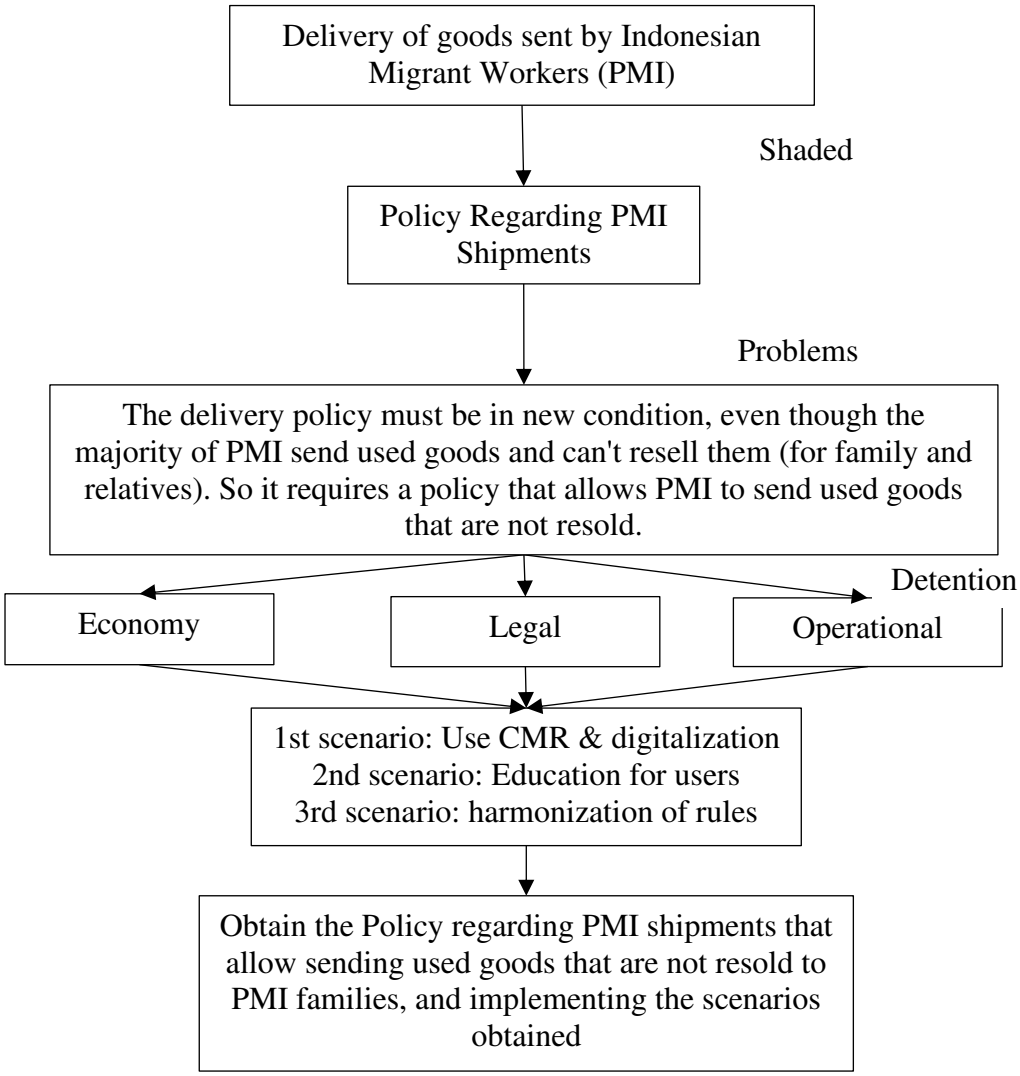

Figure 3. Research Scheme

In scenario 1, the goal is to digitize PMI data for BP2MI to synchronize data from PJTs in Indonesia with those in countries such as Saudi Arabia, Hong Kong, and Taiwan, to support the special shipment policy. For scenario 2, BP2MI and the relevant ministry will conduct educational programs to explain the special policies for sending goods from abroad. In scenario 3, policy harmonization is achieved by aligning customs and excise policies with the shipping regulations of each country, with a focus on the factor that holds the highest weight.

Scenarios were determined based on the problems faced by each PJT. Scenarios 1 and 2 were developed in response to the issue reported by PJTs in Saudi Arabia, who assume that the PMI in the country and several other nations have limited space and mobility due to their employer. By digitizing data, they can send goods without being far from their employers and be provided with information on the shipment procedures. Scenario 3 is based on the common problems faced by all PJTs, such as misunderstanding about consignments check policies which are often interpreted as a violation of privacy (especially in Hong Kong). This issue can be eliminated through harmonization policies.

4. RESULTS

Before conducting interviews with the eleven selected respondents, only eight were able to provide data related to this research. Respondents that were unable to assist were PDTT, Customer Clearance PJT, and one of the consignment notes application operators. For interviewees, consignment notes operators and application providers were classified as a group of policy regulators, while for each regional PJT became a group of policy executors. Since this analysis uses the AHP method, the inconsistency score serves as a validation value for each weighting, where < 0.1 is considered as valid. Before determining the overall, weighting for each factor and sub-factor will be obtained.

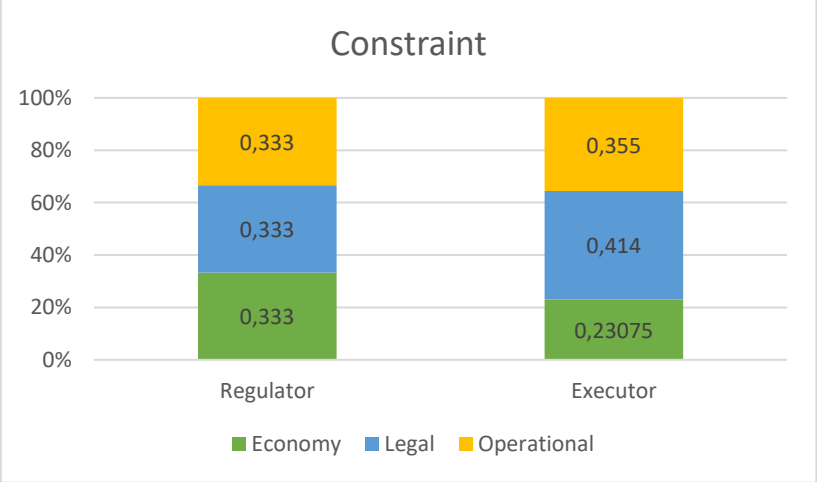

Figure 5. Weighted Score For Each Factor

As shown in Figure 4, the regulators provide the same weighting score for each category. However, for executor, it was discovered that generally, legal factors are the primary obstacle in creating or modifying new policies. Several opinions from PJT in each respondent regions were also taking into account, such as that of Saudi Arabia and Taiwan, which considers economic and operational factors to be the main issue in policy making. In contrast, to PJT Hong Kong and Surabaya view legal rights to be an issue in policy making. The following shows the weighting of each sub-factor of each respondent:

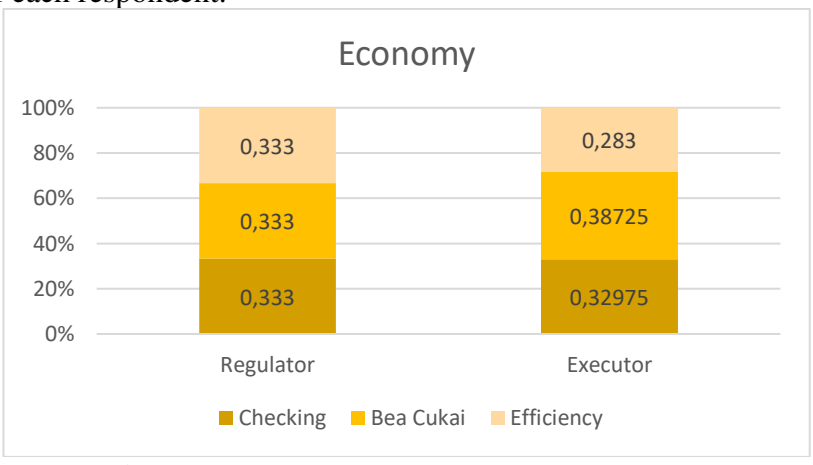

Figure 5. Economic Subfactor Weighted Score

According to Figure 5, regulators have a similar weighting for each economic sub-factor. However, for the executor, there is a trend of customs fees being considered a hindrance to policy. Based on statements from several PJTs, Saudi Arabian respondents stated that customs fees and transport efficiency affect policy. Those in Hong Kong indicated that the cost of checking is an obstacle to policy formation in the country. For PJT Surabaya, customs fees are an obstacle to determining policy. Furthermore, for Taiwan, transport efficiency can hinder policy formation. These differences can be caused by the policies of each region and the problems in each area where the distribution of PMI is different. According to a BP2MI publication in November 2022, Saudi Arabia has the highest number of complaints which is expected to be reduced by tightening permits. In Hong Kong PJT, it is known that the cost of checking is a significant concern as several PMI in the country do not want their shipments to be completely disassembled. Therefore, reducing the cost of checking is expected to minimize dismantling while ensuring safety. The following is a graph of the weighting of the Legal sub-factor.

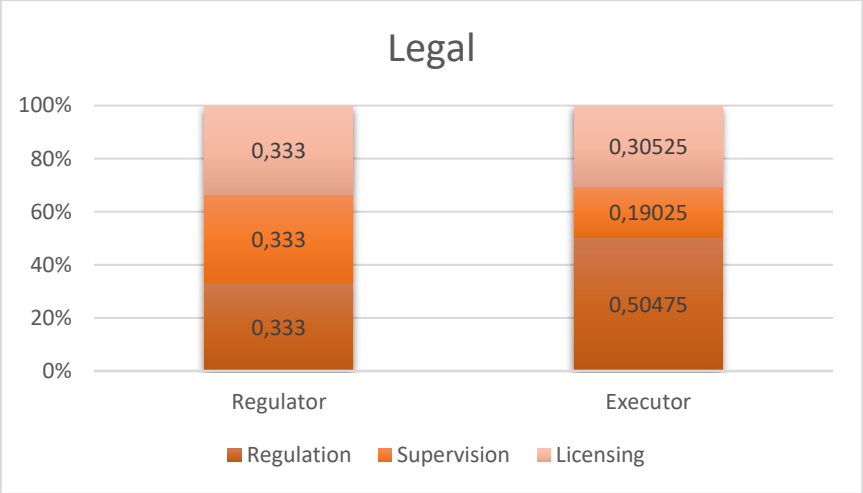

Figure 6. Legal Subfactor Weighted Score

Based on Figure 6, regulators have similar weighting for each legal sub-factor. However, for the executor, regulation is the main obstacle in policy-making. This is logical as regulations and permits are the main considerations in making new policies, typically involving a combination of previous policies and procedures to resolve the problem. Furthermore, previous policies are considered a regulatory sub-factor, while procedural problems are a licensing factor. The weighting of the operational sub-factor for each respondent will be further explained in the following graph.

Figure 7. Operational Subfactor Weighted Score

According to Figure 7, the regulator have similar the same weighting for each legal sub-factor. However, the executor showed different results for each PJT respondent. The implementation of policy can be hindered by checking consignment, implementing entities, and accessibility, as stated by the Saudi Arabia, Hong Kong and Surabaya, and Taiwan PJTs, respectively. The following is the overall weighting for each scenario.

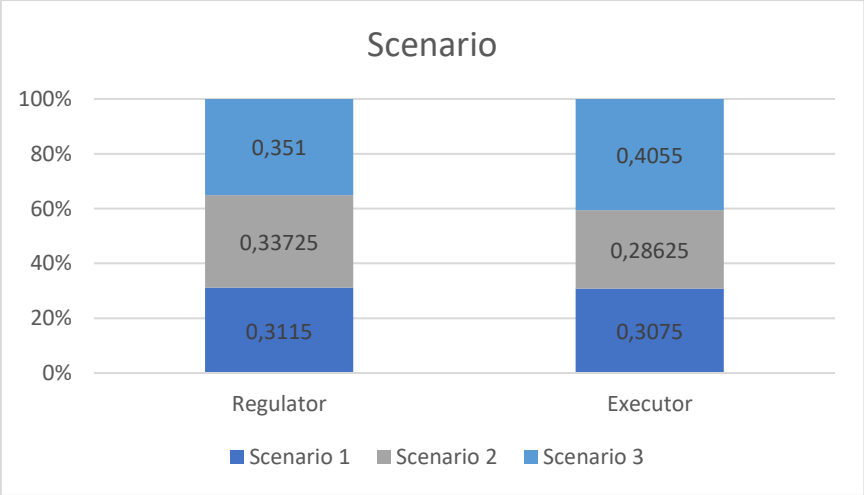

Figure 8. Weighted Score of Each Scenario

As shown in Figure 8, regulator and executor respondents tend to choose scenario 3 as the solution for creating special policies for PMI shipments. This is because, for them, integrating state with international policies in customs matters will make it easier for individuals, especially migrant workers worldwide, to deliver goods. A respondent agreed to use scenario 1, namely digitizing CMR to make it easier to record consignments. Detailed information is shown on the graph of the weighting of each scenario against the factors used.

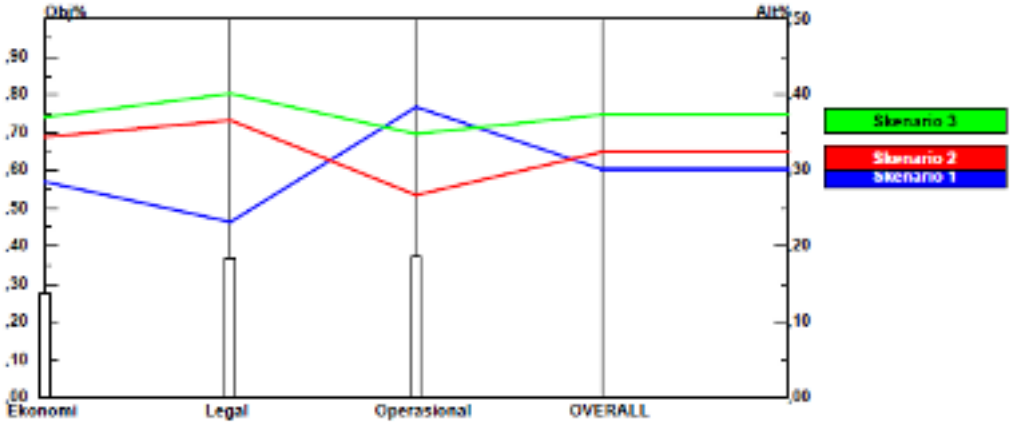

Figure 9. Weighting for Each Scenario against the Factors used

Figure 9 shows that legal and operational factors influence more than economic factors. When prioritizing economic or legal factors, scenario 3, which involves harmonizing international policies, is the recommended option for implementation in Indonesia. However, scenario 1, involving CMR digitalization, is deemed the most appropriate when the weighting focuses on operational factors. Given that the operation factor has the highest weight, scenario 1 is proposed as the primary solution. Therefore, it should be noted that when a country experiences special operational problems in sending goods, scenario one can be considered an alternative.

5. CONCLUSION

By selecting scenario 3 as a solution to solving obstacles in policy-making, the government should work towards harmonizing international policies with different cultures and thoughts, especially concerning PMI shipments. This can be achieved by implementing entities in the customs sector, such as the Ministry of Trade, the Ministry of Administrative Reform, BP2MI, and the Director General of Customs and Excise. Through the implementation of scenario 3, each PMI distribution country can integrate policies that would be beneficial for their respective representative. As a result of the harmonization of international policies, each country can perform its PMI delivery policy without conflicting with the culture and thoughts of each nation. This also facilitatess the supply chain for PMI shipments and implements new policies that make it easier for PMI parties to send used goods that are not intended for resale. Additionally, by adjusting customs and excise policies in Indonesia with certain countries, it is expected to reduce misunderstandings regarding shipping duties. However, it should be noted that operational factor should be given the highest priority in these efforts.

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DETERMINANTS OF GREEN PURCHASE INTENTION THROUGH THE APPLICATION OF STIMULUS ORGANISM RESPONSE THEORY (SOR)

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ABSTRACT

Climate change and the worsening environment are increasing consumer concerns. Green product consumption has multiplied as demand for green products increases. One way that companies can do amid environmental and economic problems is by doing green marketing. This study examines how internal stimulus impacts customers' intention to purchase green products, using the SOR paradigm and the theory of planned behavior, an original approach. Data was collected from 274 respondents using non-probability sampling and analyzed using SPSS 27 and AMOS 26 version packages applying structural equation modeling. The result showed that 9 out of 11 hypotheses that measured the determinants of green purchase intention are supported. The findings suggest (a) previous purchase experience and green perceived value influence consumers' environmental consciousness, green perceived value positively influence green attitude and green perceived risk negatively influence green attitude, and previous purchase experience and green perceived value influence green trust; (b) previous purchase experience does not impact green attitude and green perceived risk does not negatively influence green trust; (c) environmental consciousness, green attitude and green trust has significantly impact the intention to purchase green products. The research has significant implications for understanding Indonesia's green products intention and for companies to develop a new green marketing strategy to gain a better competitive edge.

Keywords: Environmental Consciousness, Green Perceived Risk, Green Perceived Value, Green Products, Green Purchase Intention

1. INTRODUCTION

People's understanding of green concepts and their benefits in protecting the environment has increased in several parts of the world. Global warming is increasing every year, causing people to be suspicious of being more careful in using goods that can oppose global warming and endanger humans (Silvia et al., 2014). Currently, consumers are aware that their buying behavior has a direct impact on the emergence of various kinds of environmental problems. Consumers are starting to think about their shopping habits' impact on the environment. Consumers can reduce the impact of their shopping style on the environment by checking products that can be recycled and whether the products they buy are environmentally friendly (Qurniawati, 2018).

Growing awareness of environmental impacts and health trends towards green consumption has raised the consumption of green products, including cosmetic products with natural ingredients that avoid chemical additives. Daily use of beauty products poses a threat to the environment. For example, microbeads from facial scrub products are not biodegradable, and their waste is often released into the sea and pollutes the environment. Common ingredients in cosmetic products such as parabens, triclosan, and siloxane are found in sunscreens, shampoos, moisturizers, liquid soaps, and hair conditioners, being discharged into aquatic and terrestrial environments every day which can pose ecological risks and toxic effects on plant and animal species (Munerah et al., 2021).

Indonesia's beauty industry is experiencing rapid growth due to the increasing demand for cosmetics and facial care series. A vast population, changing beauty trends and increasingly advanced beauty technology are driving the beauty industry in Indonesia to continue to grow. The large population attracts multinational and national companies to enter this market industry. Until 2019, there were 797 companies in the large cosmetics industry and small and medium industries in Indonesia. This figure has increased compared to 2018, which consisted of 760 companies (Tempo, 2020). According to the Association of Indonesian Cosmetic Companies and Associations (PPAK Indonesia), in 2021, sales of cosmetic products will grow by around 7% to US$7.45 million from US$6.95 million in 2020. The increase in sales will also be due to online sales growth. Online sales reached 21% this year compared to the previous year, which was only 14% (Ayu, 2021).

As cosmetic companies increase in Indonesia, several local cosmetic brands actively respond to environmental issues. Local brands such as Somethinc, Sensatia Botanica, Klen & Kind, and REI Skin often carry out activities and campaigns about the environment and the importance of protecting the environment itself. However, in this study, a case study will be carried out on The Body Shop brand, which is a personal care company from England. The Body Shop is the company used as a case study in this study because The Body Shop is a multinational company that is on top of mind for consumers when discussing green cosmetics.

2. LITERATURE REVIEW

Theory Of Planned Behavior

The theory of planned behavior, commonly called TPB, is an addition to the Theory of Reasoned Action (TRA) that Fishbein and Ajzen previously put forward in 1975. Ajzen argues that TRA is very good when describing behavior, mostly under volitional control. The performance of the theory appears to be poor for behavior in which people have incomplete volitional control. In the end, Ajzen added a third element to Fishbein and Ajzen's original model: perceived behavioral control. Thus, the Theory of Planned Behavior goes beyond the Theory of Reasoned Action to include the concept of perceived behavioral control. As in the theory of reasoned action, the main factor in the theory of planned behavior is the individual's intention or intention to perform a specific behavior. The intention is explained as a motivational factor that influences human behavior. Where the intention is an indication of how much the individual is willing to try and how much effort they plan to carry out the behavior. The greater the intention to engage in a behavior, the more likely it is to perform.

Stimulus Organism Response Theory

Sultan et al. (2021) stated in their research that the evolution of stimulus Organism Response Theory (SOR) in psychology began with the work of Thorndike (1898), the Law of Effect or Stimulus-Response (S-R) Theory, which explained that a behavioral response (R) that gives satisfactory results is very likely to sustain and respond to the same stimulus (S). The Law of

Effect is not mediated and assumes that the same stimulus will likely produce a similar response. Then Woodworth (1918) perfected the learning theory or S-R model of behavior into the S-O-R model in his books "Dynamic Psychology" and "Dynamics of Behavior", where Woodworth defined it as a functionalist approach.

Hypotheses Development and Conceptual Framework:

Previous purchase experience and environmental consciousness

The purchase experience is vital in internalizing factors related to survival because external stimuli are better understood when assimilated by the act of buying itself and can guide moments of similar consumption (McColl-Kennedy et al., 2015). Experience results can increase environmental consciousness, including information not available before getting the experience (Nuttavuthisit & Thøgersen, 2017).

H1a: Previous purchase experience positively influence environmental consciousness

Previous purchase experience and green attitude

A set of dimensions can play an essential role in influencing an individual's attitude, such as previous purchase experience. Consumers have a positive attitude towards sustainability when they believe their efforts improve the environment.The consumer learns and adapts from the previous experience, and this experience can influence their attitude toward a product (Anshu et al., 2022). Therefore, from experience, an individual can feel the effectiveness of the product and its impact on the environment, which leads to a more positive attitude (Curvelo et al., 2019)

H1b: Previous purchase experience positively influence green attitude

Previous purchase experience and green trust

According to Helson (1964) in Ling et al. (2010), Individual assessment responses are based on three aspects: past individual experiences, context or background and stimulus. An experience will provide consumers with memories, which can generate consumer trust in the good or bad experience (Syahputra & Murwatiningsih, 2019).

H1c: Previous purchase experience positively influence green trust

Green perceived value and environmental consciousness

Green perceived value is a consumer behavior that can influence consumers to select environmentally friendly products (Groening et al., 2018). Some consumer considerations for these behaviors are known as product advantages and costs. Customer interest is higher in choosing environmentally friendly products when product knowledge and prices are assumed to be positive (Alamsyah & Mohammed, 2019).

H2a: Green perceived value positively influence environmental consciousness

Green perceived value and green attitude

Perceived value is a subjective concept, and it is due to the dependence on various contexts that determine the characteristics of the products. Therefore, perceived value has been recognized as the main factor determining consumer buying behavior (Sanchez et al., 2006). According to Patterson and Spreng (1997), the perceived value reflects a person's attitude towards performance and behavior. In more detail, Ekinci et al. (2008) noted that attitude refers to a favourable or unfavourable feeling and guides behavioral intention to buy a product.

H2b: Green perceived value positively influence green attitude

Green perceived value and green trust

Perceived value refers to the overall consumer assessment of a product's or service's benefits (Patterson & Spreng, 1997). Meanwhile, trust is the willingness to depend on an object based on expectations of its ability, reliability and benevolence (Ganesan, 1994). The impact of perceived value on green trust can be determined through consumers' general assessment of the green benefits of products for the environment. Thus, when consumers perceive products with high

green value, they will believe that these products have a minor impact on the environment than other products (Rahardjo, 2015).

H2c: Green perceived value positively influence green trust

Green perceived risk and green attitude

Perceived risk is a psychological variable that has attracted much attention in social psychology research and has been defined in various ways(Dunn et al., 1986) define perceived risk as the negative utility consumers associate with purchasing certain products or services.

H3a: perceived risk negatively influence green attitude

Green perceived risk and green trust

In the face of customer uncertainty and suspicion regarding the arguments made by green products or companies, previous researchers created a structure called green perceived risk. Green perceived risk relates to the interpretation of wrong decisions regarding environmental impacts. Perceived risk relates to the environment and the physical consumer (Tarabieh, 2021). According to research by Chen and Chang (2012), perceived risk will affect purchasing decisions and consumer green trust. The consumer's choice to believe (trust) or not will also be influenced by the level of perceived risk (Harridge-March, 2006)

H3b: perceived risk negatively influence green trust

Environmental consciousness and purchase intention

Environmental consciousness is related to a person's tendency to engage in pro-environmental behavior. Considering the progress of studies in this field and the direct access of consumers to information, issues regarding sustainability and the impact of purchasing on the environment have attracted the attention of individuals, even those who previously did not show interest in environmental issues, who have the intention to make a purchase. (Kushwah et al., 2019). Environmental consciousness can affect a person's attitude and behavior towards green products, which can lead to their purchase intention towards green products. Research conducted by D'amico et al. (2016) stated that consumers often consider animal welfare and environmental protection when buying green products.

H4: Environmental consciousness positively influences purchase intention.

Green attitude and purchase intention

Attitudes have been researched and studied regarding their attachment to sustainable goods and services, especially green products, where research on this topic shows that consumers with a positive attitude towards sustainability prefer to buy this type of product (Policarpo & Aguiar, 2020). That is because people are becoming more aware of environmental and social issues and a positive attitude about sustainability makes consumers choose products that are aligned with these issues (Policarpo & Aguiar, 2020)

H5: Green attitude positively influences purchase intention.

Green trust and purchase intention

Green trust refers to consumers' readiness to buy and depend on green products, including products based on previous performance, credibility, effectiveness, and function (Chen, 2010). Several studies suggest that trust can regulate the relationship between buyers and sellers, consequently attracting higher perceptions of customer loyalty to the company (Nuttavuthisit & Thøgersen, 2017). Consumer trust becomes one of the determinants of consumer behavior in the long term. If the consumer already has experience trusting the seller, then the consumer has a purchase intention, which is a long-term consumer behavior in the future (Chen & Chang, 2012).

H6: Green trust positively influence purchase intention.

The Conceptual Framework

Based on the literature reviewed, the conceptual framework for this study is presented below.

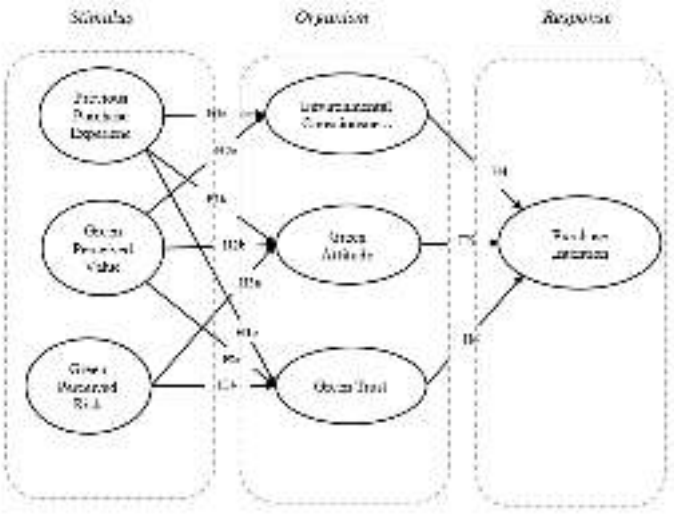

Figure 1 The Conceptual Framework

3. Methods

This study will collect data using a self-administered survey, where respondents can access questionnaires. Researchers will distribute questionnaires via links containing questionnaires that use Google form media. Links will be shared via e-mail, Twitter, Instagram, WhatsApp, line, and other digital media to make it easier for researchers and respondents. The researcher wrote down and distributed leaflets on the criteria for respondents who could fill out the questionnaire. This study will analyze the data using SEM (structural equation modeling). The number of respondents who were collected was 283 respondents, but the respondents who met the criteria of this study were 274 respondents. The sampling method used in this study is non-probability sampling.

4. RESULTS

The confirmatory study (CFA) method was used to test the validity of the research model. SPSS version 23 is used to process the results of descriptive analysis. AMOS is used to test the entire model.

Table 1 Demographic Tabulation

No	Description	Category	Total Respondent (n=274)	
1	Gender	Female	228	83,2%
		Male	46	16,8%
2	Age	18 - 22	172	62,8%
		23 - 27	86	31,4%
		28 - 32	12	4,4%
		33 - 37	2	0,7%
		>38	2	0,7%

3	Education	Primary School	2	0,7%
		Secondary School	1	0,4%
		High School	162	59,1%
		Diploma	10	3,6%
		Bachelor	98	35,8%
		Master	1	0,4%
4	Job	Not Working	28	10,2%
		Student	166	60,6%
		Government Employee	3	1,1%
		Private Employee	54	19,7%
		Others	23	8,4%
5	Personal Care Expense/Month	<Rp 250.000	77	28,1%
		Rp 250.000 - Rp 500.000	113	41,2%
		Rp 500.001 - Rp 750.000	35	12,8%
		Rp 700.001 - Rp 1.000.000	16	5,8%
		>Rp1.000.000	33	12,0%

Based on Table 1, it can be seen that the research respondents were dominated by female respondents, namely 83.2% (228). Meanwhile, male respondents had a percentage of 16.8% (46). Most of the research respondents were respondents with an age range of 18 to 22 years, with a proportion of 62.8% (172). Then, most respondents had completed high school, namely 59.1% (162). Judging from the demographics in the table, most respondents are still students at 60.6% or as many as 166 people. Furthermore, in the monthly expenses for personal care products category, 113 people or 41.2% are dominated by respondents with monthly personal care expenses ranging from IDR 250,000 to IDR 500,000.

Table 2 Construct Reliability and Validity

Variable	**Indicators**	**Factor Loading**	**Validity**	**CR**	**AVE**	**Reliability**
Pervious Purchase Experience	PPE1	0,740	Valid	0,788	0,554	Reliable
	PPE2	0,775				
	PPE3	0,717				
Green Perceived Value	GPV1	0,797	Valid	0,898	0,637	Reliable
	GPV2	0,783				
	GPV3	0,800				
	GPV4	0,795				
	GPV5	0,814				
Green Perceived Risk	GPR1	0,804	Valid	0,925	0,755	Reliable
	GPR2	0,894				
	GPR3	0,900				
	GPR4	0,875				
Environmental	EC1	0,724	Valid	0,860	0,606	Reliable

Consciousness	EC2	0,83				
	EC3	0,841				
	EC4	0,71				
Green Attitude	GA1	0,812	Valid	0,849	0,651	Reliable
	GA2	0,809				
	GA3	0,800				
Green Trust	GT1	0,794	Valid	0,821	0,605	Reliable
	GT2	0,743				
	GT3	0,796				
	GT4	0,846				
	GT5	0,822				
Purchase Intention	PI1	0,718	Valid	0,856	0,599	Reliable
	PI2	0,742				
	PI3	0,789				
	PI4	0,842				

Hair (2009) states that the minimum value for standardized factor loading is 0.50. After getting the standardized factor loading values from the variable indicators, the next thing to do is to calculate the Composite Reliability (CR) and Average Variance Extracted (AVE). The two values of CR and AVE are used to determine the validity and reliability of the variables in this study. According to Malhotra et al. (2017), variables are valid and reliable if the CR value ≥ 0.70 and the AVE value ≥ 0.50. All variables have a standardized factor loading (SFL) higher than 0.5, according to table 2. It shows that the measurement variables already have good convergent validity and are declared valid. In addition, all variables have an AVE value greater than 0.50 and the construct reliability value for each variable has a value greater than 0.70. That is, all variables from this study are declared reliable.

Table 3 Hypothesis testing

Hypothesis	***Path***	**CR**	**P**	**Decision**
H1a	*Previous Purchase Experience → Environmental Consciousness*	5,095	,000	Supported
H1b	*Previous Purchase Experience → Green Attitude*	1,616	,106	Unsupported
H1c	*Previous Purchase Experience → Green Trust*	4,461	,000	Supported
H2a	*Green Perceived Value → Environmental Consciousness*	2,972	,003	Supported
H2b	*Green Perceived Value → Green Attitude*	9,184	,000	Supported
H2c	*Green Perceived Value → Green Trust*	6,915	,000	Supported
H3a	*Green Perceived Risk → Green Attitude*	-2,342	,019	Supported
H3b	*Green Perceived Risk → Green Trust*	-1,410	,158	Unsupported
H4	*Environmental Consciousness → Purchase Intention*	4,358	,000	Supported
H5	*Green Attitude → Purchase Intention*	3,189	,001	Supported
H6	*Green Trust → Purchase Intention*	3,160	,002	Supported

Table 3 shows that of all the existing hypotheses, two hypotheses were rejected, namely hypotheses H1b and H3b. Hypothesis H1b is rejected because it has a probability value of more

than 0.05, while hypothesis H3b is rejected because it has a CR value of less than 1.96 and a probability value of more than 0.05. The other hypothesis is accepted because it meets the requirements. Namely, the probability value is less than 0.05 and the CR value is more than 1.96.

5. CONCLUSIONS

Based on the results of model processing and hypothesis analysis tests discussed in the previous chapter, several points can be concluded from this study. Previous purchase experience of The Body Shop products significantly and positively influences consumer environmental consciousness and green trust. It shows that most respondents have a positive attitude towards environmental awareness and their belief in the greenness of The Body Shop products. Meanwhile, the previous purchase experience did not affect the green attitude of the respondents. It could be because even though consumers already have experience purchasing green products, the information obtained from this experience cannot be used to shape consumer attitudes towards environmentally friendly products. Although the buying experience of the respondents did not influence their attitude toward green products, their previous purchasing experiences provided information for respondents so that respondents were more aware of the environment and believed that The Body Shop products were credible green products.

Green perceived risk negatively affects green attitude. It suggests that consumers' perceived risk negatively influences their attitudes towards green products. However, it is different from the effect of green perceived risk on green trust. Green perceived risk does not negatively affect consumer green trust. This shows that consumers who have a perception of risk do not negatively affect consumer confidence in the product

Managerial Implication

From the study's conclusions, several suggestions can be given to management. From this research, it is hoped that companies engaged in the personal care sector will be able to find out which factors can have the greatest influence on the formation of green product intentions or intentions. Several internal stimuli from consumers influence environmental consciousness, attitude and consumer trust. Therefore, marketers need to ask for information on the experience of consumers who have purchased a product, provide information about the benefits of the product on the environment, the performance of the product they have, and provide information that the product they have does not pose a risk to the environment. Thus consumers become more aware of the environment, respond positively to environmental issues and have confidence in green products.

Indicators regarding product concern for the environment that meet respondents' expectations greatly influence respondents' trust in products. In addition, consumer concern about the negative impact of products on the environment is the most significant indicator of consumer attitudes. Therefore, marketers can increase campaigns about sustainability, increase company activities for environmental preservation, and state positive product performance towards the environment, which can increase customers' trust and attitude for products.

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EFFICIENCY ANALYSIS OF MSME LOAN DISBURSEMENT BY STATE OWNED BANKS USING DATA ENVELOPMENT ANALYSIS METHOD

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ABSTRACT

As government representative, productive loan disbursement currently dominated by state-owned banks in Indonesia. However, high disbursement leads to high risk because the repayment source is non fixed income and worsen due to COVID-19 pandemic. This analysis was done using Data Envelopment Analysis (DEA) method to calculate the ratio between outputs consist of loan, interest income, performance loan, non restructuring loan, and non-CKPN loan towards inputs consist of fixed asset, fund, capital, labor expense, operating expense, and interest expense. The correlation between input and output was tested using Spearman and Pearson correlation test, and it was found that there was strong correlation between input and output variables. Before pandemic (2017-2019), state-owned banks had a value of efficiency (θ) = 1 or efficient. In 2020, θ value of BRI and Bank Mandiri was < 1 or inefficient, resulting that the efficient state-owned banks were only BNI and BTN. The result of this study indicates that COVID-19 pandemic affect the efficiency of lending process in state-owned banks. In order to improve this condition, BRI and Bank Mandiri can not be operated as usual. They need improvement in input and output variables to obtain $\theta = 1$.

Keywords: productive loan, state-owned banks, nonperformance loan, pandemic, data envelopment analysis

1. INTRODUCTION

As the main source of income in bank industry in Indonesia, productive loan disbursement currently dominated by state-owned banks. As government representative, these banks have greater opportunity in lending business because of larger portfolio allocation and easier regulation. However, high disbursement leads to high risk, because the source of loan payments comes from debtor's business as non fixed income. COVID-19 pandemic has caused unstable economic condition, increasing the risk of default by debtors and non performance loan portfolio. As risk mitigation, it is necessary to set allowance for impairment losses (*Cadangan Kerugian Penurunan Nilai*/CKPN) in every loan disbursement with a value that is directly proportional value to collectibility. However, CPKN is recorded as a deduction in income statement and affects the company's profits. To support business sustainability, government created National Economic

Recovery Program (*Pemulihan Ekonomi Nasional*/PEN) especially the informal sector or MSMEs. This program included providing credit interest subsidies to entrepreneurs through commercial banks, especially state-owned banks. The implementation of PSAK 71 causes the calculation of CKPN to be larger and PEN Program causes state-owned banks unable to supress their disbursements, so it is necessary to review the efficiency of state-owned banks's lending activity.

Data Envelopment Analysis is nonparametric method in operations research for measuring the efficiency of Decision Making Units (DMUs) using multiple inputs to outputs configurations. This method is the most commonly used tool for frontier estimations in assessments of productivity and efficiency applied to many fields such as economic activities, manufacture performance, and service operation. DEA is considerately easy to use because it can be used to multiple outputs and inputs. There is no need to know the exact correlation between input and output and still can be processed eventhough the variabels have different unit. For inefficient result, variables can be improved using Constant Return to Scale (CRS) or Variable Return to Scale (VRS) method.

2. LITERATURE REVIEW

Study about bank efficient during pandemic and crisis have been done a lot before. During the crisis caused by the bankruptcy of Lehman Brothers in 2008, Havnarek (2016) examined cost efficiency for commercial banks in the Czech Republic becauce of heterogeneity in pricing policies on products and bank services, especially credit interest. By using SFA and DEA, Havnarek compared the cost structure of banks before and after crisis conditions, where price wars occurred some time after the crisis, but did not last long so that the prices offered by banks tended to fluctuate significantly. Havnarek used loan as output variable to obtain the cost structure while examine the input such as fixed asset, capital, and labor. Same method also used by Wang (2019) to obtain bank efficiency in Vietnam. Wang also examined every cost that could be affect bank efficiency such as labor, operational cost, and interest cost. For benchmarking purpose, Wang used multiyears data and compare the result year by year.

In Malaysia, Hamid (2017) and Karim (2010) suggested to add nonperformance loan as output variable and used DDF dan DEA to obtain banks efficiency for their research in loan performance. In Turkey, Partovi (2019) also used nonperformance loan as output variable for his research since the happening of Banking Sector Restructuring Program (BSRP), added deposit as one of key input and indicated that deposit gave good impact on the bank, although the funds that the bank manages to collect are not always optimal. Most of them using Constant Return to Scale (CRS) to repair the value of input or output in order to obtain the efficient results.

3. METHODS

This analysis was done using Data Envelopment Analysis (DEA) method to calculate the ratio between output an input variabels. Before modelling the variables, the correlation between input and output was tested using Spearman correlation test with initial assumption (H_o) was there was no correlation between input and output variables. If p-value was obtained < 5%, H_o was rejected, so concluded that there is correlation between input and output variables as the new assumption (H_a).

Spearman correlation test was done by finding the difference (d_i) between i-th output (y_i) and i-th input (x_i) that will be tested for certain number of data (n), and the Spearman coefficient (ρ) is calculated as follows:

$$\rho = 1 - \frac{6 \sum_{i-1}^{n} d_i^2}{n(n^2 - 1)}$$

The correlation coefficient has a value between -1 to 1. If the value is closer to 1, the correlation between the two variables is considered to be stronger. If the value is closer to 0, the correlation is getting lower. Positive value means directly proportional correlation between the variables while negative value means inversly proportional correlation. The coefficient range that is commonly used is the correlation level of 0.00 to 0.20 means almost no correlation, 0.21 to 0.40 means it has a weak correlation, 0.41 to 0.60 means it has a moderate correlation, 0.61 to 0.80 means strong correlation, and 0.81 to 1.00 means very strong correlation.

Table 1. Input Variabels

Bank	Input											
	Fixed Asset				Funding				Capital			
	v_1				v_2				v_3			
	2017	2018	2019	2020	2017	2018	2019	2020	2017	2018	2019	2020
BRI	25	27	31	32	842	944	996	1.088	168	185	209	200
BNI	23	26	27	27	493	552	583	648	101	110	125	113
Mandiri	37	38	45	47	750	766	850	964	170	185	209	194
BTN	5	5	5	6	177	211	207	259	22	24	24	20
Bank	**Input**											
	Labor Expense				Operational Expense				Interest Expense			
	v_4				v_5				v_6			
	2017	2018	2019	2020	2017	2018	2019	2020	2017	2018	2019	2020
BRI	20	22	24	26	39	42	45	50	34	30	40	38
BNI	9	10	10	10	21	22	24	24	16	19	21	18
Mandiri	15	16	17	18	35	38	40	41	26	25	31	32
BTN	3	3	3	3	6	7	7	7	11	13	15	15

Table 2. Output Variabels

Bank	Output											
	Loan				Interest Income				Performance Loan			
	u_1				u_2				u_3			
	2017	2018	2019	2020	2017	2018	2019	2020	2017	2018	2019	2020
BRI	719	820	877	899	88	127	105	97	689	790	840	869
BNI	441	513	557	586	39	43	48	45	414	482	518	533
Mandiri	712	800	886	870	59	62	69	64	659	746	825	804
BTN	199	238	256	260	17	20	22	21	176	211	217	230
Bank	**Output**											
	Nonrestructuring Loan				Non-CKPN Loan							
	u_4				u_5							
	2017	2018	2019	2020	2017	2018	2019	2020				
BRI	677	771	826	705	690	785	839	834				
BNI	411	484	518	437	427	498	540	542				
Mandiri	657	742	826	697	678	768	856	808				
BTN	186	217	229	187	196	235	250	247				

Variables used in this study is financial statements from Indonesian state-owned banks (BRI, BNI, Bank Mandiri, and BTN) from year 2017-2020 as shown in **Tabel 1** and **Tabel 2**. This data was analyzed in cross section, so it was processed in each period to determine the efficiency of the bank in each analysis period. By comparing the efficiency of the bank in each period, information will be obtained regarding the period in which the bank is considered inefficient and how to optimize its input and output variables to make it efficient. All variables are modeled to compare multiple inputs and outputs as equation below:

$$\max \theta = \frac{\sum_{i=1}^{n} y_i u_i}{\sum_{i=1}^{n} x_i v_i}$$

with the constraint of $\sum_{i=1}^{n} x_i v_i = 1$ and $\sum_{i=1}^{n} y_i u_i - \sum_{i=1}^{n} x_i v_i \leq 0$, where θ is efficiency, n is the number of data, y_i is the i-th value of output, u_i is the i-th output, x_i is the i-th value of input, and v_i is the i-th input. The results of the equation is to obtain the efficiency value (θ) in a range of $0 \leq \theta \leq 1$. If $\theta = 1$, it indicates that the bank is efficient. But if $\theta < 1$, it indicates that the bank is inefficient. The inefficiency needs to be fixed by improving the value of input and output variables.

4. RESULTS

The correlation between input and output was tested using Spearman correlation test and run using SPSS Program, and it was found that the correlation range mostly > 0,8, indicates that there was strong correlation between input and output variables as shown in **Table 3**.

Table 3. Spearman Correlation Test Result

Variables		Input					
		Fixed Asset	Funding	Capital	Labor Expense	Operational Expense	Interest Expense
Output	Loan	0,864	0,624	0,965	0,942	0,973	0,937
	Interest Income	0,710	0,691	0,906	0,975	0,973	0,946
	Performance Loan	0,852	0,632	0,965	0,954	0,982	0,949
	Nonrestructuring Loan	0,817	0,743	0,966	0,907	0,929	0,895
	Non-CKPN Loan	0,864	0,697	0,982	0,924	0,958	0,932

After modelling the variables using equation above, the model was process using LINGO Program and resulting θ as shown in **Table 4**.

Table 4. State Owned Banks Efficiency

Efficiency	2017	2018	2019	2020
θ_{BRI}	1,000000	1,000000	1,000000	0,578889
θ_{BNI}	1,000000	1,000000	1,000000	1,000000
$\theta_{MANDIRI}$	1,000000	1,000000	1,000000	0,777164
θ_{BTN}	1,000000	1,000000	1,000000	1,000000

The result of bank efficiency as shown in **Table 4** indicates that all state-owned bank was efficient before year 2020. In year 2020, only BNI dan BTN were efficient. In order to to improve this condition, BRI and Bank Mandiri can not be operated as usual. They need improvement in input and output variables to obtain $\theta = 1$. The available improvement for BRI is by increasing the

output to 173% from current value or reducing the input to 80%. For Bank Mandiri, the output needed to be increased to 129% or reducing the input to 88%.

5. CONCLUSIONS

Before the pandemic (2017-2019), the efficiency value (θ) of all state-owned banks was 1 or efficient. This could indicate that in lending business, banks had run their business with efficient product distribution and focus in accordance with their respective fields. In 2020, the efficient state-owned banks were only BNI and BTN because θ value of BRI and Bank Mandiri was < 1. For efficient process, BRI and Bank Mandiri should not operated as usual for next year, instead they need to increase their outputs or lower the inputs.

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Analysis of Employees' Readiness of PT PLN ULP Makale as Agent of New PLN Mobile Application

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ABSTRACT

PT Perusahaan Listrik Negara (Persero) is the largest state-owned electricity provider company in Indonesia. Since December 2020, PT PLN had launched a super app called New PLN Mobile to provide one-stop service solution for the customers. The app's primary features include token purchasing for prepaid electricity customers, electricity use monitoring, billing through partnerships with several banks and financial technology (fintech) platforms, and customer services. PT PLN (Persero) Unit Layanan Pelanggan Makale continually supports the business paradigm of PT PLN by increasing employees' readiness as agents of the New PLN Mobile application. Objectives of this study are identifying the factors that influence acceptance and employees' readiness of New PLN Mobile application usage using Unified Theory of Acceptance and Use of Technology (UTAUT) model and analyzing employees' readiness using Technology Readiness Index (TRI). Variables of this study are performance expectancy, effort expectancy, social influence, facilitating condition, behavioral intention, use behavior, optimism, and innovativeness. Analysis of this study was done using Structural Equation Model Partial Least Square (SEM-PLS) PL by SMARTPLS application. The result of this study is strategy for increasing employees' readiness as agents of New PLN Mobile application which can be a suggestion for the management team. Indirectly, the realized suggestion can affect the widespread usage of New PLN Mobile application which supports sustainable digital lifestyle by minimalizing paper consumption dan reducing customers' need to travel.

***Keywords**: SEM-PLS, New PLN Mobile, Unified Theory of Acceptance and Use of Technology, Technology Readiness Index.*

1. INTRODUCTION

Covid-19 pandemic encourage companies to innovate customer servicing in order to increase customer satisfaction. Since December 2020, PT PLN had launched a super app called New PLN Mobile to provide one-stop service solution for the customers. The app's primary features include token purchasing for prepaid electricity customers, electricity use monitoring, billing through partnerships with several banks and financial technology (fintech) platforms, and customer services. PT PLN (Persero)'s business paradigm on 2021-2021 was digitalization service and on 2023-2024 is boosting non-electricity revenue.

PT PLN (Persero) Unit Layanan Pelanggan Makale (PLN ULP Makale) is located in Tana Toraja, Sulawesi Selatan with 51.361 customers on 2021. This shows that there is a great potential

for increasing New PLN Mobile users among customers and for increasing socialization by employees to customers. Yante Optimization and Outage Management Data on February 2022 shows that the downloader targets of New PLN Mobile on January 2022 and February 2022 were 734 and 734 respectively, but the realization on January 2022 and February 2022 were only 625 and 18. Moreover, the rating targets of 1-2 value on January 2022 and February 2022 were 0, but on January 2022 the target could not be achieved because there were 2 accounts who give the rating of 1-2 value on Play Store.

The top management of PLN ULP Makale instructed all employees to constantly socialize the usage of New PLN Mobile as a countermeasure for target unattainability, because this gap is caused by the lack of socialization of New PLN Mobile among customers. Based on a survey conducted on 89 employees on March 2022, only 60.67% employees have downloaded New PLN Mobile application and only 16.85% employees have recommended the application to customers. Based on this reason, an analysis related to the factors of employees' acceptance of application as a customer is conducted in this study.

Methods used in this study will be Unified Theory of Acceptance and Use of Technology (UTAUT) to understand the user acceptance of the application and Technology Readiness Index (TRI) to measure user's readiness on a new technology. Parasuraman (2000) stated that TRI is a model used for measuring user readiness in using new technology with four variables consist of optimism, innovativeness, discomfort and insecurity.

2. LITERATURE REVIEW

2.1. UTAUT

Malik (2016) stated that UTAUT model developed because of Technology Acceptance Model's limitation that lack of comprehensive in considering some influential aspects of user acceptance of technology acceptance. UTAUT is a model that developed from antecedent theories such Theory of Reasoned Action (TRA), Technology Acceptance Model (TAM), combined TAM and TPB, Theory of Planned Behaviour (TPB), Model of PC Utilization, Diffusion of Innovation, Motivational Model and Social Cognitive Theory. Six constructs of UTAUT based on Venkatesh (2003) are defined below.

1. Performance Expectancy: the degree to which individual believes that using the system will help him or her to attain gains in job performance
2. Effort Expectancy: the degree of ease associated with the use of system
3. Social Influence: the degree to which an individual perceives that important others believe he or she should use the new system
4. Facilitating Condition: the degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system
5. Behavioral Intention: the degree to which intention of technology usage
6. Use Behavior: behavior of technology usage

UTAUT was developed become UTAUT 2. Based on Marikyan & Papagiannidis (2021), objective of UTAUT 2 is propose behavioral model from consumer's technology acceptance and different from UTAUT that developed for testing technology in organizational scope.

2.2. TRI

TRI is a method for measuring the readiness of technology usage. Parasuraman (2000) state that technology readiness' constructs refer to tendency in embracing and using new technology to achieve target at home or office. There are four variables based on Parasuraman (2000) below.

1. Optimism: A positive view of technology and a belief that it offers people increased control, flexibility, and efficiency in their lives
2. Innovativeness: A tendency to be a technology pioneer and thought leader
3. Discomfort: A perceived lack of control over technology and a feeling of being overwhelmed by it
4. Insecurity: Distrust of technology and skepticism about its ability to work properly

Napitupulu *et al*. (2020) proposed a model called TRUTAUT, a combination between TRI and UTAUT. The objective of the study is to predict user behavior in application adoption called LAPOR! and from 13 hypotheses, there were two constructs that negatively impact such discomfort and insecurity. The proposed model of Napitupulu *et al*. (2020) is shown below.

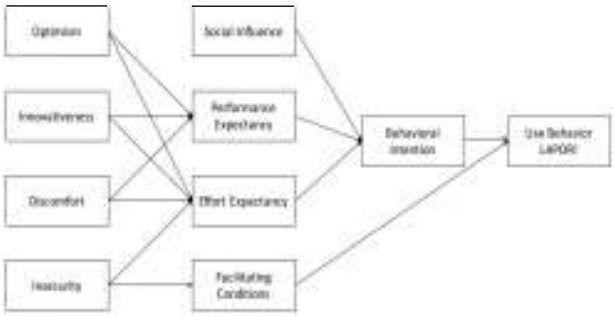

Figure 1. Proposed Model of Napitupulu *et al*. (2020)

3. METHODS

UTAUT method is used in this study because the scope is only specific to PLN ULP Makale organization. Also, it only uses contributor aspects of TRI which consists of optimism and innovativeness, while all UTAUT constructs would be used in this study. The reason of using only contributor aspects is because respondents of this study were not classified as laggard or paranoid. According to Napitupulu *et al*. (2020), technology readiness scores were classified in five categories which are explorers, pioneers, skeptics, paranoids and laggards with the latter had highest score of inhibitors dimension and lowest score of contributors dimension. Generally, people that categorized as laggards are old women with low education and low income. Paranoids tend to have interest in technology but they also consider risk factors; this is indicated by a high degree of discomfort and insecurity. Generally, women above the average with low education and income were classified into this group. The lowest education level of women employees of PLN ULP Makale is highchool and the oldest age is 45 years old. Also, their income is higher that of the minimum regional wage of Tana Toraja 2022 in the amount of Rp 3.384.876. Based on the facts, respondents of this study are not classified as laggard or paranoids, therefore inhibitors are ignored.

This quantitative study was conducted on employees of PLN ULP Makale who have downloaded New PLN Mobile and became respondents of survey on March 2022. The number of respondents of this study are 54 employees. Primary data was obtained from respondents using questionnaire with likert scale. This study was processed using SEM-PLS by SMARTPLS 3.0. application. Proposed model on this study consists of 9 hypotheses which constitutes from TRI and UTAUT theory. Hypotheses determination is based on antecedent studies. As shown in the picture below, the yellow boxes are aspects of TRI, while the white boxes are aspects of UTAUT.

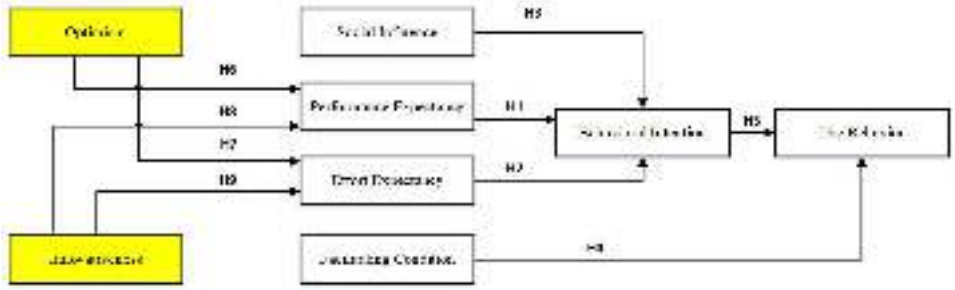

Figure 2. Proposed Model

The hypotheses of this study are below.

1. H1 : Performance expectancy has positive influence on behavioral intention.
2. H2 : Effort expectancy has positive influence on behavioral intention.
3. H3 : Social influence has positive influence on behavioral intention.
4. H4 : Facilitating conditions has positive influence on use behavior.
5. H5 : Behavioral intention has positive influence on use behavior.
6. H6 : Optimism has positive influence on performance expectancy.
7. H7 : Optimism has positive influence on effort expectancy.
8. H8 : Innovativeness has positive influence on performance expectancy.
9. H9 : Innovativeness has positive influence on effort expectancy.

4. RESULTS

This section presents the result of data processing using SMARTPLS 3.0. software. The demographic characteristics can be seen in the Table 1. Demographic of Respondents.

Table 1. Demographic of Respondents

Category	Item	Quantity	Percentage
Gender	Men	49	91%
	Women	5	9%
Age	20-25 years old	7	13%
	26-30 years old	14	26%
	31-35 years old	11	20%
	36-40 years old	5	9%
	41-45 years old	5	9%
	46-50 years old	10	19%
	51-55 years old	2	4%
Education	High School	37	69%
	Diploma	2	4%
	Bachelor	15	28%

All hypotheses are tested in SEM PLS modelling using SMARTPLS. Evaluation methods consist of outer model evaluation, inner model evaluation and hypotheses evaluation. Based on outer model evaluation, all variables have the value of Cronbach's Alpha and Composite Reliability greater than 0.8. Also, AVE value of all variables are greater than 0.5. Therefore, we can conclude that all variables are reliable.

Inner model evaluation's objective is to understand the connection between latent variables. Based on R-square value, BI and PE variables are categorized as moderate. EE and UB variables are categorized as good.

Evaluation of structural model are done by hypotheses testing. Hypotheses testing between variables is shown on Table 2. Hypotheses Testing.

Table 2. Hypotheses Testing

Hypotheses	Variable Connection	T Statistics	P Values	Result
H5	BI -> UB	4.408	0	Accepted
H2	EE -> BI	0.107	0.915	Rejected
H4	FC -> UB	7.626	0	Accepted
H9	INN -> EE	0.694	0.488	Rejected
H8	INN -> PE	0.162	0.871	Rejected
H7	OPT -> EE	5.045	0	Accepted
H6	OPT -> PE	3.575	0	Accepted
H1	PE -> BI	2.423	0.016	Accepted
H3	SI -> BI	1.634	0.103	Rejected

4.1. Performance Expectancy has positive influence on Behavioral Intention

Performance expectancy is related to the level of individual confidence in using application to improve work performance. Users believe that by using the New PLN Mobile application, they can improve their performance. For example, when transacting a power change request users only need to register through the application and get a registration number that can be purchased through any Payment Point Online Banking (PPOB). Users just have to wait at home for the execution of the request. Apart from that, this application certainly minimizes potential brokers in managing transactions at PLN. Brokers are of course detrimental to PLN customers because brokerage fees are costly for handling transactions. This research supports previous research from Pratiwi & Mauritsius (2021) where performance expectancy influences behavioral intention in terms of transactions using applications.

4.2. Facilitating Condition has positive influence on Use Behavior

Facilitating conditions is related to the facilities featured in applications that can increase users' confidence. Users believe that the facilities contained in New PLN Mobile are guaranteed security. For example, when activating a New PLN Mobile account, users need to take a selfie with their identity card (KTP) for the confirmation process which takes up to 1x24 hours. If the KTP photo is not clear then the activation process is rejected. With such activation system, users feel that there is a guarantee of security in using the application. Moreover, users can use assistance facilities in the application in the form of live chat, call center and email to assist them in using the application.

4.3. Behavioral Intention has positive influence on Use Behavior

Testing behavioral intention to use behavior produces a t-value of 4.408 and a p-value of 0.000, so based on these values where the p-value is less than 0.05 and the t-statistic value is greater than 1.96, the hypothesis is accepted. Behavioral intention reflects a person's intention to use the application. Users, in this case the FGD participants consist of employees from customer

service, technical service and health, safety and environment division, have the desire to use the New PLN Mobile application for subsequent transactions as well as the users' intention to increase transactions using the New PLN Mobile application. The existence of this intention is partly because the user, for example when making a new installation transaction, feels that his needs are met due to the convenience, thus encouraging the user to try other transactions.

4.4. Optimism has positive influence on Performance Expectancy

Testing optimism on performance expectancy produces a t-value of 3.575 and a p-value of 0.000, so based on these values where the p-value is less than 0.05 and the t-statistic value is greater than 1.96, the hypothesis is accepted. Optimism relates to user optimism in using the application because it is flexible and efficient. Users feel the flexibility in making transactions or complaints through the New PLN Mobile application because the usage is not limited in office hours. In addition, users feel that using the application is more efficient because they do not need to come to the nearest PLN office due to the facilities featured in the application has already met the user needs. This is in accordance with the research of Napitupulu et al. (2020) that optimism has a significantly positive effect on performance expectancy.

4.5. Optimism has positive influence on Effort Expectancy

Testing optimism for effort expectancy produces a t-value of 5.045 and a p-value of 0.000, so based on these values where the p-value is less than 0.05 and the t-statistic value is greater than 1.96, the hypothesis is accepted. This means that there is a positive optimism or belief in using the application because of its convenience. Users feel that making transactions using the New PLN Mobile application is faster than contacting the PLN call center (area code) 123 or asking directly to the nearest PLN office. Users feel that the New PLN Mobile application is quite easy to understand. This is in accordance with the research of Napitupulu et al. (2020) that optimism has a significantly positive effect on effort expectancy.

4.6. Employees' Readiness as Application Agent

It can be said that PLN ULP Makale employees are not ready to become application agents because there is still a low number of employees who have marketed the application to customers and no internal guide to assist them in using the application. The guides that have existed so far are in the form of FAQs or chatbot menus which tend to take a lengthy time to get the feedback. A short guide is needed by employees when helping customers as new users to show the menus that are important and frequently used by customers. Even the pop up menu guide for the account activation menu doesn't appear so employees often forget to inform to the customers. In fact, account activation is required so that customers can transact. Adding guide features requires further development process by the head office, therefore what can be done currently is to conduct more in-depth training for employees and distribute mini guides in the form of pamphlets or e-pamphlets regarding how to activate accounts, using SwaCAM, request new installs and power increase. So, when employees forget about the account activation method during socialization to customers, employees can see it in the form of pamphlets or e-pamphlets and can even share it with the customers.

In addition, to increase employee awareness and readiness to carry out application marketing to customers, it is necessary to have firm's support and firm's mandatory. This is in line with research conducted by Blut & Wang (2020) which adds moderating effects in the form of technology, firm, country and controls. In this study, technology, firm, country and controls moderate between technology readiness and application use. The Blut & Wang (2020) research

model uses 193 independent samples extracted from 163 articles regarding customer service and application marketing. The model that can be proposed in this study is by adding a moderating variable in the valid model obtained from the results of SEM-PLS data processing using SMARTPLS 3.0. The model is depicted in Figure 4.8. Valid Model with Firm's Mandatory Moderation and Support

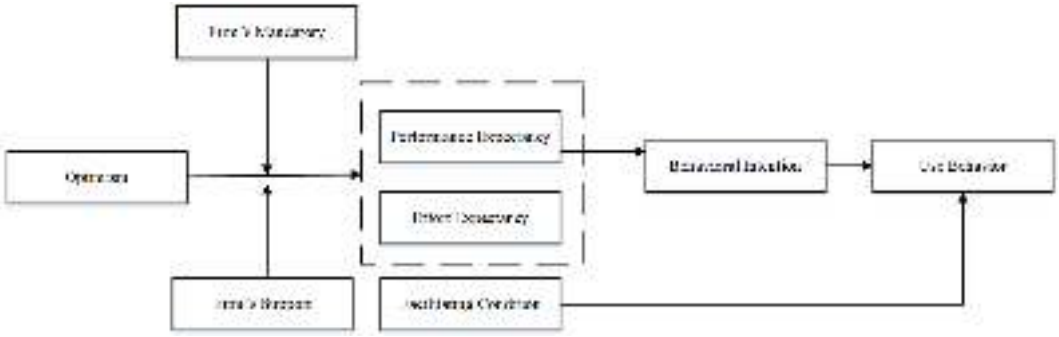

Figure 3. Valid Model with Firm's Mandatory Moderation and Support

The moderating variable can also be tested for the purpose of new theoretical insights (Rahadi et al., 2021). Firm's mandatory makes employees feel obligated to do application marketing with set targets. These marketing tasks need to be included in the worker job description rules for each section and each Customer Service Unit needs to document them and ensure that every employee understands the job description. Firm's support in the form of incentives, for example, can increase employee morale in achieving marketing targets and firm's support in the form of guides or training for employees can facilitate their performance in carrying out application marketing tasks in order to achieve targets. Massive marketing by employees will affect the as well massive use of the New PLN Mobile application. Moreover, the widespread use of the New PLN Mobile application indirectly supports a sustainable digital lifestyle by minimizing paper consumption because every transaction's output is stored in digital form and also reduces customers' need to travel because people can do transactions conveniently anywhere.

6. CONCLUSIONS

Factors that influence employee acceptance and readiness to use the New PLN Mobile application are performance expectancy, effort expectancy, behavioral intention, facilitating conditions, use behavior, and optimism. The readiness of employees as application agents can be said to be not yet achieved because there are no supporting factors such as a guide or marketing targets contained in the job desk document. Therefore, to increase employee readiness there is a need for firm's support and firm's mandatory factors. Firm's support in the form of incentives can motivate employees to carry out massive marketing. Firm's mandatory in the form of performance targets contained in job description can increase employees' awareness regarding their obligations in conducting marketing in order to achieves target.

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RECOMMENDATION OF INFORMATION TECHNOLOGY GOVERNANCE USING COBIT 2019

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ABSTRACT

The presence of Information technology in the world of education brings many changes in teaching and learning activities process. XYZ Campus carries out the Tri Dharma of Higher Education and the administration process does not escape the use of IT. One of the programs contained in Strategic Plan is make organization structure management unit Information Technology but currently this has not been realized so that problems often occur in management of IT resources and risk that are not managed properly result in management of IT being not optimal. By studying the literature, conducting interviews, and distributing questioners with reference to COBIT 2019. Important processes were obtained namely BAI02, BAI03, BAI06, BAI07, BAI09, BAI10 and BAI11 but based on discussions with leadership so that the objective process was obtained which become priority namely APO04, APO07 and BAI09. The result of the assessment that the IT process is still in one level its mean that there are still many activities that have not been do. The output of this research are recommendations for good IT management to support organization goals.

Keywords: Recommendation, Governance, Information Technology, COBIT 2019

1. INTRODUCTION

The role of information technology brings many changes in teaching and learning process, especially at the advanced level of Education High Schools which are required to carry out innovative learning. The demands of using IT require a good IT governance approach Sulistyoati (2021),IT governance is a concept that has developed from the private sector, but with the development of the use of IT by the public sector and governance must also be applied in sectors that demand a lot of service is part of organizational governance which includes system and information technology and risk management. Elazhary .(2022) IT governance is very important role to increasing the value of business. Implementation of effective governance will provide added value provide added value such as increasing public trust in an organization or company. Joshi et al. (2022) the benefits of IT governance are very important in making decisions such as how to use existing IT assets and can be used in assessing the expected achievements by an organization. The implementation of good governance will improve the bossiness to be run and make it possible to avoid risk- prone threats, because implementing governance not only provide added value of the organization but also provides risk opportunities if not manage properly. Magnusson, Koutsikouri, and Päivärinta (2020)The ambidexterity design suggest that the success of organization needs to exploited because it provides opportunities for achieving efficient

governance innovations Magnusson, Koutsikouri, and Päivärinta.(2020) by IT governance (ITG) mechanism can bring changes in governance process so that they are considered important by the organization because it can know a person's behavior through more effective participation.

In strategic plan document owned by one of the High School (XYZ Campus) one of priority program is creating an organizational structure for the informational structure for information technology management unit but not have been implemented so the resources cannot be managed well so causing many problems such as risk of violations of data security and compliance with the regulations committed by several us unscrupulous exiting staff to the detriment of the XYZ Campus. Therefor this research conducted to assist XYZ campus XYZ to realizing one of the priority programs contained in strategic plan. Baskici and Ercil (2020) A strategic plan is a plan that will be executed by decision makers as a strategic source of information for the future. The purpose of this study is to make an IT governance plan in recommendations form for XYZ Campus to help achieve the IT goals caontained the strategic plan document. The recommendations given refer to ISACA book by title Governance and Management Objectives ISACA (2019) COBIT 2019 has five domains consisting of 40 objective process that provide solutions related organization governance.

2. LITERATURE REVIEW

There are several studies that are relevant to this research as carried out by Indrawanti (2022) Regarding the design IT governance based on COBIT 2019 in technology division of PT Telkom Indonesia city of Bandung by result that capability level IT process average on level 4 , Its mean that the process is active and position is defined with good performance. (Sutomo and Saputra (2017)Conduct the research about design IT governance because IT governance that was implemented not as expected because the lack of understanding of computer use and there are no procedures for using IT and results of the research is suggestions form for improving governance for DSS01, APO07 and DSS05 according to the recommendations that have been given by the author. System or organization control is very important do. Mohamed, Kaur, and Singh (2012) To monitor performance of organizational with the aim to knowing the effectiveness of IT governance and organizational performance by make a connections organization culture, organization's external environment, the characteristics of the IT used and organization performance are explored well. Priyadarsini and Kumar (2022)The organization environment has strong influence to controlling the internal system to conduct an analysis of IT governance framework using COBIT to assess the company's internal court System. Naim et al. (2021)It decision-making has significant influence on change in IT governance and increases the effectiveness and efficiency of managing IT resources to support strategic objectives. Organization Governance is carried out systematically Ilmudeen (2022) there is a positive impact from innovative speed of good governance mechanisms. Joshi et al (2022)Introduce the concept of measuring IT governance as company's ability to identify, design, implement and utilize governance process. To find conditions of organization so needed to do assessment like was done by Herianto and Wasilah (2022)about assessment Capability and maturity level IT governance and result of the research capability and maturity level OF IT governance with important objective domain with important value of >60 and capability target is 4.00 namely in the objective with domain APO11, APO13, DSS02, and DSS03. The importance of technology to achieve the goals it wants to achieve. Zhang and Qian (2020)Investments of IT to increase the efficiency from governance contract in relation to sophisticated IT can be increase efficiency in contract design and provision of implementation protection contracts. Nfuka and Rusu (2011) Analyzed the influence of critical success factors on resources factors on resources by analizyng the relationship

between CSF and IT governance to produce a CSF model for affective IT governance and resources

3. METHODS

The kinds of research that was used secondary research that conduct by interviews and discussions with the leaders of Campus XYZ to determine the priority objectives proses. Data collection was also carried out by distributing questioners by used google form to respondents to find the current condition of IT process. The methodology used is adopt the roadmap implementation approach COBIT 2019 to design IT governance there are four steps are carried out: **Stage 1** understand the organization context and strategy by interviewing the leaders in Campus XYZ to identify organization strategy, to knowing the current organization strategy. **Stage 2** Determines the initial scope of governance system by considering aspects of design factor 1 to design factor 4 **Stage 3** Identified improvements to the initial scope of the governance system by considering aspects of design factor 5 to design factor 11 in design guide COBIT 2019. **Stage 4** the final stage is concluding the design governance system. The output from all design factor is summary score from-100-100. Scale 75 above are target of governance.

4. RESULTS

The results of four stages to design IT governance in this research based on COBIT 2019.

4.1. Understand the organization context and strategy.

To understand and determine organization strategy based on design factor criteria COBIT 2019. XYZ Campus strategy has focus on providing innovation services to university students.

4.2. Determine The Initial Scope of the Governance System

4.2.1. Design Factor 1 Organization Strategi

To Find out the organization strategy, interview were conducted with stakeholders Campus XYZ by reference to questions contained in COBIT 2019 Toolkit, known that the focus of XYZ campus is innovation service

4.2.2 Design Factor 2

Based of interviews with stakeholders of XYZ Campus **Figure 4.1** explaining golds of XYZ Campus focus are EG07 (focus on information quality), EG013 (Focus on digital transformation programs) and EG14 (focus on innovations) with important level 5

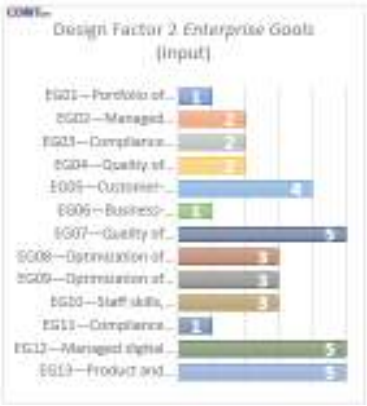

Figure 4.1. Enterprise goals

(Toolkit COBIT 2019)

4.2.3. Design factor 3 (IT Risk Profile)

Based on the design factor 3 assessment that the very high IT risk of XYZ Campus are unauthorized action and risk of data and information that is not kept secure **Figure 4.2**

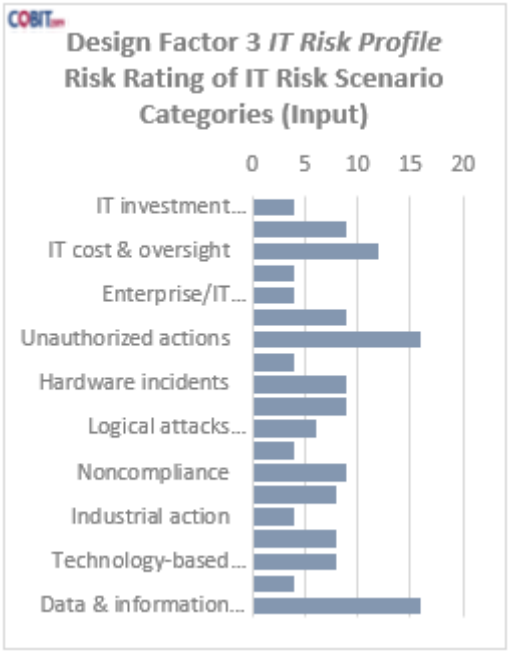

Figure 4.2 IT Risk Profile
(Toolkit COBIT 2019)

4.2.4. Design Factor 4 IT Related Issues

Based on design factor 4 assessment **Figure 4.3** The problems that often occur are such as the problem of service delivery by outsourcing IT. substantial hidden and rogue IT, deployment of IT by abnormal use, insufficient IT resources, staff with dissatisfaction, Reluctance of members leadership to engage wit IT or lack of commitment Complex operating models and unclear decision mechanism related IT decisions and high IT costs.

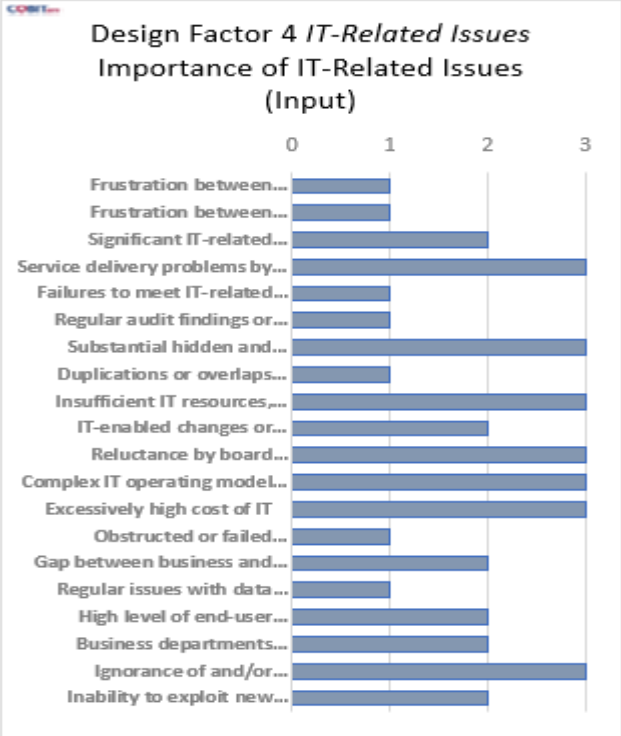

Figure 4.3 Design factor 4 IT Related Issues (Toolkit COBIT 2019)

4.3. Refine the Scope of the Governance System

4.3.1. Design Factor 5

Based on interviews conducted with stakeholders of XYZ Campus in **Figure 4.4** about IT Threat landscape 65% it is mean that fully explained that environment that has normal level of threat

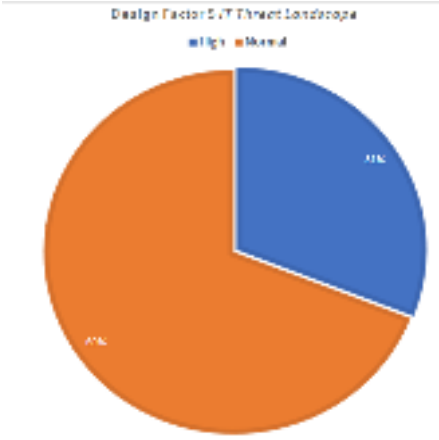

Figure 4.4. Design Factor 5 IT Threat Lanscape (Toolkit COBIT 2019)

4.3.1. Design Factor 6

Based on the result of interviews in **Figure 4.5**. The types of regulations implemented by XYZ Campus is 71% it is mean that normal types of regulations. It is said to apply a normal type because it obeys regulations made by the governance.

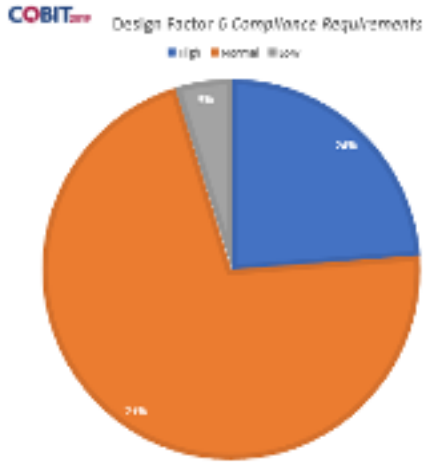

Figure 4.5.Design Factor 6 Compliance Requirements Toolkit COBIT 2019

4.3.2. Design Factor 7 Role Of IT

Besed result of interview in figure 4.6. the role of IT in XYZ Campus with the high important level are support, turnaroud and strategy. It mean that because it can change things that are strategic in the organizatio, such as management changes and technology change.

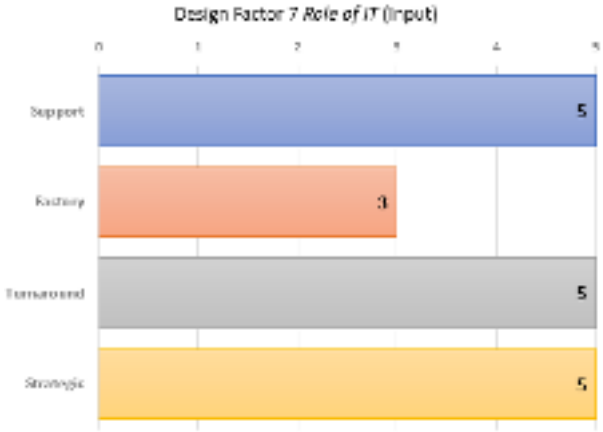

Figure 4.6. Design Factor 7 Role of IT Toolkit COBIT 2019

4.3.3. Design factor 8 IT Sourcing Model

Based on results of the interview **Figure 4.7** outsourching has the hoghest percentage in IT modeling in XYZ Campus is 45% it is mean that. The implementing of IT used more outsourching as an IT service provider organizations

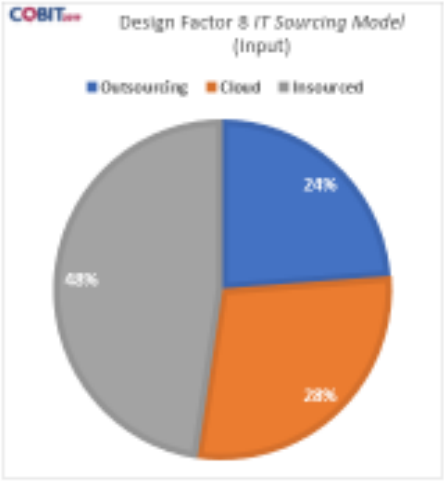

Figure 4.7. Desain Factor 8 IT Sourching Model
Toolkit COBIT 2019

4.3.4. Design Factor 9 IT Implementation Method

Based on result of interviews **Figure 4.8** XYZ Campus show that Agile with percentage 48% method in carrying out IT implementation.

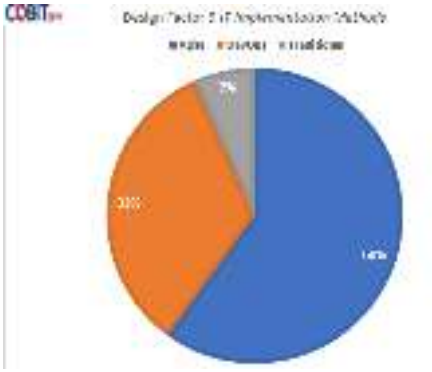

Figure 4.8 Desgn Factor 9 IT Implementation Method
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4.3.5. Design factor 10 Technology Adoption Strategy

Based on result of interviews with Stakeholders XYZ Campus **Figure 4.9** because it is informatic Campus so Technology adoption strategy want to adopting and implementing by XYZ Campus is the first mover

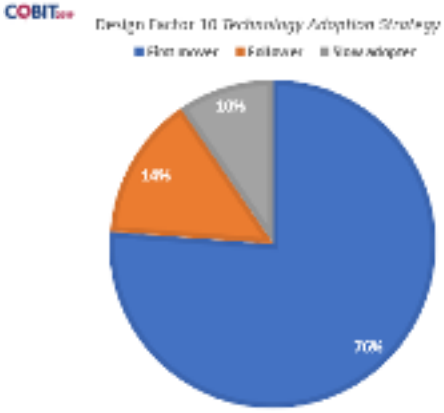

Figure 4.9. Design Factor 10 Technology Adoption Strategy

4.4. Conclude the Governance System Design

Resulths of desain factor asssements that have score 75 above are BAI02, BAI03, BAI06, BAI07,BAI09, BAI010 and BAI11 however, after discusing with leaders of XYZ Campus determine priority domain proces COBIT are APO04,APO09 and BAI09 **Table 4.1**. While based result of questioners for level 2 that ditributed to responding is known that the current level of IT process is still in level 1 **Table 4.1.** It maen that XYZ Campus has not implemented the program contained in the strategic plan

Table 4.1. Gap Analysis of Current and expected IT Process

Process	Current of Capability Level	Expected level of Capability	Gap
APO04	1	3	3
APO07	1	3	2
BAI09	1	4	3

Based of result analysis, there are gap between current of capability level and expected level of capability as presented in **Table 4.1** its mean that IT implementation that used in XYZ Campus is not aligned with organization goals.

4.5. Recommendations

To support organization goals through the realization of programs that contained in strategic plan document of XYZ Campus. The corrective action that must be do is IT governance planning do by referring to the ISACA book by title Governance and management Objective COBIT 2019 with the following components.

1. IT Domain Process
   Name of IT domain process selected.
2. Objective process domain
   The objectives that focus to policy objectives for IT process
3. Organization goal
   Shows a set of alignment goals and the main achievements of the organization.
4. Key Governance practices
   Know the practices that can be do related the IT Process
5. Key Governance practice
   Focus on indicators that can be used to measuring the effectiveness of organization to achieving organization goal through implementation.
6. Work result
   Shows output of implementation process.
7. Map of Roles of Responsibilities
   Identify the responsible key practice from each selected IT Process

6. CONCLUSIONS

Based on results of the research. Can be conclude that:

1. The results of domain COBIT selecting are BAI02, BAI03, BAI06, BAI07, BAI09, BAI09, BAI10 and BAI11 but based on discussions with leaders of XYZ Campus that the priority objective process are APO04, APO07, and BAI09.The capability level of IT process XYZ Campus still in level 1 **Table 4.1**
2. XYZ Campus does not yet have an IT management unit, its mean that the priority programs contain in Strategic Plan documents have not been implemented.

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THE ANALYSIS OF RISK RESPONSE ON WELL-CONNECTION IN "MAHAKAM BLOCK"

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ABSTRACT

Well connection connects a new well to an existing facility for flowing oil and gas production. The result of risk identification on well-connection in the previous research shows that 11 risk factors affect the cost and the completion time and increase costs in well-connection operations. Some identified risk is categorized as significant (unacceptable). Those risks are shutdown planning, the delay of the material delivery, the drilling sequence, and the contractor's financial condition. Risk factors that significantly affect time and cost need to be solved using risk response planning to reduce the level of probability and impact. Determining the risk response options is done using the Bow-Tie Analysis (BTA) method, followed by a Focus Group Discussion (FGD) to validate the most appropriate option. The FGD method is carried out with experienced personnel such as project managers, senior engineers, site superintendents, and site supervisors who are involved in this job. Residual risk analysis is carried out by assessing the probability level and the impact. Residual risk analysis is also carried out by evaluating the amount of risk response costs using the FGD method. The final results of this study are 34 factors that cause risk, then 75 preventive risk response options and 38 curative response options can be done. Implementing this risk response can result in a decrease in the probability level of 52.56%, a reduction in the impact on costs by 25.96%, and a reduced 28.43% impact on time.

Keywords: Cost, Response, Risk, Well-connection.

1. INTRODUCTION

Indonesia has an oil and gas production target used as state revenue from the oil and gas industry. Increasing the number of potential new wells is necessary to achieve the targeted oil and gas production. Wells with high production potential have preparation for drilling up to connecting a new well to an existing one.

Most well development is placed in the delta area or the swamp area. The well-connection job in the swamp area has the highest level of complexity compared to the offshore site. It is due to natural conditions and the ongoing developed facilities. The well-connection activity has high complexity and high risk. So, it needs proper handling as a step in the risk management process.

Kurniawan (2014) has carried out one of the stages of risk management, namely, a risk assessment. It contains the well-connection operation's risk identification, analysis, and evaluation stages. The risk assessment in the risk management process refers to the ISO 31000:2018 standard. The well-connection risk assessment results found that there were 11 significant risk factors, namely unacceptable risks, including shutdown planning, material delivery delays, life production facilities,

scope creep, and SIMOPS activities. Some significant risk factors indeed inhibit job completion on time.

Hamed (2020) states that integrated and coherent risk response planning can reduce threats and maximize outcomes in improving and developing risk management processes. Integrated and coherent risk response planning can ensure the success of a project and overcome obstacles at the lowest cost.

Recently, within the period the risk analysis is carried out, the bad impact on costs and completion time of well-connection work still occurs frequently. It is due to risk response planning that has not been well integrated and precisely managed so that risks arise repeatedly. This study attempts to formulate a comprehensive and well-integrated risk response using the bow-tie analysis (BTA) method. SNI-13010 (2016) states that the BTA method can be recommended in conducting a risk analysis because the BTA method is described in a simple chart to analyze the risk path from the cause to the effect. The BTA method is also a risk analysis method that combines fault tree analysis (FTA) and Event Tree Analysis (ETA) to focus on the failure control path.

The problems above suggest that it is important to carry out a proper risk response planning study on well-connection work. It is not only limited to risk response planning but the risk management process iterations are also required to evaluate residual risk and assess risk response costs. The results of this evaluation, management must consider and focus on determining and implementing the best risk response. So, the risks of well-connection work can be accepted.

2. LITERATURE REVIEW

Kerzner (2017); Mulcahy (2019) suggests risk management is a systematic and proactive approach to controlling the project. It includes several phases, including risk planning, risk identification, risk analysis, and measurement, development of strategies for managing risk, and policy supervision so that it is predicted how far these risks can be changed.

Fiorentini (2022) suggests that Comprehensive risk identification is very important because risks not identified at this stage will not be considered in subsequent analysis. The identification should include risks whose sources are not under the organization's control, even when it does not immediately identify their source or cause. Risk identification should also include examining the chain of accidents, exposure, and cumulative effects.

Fiorentini (2022) suggests that risk analysis combines the consequences and associated probabilities of risk events identified in the previous hazard identification phase. It also considers the presence of controlling existing effectiveness measures. The level of consequence and probability of occurrence are then combined to determine the level of risk (low, medium, or high), which is defined by ISO 73 Guidance as the magnitude of the risk or risk combination expressed in terms of the consequences combination and their likelihood.

PMI (2017) Plan Risk Response is developing response options, selecting strategies, and accepting response options that can be aimed at the overall risk exposure. Risk responses can be proactive or preventive; some are used for correction or curative. Preventative action is useful for reducing risk possibility or probability. Meanwhile, curative action reduces the consequence of risks and possible impacts.

IEC/ISO 31010 (2016) Bow-tie analysis (BTA) is a diagrammatic method for describing and analyzing the risk from cause to impact. This method is often considered a combination of the fault tree analysis (FTA) method. This method analyzes the causes of events with the event tree analysis (ETA) method, which analyzes the impact. Lewis (2010) states that the top events that occur are the release of danger (when the hazard is released) and the loss of control (when the control is lost).

Residual risk is the risk that occurs after taking into account the controls that have been implemented to reduce the impact of the main risk. Monahan (2008) residual risk can have the same value as the initial risk if the applied controls have no effect. So, organizations must focus on implementing controls so that objectives can run optimally. The cost risk is managing risk and incurring losses due to risk. Jensen (2017) The total cost risk is the sum of all aspects of an organization's operations related to risk, including retained (uninsured) losses and related loss adjustment costs, risk control costs, transfer fees, and administrative costs.

Well-connection is an activity of connecting a new well to an existing production facility. Then this connection can channel the oil or gas from the well, and those resources can be produced and processed further. In well-connection operation, a series of activities are quite complex and involve scientific disciplines, namely structure, mechanical & piping, electrical, and instrumentation.

Kurniawan (2014) analyzed risk factors in well-connection work, especially on the cost impact and time. It also discusses the stages of risk management in well-connection. The stages of risk analysis are carried out by identifying the risk, describing the impact, calculating the risk impact on cost and time, testing the mean of average cost and time, and assessing the most dominant risk with a different test based on the index ratio.

The research was conducted using the Focus Group Discussion (FGD) method to identify risks and determine the probability scale and impact of these risks. The variables used in determining risk factors are based on socio-political, economical-financial-tax risk, contractual risk, organizational risk, supplier risk, and Occupational Safety and Health (OSH) risk. From all the stages above, it can be concluded that 11 risk factors affect the cost and completion time of the well-connection operation.

3. METHODS

This study used qualitative methods, where qualitative analysis was carried out in the risk response planning stage, assisted by the Bow-tie analysis (BTA) method and residual risk evaluation after implementing the risk response. This research site was on the well-connection in the Mahakam block area, which has a high level of risk and complexity, so proper risk management is needed. In addition, carrying out risk response analysis in this work is based on previous research related to risk analysis on well-connection that has been completed. So, the implementation of this research involved personnel in well-connection and experienced in similar construction fields.

The analysis in this study starts with analyzing the company guidelines such as SOPs, RBS, risk registers, and work data. Risk response planning is carried out using the Bow-Tie Analysis (BTA) method so that it is easier to describe the sources of risk, consequences, and preventive and curative action nodes. The results of the bow-tie analysis were then validated by the personnel involved in the well-connection work, including project managers, senior engineers, site superintendents, site planners, fabrication and quality coordinators, and site supervisors. Selecting risk responses were validated in a Focus Group Discussion (FGD) forum. Participants were shown risk response options and then given a detailed explanation. The participants then gave their views according to their respective expertise and experiences while involved in well-connection or similar construction work.

The next analysis stage is residual risk analysis, which was selected in the previous stage. Residual risk analysis is carried out by assessing the probability of the impact of risk on cost and time by giving a questionnaire to FGD members. An assessment of risk response costs follows residual risk analysis by assessing the previous work documents and determining the number of response costs that have been carried out.

4. RESULTS

4.1.Risk Response Planning

Risk response planning is part of preparing response options, selecting options, and validating response options to be implemented in well-connection work. Risk response planning begins with preparing risk response options based on 11 significant risk factors resulting from well-connection job risk analysis in previous studies. Risk response planning is based on the project's risk breakdown structure (RBS) in the Individual Work Procedure (TKI) related to Project Risk Management.

Kurniawan (2014) states that One of the 11 risk factors, namely risk with the RISK-01 code, namely Shutdown Planning, is a risk in the organizational category that has a relationship with a project or work coordination, communication, and management involvement both internally and externally. Shutdown planning is also part of the specific risks in fabrication activities and closely relates to RISK-10, namely SIMOPS activities.

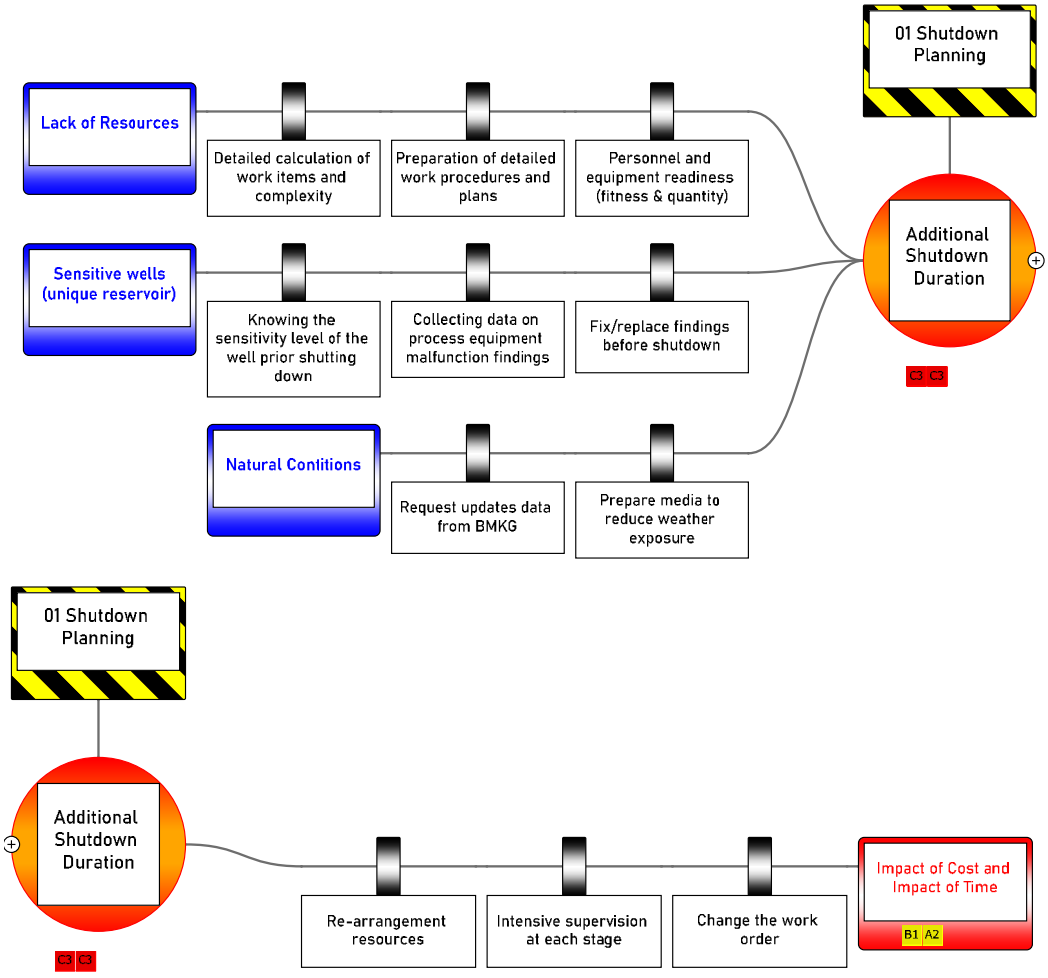

Figure 1. BTA diagram on the risk of shutdown planning

The chart in the BTA assessment above shows that the first step in conducting the analysis is to identify the causes of risk, which in the shutdown planning risk have contributing factors such

as a lack of resources, sensitive wells, and natural conditions. It is necessary to take action to address the causes of a lack of resources, which includes detailed calculation of work items & complexity, preparation of detailed work procedures and plans, readiness of personnel and equipment (fitness & quantity). According to the findings of the analysis, implementing the three preventive actions can help to avoid resource shortages.

Table 2 contains the following information: it used secondary data analysis from the risk register, risk breakdown structure (RBS), and working reports to determine the risk response options. The data is processed qualitatively to get the suitable risk response options in reducing the possibility of risk based on causal factors. The stages of selecting a risk response use the BTA method in placing appropriate preventive actions in each chart described. The last risk response planning stage is conducting validation in the FGD forum to obtain input according to the expertise of each participant. In this discussion, each FGD participant provided a point of view on each comprehensive risk response option. Participants can revise, add, and remove risk response options considered less relevant and effective.

As an example, when obtaining an identified risk response option with code "KUR-11", it is necessary to take curative action by re-arranging a new schedule for work progress in order to reduce the impact on costs and time. Participants in the FGD discussion given insight on the need to arrange resource requirements in the schedule changes made. As a result of the collective agreement and validation, the risk response option developed into a re-setting schedules and resources.

Table 1. The results of the agreement in the FGD forum

Risk Response Code **1**	**Risk Response Options** **2**	**Selected (Yes/No)** **3**
PRE-11	Detailed calculation of work items & complexity	YES (revision)
PRE-12	Preparation of detailed work procedures and plans	YES
PRE-13	Readiness of personnel and equipment (fitness & quantity)	YES
PRE-14	Monitoring the sensitivity level of the well before shutting down	YES
PRE-15	Collecting data on findings of process equipment malfunctions	YES
PRE-16	Fix/replace findings before shutdown	YES
PRE-17	Request the latest data from *BMKG*	YES
PRE-18	Prepare media to reduce weather exposure	YES
KUR-11	Resetting schedules and resources	YES (revision)
KUR-12	Supervision is more intensive at each stage	YES
KUR-13	Change the order of work	YES (additional)

Note: PRE =Preventive Action; KUR = Curative Action

The analysis uses the Bow-Tie Analysis (BTA) method in risk response planning to obtain causal factors, consequences, and preventive and curative actions. Table 1 shows that the results of preparing risk response options were discussed in the FGD forum with the workers involved: project managers, senior engineers, site superintendents, site planners, fabrication coordinators, QC coordinators, and site supervisors. The FGD members held discussions to provide input and approval based on their expertise and experience.

Table 1 presents the validation results of risk response options in RISK-01, namely Shutdown planning. It is known that 3 risk factors cause risk. The preparation of risk response

options results from the three causal factors. Implementing eight (8) preventive options is necessary to reduce the probability of a risk occurring. There are 3 curative actions to minimize the impact on costs and time. The risk response planning process is also carried out for 10 other risks to obtain causal factors and preventive and curative actions. From 11 risk factors in well-connection work, 34 causes of risk and 75 risk responses are required as preventive actions and 38 risk response options as curative actions.

4.2.Residual Risk Evaluation

Risk identification is unquestionably the first step; but nevertheless, leaving these risks neglected is just as dangerous as not identifying them. Risks' severity levels in relation to the established risk tolerance criteria determine whether they should be given appropriate treatment. During the risk identification stage, an analysis is performed to determine the level of significance of a risk, as previous researchers (Kurniawan, 2014) have concluded there are eleven risks things that affect well connection work as shown in table 2. The eleven significant risk factors necessarily require response to reduce the probability and impact of the risk occurring. Even though Residual Risk is defined as the risk that remains after proper handling, it is important to discuss risk management techniques, or risk response action planning strategies using the BTA method.

After implementing 75 preventive risk responses, residual risk was evaluated by questionnaire distributed to 13 FGD members to assess risk probability. The assessment was also performed to determine the impact of the remaining risks following the implementation of the 38 curative responses. According to the questions on the initial risk assessment in previous studies, respondents were given questions and a choice of assessment levels on probability and effect.

Table 2. Risk variable of initial work risk analysis result on well-connection

Code 1	Risk Variable 2	Probability 3	The effect on the cost 4	The effect on time 5	Risk Index 6			
					Cost		Time	
					N	K	N	K
Risk-01	Shutdown Planning	2,80	3,07	2,67	8	Unacceptable	7	Unacceptable
Risk-02	Late delivery material	3,00	2,80	3,20	8	Unacceptable	8	Unacceptable
Risk-03	Drilling Sequence / Program	2,87	2,87	2,60	8	Unacceptable	7	Unacceptable
Risk-04	Delay in mobilization	2,73	2,33	3,33	6	Major	8	Unacceptable
Risk-05	Life existing facilities	3,00	2,73	2,67	8	Unacceptable	8	Unacceptable
Risk-06	Limited qualified contractors	2,73	2,93	2,93	8	Unacceptable	8	Unacceptable
Risk-07	Material Stock Management	3,13	2,47	2,60	8	Unacceptable	8	Unacceptable
Risk-08	Change in the scope of work	2,80	2,73	2,87	8	Unacceptable	8	Unacceptable
Risk-09	CTR Financial Condition	2,87	2,60	3,20	7	Unacceptable	8	Unacceptable
Risk-10	SIMOPS activity	2,80	2,60	2,40	7	Unacceptable	7	Unacceptable

Code 1	Risk Variable 2	Probability 3	The effect on the cost 4	The effect on time 5	Risk Index 6			
					Cost		Time	
					N	K	N	K
Risk-11	The received material is the low quality /rejected	2,40	3,00	3,13	7	Unacceptable	8	Unacceptable
Average		2,83	2,74	2,87				

Source: Kurniawan, (2014), The Cost Risk Analysis and Project Completion Time on Well-Connection in the Mahakam Block (*translated*)

As a comparison purposes of residual risk evaluation in this study, consider the risk factor with code RISK-01 for shutdown planning, where the risk index for cost and time is 8 and 7 respectively, both of which are unacceptable risks. Three causal factors were identified as a result of risk response planning using the BTA method: a lack of resources, sensitive wells, and natural conditions. Eight preventive actions were obtained from the three causal factors to reduce the probability level of risk, and three curative actions were obtained to reduce the impact level.

The results of processing the questionnaire data show that the majority of respondents answered that the implementation of these preventive measures caused a decrease in the level of probability, as well as the existence of curative measures, but that there should not be a significant decrease. As shown in table 3, the residual risk evaluation on shutdown planning risk generated a mean value of 1.31 and a mean value of 2.15 and 2.31 for the impact on costs and time, respectively. As a result of calculating the probability and impact, the risk index on cost and time both has a value of 3, placing them in the very low category.

Table 3. Residual risk evaluation results and residual risk index calculations

Code 1	Risk Variable 2	Probability 3	Impact on costs 4	Impact on time 5	risk index 6			
					Cost		Time	
					N	K	N	K
Risk-01	Shutdown Planning	1.31	2,15	2,31	3	Very Low	3	Very Low
Risk-02	Late delivery materials	1.31	2,23	2.38	3	Very Low	3	Very Low
Risk-03	Drilling Sequences / Programs	1.46	1.85	1.69	3	Very Low	2	Negligible
Risk-04	Delay in mobilization	1.46	2.00	2.46	3	Very Low	4	Low
Risk-05	Life existing facilities	1.31	1.85	1.92	2	Negligible	3	Very Low
Risk-06	Limited qualified contractors	1.38	2.08	2,31	3	Very Low	3	Very Low
Risk-07	Material Stock Management	1.38	2,31	1.69	3	Very Low	2	Negligible
Risk-08	Change in the scope of work	1.31	1.69	2,15	2	Negligible	3	Very Low
Risk-09	Contractor's Financial Conditions	1.23	1.92	1.85	2	Negligible	2	Negligible
Risk-10	SIMOPS activity	1.38	2.00	1.69	3	Very Low	2	Negligible

Code 1	Risk Variable 2	Probability 3	Impact on costs 4	Impact on time 5	risk index 6			
					Cost		Time	
					N	K	N	K
Risk-11	The incoming material is in a low quality/rejected	1.23	2,23	2,15	3	Very Low	3	Very Low
Average		1,34	2,03	2,06				

Based on the results of the analysis shown in table 3, it is known that there has been a significant decrease in probability. It is also shown in Risk-01 Shutdown planning, where the initial mean risk value is 2.80. There has been a decrease to 1.31 due to the application of the selected risk response at the initial stage of the analysis. Likewise, the impact on costs, in Risk-01, the initial risk is known to have an effect of 3.07 and can be reduced to 2.15, while the impact on time managed to decrease from 2.67 to 2.31.

Overall, the average of the 11 risks is known that the probability has decreased by 52.56% to 1.34, while the impact on costs and time has reduced by 25.96% and 28.43%, respectively. So large reduction, the risk index can decrease into low, very low, and negligible, where those three categories are included in the acceptable category.

Based on the analysis results of the related risk response and the analysis of the cost of risk response, several causes influence the occurrence of these risks. The factors that cause risks must be considered include the availability of transportation facilities, long lead items, work documents, the readiness of drilling locations, equipment that is not yet certified, facilities hit by boom cranes, contractors and personnel who lack experience, material needs that exceed stock, social conditions of the surrounding community, poor financial monitoring, and material availability in the market.

The analysis results show the need for project management entities to prepare a comprehensive work execution plan at each stage and integrate all related entities known by stakeholders. On the other hand, related to job risk management, it is important to know the parties, contractors, and companies to examine the risks in detail that can affect work implementation. So those parties understand their responsibilities in the work process.

6. CONCLUSIONS

The research was conducted and validated in Focus Group Discussion (FGD). It was found that there were 34 causes of eleven risk factors and 75 responses to risks. Then, preventive actions and 38 reactions to risks are needed as curative actions to reduce the effect of cost and time in completing a well-connection work.

Residual risk evaluation is carried out with preventive and curative measures. It resulted in a decrease in the average probability value of 52.56% to an average of 1.34, an average decrease in the value of the coating impact by 25.96% to an average of 2.03, and reducing the average value of the effect of time by 28.43% to an average of 2.06.

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DESIGNING OPTIMUM INVENTORY POLICY: A CASE STUDY OF THE STATE-OWN ELECTRICITY COMPANY

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ABSTRACT

This paper evaluates and designs an inventory policy for a state-own electricity distribution company. The objective of the study is to determine the optimal inventory levels to satisfy customer demand whilst minimizing cost. The products unders study are all products required for new-install and power-update demands. New-Install demands occur when customers requires new electricity connection, whilst power-update demand occurs when existing customers requires upgrade of their electricity power subscription. Both new-install and power-update demands require some materials including kilowatt-hour meters (KWH-Meters) and Mini-Circuit-Breaker (MCB). Utilizing Exponential Smoothing and Artificial Neural Network techniques, an estimation of the demand for Pasang Baru and Perubahan Daya was made. The Economic Order Quantity (EOQ) method was used to determine optimum order for Kwh-Meters and MCBs. Reorder point and Safety stock were also calculated with service level of 95%. A total inventory cost of IDR 47 billion was calculated using the EOQ method, which is 20% more efficient than the existing condition method.

Keywords: Economic Order Quantity, Reorder Point, Safety Stock, Exponential Smoothing, Artificial Neural Network.

1. INTRODUCTION

Inventories appear in various places in various forms and functions throughout the supply chain process. According to Pujawan and Mahendrawati (2010), this uncertainty is experienced by companies operating with a make-to-stock system. Material inventory control is a very important activity to improve the reliability of electric power distribution. The availability of materials must be maintained so that operational activities run well. PT. PLN (Persero) has a Key Performance Indicator (KPI) for customer services in the form of increasing the number of customers and electricity usage. Increasing the number of customers can be carried out with a business activity called Pasang Baru (PB) while the use of electric power can be optimized with a Perubahan Daya (PD) business activity.

Based on the realization of the performance of Pasang Baru and Perubahan Daya services in 2021, it is known that the average service level was 87.5%, where the lowest achievement occurred in December, which was 84.5%, while the highest achievement occurred in April, which was 90.8%. Restitution in 2021 is caused by various things, such as buildings that are not ready, need network expansion, materials not available, permits, Certificates of Operation Worthiness

that are not ready, etc. It can be seen that most are caused by material shortages or material is not available, namely 35.75%. Based on data from the Marketing Department of PT. PLN (Persero) the type of material is not available which causes restitution for Pasang Baru and Perubahan Daya services consisting of 1 Phase Kwh Meter, 3 phase Kwh Meter, 1 Phase MCB, 3 Phase MCB, Conductors, Distribution Transformers and Network Poles. Material unavailability was dominated by 1 Phase Kwh Meter at 66.67% and 1 Phase MCB at 16.38%.

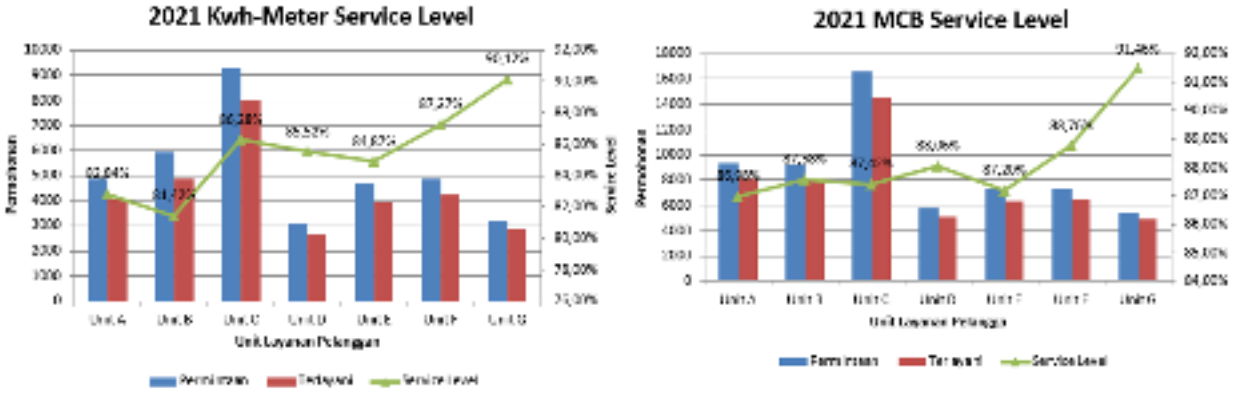

Figure 1 Kwh-Meter and MCB Service Level in 2021

The kWh-meter's service level for Pasang Baru and Perubahan Daya services is as shown in the figure 1 above, Unit G has the highest kWh-meter service level with a value of 90.12% while Unit B has the lowest kWh-meter service with a value of 81.42%. Each unit has a different service level of MCB. Unit G has the highest MCB service level with a value of 91.46%, while Unit C has the lowest MCB service level with a value of 87.42%. After this research is done, it is expected to get an estimation of the demand for Pasang Baru and Perubahan Daya in the future. With EOQ calculations, safety stock and reorder points can become the basis for material inventory control policies. By optimizing materials order, it is hoped that the total cost of inventory will be minimized and the possibility of material unavailability will be small, which according to the service level set by the company, is 95%.

2. LITERATURE REVIEW

According to Pujawan (2017), Inventory can arise for various reasons, including the location of demand being different from the location of production so there is a lead time, the speed of production being different from the speed of demand, the uncertainty of demand and supply, and the motive of achieving economies of scale in production and delivery activities.

Inventory classification based on its function, inventory can be divided into: (1) Pipeline/transit inventories: This inventory arises because of the delivery lead time from one point to another. (2) Cycle Stock: When the shipping process is in large quantities, it gradually decreases as a result of being used or sold until it runs out, then a new cycle will begin. (3) Safety Stock: This supply serves as protection against uncertainties in both demand and supply. (4) Anticipation Stock: Inventory types are inventories needed to anticipate an increase in demand due to the seasonal nature of the demand for a good or service.

The following are the types of inventory costs, (1) Ordering Cost: Costs incurred as a result of bringing in goods from outside. (2) Setup Cost: Costs incurred as a result of preparing for the production process of an item. (3) Holding Cost: Costs incurred as a result of storing an item.

Probabilistic demand makes it possible that supplies will run out while orders have not yet arrived. To overcome this, it is necessary to take into account safety stock. Under conditions of constant demand and probabilistic lead time, if the lead time is shorter then unused stock will appear, but if the lead time is longer then a shortage will occur.

There are four inventory control conditions, (1) Demand and lead time are constant, so safety stock is not needed (deterministic conditions). (2) Constant demand, fixed lead time, safety stock are determined by lead time uncertainty. (3) Demand is not constant, lead time is constant, then safety stock is determined by demand uncertainty (4) Demand and lead time are not constant, so safety stock is determined by the interaction of two uncertainties.

3. METHODS

3.1. Forecasting

Forecasting the demand of Pasang Baru and Perubahan use two methods, namely the exponential smoothing method and the artificial neural network method. The exponential smoothing method is used because the data obtained is fluctuating so the smoothing constant can minimize errors. While the use of artificial neural network methods to accommodate trends in the data obtained. Forecasting is done with 21 independent variables (y). These independent variables are the various kind of demand for Pasang Baru and Perubahan Daya.

3.2. Conversion of Forecasting Results into Materials Needs.

The results of forecasting demand for Pasang Baru and Perubahan Daya, it is then converted into material needs. The Bill of Materials that has been set by the company as a reference for the process of converting requests into material requirements.

3.3. Materials Classification.

PLN has established a material supply policy listed in the Directors Decree Number 717.K/DIR/2010. The method used in the Decree of the Board of Directors Number 717.K/DIR/2010 is the ABC method. In this classification, Materials are identified based on three categories, namely the level of criticality, level of availability, and level of use. Each type of Material is grouped based on class level using the letters A, B, C, and D. The level of criticality and availability is divided into classes A, B, and C. Meanwhile, the level of use is divided into classes A, B, C, and D. The following table below is the category of material classification processes according to company policy.

Table 1 Material Classification Criteria

Category	Criticality	Availability (days of calender)	Usage (years)
A	Highly Critical	Long lead time (>90)	>IDR 500 Million
B	Critical	Medium lead time (30-90)	IDR 100-500 Million
C	Less Critical	Short lead time (<30)	< IDR 100 Million
D	-	-	Rp 0

3.4. Calculation of EOQ, ROP, and SS.

EOQ calculation is one of the methods used in probabilistic inventory control. EOQ is defined as the optimal order quantity that minimizes the total inventory cost. This model is used in various situations, such as: (1) demand is known, but the lead time is uncertain, (2) the demand is

not known with certainty, but the lead time is definitely known, or (3) demand and lead time are not known with certainty. Probabilistic EOQ is calculated based on Formula 1 below.

$$EOQ = \sqrt{\frac{2\ x\ D\ x\ R}{H}}$$

Equation 1 Calculation of EOQ

Known :
EOQ :Economic order quantity
H :Storage cost
D :Demand for needs within a certain period of time (annual, monthly, daily)
S :Ordering cost per unit

The principle of safety stock is additional inventory to prevent the possibility of material shortages during the production/operational process. Because in probabilistic demand conditions and the company determines the service level to be achieved is 95%, a Z value of 1.65 is obtained. From the demand data in a year, it has a standard deviation of 156.722. To calculate safety stock, the formula used is:

$$SS = Z\ x\ \sigma\ x\ \sqrt{LT}$$

Equation 2 Calculation of Safety Stock

Known :
SS :Safety Stock
Z :Safety Factor
σ :Standard Deviation
LT :Lead Time

Reorder point is a calculation to find out the right time to reorder products. In other words, ROP is the period during which the order has to be re-created. ROP is also related to lead time and safety stock. To calculate the reorder point, the formula used is:

$$ROP = (\bar{D}x\ LT) + SS$$

Equation 3 Calculation of Reorder Point

Known :
ROP :Reorder Point
$\bar{D}$:Average Demand
SS :Safety Stock
LT :Lead Time

4. RESULTS

The results of forecasting the Exponential Smoothing method are compared with the Artificial Neural Network method. The Artificial Neural Network method is used because of its superiority in predicting input and output patterns. Artificial Neural Network is a method that has a training process, where the Artificial Neural Network identifies and learns the historical data patterns used. ANN can identify various incomplete and fluctuating data patterns. With a fluctuating pattern of Pasang Baru and Perubahan Daya demand data, ANN is a method that is suitable and capable of making predictions. Comparison of actual demand per month with

forecasting results using the exponential smoothing method and artificial neural network per month can be seen in the table below.

Table 2 Results of Forecasting

Variable	Services	Demand per Month		
		Actual	Exponential Smoothing	ANN
Y1	PB Pre-Paid 450 VA	263	259	264
Y2	PB Pre-Paid 900 VA	972	972	980
Y3	PB Pre-Paid 1300 VA	560	462	561
Y4	PB Pre-Paid 2200 VA	247	249	248
Y5	PB Pre-Paid 3500 VA	238	243	236
Y6	PB Pre-Paid 4400 VA	66	69	66
Y7	PB Pre-Paid 5500 VA	150	132	151
Y8	PB Post-Paid 450 VA	1	1	1
Y9	PB Post-Paid 900 VA	1	1	1
Y10	PB Post-Paid 1300 VA	2	1	1
Y11	PB Post-Paid 2200 VA	1	1	1
Y12	PB Post-Paid 3500 VA	1	1	1
Y13	PB Post-Paid 4400 VA	1	1	1
Y14	PB Post-Paid 5500 VA	1	1	1
Y15	PD 450 VA	4	2	4
Y16	PD 900 VA	456	447	457
Y17	PD 1300 VA	190	258	190
Y18	PD 2200 VA	207	140	208
Y19	PD 3500 VA	153	101	153
Y20	PD 4400 VA	82	69	81
Y21	PD 5500 VA	286	105	283

Following below are the results of the evaluation of demand forecasting for Pasang Baru and Perubahan Daya.

Table 3 Results of the Evaluation of Forecasting Methods

Services	Exponential Smoothing			Artificial Neural Network		Best Method
	Alpha	RMSE	MAPE	RMSE	MAPE	
PB Pre-Paid 450	0,999	100,84191	30%	46,52057	16%	ANN
PB Pre-Paid 900	0,999	266,31045	24%	122,230705	15%	ANN
PB Pre-Paid 1300	0,1063	219,07751	38%	98,4314688	22%	ANN
PB Pre-Paid 2200	0,77842	109,92195	34%	47,9558185	22%	ANN
PB Pre-Paid 3500	0,999	83,977880	32%	59,9746513	30%	ANN
PB Pre-Paid 4400	0,51247	39,365089	43%	26,4467060	30%	ANN
PB Pre-Paid 5500	0,1411	65,477884	36%	31,5592364	21%	ANN
PB Post-Paid 450	0,0594	0,8430564	22%	0,4007491	30%	ANN
PB Post-Paid 900	0,999	1,0936619	30%	0,68679652	22%	ANN
PB Post-Paid 1300	0,001	1,6290903	19%	0,92600082	63%	ES
PB Post-Paid 2200	0,2	0,2041242	4%	0	0%	ANN

Services	Exponential Smoothing			Artificial Neural Network		Best Method
	Alpha	RMSE	MAPE	RMSE	MAPE	
PB Post-Paid 3500	0,001	0,2886759	6%	0,10769489	10%	ES
PB Post-Paid 4400	0,001	0,2886754	6%	0,17855740	7%	ES
PB Post-Paid 5500	0,8165	0,7694447	18%	0,29667928	22%	ANN
PD 450	0,01995	4,5748507	52%	1,86692551	47%	ANN
PD 900	0,2057	200,6091	31%	73,9696996	13%	ANN
PD 1300	0,001	113,76230	60%	43,7028401	18%	ANN
PD 2200	0,001	156,09948	50%	47,5208583	21%	ANN
PD 3500	0,001	112,41395	41%	36,6651752	20%	ANN
PD 4400	0,001	68,493784	87%	24,215394	41%	ANN
PD 5500	0,00872	397,69299	59%	286,24656	101%	ES

From the table above it can be seen that almost all demand for Pasang Baru and Perubahan Daya have lower RMSE and MAPE values in the ANN method than in the Exponential Smoothing method. The applications for PB Post-Paid 1300 VA, PB Post-Paid 3500 VA, PB Post-Paid 4400 VA, and PD 5500 VA have lower MAPE values with the Exponential Smoothing method than with the ANN method. In this study, the ANN method was chosen because the results of evaluating forecasting accuracy with MAPE presented the same characteristics for the errors of each data.

In the conversion of the forecasting results for Pasang Baru and Perubahan Daya, 10 types of MDUs are produced to serve PB and PD requests. Based on Material classification according to company policy for the critical category, all Materials are included in the critical category. All Materials are classified as critical because if the Material is not available then the Pasang Baru and Perubahan Daya services cannot run. For the availability category, availability is based on a Material provision which can be seen from the lead time. All types of Material used in this study are included in the criticality category B. What distinguishes the 10 types of Material is the level of Material usage per year. Following below are the results the conversion from the results of forecasting the demand for new pairs and changes in power into MDU needs per year and the average per month of and material classification based on company policy can be seen in the table below.

Table 4 Conversion into Materials Needs

Material's ID	Material	Class	Material's Demand		Unit
			Average per Months	Per Year	
2190224	MTR;kWH E-PR;;1P;230V;5-60A;1;;2W	ABA	2531	30369	BH
2190222	MTR; kWH ECOM;1P; 230V;5-40A MINMCB;1;	ABC	8	99	BH
3250047	MCB;220/250V;1P;2A;50Hz;	ABB	76172	914058	BH
3250049	MCB;220/250V;1P;4A;50Hz;	ABA	253	3038	BH
3250051	MCB;220/250V;1P;6A;50Hz;	ABA	1582	18988	BH
3250053	MCB;220/250V;1P;10A;50Hz;	ABB	768	9211	BH

Material's ID	Material	Class	Material's Demand		Unit
			Average per Months	Per Year	
3250055	MCB;220/250V;1P;16A;50Hz;	ABB	443	5311	BH
3250057	MCB;220/250V;1P;20A;50Hz;	ABB	332	3990	BH
3250168	MCB;220/250V;1P;25A;50Hz;	ABB	118	1420	BH
3110025	CABLE PWR;NFA2X;2X10mm2;0.6/1kV;OH	ABA	509	6107	M

After classifying materials based on company policies, the next step is to calculate the parameters of the MDU inventory control policy using the EOQ, safety stock, and reorder point methods. These calculations were carried out on 10 types of materials. Total inventory cost is the sum of purchasing costs, ordering costs, and storage costs. Purchase costs are costs incurred as a result of purchases which are calculated based on the amount of material ordered multiplied by the unit price of the material. Ordering costs are costs incurred as a result of each purchasing activity carried out by the company. Storage costs are costs incurred due to material storage such as capital costs, taxes, etc. The following table below is the result of the EOQ, ROP, SS and total inventory cost calculation.

Table 5 EOQ, ROP, SS, and Total Inventory Cost

Material's ID	ROP	SS	EOQ	Total Inventory Cost		Saving
				Existing	EOQ	
ABA Class						
2190224	4.113	317	971	Rp 9.486.624.137	Rp 7.434.560.303	22%
3110025	123.747	9.490	14.976	Rp 750.033.459	Rp 612.858.331	18%
3250049	1.930	348	2.158	Rp 500.600.828	Rp 411.675.733	18%
3250051	956	189	1.282	Rp 36.106.332.055	Rp 28.777.888.849	20%
ABB Class						
3250047	346	93	863	Rp 119.997.223	Rp 102.273.125	15%
3250053	956	189	1.167	Rp 200.703.307	Rp 168.389.434	16%
3250055	629	187	1.008	Rp 151.794.665	Rp 128.386.842	15%
3250057	479	147	590	Rp 56.090.979	Rp 49.327.955	12%
3250168	197	78	2.827	Rp 45.247.882	Rp 40.232.329	11%
ABC Class						
2190222	23	11	64	Rp 23.660.051	Rp 22.698.345	4%

6. CONCLUSIONS

Forecasting for 17 of 21 types of Pasang Baru and Perubahan Daya demand using the Artificial Neural Network method gives lower RMSE and MAPE values than using the Exponential Smoothing method. Based on company policy, 3 material classes are obtained, namely ABA, ABB, and ABC class materials. ABA class material consists of 4 types of material. ABB class material consists of 5 types of material. While the ABC class Material consists of 1 type of Material. It has been generated from the calculation of Economic Order Quantity, Safety Stock,

and Reorder Point as the basis for material control policies. The use of the EOQ method can reduce the total cost of inventory by IDR 9,692,793,338, which means that get a savings of 20% of the total cost of inventory in the existing conditions. The biggest savings are in ABA Class Material of IDR 9,606,607,262 or a savings of 21%. While the smallest savings are found in Material Class ABC of IDR 961,706 or a savings of 4% of the total inventory cost in the existing condition. Between ABA and ABC Class Materials, there is ABB Class Material which has a savings of IDR 85,324,370 or a savings of 15% of the total inventory cost in the existing condition.

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Wood-Based Energy-Saving Windows: Utilization of Transparent Wood From Mahogany Timber for Structural Applications

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ABSTRACT

Wood is one of the materials used in various applications due to its chemical and physical structure. The use of this wood ranges from technology products, household appliances, and furniture to structural applications in buildings. Along with the concern about global warming, the efficient use of wood-based products can be considered strategic management for reducing carbon dioxide emissions and mitigating climate change through the sustainability of the forest wood chain. In Indonesia, various types of local wood are often used for structural applications, one of which is mahogany (*Swietenia macrophylla*). Along with the development of process technology and materials, various types of wood have the potential to be optically transparent for application as windows in buildings, including mahogany. A study was conducted to obtain transparent wood-based window products for structural applications in buildings through delignification and bleaching using the lignin-retaining method using sodium hydroxide (NaOH) and hydrogen peroxide (H_2O_2) followed by infiltration of epoxy resin into the delignified wood matrix. The transparent wood fabricated using this method has transparent properties with high haze and provides a transmittance of up to 84.053%. The simulation of thermal exposure on a building model explains the properties of transparent wood, which acts as a heat insulator, by lowering the room temperature to 4.75 degrees Celsius in a small building model during 20 minutes of infrared exposure. This window application in buildings provides benefits in terms of sustainability, lightweight, good thermal insulation properties, and transmittance comparable to clear glass.

Keywords: mahogany, wood timber, transparent wood, energy-efficient windows.

1. INTRODUCTION

Wood is one of nature's most remarkable products and has been used by humans for centuries for various purposes due to its chemical and physical structure. Wood can be used for multiple purposes directly related to daily human activities, such as technology products, agricultural equipment, household appliances, furniture, and transportation (Christoforo et al., 2013; Namichev & Petrovski, 2019). Wood is also the most widely used bio-based material in structural applications in buildings due to its mechanical solid performance due to the chemical bonds in the wood (Li et al., 2018; Ramage et al., 2017; Sun et al., 2020).

Along with the concern about global warming, environmental pollution, and energy crisis, sustainable materials for structural applications are becoming a new interest. One of them is the use of wood material, which is considered an eco-friendly and recyclable material (Sun et al., 2020; Tsai & Wonodihardjo, 2018). As a structural material in construction, wood can then be seen as an eco-friendly raw resource that is widely available in nature, easy to handle, and is a strategically managed carbon pool to reduce carbon dioxide emissions (Ramage et al., 2017; Tsai & Wonodihardjo, 2018). Besides that, the use of wood materials also has an impact on sustainability related to social, economic, and environmental aspects such as longevity in use, the impact of convenience in the environment, compatibility with aesthetic perceptions, and its carbon storage properties (Harju, 2022; Lähtinen et al., 2021; Lippke et al., 2011; Rhee, 2018; Viholainen et al., 2020). Studies also report that using wood in substituting conventional building materials also has the potential to reduce construction phase emissions by 69% with an average reduction of 216 $kgCO_2e/m^2$ of floor area (Himes & Busby, 2020). For this reason, wood consumption is important in supporting sustainable development and the transition towards a bio-based circular economy.

In its application as a structural material, wood can be used in various functions in construction, either directly in the building structure or as other subsystem elements, such as structural beams and columns, insulating envelopes, shear walls, and flooring materials (Caniato et al., 2021). These various structural applications are based on their excellent strength-to-weight ratio, ideal thermal insulation properties, and their role as acoustic dampers (Aly et al., 2021; Caniato et al., 2021; Sun et al., 2020). Therefore, wood can be a promising component for building design and construction that requires high-performance acoustic and thermal insulation materials, providing comfortable living conditions, and providing energy-saving benefits, and building sustainability.

The use of wood species for construction varies considerably based on the characteristics of each type of wood. This characteristic refers to the wood's chemical structure and physical properties, one of which is the density of the wood (You et al., 2021). In Indonesia, various types of local wood are often used for structural applications, one of which is teak (*Tectona grandis*). However, teak wood is quite expensive compared to other types of wood. For this reason, mahogany (*Swietenia macrophylla*) is also widely used as construction wood in Indonesia because the price is lower and the quantity is more abundant (Wahidi et al., 2021).

Along with the development of process technology and material sciences, various types of wood have the potential to be optically transparent for applications such as windows in buildings. Multiple types of wood have also been carried for transparent wood fabrication, for example, balsa wood (*Ochroma pyramidale*) (Li et al., 2016, 2017; Mi et al., 2020; Yang et al., 2021), birch (*Betula pendula*) (Jungstedt et al., 2020), bass (*Tilia americana*) (Wu et al., 2021), and poplar (*Populus alba*) (Bisht et al., 2022; Subba Rao et al., 2019; Zou et al., 2019). Seeing a large number of production forests and the potential for wood products from local wood species in Indonesia, mahogany wood is being promoted as a raw material for transparent wood fabrication. This study aims to prepare transparent wood products using local wood materials, especially mahogany wood,

for later application as windows in buildings. The characterization of this transparent wood product refers to its optical transparency, mechanical strength, and thermal insulation ability.

2. THE CHEMISTRY AND PHYSICS OF MAHOGANY WOOD

Wood is an anisotropic cellular material with well-defined organization at multiple structural levels (Gibson, 2012; Hossain et al., 2022). The hierarchical structure of wood extends from the macro scale (stem level) to the micro scale with tissue structures (growth rings), and down to the nanoscale with the assembly of cell wall layers and biopolymers.

In general, wood biopolymers consist of a network of cellulose, hemicellulose, and lignin that are interconnected with small amounts of extractives and inorganic compounds. In general, softwood species have an average value of 53.71% cellulose and 50.23% for hardwood, while the average value of lignin is 26.87% for softwood and 25.14% for hardwood (Karlinasari et al., 2010). Mahogany wood which is classified as hardwood also has similar properties. Mahogany wood, specifically Indonesian local wood, contains chemical components as shown in Table 1.

Table 1. Chemical components of Indonesian mahogany wood (Karlinasari et al., 2010).

Contained Substances	Average Percentage
Cellulose	47.26 %
Hemicellulose	27.37 %
Lignin	25.82 %

The content of chemical components in mahogany wood is also correlated with the various physical properties of mahogany wood. In general, mahogany logs had a volume of 0.17 m^3, and bark thickness was 2.9 ± 2.1 mm (Anoop et al., 2014). Mahogany wood has a shrinkage in the radial direction of 0.9% to 3.3% and the tangential direction of 1.3% to 5.7%. Natural drying of mahogany wood with a thickness of 2.5 cm from an initial moisture content of 40% for 40 days can reach air-dry moisture content. Meanwhile, with a mahogany wood dryer with a thickness of 2.5 cm, it can get a moisture content of up to 10% with temperatures ranging from 43°C to 76°C with relative humidity ranging from 75% to 33% (Forest Management Office for Lebak and Tangerang Regions, 2017). Various physical properties of mahogany wood are shown in Table 2.

Table 2. Physical properties of Indonesian mahogany wood (Karlinasari et al., 2010; Kusumaningtyas & Subagio, 2012; Listyanto et al., 2021).

Physical Parameters	Value
Density (ρ)	0.53~0.72 g/cm³
Modulus of Elasticity (E)	5.81 GN/m^2
Fiber Length	1,047 μm
Fiber Diameter (d_f)	18.34 μm
Lumen Diameter (d_{ll})	12.54 μm
Wall Thickness	2.90 μm
Microfibril Angle (	18.15 %
Crystallinity Index	38.33 %
Speed of Sound (c)	3,105 m/s
Damping Factor (ξ)	0.078

3. APPLICATION OF MAHOGANY WOOD

Mahogany wood is one of the most commonly used forest products in the industry today in Indonesia (Rahayu et al., 2019). In the wood industry in Indonesia, mahogany wood belongs to the excellent class, having a specific gravity ranging from 0.53 to 0.72, including strong class III to strong class II (Forest Management Office for Lebak and Tangerang Regions, 2017). This wood has well-fast growth and well-machining properties (Listyanto et al., 2021). Based on data from the Central Statistics Agency (BPS), 295,739.28 m^3 of mahogany wood was produced in Indonesia in 2015, and the number continues to increase yearly.

Mahogany wood is very likely to be used in various applications because it has aesthetic value, good physical characteristics, and ease of workmanship (Langbour et al., 2011; Shanley et al., 2011). Some of the applications of this mahogany are as follows.

3.1. Furniture and Cabinet

The most dominant use of mahogany wood is for furniture, both home and office furniture (Fadillah et al., 2014; Lamb, 1947; Zeng & Deng, 2017; Zhang, 2018). Woodworkers and cabinet makers use mahogany extensively because it has a beautiful uniformity of color and texture, easy to obtain large cuts, clean and sap-free cuts, ease in producing a smooth surface, and the rare and permanent beauty and stability of mahogany (Lamb, 1947).

In Indonesia itself, the types of wood used by the furniture industry are quite diverse. As in one of the woodcraft centers in Jepara, the types of wood used vary from teak, mahogany, sono, and mindi (Salim & Munadi, 2017). Furniture made of mahogany wood has advantages because of its strength, durability, color, and decorative properties, which are widely used and preferred for making cabinets, chairs, tables, and beds (Forest Management Office for Lebak and Tangerang Regions, 2017). Generally, Jepara's furniture mahogany is harvested from plantations and community forests. The trees are felled at 8-15 years old and contain most of the juvenile wood (Fadillah et al., 2014).

3.2. Boatbuilding

In the world of shipbuilding, mahogany wood is widely used in making boats. Edward Challoner, in 1850 stated that mahogany has excellent potential in the world of shipbuilding, mainly because of its invaluable and invaluable qualities of great buoyancy, durability, slowness to ignite, non-shrinkage, freedom from dry rot, and resistance to destructive acid action (Lamb, 1947).

In Indonesia, the use of mahogany wood for shipbuilding is permitted by the National Standardization Agency of Indonesia (BSN), referring to the SNI 7973:2013 standard. This application relates to the classification of mahogany wood in strength groups II-III. Still, this wood can only be used in limited construction, which sometimes interacts with seawater (National Standardization Agency of Indonesia, 2013).

3.3. Musical Instruments

Mahogany wood has the potential to be used in musical instruments, one of which is the piano. The use of mahogany for pianos began with an instrument, called a Clavecin, which was produced in the 1790s in England and owned by Bach (Lamb, 1947). Many modest pianos made in history are made of mahogany, one of which is from Broadwood & Sons for a mahogany cottage upright piano (Carnevali & Newton, 2013).

For guitars, mahogany wood also has the potential to be used in forming the body of the guitar. The study found that the use of mahogany significantly impacted price persistence, and all matched the four attributes of traditionality, decay resistance, rarity, and aesthetics (Zhou et al., 2022).

Besides this, mahogany can also be used in violins, where studies have shown that the acoustic characteristics of mahogany are very similar to those of maple and still relatively close to

those of Indian rosewood, which makes it a very suitable local material for the back plates of violins (Kusumaningtyas & Subagio, 2012).

3.4. Building Construction and Interior

In Indonesia, teak and mahogany are the two kinds of wood most often used for interiors, frames, doors, and windows (Indrani, 2004). For structural and construction applications, the size and shape of the panels may vary, and the decorative cornices and pilasters may be simple or ornate (Lamb, 1947). Mahogany is one of the least susceptible to atmospheric changes and therefore makes doors that keep their appearance and shape throughout the year (Lamb, 1947).

4. TRANSPARENT MAHOGANY WOOD

Wood is naturally a non-transparent material in the visible light spectral range due to its strong absorption and scattering of light. Biochemically, wood comprises three main components: cellulose, hemicellulose, and lignin. Among the three components of wood, lignin is responsible for about 80-90% of wood's light absorption. Thus, to obtain the transparency properties of wood, the constituent components that cause absorption and scattering must be removed, either by removing the entire lignin component or deactivating the chromophores in the lignin (Li et al., 2018).

Current approaches to fabricating transparent wood are generally based on delignification processes to remove most light-absorbing materials (lignin and extractives) or through bleaching, eliminating the chromophoric component with around 80% lignin remaining (Mi et al., 2020). The delignified wood is then impregnated using a polymer with a refractive index matching the wood substrate to reduce the refractive index contrast and obtain high optical transmittance. Several polymers that are widely used to make transparent wood include poly(methyl methacrylate) (PMMA, refractive index around 1.49), epoxy resin (refractive index around 1.5), polyvinylpyrrolidone (PVP, refractive index around 1.53), n-butyl methacrylate (refractive index of about 1.50), polystyrene (refractive index of about 1.59), dibutyl phthalate (refractive index of about 1.52), iso-bornyl methacrylate (refractive index of about 1.48–1.50), diallyl phthalate and poly vinyl carbazole (refractive index of about 1 .68) (Li et al., 2018).

Compared to clear glass, transparent wood has advantages in its thermal insulation properties, impact resistance, lightweight, and sustainability. The transmittance properties obtained can also be compared to glass. The level of clarity is somewhat reduced due to the high haze that may appear from transparent wood products. Some of the advantages of this transparent wood are shown in the chart in Figure 1.

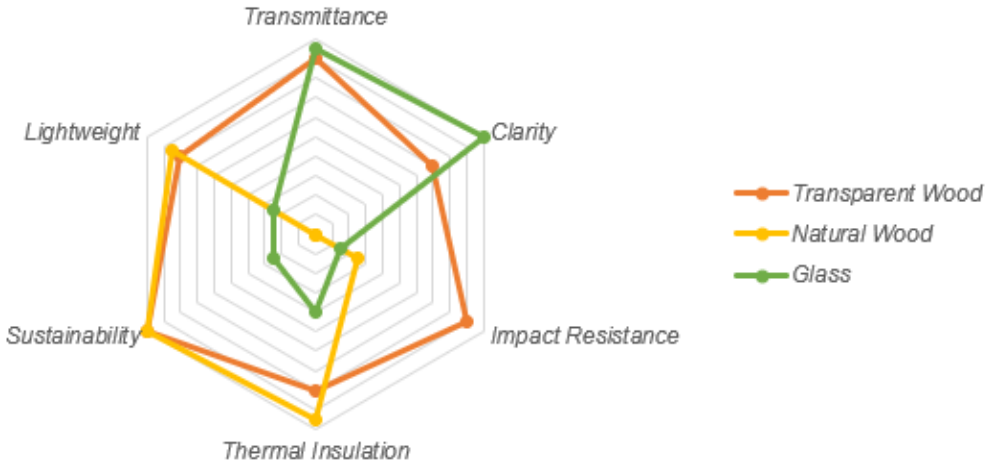

Figure 1. A radar chart comparing the properties of transparent wood, natural wood, and clear glass when used as building materials.

5. METHODS

The method is divided into two main parts: transparent wood fabrication and characterization. This fabrication process goes through two main steps, namely delignification and bleaching, followed by polymer infiltration of the wood matrix. In contrast, the characterization will be carried out to obtain three main parameters that are used to compare the quality of the windows, especially regarding the optical, thermal, and mechanical properties.

5.1. Preparation

Wood samples were prepared from mahogany veneer with a thickness of 0.6 cm. Each piece of wood is cut to 4 cm × 4 cm. The cut wood is then cleaned with an ultrasonic cleaner for 10 minutes or two cleaning cycles.

5.2. Delignification and Bleaching

The delignification process will dissolve the lignin in the wood structure through soda pulping and bleaching using the lignin-retaining method. In the soda pulping process, wood samples were soaked in 1M sodium hydroxide (NaOH) solution at 60 °C for 8 hours and stirred continuously using a magnetic stirrer, followed by immersion at room temperature for 16 hours. After that, the wood samples were rinsed with distilled water repeatedly to remove chemical residues.

The bleaching process was then carried out on the wood samples using hydrogen peroxide (H2O2) with a mass concentration of 50 wt% at room temperature for 48 hours to obtain white delignified wood. The samples were then washed with aquadest and stored in 95% ethanol at room temperature until used for the next step.

5.3. Polymer Infiltration

The polymer infiltration process on the wood substrate is used to adjust the refractive index to obtain wood that has transparent properties. Epoxy resin A (bisphenol A – epichlorohydrin) and epoxy hardener EPH 555 (cycloaliphatic amine) were used in a 3:2 ratio. Infiltration of epoxy resin on the wood matrix was carried out at a pressure of 5 MPa in a vacuum chamber for 60 minutes until the wood showed its transparent properties. After that, the wood samples infiltrated with polymer were left for 24 hours to ensure that the epoxy resin had completely hardened.

5.4. Characterization

In this initial characterization, light transmittance was tested to represent its optical characteristics, and thermal conductivity tests were carried out on building simulations in a real environment. Visible light transmittance testing was carried out using the UV-Vis spectrophotometry method using the Shimadzu UV-Vis Spectrophotometer UV-2600 with an operating range of 150 nm to 1000 nm.

Furthermore, as a window with excellent thermal insulation features, thermoregulation testing needs to be carried out. This test uses a building model that describes the real environment. This building model has 5 mm thick boards painted on both sides for thermal insulation. Transparent wooden and glass windows are installed on the facades of two identical building models. A 150W infrared lamp (Philips) was placed in the center of the front of the building model facing the window area. Two thermocouples were installed to measure indoor temperatures in each of the building models that were made.

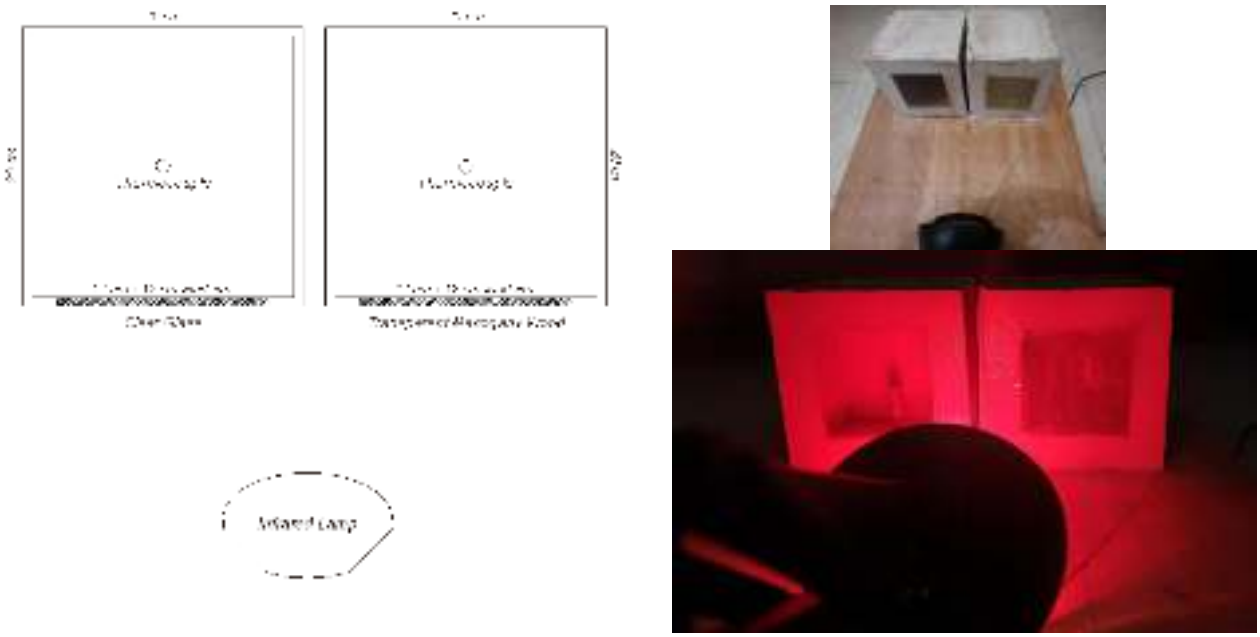

Figure 2. Model house to simulate thermoregulation capabilities in a real environment.

6. RESULTS AND DISCUSSION

6.1. Wood Delignification

In its fabrication, wood is prepared through chemical methods and the insertion of wood structures to achieve specific functions. An efficient approach to increasing cell wall accessibility in wood substrates is the partial and selective removal of wood components through delignification treatments. Delignification treatment of wood will rearrange the cell wall biopolymer by changing the chemical composition of the wood cell wall by removing the target percentage of lignin and, in some cases, hemicellulose (Kumar et al., 2021). This removal of lignin from wood can significantly alter the cell wall structure at the microscopic level and simultaneously affect wood's physical, chemical, and mechanical properties. Figure 3 shows the appearance of the mahogany wood used in this study before and after delignification.

(a) (b)

Figure 3. Mahogany wood (a) before delignification and (b) after delignification.

The delignification process gave a significant color change to the wood, where the wood turned white after soaking in the solution. In this delignification process, the solution penetrates the cell wall slowly as the reaction time increases, leading to the rapid removal of lignin in the cell wall

when the solution in the cell wall reaches a specific concentration. Delignification reactions tend to reach equilibrium when large amounts of lignin are removed.

6.2. Transparent Wood Fabrication and Functionalities

Wood contains a highly ordered cell system with optical heterogeneity due to its microscale porous structure, different chemical components in the cell walls with different refractive indices, and the presence of chemical entities that absorb light strongly. In its interaction with light, wood has a combination of reflection, refraction, absorption, and transmission effects. Light scattering occurs at all cell wall interfaces due to a significant difference in refractive index between the cell wall and air, where the cell wall itself is composed of three main components namely cellulose which has a refractive index of 1.56, hemicellulose, which has a refractive index of 1.53, and lignin which has a refractive index of 1.61 (Li et al., 2018). Besides that, in wood, there is also strong absorption of light due to the presence of light-absorbing components in the cell walls, of which lignin contributes 80-95% of light absorption.

Due to light scattering at the interface between the cell wall and air in the lumen and between cellulose nanofibers and air in the cell wall, delignified wood still needed to be transparent. When light is transmitted through delignified wood, only a fraction of the light retains its original direction due to the large-scale porosity of the wood (10 μm scale) and the refractive index mismatch between air (refractive index 1.0) and the cell walls of the wood (refractive index ≈ 1.53 based on cellulose and hemicellulose) (Li et al., 2016). Nevertheless, delignification significantly affects the cell walls' refractive index, where removing lignin with a refractive index of 1.61 will make the refractive index of the cell walls of wood more uniform, namely cellulose and hemicellulose, both of which are around 1.53.

To further eliminate the difference in the index of refraction in the delignified wood matrix, polymer impregnation was carried out with a refractive index adjusted to the index of refraction of wood to obtain transparency properties later. Impregnation of polymer epoxy resin in a wood matrix can significantly reduce light scattering, resulting in almost complete light transmission and optical transparency. Figure 4 shows how mahogany wood can then be made transparent through this fabrication method. In this picture, the clear appearance of the letters beneath the transparent wood sample explains that the obtained wood can have optical transparency properties.

Figure 4. The transparent mahogany wood fabricated in this study.

In the results obtained, transparent wood from mahogany veneer shows its transparent properties by penetrating the writing behind the transparent wood. The results indicate a yellowish characteristic caused by light absorption by lignin, tannins, and other resin compounds containing

chromophore groups. In addition, the strong scattering of light between the wood microstructure and porous parenchyma cells also gives a yellowish color effect.

6.3. Optical Transmittance Properties of Transparent Wood

The light transmittance of natural wood is very low in the visible light wavelength range, mainly due to light absorption from color-producing components such as lignin, and also includes light scattering caused by the pores of the wood nanostructure. Removal of chromophores and lignin and infiltration of polymers in the wood nanostructure provides an adjustment of the refractive index, which reduces the scattering significantly, and thus the wood gradually becomes transparent.

Figure 5 shows the results of the transparency test from samples of natural wood, delignified wood, and transparent wood using the UV-Vis spectrophotometry method.

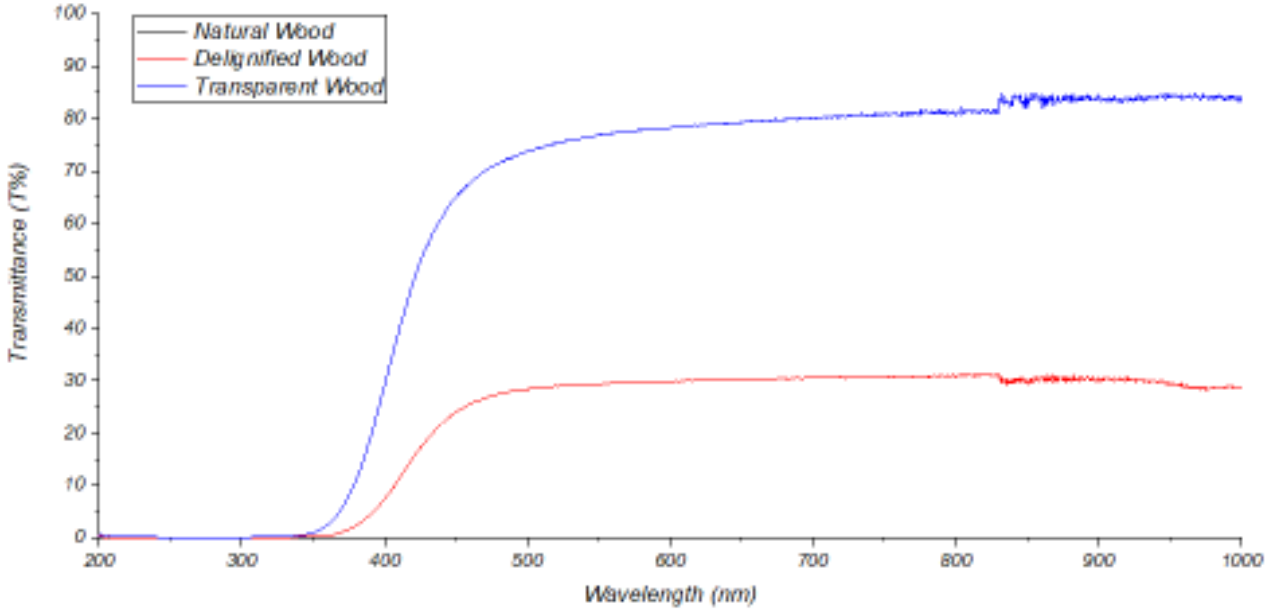

Figure 5. Optical transmittance of transparent mahogany wood.

The high transmittance value reached 84.95% at a wavelength of 853 nm obtained at a transparent wood thickness of 0.6 mm. This transmittance value should increase when the thickness of the wood is reduced and vice versa. It will decrease when the thickness of the wood is increased. This is because if the thickness is bigger, the transmission will be reduced because the light path is also longer.

The advantage of the transparent wood concept is that the cellulose content can be widely tunable (Li et al., 2016). In principle, selecting a wood with the right density is the key to obtaining more transparent wood. The transmittance value of wood may be increased by further structural tailoring to reduce nanocellulose agglomeration in the cell walls and adjustment of refractive index matching between polymer components.

6.4. Thermoregulation Properties of Transparent Wood

The thermal properties of transparent wood were studied by comparing the thermoregulatory effect in transparent wood from mahogany wood with clear glass. This test was carried out on a model house to describe the real environment by irradiating heat using an infrared lamp. The temperature of the model house with clear glass shows a higher measured temperature than transparent wood, as shown in Table 3. This illustrates how transparent wood is a heat blocker to prevent heat from entering the room.

Table 3. Temperature measurements on thermocouples in both rooms comparing the use of clear glass with transparent wood in a continuous simulation of infrared radiation.

Time (s)	Measured Temperature (°C)		Temperature Reduction (°C)
	Clear Glass	Transparent Mahogany Wood	
0	21.00	20.00	1.00
120	22.75	21.50	1.25
240	25.50	22.50	3.00
360	27.00	23.75	3.25
480	28.50	24.50	4.00
600	29.25	24.75	4.50
720	30.00	25.75	4.25
840	30.75	26.25	4.50
960	30.75	26.00	4.75
1080	30.50	26.25	4.25
1200	30.50	26.25	4.25

These results indicate that transparent mahogany has excellent heat-shielding performance and can be used as an energy-saving window material. In the simulation for 1200 seconds (20 minutes), a gradual decrease in temperature was obtained from the comparison between transparent wood and clear glass under the same infrared irradiation. This reduced value means that a small amount of irradiation is blocked by the transparent wood, either reflected back to the outside or absorbed in the porous structure of the wood. This result can be explained by the absorption of infrared waves originating from the molecular vibrations of the functional groups in cellulose in the wood microstructure.

7. CONCLUSIONS

Mahogany wood has been fabricated into transparent wood with energy-saving features by removing lignin chromophores through delignification and bleaching processes and polymer infiltration with an adjusted index of refraction to reduce optical scattering in the wood, thus obtaining transparency properties. This method is rapid, inexpensive, and sustainable to fabricate transparent wood from mahogany. High optical transmittance of 84.95% with high haze properties, and thermoregulatory properties that reach a reduction of 4.75 degrees Celsius is obtained. These results indicate that transparent mahogany wood is a good option for heat-shielding windows for energy-saving building applications.

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FORECASTING AND MATERIAL INVENTORY CONTROL IN THE ELECTRICAL DISTRIBUTION INDUSTRY

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ABSTRACT

One of the company's strategic goals is customer focused, which means that the company strives to provide customers with the best service possible. The speed of services such as the process of new connections/addition of power and interruptions can be done properly if the required material is available in the warehouse. Currently, the customer service process at PT. PLN UP3 X frequently encounters problems because the required materials are often out of stock. Furthermore, there was a buildup of slow-moving material where the total inventory value yielded the highest yield. To address issues with inventory management that were not yet optimal, the company grouped materials using ABC classification and ADI-CV analysis. Based on the material demand pattern, forecasting was carried out using the exponential smoothing method for smooth demand patterns. Forecasting for erratic, lumpy, and intermittent demand patterns were done using the Croston and SBA methods. After that, material inventory management was carried out using the continuous review (s,S) method and the periodic review (R,s,S) method. The results of inventory management show that the continuous review (s,S) method can provide optimal results of a 4% cost reduction from the existing condition and can increase the service levels to reach 92%.

Keywords: Exponential Smoothing, Croston, SBA, Periodic Review (R,s,S), Continuous Review (s,S).

1. INTRODUCTION

One of the company's strategic objectives is customer focused in which the company tries to provide satisfaction through providing quality services. The speed of customer service influences the quality of services. Speed of services can be fulfilled when the required material is available in the warehouse. Therefore, it is important to have material inventory management to create reliability and efficiency in the distribution of electricity. Inefficient inventory management causes two problems, namely excess and/or shortage of inventory. Excess inventory can freeze company funds while a shortage of inventory can cause penalties, loss of customers, and company losses (Ivanov, et al., 2019). These conditions occurred in PT. PLN UP3 X in which the company often experiences a shortage of fast-moving materials which results in delays in the customer service process and causes lost opportunities. On the other hand, the company also experienced an excess inventory of slow-moving materials which resulted in the piling up of materials in the warehouse. Based on the data obtained, PT. PLN UP3 X has a slow-moving material inventory value of Rp.1,057 billion which is the highest compared to other units in East Java.

The high value of slow-moving material inventory becomes a concern for the company as it can affect the company's performance, namely Inventory Turnover (ITO). **Figure 1** shows that not many ITO performance targets have been achieved, even the realization is very low for each month. It is because of the large number of material orders resulting from forecasting errors and less optimal inventory control that make the cost of material inventory increases and affects the value of ITO performance.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Target	0,39	0,78	1,17	1,49	1,82	2,15	2,26	2,6	3,03	3,24	3,6	3,86
Realization	-0,01	0,05	0,27	0,4	0,53	2,39	1,82	2,05	3,13	3,16	4,35	4,69

Figure 1. Inventory Turnover Performance in 2021

Many studies in Inventory management have used forecasting results to determine inventory control policies in several industries such as the Nickel industry (Pardede and Vanany, 2021), the electricity transmission industry (Riskianto et al.,2021), the electrical power industry (Eviondra and Vanany, 2021). However, efforts to use several forecasting methods as well as 2 types of policies (continuous and periodic review) are not enough to do so. This research was carried out to prioritize the problems that exist in the industry from the object of this research, namely the occurrence of less optimal inventory management which causes an increase in material inventory costs, this research aims to classify materials for appropriate forecasting methods and inventory control to reduce material inventory costs.

2. LITERATURE REVIEW

The inventory system is a set of policies to monitor inventory levels, and determine the level of inventory to be maintained, the inventory schedule, and the size of the order (Chase, et al., 2006). At certain times, inventory is one of the biggest assets in the statement of financial position which is difficult to liquidate. Thus, the company has to maintain optimal inventory levels as much as possible.

2.1 ABC Classification

ABC classification divides inventories into three groups based on annual volume in cash. The ABC analysis method is useful in focusing management attention to determining the most important items to be prioritized in inventory (Heizer & Render, 2017). The ABC classification of materials is based on the Pareto principle which is grouped into three classes, namely group A with an inventory value of 80%, group B with an inventory value of 15%, and group C with an inventory value of 5%.

2.2 ADI-CV Analysis

ADI (Average Demand Interval) – CV (Coefficient of Variation) is a method to classify products according to the demand characteristics based on the inter-arrival of demand and the variation of the demand. Based on the ADI-CV analysis, the demand pattern can be seen in **Fig. 2** below:

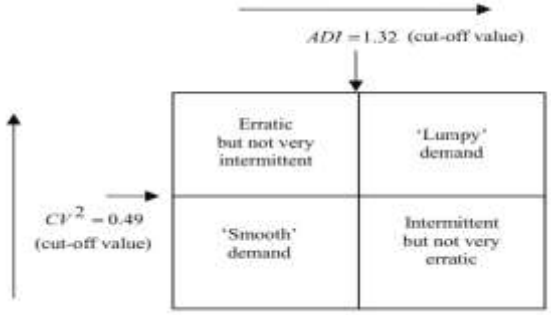

Figure 2. Demand Pattern Classification
(Ghobbar & Friend, 2002)

$$ADI = \frac{\sum_{N}^{i=1} t_i}{N}$$
$$ADI = \frac{Total\ number\ of\ periods}{Number\ of\ demand\ buckets} \quad (1)$$

$$CV = \frac{\sqrt{\frac{\sum_{i=1}^{N}(\varepsilon_i - \varepsilon)^2}{N}}}{\varepsilon}$$
$$CV = \frac{Standard\ deviation\ of\ population}{Average\ value\ of\ a\ population} \quad (2)$$

ε can be obtained from the following equation:

$$\varepsilon = \frac{\sum_{i=1}^{N} \varepsilon_i}{N} \quad (3)$$

2.3 Forecasting Method

Forecasting should be based on the right forecasting method to provide clear and accountable future projections. This study used some forecasting methods such as:

a. *Exponential smoothing* is a procedure that improves forecasting continually by averaging past values of time series data exponentially. The exponential smoothing methods can be seen below (Makridakis, et al., 1999):

1) *Single Exponential Smoothing*

The weighted moving average method assumes that the data fluctuates around a fixed mean value without any trend, the Single Exponential Smoothing formula can be seen below:

$$F_{t+1} = \alpha Y_t + (1-\alpha)F_t \quad (4)$$

Notes:

F_{t+1} = forecasting for the next period

α = smoothing constant ($0 \leq \alpha \leq 1$)

Y_t = actual demand in t period

F_t = forecasting the previous period

2) *Double Exponential Smoothing* (Holt)

This method is used when demand is influenced by the trend but not seasonally. The formula are:

$$S_t = \alpha Y_t + (1-\alpha)\ (S_{t-1} + b_{t-1}) \quad (5)$$

$$b_t = \gamma(S_t - S_{t-1}) + (1-\gamma)\ b_{t-1}) \quad (6)$$

$$F_{t+m} = S_t + b_t m \quad (7)$$

Notes:

S_t = exponential smoothing value

α = smoothing constant ($0 < \alpha < 1$)

γ = smoothing constant for trend estimation ($0 < \gamma < 1$)

b_t = estimated trend

Y_t = actual demand in the period

m = number of forecasted periods

b. Croston method is a more accurate forecasting method for the estimation of intermittent demand. This method updates the interval and demand size after the occurrence of positive demand. Therefore, if there is a period t with demand is zero, the method will only increment the count of time periods since the last occurrence of demand.

$$Z_t = \begin{cases} Z_{t-1}, if\ X_t = 0 \\ \alpha\ X_t + (1-\alpha) Z_{t-1}, if\ X_t > 0 \end{cases} \quad (8)$$

$$q_t = \begin{cases} q_{t-1} + 1, if\ X_t = 0 \\ 1,\ if\ X_t > 0 \end{cases} \quad (9)$$

$$P_t = \begin{cases} P_{t-1}, if\ X_t = 0 \\ \alpha\ q_t + (1-\alpha) p_{t-1}, if\ X_t > 0 \end{cases} \quad (10)$$

$$F_t = \frac{Z_t}{P_t} \quad (11)$$

Notes:

X_t = actual demand in t period

F_t = forecast demand t period

α = smoothing factor $0 \leq \alpha \leq 1$

Z_t = average non-zero demand

q_t = non zero demand period

c. *Syntetos-Boylan Approximation* (SBA) method is a modification of the Croston's method. The SBA shows that the Croston method produces a positive bias. Thus, Syntetos and Boylan propose to add a factor (1-α/2) to estimate the average demand in which the value of the smoothing constant is to update the interval between orders (Syntetos & Boylan, 2005).

$$F_t = (1 - \frac{\alpha}{2}) \frac{Z_t}{P_t} \quad (12)$$

2.4 Forecasting Accuracy

The overall accuracy of forecasting methods can be determined by comparing the predicted values with the actual observed values. Some ways to evaluate forecasting techniques (Heizer & Render, 2017) are:

a. *Mean Absoulute Deviation* (MAD)
Mean absolute deviation value is calculated bytaking the sum of the absolute values of forecasting erors and dividing them by the number of periods. MAD canbe a better measure of error than MSE if the forecast error does not possess a symmetric distribution.

$$\text{MAD} = \frac{\sum_{t=1}^{n} |A_t - F_t|}{n} \quad (13)$$

b. *Mean Square Error* (MSE)
Mean square error is the average of the squared differences between forecasted and observed values. MSE penalizes large errors more significantly because all errors are squared. The MSE calculation formula can be seen below.

$$\text{MSE} = \frac{\sum_{t=1}^{n} (A_t - F_t)^2}{n} \quad (14)$$

c. *Mean Absolute Percentage Error* (MAPE)
Mean absolute percentage error is the average absolute difference between forecasted and actual values reflected as a percentage of actual values. MAPE reflects forecasting error as a percentage of actual data that is not distorted by a single large value. MAPE calculation can be seen below:

$$\text{MAPE} = \frac{\sum_{t=1}^{n} |A_t - F_t| \frac{1}{A_t}}{n} \text{ x } 100\% \quad (15)$$

Notes:

A_t = actual data value F_t = forecasting result value

n = number of data periods t = t-period

2.5 Inventory Control Method

The determination of a probabilistic inventory policy can be done using two basic methods, namely continuous review and periodic review. The guidelines for selecting control policies based on continuous or periodic review can be seen below (Tersine 1994):

Table 1. Inventory Policy Guidelines

	Continuous Review	*Periodic Review*
Classification A	(s,S)	(R,s,S)
Classification B	(s,Q)	(R,S)

a. Continuous Review Method (s,S)
In the (s, S) model, inventory orders are made when the inventory level has reached point s or below with the order quantity increasing the inventory level until it reaches point S. The (s, S) system is referred to as the min-max system as the inventory position is between the minimum value of s and the maximum value of S. The advantage of the system is that it can generate a lower total cost of replenishment, carrying inventory and shortage cost compared to the (s,Q) system.

b. Periodic Review Method (R,s,S)
The (R,s,S) system is a combination of the (s,S) and (R,S) system. , inventory orders are made when the time for reviewing comes and the inventory level has reached point s or below.

Inventory orders are made with the order quantity that raises the inventory level to point S. This system can produce a lower total of carrying, replenishment, and shortage cost than any system.

3. METHODS

This chapter explains the method used in this study. The procedure of the study covered some stages as follows:

a. Data Collection Stage
   The data that are collected consists of material demand, material usage, material lead time, price for each material and cost related to ordering material from the historical data from 2019-2021.
b. Data Processing Stage
   The data processing was carried out in some stages as follows:
   1) ABC Classification
      Materials are classified based on the money value of the items towards the company. The items are classified into three different categories which 15 types of materials were selected, consisting of 5 materials from each category A, B, and C.
   2) ADI-CV Analysis
      Grouping materials was based on demand patterns according to ADI (Average Demand Interval) & CV (Coefficient of Variation). Materials were considered in smooth demand if $ADI \leq 1.32$ and $CV^2 \leq 0.49$; materials were considered in intermittent demand if $ADI > 1.32$ and $CV^2 \leq 0.49$; materials were considered in erratic demand if $ADI \leq 1.32$ and $CV^2 > 0.49$; and materials were considered in lumpy demand if $ADI > 1.32$ and $CV^2 > 0.49$. ADI-CV analysis is conducted due to the different pattern that the data exhibited that required different treatment.
   3) Forecasting Demand Material
      After the materials are classified, the next step was forecasting the material demand. For materials with smooth demand pattern, forecasting was carried out using the exponential smoothing method (SES and Holt). Meanwhile, for erratic, lumpy and intermittent demand patterns, it used the Croston and SBA methods. The accuracy of the forecasts is compared using the value of forecast error. Forecast error is measured using MAD, MSE, and MAPE, the accuracy that produces the lowestt error value was selected to forecast material.
   4) Inventory Control Policy
      In this stage, the inventory control policy parameters are formulated. The calculation requires the inventory costs such as purchase cost, order cost, holding cost, and stockout cost. The inventory control policy that are used are continuous review (s,S) and periodic review (R,s,S). The material inventory control method that provides the lowest total cost and the desired service level was selected.

4. RESULTS

In this chapter, the data collection and data processing results were presented. The first step was to collect material demand data at PT. PLN UP3 X for 3 years from January 2019-December 2021. The data were used in data processing to obtain an effective inventory control policy.

4.1 Material Classification

The initial step for material classification was based on the highest to lowest material values with ABC analysis and based on their usage patterns with ADI-CV analysis. The results of the material classification are presented in **Table 2**.

Table 2. Results of Material Classification using the ABC Analysis and ADI-CV Analysis

No	Material	Class	ADI	CV^2	Demand Pattern
1	2190224	A	1,00	0,06	*Smooth demand*
2	3110034	A	2,77	7,17	*Lumpy demand*
3	2190222	A	1,13	0,25	*Smooth demand*
4	3110542	A	1,00	0,03	*Smooth demand*
5	3110025	A	1,00	0,01	*Smooth demand*
6	2090032	B	1,00	0,03	*Smooth demand*
7	1030076	B	2,12	1,60	*Lumpy demand*
8	3210020	B	7,20	7,66	*Lumpy demand*
9	3190002	B	1,03	0,51	*Erratic demand*
10	3050084	B	1,16	0,91	*Erratic demand*
11	4120352	C	2,57	3,48	*Lumpy demand*
12	4120351	C	3,00	3,39	*Lumpy demand*
13	3250052	C	1,33	0,47	*Intermittent demand*
14	4120355	C	2,57	3,38	*Lumpy demand*
15	2190253	C	1,06	0,53	*Erratic demand*

4.2 Forecasting Material Demand

Forecasting the material demand was based on the results of material grouping from ADI-CV value. For the smooth demand category, the forecasting method used is to compare the two exponential smoothing methods, namely single and double exponential smoothing. As for materials with lumpy, erratic, and intermittent demand categories, the Croston and SBA forecasting methods were compared.

a. Forecasting for Smooth Demand

The first step is plotting the data to find out the pattern of demand material. Single Exponential Smoothing method would be used if the data are stationary and have no elements of trend or seasonal. If the data have a trend element, forecasting could be done using the Double Exponential Smoothing method. The determination of the initial values of the smoothing constant for level (α) and trend (γ) with values ranging from 0 to 1 using the Solver. Based on the forecasting results of the two methods, comparisons between models were made to find the best forecasting method and reduce estimation errors using MAD, MSE, and MAPE according to **Table 3**.

Table 3. Results of Forecasting Accuracy Using Single and Double Exponential Smoothing

No	**Mate-rial**	***SES***			***HOLT***			**Selected Method**
		MAD	***MSE***	***MAPE***	***MAD***	***MSE***	***MAPE***	
1	2190224	307,3	147.790,2	18,6	326,1	163.999,2	19,9	*SES*
2	2190222	263,2	122.286,6	22,0	257,9	134.643,4	21,0	*HOLT*
3	3110542	291,4	150.191,4	15,6	284,2	162.294,8	16,4	*SES*
4	3110025	2.456,2	10.521.800,7	9,6	2.599,5	11.273.324,9	10,2	*SES*
5	2090032	8,1	95,1	13,0	8,0	96,8	13,1	*SES*

b. Forecasting for Lumpy, Erratic, and Intermittent Demand

The pattern for lumpy, erratic, and intermittent material demand used the Croston and Syntetos-Boylan (SBA) methods because forecasting methods such as exponential smoothing have weaknesses for intermittent demand. It is necessary to use the Croston and SBA methods which can adjust when there is no demand in order to produce more accurate demand patterns. **Table 4**. shows a recapitulation of forecasting accuracy tests using the Croston and SBA methods. The best forecasting method is the method that can produce the lowest error value.

Table 4. Results of Forecasting Accuracy Test using Croston and SBA Methods

No	Material	Croston			SBA			Selected Method
		MAD	MSE	MAPE	MAD	MSE	MAPE	
1	3110034	959,60	2077885,05	10,02	808,20	1988846,82	14,20	*SBA*
2	1030076	0,98	1,62	6,67	0,95	1,12	19,73	*SBA*
3	3210020	0,77	1,148	10,44	0,76	1,145	10,51	*SBA*
4	3190002	7,29	78,14	25,65	14,52	390,74	29,27	*Croston*
5	3050084	472,06	480583,61	32,29	498,72	465367,34	27,03	*SBA*
6	4120352	1,08	2,573	14,50	1,07	2,570	14,87	*SBA*
7	4120351	1,06	2,04	17,07	1,03	2,02	17,73	*SBA*
8	3250052	134,76	29178,00	16,90	137,37	29203,92	18,23	*Croston*
9	4120355	0,90	1,62	11,09	0,86	1,54	12,04	*SBA*
10	2190253	1,03	2,04	18,52	2,53	10,85	33,21	*Croston*

4.3 Material Inventory Control Policy

In this sub-chapter, the process of calculating material inventory control policy parameters was carried out in 3 conditions, namely existing conditions, and repair conditions using continuous review (s,S) and periodic review (R,s,S) methods. The recapitulation of inventory control parameters in the three methods is presented in **Table. 5.**

Table 5. Recapitulation of Inventory Control Parameters

Material	*Existing Policy*		*Continuous Review (s,S)*		*Periodic Review (R,s,S)*	
	s	*S*	*s*	*S*	*s*	*S*
2190224	1121	3362	231	3516	7576	9309
3110034	546	1638	1111	4462	9980	70847
2190222	610	1829	503	3041	5854	14666
3110542	1554	4662	319	5897	10497	11651
3110025	18750	56250	1276	53939	115224	117365
2090032	32	96	10	185	298	376
1030076	1	2	1	5	9	57
3210020	1	2	0	1	2	3
3190002	18	54	22	148	251	750
3050084	819	2457	1003	6030	9665	23515

Material	*Existing Policy*		*Continuous Review (s,S)*		*Periodic Review (R,s,S)*	
	s	*S*	*s*	*S*	*s*	*S*
4120352	1	2	0	4	3	3
4120351	1	2	0	4	4	9
3250052	131	392	40	1265	1234	1376
4120355	1	2	0	4	5	12
2190253	3	9	3	36	46	134

This study used two main indicators in determining the most optimal probabilistic control method for the company, based on the total cost of inventory and the resulting service level. Based on the results of the inventory control parameters for each material, a simulation of the application of the inventory control method was carried out for the three methods. **Table 6.** presents the results of the total cost of inventory and service level on the existing policy, continuous review (s,S), and periodic review (R,s,S).

Table 6. Total Inventory Cost and Material Service Level

Policy	Purchase Cost	Order Cost	Holding Cost	Stockout Cost	Total Inventory Cost	Service Level
Existing Policy	33.394.287.125	400.800.000	894.742.447	3.744.676.830	38.434.506.402	88%
Continuous Review	32.343.810.110	177.600.000	1.475.187.699	2.891.207.321	36.887.805.130	92%
Periodic Review	52.792.162.920	127.200.000	13.689.459.474	284.526.355	66.893.348.749	99%

Based on **Table 6**, the lowest total purchase cost is obtained by the continuous review (s,S) policy of Rp. 32,343,810,110. Besides, for the lowest total order cost is the periodic review policy (R,s,S) results in a cost of Rp. 127,200,000. It is because the frequency of orders in the periodic review is the lowest compared to the other two methods but the number of orders in each order is the highest due to the higher reorder point and maximum inventory values. The lowest of holding cost obtained by the existing control policy is Rp.894,742,447. Meanwhile, the lowest total stock-out cost was obtained by the periodic review policy (R,s,S) of Rp. 284,526,355. This value is lower than the other two methods due to the large number of orders made to avoid out-of-stock materials. Thus, the service level value of this method is also the highest, namely 99% as almost all requests can be fulfilled but result in a very high total purchase cost.

5. CONCLUSIONS

Based on the results of data analysis, the ABC classification of 15 materials shows that 5 materials are in the smooth demand category, 6 materials in the lumpy demand category, 3 materials in the erratic demand category, and 1 material in the intermittent demand category. The results of the material forecasting show that 4 materials use single exponential smoothing; 1 material uses double exponential smoothing; 7 materials use the SBA method, and 3 materials use the Croston method.

According to the results of the recapitulation of inventory control calculations using the continuous review (s,S) and the periodic review (R,s,S) methods, the application of the continuous review (s,S) method obtains a total inventory cost of Rp 36,887,805,130 (experiencing a cost

reduction of 4% from the existing condition) with a service level of 92% (experiencing an increase in service level of 4%). Meanwhile, the application of the periodic review method (R,s,S) obtains the total cost of inventory of Rp.66,893,348,749 (experiencing a cost increase of 74% from the existing condition) with a service level achievement of 99%. As the company aims to optimize costs, the continuous review method is selected. Besides being able to reduce costs, this method can increase service levels to reach 92%.

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DETERMINING THE PRIORITY OF FEEDER MAINTENANCE AS A SUPPORT OF THE 20 kV NETWORK RELIABILITY IMPROVEMENT PROGRAM USING THE AHP-TOPSIS METHOD

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ABSTRACT

At PLN, distribution is the most important unit that is close to PLN's customers. Customers as the main source of income in PLN's business processes will certainly be of great concern. Therefore, the program to increase the reliability of the 20 kV network is one of PLN's ways to maintain electricity. With the intention of making the flow of income from customers can take place continuously and increase. The 20 kV network that comes out of the substation referred to as the feeder is maintained for reliability so the disturbances that cause outages can be suppressed. However, based on PLN ULP Ploso 2021 performance achievement data, there were 26 feeder disturbances out of a total target of 18 times. Of course, not all existing feeder proposals can be budgeted for all their needs. So that an implementation priority is needed based on factors that need to be considered, including feeder conditions, feeder disturbance potential, electricity revenue, and ease of execution. The combined AHP-TOPSIS method calculates that factor's weight and prioritizes the 19 feeders that became the alternative. The result is three feeders which are prioritized for maintenance to support the reliability of the 20 kV network.

Keywords: AHP, TOPSIS, 20 kV feeders, feeder reliability, electricity revenue.

1. INTRODUCTION

Excellent service to provide high satisfaction scores is one of PLN's strategies to improve service quality in the eyes of the public. This excellent service can be seen from the new power-added installation service, the speed of handling complaints and disturbances, network reliability, and others. One of the main focuses of PLN at this time is increasing electricity revenue. Of course, the increase in revenue is supported by increasing network reliability as a technical service work program at PLN. Maintaining the reliable quality of the electricity supply will have an impact on increasing growth both in terms of kWh usage revenue and increasing sales of electrical energy.

Based on data from the PLN 2021 statistical report (2021), it was found that the number of transmission network disturbances, especially in East Java, was zero compared to the achievement of the number of disturbances on the distribution network with a total of 1,822 times. Thus suppressing distribution network disruptions is the biggest focus of the PLN and becomes the Key Performance Indicator (KPI). Based on the recap results of the PLN UP3 SBU (2021) at PLN ULP Ploso itself the KPI of reliability that has not yet been achieved is the feeder disturbance target

until the end of 2021, namely 18 times with the realization of achieving the 2021 target, it was recorded that it had reached 26 disturbances at the end of December 2021. The program is in line with the direction of the President of the Republic of Indonesia in the 2021-2030 RUPLT (2021a), the focus of the proposed work budget plan focuses on maintaining the 20 kV distribution network to increase reliability.

In the process of executing the program, of course, it is impossible without blackouts. Another problem is the metropolis condition at PLN ULP Ploso with critical customer characteristics related to the number of disturbances in one month. At PLN itself, the reason for choosing the proposed feeder to be maintained is still focusing on the recap of disturbance conditions, so this thesis tries to raise other factors that are aligned with the company's KPIs to obtain criteria and sub-criteria for increasing the reliability of the 20 kV network. Budget constraints make demands for productive efficiency to be carried out. In this case, it is hoped that the budget issued can be right on target according to the existing problems. This is because not all of the proposals outlined in the program cannot be realized because of the budget. So determining the choice of alternative feeders is necessary to support the 20 kV network reliability program.

Reviewing previous research, the combined use of the Analytical Hierarchy Process (AHP) method with the Technique for Other Preferences by Similarity of Ideal Solution (TOPSIS) was used to obtain the most optimal project from the many choices of projects as alternatives to be run. According to Watróbski (2020), the AHP method is stated as one of the methods in the Multi-criteria Decision Analysis (MCDA) which itself is suitable for use at the managerial level to get fast results from various existing criteria. Nurani (2017) suggests the TOPSIS method as a follow-up to AHP weighting calculations using data on the condition of the object under study.

2. LITERATURE REVIEW

Based on the results of the KPI of reliability obtained at the end of December 2021, the performance of feeder disturbances was a performance that was still not achieved by 76% with the achievement of the System Average Interruption Duration Index (SAIDI) of 105%, the System Average Interruption Frequency Index (SAIFI) of 137%, and transformer disturbances of 100%. SAIDI and SAIFI are related to the quality of feeder performance because it is closely related to the customer's perceived outage duration so it will be considered in the form of easiness of execution criteria. In this case, the ease in minimizing the outage's duration can be seen based on the construction conditions of each feeder. Based on the construction guidebook made by WS Hariyanto (2013), constructions such as TM5, TM8, TM10, and TM11 can be used to cut networks so as to minimize outage areas. PLN, of course, also sets KPIs of sales and revenue that are aligned with the objectives of business activities. Electricity sales and revenues are obtained from business activities in the distribution business program at PLN, namely new installations, added power, and regular customers who subscribe to electricity which provide income at PLN, thus making it one of the criteria that need to be considered in the form of income criteria represented by KWh average data and payment for each feeder's newly added power pair to determine the selection of the feeder to be maintained.

Saaty (1985) argues that the AHP method is a way to assess elements that represent a problem hierarchically, namely by breaking the problem down into smaller criteria in the form of which are then assessed in the form of numbers that are interconnected between one criterion and another. From the assessment of these criteria, alternative solutions will be obtained based on priority. According to El Alaoui (2021), the TOPSIS method is widely used to complete practical decision-making. This is because the concept is simple and easy to understand, the calculation is efficient, and it can measure the negative performance of decision alternatives.

In applying the combined AHP-TOPSIS method in previous studies, there is an overview of the criteria used in determining alternative feeder priorities for the 20 kV distribution network system that need to be maintained to achieve reliability. Such as research conducted by Goh (2013) considers loading in a load-shedding system to be able to get optimal results in production. Özcan (2017) uses condition criteria by looking at system blackout times, potential damage criteria, and execution criteria by looking at equipment and additional work that is considered easy to get priority on hydroelectric power plants maintenance strategies. Nurani (2017) uses criteria for road conditions and potential damage based on a recap of field findings data to determine priority bridge lines that need to be maintained. Zhu (2020) uses criteria for heat exchanger specification conditions, economic criteria by looking at installation and maintenance costs, and execution criteria using an assessment of the ease of implementation of the design which aims to get alternative heat exchanger design options that should be prioritized. Broadly speaking, Watróbski (2020) uses condition criteria that exist in the production line as an evaluation material for selecting alternative production lines that need to be optimized. In Gulum's research (2021), the factors that have the potential to cause a disaster are used as criteria for determining alternatives for the development of disaster response posts. This provides additional information on potential disturbances that can be used as a criterion for determining which feeder to maintain.

3. METHODS

3.1 AHP Method

The AHP method in this study was used to obtain the weighted value of the criteria and sub-criteria for increasing the reliability of the 20 kV network which had been determined based on the results of a literature study. Five criteria are obtained with each sub-criteria as a factor that needs to be considered based on data adjustments that can be obtained from network assets and achievement history at PLN ULP Ploso. The calculation process in this study is,

1. Determine the criteria and sub-criteria for increasing the reliability of the 20 kV network

Table 1. Criteria and Sub-Criteria for Increasing Network Reliability 20 kV

Criteria	Sub-Criteria
Feeder condition	Feeder disturbances (A1)
	Recloser disturbances (A2)
Feeder disturbance potential	The length of not isolated network in 1 feeder (B1)
	Material not covered in 1 feeder (B2)
	Old material in 1 feeder (B3)
Electricity revenue	Average kWh in 1 feeder (C1)
	Average payment for new installations and added power in 1 feeder (C2)
Ease of execution	Intersections and branches in 1 feeder (D1)
	The length of the SUTM network above the SUTM network with a different feeder (D2)

2. Determine alternatives and create decision hierarchies

There are 19 feeder alternatives selected as maintenance priorities to support the increased reliability of the 20 kV distribution network. The feeder is selected based on the assets in

the 20 kV distribution network which still has non-insulated medium voltage overhead lines at PLN ULP Ploso. Hierarchically, you can see the sequence of criteria and sub-criteria for the reliability of the 20 kV network calculated in **Figure 1**.

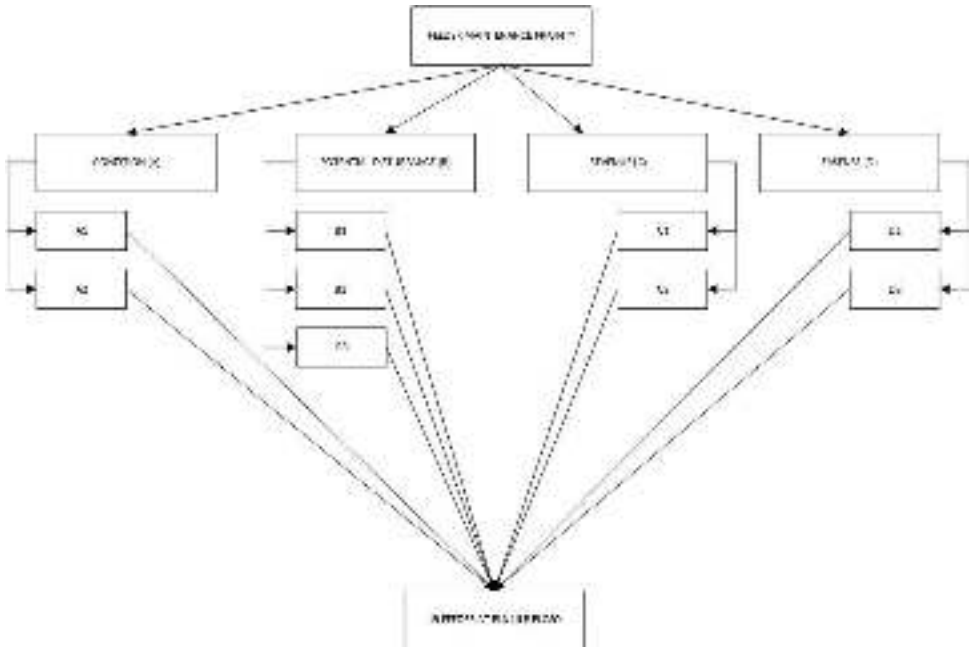

Figure 1. The Hierarchy Used in The Weighting Process

3. Make pairwise comparisons of the criteria and sub-criteria with a total of [n x (n-1)] / 2 comparisons
4. Calculating the eigenvalues and calculating the consistency results, if they are not consistent, the assessment data will be collected again

$$CI = \frac{\lambda max - n}{n - 1} \quad [1]$$

Where

$$CR = \frac{CI}{RI} \quad [2]$$

CI = consistency index
CR = consistency ratio
RI = random index
λ = eigenvalues
n = amount of data

Random index (*RI*) values will be obtained based on the reference of Saaty (2007) with a total of 1-15 data in **Table 2** and Alonso (2006) with a total of 16-30 data in **Table 3**.

Table 2. RI Value with The Number of N from 0-15

N	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.48	1.56	1.57	1.59

Table 3. RI Value with The Number of N from 16-30

N	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
RI	1.60	1.61	1.62	1.63	1.64	1.65	1.66	1.66	1.66	1.67	1.67	1.67	1.67	1.68	1.69

3.2 TOPSIS Method

The results of the weighting of the criteria and sub-criteria from the AHP method will be integrated with the secondary data that is calculated in the TOPSIS method. In this research, 19 feeder alternatives will be searched to get priority. The calculation process with the TOPSIS method itself requires determining the positive ideal and negative ideal values that affect the calculation results. The positive ideal itself describes the selection of higher priorities based on the secondary data used. This is because the secondary data is directly proportional to the purpose of maintenance, while the negative ideal is the opposite, namely the greater the secondary data obtained, the lower the priority level to be selected. In its application, there are 6 stages carried out in the calculation of the TOPSIS method.

1. Create a normalized decision matrix

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \quad [3]$$

r_{ij} represents normalized evaluation value based on criteria up to j

2. Create a weighted normalized matrix

$$Y = \begin{bmatrix} w_1 r_{11} & w_1 r_{12} & \cdots & w_1 r_{1m} \\ \cdots & \cdots & \ddots & \cdots \\ w_m r_{m1} & w_m r_{m2} & \cdots & w_m r_{mm} \end{bmatrix} \quad [4]$$

3. Determine the ideal solution

$$A^+ = \{y_1^+, y_2^+, \ldots, y_n^+\}$$
$$A^- = \{y_1^-, y_2^-, \ldots, y_n^-\} \quad [5]$$

Table 4. Positive Ideal and Negative Ideal for TOPSIS calculation

Sub-Criteria	Ideal
Feeder disturbances (A1)	+
Recloser disturbances (A2)	+
The length of not isolated network in 1 feeder (B1)	+
Material not covered in 1 feeder (B2)	+
Old material in 1 feeder (B3)	+
Average kWh in 1 feeder (C1)	+
Average payment for new installations and added power in 1 feeder (C2)	+
Intersections and branches in 1 feeder (D1)	+
The length of the SUTM network above the SUTM network with a different feeder (D2)	-

4. Take into account the distance at each ideal solution

$$D^{+} = \sqrt{\sum_{j=1}^{n} (y_i^{+} - y_{ij})^2}$$

$$D^{-} = \sqrt{\sum_{j=1}^{n} (y_{ij} - y_i^{-})^2}$$

[6]

5. Determine the preference value for each alternative that has been selected

$$V_i = \frac{D_I^{-}}{D_I^{-} + D_I^{+}}$$

[7]

6. Sort the alternatives based on the results of the preference calculations used to get the priority order of the alternatives, so the greater the preference value obtained, the higher priority will be selected.

4. RESULTS

4.1 AHP Result

The calculation data was obtained from the answers to the questionnaire which contained a comparison of the criteria and sub-criteria for the reliability of the 20 kV network. The comparison results are calculated using the geometric mean value as input data for a validated comparison matrix. It can be seen from the results of CR <0.1.

Table 5. Matrix Comparations (Criteria)

CR = 0.05168	Condition	P.Disturbance	Revenue	Ease
Condition	1.000	0.188323917	0.60938452	1.768
P.Disturbance	5.310	1.000	2.572	5.475
Revenue	1.641	0.389	1.000	3.487
Ease	0.566	0.183	0.287	1.000

Table 6. Matrix Comparations (Condition Sub-Criteria)

CR = 0.0	A1	A2
A1	1.000	4.367
A2	0.229	1.000

Table 7. Matrix Comparations (Potential Disturbance Sub-Criteria)

CR= 0.0168	B1	B2	B3
B1	1.000	1.949	4.149
B2	0.513	1.000	3.165
B3	0.241	0.316	1.000

Table 8. Matrix Comparations (Revenue Sub-Criteria)

CR = 0.0	C1	C2
C1	1.000	4.000
C2	0.250	1.000

Table 9. Matrix Comparations (Ease Sub-Criteria)

CR = 0.0	D1	D2
D1	1.000	5.618
D2	0.178	1.000

Matrix comparison data is used in AHP calculations and the weighted value of each criterion and sub-criteria for 20 kV network reliability is obtained in **Table 10**.

Table 10. The weighting of 20 kV Network Reliability Criteria and Sub-Criteria

Criteria and Sub-Criteria	Local Weight	Global Weight
Feeder condition	**0.109**	**0.109**
-Feeder blackout times (A1)	0.814	0.089
-Recloser outage times (A2)	0.186	0.020
Feeder disturbance potential	**0.605**	**0.605**
-The length of not isolated network in 1 feeder (B1)	0.557	0.337
-Material not covered in 1 feeder (B2)	0.325	0.197
-Old material in 1 feeder (B3)	0.118	0.071
Electricity revenue	**0.234**	**0.234**
-Average kWh in 1 feeder (C1)	0.800	0.187
-Average payment for new installations and added power in 1 feeder (C2)	0.200	0.047
Ease of execution	**0.052**	**0.052**
-Intersections and branches in 1 feeder (D1)	0.889	0.046
-The length of the SUTM network above the SUTM network with a different feeder (D2)	0.111	0.006

4.2 TOPSIS Result

Based on the global weighting in **Table 10**, the top tree feeders are obtained, namely Kalijudan, Rangkah, and Gresikan which need to be considered for the maintenance program as a planning priority consideration for the procurement of goods and services in supporting the

reliability of the 20 kV distribution network. These results can be seen in **Table 11** as a consideration for management at PLN.

The sensitivity analysis was continued from the results of the TOPSIS calculations by changing the weighting of the largest criteria, namely the potential disturbance criteria of -0.15 and +0.15 or equivalent to + 25% of the initial weighting. Then it is divided equally among the other criteria to keep the total weighted value of 1.

Table 11. Alternate order of 19 feeders for maintenance to increase the reliability of the 20 kV network

ALTERNATIVE	Vi	Vi-	Vi+	OLD RANK	RANK-0.15	RANK+0.15
KALIJUDAN	0.7483745	0.6494562	0.8225538	1	2	1
RANGKAH	0.7279373	0.6495164	0.7785065	2	1	2
GERSIKAN	0.6613087	0.6004762	0.6916393	3	3	3
BABATAN	0.5544611	0.5608579	0.5527273	4	5	5
TEMPUREJO	0.5341293	0.591695	0.5036063	5	4	6
TAPAK SIRING	0.5199841	0.4427038	0.5663038	6	8	4
TAMBAK DERES	0.4117777	0.3783213	0.4299051	7	11	7
NAKAMURA	0.4085647	0.4302484	0.3957708	8	9	8
MULYOSARI	0.403169	0.49641	0.3373417	9	6	11
TAMBAK SARI	0.3912604	0.4874119	0.3281369	10	7	12
KARANGASEM	0.3588647	0.3209211	0.3791264	11	14	9
GALAXY	0.3374209	0.3401904	0.3410351	12	12	10
BOGEN	0.3201937	0.3235371	0.3171666	13	13	13
RESMAN	0.3153256	0.3196737	0.3127937	14	15	14
RIVERSIDE	0.3037111	0.389002	0.2334066	15	10	16
MOESTOPO	0.2761503	0.3012487	0.2664723	16	16	15
WISPER	0.1482362	0.1492595	0.1513251	17	19	17
MOJOARUM	0.1341263	0.1612117	0.1166908	18	17	18
EASCOST	0.1210378	0.1519929	0.1067045	19	18	19

5. CONCLUSIONS

It can be interpreted that the criteria for potential disturbance are the criteria that are most considered in the selection of feeder maintenance. This is to the directives of the network reliability work program to reduce the potential that can cause power outages mainly due to touch as the first biggest cause and material breakdown as the second biggest cause.

In the priority level of the sub-criteria for potential disturbance, what can be understood is that non-insulated networks and imperfect construction of animal barrier covers are more important when compared to the findings of old insulating materials. The weighting indicates the suppression of potential distractions, which focuses more on suppressing distractions caused by touch. Followed by the income criterion which is in second place after potential disturbances to be considered in the selection of feeder maintenance. It can be understood that as a company, revenue sustainability is the main goal in business processes at PLN. Where the statement is appropriate if

translated into sub-criteria income, sales of kWh will be more important than income from paying for new installations and added power.

Feeder rankings in general have not changed much. Based on the comparison results in **Table 11**, the Kalijudan, Rangkah, and Gresikan feeder sequences still occupy the top three positions to be prioritized in the 20 kV network maintenance program. So that the three feeders can become a management consideration at PLN to focus on procuring goods and services.

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THE ANALYSIS OF JOB SATISFACTION AND ORGANIZATIONAL COMMITMENT INFLUENCE TOWARDS YANTEK OFFICER WORK STRESS MODERATION PERFORMANCE (ULP KUPANG CASE STUDY)

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ABSTRACT

Work Stress Moderation can have an impact on reducing employee performance, while the success of the company is greatly influenced by the condition of its employees. The YO (Yantek Optimization) transformation which began in April 2020 and was effectively implemented in 2021, has made Yantek officers change the way they work and getting new workloads, thus impacting to the unachieved 2021 performance. This research uses 4 variables formulated in 5 research hypotheses, 32 respondents primary data, and data analysis will be carried out using SEM-PLS. The results of the research, from 4 hypotheses obtained, it is found that satisfaction has a positive and significant effect on Yantek performance with a coefficient value path of 0.389, work stress strengthens and significantly moderates the job satisfaction effect on Yantek performance with a positive effect coefficient value path of 0.275, organizational commitment has a positive and significant effect on Yantek performance with coefficient value path of 0.354, Work stress does not significantly moderate the influence of organizational depression on Yantek performance, and work stress negatively affects Yantek performance with coefficient value path of -0.233. Work Stress was able to moderate Yantek's performance by R^2=62.1%, and was influenced by other variables by 37.9%.

Keywords: *Job Satisfaction, Organizational Commitment, Job Stress, Performance, Moderation, Transformation, PLS-SEM*

1. INTRODUCTION

PLN continues to move forward by accelerating the transformation of business process styles to answer the challenges of current circumstances. Through PLN's **"Power Beyond Generations"** transformation implemented by YO (Yantek Optimization) program is a Customer Focused aspiration. In April 2020, organizational structure of PLN ULP Kupang has 4 fields, such as field of Engineering, field of Customer Service, field of Energy Transactions and field of HSSE

Occupational Safety and Health with a total of 32 officers. Through the change of officer's way of work and a new workload will have a performance impact.

Performance is the result of work produced by an employee in accordance with his responsibilities based on his abilities and expertise, according to Mangkunegara, Prabu (2013). The increase of employee's job satisfaction will also improve company performance, according to Sudrajat & Yuniawan (2016). Organizational commitment is an attitude that reflects the extent to which an individual recognizes and is attached to his organization, according to Moorhead & Griffin (2015 p.134). Work Stress is a sense of pressure experienced by employees in their working place, According to Anwar (1993:93) SEM (Structural Equation Modelling) is an analytical method that can be used to describe the relationship between variables in the observation of each indicator, according to Prihandini (2011).

2. LITERATURE REVIEW

According to KPI (Key Performance Indicator) performance achievement 2021, performance achievement service rating was not achieved by 8% from the 50% target, service speed performance was not achieved by 79% of 85.6 minutes/customer from the target of 67.95 minutes/customer, Skip-Step service performance was not achieved by 81% from the 100% total report target, repeated interruption performance was not achieved by 68% from the 100% total report target, and in addition there is 25% of officers are out of work due to illness and 50% showed up late.

Through previous research, there is a positive and significant influence of work stress and job satisfaction on employee performance, and a negative and significant relationship of work stress to employee performance, according to Charima, Novi (2018). The higher job satisfaction and organizational commitment, will affect the improvement of PT SCI's company performance, according to M.Sutanto, Eddy (2013). So as to improve the engineering field performance in ULP Kupang, research were conducted using variables such as job satisfaction, organizational commitment, and seeing the influence of work stress of Yantek officers with the help of data analysis using SEM-PLS analytical method which can be used to describe the relationship between variables on the observation of each indicator. Therefore, it will be able to provide input for company management to evaluate according to the changes in the company environment by looking at their workmen characteristics.

3. METHODS

The PLS-SEM method in this research is used to describe the relationship between variables in the observation of each indicator in the work environment of PT PLN (persero) ULP Kupang. The aim is to evaluate the characteristics of workers in order to achieve the optimal engineering performance.

This study uses 4 variables including 2 independent variables, including Job Satisfaction and Organizational Commitment, one Dependent Variable related to engineering performance, and moderating variable related to Work Stress which can be explained in Figure 1

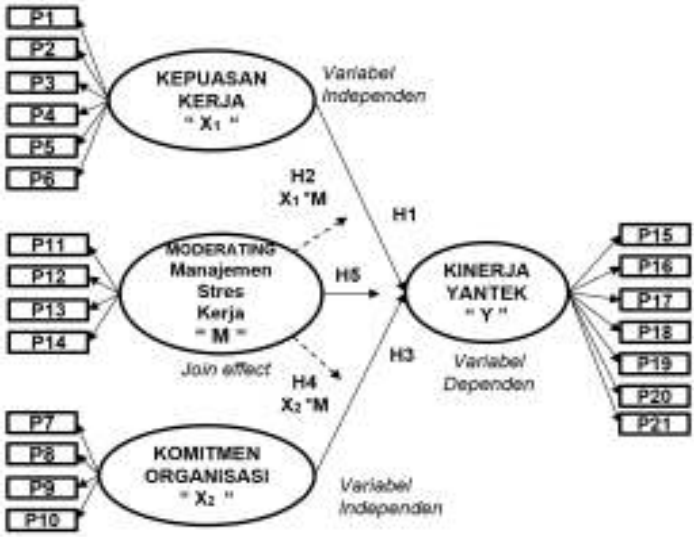

Figure 1. Research Framework Model

From Figure above, 4 variables that have been described. From some previous research literature, 5 hypotheses were obtained which were used as a temporary thinking framework that will be tested at ULP Kupang Yantek officers including;

H1: Job satisfaction has a positive effect on performance.
H2: Job Stress as a moderating variable strengthens the effect of job satisfaction on performance.
H3: Organizational commitment has a positive effect on performance.
H4: Job Stress as a moderating variable weakens the effect of organizational commitment on performance.
H5: Work stress has a negative effect on performance.

After determining the framework and hypothesis, the next step is to collect the data from the respondents by distributing a technical questionnaire with 21 question indicators. Likert measurement scale will be used as the assessment system, which can be seen in Table 1;

Table 1. Likert Measurement Scale

Value	Measurement Scale		Information
	Criteria	Code	
1	Strongly Disagree	STS	Respondents strongly disagreed with the statement because it was not in accordance with the situation they were experiencing
2	Don't agree	TS	Respondents did not agree with the statement because they were not in accordance with the situation experienced
3	Disagree	KS	Respondents disagreed with the statement because it was in accordance with the circumstances experienced
4	Agree	S	Respondents agree with the statement because it is in accordance with the circumstances experienced
5	Strongly Agree	SS	Respondents strongly agree with the statement because it is in accordance with the circumstances experienced

4. RESULTS

There are 32 respondents obtained from ULP Kupang, and the characteristics are profiled into gender, education, and age, which can be seen in Table 2.

Table 2. Profile of Research Respondents

No	Profile	Information	
1	Research Sites	PT PLN (Persero) ULP Kupang, NTT	
2	Respondents	32 Person	
3	Gender	Male : 32 People Female : 0 People	
4	Education	SMA : 29 People D3 : 3 People	
5	Age	17-30 Years : 1 People 31-35 Years: 13 People	36-40 Years: 12 People 41-56 Years: 6 People
6	Marriage Status	Married : 29 People Not Married : 3 People	

SmartPLS V.4 application is used as this research which acts as a PLS-SEM analysis tool to predict relationships between constructs, confirm theories and to explain whether there is a relationship between latent variables. In this study there are two models, such as theinitial model and the final model which can be seen in Figure 2, Figure 3 and Table 3, Table 4

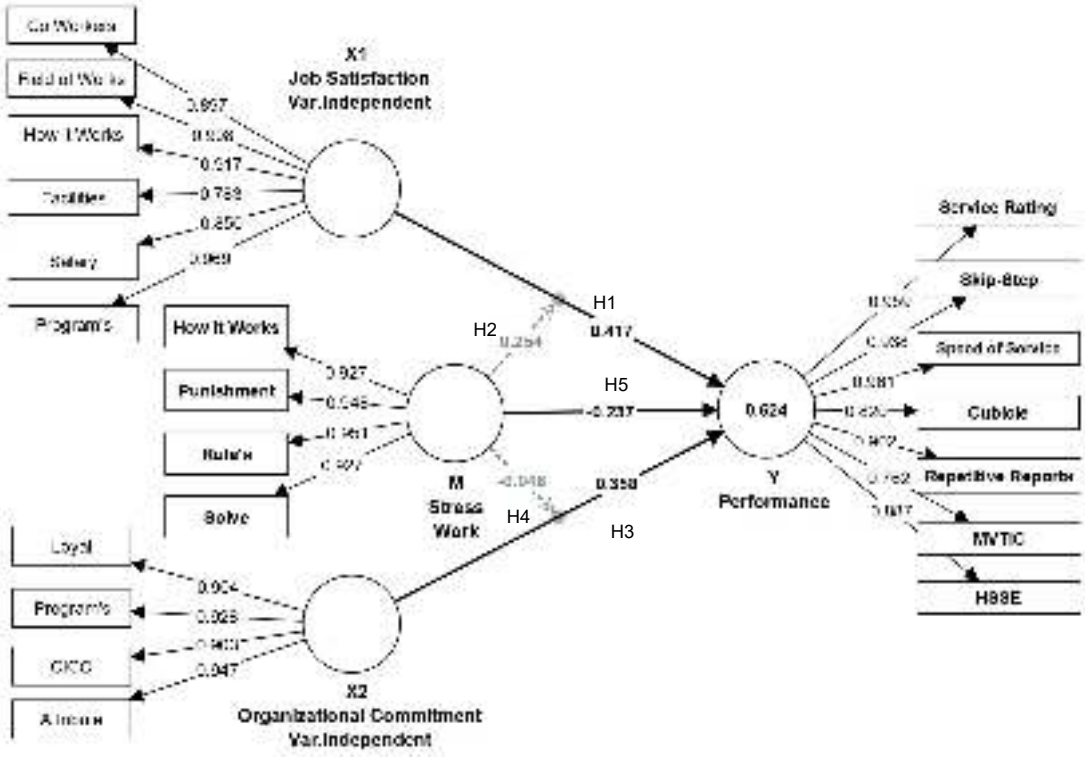

Figure 2. Initial Research Model

Table 3. Initial Research Model Results

Hypothesis	Connection Variable	Original sample	T Statistics	P Values	Information
H1	X1 --> Y	0.417	2.606	0.005	Significant, Positive Influence
H2	M*X1 --> Y	0.254	1.61	0.054	Not Significant, Positive Influence
H3	X2 --> Y	0.358	1.762	0.039	Significant, Positive Influence
H4	**M*X2 --> Y**	**-0.046**	**0.3**	**0.382**	**Not Significant**
H5	M --> Y	-0.237	1.68	0.047	Significant, negative influence

The initial research model can be seen in Figure 2 and Table 4 from the 5 hypothesis test. Hypothesis H4 were meant to see the relationship of work stress variables as a moderation of organizational commitment to performance. The result shows a negative and insignificant effect, so the H4 hypothesis will be issued in the research model and tested again .

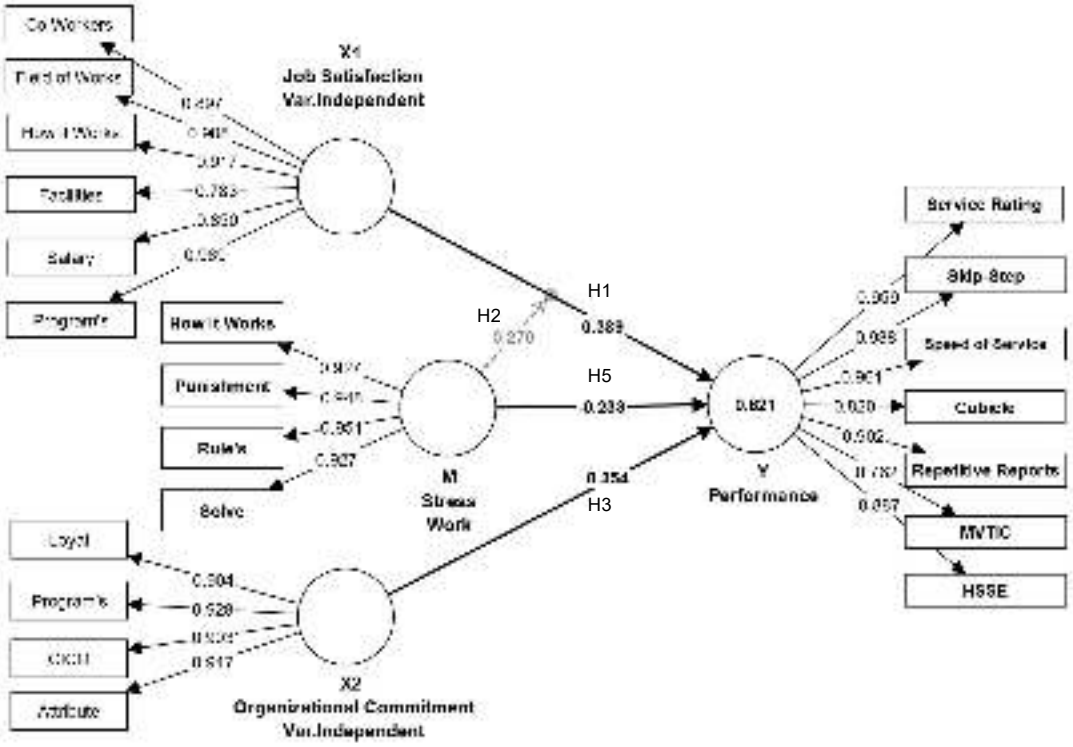

Figure 3. Final Research Model

Table 4. Final Research Model Results

Hypothesis	Connection Variable	Original sample	T Statistics	P Values	Information
H1	X1 --> Y	0.389	2.537	0.006	Significant, Positive Influence
H2	M*X1 --> Y	0.270	1.602	0.055	Not Significant, Positive Influence
H3	X2 --> Y	0.354	1.686	0.046	Significant, Positive Influence
H5	M --> Y	-0.233	1.588	0.056	Significant, negative influence

Figure 3 and Figure 4 are the results of the final model of the study. Significant results are obtained from 4 hypotheses tested. This explains that based on managerial implementation, the higher Yantek officer's jobs satisfaction along with the rights given by the company, the more optimal thimpact on performance will be. In this study, Stress work as a moderation of job satisfaction on performance has a positive effect on improving performance. This is the character of respondents in the ULP Kupang work environment, supported by the background of dominant respondents with high school education, already married and dominant age 31-35 years, so they are eager support to the family. This research, obtained modeling equations;

Performance = b1X1 + b2X2 + b2M + b3 (X1 M)
Performance = 0.389 X1 + 0.354 X2 - 0.233 M + 0.270 (X1 M)

Table 5. R-*Square* (R^2)

Dependent Variables	R^2	Information
Y (Yantek Performance)	0.621	Moderate Influence

According to Chin (1998) R^2 = 0.67 (strong) R^2= 0.33 (moderate) and R^2 = 0.19 (weak). From the results of Table 4.14, it is known that the R^2 value of Yantek Performance (Y) is 0.624, which means Job Satisfaction (X_1) Organizational Commitment (X_2) Work Stress (M) is able to explain moderate to Yantek Performance (Y) by 62.1%. So it is said to be able to moderate the performance of Yantek (Y) and 37.9% is influenced by variables outside the study.

6. CONCLUSIONS

From the research conducted in ULP Kupang, it can be concluded that the performance of the engineering field Job Satisfaction has a positive and significant effect on Yantek performance, with a coefficient value path of 0.389, work stress strengthens and significantly moderates the job satisfaction effect on Yantek performance with a positive effect coefficient value path of 0.275, organizational commitment has a positive and significant effect on Yantek performance with coefficient value path of 0.354, Work stress does not significantly moderate the influence of organizational depression on Yantek performance, and work stress negatively affects Yantek performance with coefficient value path of -0.233. Work Stress was able to moderate Yantek's performance by R^2=62.1%, and was influenced by other variables by 37.9%.

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INVESTMENT ANALYSIS OF ENTERPRISE DATA WAREHOUSE IMPLEMENTATION WITH IT BALANCED SCORECARD AND INFORMATION ECONOMICS

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ABSTRACT

Along with increasingly competitive business developments, PT Bank Rakyat Indonesia.Tbk requires good and fast data preparation to assist management in making decisions for future business needs. This was then stated in one of the company's grand strategies, namely the Excel Data-driven Organization. To be able to realize this, an investment in the data platform is needed, namely in Enterprise Data Warehouse (EDW). To analyze whether the EDW investment is the right investment, an analysis is using the IT Balanced Scorecard perspective company's contribution and information economics. Based on the analysis of tangible and quasi-tangible value, the initial investment cost of EDW was Rp. 43,990,000,000.00, and the total benefit for 3 years is Rp. 59,190,000,000.00. Based on the value above, the enhanced return on investment (EROI) is 135%. The values obtained for each category in the intangible value analysis are devided into 2, Business domain and Technology domain, then formed the Information Economics Scorecard with a total score of 69 with a scale of 41 - 70 having the title worthy of development. So, the implementation of EDW is an investment that is worth developing, and EDW can provide performance results that can support the overall performance of the company.

Keywords: IT Investment, Bank BRI, Enterprise Data Warehouse, IT Balanced Score Card, Information Economics.

1. INTRODUCTION

Banking is one sector of the business that deals with many kinds of customers with various kinds of services and products. Along with the development of the banking business in the digital era that increasingly complex and competitive, and to achieve the vision and mission of PT. Bank Rakyat Indonesia. Tbk. to develop became a Grand strategy called GREAT, which in GS 3 is Excel Data-driven Organization (PT. Bank Rakyat Indonesia. Tbk, 2021). The company needs good and fast data preparation to help management make decisions for business needs in the future. The development of information technology (IT) today is growing rapidly. The data includes customer information, transactions, and all other financial data that can be used as important information for the company (Tian, Han, Wang, Lu, & Zhan, 2015). According to Irina Peregud, a company that wants to become a data-driven organization requires five characteristics called CADILAC (Creative, passionate, and curious executives; Data Democratization; Data Literacy; Data Automation; and a company-wide data-driven culture (Peregud, 2018). To realize this, one of the data platforms needed is the data warehouse or enterprise data warehouse (EDW).

Currently, PT. Bank Rakyat Indonesia, Tbk has 1482 reports. Not only is the number of reports increasing, but so are data storage requirements, which have quickly become a challenge for PT. Bank Rakyat Indonesia. Tbk's IT team in providing such services. Based on the research from the Standish Group, which showed that the success rate of IT projects in the field of banking was only 30%, in addition, partial failures or total failures (The Standish Group International, Inc., 2015), the required performance measurement of project IT. To determine whether the investment EDW is an investment that can contribute to achieving the business objectives for the company, we carried out this research as a form of analysis of the evaluation of the investment EDW on PT. Bank Rakyat Indonesia, Tbk. The Perspective of Corporate Contribution in the IT Balanced Scorecard has the purpose of measuring how IT investment can contribute to achieving the goals of the business. There are 2 basic measurements from the perspective of the company's contribution: financial evaluation based, and business evaluation based. For the financial evaluation, the method of Return on Investment (ROI) was used. Based on the background, by analyzing the evaluation of both the EDW and the implementation of the EDW by using the methods of IT Balanced Scorecard and Information Economics.

2. LITERATURE REVIEW

2.1.Definition of EDW

Data Warehouse (DWH) or Enterprise Data Warehouse (EDW) is a system for reporting and data analysis that has become a critical component of a Business Intelligence (BI) system. A data warehouse is data integrated with a variety of sources, both internal and external, in which the storage of new and historical data is conducted in a place that is used to report the results of the analysis for the organization. EDW aims to provide a "single source of truth" that is collected from the integration of different sources of reference data in the company (Naeem, 2020).

2.2.IT Balanced Scorecard (IT BSC)

The IT Balanced Scorecard is a derivative of the Balance Scorecard that was developed by Van Grenbergen and Steven De Haes and is used to evaluate project technology information (Grembergen & Haes, 2005). The purpose of the IT Balanced Scorecard is to be able to adjust the planning and activities of system information, adjust the efforts of employees with the goals of system information, provide the tools to evaluate the effectiveness of the system information, as well as encourage and maintain the performance of the system information to get the achievement of results that are balanced among the groups of stakeholders.

2.3.Information Economics (IE)

One method that can be used to assess the feasibility of an investment is the Information Economics method. This method developed by Marylin Parker describes how to quantify corporate investments, especially in the field of information technology (IT), both tangible and intangible (Parker & Benson, 1988). From the above framework, Information Economics classifies its approach into two categories, namely the financial approach and the non-financial approach. The financial approach covers factors of tangible and quasi-tangible that can both be measured in financial, while the approach of non-financial is used to analyze the factors of intangible, which is divided into 2 domains: business and technology.

2.3.1. Tangible Benefits

The Analysis of Tangible Benefits is a qualitative analysis, the benefits that can be counted and have a financial impact when compared to companies that do both. Methods of calculation that can be used in Return on Investment (ROI). There are three worksheets that are utilized as tools in the framework Information Economics for analyzing Tangible Benefits. namely as follows:

- Information Economics Development Cost Worksheet
- Information Economics Expenses Worksheet
- Information Economics Impact Worksheet

2.3.2. Quasi - Tangible Benefits

The benefit of being quasi-tangible is a benefit that focuses on efficiency and profit of the company, but it is more complicated to calculate in monetary terms. Methods of calculation that can be used together with the benefits of Tangible, i.e., using the Return on Investment (ROI). However, because the quasi-tangiblae analysis is complicated to calculate, it can be helped by using variables namely Value Linking (VL), Value Acceleration (VA), Value Resturcturing (VR), Innovation Valuation (IV).

2.3.3. Intangible Benefits

Intangible benefits are benefits that cannot be calculated financially but can increase the effectiveness of the company. In the analysis of intangible benefits, there are two assessment criteria, namely Business Domain and Technology Domain. Business Domain is the domain focused on profits generated over the existence of IT. This Domain has the following components namely Strategic Match (SM), Competitive Advantage (CA), Management Information Support (MI), Competitive Response (CR), and Organizational Risk (OR). In Technology Domain is the domain focused on the use of IT to produce products, services, and the needs for the procurement of other facilities. This domain has the following components namely Strategic IS Architecture (SA), Definitional Uncertainty (DU), Technical Uncertainty (TU), and IS Infrastructure Risk (IR) Intangible benefits will get a number score of 0 - 5 using the method of the questionnaire.

2.3.4. Information Economics Scorecard

The Information Economics Scorecard is the final stage of Information Economics, which is the process of adding up all values in the weighting of enhanced ROI and value obtained from business domains and technology domains that are then predicated on value from the project investment. The weighting in this assessment is obtained from the results of a quadrant analysis on corporate value in the organization. The final value of the Information Economics Scorecard is used to provide the predicate of the feasibility of the results of investment analysis.

3. METHODS

In this research, the author uses an approach to measure IT performance called the IT Balanced Scorecard and Information Economics. The following is the research plan and the stages carried out.

3.1. Gathering Data

First, namely, reviewing documents regarding the Enterprise Data Management Strategy Framework and other supporting documents. This review document is used as a basis for conducting an analysis of Tangible and Quasi Tangible Information Economics, which focuses on the financial benefits of investing in the EDW project, then the Online Questionnaire Method was used as a data collection method to gather feedback from stakeholder users of the EDW system, namely

management and staff from the Enterprise Data Management Division of PT. Bank Rakyat Indonesia, Tbk. This method is used to obtain data related to the evaluation of the IT Balanced Scorecard and the benefits of Intangible Information Economics.

3.2. Test Validity,Reliability and Credibility of Data

At this stage, the authors conduct a test of validity and reliability on the results of the interview and the questionnaire that were obtained from the retrieval of the data. This validity and reliability test is used to test whether the results of this questionnaire present good data and can provide precise conclusions from the results of the study.

3.3.Data Classification

This stage is carried out through the classification of the data according to the needs for the analysis of Tangible Value using ROI and Quasi-Tangible and Intangible with the use of Information Economics. Financial data is usually obtained at the stage of document review and focused interview, namely all data for system implementation costs, system maintenance costs, system improvement costs, system user training costs, and other costs. As for non-financial data obtained from questionnaire data from EDW system user stakeholders, namely management and staff from the Enterprise Data Management Division of PT. Bank Rakyat Indonesia, Tbk is data on the benefits or consequences of the application of the system or other data that is not related to finance.

3.4.Data Analysis

At this stage of analysis IT Balanced Scorecard perspective of corporate contribution to the data obtained and classified using Information Economics.

- Calculate the Tangible Value using a ROI
  At this stage of analysis related to the benefits of tangible investment system EDW, which includes the cost of the initiation of the investment system, the cost of development software and hardware, maintenance costs, and the cost of training, is needed. These calculations can be assisted by the charge of the three information economic worksheets, Information Economics Development Cost Worksheet, Information Economics Expenses Worksheet, and Information Economics Impact Worksheet.
- Assessment Of The Quasi Tangible Value
  At this stage, they carried out an assessment based on 4 areas, namely: value linking, acceleration value, value restructuring, and innovation valuation.
- Valuation Of Intangible Value
  At this point, they carried out the analysis on the benefits of the intangible investment in EDW by using the approach of domain business and technology. At the end of this, an evaluation of the obtained based on the results of the questionnaire on the domain of technology and the domain of business is assigned a value between 0 and 5 in accordance with the Information Economics format.

4. RESULTS

4.1.Validity, Reliability and Credibility Test

The validity test of this study aims to determine whether the question items succeed in evaluating what is being tested (validity). The r-table value determined depends on the total number of respondents (N), and a significance test with a cutoff of 5% or 0.05 confirms its validity. With a total of 46 respondents in this study, an item is considered valid if the value is r count > r table.

Table 4.1 shows the results of the validity test for each indicator item using the Pearson correlation coefficient.

Table 4.1. Validity Test

Item	Nilai r hitung	Nilai r tabel	Keterangan	Item	Nilai r hitung	Nilai r tabel	Keterangan
1	0,621	0,285	*Valid*	6	0,401	0,285	*Valid*
2	0,828	0,285	*Valid*	7	0,640	0,285	*Valid*
3	0,399	0,285	*Valid*	8	0,664	0,285	*Valid*
4	0,502	0,285	*Valid*	9	0,401	0,285	*Valid*
5	0,765	0,285	*Valid*				

The purpose of the research reliability test is to guarantee the quality and dependability of the data gathered through surveying. When a variable's Cronbach's Alpha score is higher than 0.60, that variable is regarded as dependent. Each statement on the questionnaire was able to attain a Cronbach's Alpha value over 0.6, which was 0.650, according to the reliability test findings.

Qualitative data obtained through interviews and document observation methods required a process to test the credibility of the data. One of the methods that can be used is the source triangulation method. This triangulation process was carried out by conducting interviews with the team leader of the Enterprise Data Warehouse Development Team (EDW). This step was taken to validate the data obtained from the Enterprise Data Strategy and Governance (ESG) Department, and it was stated that the data used to carry out tangible value and quasi-tangible value analysis was credible and valid.

4.2.*Corporate Value Analysis*

Based on the results of interviews and analysis of documents related to investment in the implementation of an enterprise data warehouse at Bank BRI, the corporate values obtained are as follows:

1. The Enterprise Data Warehouse implementation project helps BRI achieve Grand Strategy No. 3, which is to become an Excel Data Driven Organization.
2. There is an increase in productivity with the implementation of an enterprise data warehouse. On the other hand, delaying the implementation of the enterprise data warehouse can result in losses for companies, such as longer data management or fines resulting from delays in reporting to regulatory authorities.
3. Bank BRI has a division that is responsible for mitigating both business and IT risks. so that Bank BRI can create operational and business activities that comply with regulations and good corporate governance (GCG) and avoid financial and non-financial losses.

Based on the above company conditions, Bank BRI has the same good and strong capabilities in business processes and information technology support. The company has strong integration and use of information technology in carrying out its business processes, so it is concluded that Bank BRI with investments in enterprise data warehouse implementation is in Quandrant B Strategic with a weighted value (Parker & Benson, 1988) in Table 4.2.

Table 4.2. Strategic Quandrant Corporate Value

Business Domain	***Resulting Weight***	***Technology Domain***	***Resulting Weight***
ROI	2	*Definitional Uncertainty*	1
Strategic Match	4	*Technical Uncertainty*	-2
Competitive Advantage	6	*Strategic IS Architecture*	-1

Business Domain	*Resulting Weight*	*Technology Domain*	*Resulting Weight*
Management Information Support	2	*IS Infrastructure Risk*	1
Competitive Response	4		
Organizational Risk	-1		

4.3.Tangible Value Analysis

In the tangible value analysis, there are three components that are taken into account, namely: system development costs, which are compiled in the Information Economics Development Cost Worksheet; system operational costs, which are compiled in the Information Economics Expenses Worksheet; and direct cost savings benefits, which are compiled in the Information Economics Impact Worksheets.

4.3.1. Information Economics Development Cost Worksheet

System development costs, which are the main investment, can be arranged in the Development Cost Worksheet shown in Table 4.3:

Table 4.3. Development Cost Worksheet

Development Item	Amount	Cost
A. Development Process		
Development/Implementation Costs	1	Rp 5,720,000,000,00
B. New Hardware		
Staging and ETL Server	1	Rp. 1.000.000.000,00
Datawarehouse Always ON Server	2	Rp. 2.000.000.000,00
Reporting Services Server	6	Rp. 6.000.000.000,00
SAN Storage Flash	1	Rp. 800.000.000,00
C. New Software		
ETL and SSIS - SQL Server (24 Cores)	12	Rp. 3.500.000.000,00
Enterprise Datawarehouse - SQL Server (2 x 40 Cores)	40	Rp. 10.000.000.000,00
OLAP and SSRS – SQL Server (6 x 16 Cores)	48	Rp. 7.000.000.000,00
Windows Server Data Center Core	100	Rp. 7.500.000.000,00
TOTAL		**Rp. 43,990,000,000.00**

4.3.2. Information Economics Expenses Worksheet

In the Information Economics Expenses Worksheet, it discusses expenses related to operational and maintenance costs during a certain period of running an enterprise data warehouse project shown in Table 4.4:

Table 4.4. Expenses Worksheet

	Year		
	1	2	3
Software Maintenance	Rp. 1.300.000.000,00	Rp. 1.300.000.000,00	Rp. 1.300.000.000,00
Hardware Maintenance	Rp. 100.000.000,00	Rp. 100.000.000,00	Rp. 100.000.000,00
Additional Data Storage	Rp. 500.000.000,00	Rp. 500.000.000,00	Rp. 500.000.000,00
User training and certification	Rp. 470.000.000,00	Rp. 470.000.000,00	Rp. 470.000.000,00
Network Fees	Rp. 100.000.000,00	Rp. 100.000.000,00	Rp. 100.000.000,00
Total Expenditures Per Year	**Rp.2.470.000.000,00**	**Rp.2.470.000.000,00**	**Rp.2.470.000.000,00**
		Total Expenses	**Rp. 7.410.000.000,00**

4.3.3. Information Economics Impact Worksheet

With the implementation of the Enterprise Data Warehouse, there has been an increase in performance and a decrease in operational costs at Bank BRI. In the Enterprise Data Warehouse

system, reports that were previously generated manually can be automated. This in addition to making costs for workers who make reports can be made savings. Based on the calculation of salary efficiency for data processing administrative workers, which is calculated from the salary of Enterprise Data Warehouse Division workers (work hours/per month/salary). To handle reporting, overtime costs are required every first 10 days at the beginning of the month with an average of 3 hours overtime per day with the calculation shown in Table 4.5:

Table 4.5. Impact Worksheet

Overtime / Hour Salary	Rp. 200.000,00
The number of workers	46
Total overtime hours	30
Number of Years/Months	3 Tahun/36 Bulan
Total Per Year	**Rp. 3,312,000,000.00**
Total	**Rp. 9,936,000,000.00**

4.4.Quasi Tangible Value Analysis

In the analysis of quasi-tangible benefits, the assessment focuses on the efficiency and profits of the company, which are assessed through the application of variables, namely:

4.4.1. Value Linking (VL)

With the implementation of the Enterprise Data Warehouse, an increase in performance can minimize the potential fines imposed by regulatory agencies due to delays in submitting reports. The potential for regulatory fines listed in Bank Indonesia regulation number 23/6/PBI/2021 concerning payment service providers states that if you do not submit or are declared not to have submitted a report, you will be subject to an administrative sanction of a fine of Rp. 20,000,000.00 (twenty million rupiah) per report. (Bank Indonesia, 2021). Meanwhile, the number of reports submitted by Bank BRI to Bank Indonesia as regulatory amounted to 100. The calculation of value linking benefits is shown in Table 4.6:

Table 4.6. Value Linking Benefit

Potential Fines/per report	Rp. 20.000.000,00
Number of Reports/months	30
Number of Years/Months	3/36
Total Per Year	Rp. 7.200.000.000,00
Total	**Rp. 21,600,000,000.00**

4.4.2. Value Acceleration (VA)

With the implementation of the Enterprise Data Warehouse, reports and dashboards can be formed more quickly with automation and jobs that are run daily. In the previous system, data that could be downloaded from the data warehouse was in position H+2. With the implementation of Enterprise Data Warehouse, data processing time was reduced to H+1. This can be a weapon for determining marketing strategies to increase the number of customers who use BRI products.

4.4.3. *Value Restructuring* (VR)

Value Restructuring is a benefit that is determined by the process of reorganizing company functions. At Bank BRI, the change that has occurred is the formation of a special team to handle the Enterprise Data Warehouse system, namely the Enterprise Data Warehouse Development Team. The establishment of the Enterprise Data Warehouse Development Team is intended because a

function is needed to handle the development of the Enterprise Data Warehouse system so that the system can support the achievement of company goals.

4.4.4. *Innovation Valuation* (IV)

Implementation of Enterprise Data Warehouse can indirectly create opportunities for innovation. One of the important innovations is the availability of customer checking account statements with data retention of up to 20 years. The service fee is charged to customers for printing checking account statements for a period of more than 12 months, which is Rp. 25,000.00 per report. The following is the fee-based income earned by Bank BRI in the Current Account program in Table 4.7. below:

Table 4.7. Value Innovation Benefit

Cost of Printing Account Statements	Rp. 25.000,00
Number of Reports/months	50.000
Number of Years/Months	3/36
Total Per Year	Rp. 15,000,000,000.00
Total	**Rp. 45,000,000,000.00**

4.4.5. Enhanced ROI Calculation

Based on the results of the Tangible Value and Quasi Tangible Value analysis, the Enhanced ROI calculation values are as follows:

Table 4.8. Enhanced ROI

Enhanced ROI				
Investment Cost	*Rp*. 43,990,000,000.00			
Annual Fee	Tahun 1	Tahun 2	Tahun 3	Total
Expenses	Rp. 2.470.000.000,00	Rp. 2.470.000.000,00	Rp.2.470.000.000,00	**Rp. 7.410.000.000,00**
Value Linking	Rp. 7.200.000.000,00	Rp. 7.200.000.000,00	Rp. 7.200.000.000,00	**Rp. 21,600,000,000.00**
Value Innovation	Rp. 15,000,000,000.00	Rp. 15,000,000,000.00	Rp. 15,000,000,000.00	**Rp. 45,000,000,000.00**
Total Benefits	Rp. 19,730,000,000.00	Rp. 19,730,000,000.00	Rp. 19,730,000,000.00	**Rp. 59,190,000,000.00**

Based on the calculations in Table 4.8. the results of the value of Enhanced Return on Investment (ROI) are as follows:

$$ROI = \frac{59{,}190{,}000{,}000.00}{43{,}990{,}000{,}000.00} \; X \; 100\% = \; 135\%$$

4.5.Intangible Value Analysis

The results of the intangible value analysis were obtained from the results of questionnaires completed by respondents, namely employees of the Enterprise Data Management Division of Bank BRI, regarding investment in Enterprise Data Warehouse implementation. Based on the results of the questionnaire, scores were obtained for each business and technology domain. The value in the intangible value analysis is obtained from the value that most often comes out of the results of the questionnaire for each category and has a scale of 0–5. Table 4.9. displays the analysis findings for each category.

Table 4.9. Intagible Value Analysis

Business Domain	Score	Technology Domain	Score
Strategic Match (SM)	4	Strategic IS Architecture (SA)	5
Competitive Advantage (CA)	4	Defitional Uncertainty (DU)	1
Management Information Support (MI)	5	Technical Uncertainty (TU)	4
Competitive Response (CR)	4	IS Infrastrucure Risk (IR)	3
Organizational Risk (OR)	1		

4.6.Information Economics Scorecard

The Information Economic Scorecard is the result of accumulated analysis to be able to show the level of investment feasibility of implementing Enterprise Data Warehouse at Bank BRI. The results of the assessment on the Information Economic Scorecard are obtained from the sum of each value from the Tangible value analysis, quasi tangible value which is calculated by Return On Investment (ROI) and Intangible value which consists of business and technology domains multiplied by the weight obtained from the Corporate Value assessment.

The benefit value and risk value of the investment are listed in the Information Economic Scorecard with positive and negative values respectively. This number is used to determine how much a company is willing to risk reaping the benefits of implementing an enterprise data warehouse. Assessment in the Information Economic Scorecard is shown in Table 4.10.

Table 4.10. Information Economics Scorecard

	EROI	Business Domain					Technology Domain				Total
		SM	CA	MI	CR	OR	SA	DU	TU	IR	
Score	1	4	4	5	4	1	5	1	4	3	
Weight	2	4	6	2	4	-1	1	-2	-1	1	
Project Score	2	16	24	10	16	-1	5	-2	-4	3	69

Based on the assessment from the Information Economic Scorecard, the total score of the project is 69. So based on the score above, the investment project for implementing Enterprise Data Warehouse at Bank BRI gets the title worth development.

5. CONCLUSIONS

The conclusion of the research and the results of the analysis of tangible values have been obtained. This value is obtained from the total percentage of net cash flow for 3 years worth Rp. 2,526,000,000 divided by the initial investment cost of Rp. 43,990,000,000. Then, in the quasi-tangible value analysis, the results of the enhanced return on investment (EROI) obtained a total benefit for 3 years worth Rp. 59,190,000,000.00, divided by the initial investment cost of Rp. 43,990,000,000.00, the result being 135%. Based on the results above, the enhanced ROI score is 1. In addition, in terms of quasi-tangible value, there are 2 values that cannot be directly assessed financially: value acceleration, which can unlock the potential to make it easier for marketers to be able to improve the number of BRI customers, and value restructuring, which opens opportunities for the development of corporate organizations by forming a special team, namely the Enterprise Data Warehouse Development Team.

Based on the results of the intangible value analysis of the results of the questionnaire obtained from respondents to the staff of the Enterprise Data Management Division of PT Bank Rakyat Indonesia, Tbk, the values obtained for each category were Strategic Match (4), Competitive Advantage (4), Management Information Support (5), Competitive Response (4), Organizational

Risk (1), Strategic IS Architecture (5), Defitional Uncertainty (1), Technical Uncertainty (4), and IS Infrastructure Risk (3). Furthermore, based on the results of the Information Economic Scorecard, the project score is 69. Based on the score above, with the information economics scorecard assessment parameters of 41 to 70, it is deemed worthy of development, so the investment project implementing Enterprise Data Warehouse at Bank BRI is deemed worthy of development.

Based on Managerial Implications, recommendations regarding the implementation of Enterprise Data Warehouse are obtained, namely that Enterprise Data Warehouse investment is financially profitable with a total benefit of Rp. 59,190,000,000.00 and the value of Payback Period 2 Years 84 Days. In addition, from a business perspective, Enterprise Data Warehouse investment can support the achievement of company goals, improve the company's competitive position, delaying investment can increase potential losses, is a strategic plan for the company's IS/IT, clear specifications, and minimal changes. In addition, with the Enterprise Data Warehouse investment, Bank BRI is required to continue this project in a sustainable manner and have employees who are skilled in operating the Enterprise Data Warehouse.

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SUPPLIER ASSESSMENT BASED ON GREEN PROCUREMENT USING ANALYTICAL NETWORK PROCESS METHOD AT GLOVE MANUFACTURING COMPANY

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ABSTRACT

Goods supplied by the supplier play the significant role towards the manufacturing process in the business. However, firms have increasingly encountered issues with supply chain distribution, namely supplier distribution. For instance, quality that falls short of expectations, delay problems, and bad service. Nowadays, the Indonesian government's policies in handling waste management also often force companies to adapt to these policies. One of the companies that are facing these problems is a company engaged in the manufacturing of golf gloves. In order to respond to public concern about environmental impact issues and government policies, the company needs to change the production system towards a more environmentally friendly direction. This research will use the concept of Green Procurement (GP) which integrates environmental aspects into business processes, and assess suppliers based on company criteria and sub-criteria using the Analytical Network Process (ANP) method. The results showed that the value for environmental criteria was 0.2505, financial criteria was 0.2502, quality criteria was 0.2499, and service criteria was 0.2494. Alternative supplier recommendations for goatskin raw materials are PT B with a value of 0.312, for cotton lycra fabric raw materials are PT L with a value of 0.333, and for polyester filament yarn raw materials are PT P with a value of 0.323

Keywords: supplier, green procurement, analytical network process.

1. INTRODUCTION

Implementing supply chain management (SCM) is nothing new for businesses. Many businesses are embracing SCM since it is believed to improve the efficiency of their logistical processes. Referring to Zhang and Li (2020), SCM defines as the transportation, movement, and management of raw materials and the transformation of raw materials into completed commodities for shipment to customers. In a company's production process, the demand for raw materials or other components supplied by suppliers is a significant issue. According to Zhu and Shah (2018), selecting the correct supplier is crucial towards company's competitiveness. Currently, however, some businesses are not selecting their suppliers optimally. This is due to the company's assessment, which solely considers quality and price when selecting suppliers, and disregards tangible and intangible characteristics.

In addition to the obstacles associated with the distribution of goods and information, environmental issues are now an additional obstacle for businesses. People's impressions of how a firm manages its entities without harming the environment are altered by these factors. M moreover, the existence of environmental restrictions in Indonesia, as outlined in Law No. 32 of 2009 concerning Environmental Protection and Management, compels businesses to adhere to these regulations. This impacts the company's business management. In response to the growing public concern for the environment, businesses exploit these obstacles to maximise revenues and customer trust.

Yadav (2021) mentioned that green production is an environmentally friendly production strategy that incorporates green supply chain management. Companies prioritise the deployment of green supply chain management (GSCM). This is because the strategy may shorten product or service lead times, cut costs, and enhance environmentally friendly supply chains. Environmentally conscious supply chain management is the philosophy underlying GSCM. It is consistent with the company's primary objective of maximising earnings without diminishing client confidence. Thus, GSCM is vital to execute since it considers not only business considerations, but also the company's environmental legislation and policies in order to avoid environmental damage.

This study examines a manufacturing company that specialises in the production of sports gloves. It began as a small supplier of sporting gloves in 1987 and has since become a market leader whose market has expanded internationally. The production process entails measuring, cutting, joining, sewing, checking (finishing), packing, and sending products to clients. This company's primary product is golf gloves. Table 1 displays the primary raw materials for the production of gloves, as supplied by various companies.

Table 1. List of Raw Material Suppliers

Company Name	Goods Supplied
PT A	Goat leather
PT B	Goat leather
PT C	Goat leather
PT D	Goat leather
PT E	Goat leather
PT F	Goat leather
PT G	Goat leather
PT H	Goat leather
PT I	Cotton lycra fabric
PT J	Cotton lycra fabric
PT K	Cotton lycra fabric
PT L	Cotton lycra fabric
PT M	Cotton lycra fabric
PT N	Cotton lycra fabric
PT O	Polyester filament yarn
PT P	Polyester filament yarn
PT Q	Polyester filament yarn
PT R	Polyester filament yarn
PT S	Polyester filament yarn
PT T	Polyester filament yarn

Utilizing the concept of green procurement becomes an approach for businesses to overcome the difficulty of selecting suppliers, addressing regulatory challenges, and addressing environmental concerns. Therefore, supplier selection must be conducted appropriately based on business requirements. In order for the company's manufacturing and distribution processes to function optimally, the supplier evaluation is based on predetermined criteria and sub-criteria. As per Govindan (2020), the selection of suppliers is based on two reference criterion approaches: traditional and green procurement. Traditional procurement criteria include quality, service, and finances, while green procurement criteria include environmental management.

2. LITERATURE REVIEW

Supply Chain

Supply Chain (SC) is the process of originating, receiving, and fulfilling orders for the distribution of goods, services, or data. The activity can integrate relationships between firm elements or organisations, allowing for the distribution of products or services in an appropriate and targeted manner. SC's applicability is not limited to integrating the interaction between company aspects; it can also assist businesses in efficiently achieving their objectives. This is consistent with Gao's (2018) remark regarding the objective of supply chain management, which is to ensure that the products and services offered can provide value to customers and advantages to each entity in the supply chain. In addition, SC examines eco-friendly integration technologies, such as Green Supply Chain and Green Procurement.

Referring to Gonzalez (2022), green supply chain (GSC) is an action undertaken by businesses to reduce production waste and enhance sustainable production process schemes. In addition, GSC can be utilised in a variety of industries, including the food industry, the health industry, and others. To achieve environmental sustainability, businesses must increase their efforts by enhancing environment-related behaviours along the SC pathway. In order to protect the environment, it is vital to manage SC by considering the environmental impact of all industrial processes.

Green Procurement

As per Khan (2018), Green Procurement refers to procurement activities that examine cost and quality criteria and incorporate environmental considerations. Additionally, Green Procurement operations emphasise green issues through lowering pollution and enhancing the environment's greenness. Green Procurement is a solution for organisations concerned with the environment and fiscal conservatism, as well as a concept for acquiring product and service options with minimal negative environmental repercussions. To implement green procurement in the selection of suppliers, certain criteria and sub-criteria must be considered. Table 2 displays the criteria and sub-criteria.

Table 2. Criterias of Green Procurement and is sub-criterias

Criteria	Sub-Criteria
Quality	Conformity of a product to its specifications
	Quality Management Standard
	Product's Guarantee
Service	On-time Delivery
	Responsiveness

	Delivery Capacity
Environment	Environment Management Standard
	Waste Management Technology
	Green Process
Financial	Price
	Payment System
	Price Reduction

Supplier

Multiple industrial sectors are attempting to define their respective capabilities in order to optimise partnership between the parties involved, particularly vendors or suppliers associated with the industrial supply network. As said by Kahraman (2021), suppliers are sources that provide the first material in the distribution chain of commodities, including raw materials, raw materials, spare parts, and others. As per Simchi-Levi (2008), the supplier network is the process of generating temporal spatial patterns at many facility nodes via distribution linkages in order to add product value to customers during both the manufacturing and delivery processes. As a result of the company's competitiveness in providing items to customers, teamwork throughout the supply chain is regarded as an essential factor.

Supplier selection is one of the company's most significant activities in deciding procurement strategies. According to Amid (2006), supplier selection activities are crucial and strategic decisions that impact supply chain management. However, the process of selecting a supplier requires numerous resources, including information, data, materials, and time. Thus, the supplier selection process necessitates data and research to ensure that decisions are accurate.

Analytical Network Process

Referring to Saaty and Vargas (2006), Analytical network process (ANP) is a general theory of relative measurement used to build composite priority ratios from individual ratio scales that reflect relative assessments of the influence of interacting factors on control criteria. Prioritization in ANP is determined by determining the relative weight of items such that the level of significance of each element is known. Compiling pairwise comparisons for each hierarchical subsystem before transforming them into matrices for numerical analysis is the first step in finding the priority arrangement. Table 3 shows the numerical values utilised for comparison.

Table 3. Scale of Value Comparison

Importance Level	Definition	Description
1	Equal	Both elements have same effect
3	Little more important	Experience and judgment are slightly more partial to one element compared to their partners
5	More important	Experience and judgment are very favorable to one element compared to their partner
7	Very important	One element is well liked and practically its dominance is very real compared to its partner element.
9	Absolute	One element proved to be absolutely preferred compared to its partner at the highest level of confidence

2,4,6,8	Middle	Given if there is doubtful judgment between two adjacent judgments

3. METHODS

In this study, two types of data are required: primary data, which includes the completion of questionnaires, and secondary data, that further includes information on the use of raw materials for goatskin, cotton lycra fabric, and polyester filament yarn, as well as research-supporting books, articles, and journals. After receiving the application criteria and sub-criteria for the idea of green procurement, a questionnaire is created. Two sorts of questionnaires will be provided in the future. The objective of the first questionnaire is to establish the relationship between supplier selection criteria for raw materials used to manufacture golf gloves, and the objective of the second questionnaire is to establish the relative importance of each level of the network structure through pairwise comparison weighting. The questionnaire will be delivered to production planning and inventory control professionals (PPIC). The specialists are listed in Table 4. The questionnaire data will be analysed using the analytical network procedure.

Table 4. Respondents List

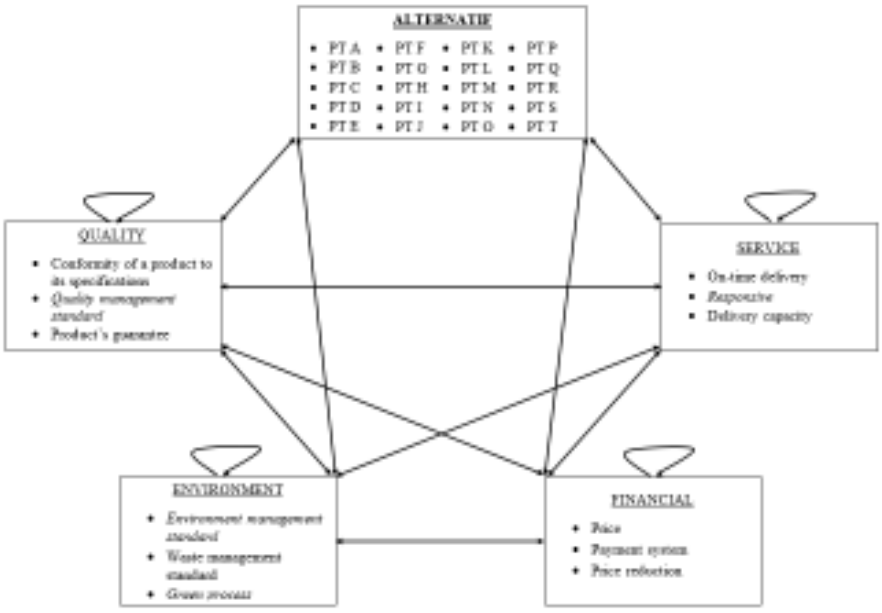
Jabatan	Pendidikan terakhir	Pengalaman kerja
Head of PPIC Department	S2	17 years
Assitance Head of PPIC Department	S1	11 years
Supervisor of PPIC	S1	8 years

4. RESULTS

Network Structure

Based on the results of the initial questionnaire, Figure 1 depicts the relationship between criteria, sub-criteria, and alternatives as a network structure. Each criterion provides a link to other criteria in supplier evaluation, as shown in the diagram.

Figure 1. Network Structure



Weighted Criteria

Overall, weights of each criterion are listed in Table 5 based on the outcomes of the second questionnaire and calculations performed using ANP. The environmental criterion with a score of 0.2505 has the highest value, whereas the sub-criteria with the highest value is on-time delivery.

Table 5. Weighted criteria and sub-criteria values

Criteria	Bobot kriteria	Sub-criteria	Bobot sub-criteria
Quality	0.2499	Conformity of a product to its specifications	0.134
		Quality Management Standard	0.067
		Product's Guarantee	0.049
Service	0.2494	On-time Delivery	0.145
		Responsiveness	0.063
		Delivery Capacity	0.041
Environment	0.2505	Environment Management Standard	0.120
		Waste Management Technology	0.043
		Green Process	0.087
Financial	0.2502	Price	0.131
		Payment System	0.051
		Price Reduction	0.069

Weighted Alternatives

Then, alternative supplier weights are calculated based on the type of raw material supplied. Table 6 contains alternative goat skin raw material weights. It is evident that PT B has the greatest value, 0.280. Based on these calculations, PT B can be employed as a provider of goat skin raw materials for the production of golf gloves because it meets the green procurement standards.

Table 6. Alternate weighted values for goat leather raw materials

Company name	Weighted Values
PT A	0.064
PT B	0.280
PT C	0.173
PT D	0.049
PT E	0.099
PT F	0.033
PT G	0.233
PT H	0.069

Regarding table 7 is an alternate table of weights for cotton lycra fabric basic ingredients. PT L has the greatest value, 0.299, as observed. Based on these calculations, PT L can be employed as a provider of cotton lycra fabric raw materials for the production of golf gloves, as it meets the green procurement standards.

Table 7. Alternate weighted values for cotton lycra fabric raw materials

Company name	Weighted Values
PT I	0.105
PT J	0.093
PT K	0.291
PT L	0.299
PT M	0.052
PT N	0.160

The table 8 is an alternate weighing table for raw polyester yarn filaments. It is evident that PT P has the greatest value, 0.290. Based on these calculations, PT P can be used as a provider of polyester yarn filament raw materials to produce golf gloves because it has met the green procurement standards.

Table 8. Alternate weighted values for filament polyester yarn raw materials

Company name	Weighted Values
PT O	0.092
PT P	0.209
PT Q	0.183
PT R	0.250
PT S	0.124
PT T	0.060

Performance Alternatives

On the basis of tables 9, 10, and 11, it is evident that the performance of alternative suppliers PT B for goat leather raw materials, PT K for cotton lycra fabric raw materials, and PT P for polyester filament yarn raw materials achieves the greatest value for nearly every criterion.

Table 9. alternative goat leather suppliers' efficiency

Criteria	PT A	PT B	PT C	PT D	PT E	PT F	PT G	PT H
Quality	0.212	0.773	0.421	0.118	0.272	0.092	0.717	0.169
Service	0.284	0.706	0.454	0.147	0.239	0.109	0.628	0.195
Environment	0.188	0.724	0.490	0.148	0.232	0.084	0.703	0.190
Financial	0.126	0.725	0.603	0.200	0.397	0.102	0.595	0.156
Total	0.810	2.928	1.968	0.612	1.039	0.387	2.642	0.710

Table 10. alternative cotton lycra fabric suppliers' efficiency

Criteria	PT I	PT J	PT K	PT L	PT M	PT N
Quality	0.562	0.284	0.679	0.743	0.172	0.348
Service	0.169	0.215	0.761	0.955	0.199	0.486
Environment	0.159	0.216	0.791	0.921	0.108	0.578
Financial	0.350	0.206	0.860	0.789	0.145	0.497

Total	1.240	0.966	3.091	3.409	0.625	1.909

Table 11. alternative filament polyester yarn suppliers' efficiency

Criteria	PT O	PT P	PT Q	PT R	PT S	PT T
Quality	0.284	0.743	0.464	0.736	0.371	0.250
Service	0.470	0.564	0.449	0.704	0.434	0.122
Environment	0.284	0.958	0.393	0.793	0.239	0.147
Financial	0.420	0.885	0.568	0.423	0.398	0.156
Total	1.457	3.149	1.873	2.657	1.442	0.675

5. CONCLUSIONS

On the basis of the findings of a study on supplier evaluation based on green procurement utilising the analytical network process (ANP) technique in the glove manufacturing business, the following conclusions can be drawn:

1. The first questionnaire revealed the interaction between criteria and sub-criteria in the glove manufacturing industry's network for assessing raw material suppliers.

2. Using the analytical network process method, the value of each alternative supplier's priority is determined. For alternative suppliers of goat leather raw materials PT A receives scores of 0.212 on quality criteria, 0.284 on service criteria, 0.188 on environmental criteria, and 0.126 on financial criteria for alternative suppliers of goat skin raw materials. PT B receives a score of 0.773 for quality, 0.706 for service, 0.724 for environmental, and 0.725 for financial factors. PT C has a quality value of 0.421, a service score of 0.454, an environmental score of 0.490, and a financial score of 0.603. PT D has a quality score of 0.118, a service score of 0.147, an environmental score of 0.148, and a financial score of 0.200. PT E has a quality score of 0.272, a service score of 0.239, an environmental score of 0.232, and a financial score of 0.397. PT F has a quality score of 0.092, a service score of 0.109, an environmental score of 0.084, and a financial score of 0.102. PT G had a score of 0.717 for quality, 0.628 for service, 0.703 for environmental, and 0.595 for financial factors. PT H received a score of 0.169 for quality, 0.195 for service, 0.190 for environmental, and 0.156 for financial categories.

   For alternative suppliers of cotton lycra fabric raw materials PT I produce a score of 0.562 on quality criteria, 0.169 on service criteria, 0.159 on environmental criteria, and 0.350 on financial criteria for alternative suppliers of cotton lycra raw materials. PT J scores 0.284% on the quality criterion, 0.215 on the service criteria, 0.261 on the environmental criteria, and 0.206 on the financial criteria. PT K scores 0.679 on the quality criteria, 0.761 on the service criteria, 0.791 on the environmental criteria, and 0.860 on the financial criteria. PT L scores 0.743 on the quality criteria, 0.955 on the service criteria, 0.921 on the environmental criteria, and 0.789 on the financial criteria. PT M produces a quality score of 0.172, a service score of 0.199, an environmental score of 0.108, and a financial score of 0.145. PT N scores 0.348 on the quality criterion, 0.486 on the service criterion, 0.578 on the environmental criterion, and 0.497 on the financial criterion.

For alternative suppliers of polyester filament yarn raw materials PT O has a value of 0.284 on quality criteria, 0.470 on service criteria 0.284 on environmental criteria, and 0.420 on financial criteria. PT P has a value of 0.743 on quality criteria, 0.564 on service criteria 0.958 on environmental criteria, and 0.885 on financial criteria. PT Q has 0.464 on quality criteria, 0.449 on service criteria 0.393 on environmental criteria, and 0.568 on financial criteria. PT R has 0.736 on quality criteria, 0.704 on service criteria 0.793 on environmental criteria, and 0.423 on financial criteria. PT S has a value of 0.731 on quality criteria, 0.434 on service criteria 0.239 on environmental criteria, and 0.398 on financial criteria. PT T has a value of 0.250 on quality criteria, 0.122 on service criteria 0.147 on environmental criteria, and 0.156 on financial criteria.

3. The company's dedication towards implementing the green procurement concept's requirements is demonstrated by the analytical network process calculation. The environmental categories are ranked first with a 0.2505 score, followed by the financial, quality, and service criteria. For calculations utilising the analytical network technique for each alternative provider of goatskin raw materials, PT B generates the greatest value with a value of 0.31. With a rating of 0.333, PT L receives the highest score in the alternative supplier sector for cotton lycra fabric. In addition, PT P produces the highest value among alternative suppliers of polyester filament yarn, at 0.323%. Therefore, PT B, PT L, and PT P can be chosen to offer the necessary raw materials for the production of golf gloves, as they meet the criteria of the green procurement concept and receive the highest score.

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EVALUATION OF SUPPLY CHAIN SOFTWARE AS A SERVICE IMPLEMENTATION USING HUMAN, ORGANIZATION, AND TECHNOLOGY-FIT (HOT-FIT) FRAMEWORK

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ABSTRACT

The implementation of information technology in the company's business processes can generate significant economic benefits in the long term. Digital product selection needs to consider the company culture, data security, system development cost and time, and training for employee. To answer this challenge, introduced an emerging technology called Software as a Service (SaaS). One of the SaaS providers in Indonesia is company XYZ**.** This company has developed an application that has various features related to the supply chain. One of the services provided is the Market Info module. This module will record the inventory information for each product at stores visited by staffs. There are several issues in the system, such as the application crashed, the data sent via the smartphone was not stored in the database, there was duplication of data, and the module features were not yet understood. Conducted research evaluating the implementation SaaS applications use the Human, Organization, Technology Fit research model (HOT-Fit), and data processing using the Structural Equation Partial Least Square (SEM-PLS) to determine the relationship between variables. The results show system quality has a big role to affect into system use, customer satisfaction, and organizational structure. Also, system use and customer satisfaction has an effect to net benefit for users.

Keywords: evaluation, supply chain software, software-as-a-service, HOT-Fit, SEM-PLS

1. INTRODUCTION

Digital transformation is a process of change related to information technology implementation in various activities to create more added value, Verhoef, et al., (2021). In a global or organizational scale, those who be able utilize the best use of digital transformation will reap significant economic benefits in the long run, while the organizations who slow to adapt in this moment have huge probability to be left behind, Das, et al. (2016). Increasing productivity through digitalization can generate cost savings in the value chain, from planning, product development, operations, sales, and services activities.

The benefits of digitalization also apply to supply chain management. Digitalization brings down the walls between the chain and becomes a completely integrated ecosystem that is fully transparent to all stakeholders involved, Freitas & Neto (2017). These abilities can be provided by a Software-as-a-Service (SaaS) provider. SaaS is a cloud computing service that provides a system that is accessed via internet for users who have subscribed to its services. All services including

software and hardware installation, data storage, system update and maintenance are done by SaaS provider Ali, et al. (2020).

One of the SaaS providers in Indonesia is XYZ company, which has been operating since 2016. This provider develops an application that has various features related to supply chain management, such as inventory management system, warehouse management system, delivery management system, and product digitalization system. One of the services provided is Market Info module. This application can be accessed via user's smartphone. This module is usually used by merchandiser or sales team who visit distributor or store regularly. Merchandiser or salesperson will submit the product information such as stock availability, expiration date, selling price, and purchase store in the store they visit that day. This data will be stored in database which can be accessed and reviewed by the supervisor via website. The supervisor can do data processing to get the right analysis, conclusion, and right decision.

Market Info module has been used by several big companies as the client of XYZ company, and the number of users will continue to grow as the XYZ's client grow. In its implementation, this application has not fully been able to run as expected, there are still some issues reported by users to customer service team. Some recurring issues such as application having a forced close or crashed while being used, duplicated data, missing data, unfamiliar feature, huge battery consumption, and long troubleshooting process. In addition, this module has never been evaluated and success metric of application has never been set. The key success of an information system is determined by how it can get the input, process the information, and how the user's perception when they use it, whether they want to use it and don't have major difficulties on it. So, the organizational goals can be achieved.

Evaluation is needed to know the information system performance. Through evaluation, we can get the information of the extent to which this system is successful and which part that should be improved. Research conducted by Lynn, et al., (2018) suggests that the most of problems experienced in information system implementation are associated with a mismatch between technological, organizational, and human factor. The framework that can accommodate those three components is Human, Organization, and Technology Fit that introduced by Yusof, et al., (2016). Based on the importance of Market Info implementation to improve user and client performance described above, the authors conducted a study related to application evaluation by referring to the HOT-Fit framework that have complete aspect of assessment and in accordance with existing problems.

2. LITERATURE REVIEW

Information system is a collection of hardware, software and networks built in an integrated manner to collect, create, and disseminate information within an organization. Organizations that invest in information systems and technology aim to increase the economic value of their business by assuming that the return on investment in information technology is able to exceed the return on investment in buildings, machinery, and other assets. This large profit will be obtained through increased productivity which results in increased income. Every company has an information chain, where the initial data will be collected systematically and transformed into valuable information.

Software as a Service (SaaS)

Software as a Service is a software model created by a party and can be accessed via the internet by users who have subscribed to the service. The subscription system is carried out using

a pay per user system. If the subscription period has expired, the user will not be able to access the software. Based on Poonam & Siddiqui (2014), the advantages that offered by SaaS, such as:

- An easy-to-understand payment system that is based on subscription fee per user per period and based on selected package
- SaaS provider has responsibility to update and do maintenance of system regularly, so the client does not need to provide dedicated resources to carry out these activities
- Services can be accessed flexibly from various devices as long as they are connected to the internet
- Ease of stopping the subscription if client wants to migrate to another service provider that is more suitable to their needs

In contrast, SaaS also has disadvantages that need to be considered, such as:

- Lack of client control over the software development and capabilities that are fully monitored by the SaaS provider
- Limited features compared to client business process because SaaS will design their services that suitable for most of business process. In this case, sometimes the SaaS provider can accept additional feature request with additional cost
- Data and credential security are fully stored by SaaS provider, as well as the potential of data misuse

Human, Organization, Technology Fit (HOT-Fit)

The HOT-Fit model is introduced by Yusof, et al., (2016). The idea of this model is the development of Delone and McLean success model (D&M IS success model) and IT-Organization Fit Model. The proposed model has three main components, namely Human, Organization, and Technology that will affect the Net Benefit. An information system works by meeting human and organizational needs. Therefore, the information system is expected to be able to assist humans in completing their work. Likewise, humans as users of information systems should have knowledge regarding how to use information systems, as well as an organization that should be equipped with technology that suits their needs and prepares its members to be able to adapt to the use of information systems.

1. **Human**

   Human in this model are users of the information system to be evaluated. The human aspect in the HOT Fit model uses two dimensions to assess the success of information technology implementation, namely system use and user satisfaction. System Use relates to the user's knowledge in operating the information system, this will affect the quality of the system used. Knowledge related to mastery of information systems owned by users, Monalizabeth (2015). This dimension is also related to expectations, acceptance, or rejection of information system. User Satisfaction related to the benefits felt by users when using information systems, and evaluating user experience and the impact obtained from using information system.

2. **Organization**

   Organizations are able to evaluate information systems based on organizational structure and environment. The organizational structure consists of culture, politics, hierarchy, autonomy, planning and control systems, strategy, management, and communication. The assessment includes the ability of information systems to support company strategy and performance improvement. Management support and training are also needed in evaluating and improving the quality of information systems.

3. **Technology**
   Technological aspect will assess the system from the technology used. The technology component will evaluate the information system from system quality, information quality, and service quality. System Quality concerns performance evaluation both in terms of hardware and software to provide information to users. The quality of this system can be measured through ease of learning, ease of use, functionality, reliability or reliability, system flexibility or flexibility, data quality, portability, integration, and the importance of information systems. Information Quality discusses the quality of the output/output information provided by the information system. This can be assessed for the completeness, accuracy, availability, relevance, consistency of data or information received or stored on the system. Service Quality discusses the services received by users, including reliability, support, and quality assurance provided by information system service providers, as well as the empathy given to users, Esperanza & Pribadi (2022).

3. METHODS

This research uses a quantitative approach with descriptive and associative causal research method by conducting survey to 100 market info module users. There are 41 statement points on the questionnaire that was measured using five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Surveys are analyzed using SEM-PLS method run in SMARTPLS software version 3.7.7. The statement points were built based on variables for each aspect in HOT-Fit framework, such as system quality, information quality, service quality, system use, user satisfaction, organizational structure, and net benefit. This study uses HOT-Fit framework as below:

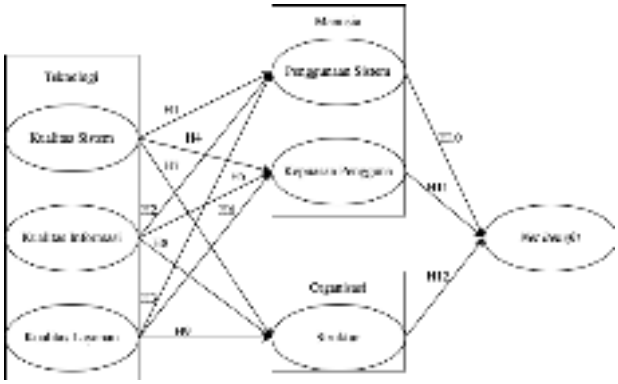

Figure 1. HOT-Fit Model of the study

4. RESULTS

4.1 Descriptive Statistical Analysis

Descriptive statistical analysis is used to describe the basic features of the data in this study. This study involved seven latent variables and several indicators to explain the latent variables. The indicators were developed into 41 statements that has value ranging 1 to 5. Descriptive analysis will show the mean and standard deviation for each indicator. The results are shown in Table 1 below.

Table 1. Descriptive Statistical Analysis

Variable	Indicator	Mean	Standard Deviation
System Quality	Ease of use	3.847	1.010
	Response time	3.720	1.000
	Security	3.860	1.000
	Functionality	3.445	1.060
Information Quality	Accuracy	3.719	1.261
	Data completeness	3.893	1.134
	Punctuality	3.895	1.265
Service Quality	Service guarantee	3.683	1.305
	Empathy	3.903	1.319
System Use	Level of use	3.787	1.148
	Expectation	3.750	1.036
User Satisfaction	User satisfaction	3.350	1.169
	Perceived benefit	3.517	1.090
Organizational Structure	Management support	4.150	1.069
	Strategy	3.865	1.064
Net Benefit	Direct benefit	3.595	1.080
	Effectiveness and efficiency	3.770	0.996

4.2 Measurement Model Analysis

In measurement model or outer model, a unidimensional reflective relationship model is applied where the causal direction is from the latent variable to the indicator, so the test needs to be done first order confirmatory factor analysis to test whether the data has the validity and reliability of the indicators that make up the latent variable. The steps taken in this test are to determine the value of convergent validity and discriminant validity of the latent variable forming indicators.

a. Convergent validity can be measured based on the value of loading factor and average variance extracted (AVE). If value for a loading factor > 0.70 and an AVE value > 0.50, then the convergent can be said to be valid, Hair, et al., (2018). The result in Figure 1 shows 37 indicators meet the convergent validity, four indicators that doesn't meet the threshold must be eliminated.

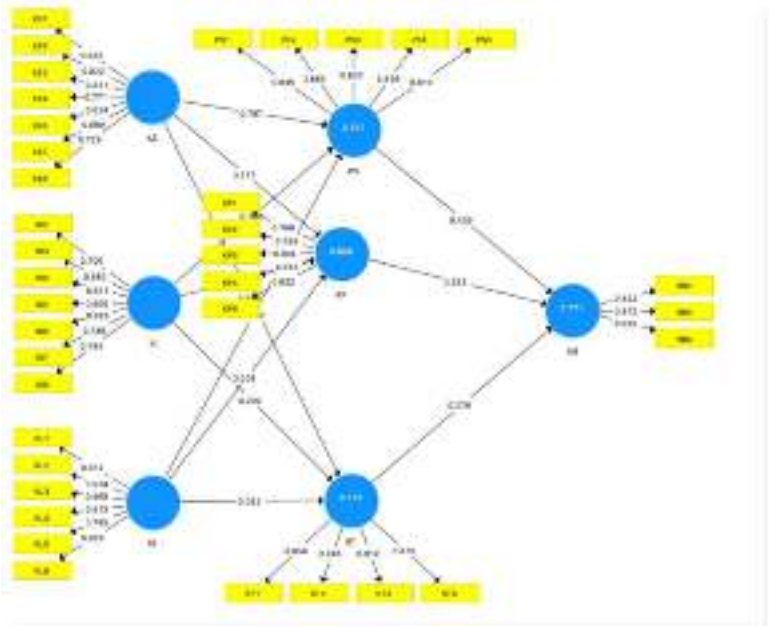

Figure 2. Outer Loading Value

b. Discriminant validity uses square root AVE value compared to AVE value, Hair, et al., (2018). The square root of AVE for each variable has greater value than the AVE value, hence the evaluation of discriminant value has been fulfilled.

Table 2. Discriminant Validity

Variable	AVE	Root AVE
System Quality	0.662	0.814
Information Quality	0.691	0.831
Service Quality	0.678	0.823
System Use	0.702	0.838
User Satisfaction	0.710	0.843
Organizational Structure	0.805	0.897
Net Benefit	0.713	0.844

c. Reliability test in this study was carried out by assessing Cronbach's alpha and composite reliability in each construct. Based on 3, Cronbach's alpha and composite values for all latent variables are > 0.70, which can be said to be reliable.

Table 3. Reliability Test

Variable	Cronbach's Alpha	Composite Reliability	Description
System Quality	0,914	0,932	Reliable
Information Quality	0,924	0,940	Reliable
Service Quality	0,905	0,927	Reliable
System Use	0,894	0,922	Reliable
User Satisfaction	0,897	0,924	Reliable

Organizational Structure	0,919	0,943	Reliable
Net Benefit	0,799	0,882	Reliable

4.3 Structural Model Analysis

The analysis of structural model or inner model will be explained using R-square and bootstrapping. R-square value is used to know how much the independent variables determined by the researcher contribute to the dependent variable, Chen (1998).. The result of R-square is shown in Table 4 below.

Table 4. R-square Result

Variable	R-square	Description
System Use	0,757	Strong
User Satisfaction	0,628	Moderate
Organizational Structure	0,773	Strong
Net Benefit	0,771	Strong

Based on Table 4 it can be stated that the system usage variable can be explained strongly by 75.7% by the independent variable, the customer satisfaction variable can be explained moderately by 62.8% by the variable independently, the structure variable can be explained strongly by 77.3% by the independent variable, and the net benefit is able to explain strongly by 77.1% by the human aspect on the variable system usage (PS) and user satisfaction (KP), organizational aspects on structural variables (ST), and technological aspects of system quality (KS), information quality (KI), and service quality (KL) variables. While the remaining 22.9% is explained by other variables outside of this study.

4.4 Hypothesis Testing

The path coefficient is the next step in the inner model test where path coefficient is carried out to evaluate the significance of the influence between latent variables used in research. The process for measuring the path coefficient is using the bootstrapping process, Hair, et al., (2018). The path coefficient function is to determine the direction of the relationship between variables.

Table 5. Path Coefficient

Variable Relations	Path Coefficient	T statistic	P-value	Result
System Quality - System Use	0,787	11,713	0,000	H1 Accepted
Information Quality - System Use	0,162	1,814	0,070	H2 Rejected
Service Quality - System Use	-0,052	0,661	0,509	H3 Rejected
System Quality - User Satisfaction	0,717	8,674	0,000	H4 Accepted
Information Quality - User Satisfaction	0,097	1,122	0,262	H5 Rejected
Service Quality - User Satisfaction	0,009	0,106	0,916	H6 Rejected
System Quality - Organizational Structure	0,586	8,148	0,000	H7 Accepted
Information Quality - Organizational Structure	0,292	3,444	0,000	H8 Accepted
Service Quality - Organizational Structure	0,082	1,052	0,293	H9 Rejected
System Use - Net Benefit	0,439	3,894	0,000	H10 Accepted
User Satisfaction - Net Benefit	0,252	2,829	0,005	H11 Accepted
Organizational Structure - Net Benefit	0,276	1,791	0,074	H12 Rejected

As shown in Table 5, all variable relations except service quality to system use have positive coefficient value, which means independent and dependent variable move to the same direction. In

the other hand, service quality to system use has negative coefficient value, which means independent and dependent variable move to opposite direction.

Through T-statistic or P-value, it can be shown the accepted or rejected hypothesis. Hypothesis is accepted if it has T statistic > 1.96 or P-value < 0.05, and hypothesis is rejected if it has T statistic < 1.96 or P-value > 0.05. Based on this rules, there are 6 of 12 hypotheses that can be accepted: H1, H4, H7, H8, H10, H11. Referring from Table 5, system quality is the only variable in technology aspect that has significant impact to system use and user satisfaction. Also, system use and user satisfaction has significant impact to net benefit.

5. CONCLUSIONS

Based on the 12 hypotheses made to determine whether there is a relationship with the aspects observed in the HOT-Fit framework, namely humans, organization and technology, there are six hypotheses that result in H0 being rejected, which means there is a relationship between these variables. This can be seen from the p-value < 0.05 or T2 > 1.96. Significant variable relationships are system quality (KS) on system use (PS), system quality (KS) on user satisfaction (KP), system quality (KS) on structure (ST), information quality (KI) on structure (ST) , use of the system (PS) for the net benefit (NB), and user satisfaction (KP) for the net benefit (NB). It can be seen that system quality (KS) has an important role in increasing net benefits. Thus, this can be the main focus for service providers to improve the quality of their systems. System quality can be improved by paying attention to factors such as ease of use, application response time, application security, and application functionality.

Based on the results of the path coefficient test, it can be seen that increasing the net benefit for users is influenced by the system usage variable of 0.439 and user satisfaction of 0.252. To increase the use of the system, this is influenced by the quality of the system, which is equal to 0.787. Meanwhile, to increase user satisfaction is influenced by the system quality variable of 0.717. Based on the descriptive analysis conducted on the research variables, the average value of user satisfaction was 3,350 and the direct benefits felt by users had an average of 3,595. Things that already feel good about this application are the empathy that service providers provide for users, with an average value of 3,903. In addition, the application is also considered quite easy to use and users feel safe when using the application, seen from the average values of 3,847 and 3,860. Things that need to be improved based on this research, namely application functionality with an average of 3,445, this is one indicator of the system quality variable.

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EFFECTIVENESS OF APPLICATION OF WORK FROM HOME TO SCRUM-BASED PROJECT COMPLETION

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ABSTRACT

The scrum method is a framework that emerged around the early 2000s and is being popularly used by companies or organizations, especially in projects based on software development, due to its high success rate compared to the use of traditional methods. However, since the pandemic due to Covid-19 which has made some employees work from home which certainly affects the way of working to the performance of employees and companies, as well as seeing many technology companies that implement work from home permanently, it is background to find a relationship between the effectiveness of implementing work from home with the completion of scrum-based projects. This study used the structural equation modeling (SEM) method to analyze the primary data obtained from the questionnaire results of 125 respondents. The results of this test analysis show that the application of work from home is considered quite effective in completing scrum projects, this can be proven from the majority of respondents who after the pandemic continue to work online from home or alternately (hybrid). The variables core values scrum, people factor, and productivity are variables that have a significant effect on the completion of scrum projects that are done work from home.

Keywords: Agile, Scrum, Work from Home, Structural Equation Modelling

1. INTRODUCTION

The rapid growth of technology has made major changes to the types of industries in Indonesia, many incubation or acceleration programs that can encourage today's society to be able to create new innovations with a technological approach as a solution to existing problems, and as per 2022, Indonesia has 2.351 startups. Startups work type is adapting user-focused work methods that work quickly and flexibly. Not only startups, companies or organizations that focus on software development also have challenges, such as minimizing costs and processing time but must keep up with the latest technological innovations, Hron (2022). Based on survey from Digital.ai, then implementing the scrum that has a domination user as much as 66% in agile method and the success rate up to 60% is one of the solutions that can be considered because developers can work more specifically according to predetermined needs in a short time (2021). Scrum has an approach to be able to organize and solve the challenges of a complex business

environment then its implementation requires a very intense coordination and communication between its team, like the scrum team must participate in each scrum activities.

Due to Covid-19, which has an impact on the world of work globally and based on survey from World Economic Forum in 2020 that 91.7% companies in Indonesia from all sectors have implemented work from home. There are many advantages for company to implement a work from home system, including cost and time saving, flexibility, and increase job satisfaction. However, there are also challenges that can be considered as obstacles in work from home. As Jain saying, work from home makes easy to find distractions and the boundary between work and non-work becomes thin. Often work from home is considered a way to work that can be standby for 24x7.

By seeing how the scrum framework works so fast and activity-intensive and requires a lot of communication and collaboration between teams, of course, employees will feel the impact of changes from the implementation of work from home, Russo (2021). But since the pandemic caused by Covid-19, the adoption of the use of agile methods has grown rapidly to 86%. Based on research by Kadasah et al it was also found that the project success rate remained high and was not affected by the implementation of work from home (2021). So, the purpose in this paper is to know the relation between work from home and deliverables of scrum project and also the potential to implement work from home for organization or company. The effectiveness from implementation work from home to deliver a scrum project will be analyzed.

2. LITERATURE REVIEW

2.1 Scrum

Working on projects using agile methods is indeed quite satisfying, especially for software development projects. Based on the results of a survey conducted by Kropp (2020), the existence of agile collaboration is the main reason for satisfaction with the use of agile methods. Another reason for the use of agile is that it can accelerate project completion, accommodate changes in work priorities and focus on clients.

Due to the fast agile work cycle, team members feel short on time when testing in each iteration. And although agile excels because of its flexibility in accepting change, this backfire if it is not accompanied by projections of what kind of project in the future, because agile actors still need work prioritization planning for several periods later. This has implications for one of the agile frameworks that has been widely used in the last five years, namely scrum. Research conducted by Prasetya (2021), which shows that the use of the scrum method is not easy, especially if using a development team from a third party, because it requires a fairly frequent intensity of coordination and communication, but scrum has advantages over other methods, namely faster processing time and more maintained scope of work, because the planning and communication process takes precedence over this method, so that the use of this method can save it cost. Also, the results of a survey conducted by Kadasah, it is known that 75% of the 114 respondents are team members who have implemented scrum, so it can be stated that the scrum framework is a framework that is in great demand by companies or organizations (2021).

2.2 Work from Home

Work from home (WFH) is one of the concepts of remote work (telecommuting) or commonly referred to as working remotely, which has actually been known since 1970, as an effort to overcome problems that occur in many workers, namely congestion (Mungkasa, 2020). The definition of WFH itself is a way of working that is done from home or not from the office

periodically, it can be a day or more than a day in one week, so it can be said to be an alternative way of working that has flexibility in working hours and regulates workload priorities (Afrianty, 2022).

Factors of gender, education level, ethnicity, type of employee also determine the probability for employees to work from home. The higher level of education followed by the higher the income earned, the more likely it is to work from home. Based on study from Kadasah, the disadvantages from work from home makes the relationship between teams in the form of interaction or internal communication will also be a little more difficult (2021), because there is no direct supervision, also affects aspects of psychology, such as bringing up feelings of loneliness, easier to get distractions/ distractions, stress, to have implications for negative job satisfaction levels, Kong (2022). But workers who work from home turn out to add satisfaction at work, improvise performance, increase productivity, feel happy, and tend to be more loyal to the company, Afrianty (2022). Not only has an impact on personal conditions, working remotely can save electricity costs, renting a place, or the needs of the organization / company itself. It can even have an impact on the environment, because it can reduce the activities of the transportation sector that produce harmful emissions.

2.3 Structural Equation Modeling – Partial Least Square

Structural Equation Modeling is a technique for multivariate evaluation and analysis in carrying out data processing, which can be used to analyze relationships between complex variables, Hair (2022). This technique combines two statistical concepts, namely the concept of factor analysis that is included in the measurement model and the concept of regression using a structural model. This technique used to confirm complex intervariable relationship theory, but Structural Equation Modeling – Partial Least Square itself can be used as an alternative to the existing problems in covariance-based SEM. SEM-PLS is more useful to use if the destination model is in the form of predictions and as an explanation of the truth of hypothesis testing, Restu (2021), where the target output obtained from in-sample and out-sample metrics, Hair (2022).

3. METHODS

This study applies a descriptive and associative causal research method with a quantitative approach. Associative research itself is research carried out to find the relationship between one variable and another. The research is explanatory research, in that it seeks to identify the main determinants of deliverables of the scrum project while in the WFH programs, and it is exploratory in that it collects data from one organisation at one point in time. The variables that used in this study consist of core values scrum, productivity, job satisfaction, organizational factor, people factor, technological factor, and environmental factor. The data were gathered using structured online questionnaires and distributed to employees who were in a scrum project and had an experience in both WFH and WFO in Indonesia. A total of 125 surveys were collected and analysed using Smart Partial Least Square (SmartPLS) version 4.0.

4. RESULTS

4.1 Demographic Information

In the demographic analysis section, this respondent was carried out using questionnaire data that had been obtained from 125 respondents. The demographic information of the

respondents is shown in Table 1. More than 50% respondents are male and as a millennial generation between the ages of 26-35; dominated with participants who has an experience with scrum more than a year; around a half participant never implemented a WFH before pandemic; and more hybrid work type employee dominated as a participant.

Table 1. Demographic Information

No	Characteristic of Respondents	Number	Percentage (%)
1	**Age (Years)**		
	Under 26	29	23.20%
	26 - 35	83	66.40%
	36 - 45	12	9.60%
	45 plus	1	0.80%
2	**Gender**		
	Male	80	64.00%
	Female	45	36.00%
3	**Education**		
	Highschool	4	3.20%
	Diploma	4	3.20%
	Bachelor's degree	104	83.20%
	Master's degree	11	8.80%
	PhD	2	1.60%
4	**Scrum Experience**		
	Less than 6 months	22	17.60%
	6 - 12 months	25	20.00%
	1 - 3 years	55	44.00%
	More than 3 years	23	18.40%
5	**Use of Scrum in Organization**		
	Less than 6 months	14	11.20%
	6 - 12 months	23	18.40%
	1 - 3 years	53	42.40%
	More than 3 years	35	28.00%
6	**Role in Scrum**		
	Developer/Engineer	32	25.60%
	Product Designer	14	11.20%
	Product Owner/Product Manager/Business Analyst	50	40.00%
	Scrum Master/Project Manager	14	11.20%
	Software/QA Tester	15	12.00%
7	**Current Work Type**		
	Hybrid	75	60.00%
	Work from Home/Anywhere	34	27.20%
	Work from Office	16	12.80%
8	**WFH Duration Before the Pandemic**		
	1-2 days/week	19	15.20%
	3-4 days/week	15	12.00%
	Every day (fully WFH)	31	24.80%
	Never	60	48.00%

4.2 Validity and Reliability Assessment

The validity assessment of the measurement model is carried out based on two stages, namely, convergent validity and discriminant validity. Convergent validity can be measured based on loading factor values and average variance extracted (AVE). If the value for the loading factor > 0.70 and the AVE value > 0.50, then in the convergent validity test it can be said to be valid and the construct can explain 50% or more for the item variant.

Then, for the reliability assessment which aims to measure the consistency of each variable used. The reliability test in this study was carried out by assessing Cronbach's alpha and composite reliability in each construct. If these values show values above 0.60, then it can be said that the model being tested is considered to have good reliability.

Table 2. Convergent Validity & Reliability Assessment

Latent Variable	AVE	Cronbach's Alpha	Composite Reliability	Notes
Core Values Scrum	0.591	0.885	0.910	Reliable
Job Satisfaction	0.673	0.838	0.891	Reliable
Organizational Factor	0.674	0.838	0.892	Reliable
People Factor	0.649	0.866	0.902	Reliable
Technological Factor	0.735	0.880	0.917	Reliable
Environmental Factor	0.728	0.816	0.889	Reliable
Productivity	0.720	0.870	0.911	Reliable
Deliverables	0.709	0.864	0.907	Reliable

4.3 Hypothesis Testing

Hypothesis testing was carried out through examining the t-statistics on each path of direct and indirect effects. The criteria for a significant effect require that the t-statistics of each path coefficient ≥ t-table (1.96). The results of the hypothesis testing of direct and indirect effects can be seen in Table 3, respectively.

Table 3. Hypothesis Result

Variable Relationship	Path Coefficient	T^2	P-value	Result
Productivity → *Deliverables*	0.485	4.836	0.000	Reject H_0
Core Values Scrum → *Deliverables*	0.266	2.264	0.024	Reject H_0
Core Values Scrum → Productivity	0.436	4.957	0.000	Reject H_0
Job Satisfaction → Productivity	0.145	1.036	0.300	H_0 Accepted
Organizational Factor → Productivity	0.064	0.658	0.510	H_0 Accepted
People Factor → Productivity	0.324	2.417	0.023	Reject H_0
Environmental Factor → Productivity	-0.076	1.056	0.409	H_0 Accepted
Technological Factor → Productivity	-0.009	0.090	0.928	H_0 Accepted

Based on the results of the hypotheses that have been carried out, four hypotheses were obtained that were accepted and four hypotheses that were rejected. Referring from Table 3, variable productivity, core values scrum, people factor have a significant positive influence on project completion during work from home. But for variable job satisfaction, organizational factor does not have a significant impact on productivity and also on deliverables when work from home. And for variable environmental factor and technological factor does not have a significant impact

on productivity when working from home and a negative value of the path coefficient indicates that each increase in the value of the variable will decrease the value of productivity.

6. CONCLUSIONS

Work from home is considered quite effective in completing scrum-based projects, due to the large number of organizations, namely 37.6% of 125 respondents have implemented work from home for more than 24 months and from 87.2% of respondents it can be concluded that work from home has become a new option in working for various kinds of work industries. For scrum-based projects, work from home has the potential to be used as an option for how to work permanently for a company or organization, but the organization or company must still look for the right policies so that employees remain productive and feel satisfied. There are three variables that affect the completion of a scrum project significantly and positively when working from home, namely core values scrum, productivity, and people factor.

For companies or organizations that will or are implementing work from home for their employees, they can consider maintaining core values scrum, productivity, and people factor. Besides that, the company or organization must improve their work from home regulations and pay attention to the technology stack and supporting facilities that can be provided for employees in the workplace to provide the best work experience, so that employee can be more productive in their daily work.

In future research, can be carried out research development, using variables other than variables used by researchers and also can use different objects, such as frameworks other than scrum or work models other than work from home, so that it can be a effectiveness comparison. In addition, the selection of question indicators can be reviewed to get even better result.

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ANALYSIS OF USER SATISFACTION IN THE QUALITY OF PORT SERVICES IN BOOM BANYUWANGI REGENCY

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ABSTRACT

Since the establishment of the UPT Pelabuhan Pengumpan Regional Banyuwangi which is located at Boom Seaport in 2016 and began operating in 2017 as a follow-up to the ratification of Undang-Undang number 23 year of 2014 about Regional government, the service quality of this UPT has never been evaluated. Referring to data on ship calls and loading and unloading, which fluctuate and tend to decrease in 2021, the researcher intends to analyze the satisfaction of port service users on the performance and provide information on efforts to improve the quality of of UPT Pelabuhan Pengumpan Regional Banyuwangi services at Boom Port so that this port progressed faster by using the Servqual and QFD methods. The data used is data obtained from a questionnaire survey to port service users at Boom seaport, namely the captain and loading-unloading workers with the aim of obtaining data about the level of service quality. The results showed that there were 15 out of a total of 21 attributes that had a negative gap, consist of 7 Tangible attributes (X1), 1 Responsiveness attribute (X2), 3 Assurance attributes (X3), 2 Empathy attributes (X4), and 2 Reability attributes (X5). Of all the attributes that have a negative gap, 6 of them come from officer's performance of UPT Pelabuhan Pengumpan Regional Banyuwangi, and after being analyzed with QFD, the technical responses which has top priority to improve the quality of port services including proper training for officers in the field, forming clear SOPs related to the handling of loading and unloading services, and construction of warehouses and development of storage yard.

Keywords: Service Quality, Servqual, QFD, Port.

1. INTRODUCTION

After the ratification of Undang-undang number 23 of 2014 concerning Regional Government, UPT Pelabuhan Pengumpan Regional established through the ratification of Peraturan Gubernur Number 106 of 2016, which was later changed to Peraturan Gubernur Number 54 of 2018 concerning Nomenclature, Organizational Structure, Job Description and the Functions and Working Units of the Technical Implementation Office of the Department of Transportation East Java Province. UPT Pelabuhan Pengumpan Regional have the task of carrying out some of the technical tasks of the Department of Transportation in carrying out arrangements, control and supervision of port activities, as well as the provision and/or port services which include regional

feeder ports, river, lake and ferry transportation ports, as well as administrative duties and community services.

Boom port of Banyuwangi Regency is one of the ports operated by the Department of Transportation through UPT Pelabuhan Pengumpan Regional Banyuwangi. The dominant activity at this port is the people's cruises known as Pelayaran Rakyat (Pelra). It is a traditional voyage with small vessels to serve freight transport to and from remote islands throughout Indonesia that cannot be reached by national shipping vessels, originating from the islands in Sumenep Regency, such as Sapeken Island, Kangean Island, Sepanjang Island and Pagerungan Island. These ships unload crops such as coconut, copra and fish for sale in Banyuwangi, and load building materials and staples back to the islands. Based on data on ship visits since Boom Port was operated by UPT Pelabuhan Pengumpan Regional Banyuwangi in 2017 to 2021 the trend of ship visits fluctuated and tended to decrease in 2021 and unloading loads were smaller than loading, meaning that goods brought out of Java Island through Boom Port were larger of the goods brought in. From the beginning the UPT Pelabuhan Pengumpan Regional Banyuwangi was formed in 2016 and started operating the Boom Port of Banyuwangi Regency in 2017, there has not been sufficient information from port service users at Boom port on UPT performance.

Measuring customer satisfaction using the Servqual method which is then followed by Quality function deployment (QFD), which suggested by Razik (2015) that QFD especially in HOQ is an effective management tool in customer expectations are used to drive the design process or to improvement in service industries. It's give the solution to port management WHATs and HOWs aspects must be improved. This research is expected to provide information to the Department of Transportation East Java Province in determining service performance and customers satisfaction as well as being taken into consideration in determining policy directions in improving UPT Pelabuhan Pengumpan Regional Banyuwangi services to meet the expectations of port services customers to be able to compete at the same time in order to help increase PAD (Regional Revenue) of East Java Province through the sea transportation sector because as Morris, B. (1998) suggest there exists a direct relationships between the capability of employee, customer satisfaction, customer loyalty and the firm's profit.

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2. LITERATURE REVIEW

2.1. Port Definition

According to Peraturan Pemerintah Number 61 of 2009 concerning Ports as amended into Peraturan Pemerintah Number 64 of 2015 article 1 paragraph 1 a port is a place consisting of land and/or waters with certain boundaries as a place for government activities and business activities used as a place ships docking, boarding and disembarking passengers, and/or loading and unloading of goods, in the form of ship terminals and berths equipped with shipping safety and security facilities and port supporting activities as well as places for intra- and intermodal transportation. According to Triatmodjo (1992) a port is an area of water that is protected from waves and is used as a berth for ships and other water vehicles which functions to raise or lower passengers, goods and animals, repair, refueling and so on which is equipped with wharves for mooring ships, cranes for loading and unloading of goods, transit warehouses, as well as places for storing goods for a longer time, while waiting for distribution to the destination area or the next shipment. In addition, the port is a gateway as well as facilitating relations between regions, islands and even continents as well as between nations that can advance the area behind it or also known as the area of influence. This rear area is an area that has a relationship of economic, social and defense interests, known as a naval military base.

2.2. Boom Port services customers

The People's cruises known as Pelayaran Rakyat (Pelra) is a traditional voyage with small vessels to serve freight transport to and from remote islands throughout Indonesia that cannot be reached by national shipping vessels, originating from the islands in Sumenep Regency, such as Sapeken Island, Kangean Island, Sepanjang Island and Pagerungan Island. Based on Presidential Peraturan Presiden Number 74 of 2021 concerning Empowerment of Angkutan laut-Pelayaran Rakyat, this transportation is traditional and has its own characteristics to carry out transportation in waters by using sailing ships, motorized sailing ships, and/or simple motor boats with the Indonesian flag with a certain size. Port facilities for people's cruises must have facilities and infrastructure for docking and loading and unloading of ships, warehouses, offices, commercial buildings, places of religious worship, public refueling stations, electricity, drinking water, sanitation, health facilities and other facilities for activities related to people's cruises. Since Boom Port has been operated by UPT PPR Banyuwangi, docking and loading and unloading activities have only been carried out by people's cruises. Menawhile the other customer is Loading and unloading workers (TKBM) are all workers registered at the local port who carry out loading and unloading work at the port. Loading and unloading work can only be carried out by TKBMs that have been registered at the port and are organized in cooperatives. In every loading and unloading activity, the TKBM Cooperative works closely with the Loading and Unloading Company (PBM). In the Regulation of Peraturan Menteri Perhubungan Number KM 21 of 2007 concerning Systems and Procedures for Ship, Goods and Passenger Services at Seaports Organized by the Port Office Technical Implementation Unit (UPT), CHAPTER I Article 1 Paragraph 13 explains that, "Activities for loading and unloading of goods from and to ships are activities that include stevedoring, cargodoring and receiving/delivery at the port". Stevedoring is the work of unloading goods from the ship to the dock/barge/truck or loading goods from the dock/barge/truck onto the ship until they are stacked in the ship's hold using a ship crane or land crane. Cargodoing is the work of releasing goods from the ropes/nets at the wharf and transporting them from the wharf to the warehouse/yard for goods stacking or vice versa. Receiving/Delivery is the work of moving goods from the stockpile/stacking place to the warehouse/stockpiling yard and handing them over to the vehicle at the door of the warehouse/stockpiling yard or vice versa. This means that the unloading activities include the activities carried out when the goods are unloaded from the ship and transported to the port exit.

2.3. Management of Boom Port

Based on the Regulation of Peraturan Menteri Perhubungan Number 51 of 2015 amended Number 57 of 2020 concerning the Implementation of Seaports, the UPT is a Government institution at the port as the authority that carries out regulatory functions, controls the supervision of Port activities, and provides port services for ports that have not been commercially operated. UPT as intended, in carrying out the functions of regulation and guidance, control and supervision of port activities has the duties and responsibilities of:

a. provide and maintain wave barriers, harbor pools, and shipping lanes;
b. provide and maintain shipping-navigation aids;
c. ensure security and order at the port;
d. ensure and maintain environmental sustainability at the port;
e. preparing Port Master Plans as well as DLKr and DLKp;
f. ensure the smooth flow of goods; and
g. provide port facilities.

3. METHODS

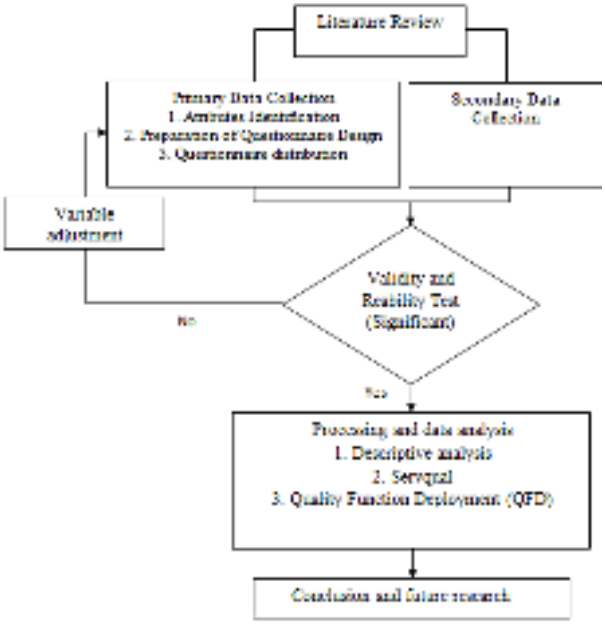


Fig. 1 The flow process of research methodology used for this paper

From Fig. 1, the design of the study began with the study of literature includes studies secondary data obtained. Next, the literature review to be fine-tuned instrument including a Servqual attributes and questionnaire identification, testing the significant of survey using validity and reability test, the proceed with descriptive analysis, Servqual and QFD. The study concludes with a summary and some suggestions for future researches.

4. RESULTS

Questionnaire data design using the SERVQUAL method is based on five dimensions of service quality consists of Tangible (X1), Responsiveness (X2), Assurance (X3), Empathy (X4), and Reability (X5) as shown in Table 4.1

Table 4.1. Servqual attributes of UPT PPR Banyuwangi

Dimensions	Attributes	
Tangible (X1)	x1.1	Shipping lanes are safe
	x1.2	Port basin are safe and secure
	x1.3	Navigating-Shipping Supporting Facilities are well functioned
	x1.4	Safe and adequate loading and unloading facilities for both day and night
	x1.5	Availability of adequate warehouses and storage yard
	x1.6	Availability of good and adequate water supply
	x1.7	Availability of good and adequate marine fuel supply
	x1.8	Officers appearance are neat and professional

Table 4.1. Servqual attributes of UPT PPR Banyuwangi (cont.)

Dimensions	Attributes	
Responsiveness (X2)	x2.1	UPT PPR Banyuwangi officers are ready and responsive when help is needed
	x2.2	Customers complaints/problems can always be handled appropriately by the Officer
	x2.3	Customers complaints/problems can always be handled quickly by the Officer
Assurance(X3)	x3.1	Guarantee of security and orderliness when carrying out activities at the Port
	x3.2	Guarantee that offficers have sufficient knowledge in dealing with problems that arise during port services
	x3.3	officers attitude are professional so that customers are confident in the quality of services provided.
	x3.4	Orderliness of the flow of goods during loading and unloading is guaranteed
Empathy(X4)	x4.1	Officers offer assistance and are sympathetic to the problems of customers
	x4.2	Every time a complaint or question is submitted, the officers are carefully listen and well comunicated
	x4.3	Officers are able to give a pleasant impression to customers
Reability (X5)	x5.1	Accuracy of loading and unloading weighing result
	x5.2	Ease at obtaining information and services
	x5.3	Orderliness when loading and unloading activities are crowded
	x5.4	Officers provide services in accordance with the specified / promised time period

Data on the results of the respondent's questionnaire were 71 questionnaires consist of 38 ship's captain and 33 loading and unloading workers (TKBM). The method used to test the validity is to use Product Moment Pearson. The result of the calculation expressed by Pearson correlation, where this Pearson correlation measures the existence of a relationship linear between attributes. If the attribute is not valid, r count is smaller than r table, then no included in the next analysis. With a significant level of 10%, through testing it is known that all attributes are valid.

An attribute is said to be reliable if the construct's Alpha Cronbach value is at range 0.6-0.9. It appears that Cronbach's Alpha values for all constructs are in the range 0.6 - 0.9 then the questionnaire is reliable.

Servqual Analysis of UPT Pelabuhan Pengumpan Regional Banyuwangi is carried out by calculating the Level of Perceptions, Expectations and Gaps in order from the the highest to lowest satisfaction average as presented in Table 4.2.

Table 4.2. Evaluations of Servqual Attributes

No	Attributes	Variables	Satisfaction Avg.	Expectation Avg.	Gap
1.	Guarantee of security and orderliness when carrying out activities at the Port	x3.1	4.1549	4.0563	0.0986
2.	Orderliness of the flow of goods during loading and unloading is guaranteed	x3.4	4.0563	4.2535	- 0.1972
3.	Officers are able to give a pleasant impression to customers	x4.3	4.0282	3.7042	0.3239
4.	Port basin are safe and secure	x1.2	3.9437	4.0986	- 0.1549
5.	Customers complaints/problems can always be handled quickly by the Officer	x2.3	3.9437	3.8873	0.0563
6.	Shipping lanes are safe	x1.1	3.9296	4.0845	- 0.1549
7.	Every time a complaint or question is submitted, the officers are carefully listen and well comunicated	x4.2	3.9155	3.9718	- 0.0563
8.	Accuracy of loading and unloading weighing result	x5.1	3.9155	3.6620	0.2535
9.	Ease at obtaining information and services	x5.2	3.9155	3.8451	0.0704
10.	officers attitude are professional so that customers are confident in the quality of services provided.	x3.3	3.8592	4.0282	- 0.1690
11.	UPT PPR Banyuwangi officers are ready and responsive when help is needed	x2.1	3.8310	3.6901	0.1408
12.	Officers offer assistance and are sympathetic to the problems of customers	x4.1	3.8028	3.8873	- 0.0845
13.	Guarantee that offficers have sufficient knowledge in dealing with problems that arise during port services	x3.2	3.7887	4.0704	- 0.2817
14.	Orderliness when loading and unloading activities are crowded	x5.3	3.7887	3.8169	- 0.0282
15.	Navigating-Shipping Supporting Facilities are well functioned	x1.3	3.7324	3.7606	- 0.0282
16.	Officers appearance are neat and professional	x1.8	3.7324	3.5211	0.2113
17.	Customers complaints/problems can always be handled appropriately by the Officer	x2.2	3.7183	3.8451	- 0.1268
18.	Safe and adequate loading and unloading facilities for both day and night	x1.4	3.6479	4.3239	- 0.6761
19.	Officers provide services in accordance with the specified / promised time period	x5.4	3.6479	3.9437	- 0.2958
20.	Availability of adequate warehouses and storage yard	x1.5	3.5775	3.9296	- 0.3521
21.	Availability of good and adequate water supply	x1.6	3.1408	4.1831	- 1.0423
22	Availability of good and adequate marine fuel supply	x1.7	3.1268	3.6479	- 0.5211

Table 4.2 show that the highest customer satisfaction come from assurance that there are guarantee of security and orderliness when carrying out activities at the Port, orderliness of the flow of goods during loading and unloading, and officers are able to give a pleasant impression to customers, meanwhile the lowest customer satisfaction come from availability of adequate marine fuel and water supply, also adequate warehouses and storage yard. The left coloumn show that there are 15 attributes out of 22 attributes that have a negative gap value, which means that customer satisfaction has not been met on these attribute aspects.

Processing data with QFD is by making a House of Quality (HoQ). The first stage in making a HoQ is to arrange Voice of Customers which are obtained from Servqual attributes that have a negative gap. Importance to Customer can be seen in Table 4.2. on the Expectation level average, the highest value is on attribute X1.4 “Safe and adequate loading and unloading facilities for both day and night”. The value is 4.3239, which means that the customer values this attribute highly. This matter it is very important to be noticed by UPT PPR Banyuwangi. The attribute that has the lowest level of importance is X1.8 “Officers appearance are neat and professional” with a value of 3.5211. This shows that this attribute is not so important according to the customer. The Improvement Ratio is obtained based on the results of a comparison between Goal and actual customer satisfaction. The highest Improvement Ratio value is X1.6 “Availability of good and adequate water supply” with a value of 1,592. The lowest attribute value is X4.2 “"Every time a complaint or question is submitted, the officers are carefully listened and well communicated” with a value of 1,022. Sales Point is determined by UPT PPR Banyuwangi. This value reflects the level of importance that can be obtained if the improvement and refinement of the attribute is carried out. In this case, there are 9 attributes that have the highest Sales Point value (1.5). Technical Response was obtained from an interview with UPT PPR Banyuwangi. The results of this analysis are 10 Technical Responses items listed in Table 4.3.

Table 4.3 Customer Requirement

Variable	Atribut	Satisfaction	Goal	Improvement Ratio	Expectation	Sales Point	Raw Weight	Normalized Raw Weight	Gap	Technical Response
x1.6	Availability of well and adequate water supply	3.141	5.000	1.592	4.183	1.500	9.989	0.099	- 1.0423	Adding booster pump for water supply
x1.4	Safe and adequate loading and unloading facilities for both day and night	3.648	5.000	1.371	4.324	1.500	8.890	0.088	- 0.6761	Rehabilitation of broken lights at port
x1.7	Availability of well and adequate marine fuel supply	3.127	4.000	1.279	3.648	1.200	5.600	0.056	- 0.5211	Partnership with marine fuel service provider
x1.5	Availability of adequate warehouses and storage yard	3.577	4.000	1.118	3.930	1.500	6.591	0.066	- 0.3521	Construction of warehouses and development of storage yard
x5.4	Officers provide services in accordance with the specified / promised time period	3.648	4.000	1.097	3.944	1.500	6.486	0.065	- 0.2958	Handling time efficiency
x3.2	Guarantee that offficers have sufficient knowledge in dealing with problems that arise during port services	3.789	5.000	1.320	4.070	1.200	6.446	0.064	- 0.2817	Training for officers in the field
x3.4	Orderliness of the flow of goods during loading and unloading is guaranteed	4.056	5.000	1.233	4.254	1.500	7.865	0.078	- 0.1972	Forming clear SOPs related to the handling of loading and unloading services
x3.3	officers attitude are professional so that customers are confident in the quality of services provided.	3.859	5.000	1.296	4.028	1.200	6.263	0.062	- 0.1690	Training for officers in the field
x1.2	Port basin are safe and secure	3.944	5.000	1.268	4.099	1.500	7.795	0.078	- 0.1549	Periodic Dredging
x1.1	Shipping lanes are safe	3.930	5.000	1.272	4.085	1.500	7.796	0.078	- 0.1549	Extending groin/breakwater when sediment/settlement basin are full
x2.2	Customers complaints/problems can always be handled appropriately by the Officer	3.718	4.000	1.076	3.845	1.200	4.964	0.049	- 0.1268	Training for officers in the field

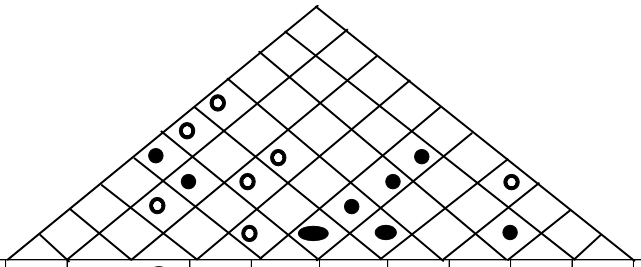
Table 4.3 Customer Requirement (cont.)

Variable	Atribut	Satisfaction	Goal	Improvement Ratio	Expectation	Sales Point	Raw Weight	Normalized Raw Weight	Gap	Technical Response
x4.1	Officers offer assistance and are sympathetic to the problems of customers	3.803	4.000	1.052	3.887	1.200	4.907	0.049	- 0.0845	Training for officers in the field
x4.2	Every time a complaint or question is submitted, the officers are carefully listen and well comunicated	3.915	4.000	1.022	3.972	1.200	4.869	0.048	- 0.0563	Training for officers in the field
x1.3	Navigating-Shipping Supporting Facilities are well functioned	3.732	4.000	1.072	3.761	1.500	6.045	0.060	- 0.0282	Periodically maintaining Navigating-Shipping Supporting Facilities
x5.3	Orderliness when loading and unloading activities are crowded	3.789	4.000	1.056	3.817	1.500	6.045	0.060	- 0.0282	Forming clear SOPs related to the handling of loading and unloading services
Total *Raw Weight*							100.549			

The raw weight value in this study is closely related to the level of satisfaction of port service customers. The amount of effort required to implement the increase in the attributes and values of port services. Raw weight is how much the attribute contributes to quality improvement as listed in Table 4.3. The size of UPT PPR Banyuwangi's effort to improve the quality of Port Services is that the highest is regarding the availability of good and adequate water supply. Normalized Raw Weight is obtained by comparing the Raw Weight value of each attribute with the total Raw Weight. This value indicates the magnitude of the attribute's contribution to the satisfaction of all the expectation of Port Service customers. The greater the normalized raw weight value, the greater the contribution of the attributes in fulfilling the expectation of port service customers. “The availability of a good and adequate water supply” will contribute greatly to improving the quality of port services with a normalized raw weight value of 0.099. While the attribute that has the lowest value is “Customers complaints/problems can always be handled appropriately by the Officer”, with the normalized raw weight value being 0.048. In the Technical Importance stage, priorities are determined which will be developed first in the process of improving the quality of port services based on technical importance. Attribute ratings are made as many as the number of technical responses which total 10 (ten) items.

From the analysis of the House of Quality as shown in Figure 4.1 below, improving the quality of port services based on priority ranking is as follows :

1. Proper training for UPT PPR Banyuwangi’s officers in the field
2. Forming clear SOPs related to handling loading and unloading services
3. Construction of warehouses and development of storage yard.
4. Periodic Dredging
5. Extending groin/breakwater when sediment/settlement basin are full
6. Handling time efficiency
7. Periodically maintaining Navigating-Shipping Supporting Facilities
8. Rehabilitation of broken lights
9. Adding booster pump for water supply
10. Partnership with fuel service providers.



Technical Importance		Atribut	Adding booster pump for water supply	Rehabilitation of broken lights at port	Partnership with marine fuel service provider	Construction of warehouses and development of storage yard	Handling time efficiency	Training for officers in the field	Forming clear SOPs related to the handling of loading and unloading services	Periodic Dredging	Extending groin/breakwater when sediment/settlement basin are full	Periodically maintaining Navigating-Shipping Supporting Facilities	Goal	Sales Point	Improvement Ratio	Raw Weight	Normalized Raw Weight
			↑	↑	◯	↑	↑	↑	↑	↑	↑	↑					
			Technical Response														
4.183099	Kebutuhan Pengguna Jasa	Availability of well and adequate water supply	●										5	1.5	1.591928	9.988789	0.099343
4.323944		Safe and adequate loading and unloading facilities for both day and night		●		●		○	○	○	Δ	○	5	1.5	1.370656	8.889961	0.088414
3.647887		Availability of well and adequate marine fuel supply			●								4	1.2	1.279279	5.6	0.055694
3.929577		Availability of adequate warehouses and storage yard				●							4	1.5	1.11811	6.590551	0.065546
3.943662		Officers provide services in accordance with the specified / promised time period	○	○		○	●	●	●	Δ	Δ	○	4	1.5	1.096525	6.486486	0.064511
4.070423		Guarantee that offficers have sufficient knowledge in dealing with problems that arise during port services						●	○				5	1.2	1.319703	6.446097	0.064109
4.253521		Orderliness of the flow of goods during loading and unloading is guaranteed	Δ	○		Δ	●	●	●	Δ	Δ	○	5	1.5	1.232639	7.864583	0.078217
4.028169		officers attitude are professional so that customers are confident in the quality of services provided.						●					5	1.2	1.29562	6.262774	0.062286
4.098592		Port basin are safe and secure								●	●		5	1.5	1.267857	7.794643	0.077521
4.084507		Shipping lanes are safe								●	●		5	1.5	1.272401	7.795699	0.077531
3.84507		Customers complaints/problems can always be handled appropriately by the Officer						●	○				4	1.2	1.075758	4.963636	0.049365
3.887324		Officers offer assistance and are sympathetic to the problems of customers						●					4	1.2	1.051852	4.906667	0.048799
3.971831		Every time a complaint or question is submitted, the officers are carefully listen and well comunicated						●					4	1.2	1.021583	4.869065	0.048425
3.760563		Navigating-Shipping Supporting Facilities are well functioned										●	4	1.5	1.071698	6.045283	0.060123
3.816901		Orderliness when loading and unloading activities are crowded				○	○	○	●			○	4	1.5	1.055762	6.04461	0.060116
		Weight / Importance	53.73	63.51	32.83	101.8	85.225	276.42	144.8	94.82	86.17	82.86					
		Relative Weight	5.26%	6.21%	3.21%	9.96%	8.34%	27.04%	14.17%	9.28%	8.43%	8.11%					
		Ranking	9	8	10	3	6	1	2	4	5	7					

Figure 4.1. House of Quality

6. CONCLUSIONS

Attributes of Port Services are identified from a review of the duties and responsibilities of the Port Administration Unit (UPT) in carrying out the functions of regulating and fostering, controlling and supervising port activities based on the Regulation of Peraturan Menteri Perhubungan Number 51 of 2015 amended Number 57 of 2020 concerning the Implementation of Seaports so that 22 attributes were obtained with details of 8 tangible dimensions, 3 responsiveness dimensions, 4 assurance dimensions, 3 empathy dimensions, and 4 reliability dimensions. The results of the analysis using Servqual show that the 3 attributes that have the highest level of satisfaction are 2 dimensions of assurance, namely guarantee of security and orderliness when carrying out activities at the Port and orderliness of the flow of goods during loading is guaranteed, and 1 dimension of empathy, namely Officers are able to give a pleasant impression to customers. Meanwhile 3 attributes that have the highest level of expectation is 2

dimensions of Tangible namely safe and adequate loading and unloading facilities for both day and night and availability of good and adequate water supply, 1 dimension of assurance namely orderliness of the flow of goods during loading and unloading is guaranteed.

Of the 15 attributes that have a negative Gap, there are 7 Tangible attributes (X1), 1 Responsiveness attribute (X2), 3 Assurance attributes (X3), 2 Empathy attributes (X4), and 2 Reability attributes (X5) where 6 of them come from from the performance of Banyuwangi Regional UPT Feeder Officers, and based on these 15 attributes that become the Voice of Customer, 10 technical responses are generated with 3 top priority consisting of proper training for officers in the field, forming clear SOPs related to the handling of loading and unloading services, and construction of warehouses and development of storage yard.

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THE IMPLEMENTATION OF TOTAL PRODUCTIVE MAINTENANCE IN REDUCE LOSES AND INCREASE THE EFFICIENCY OF LINE PELLETIZING IN PET FOOD INDUSTRY

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ABSTRACT

During the pandemic, the cat feed production industry significantly demanded a high demand for fulfillment. The object of research is a multinational company that focuses on the poultry and pet feed production industry. It should be noted that during the last nine months, there have been indications of production losses between the production target and the actual output of production. Based on data from the company, the pelletizing line production process contributed significantly to product failure. So, to overcome this we need management planning and controlling based on quantitative and qualitative data to determine the performance of production facilities to reduce losses, which is commonly referred to as Total Productive Maintenance. This study will be supported by several TPM methods to eliminate and analyze the causes of product failure losses in the form of Overall Equipment Effectiveness (OEE), Failure Mode and Effect Analysis, and Root Cause Analysis. Based on the average OEE value is still below the standard with a value of 76.26% when compared to the international standard OEE. Based on the three OEE benchmarks, availability is the vulnerability value. This is influenced by the optimal operating time during production despite unplanned downtime. From the results of OEE, the average value that contributes the most downtime and influences the production process losses is a mechanical breakdown with a value of 1750 minutes with a total average total downtime interval of nine months of 3851 minutes. February 2022 was the highest point for equipment failure loss with a percentage of 10.07% and an average value of the entire equipment failure loss is 6.87% in nine months of ongoing production and this average is the most significant value. Large compared to the downtime indicator in the classification of the other six big losses.

Keywords: Production Losses, Line Pelletizing, Total Productive Maintenance, Productivity

1. INTRODUCTION

To minimize the increase in the chain of transmission of this virus COVID-19 outbreak, the government directed people to carry out all routines outside the home to do more activities only indoors. Over time, humans experience saturation activities in the room. To reduce their boredom, they started looking for new activities, one of which is taking care of cats. So that during this pandemic, the cat food production industry experienced an increase in demand to meet the significantly high demand for cat food. The more needs that are produced, the greater the performance burden on the production facilities that will be used later. In a production process,

there are complex problems internally or externally that can affect the running of a production process. One of the internal problems that often occurs is failure and damage to production facilities. Production facilities play an important role in increasing the quantity and quality of the products produced. If the production facility works well, it can produce the desired product quality and quantity. The research object is a company that focuses on the livestock and pet feed production industry, divided into several plants, one of which was just established in early 2020, namely a cat feed production plant. During interval of nine months back in cat food production, there were indications of problems with achieving the cat feed production target that did not meet the company's Key Performance Indicator (KPI). There are losses between the production target and the actual production output **Figure 1**.

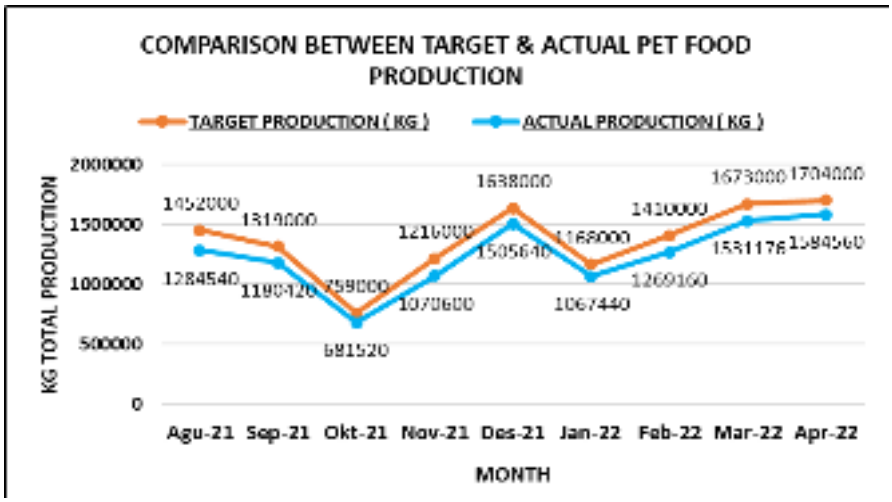

Figure 1. Comparison Data Production Between Target and Actual Production

This problem is very disruptive to the productivity of the company. To overcome this, a management plan, management, and control of an operation based on quantitative and qualitative data are needed to determine the performance of production facilities to reduce the number of losses or failures which are known as Total Productive Maintenance (TPM). The implementation of TPM also needed a method to measure the performance of production facilities. The method in question is often referred to as Overall Equipment Effectiveness (OEE). Measurement of the OEE method is very important to measure the success of the TPM program implemented in a company. In other words, the OEE results are the main Key Performance Index (KPI) from the results of TPM implementation. This study, it is not only measuring the performance of production facilities. A method of analyzing the cause and effect of production facility failure is also needed. So that later these failures can be eliminated and reduced to optimize the productivity value of the production process in the pelletizing line. Related to this, the Failure Mode and Effect (FMEA) and Root Cause Analysis (RCA) methods are considered to be able to support this.

2. LITERATURE REVIEW

2.1 Total Productive Maintenance (TPM)

Total Productive Maintenance (TPM) can be a method that aims to maximize the level of efficiency in the use of production facilities and preventive action systems designed for all equipment by implementing a rule for all parts within a company [6]. TPM is a responsibility aimed at all entities in the company, from operators to top management, to be able to fulfill and achieve company goals. As for the benefits of implementing the TPM method, both directly and

indirectly quoted [1]. it is explained that the direct benefits of TPM include increasing productivity, reducing production costs, meeting customer demands, and reducing workplace accidents.

The indirect benefits include increasing trust between workers, making the workplace environment clean and tidy, changing attitudes towards good entities in the company, sharing experience and knowledge, and developing the competence of workers or operators in operating existing production facilities. By implementing TPM, companies must strive towards the vision of an ideal manufacturing situation that includes zero damage, zero defects, zero abnormalities, and zero accidents [23].

2.2 Overall Equipment Effectiveness (OEE)

For the most part, the basic understanding of machine productivity is the ratio of work achieved during the entire process divided by the time used for the production process. It is recognized that productivity can be increased by increasing the effectiveness of equipment. the difference with efficiency because efficiency is doing the right thing effectiveness is doing the right thing. One of the most important and widely adopted indicators of effectiveness, and from the point of the metric developed here, is Overall Equipment Effectiveness (OEE) [25].

There are three main components in OEE namely availability, performance and quality. The existence of these three main factors can identify various types of manufacturing losses and areas where corrective corrective action is needed to reduce losses in the production process. These three determinants are also closely related to the six big losses [3].

2.3 Six Big Losses

Six big losses themselves have been introduced as a concept of TPM as one of the loss indicators that must be considered during the production process. Measurement of the six big losses is activities and actions aimed at preventing, minimizing, and eliminating activities or things that hinder the running of a production process. One of the biggest obstacles in the production process is the low level of effectiveness in the use of machines or equipment so production downtime or downtime often occurs, this also causes many companies to experience operational losses. There are three main losses, namely downtime losses, speed losses, and defect losses. Downtime losses include equipment failure (breakdown), Speed losses include set up and adjustment, idling, and minor stoppage while defect losses include reduced speed, quality defects, and reduced yield losses (startup losses) [17].

2.4 Root Cause Analysis (RCA)

Root Cause Analysis (RCA) is a step-by-step method used to analyze failures and problems down to their root causes. Every failure in a production facility or component occurs for several reasons [13]. There is a definite progression of actions and consequences that lead to failure. RCA investigation traces the cause and traces the effects of the ultimate failure back to the root cause to determine what happened, why it happened, and more importantly figure out what to do to reduce the likelihood that it will happen again. The process of analyzing the root causes of failure and acting to eliminate them is one of the most powerful tools in increasing plant reliability [18].

2.6 Failure Modes and Effects Analysis (FMEA)

The concept of good maintenance also requires a way to analyze the causes of poor engine performance. Many methods can be used to mitigate problems that arise in the production process. One of the tools or tools that can be used to identify problems in the production process is Failure Modes and Effects Analysis (FMEA) [14]. FMEA is a method for evaluating deficiencies in a system, design, process, or service. Problems that have the potential to occur can be identified by

setting each risk priority or better known as RPN based on the level of the incident (Incident), severity (Severity), and level of detection (Detection) [11].

3. METHODS

This research will be carried out with several stages of analysis through observation, approach, and application of Total Productive Maintenance (TPM) in cat feed production plants in the pelletizing process. The initial stage will begin by determining the Overall Equipment Effectiveness (OEE) value by first calculating three components, namely availability, performance, and quality. The input data used in calculating these three components comes from data on the production of the pelletizing line with the interval from August 2021 to April 2022 and the data is in the form of daily records of repair damage to the pelletizing line. OEE will be used as a benchmark for the efficiency of the performance of production facilities, especially in the pelletizing process. From these three components, the Six Big Losses analysis will be carried out using a Pareto chart. The Pareto diagram is used to classify and sort the types of losses based on the intensity of the repetition of events every month during the production process.

After some data losses have been collected, a worksheet is created to facilitate the application of the Failure Mode and Effect Analysis (FMEA) method. From each of these data losses, a Risk Priority Number (RPN) is weighed based on the level of the incident (Incident), severity (Severity), and level of detection (Detection) to rank the highest value of the RPN and then make recommendations for improvement. Before providing recommendations for improvement using the FMEA method, some steps need to be carried out first, namely identifying the root causes of the highest RPN value using the Root Cause Analysis (RCA) method. The tools or tools used in this RCA are in the form of a fishbone diagram and 5 whys analysis, so that the root causes of events or problems can be obtained which can be studied and eliminated.

4. RESULTS

4.1 OEE Results

In Figure 1.1, the highest availability rate was reached in April 2022 with a value of 89.91%, but the overall availability rate has not exceeded the international standard with a value of 90%. This is influenced by the unplanned downtime that occurs during the production process. The lowest availability rate is in the 7th month, namely February 2022 in the chart above with a value of 84.33%. The failure of several months of production on the OEE indicator in the form of an availability rate indicates that the utilization of available operating or production time in this pelletizing line is still not optimal and requires improvement or elimination of factors that have a big influence. Performance values above standard were only achieved in March and April 2022, clearly this significantly affected the OEE value.

The failure of several months of production on the OEE indicator in the form of a performance rate indicates that the utilization of the availability of the machines being operated cannot be said to be optimal. Out of nine months of cat feed production on the pelletizing line, none of them met international standard values. The lowest quality rate occurred in November with a value of 94.53% and the highest occurred in April with a value of 98.08%. So that it can be said, the failure to achieve a quality rate during the nine-month production process shows that the company for the cat feed production machine facility has a canvas design that is not suitable and causes many defects in the production results on the pelletizing line to be improved.

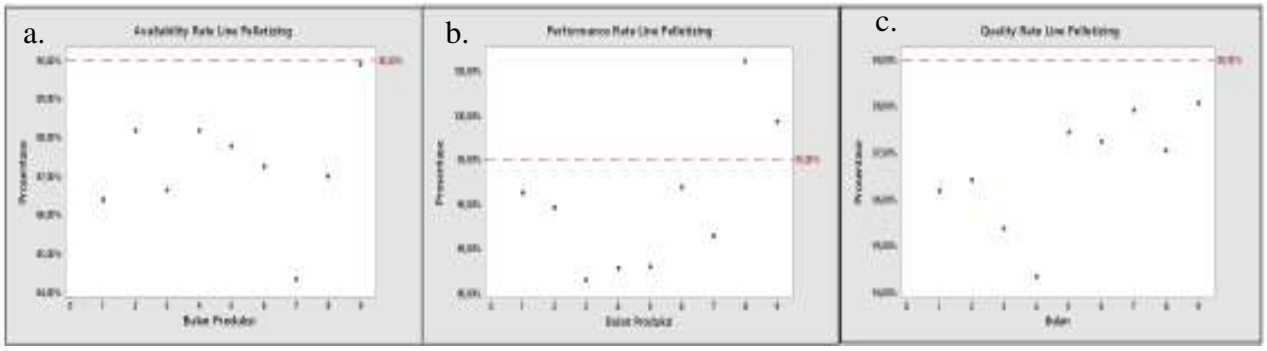

Figure 1. 1 Scatterplot diagram of (a) Availability rate, (b) Performance rate, (c) Quality rate line pelletizing

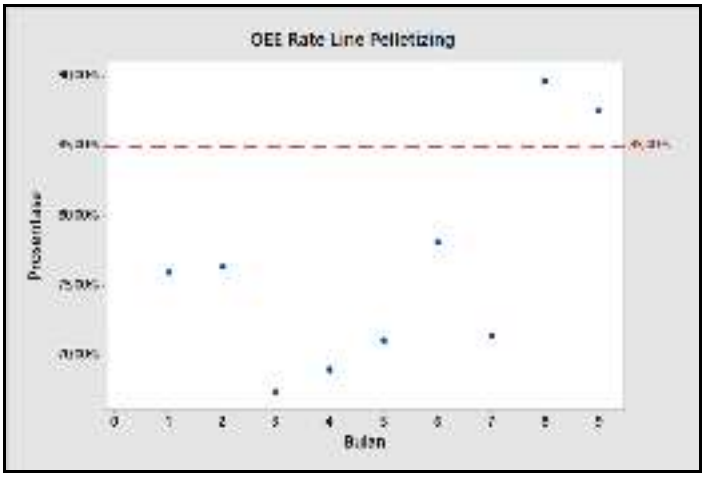

Figure 1. 2 Scatterplot diagram of OEE rate line pelletizing

Calculation of overall equipment effectiveness has the goal of being able to determine the level of effectiveness in the pelletizing line for cat feed production. In implementing Overall Equipment Effectiveness (OEE), the company must consider the time, quality, and performance of the focused product line. Can be seen in Figure 1.2 is an OEE scatterplot diagram during the nine months of the cat food production process. In this diagram, the highest OEE score during the nine-month interval was the highest in March with a value of 89.68%. From the Figure 1.2, several OEE values in other months are still below the standard with a value of less than 85%. So that it can be said, a low OEE value indicates that the company needs improvement so that the effectiveness of the cat feed production machine in the pelletizing line can be increased again.

4.2 Six Big Losses Identification

It can be seen in Figure 1.3 that it is clear that the biggest factor affecting the company's productivity is equipment failure losses with a total time of 19211 minutes and a percentage of 55.4% of the total time lost in the total nine months of the production process. In this study, equipment failure losses in the six big losses tend to lead to the type of failure in the form of mechanical breakdown or damage to production facilities in the pelletizing line which results in loss of time for unplanned production stops. It can be seen in the pareto diagram that the mechanical breakdown with the highest incident intensity was the change of blades and dies on the pelletizing line with a loss time of 12528 minutes in the nine months of the production process. Thus, this research focused on finding the root causes and factors that resulted in a mechanical

breakdown during the nine monthly production process to carry out improvement and elimination of activities that were considered less efficient.

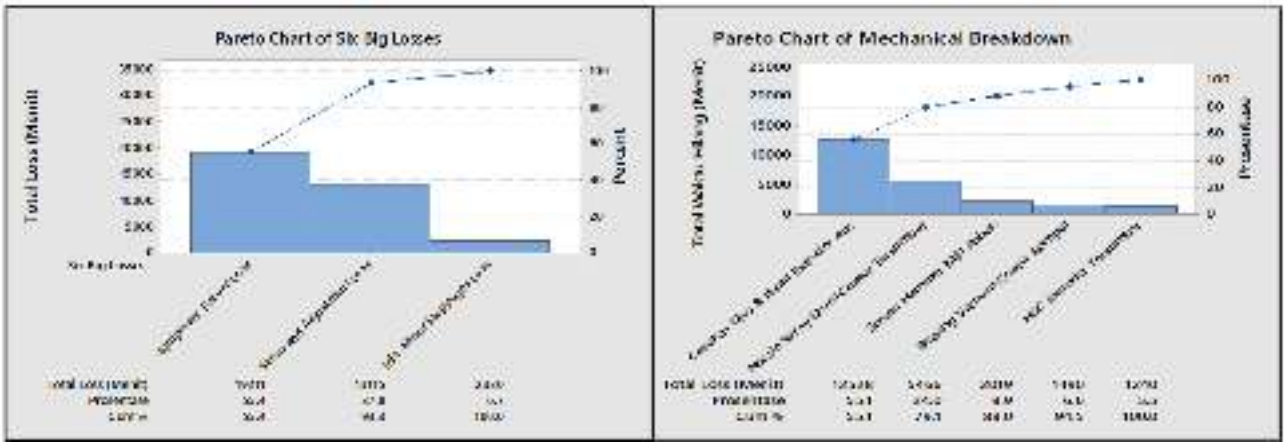

Figure 1. 3 Pareto diagram of (a) six big losses and (b) equipment failure or mechanical breakdown activity.

4.3 Root Cause Analysis (RCA)

Can be seen in Figure 1.4, that during the course of the production process, the company lost a lot of production time because it was caused by up-planned downtime, namely in the form of mechanical breakdowns from nine-month intervals during the production period. Therefore mechanical breakdown is a top priority to be analyzed using a fishbone diagram to find out the cause of the loss. The analysis was carried out through a group discussion forum (FGD) process. To facilitate the analysis process, a classification or grouping of causes is carried out based on 6M, namely manpower, material, method, measurement, machine, and mother nature or environment.

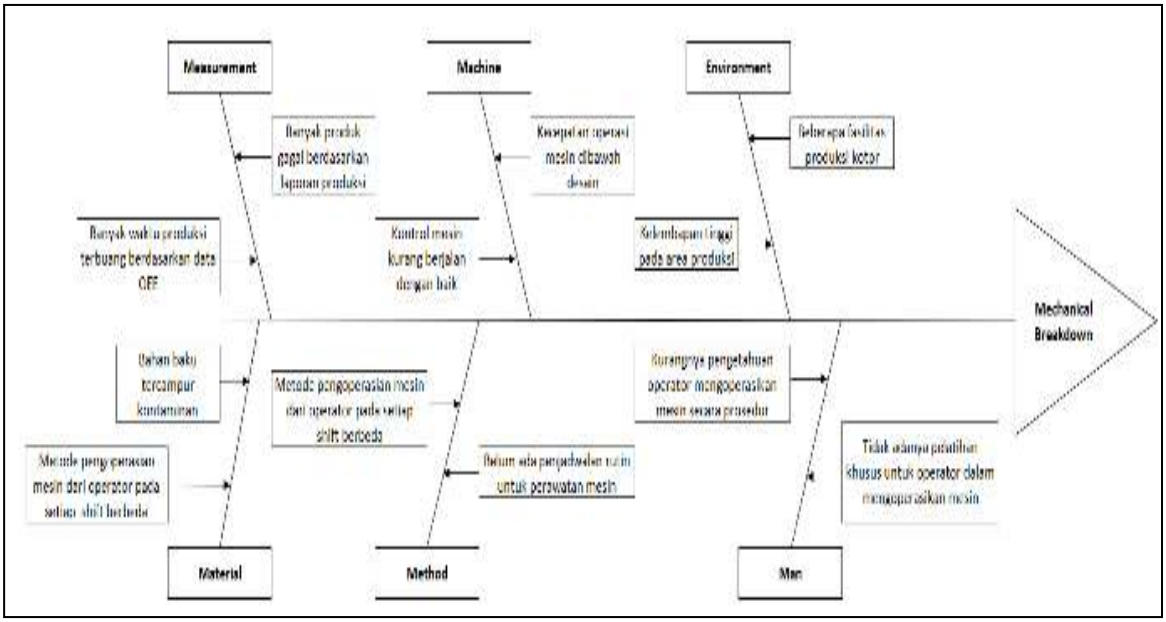

Figure 1. 4 Root cause analysis mechanical breakdown

Based on the Pareto diagram analysis in the previous sub-chapter, it is known that the most frequent incident intensity in mechanical breakdown line pelletizing is damage in the form of mold or knife wear on the extruder machine. So it is necessary to do a more detailed analysis to find out

the root causes of these activities with the RCA method in the form of a 5 Whys analysis. From the results of the analysis, it was found that five main points caused the damage problem to occur. As can be seen in Figure 1.5, this is the result of an analysis of the causes of damage to mold or blade wear on the extruder line pelletizing machine, the main root cause is ambiguity and there is no initiative from management in requesting guidelines for the operation and maintenance of production items from the licensor to the vendor for items used in the pelletizing line. With the existence of legal and standardized operational guidelines, management can make Standard Operating Procedures (SOP) for pelletizing lines to reduce changes in settings outside of instrument calculations from the licensor which cause the production machine to run abnormally and optimally.

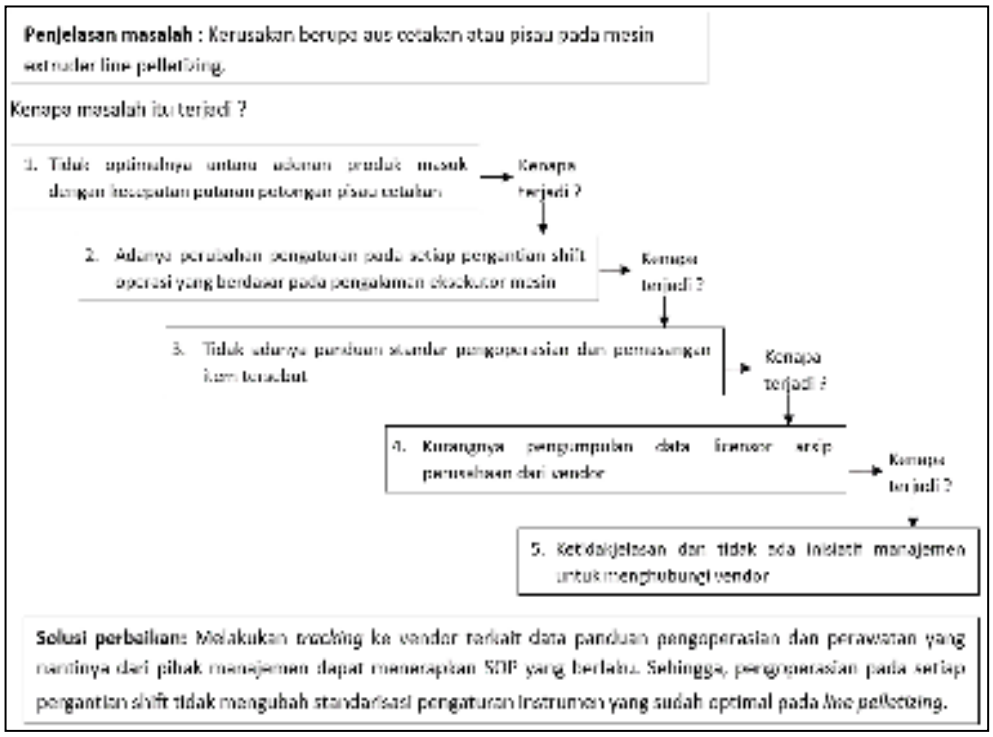

Figure 1. 5 Five whys analysis method of mechanical breakdown activity

4.4 Failure Mode and Effect Analysis (FMEA)

From the analysis, it was found that damage to the extruder dies and blade had the highest RPN value of 210. This assessment can be made from the results of processing and data collection from the previous chapter. Whereas the smallest RPN value of 75 is obtained from the HSC steam item. the several damages that have been listed in Table 4.14, the damage with the highest RPN value is in the wear of the blades and extruder molds which are caused by pure errors from operations in the process of installing blades or dies on the extruder machine. Control of this damage can be done by making SOPs in the knife or mold installation process so that later during the change of work shift the operation does not change the settings in the form of knife quantity, speed of rotation per minute (RPM), and also the gap between the knife and the mold so that production instruments run following the design of the tool to obtain optimal results during the production process.

Failure Mode and Effects Analysis
(Design FMEA)

System: Pet Food Production
Subsystem: Line Palletizing

FMEA Number: Project I
Prepared By: Nabil Rheza
FMEA Date: 22/09/2022

Item / Function	Potential Failure Mode(s)	Potential Effect(s) of Failure	Sev	Potential Cause(s)/ Mechanism(s) of Failure	Occ	Current Design Controls	Det	RPN	Recommended Action(s)	Responsibility & Target Completion Date	Action Results				
											Actions Taken	New Sev	New Occ	New Det	New RPN
Extruder	Kerusakan pada pisau dan cetakan produk mesin extruder	Bentuk visual dan dimensi produk tidak sesuai dengan spesifikasi penjualan	7	Kesalahan pengoperasian	6	Prosedur pengoperasian resmi dari licensor	5	210	Pembuatan SOP dan operasi tidak merubah pengaturan sistem		Tim teknik & produksi				
HSC Steam	Tersumbatnya bahan baku pada *paddle sleeve* HSC Steam	Bulk densitas dari produk tidak sesuai dengan spesifikasi penjualan	5	Kesalahan pengoperasian merubah pengaturan steam setiap pergantian shift	3	Bulk densitas > 370 gr/L	5	75	Pembuatan SOP untuk pengaturan steam yang masuk		Tim teknik & produksi				
Hammer Mill	Kerusakan berupa robek pada screen *hammer mill*	Kerusakan pada pisau ekstruder karena terkena benda asing yang lolos pada screen	7	Kurang adanya pengecekan dari tim teknik	5	Pergantian ukuran lubang screen disesuaikan jenis bahan baku yang ada	5	175	Pembuatan SOP untuk pergantian screen kelika ganti jenis bahan baku		Tim teknik & produksi				
Vacuum Coater	Kerusakan pada *bearing vacuum coater*	Unplanned downtime produksi	5	Kurang optimal perawatan preventif dari tim teknik	4	Penyesuaian dimensi bearing berdasarkan standar desain item	5	100	Pembuatan SOP untuk penggantian bearing berdasar pada buku panduan licensor		Tim teknik & produksi				
Drum Coater	Tersumbatnya *nozzle spray* pada drum coater	Warna produk belang karena coating tidak merata, produk gagal	6	Kesalahan pengoperasian	6	Temperatur minyak coating pada tangki harus 60-70C	5	180	Pemasangan thermo couple dan elemen pemanas pada tangki dan fine tuning tangki	Nov-22	Tim teknik & produksi	6	5	3	90

Figure 1. 6 FMEA method of mechanical breakdown activity

5. CONCLUSIONS

Based on the results of research in the effort to implement total productive maintenance (TPM) through the analysis process of measuring overall equipment effectiveness (OEE), root cause analysis (RCA), and adding event value weighting based on failure mode and effect analysis (FMEA) which has been carried out in line pelletizing production of cat feed, the following conclusions can be drawn:

1. The average value of the OEE line pelletizing in cat feed production during the nine months of production can be obtained with a value of 76.26% with the lowest score achieving 71.03% in December 2021 and the highest value of 89.68% in March 2022. Based on the OEE data, the overall value is still not optimal and ideal because it is still far in comparison to international OEE standard, which is 85%. Significant OEE indicators are far below standard, namely the availability rate and performance rate. From the classification results through six big losses with the OEE indicator database, it can be concluded that the most common loss time factor that occurs is equipment failure with a total percentage of 6.87% when compared to the other two-loss times of the total production time for nine months.
2. The high loss of time is based on the results of the analysis of six big losses and root cause analysis caused by equipment failure loss. If further elaborated, it can be determined that three plate failures caused a lot of time lost in the production process. Equipment failure contributing to the biggest time loss was damage to the blades and molds on the pelletizing machine with a total production loss time of 19211 minutes of the total equipment failure loss time. This is reinforced by the results of the FMEA analysis that the RPN value of 210 for the damage is greater than the other three failures. So, it is necessary to focus on repairing the damage.
3. It can be seen from the results of the analysis in the chapter above that the process of maintaining and maintaining the machine is still not carried out efficiently. Can be proven through existing data analysis. So it can be recommended that the implementation of TPM on the pelletizing line to reduce the existing loss time.
4. Based on the reference for processing and data analysis, the implementation of the TPM line pelletizing can be made through 3 main stages, namely introduction, implementation initiatives, and standardization.

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THE INFLUENCE OF CORE VALUES AKHLAK, LEADERSHIP MODELS, AND WORK FACILITIES ON THE PERFORMANCE THROUGH JOB SATISFACTION AS AN INTERVENING VARIABLE IN DIGITAL TRANSFORMATION ERA (Case Study in PT X Manokwari East Indonesia)

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ABSTRACT

In facing the era of digital transformation the role of human resources is so important. one indicator of the success of an organization or company is a focus on performance. PT X are one of the state-owned companies that has several indications that needs to be addressed to have better performance, such as lack of AKHLAK core value as a standardization across state-owned company, leaders that have difficult time to implement the core value in daily basis, working facilities that aren't fully supported, and core value implementation on working daily basis. Regarding this phenomenon, this research objectives is to define the connection between independent variabels (Core Values AKHLAK, Leadership Models, Work Facilities) to dependent variable (Performance) through intervening variable (job satisfaction). Using SEM-PLS as determining method to find the connection between variabels and analytical description that involving 126 employees on PT X network division. The expected results are recommendation that based on data interpretation of variabel connection and improving core value implementation, leadership model, working facilities, working satisfaction, and working performance. From 126 respondents that included, core value and working facilities variables are amongst the most significant variabel affecting both working satisfactory and working performance with T-Statistics value of 2.266 and 3.596. Another variable that has significancy on working satisfactory that affecting working performance are leadership variables with T-Statistics of 8.356.

Keywords: core value, leadership, working facilities, work satisfactory, working performances.

1. INTRODUCTION

in facing the era of digital transformation the role of human resources is so important. one indicator of the success of an organization or company is a focus on performance. As the global economy progressed into rapid pace, corporate needs to invest in many sources, including human resource. Mckinsey (2016) stated in their research that core value and organizational behaviour are among the key to progressed. With good core value and good human resource, corporates will transform into better one (Miharjo, 2016)

Erick Thohir as Minister of Public Corporation embrace AKHLAK, a core value that universally adopted so that national company will transform with harmonious synchronization. However, ACT Consultant believe that only 43.1% AKHLAK core value implemented across public corporation, this means that core value implementation has significant problems.

PT X also a public corporation with issue not only the AKHLAK implementation, but also the leadership that unsuitable with current conditions, working facilities that worn out and not protecting enough against OPM, and working satisfactory that considered low.

This research is to determine which factor critically affecting working performance and working satisfactory. Not only that but also managerial implementation that should be done to increase working satisfactory and working performance.

2. LITERATURE REVIEW

Alshoukri et.al. (2020) stated that good leadership will bring the corporate into better vision and mission, and also the positive constructive relationship between core value, in which emphasizing from Yuan & Lee (2011) and Sharna et.al. (2009) that focusing on core value and working performance, and leadership towards better working satisfactory and performances.

Zehir et.al (2011) and Zehir et.al. (2012) also focusing on leadership and working performance. The difference is that the scope of regional that researched, and intervariable of leadership and core value proven to be positive.

While Alshoukri et.al (2020) focusing on core value and leadership, Liao & Lu (2012) focusing on working facilities with working performances. The research shown that working facilities boost performance because of the feeling being appreciated and new tools will help daily tasks.

Bagis, Kusumo, & Hidayah (2021) focusing on working satisfactory, in which become intervening variables. This experiment also using SEM-PLS as method to determine factors that used in the research.

3. METHODS

The research itself are conducted in PT X network division in East Indonesia. The design itself using conclusive-descriptive methods, in which determining the test of its hypotheses, supporting variables, intervening variable, and their connections.

The data itself using quantitative method that has 126 samples from random sampling method, whereas qualitative methods by interviewing managements and supervisors. The quantitative consist of 25 question that has Likert scale from 1 for very disagree and 5 for very agree.

4. RESULTS

By creating framework in SmartPLS, the research can dismantle the indicators that under 0.7 with Cronbach's Alpha under 0.6. There are 19 indicators that used as model from third iterations. This test also called outer model. Below are the Cronbach's Alpha, composite reliability and average variant expected for validity and reliability test.

Table 1. Cronbah's Alpha, Composite Reliability, dan Average Variance Extracted

	Cronbach's Alpha	Composite Reliability	Average Variant Extracted
Core Value	0,753	0,860	0,674
Fasilitas Kerja	0,820	0,893	0,735
Kepuasan Kerja	0,680	0,824	0,610
Kinerja	0,811	0,874	0,705
Leadership	0,897	0,920	0,685

The inner model of this research is by looking at the R-Square number. The working satisfactory has 0.897, means that 89.7% of working satisfactory influenced by core value, leadership, and working facility, whereas working performance has 0.780, means that 78% of working performance influenced by core value, leadership, and working facility.

Table 2. Path Coefficient and T-Statistics from Bootstrapping

	Original Sample	Influence	T-Statistics	Significancy
Core Value → Satisfactory	0.070	Positive	1.156	Not significant enough
Core Value → Performance	0.259	Positive	2.266	Significance
Working Facilities → Satisfactory	-0.005	Negative	0.034	Not significant enough
Working Facilities → Performance	0.724	Positive	3.596	Significant
Satisfactory → performance	0.079	Positve	0.339	Not significant enough
Leadership → Satisfactory	0.908	Positive	8.356	Significance
Leadership → Performance	-0.179	Negative	0.646	Not significant enough

6. CONCLUSIONS

The conclusions are core value and working facilities has very significance towards performance with T-Statistics of 2.266 and 3.596 respectively, whereas leadership has very significance towards satisfactory with T-Statistics of 8.356.

The leadership variable can be improved through leadership model evaluation that suited with corporate internally and externally, such as program to interact more with lower grade or aligning with vision and mission of the company, which is AKHLAK. The core value implementation can be increased by making program of internally induction with social gathering, reward and punish method, etc.

Working facilities are considered to be vital, due to extreme conditions and OPM military army. Using updated, well-oiled, machine and gear will bring the worker far safer and sounder. If three variables are having positive mutualism, the working satisfaction will also having positive value.

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BOJONEGORO KAYANGAN API DEVELOPMENT STRATEGY USING DESIGN THINKING METHOD

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ABSTRACT

Tourism can contribute to improving the economy of local communities. According to the United Nations World Tourism Agreement, tourism may positively affect the environment, economy, and society if appropriately managed. The World Tourism Organization's (UNWTO) efforts in this area The World Tourism Organization (UNWTO) works in this field to utilize the synergy between the industry and other resources to increase the competitiveness of tourism industries. This research focused on the Kayangan Api tourism area in Bojonegoro Regency, East Java, Indonesia. By adhering to sustainable practices and considering the long-term consequences of its decisions, the government promotes tourism in a way that benefits the local population. The government implements a growth strategy for the tourism sector that is based on what's best for the community, considering the principles of sustainability and mitigating its effects. This study implemented a design-thinking approach. The data collection used in-depth interviews to potential tourists and experts, combined with observation and data analysis of emerging problems and demands. Next, we develop a strategy then to test the ideas and concepts.

Keywords: Sustainable Tourism, Design Thinking, Kayangan Api

1. INTRODUCTION

The substance of the tourism industry in the development and development of an area is undeniable because tourism itself can be an inherent service sector with synergetic strengths and competitiveness due to its affiliation with heterogeneous sectors whose resources are well managed. On the other hand, it can also cause losses if the procedures for public policy and implementation and management resources need to be improved. This will result in widespread negative impacts on environmental degradation (Muharto, 2020).

One of the tourist destinations in Bojonegoro, Kayangan Api has its potential and uniqueness in its appeal in the form of a geological phenomenon of flames that never goes out due to the release of natural gas from the ground through the fractures below, its location in a protected teak forest area makes it become a natural tourist destination. Considering that the development performance of the tourism sector in Bojonegoro based on the 2022 Regional Work Plan (RKPD) is measured using one indicator, namely the increase in tourists. So to achieve these indicator points in supporting the development of Kayangan Api tourism, a tourism development planning strategy is

needed based on the characteristics and preferences of tourists as the primary indicator using design thinking analysis.

2. LITERATURE REVIEW

Design thinking in tourism is used to facilitate tourists to recognize the local potential entertainingly and interestingly while helping without losing local wisdom by focusing on problems and opportunities with the highest rating among tourists or internal users. It also encourages higher levels of citizen engagement. The design thinking method has adaptability in the field of sustainability science because sustainable development is about satisfying the needs of the present and future generations, which is correlated with design thinking to identify actual needs, especially in the context of entrepreneurship and marketing as well as the possibility to find systemic solutions (Fischer, 2015).

Design thinking is generally defined as an analytical and creative process that engages people in opportunities to experiment, create and gather feedback and redesign. Design thinking is an integral part of the design, engineering, and business. It can also positively influence disciplines because it involves creative thinking in generating solutions to problems (Razzouk & Shute, 2012).

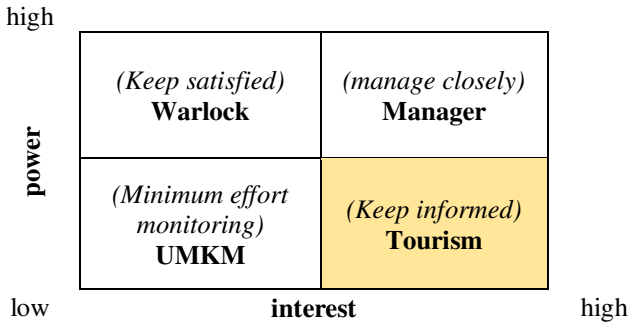
3. METHODS

In this study, the Design Thinking approach was carried out to determine the characteristics and preferences of tourists at Kayangan Api Bojonegoro and as a basis for creating tourism development ideas according to tourist preferences. Design thinking by Stanford d'school: 2008 is divided into five stages (empathize, define, ideate, prototype, and test) then the implementation process is as follows:

Figure 1. Application of Design Thinking Stages

Empathy the initial stage of empathy is carried out to understand and feel what is currently happening to the object of research through the characteristics and preferences of Kayangan Api Bojonegoro tourists so that the first step taken is to find appropriate stakeholders so that the data obtained can be a guide according to the direction and objectives of the research this:

Table 1. Stakeholder Map Analysis



Define, and identify the persona at this defined stage to formulate the focus of the problem on the Point of View table. The following is the identification of persona and user journey mapping from sources or stakeholders who have been interviewed to understand pain and gain and find out the characteristics of these stakeholders.

After understanding User Journey Mapping, an analysis of estimated needs based on tourist experience is summarized into a Point of View table with a structure consisting of identifying user characteristics and preferences and views that underlie user needs. From the user-need-insight element, it is formulated in the HMW Question as a trigger in carrying out ideas using the design thinking method to find solutions to the problems faced by users.

Table 2. Point of View & HMW Questions

Users	***need***	***Insights***	***How Might We***
Tourist/ visitor 1 Rey Lestari, career woman and housewife	Enjoy family time on the weekends at tourist spots that are comfortable and child-friendly	Limited vacation time must be used as best as possible with family. You do not need to be far from home, but comfortable to use to relax with your family where there is entertainment and safe facilities for children.	• A1 - How can we provide tourist attractions for relaxing & family picnics? • A2 - How can we provide entertainment to tourists? • A3 - How can we provide special dining facilities for children?
Tourist/ visitor 2 Puriz Purnama, IT Programmer who enjoys travelling around the city and is interested in history	Time to exercise, visit new places and learn the history	Despite his busy schedule, he always takes the time to exercise by walking or cycling around the city and looking for a place to hang out. Very interested in visiting a place that has historical value.	• A4 - How can we make both a tourist spot and a sport? • A5 - How can we create a hangout place with a unique atmosphere? • A6 - How can we convey the historical value of Kayangan Api to tourists?
Tourist/ visitor 3 Kiki Nuralaily, Traveler and Freelancer	Enjoying and looking for new experiences from the places visited are then documented.	Have a goal of travelling or travelling to various places to find new atmospheres and experiences, then hunt for photos and videos as material for posting on social media.	• A7 - How can we provide an atmosphere and travel experience that can be used as social media content? • A8 - How can we provide an exciting view as a photo spot?
Local Residents Pak Dadang, a resident who works as a tourism officer	HR management for area division for tour officers, tools to serve all visitors as guides	Limited human resources make it difficult for some officers to clean and maintain large areas and make officers unable to serve all visitors who come.	• B1 - How can we keep Kayangan Api clean with the available human resources?

Users	*need*	*Insights*	*How Might We*
UMKM Mrs Sumirah, food and beverage vendor at Kayangan Api Bojonegoro	Increasing tourist visits to increase their income.	The stand location is in a tourist area, so the main buyers are tourists or visitors.	• B2 - How can we increase our income from selling merchandise? • B3 - How can we get tourists to visit the booth?

Ideation, after knowing the characteristics and preferences of tourists, then analysis was carried out based on the previously known Madlib PoV table. So from this table, an alternative strategy can be obtained based on stakeholder needs and insights. These ideas will later be used as one solution and alternative solutions to the Madlib PoV results, which are then grouped through affinity diagrams to facilitate the identification process in conducting a descriptive analysis of the resulting strategies.

Figure 2. Affinity Diagram

Affinity diagrams make managing and understanding the ideas generated based on specific categories of planning aspects or themes easier. After the various ideas have been collected, it is necessary to describe the details of the ideas, which can later be applied to become a development strategy plan for the Kayangan Api tourist attraction in Bojonegoro according to the criteria and preferences of tourists or visitors. The following is a description of the formulation of the strategic plan from the results of grouping ideas.

4. RESULTS

From the strategic planning that has been tested on several relevant stakeholders, with the highest number of votes or choices, several strategies will be obtained that are deemed appropriate and can be applied to the Kayangan Api Bojonegoro tourist attraction, starting from a geographical perspective and also budget allocations that can be proposed to support the strategy implementation plan. Testing this strategic plan is carried out by displaying several strategic options regarding descriptions and strategic plans to stakeholders, who are then allowed to choose 3 (three) strategies and the reasons behind their selection. Here the stakeholders representing local government agencies or managers consist of 1 person and five stakeholders from tourists or visitors to Kayangan Api Bojonegoro. The following are the results of stakeholder selection from the testing process that has been carried out in the order of obtaining the most votes or points:

Table 3. Strategy Planning Testing

Strategy planning	*Strategy description*	*Point*	*feedback*
1. Taman Bahero	Playground area with mini waterpark facilities and a flora/fauna garden surrounded by decorative lights, as well as the Kayangan Api mascot to accompany playing	4	The large green area can be used as a sitting area/ picnic area to be one of the exciting facilities, with decorative lights making the park enjoyable in the afternoon/ evening. The presence of a clown/ mascot and mini waterpark facilities might become an idol spot for children who visit.
2. Alas Kayangan	Camp & Outbound area, providing tents/equipment rental for cheerful camps in tourist areas. There are bicycle and jogging tracks	3	There is yet to be a camp area/outbound in Bojonegoro, which is in the middle of a forest, so later Alas Kayangan can be the choice of camp with its natural vibes that blends with the eternal fire in the middle of a teak forest.
3. Documentation and publication/ branding team	In charge of monitoring social media, documenting every activity/event/tourist activity as digital content, serving online ticket bookings	3	Young people/teenagers today are very close to social media. Digital content is necessary to make it viral. They hope that tourist photos/videos will be reposted by tagging the Kayangan Api tourist account so they can promote their accounts.
4. Ujung Cafetaria	Outdoor/nature-themed food court with green areas for cross-legged seating, artistic/aesthetic buildings, variations of the latest food menus prepared and sold by UMKM themselves, has a rooftop to get a more expansive view	3	If Alas Kayangan is a family picnic spot, this cafeteria is a relaxing/hangout choice for young people/teenagers. The aesthetic/instagramable form of the cafeteria is a photo spot sought after by many millennial children today. The semi-outdoor atmosphere can combine a café with a natural forest atmosphere.
5. Kolam Sumber Sukma	The sulfur water therapy pool in Kayangan Api, as well as fish therapy at the end of the location, thereby increasing tourist visits to the UMKM stands and becoming a place for relaxing feet after walking around	2	The source of sulfur water, or the Blekutuk Well in Kayangan Api has yet to be fully utilized, so diverting sulfur water from the Blekutuk Well into a therapeutic pool can be an alternative to utilizing its potential.

The prototype in this research is a strategic recommendation based on the characteristics and preferences of tourists through the ideation stage, and testing of strategic planning is carried out on related stakeholders. Then 5 (five) strategy recommendations are obtained, which are analyzed using SWOT analysis and the previous descriptive sustainable tourism approach, resulting in recommendations for appropriate and applicable strategies.

6. CONCLUSIONS

Figure 3. Strategy Recommendations

From the results of this study, there are 5 (five) selected strategies from various strategies that have been tested on relevant stakeholders, and their potential has been analyzed through SWOT analysis and sustainable tourism so that later they can be used as strategic recommendations in implementing and optimizing existing potential and resources. The following are five recommendations for strategies produced in a study entitled "The Kayangan Api Bojonegoro Tourism Development Strategy Using the Design Thinking Method".

After carrying out various stages in design thinking to create a Kayangan Api tourism development strategy, several suggestions can be used as a reference for perfecting similar research on the next occasion, namely, conducting FGDs (focus group discussions) at the ideation stage with various parties to expand the range of ideas that can be poured into strategy planning, then conduct testing of the prototyping results to obtain feedback in perfecting the resulting strategies.

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CUSTOMER SEGMENTATION OF HOUSEHOLD ELECTRICITY CUSTOMERS USING K-MEANS CLUSTERING BASED ON LRFMP

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ABSTRACT

Through the 35,000 MW (Mega Watt) power plant development program, in 2020, the total generating capacity reach 63,336 MW and generates 274.8 TWh (Tera Watt hour) of electricity. The 35,000 MW program can be both opportunity and challenge for PT PLN (Persero) considering "take or pay" regulation, because all of the electricity supply have to purchased. If PT PLN (Persero) unable to sell all of the electricity supply, of course this will be a loss. This condition requires an effective strategy from the state electricity company to increase electricity sales. The initial step to increase sales is customer segmentation using k-means clustering based on LRFMP (Length, Recency, Frequency, Monetary, Payment). Customer segmentation has carried out to determine the characteristics of each customer segment. Based on the segmentation, we know the profile of customers in each to support the determination of marketing strategies. Prepaid customer divided into 3 clusters while postpaid customer divided into 2 clusters. Clustering results provide information about customer profiles in each cluster accompanied by geographic maps and analysis of the conditions of each region. The results of the ANOVA test on the cluster results show a significant difference between each cluster.

Keywords: clustering, k-means, LRFMP, sales, segmentation

1. INTRODUCTION

Indonesian government has launched a 35,000 MW (Mega Watt) power plant construction program in 2016 and opened up opportunities for the private sector to participate in the construction of power plants through the Independent Power Producers (IPP) mechanism. In 2020, the total generating capacity reached 63,336 MW with a total electricity production of 274,851 TWh (Tera Watt hour). However, with the COVID-19 pandemic, the growth of national electricity consumption in 2020 decreased, cumulatively PT PLN (Persero)'s electricity sales fell by 0.8% to 243.6 TWh compared to 2019. In 2020, the COVID-19 pandemic had a considerable impact, reducing electricity consumption in industrial and business sector, although the electricity consumption of household customers has increased due to WFH (Work From Home).

Based on these conditions, the 35,000 MW program can be an opportunity as well as a challenge for PT PLN (Persero) to be able to increase electricity sales. Through a "take or pay" policy, so that all electricity produced by IPP (Independent Power Producer) must be purchased by PT PLN (Persero). If PT PLN (Persero) is unable to sell the entire supply of incoming electrical energy, of course this will be a loss. Therefore, PT PLN (Persero) must strive to increase its

electricity sales to maintain the supply-demand balance of electricity, even during the COVID-19 pandemic, which has an impact on various sectors, especially business and industry as a potential customers for PT PLN (Persero). This condition requires an effective strategy to increase sales of electricity to deal with the recovery period after the COVID-19 pandemic.

This study discusses more specifically PT PLN (Persero) UP3 XYZ. In 2021 the achievement of PT PLN (Persero) UP3 XYZ's electricity sales target reached 96.09%, namely 1,303.31 GWh (Giga Watt hour) of the target of 1,356.34 GWh. This research is also limited to household customers, which constitute 94% of the total customers of PT PLN (Persero) UP3 XYZ. Failure to achieve this sales target requires PT PLN (Persero) UP3 XYZ to be able to evaluate and improve its marketing strategy in order to increase its electricity sales. The first step in increasing electricity sales is customer segmentation for customer mapping based on the characteristics of each customer segment. Customer segmentation is important because it can provide information regarding the behavior and preferences of different customer segments, thereby helping companies to contrive efficient strategies for each customer segments (Dibb, 1998). One of the customer segmentation methods is clustering, grouping data into several clusters so that data within one cluster has the maximum level of similarity and data between clusters has minimum similarity (Tan, 2006). Customer clustering can be done based on customer transaction history in a certain period used as a variable in clustering. The variable that is commonly used in clustering because it can provide an overview of customer behavior related to transactions is the RFM (Recency, Frequency, Monetary). The RFM can provide information about the time interval since the last transaction (Recency), the number of transactions within a certain period (Frequency) and the average amount paid by customers during a certain period (Monetary) (Peker, 2017). The RFM developed into LRFMP (Length, Recency, Frequency, Monetary, Payment) by adding a variable (Length) to distinguish which customers have a long-term relationship with the company, as well as (Payment), the amount of overdue payments by customers. On time payment is a measure of customer loyalty to the company (Muhidin, 2017). The weighting of RFM components can improve the results and accuracy of cluster formation (Hosseini, 2010). Research using the Clustering method with the LRFMP and the K-Means algorithm with two-stage clustering shows increased precision and efficiency of marketing strategies for customer segments (Sheikh, 2019). The K-Means algorithm is easy to implement and fast to use, so it is widely used for segmentation in various fields including data mining, statistical data analysis, pattern recognition, customer segmentation, and other business applications (Davidson, 2002).

Based on this description, this study applies customer segmentation with k-means clustering based on the LRFMP for PT. PLN (Persero) UP3 XYZ. Customer segmentation is carried out to determine the characteristics of each customer segment in terms of subscription time, transaction intervals, transaction frequency, transaction value and smoothness of bill payments. With this segmentation, it can be known the profile of customers in each segment and how the right treatment for each of these segments is necessary to support the determination of marketing strategies in general, as well as improve the quality of customer relationship management for PT. PLN (Persero) UP3 XYZ.

2. LITERATURE REVIEW

Marketing

Marketing is an activity to fulfill needs and wants through an exchange process (Kotler, 1997). Meanwhile, according to Stanton (2013), marketing is the whole system of business activities to plan, determine prices, promote and distribute goods and services that can satisfy the needs of buyers and prospective buyers. The marketing concept explains that the key to achieving

organizational goals consists of determining market needs and providing the satisfaction expected by consumers more effectively and efficiently than competitors (Yulianti, 2019).

Market Segmentation

Market segmentation is the activity of dividing a market or customers into different groups of customers with different needs, characteristics or behaviors that may require different products and marketing strategies (Yulianti, 2019). Market segmentation is the process of taking advantage of opportunities by dividing the market into several segments. Segmentation is the art of identifying and taking advantage of existing opportunities in the market by looking at the market creatively (Kartajaya, 2006).

Data Mining

Data mining is a process of finding relationships, patterns, and trends in data by examining large amounts of data stored in storage using pattern recognition techniques, both statistical and mathematical techniques (Larose, 2006). Data mining is an analysis process carried out on complex and large amounts of data to obtain a pattern or trend of data (Pramudiono, 2006).

Clustering

Clustering is a process of grouping data into several clusters or groups so that data within one cluster has the maximum level of similarity and data between clusters has a minimum similarity (Tan, 2006). Clustering is the process of partitioning data into subsets called clusters. Each object in a cluster has similar characteristics to each other and is different from other clusters. Clustering methods generally divided into two, namely hierarchical clustering and partitional clustering (Tan, 2011).

K-means Clustering

K-means clustering is a non-hierarchical clustering method that tries to partition data into one or more clusters/data groups. The k-means clustering method partitions data into clusters so that data with the same characteristics grouped in one cluster and data with different characteristics grouped into another cluster. The purpose of k-means clustering is to minimize the objective function that is set in the clustering process, thereby minimizing variation within one cluster and maximizing variation between clusters (Agusta, 2007).

LRFMP

According to Peker (2017) the LRFMP originated from the development of the RFM first proposed by Hughes (1996) to analyze and predict customer behavior. The basic RFM relies on three attributes namely Recency (R), Frequency (F), and Monetary (M). Recency is the time interval since the last transaction is useful for providing potential customer information. Frequency is the number of transactions in a certain period. Monetary is the average payment for each transaction over a certain period to measure the customer's contribution to the company's income (Peker, 2017).

Analytical Hierarchy Process (AHP)

Analytical Hierarchy Process (AHP) is a decision support model developed by Thomas L. Saaty. This AHP model describes complex problems with multi factors or multi criteria into a hierarchy, where the first level is the goal, followed by the factor level, criteria, sub criteria, and so on down to the last level of the alternative (Saaty, 1993).

3. METHODS

Determination of Population and Data Samples

In this study, the population and sample data used were the household customer data in PT PLN (Persero) UP3 XYZ. In order to get accurate results, in this study the data population used

was all of household customer data, totaling 722,612 customers, and the data samples taken were transactions for the period January 1 2022 – September 30 2022.

Data Collection

The data collected is monitoring billing data, settlement data and prepaid customer token purchasing data. An explanation regarding the data needed in this study described in Table 3.1.

Table 3. 1 Kebutuhan Data LRFMP

Variable	Description	Data Requirements
Length	Subscription period until October 1, 2022	The month and year registered
Recency	Last token purchase interval to October 1, 2022	Date, month, year of token purchase transaction
Frequency	Frequency of purchasing tokens per month during the period Jan 2022 - Sep 2022	Date, month, year of token purchase transaction
Monetary	Average electricity bill (RPTag) or token purchases in Jan 2022 - Sep 2022	Electricity bill (RPTag) per month Purchase of tokens per month
Payment	Payments overdue during Jan 2022 - Sep 2022	Electricity bill settlement data

Data Preprocessing

Data pre-processing consists of the following stages:

1. Data selection for selecting the appropriate attributes, the data obtained from the Subscription Master Data (DIL) is sorted and the attributes that will be used in the research are taken, namely Customer ID, name, tariff, power, location (station, village, sub-district, district) , and the month of customer registration.
2. Data cleansing for cleaning data and missing values so as not to interfere with the process or the accuracy of the results of the research conducted and find existing data anomalies.
3. Data transformation to change the raw data into ready-to-process data.

LRFMP

1. **Length**, the length of a customer's subscription, calculated from the time the customer was officially registered as a customer of PT PLN (Persero), expressed in months.
2. **Recency**, the time interval since the last transaction or purchase of the last token made by a customer until October 1, 2022, recency only applies to prepaid customers expressed in days.
3. **Frequency**, the frequency of token purchases by customers per month, frequency only applies to prepaid customers, expressed in units of times/month in the period January 1 2022 - September 30 2022.
4. **Monetary**, the amount of electricity consumption transactions (RPTag) by customers per month, which taken on average during the period January 2021 - September 2022, expressed in Rupiah per month.
5. **Payment**, the amount of payments overdue on the 20th of each month made by customers expressed in the number of times the customer has made late payments during the period January 2022 - September 2022.

Weighting the LRFMP with AHP

The weighting of the LRFMP is carried out using the AHP method, where the priority weight of the LRFMP criteria is denoted by wL, wR, wF, wM and wP. The weighting of the AHP method is carried out based on the results of the assessment of the marketing and customer service division of PT PLN (Persero) UP3 XYZ in assessing the effect of each criterion on the company. The next step is to calculate the inconsistency index and examine it for each assessment so that the weight value for each criterion is obtained.

Determining the Optimal K

The optimal number of clusters used is the “best number of clusters” based on majority rules from the results of the entire index available at Rstudio such as "hartigan", "ccc", "friedman", "rubin", "silhouette", etc.

Clustering with K-Mean Clustering

After obtaining the optimal K value, the next step is to carry out the clustering stage with the k-mean clustering algorithm. The input data used is normalized LRFMP values with weights. While the initial K value is the "best number of clusters" based on majority rules.

Clustering Results Anova F Test

ANOVA (Analysis of Variance) testing of clustering results aims to determine whether the clusters formed differ between clusters. The following is the F Anova equation used:

$$F = \frac{SSB}{SSW}$$

$$SSW\ (C, m) = \frac{1}{n}\sum_{i=1}^{m}\sum_{j \in C_i}^{m} \|x_j - C_{(p)j}\|$$

$$SSB\ (C, m) = \frac{1}{n}\sum_{i=1}^{m} n_i \|C_i - \bar{x}\|$$

4. RESULTS

The dataset in this study is the household customer of PT PLN (Persero) UP3 XYZ with a total 722,612 customers, consisting of 324,169 prepaid customers and 398,443 postpaid customers. After the preprocessing data, the next step is determine the optimal K number and clustering with k-mean clustering in RStudio software.

The optimal number of prepaid customer clusters and the plot shown in Figure 4.1.

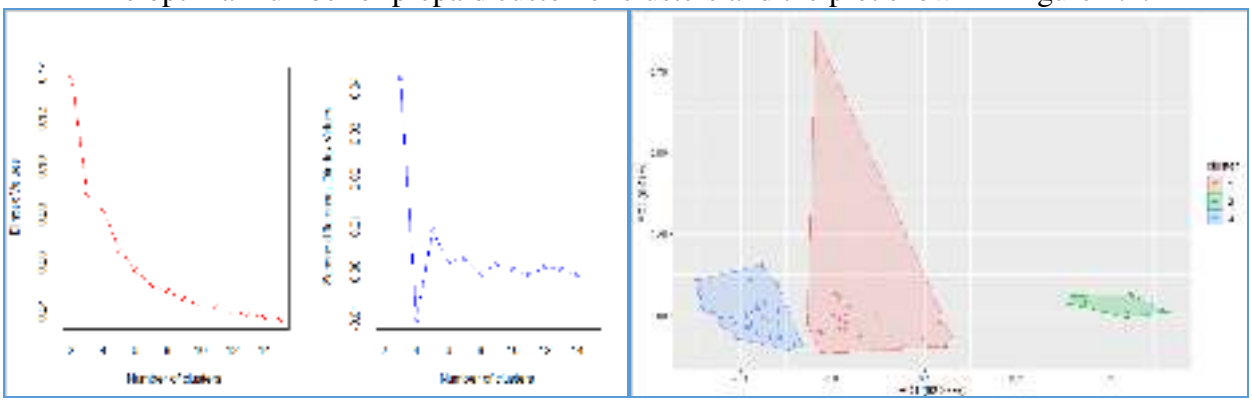

Figure 4.1 Optimal Number of Clusters and Clusters Plot of Prepaid Customers

** According to the majority rule, the best number of clusters is 3*

Then, the details of the members of each cluster are shown in the table 4.1.

Table 4.1 Prepaid Customer Clustering Results by District

	CLUSTER 1	CLUSTER 2		CLUSTER 3	
JUMLAH ANGGOTA	7	24		32	
ANGGOTA	CIBADAK	BANJAR	LABUAN	ANGSANA	CISATA
	KADUHEJO	BAYAH	LEUWIDAMAR	BANJARSARI	GUNUNGKENCANA
	KALANGANYAR	CADASARI	MAJA	BOJONG	JIPUT
	KARANG TANJUNG	CARITA	MALINGPING	BOJONGMANIK	LEBAKGEDONG
	MAJASARI	CIKEDAL	MANDALAWANGI	CIBALIUNG	MUNCANG
	PANDEGLANG	CIKULUR	MEKARJAYA	CIBEBER	MUNJUL
	RANGKASBITUNG	CIMANUK	MENES	CIBITUNG	PANGGARANGAN
		CIMARGA	PAGELARAN	CIGEMLONG	PATIA
		CIPANAS	PANIMBANG	CIGEULIS	PICUNG
		CIPEUCANG	SAJIRA	CIHARA	PULOSARI
		CURUG BITUNG	SAKETI	CIJAKU	SINDANGRESMI
		KORONCONG	WARUNGGUNUNG	CIKEUSIK	SOBANG LBK
				CILELES	SOBANG PDG
				CILOGRANG	SUKARESMI
				CIMANGGU	SUMUR
				CIRINTEN	WANASALAM
AVG LENGTH	**85,50**	**79,19**		**84,47**	
AVG RECENCY	**51,42**	**66,59**		**72,85**	
AVG FREQUENCY	**1,84**	**1,20**		**0,87**	
AVG MONETARY	**94.651,53**	**45.076,61**		**26.158,95**	

The optimal number of postpaid customer clusters and the plot shown in Figure 4.2.

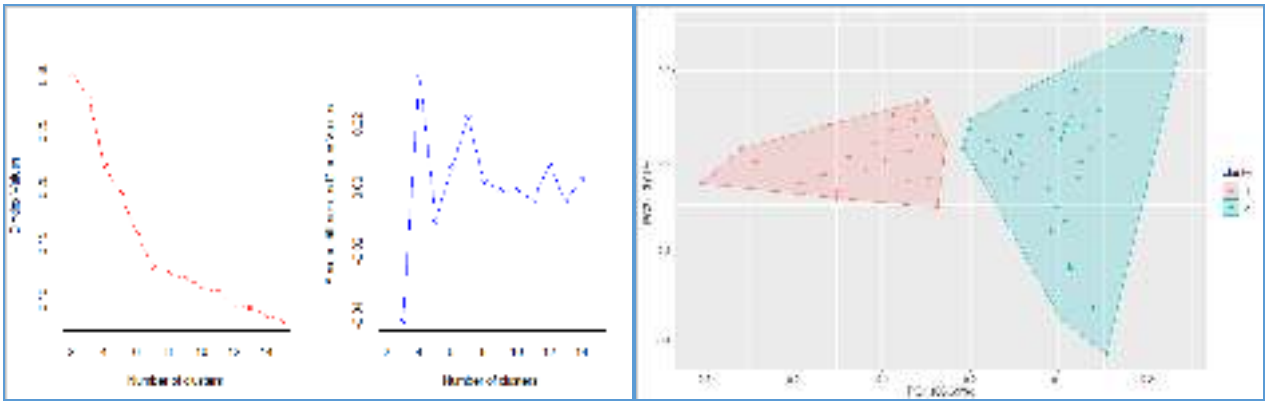

Figure 4.2 Optimal Number of Clusters and Cluster Plot of Postpaid Customers

* According to the majority rule, the best number of *cluster*s is 2

Then, the details of the members of each cluster are shown in the table 4.2.

Table 4.2 Postpaid Customer Clustering Results by District

	CLUSTER 1		CLUSTER 2	
JUMLAH ANGGOTA	28		35	
ANGGOTA	ANGSANA	CIMARGA	BANJAR	MAJA
	BAYAH	CIRINTEN	BANJARSARI	MAJASARI
	BOJONGMANIK	CISATA	BOJONG	MALINGPING
	CIBALIUNG	GUNUNGKENCANA	CADASARI	MANDALAWANGI
	CIBITUNG	JIPUT	CARITA	MENES
	CIGEMLONG	LEUWIDAMAR	CIBADAK	MUNJUL
	CIGEULIS	MEKARJAYA	CIBEBER	PAGELARAN
	CIHARA	MUNCANG	CIKEDAL	PANDEGLANG
	CIJAKU	PANGGARANGAN	CIMANUK	PANIMBANG
	CIKEUSIK	PATIA	CIPANAS	PICUNG
	CIKULUR	PULOSARI	CIPEUCANG	RANGKASBITUNG
	CILELES	SINDANGRESMI	CURUG BITUNG	SAJIRA
	CILOGRANG	SOBANG LBK	KADUHEJO	SAKETI
	CIMANGGU	SOBANG PDG	KALANGANYAR	SUKARESMI
			KARANG TANJUNG	SUMUR
			KORONCONG	WANASALAM
			LABUAN	WARUNGGUNUNG
			LEBAKGEDONG	
AVG LENGTH	**201,12**		**218,54**	
AVG MONETARY	**48.621,32**		**78.978,14**	
AVG PAYMENT	**1,72**		**2,79**	

Anova Test of Clustering Results

ANOVA (Analysis of Variance) testing of clustering results aims to determine whether the clusters formed differ between clusters, the results of the ANOVA test shown in Table 4.3.

Table 4.3 ANOVA Test Results

ANOVA Test Results					
Prepaid Customer ANOVA test results					
	Df	**Sum Sq**	**Mean Sq**	**F value**	**Pr(>F)**
ind	2	0,209	0,10448	**3,505**	**0,0749**
Residuals	9	0,2683	0,02981		
Postpaid Customer ANOVA test results					
	Df	**Sum Sq**	**Mean Sq**	**F value**	**Pr(>F)**
ind	1	0,2373	0,23728	**5,129**	**0,0862**
Residuals	4	0,1851	0,04627		

ANOVA Test Results for prepaid and postpaid customer clustering results show Pr (>f) < alpha (0.1), the decision is to reject H0, so there is a significant difference between clusters in the clustering results of prepaid and postpaid customers.

Analysis and Discussion

Household prepaid customers divided into 3 clusters where the length of cluster 1, 2, 3 has an adjacent average value. Recency of cluster 1 averages 51 days, cluster 2 averages 66 days and cluster 3 averages 72 days. Frequency in cluster 1 shows the highest value with 1.84 times then cluster 2 with 1.2 times and cluster 3 is in the rare category with 0.87 times. In terms of monetary cluster 1, it is in the medium category with IDR 94,651 while clusters 2 and 3 are in the low category with IDR 45,076 and IDR 26,158. Overall, from the results of the ANOVA test, the differences between clusters are quite significant. By the conditions of each district in each cluster, cluster 1 with the most frequent average token purchases and the largest amount is an area with good economic conditions and is the capital area of Lebak Regency and Pandeglang Regency and the supporting sub-districts next to it. Cluster 2 and cluster 3 are respectively below cluster 1 in accordance with the economic conditions of each district so that the average purchase of tokens is lower. An overview of each cluster area shown in Figure 4.3.

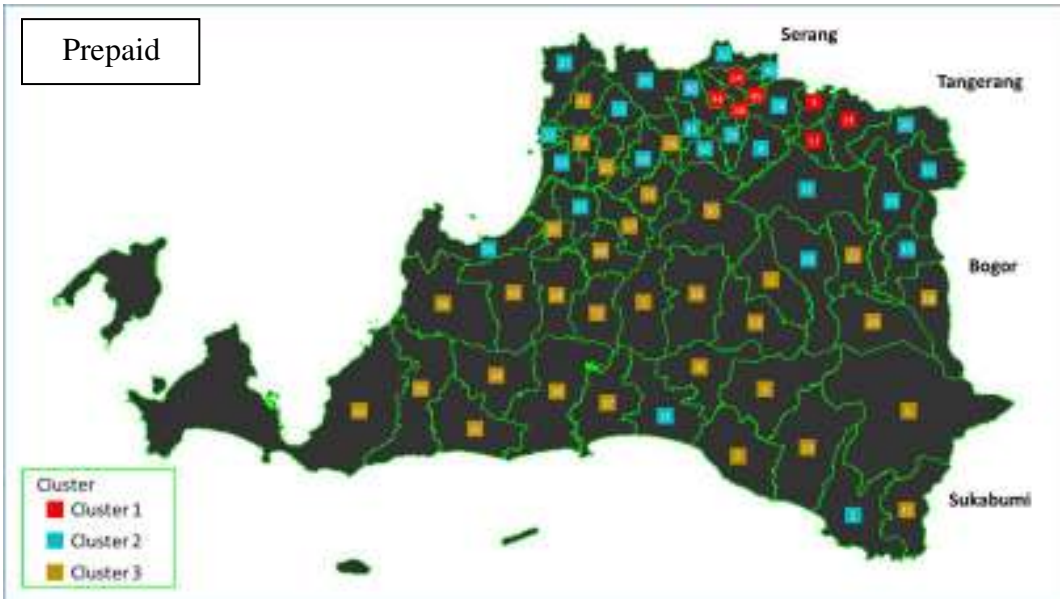

Figure 4.3 Geographic Map of Prepaid Customer Clusters

Postpaid customers divided into 2 clusters with variable length in clusters 1 and 2 both of which are in the old customer category. In terms of Cluster 1, it is in the low category with IDR 48,621 per month, while cluster 2 is in the medium category with IDR 78,978 per month. In terms of overdue rates or late payments, cluster 1 is lower with 1.72 times compared to cluster 2 with 2.79 times. The results of the ANOVA test show that the differences between clusters in the postpaid subscribers of the R tariff (households) are quite significant. If we look at the distribution based on geographical conditions, it can be seen that the 2 that have higher account payment values are indeed located in areas with better economies, namely district capital areas, areas close to big cities such as Serang and Tangerang, as well as areas with natural and tourism potential the good one. An overview of the geographical distribution of each cluster shown in Figure 4.4.

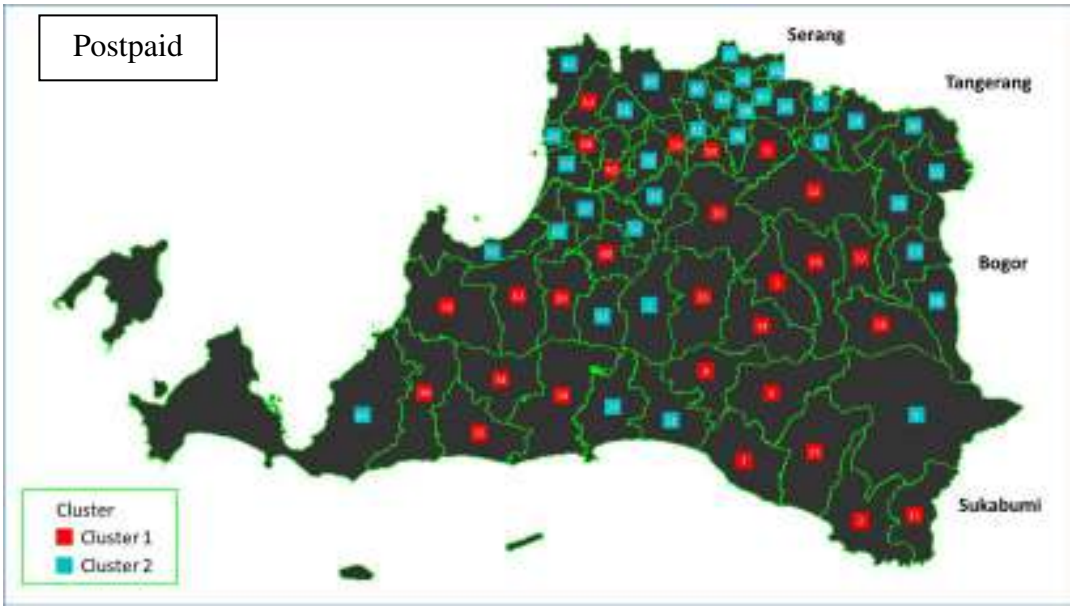

Figure 4.4 Geographic Map of Postpaid Customer Clusters

5. CONCLUSIONS

The implementation of LRFMP (Length, Recency, Frequency, Monetary, Payment) for prepaid and postpaid customers is different. Prepaid customers use LRFM (Length, Recency, Frequency, Monetary) variables. Postpaid customers use LMP (Length, Monetary, Payment) variables. Due to this difference, prepaid and postpaid customer data processed separately. K-means clustering based on the LRFMP variable was carried out for prepaid and postpaid subscribers, respectively, the results of prepaid customer clustering divide customers into 3 clusters, while the results of postpaid customer clustering divide customers into 2 clusters, each cluster shows significant differences between clusters. Clustering results Provide information related to customer profiles in each cluster accompanied by geographic maps and analysis of the conditions of each region to facilitate the decision making of strategies and policies that support the marketing strategy at PT PLN (Persero) UP3 XYZ.

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ANALYSIS OF FACTOR INFLUENCING B2B PRODUCT SALES AT PT XYZ USING THE SUPPORT VETOR MACHINE METHOD

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ABSTRACT

PT XYZ is an Indonesian telecommunications firm that offers internet services to both businesses and consumers. B2B goods developed by PT XYZ include IaaS, CPaaS, SaaS, and Analytics, which will be given to clients or businesses in need by salespeople. PT XYZ employs over 50 salespeople in Indonesia, each having a unique background and profile, such as age, geography, position, status, family, and economic circumstances, all of which influence a salesperson's performance. PT XYZ wishes to increase the sales performance of B2B products by identifying the influencing elements based on the characteristics of the salesperson through a comparison of the state of win and lose projects using Logistic Regression. Furthermore, the data will be classified based on the project's progress using the Support Vector Machine (SVM). The characteristics that influence sales from salespersons are time spent working, remaining KPR repayment time, number of trainings, marriage age, educational status. Advice that offered to PT XYZ by providing training tailored to the demands of the salesperson and also in accordance with the job is intended to boost salesperson performance, allowing them to win more products. The SVM classification results have an accuracy score of 81% with an ideal degree of 2.

Keywords: *Feature Rank,* Logistic Regression, Sales Factor, Salesperson, Support vector Machine

1. INTRODUCTION

Indonesia is one of the countries with the most internet users globally, ranking sixth in 2021. (Kominfo, 2021). In Indonesia, internet access is available not just through mobile phones, but also through other media such as laptops, Personal Computers (PCs), and other devices that require an internet connection. Indonesia presently ranks third in the world in terms of internet users, with 212.35 million users (Katadata, 2021). Indonesians use internet connections for a variety of purposes, including communication through various media, access to work with other parties, and enjoyment through current platforms. Furthermore, the current pandemic situation has an impact on the number of internet users, namely for the demands of School From Home (SFH) and Work From Home (WFH) (WFH). According to Katadata (2021), pandemic circumstances increased internet use in Indonesia, particularly mobile internet, by 53.5%.

PT. XYZ is a telecommunications firm in Indonesia that offers internet services in the Business to Business (B2B) and Business to Consumer (B2C) segments. The growing demand for internet services indicates that there is business potential that may be met by PT XYZ, which not

only targets the general public (B2C), but also Business to Business (B2B). PT. XYZ offers a wide range of B2B and B2C goods. B2C users have numerous profile characteristics such as age group, type of employment, hobbies, and location. Users in the B2C segment have a variety of profile characteristics, including their age, type of work, hobbies, and location. Users in the B2B segment at PT XYZ are divided into three groups: Key Accounts (KA), Large Enterprise (LE), and Small Medium Enterprise (SME), with the number of salespeople in each group varying. and the nature of each segment's operation. PT XYZ B2B products are classified into four categories: IaaS, CPaaS, SaaS, and Analytics. The salesperson offers the four product types to consumers or businesses that require them by completing an initial evaluation to identify the needs and then mapping the suitable items.

PT XYZ employs over 50 salespeople throughout Indonesia, each having a unique background and profile. Factors such as age, region, job, and status, as well as family circumstances, can all have an impact on a salesperson's success. This is a challenge for PT XYZ since, as the number of internet users in Indonesia increases, so will competition, particularly in the B2B category. As a result, PT XYZ wants to discover if there are any elements in each salesperson that can influence product sales and thus the money made by PT XYZ. The Support Vector Machine (SVM) method was utilized in this study to classify salesperson performance depending on whether the project was a win or a loss. Prior to SVM analysis, the data will be evaluated using logistic regression to determine which variables affect project status, and an analysis utilizing feature rank to provide variable score.

2. LITERATURE REVIEW

2.1. Data Mining

Data mining is a process that uses statistical approaches, mathematics, artificial intelligence, and machine learning to extract or identify information from multiple sources (Karolina, 2021). According to Putra (2020), data mining tries to get more specific information from a data collection that is supposed to be understood through its stages, namely data selection, data preprocessing, data interpretation, and data evaluation. According to Fayyad (1996), data mining steps begin with data selection, data cleaning or pre-processing, transformation, data mining, and interpretation or evaluation.

2.2. Support Vector Machine (SVM)

Support Vector Machine (SVM) is a data mining technology that may be used to classify and predict data (Arifin, 2018). A hyperplane is a dividing line between classes that is used to measure the distance or margin of each class in order to get the greatest point. A support vector is defined as the distance between the hyperplane and the nearest point (Prasetyo, 2012).

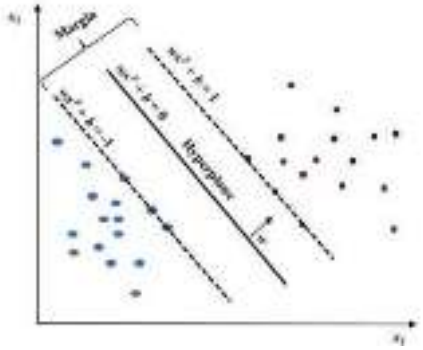

Figure 1. Support Vector Maching (SVM)

The classification on a linear hyperplane can be denoted as follows (Huang, 2018)

$$wx^T + b = 0$$

Information

w : Vector weight
x : Set of training data
b : biased

To determine training data, you can use the following equation:

$$wx_i^T + b \geq 1; if\ y_i = 1$$
$$wx_i^T + b \leq -1; if\ y_i = -1$$

The Quadratic Programming (QP) method can be used to discover the optimal hyperplane using the equation below (Santosa, 2007).

$$\frac{1}{2}w^T w$$

With the inclusion of $y_i(w^T.x_i + b) \geq 1$; $i = 1,2,3,\ldots,n$

2.3. State of The Art

Previous research on salesman performance is included in State of the Art, as well as related research on support vector machine learning.

Table 1. Research on Salesperson Performance

Research	Conclusion
Title : The Predictive Model of Relationship Between Role Stress, Personality, and Sales Performance in Service Marketing **Author** : Secapramana & Verina; 2013	Age, gender, last education, work experience, marital status, work partner, job contentment, work ambition, self-efficacy, emotional intelligence, and performance are the factors used in this study. The strongest relationship exists between job ambition and self-efficacy.
Title : The Impact of Big Five Personality Traits on Salespeople's Performance : Exploring The Moderating Role of Culture **Author** : Yakasai, Abubakar Mukhtar; 2015	This study identified five variables that were highly connected with personality traits and salesperson performance: role perceptions, skills and organizational variables, efforts and salesperson learning, individual market orientation, and customer orientation.
Title : What Skills Make a Salesperson Effective? An Explaratory Comperative Study Among Car Sales Professionals **Author** : Amor, Nour El Houda Ben; 2019	The most effective variables in this study are communication, listening skills, information possession, sales presentation abilities, flexibility and adaptation, empathy, and cooperation skills.

Table 2. Research on Support Vector Machine

Research	Conclusion
Title : Analysis of Factors Affecting Churn Rate in Telecommunications Companies Using Support vector machines (Case Study: PT Telekomunikasi XYZ) **Author** : Arifin, Samsul ; 2018	The resulting model is then tested with SVM, and it outperforms the initial data. The best accuracy is 78.2% when 70 training data and 30 testing data are used.
Title : Application of the Support Vector Machine (SVM) Method to Child Development Deviation Classification **Author** : Parapat, Indra Monika; 2018	A comparison of the findings of the child development classification with the assistance of psychologists reveals that the system yields poor accuracy. This could be due to the tiny and uneven data set employed for research.
Title : Cosmetic Sales Prediction With Support Vector Machine **Author** : Apriliyani, Aflahah; 2019	Forward selection with the best value based on the minimum error value of 0.134 with a period variable of 8, Validation Shuffled Sampling 10, and a polynomial kernel type produces better results.

3. METHODS

The data used in this study was provided by PT XYZ and has been adjusted to ensure data confidentiality while still representing true data from PT XYZ. The variables to be used are provided in Table 3 below.

Table 3. Research Data Variable's

Variables	Symbol	Number	Detail	Description	Remark
Id *Salesperson*	X_1		ID of each salesperson		Feature
Year Of Birth	X_2	0	1991-2000	Year of birth of each salesperson	Feature
		1	1981-1990		
		2	1971-1980		
		3	<1970		
Time Spent Working	X_3	0	< 5 years	Duration of employment at PT XYZ	Feature
		1	5-10 years		
		2	> 10 years		
Educational Status	X_4	0	S1	Last education of each salesperson	Feature
		1	S2		
Number Of Trainings	X_5	0	1-3 times	Number of sales training	Feature
		1	4-6 times		
		2	>6 times		
Have Side Jobs	X_6	0	Yes	Info on the side job of each salesperson	Feature
		1	No		
Marital Status	X_7	0	Single	Salesperson marital status	Feature
		1	Married		
Number Of Children	X_8	0	No Children	The number of children of each salesperson	Feature
		1	1-3 people		

Variables	Symbol	Number	Detail	Description	Remark
		2	> 3 people		
Work Area	X_9	0	West	Work Area of *salesperson*	Feature
		1	East		
Unlike Homebase	X_{10}	0	Yes	The difference between the work location and the residence of each salesperson	Feature
		1	No		
Project Location	X_{11}	0	West	The project location is located	Feature
		1	East		
Project Status	X_{12}	0	Lose	Detailed status of each project	Target
		1	Win		
Product Category	X_{13}	0	IaaS	Product category at PT XYZ	Feature
		1	CPaaS		
		2	SaaS		
		3	*Analytics*		
Project Type	X_{14}	0	Key Account	Project type of each salesperson	Feature
		1	Large Enterprise		
		2	SME		
Project Category	X_{15}	0	*Connectivity*	The project category of the product offered	Feature
		1	*Solution*		
Working Duration	X_{16}	0	0-2 Years	Duration of work as a sales person	Feature
		1	3-5 Years		
		2	>5 Years		
Work Experience In Other Companies	X_{17}	0	Yes	Have experience working in other companies	Feature
		1	No		
Career Ambition	X_{18}	0	Yes	Have the ambition to become a top leader with the consequence of moving work locations	Feature
		1	No		
Marriage Age	X_{19}	0	Single	Marriage age	Feature
		1	0-2 Year		
		2	3-5 Years		
		3	>5 Years		
KPR Status	X_{20}	0	Yes	Have a KPR or not	Feature
		1	No		
Have Credit Other Than KPR	X_{21}	0	Yes	Have credit other than KPR or not	Feature
		1	No		
Remaining KPR Repayment Time	X_{22}	0	There is no	Estimated remaining time for KPR repayments	Feature
		1	0-5 years		
		2	6-10 years		
		3	>10 years		
Remaining Loan Repayment Time	X_{23}	0	There is no	Estimated remaining time for credit repayment	Feature
		1	0-2 years		
		2	3-5 years		
		3	>5 years		

Variables	Symbol	Number	Detail	Description	Remark
Have Personal Insurance	X_{24}	0	Yes	Have personal insurance other than insurance from the office	Feature
		1	No		
Have A History Of Serious Illness	X_{25}	0	Yes	Have a history of serious illnesses such as heart disease, stroke, cancer, or other complications.	Feature
		1	No		

In this study, the data is analyzed using a support vector machine to determine the characteristics that influence B2B product sales.

1. Prepare test data and divide data based on project status, namely win or lose.
2. Statistical Descriptive for data variabel
2. Performing feature variable scoring
3. Use the support vector machine method to classify based on target variables.
4. Using the confusion matrix, compare the categorization findings.

4. RESULTS

4.1 Descriptive Statistical Analysis

Descriptive analysis is important for presenting an overview of the data to be evaluated so that the data produces easily understood information for the reader.

Table 4. Statistical Descriptive using Crosstabulation

	Variables	Detail	Status Project	
			Lose	Win
2	Year of Birth	1991-2000	1522	1542
		1981-1990	1582	1603
		1971-1980	1551	1578
		<1970	969	927
3	Time Spent Working	< 5 years	1145	1173
		5-10 years	1348	1427
		> 10 years	3131	3050
4	Educational status	S1	2863	2793
		S2	2761	2857
5	Number of trainings	1-3 times	1836	1814
		4-6 times	1937	1955
		>6 times	1851	1881
6	Have side jobs	Yes	2791	2847
		No	2833	2803
7	Marital status	Single	2827	2866
		Married	2797	2784
8	Number of children	No Children	3773	3781
		1-3 people	894	914
		> 3 people	957	955
9	work area	West	2834	2844

	Variables	Detail	Status Project	
			Lose	Win
		East	2790	2806
10	Unlike Homebase	Yes	2784	2819
		No	2840	2831
11	Project location	West	2770	2803
		East	2854	2847
13	Product category	IaaS	1361	1478
		CPaaS	1410	1372
		SaaS	1424	1419
		Analytics	1429	1381
14	Project type	Key Account	1841	1863
		Large Enterprise	1877	1920
		SME	1906	1867
15	Project category	*Connectivity*	2856	2841
		Solution	2768	2809
16	Working duration	0-2 Years	1882	1827
		3-5 Years	1914	1978
		>5 Years	1828	1845
17	Work experience in other companies	Yes	2803	2837
		No	2821	2813
18	Career ambition	Yes	2786	2824
		No	2838	2826
19	Marriage age	Single	2827	2866
		0-2 Year	885	906
		3-5 Years	944	943
		>5 Years	968	935
20	KPR status	Yes	4803	4747
		No	821	903
21	Have credit other than KPR	Yes	2809	2845
		No	2815	2805
22	Remaining KPR repayment time	There is no	825	900
		0-5 years	1887	1896
		6-10 years	1930	1945
		>10 years	982	909
23	Remaining loan repayment time	There is no	2815	2805
		0-2 years	954	949
		3-5 years	918	953
		>5 years	937	943
24	Have personal insurance	Yes	2831	2791
		No	2793	2859
25	Have a history of serious illness	Yes	2824	2818
		No	2800	2832

4.2 Logistic Regression Analysis

The analytical method of logistic regression analysis is used to determine the relationship between the dependent variable (Y) and the independent variable (X). The following is the outcome of a logistic regression analysis to determine whether the independent variable, namely the project location of PT XYZ personnel, effects the dependent variable.

Table 5. Logistic Regression Analysis partially

	B	S.E	Wald	df	Sig.	Exp(B)
X5			7,704	2	0,021	
X5(1)	-0,127	0,046	7,546	1	0,006	0,881
X5(2)	-0,470	0,046	1,040	1	0,308	0,954
X20(1)	0,073	0,038	3,722	1	0,054	1,075
Constant	0,052	0,038	0,438	1	0,508	1,025

Table 5 reveals that the Sig. is less than 0.05 in variables X_5 and X_{20}. As a result, the independent variable has a limited impact on the project's state.

4.3 Feature Rank With Logistic Regression Analysis

A method for providing score between independent variables in logistic regression is feature rank analysis using logistic regression.

Table 6. Feature Rank with Logistic Regression Analysis

Feature	Logistic Regression
Time Spent Working	0,0429853
Remaining KPR Repayment Time	0,0335829
Number of Trainings	0,0317044
Marriage Age	0,0297571
Educational Status	0,0277025

The logistic regression findings, when paired with the rank feature, provide score on the independent variables, displaying up to five variables that affect project status. The variable time spent working, especially working time more than 10 years, has a sigma value or has the largest influence. This demonstrates that a salesperson with a time spent working more than 10 years may deliver more projects with win status than other salespeople. As a result, the revenue generated for PT XYZ grows as the number of projects won grows.

4.4 Classification Analysis Using SVM

SVM classification analysis was utilized to assess the kernel function's accuracy value with the project status variable as a predictor variable and other variables as input. The Orange tools are used in SVM analysis.

Table 7. Confusion Matrix

Project Status	Predicted - Lose	Predicted - Win
Actual Lose	78%	22%
Actual Win	19%	81%

Table 7 reveals that there were 81% of projects that were declared win. The model forecasts that there were 19% that were forecasted as Lose but the actual conditions were Win (FN), and of the 22% projects predicted as Win but the real condition is Lose (FP).

Table 8. Comparison of Accuracy of Classification Results

Proportion	kernel polynomials (d = 2)			
	AUC	**Classification Accuracy**	**F1**	**Recall**
Average	0,813	0,81	0,81	0,81
Target : Win	0,813	0,81	0,817	0,816
Target : Lose	0,813	0,81	0,802	0,802

Table 8 reveals that the classification model's accuracy value is 81%. The difference between the win and lose target variables is in the F1 percentage and the recall value. The AUC in the SVM classification demonstrates that the more the percentage value, the larger the area of the resulting graph, and thus the better the accuracy of the model used, because the height of the ROC curve indicates that there are many True Positive values in a model. In contrast, the smaller the area under the curve, the lower the True Positive value of the model. F1 or F-Score is a comparison of projected results that show true positive with the sum of true positive, false positive, and false negative values. Table 8 shows that the actual win and predicted win values have the most values, indicating that the proportion of the target variable win in the F1 and recall values is higher than the proportion of the target variable lose.

6. CONCLUSIONS

Time Spent Working, Remaining KPR Repayment Time, Number of Trainings, Marriage Age, Educational status are all factors that impact sales from the salesperson. When internal variables and external factors are separated, 4 out of 5 elements that drive sales are internal factors. The amount of training acquired by the salesman is external element that the management of PT XYZ can control. The SVM classification results have an accuracy value of 81 with the ideal parameter of 2 (d = 2).

Advice that may be offered to PT XYZ to increase performance by providing training tailored to the demands of the salesperson and also in accordance with the job is intended to boost salesperson performance, allowing them to win more products.

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IMPLEMENTATION OF LEAN MANUFACTURING TO MINIMIZE WASTE WITH WASTE ASSESSMENT MODEL METHOD IN FARIS COLLECTION

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ABSTRACT

Faris Collection is a garment manufacturing company produces various types of clothing using a make-to-order system. The company strives to produce quality products on time at affordable prices. Therefore, companies need to identify which activities create value and which activities create waste, so they must be eliminated immediately. The implementation of lean manufacturing is a solution to reduce waste in production systems. The waste assessment model (WAM) is a lean manufacturing framework that aligns with matrix simplicity, broad coverage, and accurate results in identifying root causes contributing to waste.. Based on the results of WAM, the priority waste results were obtained with the top three rankings, namely inventory 22.89%, defects 18.98%, and waiting 14.06%. Then an analysis is carried out regarding the root causes using a fishbone diagram and a risk assessment using FMEA from the prioritized waste. Recommendations for improvement using fabric purchasing and fabric grouping policies for inventory waste, mall standardization and fabric pattern sizes, implementation of CCTV and daily production targets, improvement of work space, improvement of worker nutrition, procurement of material handling equipment, policy making for external tailors for defect waste, and fabric buying policies for waiting waste.

Keywords: Lean Manufacturing, Value Stream Mapping, Waste Assessment Model (WAM), Fishbone Diagram, Failure Mode and Effect Analysis (FMEA)

1. INTRODUCTION

As human civilization develops, the need for clothing continues to grow. Population growth stimulates the need for clothing. Clothing was initially only intended to protect and cover the human body. However, clothing has now evolved into a symbol of the wearer's identity, status, and position.Society needs clothing to meet the needs of work, education, organization, and collections. As a result, the garment industry has become a lucrative market to explore or master. Therefore, every garment manufacturing company is required to continue to grow to remain competitive with their competitors.

Faris Collection is a micro, small and medium enterprise engaged in garment production. Faris collection produces various types of clothing according to customer designs and requests. The number of orders received varies from a dozen to thousands. Therefore, the Faris collection production system must be adaptive to the order quantity. For bulk orders of simple designs with no variation, such as alma mater suits will be made by external tailors. Small orders and orders with complex and different designs are handled by factory workers. This policy was implemented to help manage complex and diverse design orders.

Faris Collection has a problem with delayed delivery of orders. Based on order data from October 2021 to March 2022, only 9% of orders were delivered on time. In addition, 50% of orders experienced delivery delays of 5 days or more. This has led to consumer dissatisfaction. Therefore, the company tries to optimize its resources to increase the productivity and efficiency of their production systems. The company should identify value-adding and waste-producing activities and strive to eliminate them. According to Bhasin (2015), lean manufacturing is the right way to identify and eliminate waste in sustainable production flows.

Rawabdeh (2005) developed a framework for eliminating waste called the Waste Assessment Model (WAM). The advantage of this model is the simplicity of the matrix and questionnaire. This covers a lot and gives you accurate results when it comes to identifying sources of waste. Implementing the Waste Assessment Model (WAM) is the right way to solve the problems that arose at the Faris collection.

To overcome the problem of late delivery of orders using the waste assessment model, the formulation of the problem is as follows:

1. Analysis of the types of waste generated in the production process of alma mater suits in the Faris collection external tailor production chain.
2. Minimize waste in the alma mater's suit production process in the Faris collection external tailor production chain by implementing lean manufacturing.
3. Repairing the waste that occurs in the production process of alma mater suits in the Faris collection external tailor production chain.

Based on the problem formulation as mentioned above, the objectives of this study are:

1. Identify alma mater suit production activities in the Faris collection external tailor production chain.
2. Analyzing activities leading to waste in the production process of alma mater suits in the Faris collection external tailor production chain.
3. Designing waste reduction in the production process of alma mater suits in the Faris collection external tailor production chain.

2. LITERATURE REVIEW

Lean Manufacturing

According to Dailey, Wieckhorst, & Welch (2003), lean manufacturing is a set of strategies for identifying and eliminating waste in the value stream. Lean manufacturing is a process management system derived from Toyota Production System (TPS) (Liker & Convis, 2011). Because it comes from TPS, Wilson (2010) concluded that lean manufacturing provides an absolute foundation for eliminating waste with the goal of reducing production costs.

In a lean approach, identifying valuable activities is a key process to better understand which activities provide value and which do not. According to Hines & Rich (1997), activities can be divided into three types:

- Value-added activities
  All activities that add value to products and services that customers want.
- Necessary but no value-added activities
  All activities necessary to produce a product or service without adding value to the product or service. This activity is required by current procedures and is difficult to eliminate in the short term. This activity is subject to future elimination.

- No value-added.
  All activities that does not add value to the products and services desired by the customer. This activity is pure waste and should be eliminated immediately.

Sutherland & Bennett (2007) explained that Taiichi Ohno identified waste into seven types consisting of:

- Overproduction
- Inventory
- Motion
- Defect
- Transportation
- Overprocessing
- Waiting

Value Stream Mapping

According to Rother & Shook (2003), value stream mapping is a pencil-and-paper diagram that helps you see and understand the flow of materials and information as products cross value streams. Value stream mapping offers a holistic view of the workflow of the entire system. Martin & Osterling (2013) describe five differences between value stream mapping and regular process mapping:

- Value stream mapping provides an effective means of establishing strategic direction for improvement.
- Value stream mapping provides a complete cycle view of how work progresses from request to fulfillment of that request.
- Value stream mapping helps organizations develop a better understanding of the systems of work that create value and support delivery of value to customers, thereby helping organizations make better decisions and arrange work.
- Value stream mapping provides the basis for data-driven strategic decision-making.
- Value stream mapping reflects workflow as a customer experience, as opposed to the internal focus of typical process level maps.

Waste Assessment Model

Rawabdeh (2005) said the Waste Assessment Model is a method designed to simplify the process of identifying and eliminating waste problems. The advantages of this method are the simplicity of the matrix and the completeness of the questionnaire, which helps in obtaining accurate results in identifying the root causes of waste. This method provides insight on where to concentrate efforts by weighting the contribution of different types of waste. This method is divided into three parts:

- Seven waste relationship
  All types of waste are interdependent and each type of waste impacts other wastes apart from being impacted by other wastes. All wastes have complex relationships with other wastes due to the direct or indirect impacts of each waste. The difference in the relationship and nature of each waste shows that the relationship does not have the same weight. Figure 1 shows the relationship between waste according to Rawabdeh (2005):

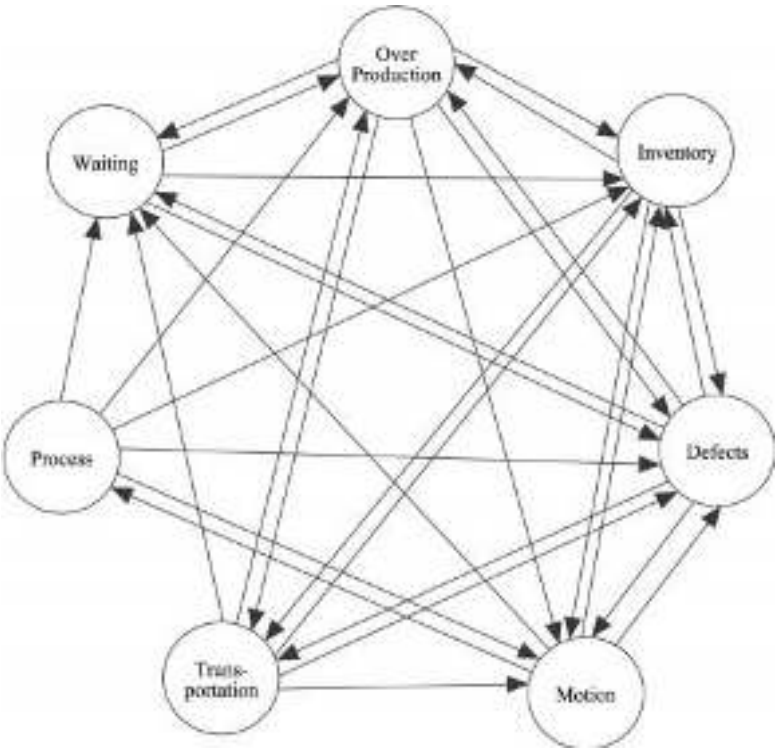

Figure 1 Seven Waste Relationship

- Waste relationship matrix
  Waste Relationship Matrix is a matrix that describes the actual relationships between wastes. Each line shows the effect of one drop on another. Each column shows how much the waste is affected by other waste. Also, by default, each drop has the highest relation to itself, shown in the diagonal matrix.
- Waste assessment questionnaire
  Waste Assessment Questionnaire (WAQ) was developed to allocate waste generated in production areas. The WAQ consists of sixty-eight different questions that aim to determine the location of the waste. Each question describes an activity, condition, or trait that indicates the occurrence of a particular waste.

Fishbone Diagram

Fishbone diagram is a root cause analysis method that can be used to identify the root cause of a problem. This diagram is shaped like a fishbone. This diagram was invented by Kaoru Ishikawa, so it is also called the Ishikawa diagram. A fishbone diagram is a representative diagram and categorization of the possible causes of a problem investigated during the brainstorming process.

Failure Mode and Effect Analysis (FMEA)

Failure Mode and Effect Analysis (FMEA) is a systematic method used to identify and prevent process or product problems before they occur. According to Mikulak, McDermott, & Beauregard (2017), the use of FMEA focuses on preventing defect, improving safety, and increasing customer satisfaction.

3. METHODS

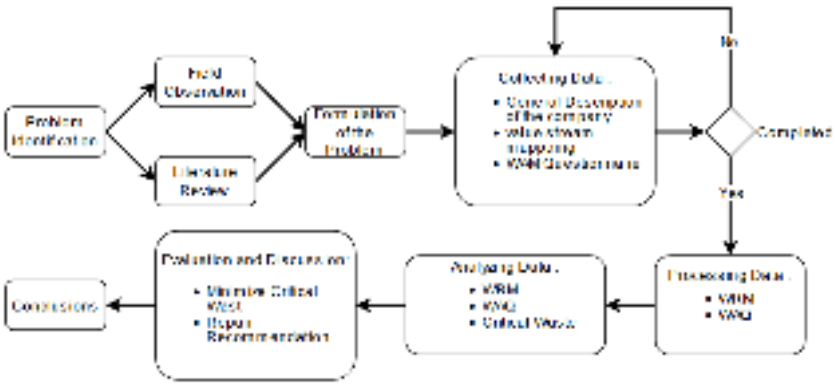

Figure 2 Research Flow Diagram

The methodology used in the study is described in detail. In general, the study uses four phases as shown in figure 2: problem identification and formulation phase, data collection and processing phase, data analysis and interpretation phase, and conclusion and proposal phase.

4. RESULTS

Faris collection is a micro, small and medium enterprise engaged in garment production. In general, the garment manufacturing process consists of four steps: Cutting process, embroidery/screen printing process, sewing/overlocking process, finishing process. Faris collection produces various types of products based on customer orders. In general, the production of these products is almost the same. The only difference is the screen printing and embroidery process, and the design of the sewing and overlocking areas. The production process of the alma mater's suit is in the production chain of the Faris collection's external tailors. You can see it in the value stream map in figure 3.

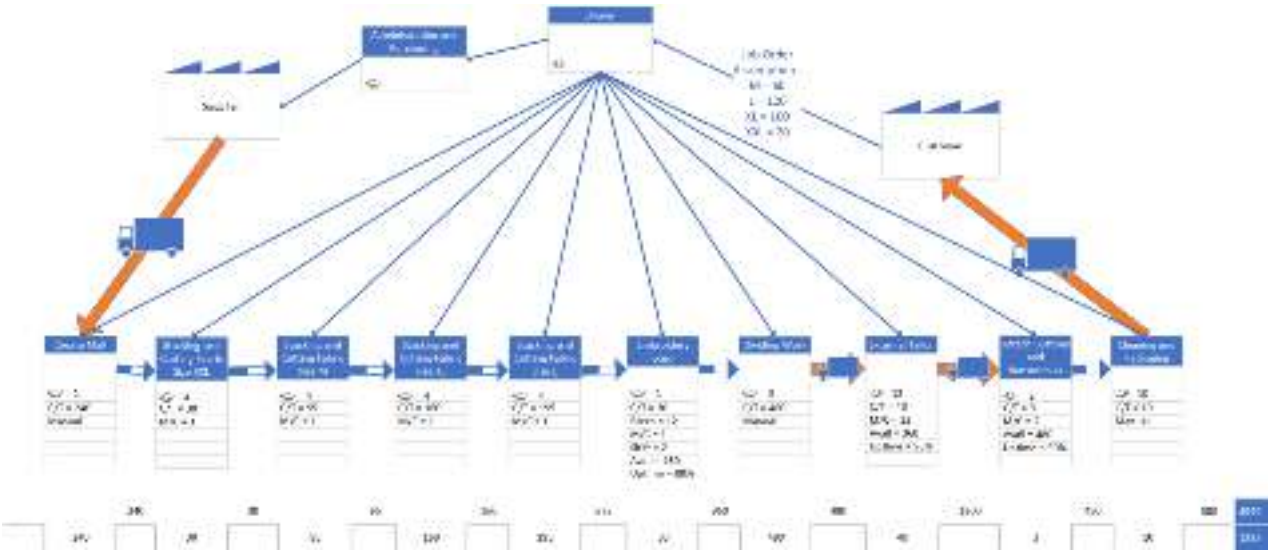

Figure 3 Value Stream Mapping of the production process of alma mater suits in the Faris collection external tailor production chain.

Based on figure 2, the value-added time in the alma mater's suit production process is 1283 minutes. On the other hand, the lead time for the alma mater's suit production process is 4590 minutes. Based on this data, the value-added time in the alma mater's suit manufacturing process is only 28% of the lead time. The process of stacking and cutting the L size fabric and the outer sewing process have the lowest cycle value. This shows that both processes are wasteful. In order to know how much waste is generated by the two processes, a lean method evaluation called a waste assessment model is required.

The first step in the waste assessment model is to measure the relationships between wastes. Based on the results of consultations with alma mater jacket production process stakeholders in the external production chain a disposition relationship matrix is created to show how much waste affects other waste and how much waste is affected by other waste. In Figure 4, we can see the value of the relationship between waste obtained from the waste relationship matrix.

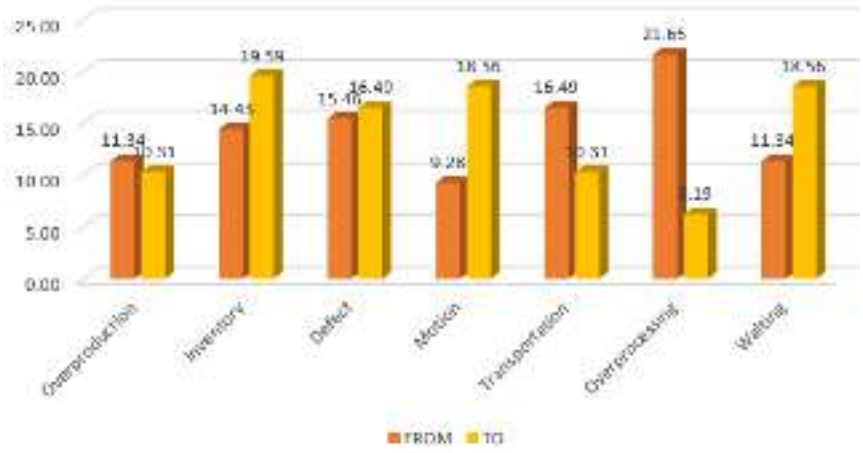

Figure 4 the value of the relationship between waste

In the figure above, the orange bar graph shows how much waste affects other waste, and the yellow bar graph shows how much one waste is affected by other waste. The figure shows that waste overprocessing has the greatest impact on other waste (21.65%). Waste inventory is 19.59% and is the waste most affected by other waste.

The relationship between waste in the waste relationship matrix are used as starting weights for the calculation of the waste assessment questionnaire. The final result of the waste assessment questionnaire calculation is in the form of a $Y_{j\ final}$ percentage representing the magnitude of impact of the waste compared to other wastes. The percentage of the $Y_{j\ final}$ value of each waste is shown in table 1.

Table 1 Waste Assessment Ranking

Ranking	Type of Waste	The Final Result ($Y_{j\ final}$)	Percentage of Final Result ($Y_{j\ final}$)
1	*Inventory* (I)	149.39	22,29 %
2	*Defect* (D)	127.19	18,98 %
3	*Waiting* (W)	94.21	14,06 %
4	*Motion* (M)	91.53	13,66 %
5	*Transportation* (T)	87.06	12,99 %
6	*Overprocessing* (P)	63.96	9,39 %
7	*Overproduction* (O)	57.87	8,63 %

The results of the above assessment indicate that a dominant waste hierarchy occurs in production floor. These results are used to prioritize waste for disposal. The top three wastes are inventory (22.29%), defects (18.98%) and waiting (14.06%). These three wastes are performed by fishbone diagram analysis to find the root cause of the waste that needs to be addressed immediately. Table 2 below shows the main sources of waste with an RPN greater than 200 and recommendations for improvement.

Table 2 Improvement Recommendation of Root Causes of Waste with RPN Greater than 200

Waste	Sub Waste	RPN	Improvement Recommendations
Inventory	Color Difference Between Rolls	288	Create a policy to order fabric with the same lot number a week before the processing time
			Grouping fabrics based on lot number before cutting
	Purchase Fabric Less Than Necessary	324	Changing the policy of buying cloth to fulfill one roll and above
			Create a policy to order fabric a week before the processing time
Defects	Nonstandard Pattern Size	210	Making repairs to malls with large sleeve patterns on alma mater suits in sizes S and M
			Sets the standard size of the fabric pattern
	Unfocused Employees	240	Install CCTV
			Set daily production targets
			Improve air circulation by adding air vents
			Providing healthy nutrition or multivitamin supplements during frequent overtime and bad weather
			Procure appropriate material handling equipment
	Untidy Stitching Results	224	Pick up pending work by external employees one day before the pick up deadline
			Evaluate and give punishment to employees who often have problems with the sewing results
	The Size of the Fabric Pattern is Too Small	210	Sets the standard size of the fabric pattern
Waiting	Purchase Fabric Less Than Necessary	360	Changing the policy of buying cloth to fulfill one roll and above
			Create a policy to order fabric a week before the processing time

6. CONCLUSIONS

The production process of the alma mater suits of the external tailor production chain consists of four processes: cutting, embroidery, sewing, overlocking, and finishing. Based on VSM diagram, it is known that the value-added time is 1283 minutes, and the lead time is 4590 minutes.

The Waste Assessment Model (WAM) methodology identified that the three most important wastes in the alma mater suits of the external tailor production chain are inventory (22.29 %), defects (18.98 %), and waiting (14.04 %).

After analyzing the fishbone diagram and FMEA, the recommendations for improving the critical waste are as follows:

- Inventory
  Fabric purchasing policy and fabric grouping.
- Defects
  Standardize mall and fabric pattern sizes, implement CCTV and daily production targets, improve workplaces, improve employee nutrition, procure material handling equipment, and make external tailor decisions.
- Waiting
  Creation of fabric purchasing policy.

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MODEL DEVELOPMENT OF AUTOMATIC TANK GAUGING DATA INTEGRATION AS A REAL-TIME STOCK MONITORING SOLUTION FOR AVIATION FUEL TERMINAL

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ABSTRACT

The development of Industry 4.0 requires integrated communication between Operational Technology (OT) in the field/site and Information Technology (IT) so that business and strategic decision-making can be performed by management more quickly and precisely. Aviation Fuel Terminal (DPPU), the operating unit of Pertamina Company, has been using Automatic Tank Gauging (ATG) as an OT device to measure product levels in storage tanks automatically and accurately but locally in each DPPU. Currently, there is a discrepancy between the stock data reported by DPPU to management every morning using daily stock data at 23.59 LT and the actual stock in the storage tank at DPPU. This problem became a primary reason for the writer to develop an ATG data integration model from multiple sites/DPPU to the Head Office. Studies and literature from previous research regarding platforms, protocols, and tools for data integration, such as OPC (Open Platform Communication) and the ISA-95 standard model, become references to develop and establish a model. As a part of model validation, model implementation is performed directly at 13 DPPU and Pertamina Head Office so that the implementation data are produced more authentic and comprehensive for analysis purposes. The model resulting from this research shows that the ATG data integration has performed a minimum accuracy rate of 99.99% and the maximum value of standard deviation is 0.0001, so that it can directly become a solution of the problems and answer management needs to gather the data and to monitor avtur stock in realtime, faster and more accurate.

Keywords: Automatic Tank Gauging, Realtime, Data Integration, Open Platform Communication, ISA-95

1. INTRODUCTION

Nakagawa et al. (2021) state that along with Industry 4.0 (also called the Industrial Internet of Things (IIoT)), the need for speed and quality of information is increasing, which requires integrated communication from upstream to downstream between all production assets, in this case, OT with Information Technology (IT) used by a company. This need also occurs at DPPU, which is currently required to be faster in conveying information related to the position of avtur

stock to Management to ensure availability and security of inventory, supply planning, and more precise and accurate business and strategic decision-making.

The current condition, monitoring and reporting of avtur stock is carried out by DPPU to management daily using daily closing stock data at 23:59. This of course, causes a difference between the reported stock and the actual stock at DPPU at the time of stock reporting. These differences have the potential to contribute directly to the company's failure to carry out supply and distribution planning. And the extreme impact of such failures is the occurrence of critical stock due to empty stock in DPPU storage tanks or demurrage of tankers and tank cars due to waiting for discharging product to storage tanks that are still full of capacity (waiting for ullage).

On the other hand, ATG data can be monitored in real-time but is limited to the operational layer, namely through the Human Machine Interface in the DPPU control room and has not been integrated into the enterprise layer at Head Office. Apart from the use of different brands, there has been no research and establishment of a standard model for ATG data integration, causing management to be unable to monitor fuel stocks in real-time for all DPPUs that have used ATG. This condition is the basis for the author to conduct research, obtain a solution and solve the problems.

2. LITERATURE REVIEW

ATG is one interpretation of the development of Operation Technology (OT), which is a field instrument for measuring the level of a product in the form of solids, liquids, and gases. The advantage of using an ATG is its ability to take measurements automatically, continuously, and quickly with a high accuracy performance without the need for human assistance. Figure 2.1 describes the general architecture of the ATG system, where one ATG system generally consists of several instruments and devices installed in storage tanks to the control room:

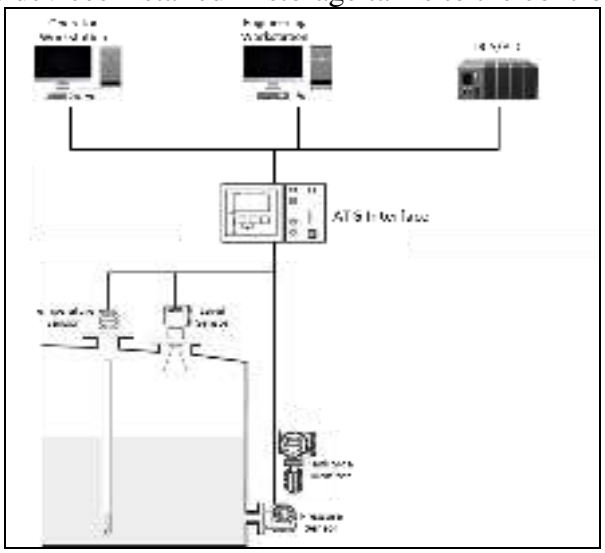

Figure 2.1 General Architecture of an Automatic Tank Gauging System
(Source: Personal Documentation)

The Aviation Fuel Terminal (DPPU) is an operating unit/site office of PT Pertamina (Persero) which has the task of receiving, stockpiling and distributing avtur at the Airport. Until now, Pertamina has 70 DPPUs spread throughout Indonesia and divided into 8 Regions. At 13 DPPUs have used OT technology in the form of Automatic Tank Gauging (ATG) as a field instrument to measure and monitor the position of avtur stock in storage tanks automatically,

quickly and accurately through a Human Machine Interface (HMI) in the Control Room. The data displayed on the HMI results from data communication between the sensors in the storage tank and an ATG Interface in the control room. Each brand of ATG has a different interface from one another, including the communication protocol generated or used, such as modbus serial, modbus TCP, VR protocol.

According to Verma et al. (2017) Real-time monitoring of field instruments using standard protocols is necessary to ensure that data communication is carried out reliably and securely. Currently, there are several data communication protocols that are popularly used such as Object Linking and Embedding for Process Control (OPC), Modbus, Profibus and other protocols. More specifically regarding OPC, Zawawi El-Sayed (2012) and Tateno et al. (2010) explain some of the advantages of OPC, especially for complicated and complex industries, such as the oil and gas industry that uses integrated control systems, these advantages include being able to provide communication standards for real-time and universal connectivity, providing standard interfaces for multi-vendors so that users can configure more flexibly according to their individual needs.

On the other hand, Apiliogullari (2022) explained that the International Society of Automation (ISA), through the ISA-95 model, established a standard hierarchical layer of the cyber-physical system that integrates the virtual/cyber world (IT) and the physical world (OT) to form a backbone in Industry 4.0. The ISA-95 model standard can be further developed according to the needs and requirements of each industry, including in this case, Pertamina's management needs for Aviation Fuel Terminal. The model can be further developed according to the needs and conditions of each different industry. Figure 2.2 (Apilioğulları, 2022) provides an example of developing a data integration model based on ISA-95, where the Connectivity Layer (MQTT, OPC) and Product Domain (PDM) are added according to the needs of the manufacturing industry studied.

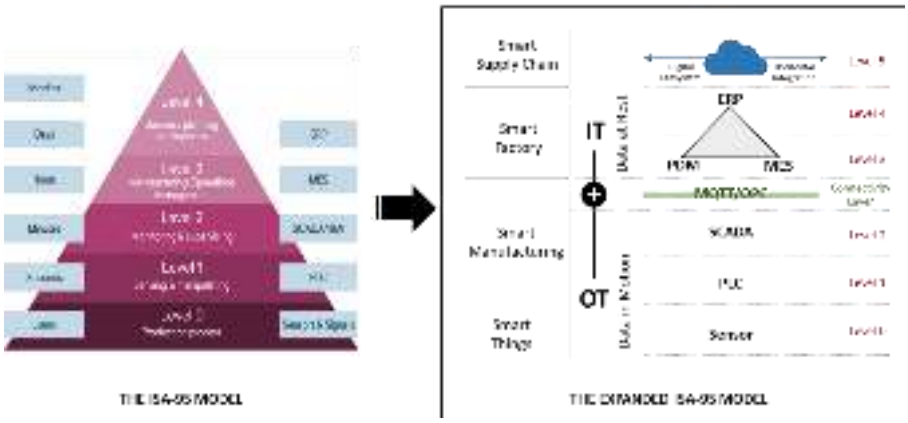

Figure 2.2 Development of ISA-95 Model for Manufacturing Industry
(Source: (Apilioğulları, 2022))

3. METHODS

The research began by conducting a literature study from various relevant sources and also research that has been done before, primarily related to Realtime Data Monitoring, ISA-95, Industry 4.0, OPC, Data Integration, etc. This literature study is an initial reference for the development and determination of a model, which is then confirmed on the object/location to be tested, including primary and secondary data collection using observation, site survey and interviews with authorized parties so that a portrait, description and identification results of the existing conditions of the ATG DPPU and its architecture are obtained including several variables

that can be used as indicators/parameters in conducting model feasibility analysis after the level, temperature, density and volume parameters.

Model validation is carried out through direct implementation in real conditions at 13 DPPUs that use ATG and Pertamina Headquarters so that accurate and comprehensive data can be generated for the purposes of model feasibility analysis. The feasibility analysis of the model is carried out using several predetermined indicators/parameters, namely the average accuracy value and its standard deviation from 4 (four) times of data collection, both level, temperature, density and volume data on the Head Office server against data on HMI/ATG displays at 13 DPPUs. The lower the standard deviation value, the closer it is to the average value. Conversely, the higher the standard deviation value, the wider the range of data variation.

To ensure that the developed model can support management needs for realtime data monitoring, latency measurements were made from the ATG Integration PCs at 13 DPPUs with the final destination being the head office server address. Referring to the Telecommunication and Internet Protocol Harmonization Over Network (TIPHON) standard issued by the European Telecommunications Standards Institute (1999), latency values <150 ms are categorized as excellent results.

4. RESULTS

From the data collection, some information was obtained that each DPPU has a different ATG system architecture due to the differences in operational activities and facilities as well as differences in the ATG brands used. In addition to this, there are several ATG systems DPPU that already have Open Platform Communication Access (OPC). On the other hand, it turns out that there are also differences in the protocol of the data output generated by each ATG DPPU interface, including Modbus Serial, Modbus TCP/IP and Veeder Root Protocol. Especially for the Modbus protocol, it can be converted into an OPC, thus providing convenience in integrating data.

From the identification of the existing conditions of the ATG system at 13 DPPUs and referring to the literature study obtained, the author developed an ATG data integration model with the following provisions:

- The ISA-95 standard model is used as a basic reference, considering that ISA-95 is currently an international reference for industries using technological devices such as Automation and Control Systems. ISA-95 has established a standard hierarchy for integration from the operational layer to the enterprise layer.
- Open Platform Communication (OPC) was involved in the model development due to its advantages in real-time and universal data communication and can be a connectivity standard for multi-vendor devices. This is very relevant to the results of the identification of the existing conditions of the ATG used at 13 DPPUs.
- (Apilioğulları, 2022) has conducted research on the development of a data integration model based on ISA-95. The results of the research conducted there is OPC as a Connectivity Layer that connects OT with IT in the manufacturing industry as the object under study.

Based on the above, the author establishes a model that has been developed to be used in the implementation of ATG data integration from 13 DPPUs to the Head Office. The determination of the model in question can be seen in Figure 4.2.

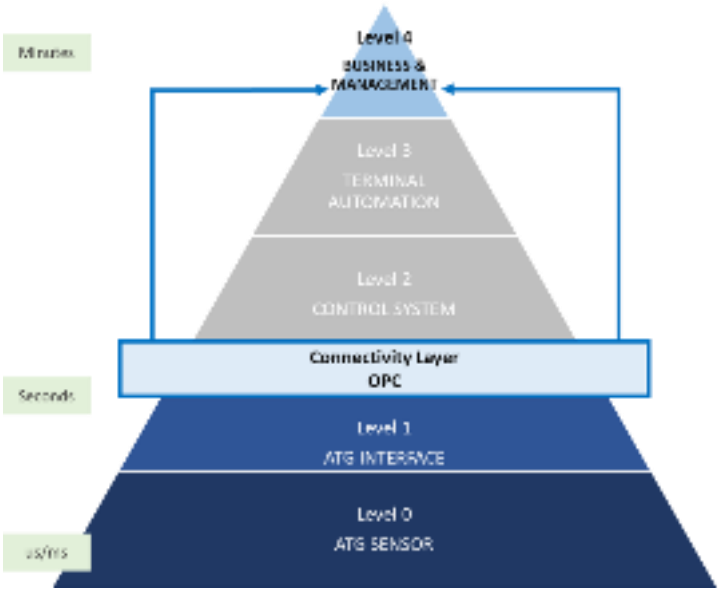

Figure 4.2 Data Integration Model of ATG DPPU

The explanation of the results of the development of the ATG data integration model is described as follows:

- Level 0 - ATG SENSOR. This is the lowest level of the operational layer. In this layer, the data source is obtained from the level, temperature and density readings taken by the ATG sensor. ATG sensors can take readings quickly, even in a matter of milliseconds (ms).
- Level 1 - ATG INTERFACE. Serves as a data collector from several ATG sensors. Some ATG interfaces at DPPU have an additional role as a data server to communicate in parallel or simultaneously to other devices such as DCS/PLC. At this level, all data from the readings of each ATG sensor located in each storage tank can be directly obtained.
- Level 2 – CONTROL SYSTEM. The use of the Control System reflects the level of operational complexity and facilities used by the DPPU. The layer functions to operate and collaborate data readings from several field instruments such as ATG, Motor Operated Valve (MOV), Product Pump, Flow Meter and others.
- Level 3 – TERMINAL AUTOMATION. It is a system for monitoring, controlling, and managing the entire product handling process automatically, where this layer becomes a bridge between the control system for running operational activities at DPPU and the system used by management, for example Enterprise Resource Planning (ERP).
- Level 4 – BUSINESS & MANAGEMENT. It is the culmination of the developed data integration model, also called the enterprise layer as the ultimate goal of ATG data integration. In this layer, management at the head office can monitor ATG data from 13 DPPUs in real-time. If in the standard ISA-95 model, this layer gets data updates on a daily/monthly basis, then in the model developed by the author, ATG data updates from DPPUs are obtained within minutes at the latest.
- Connectivity Layer – OPC. This layer plays a vital role as a direct link between the enterprise layer (Level 4) and the operational layer (Level 0 and Level 1), in this case, operational layer is ATG system at each DPPU. OPC was chosen because of its universal nature in the automation industry so that it can be a standard solution for obtaining data in real time, even though there are differences in the brand/brand and type of architecture of the ATG system used.

To test the model, model validation is carried out through direct implementation of the model at the research location, namely at 13 DPPUs that have ATG as a representation of the real conditions of the operational layer, namely level 0 and level 1 in the model, and head office management as the end user of the integrated ATG data (enterprise layer) and is called level 4 in the model. In implementing the model, the author uses OSIsoft PI System software along with some of its features. Based on the results of mapping the required software and hardware requirements, an architecture for implementing the ATG data integration model was developed, as shown in Figure 4.3.

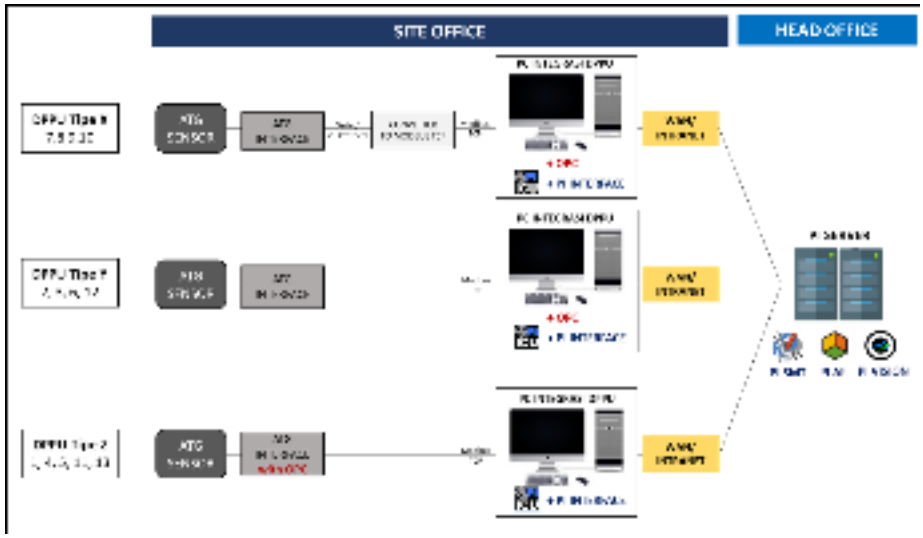

Figure 4.3 Implementation Architecture of Data Integration Model

During the implementation phase, the authors monitored the model implementation through all PI System software used in this study. In Table 4.1, it can be seen about the data recording of the results of the implementation of the DPPU ATG integration model obtained from reading the PI Vision dashboard data (Figure 4.4) and the HMI in the DPPU control room.

Figure 4.4 Head Office Dashboard (PI Vision)

Recapitulation of data analysis of model implementation results from 4 (four) times of data collection (at 02.00, 08.00, 14.00 and 20.00 WIB), can be seen in Table 4.2. Average accuracy values below 100% occurred at DPPU 5 (99.96% for level and 99.89 for volume) and DPPU 9 (99.97% for level and 99.98% for volume). Based on the results of confirmation to workers at DPPU 5 and DPPU 9, the difference in data occurs because the tanks are in "delivery" status or are being used to sell aviation fuel to aircraft, so the level and volume data from the ATG system changes during the observation and data recording period.

At DPPU 2, 3, 9 and 10 there is no accuracy value for the density parameter. Based on the results of confirmation to DPPU personnel, this condition occurs because the ATG used at the four DPPUs is not equipped with a density sensor, so of course, no data output is produced in the form of density values on the ATG interface used at the DPPU.

From the analysis of measurement data, it can be seen that sending data packets to the head office server from all 13 DPPU ATG Integration PCs has an average latency value of 32.3 ms or in the excellent category (<150 ms), so it can be stated that the implemented model can support the provision of real-time ATG data from 13 DPPUs to management at the head office.

Table 4.1 Recapitulation of Data Analysis of Model Implementation Results

DPPU ATG	AVERAGE ACCURACY								AVERAGE LATENCY (ms)
	LEVEL		TEMPERATURE		DENSITY		VOLUME		
	%	STDEV	%	STDEV	%	STDEV	%	STDEV	
DPPU 1	100.00%	0.0000	100.00%	0.0000	100.00%	0.0000	100.00%	0.0000	25.5
DPPU 2	100.00%	0.0000	100.00%	0.0000	-	-	100.00%	0.0000	29.3
DPPU 3	100.00%	0.0000	100.00%	0.0000	-	-	100.00%	0.0000	44.8
DPPU 4	100.00%	0.0000	100.00%	0.0000	100.00%	0.0000	100.00%	0.0000	21.8
DPPU 5	99.96%	0.0001	100.00%	0.0000	100.00%	0.0000	99.89%	0.0005	39.3
DPPU 6	100.00%	0.0000	100.00%	0.0000	100.00%	0.0000	100.00%	0.0000	23.5
DPPU 7	100.00%	0.0000	100.00%	0.0000	100.00%	0.0000	100.00%	0.0000	12.0
DPPU 8	100.00%	0.0000	100.00%	0.0000	100.00%	0.0000	100.00%	0.0000	14.8
DPPU 9	99.97%	0.0005	100.00%	0.0000	-	-	99.98%	0.0004	27.8
DPPU 10	100.00%	0.0000	100.00%	0.0000	-	-	100.00%	0.0000	45.0
DPPU 11	100.00%	0.0000	100.00%	0.0000	100.00%	0.0000	100.00%	0.0000	34.5
DPPU 12	100.00%	0.0000	100.00%	0.0000	100.00%	0.0000	100.00%	0.0000	50.0
DPPU 13	100.00%	0.0000	100.00%	0.0000	100.00%	0.0000	100.00%	0.0000	52.0
AVERAGE	**99.99%**	**0.0000**	**100.00%**	**0.0000**	**100.00%**	**0.0000**	**99.99%**	**0.0001**	**32.3**

5. CONCLUSIONS

The integration of ATG data from multiple site offices (13 DPPUs) to the head office has been successfully carried out through the development and implementation of a model based on ISA-95 using OPC as the Connectivity Layer from Level 1-ATG Interface to Level 4-Business Management. In addition, the development of the ATG data integration model produced in this study can be a solution while meeting the needs of Pertamina Aviation Fuel Business Management in conducting real-time and accurate Stock Monitoring, with minimum accuracy rate of 99.99% and the maximum value of standard deviation is 0.0001. This real-time stock monitoring solution will ultimately support the achievement of increased effectiveness and company operations, especially to assist management in conducting more precise business and strategic decision-making.

The results of this research can also be a reference for further research, especially to provide a reference model in integrating data from the operational layer to the enterprise layer related to Realtime Data Monitoring. And replication can also be done in industries with business patterns, operational facilities or with similar needs.

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USING THE AHP-CPM INTEGRATED METHOD IN COMMISSIONING AND STARTUP SCHEDULING OF EPCI PROJECT OF GAS PRODUCTION FACILITIES CONSTRUCTION

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ABSTRACT

Gas development project at PT. PEPC ADK is an EPCI activity. In 2021, SKKMIGAS approved the FEED for production facilities. However, project execution still has big challenges, such as uncertainty in material delivery, especially for new fabrications. The purpose of this study is to determine the network, analyze the optimal time and estimated costs to complete the project. The research method, by integrating the Analytical Hierarchy Process on the Change Order and Critical Path Method. The research subjects amounted to 5 informants as Expert Judgment who were involved in handling projects from the Engineering Leader to Managerial level. Data collection techniques used Focus Group Discussions and questionnaires regarding the level of importance of criteria and sub criteria: Quality, Cost, Delivery, and Safety. Summary of alternative network selection: material transfer agreement, modification of existing equipment, and fabrication of new equipment. The results of the research on the selection of alternative predessesor networks were obtained by the Material Transfer Agreement method. The CPM analysis obtained an optimal time of 126 days, July 5 2021 to December 27 2021. The project cost analysis is Rp. 36,827,704,786, where the value of activities on the critical path with an accelerated completion time is Rp. 27,185,512,225.

Keywords: *Critical Path Method*, *Commissioning*, *Startup, Analytical Hierarchy Process*.

1. INTRODUCTION

EPCC Industry stands for Engineering, Procurement, Construction, Commissioning. This industry is to make a design/design of the system to be built, procure/purchase goods needed for development and continue with building/carrying out the construction that has been designed. An engineering consulting/contractor company that is responsible for an EPCC (Engineering, Procurement, Construction, Commissioning) activity is usually called an EPC Company.

This research will discuss the factors that cause change orders in the EPCI project for the development and modification of gas production facilities in the Alas Dara Kemuning (ADK) field at PT. Pertamina EP Cepu from the perspective of the owner/client. The step to overcome the change order in the EPCI project is to replace the main equipment (fabrication) with old delivery on site (over 10 months, long lead items) replaced by ready stock equipment with the MTA (Material Transfer Agreement) system. Through this research, researchers will try to improve the project schedule by reducing activity duration and accelerating Commissioning and Startup scheduling in the Construction of Gas Production Facilities using the AHP and Critical Path (CPM) Methods, with the help of Microsoft Project software as a support. AHP is performed for criterion weighting. What is done is to set the criteria and orders that enter as an alternative. Then make a questionnaire and distribute it to people related to prioritizing work orders. According to Ngatilah et al., (2021), the Critical Path Method (CPM), a method for project planning and monitoring, is the most widely used system among all systems. others that use the principle of network formation. With CPM, the amount of time required to complete the various stages of the project is assumed to be known with certainty (Kusumadarma et al., 2020), as is the relationship between the resources used and the time required to complete the project. From the results of data processing using the Critical Path Method (CPM), it will be known which activities must be accelerated so that the project can be completed earlier while still paying attention to cost optimization (Lu and Li, 2003).

The issue raised here is that the development of the Kemuning field will be carried out by drilling 1 development well (NGU-2 well) and workover 1 Existing NGU-1X Exploration Well which will be converted into a production well. Here the contractor working on it is from PT. Patra Drilling Contractor (PDC), which has developed the framework from start to dripping of Liquid Natural Gas (LNG). However, in general, the project encounters problems from various sectors, namely from the long delivery of materials (Long Lead Items) and project monitoring methods. This is what causes delays in the work on the project resulting in deviations from the actual and planning that has been made. Based on the problems above, this thesis research will take the title "USING THE AHP-CPM INTEGRATED METHOD IN COMMISSIONING AND STARTUP SCHEDULING OF EPCI PROJECT OF GAS PRODUCTION FACILITIES CONSTRUCTION".

The aims of this study are to: (1) Determine the network of gas production facility construction projects in the Alas Dara Kemuning Cepu oil and gas field, (2) Analyze the optimal time to complete the gas production facility construction project in the Alas Dara oil and gas field Kemuning Cepu, and (3) Analyzing estimated costs for the gas production facility development project in the Alas Dara Kemuning Cepu oil and gas field, which has an accelerated completion time.

The researcher hopes that the results of this study can: (1) complete the project on time so that the use of the budget becomes efficient and there is no waste, (2) know which activities must be worked hard to complete so that work schedules can be fulfilled, (3) practice scheduling techniques in the world real by looking at the situation in the field which is so complicated and influences each other.

2. LITERATURE REVIEW

In this chapter a literature review will be presented as supporting material in research related to strategies to accelerate commissioning and startup scheduling in the Construction of Gas Production Facilities at the Alas Dara Kemuning Cepu Oil and Gas Field, PT. Pertamina EP Cepu ADK.

2.1 Project Management

A project according to PMBOK (PMI, 2013) is a series of activities with a specific purpose using certain resources and in a relatively limited time to create a unique service or product. Limited time means that the project has a predetermined start and finish time. There are several things that can cause the project to be said to be complete, including: the target has been reached or not achieved or the final product is no longer needed. The project is also said to be complete if one of the parties involved stops it of course with various consequences. Project management is the application of knowledge, skills/abilities, facilities and techniques to project activities in order to meet the needs of stakeholders and the expectations of a project (PMBOK, fifth edition, 2013).

Project management functions, among other things, to manage project scope, manage time/schedule, manage costs, and manage project quality and quality. While the objective of project management is so that all stages of activities can be completed on time, at a cost that is according to plan, the quality and process of activities are in accordance with the requirements so as to reduce the possibility of failure and increase the possibility of success.

2.2 Analitical Hierarchy Process (AHP)

The Analytical Hierarchy Process (AHP) is a decision support model developed by Thomas L. Saaty. The AHP model describes complex multifactor or multi-criteria problems into a more systematic hierarchy. According to Saaty (1993), the hierarchy is represented as a complex problem in a multilevel structure where the first level is the goal, followed by the level of factors, criteria, sub-criteria and so on down to the last level of alternatives. The AHP method aims to obtain priority decisions that are more like human decision-making processes such as decomposition, comparative judgments, synthesis of priority, logical consistency

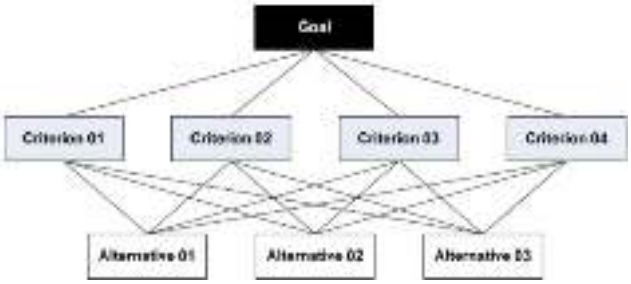

Figure 1. Hierarchy of the AHP Method

2.3 Network Planning

According to Gray and Larson (2006) network planning is a tool used to plan, schedule, and control project progress. This network diagram is a method that is considered capable of providing basic techniques in determining the sequence and period of activities, which in turn can be used to estimate the overall project completion time.

Gray and Larson (2006) suggest that there are several terms used to build project networks including activity, combined activity, parallel activity, track, predecessor, successor, critical path, Bubble activity, Event

2.4 Critical Path Method-CPM

According to Kusumadarma et al., (2020), the critical path method (CPM), which is a method for planning and monitoring projects, is the most widely used system among all other systems that use the principle of network formation. CPM assumes that the activity time is known with certainty so that it only requires one time estimate for each activity. This is the main difference with the PERT method (Heizer & Render, 2006). Similar to PERT, CPM also uses a network to describe project activities.

Critical Path Method (CPM) is a technique of analyzing network activity/activity while running a project to predict the total duration. The project's critical path is the sequence of activities that determines the fastest possible time to complete the project. The critical path is the longest path in the network diagram and has the fewest errors. A few things to note about this critical path: Delayed work on the critical path will delay the completion of the overall project path. Overall project completion can be accelerated by accelerating the completion of work on the critical path. The critical path slack work is equal to 0 (zero). This allows the relocation of resources from non-critical work to critical work (Mahardika et al., 2019).

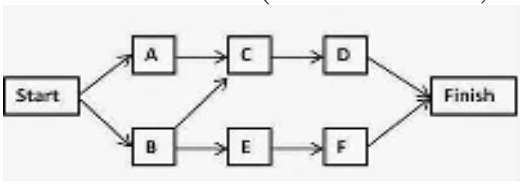

Figure 2 Critical Path Method

The data analysis is carried out by drawing a network with the CPM (Critical Path Method) as shown in Figure 2.6 below, which consists of calculating the total completion time for high-rise building construction projects and determining the critical path in accelerating several activities to achieve the scheduled target and adding manpower to it is known whether the overall cost will be cheaper or more expensive (Yu et al., 2005).

Three Basic Assumptions in calculating the critical path method :

a. Project has only one start event (start) and one terminal event (finish)
b. The fastest time for the initial event to occur is day zero
c. The slowest time for a terminal event to occur is LS = ES

3. METHODS

This research was carried out at the Kemuning Field Development project which will be carried out by drilling 1 development well (NGU-2 well) and workover 1 Existing Exploration Well NGU-1X which will be converted into a production well in the Alas Dara Kemuning field at PT. PEPC ADK. The scope of the problem regarding the Integration of AHP and CPM in the Commissioning and Startup Scheduling of the EPCI Project for the Development of Gas Production Facilities. The research methodology used is a case study with several stages which will be discussed below.

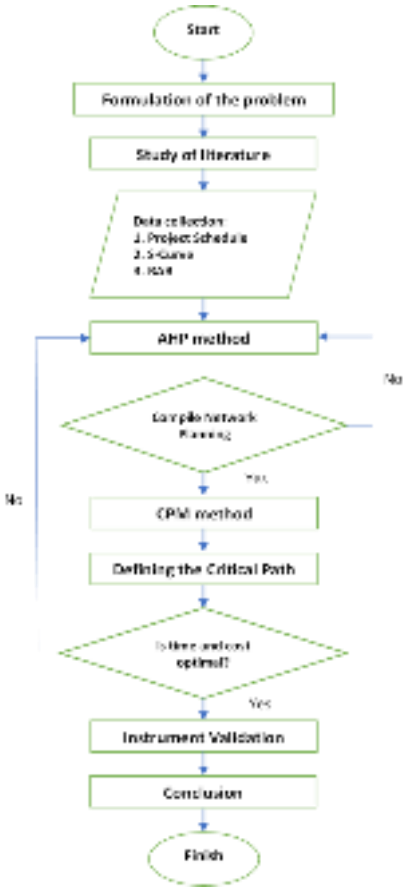

Figure 3 Research Flowchart

Description of Flowchart, as follows:

a. In the early stages, identification of research problems was carried out and then formulation of the problem was carried out to obtain the objectives of the research.
b. Then proceed with a literature study to obtain empirical data.
c. Based on the empirical data, what will be discussed in interviews with relevant stakeholders is compiled for the data collection process which consists of the project schedule, S-curve and RAB. From this data we conduct a Focus Group Discussion (FGD) so that we can identify delays, find out the causes of delays, and mitigate them. FGDs were conducted with as many as 5 employees in the function, project, production, drilling, sub surface, commercial, surface facility and finance sections.
d. Weighting to determine the main factors using AHP.
e. Based on these data, network planning can then be prepared.
f. Evaluation criteria using the CPM (Critical Path Method).
g. The existing Evaluation Criteria will be elaborated with field data and empirical data which have been mentioned in the research framework above to determine the critical time.
h. Knowing whether the implementation of the project is optimal in terms of project acceleration (cost and time).
i. Research instrument validation process.
j. After the strategy selection stage is carried out, it is continued with the discussion and the stages of drawing conclusions and suggestions

4. RESULTS

4.1 Analytical Hierarchy Process (AHP)

The AHP analysis method is used to identify criteria in order to obtain a hierarchy that can help simplify data processing in change order main equipment to select which criteria are appropriate and then be included in the CPM critical path, so that optimization of the amount of costs, duration of project work and alternatives is found. the best acceleration in commissioning and startup scheduling in the construction of gas production facilities at the Alas Dara Kemuning Oil Field PT. Pertamina EP Cepu ADK.

Assessment data by 5 respondents or experts through FGD (Focus Group Discussion) and questionnaires regarding the level of importance of the criteria and sub-criteria Quality, Cost, Delivery, and Safety as well as a summary of the selection of alternative EPCI project networks consisting of; Material transfer agreements, modification of existing equipment, and fabrication of new equipment where appropriate will then be included in the critical path. AHP Data Processing Steps.

a. Developing Criteria and Alternatives

The arrangement of the hierarchy of alternative network selection for the EPCI project in the Alas Dara Kemuning (ADK) field, can be seen in Figure 4 below:

Figure 4 Hierarchy of selection of alternative predessesor networks

1) Hierarchy 1 (Purpose)
   Hierarchy 1 for the purpose of selecting an alternative predessesor network for the EPCI project PT. Pertamina EP Cepu Alas Dara Kemuning (ADK)
2) Hierarchy 2 (Criteria)
   Hierarchy 2 is a criterion that has an important factor as a benchmark in selecting alternative predessesor networks for the PT EPCI project. Pertamina EP Cepu Alas Dara Kemuning (ADK). This study has 4 criteria based on the results of FGDs and literature studies which were confirmed by 5 experts, namely: Quality, Cost, Delivery, and Safety.
3) Hierarchy 3 (Sub Criteria)
   Hierarchy 3 is a sub-criteria for each of the Quality, Cost, Delivery and Safety criteria. Quality Sub Criteria consists of Materials, Certification, and Standardization. Cost Sub Criteria consists of Purchase, Long Term Cost and Maintenance. The Delivery Sub Criteria consists of a Commitment to the delivery process, a clear delivery time, and Guarantees of the receiving process. The Safety Sub Criteria consists of Risk Level, Severity, and Operational Hazard.
4) Hierarchy 4 (Alternative)
   Based on the results of the FGD, it was found that the selection of alternative predessesor networks for the EPCI project PT. Pertamina EP Cepu Alas Dara Kemuning (ADK), as follows: Material Transfer Agreement (MTA), Existing Equipment Modification (MAE), and New Equipment Fabrication (FPB)

b. Calculation of Weight of Interest with AHP Calculation

The stages in determining the weight of importance, namely: filling out a questionnaire containing the level of importance between criteria and between sub-criteria, determining the weight of the criteria and sub-criteria and calculating the consistency ratio. The questionnaire used in the AHP analysis uses the Saaty (2009) rating scale which starts from 1 to 9 to assess comparatively the level of importance of an element with other elements.

c. Pairwise Comparison Matrix

Paired comparison scale between criteria, sub-criteria, selection of alternative predessesor networks for the EPCI project PT. Pertamina EP Cepu Alas Dara Kemuning (ADK). obtained from expert judgment in this study, can be seen in Table below, as follows :

Table 1 Comparison of Criteria

Criteria	Quality	Cost	Delivery	Safety
Quality	1	2	2	3
Cost	½	1	3	2
Delivery	½	1/3	1	1
Safety	1/3	½	1	1
Total	2.33	3.83	7	7

Table 2 Comparison of Quality Sub Criteria

Criteria Quality	Material	Standaritation	Sertification
Material	1	2	2
Standaritation	½	1	2
Sertification	½	½	1
Total	2	3.5	5.00

Table 3 Comparison of Cost Sub Criteria Cost

Criteria Cost	Purchase	Long Term Cost	Maintenance
Purchase	1	3	2
Long Term Cost	1/3	1	1
Maintenance	½	1	1
Total	1.83	5.00	4.00

Table 4 Comparison of Delivery Sub Criteria

Kriteria Delivery	Delivery Process	Delivery Time	Acceptance Assurance
Delivery Process	1	2	2
Delivery Time	½	1	2
Acceptance Assurance	½	½	1
Total	2.00	3.50	5.00

Table 5 Comparison of Safety Sub Criteria

Criteria	Risk Level	Saverity	HAZOP
Risk Level	1	2	2
Saverity	½	1	2
HAZOP	½	½	1
Total	2.00	3.50	5

d. Testing the Consistency of the Pairwise Comparison Matrix Between Criteria at the Level of Objectives

The results of calculating the weight, consistency index (DI), consistency ratio (CR) criteria, can be seen in Table 8 as follows:

Table 6
Recapitulation of Calculation of Sub Criteria Weights

Based on Table 6, the highest priority vector percentage is 55.0%, namely: Purchase Sub Criteria. So the purchase sub-criteria decision has the most dominant influence on the selection of alternative predessesor networks for the PT EPCI project. Pertamina EP Cepu Alas Dara Kemuning (ADK) is consistently acceptable.

e. Alternative Priority Weight Calculation

The results of the selection of alternative predessesors (MTA, MAE, and FPB) for the EPCI project network PT. Pertamina EP Cepu Alas Dara Kemuning (ADK) by comparing the level of importance of the sub criteria of each criterion (Quality, Cost, Delivery, and Safety), can be seen in Table 7 and Table 8. Pertamina EP Cepu Alas Dara Kemuning (ADK).

Table 7
Interest Level of EPCI project predessesor network alternatives

Table 8
Calculation of the Global Weight of the Alternative Predessesor Network

After knowing the weights on the criteria and the weights on the sub-criteria, the final weight calculation is carried out by means of the weight of the criteria multiplied by the weight of the sub-criteria. So that the final weight for material is 0.204, the final weight for standardization is 0.130, the final weight for certification is 0.082, and so on.

After calculating the final weight, the final score is also calculated by means of the criteria weight multiplied by the sub-criteria weight multiplied by the level of importance. In order to obtain the final value of the material precisely on the Material Transfer Agreement (MTA) of 1.84, on Existing Equipment Modification (MAE) of 1.43, and on New Equipment Fabrication (FPB) of 1.22.

Then the total value is calculated for MTA, MAE and FPB by adding up all material values up to Hazod & Hazid. So that the total value of MTA is 6.50, MAE is 4.98 and FPB is 3.29. All values are then arranged into a hierarchy. More clearly see Figure 5, as follows :

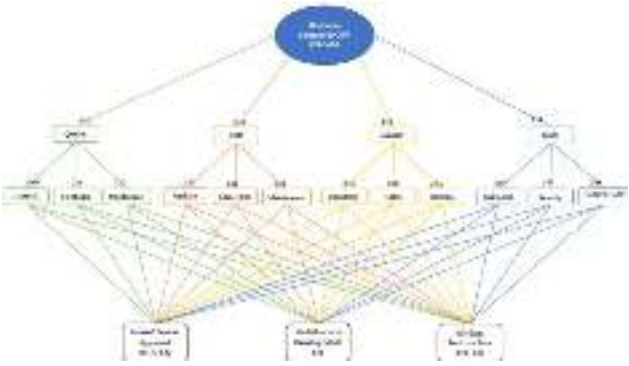

Figure 5 Figure Hierarchy Selection of alternative predecessor network

Based on Figure 4 Hierarchy of selection of alternative predessesor networks for the PT EPCI project. Pertamina EP Cepu Alas Dara Kemuning (ADK) and global weight calculations have found an alternative choice for the EPCI project predessesor network PT. Pertamina EP Cepu Alas Dara Kemuning (ADK) is a Material Transfer Agreement method used to determine a network or project network for the construction of gas production facilities in the Alas Dara Kemuning Cepu oil and gas field.

The Material Transfer Agreement method has Quality criteria which is ranked first and has a more dominant role in influencing the EPCI project predessesor network PT. Pertamina EP Cepu Alas Dara Kemuning (ADK) is compared to the Cost, Delivery and Safety criteria, because it has a Priority Vector of 42.0%. Quality criteria in the Material Transfer Agreement method have Material Quality that has been tested in a process, according to standards and has been certified by a regulatory body

While the Material Transfer Agreement Method has a Purchase sub-criteria that ranks first and has a more dominant role in influencing the EPCI project predessesor network PT. Pertamina EP Cepu Alas Dara Kemuning (ADK) than other sub criteria because it has a Priority Vector of 55.0%. This shows that this sub-criteria is the reason for which a project will be approved or not. The cheaper the initial investment/purchase of equipment for a project, the easier it will be for the project to be approved.

4.2 Critical Path Method (CPM) Analysis

The Critical Path Method (CPM) analysis is used to optimize time in project scheduling for the Development of Gas Production Facilities in the Alas Dara Kemuning Cepu Oil and Gas Field with an alternative option for the EPCI project method of material transfer agreement, which takes 126 days, starting July 5, 2021 to 27 December 2021, for more details, see the output of the Microsoft project in Table 9.

Table 9 EPCI Project Critical Network in the Alas Dara Kemuning Cepu Oil and Gas Field

Based on Table 9, it can be seen that the duration of the acceleration of the implementation of the Material Transfer Agreement (MTA) method in the gas production facility development project in the Alas Dara Kemuning Cepu Oil and Gas Field with CPM analysis (Critical Path Method - Critical Path Method) from the planned schedule of 174 days to 126 days.

4.3 Cost Estimation

The estimated cost for the gas production facility development project in the Alas Dara Kemuning Cepu oil and gas field is Rp. 36.827.704.786 according to the duration of the accelerated implementation of the Material Transfer Agreement (MTA) method with its critical path optimization of Rp. 27.185.512.225.

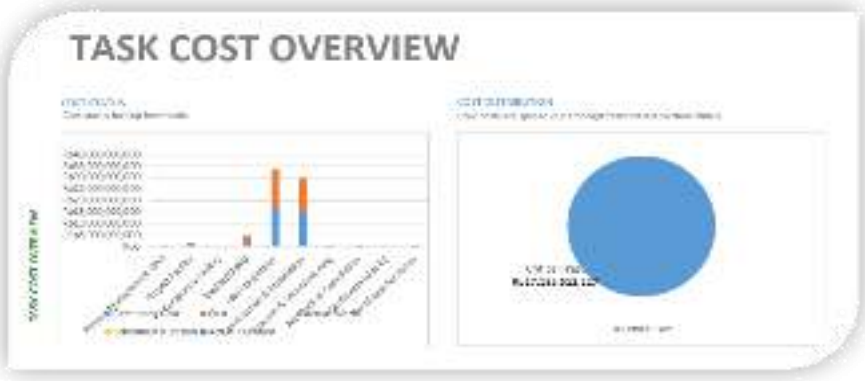

Figure 6 Cost Review

5. CONCLUSIONS

From the results of the analysis and calculations of the Analyst Hierarchical Process (AHP) and the Critical Path Method (CPM), the following conclusions can be drawn:

1) The project network for the construction of gas production facilities in the Alas Dara Kemuning Cepu Oil and Gas Field used is a Material Transfer Agreement (MTA) in accordance with the criteria and sub-critical.

2) The optimal time to complete the gas production facility development project in the Alas Dara Kemuning Cepu oil and gas field is 126 days according to the left path in the Critical Path Method (CPM).
3) The estimated cost for the gas production facility development project in the Alas Dara Kemuning Cepu oil and gas field is Rp. 36,280,304,447 according to the duration of the accelerated implementation of the Material Transfer Agreement (MTA) method with its critical path optimization of Rp. 27.185.512.225.

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IMPROVING SERVICE QUALITY IN TRUCKING COMPANY USING THE QUALITY FUNCTION DEPLOYMENT (QFD) METHOD

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ABSTRACT

In industrial developments, especially in the logistics sector after the Covid-19 pandemic, have a positive impact on the economy in Indonesia. Especially in truck logistics transportation services. This is also accompanied by the provision of excellent service as one of the advantages in a business competition, especially truck transportation. The purpose of this study is to the analysis of service quality by the service quality method (SERVQUAL) and analysis for attribute classification based on priority using the Quality Function Deployment (QFD) method with the House of Quality (HoQ) tools. This research begins with identifying service quality attributes which are distributed to respondents, to get gaps as a form of the voice of the customer. This research was conducted at a truck transportation company, namely PT Lookman Djaja Logistics. A gap score was found with a value range from 0.00 to -0.67, then the gap score with the lowest value was selected, namely -0.33 to -0.67. A total of 6 attributes were selected to be the voice of customer in the House of Quality process. Furthermore, the company provides a technical response to the voice of customer in the form of 10 technical responses which are some things that need improvement. The results of the QFD calculation showed that the improvement of the service quality attributes such as fast service, safety of the cargo and personal attention to the special needs of the clients were prioritized. While the technical responses given to the company emphasize the provision of training support to employees related to the service sector, increasing the number of employees, and employee development support that is also given to truck drivers. These three technical responses can help improve the company's service quality to achieve customer satisfaction in service to deliver goods.

Keywords: Service Quality, Logistic Service Quality, Quality Function Deployment

1. INTRODUCTION

In supply chain management activities, goods transportation services are one of the industrial services that can connect suppliers with customers (Stank et al., 2003). Logistics business actors are considered to have an important role in facilitating the distribution of goods in the expedition industry, precisely in the field of transportation services and have an important role in delivering goods to consumers (Japarianto, 2018).

Based on a survey conducted by the Central Statistics Agency (2019), the growth in the logistics sector in Indonesia was 15.79% higher than other sectors. This is supported by the increase in the average number of freight cars each year by 385,852 units or 6.19% per year. The increasing industrial sector in the logistics sector in Indonesia is also supported by the growth of various commodities, such as steel, cement, fertilizer, automotive commodities which are spread in each region and are dominated by land transportation modes described in Table 1.

Table 1. Freight transportation needs with five specific commodities by island (Supply Chain Indonesia, 2016)

Moda	Sumatera	Jawa	Kalimantan	Sulawesi	Bali Nusra	Maluku-Papua	Rata-rata
Udara	0,0%	0,0%	0,0%	0,0%	0,0%	1,1%	0,2%
Laut	2,7%	0,7%	58,8%	3,6%	0,2%	79,7%	24,2%
KA	2,1%	0,1%					1,1%
Jalan	95,2%	99,7%	41,2%	96,4%	99,8%	19,2%	75,3%

The increase in logistics distribution services is also accompanied by an increase in the number of customer growth. One of the important things for a logistics service provider company is to provide good logistics services for its customers. The level of customer satisfaction is one of the indicators in providing the best service. The level of customer satisfaction of consumers in Southeast Asia reached 28.1% where they felt dissatisfied with the delivery service (Parcel Perform & iPrice, 2019). While consumers in Indonesia, as many as 44.3% of consumers give their level of satisfaction by giving three-star to one-star ratings related to goods delivery services. This indicates a lack of customer service response in the delivery process, as well as delays in receiving packages that are not in accordance with the estimated schedule that has been determined.

Customer satisfaction is something that is received from a good service quality. Customer satisfaction is obtained from customers feeling the satisfaction of a product or service based on what they need, and can be fulfilled in an easy, convenient way, and make them loyal to the logistics service provider company (Gohoho et al., 2022).

One of the companies providing logistics services by land transportation mode is PT Lookman Djaja Logistics. This Indonesian company, which has been operating since 1985, provides professional personalized freight forwarding services as long-haul trucking. Being a fast, safe, and reliable freight logistics service provider, the company continues to make differentiation and efficiency efforts in improving the quality of services offered. The specific objectives are:

- Measuring logistics service quality using the Quality Function Deployment (QFD) model and servqual method.
- Knowing the service quality attributes concentrated at PT Lookman Djaja Logistics, as well as the quality of each attribute.
- Knowing the classification of service quality attributes based on customer satisfaction with the fulfillment of services from PT Lookman Djaja Logistics to customer needs.
- Knowing things that must be improved in improving service quality performance at PT Lookman Djaja Logistics, as an effort to improve quality among other competitors.

2. LITERATURE REVIEW

Service Quality

Service quality consists of the constructs "services" and "quality". Services are defined as a characteristic inherent in a service. Meanwhile, quality has various perspectives. Lovelock and Wirtz (2011) state that quality has different definitions. In a manufacturing perspective, it is defined as conformance to specifications developed and driven by productivity and cost control goals. Meanwhile, from a user perspective, quality is oriented towards meeting the needs of demand and is subjective.

In identifying service quality for a product or service, Parasuraman et al. (1986) developed service quality in his research and identified this variable as multidimensional. A total of 5 dimensions are used in evaluating service quality to customers which are described in Table 2.

Table 2. Service quality dimensions

Dimension	Characterized
Tangibles	Physical appearance, equipment, personnel, communication materials
Reliability	The company's ability to provide promised services reliably and accurately
Responsiveness	The company's ability to provide fast service to customers
Assurance	Knowledge level, employee courtesy, competence, credibility, and safety
Empathy	The company's ability to pay attention to the customers both in communication and

	customer understanding

Logistic Industry

Logistics is one of the needs to move material goods purchased from suppliers to buyers, move materials from within the company, move finished goods to customers safely. Quoted from the Council of Supply Chain Management Professionals (2013) logistics is a process of planning, implementing, and managing effective and effective transportation and storage procedures for goods and services to meet customer needs.

An effective logistics system is necessary to maintain the existence of the industrial environment. The logistics function creates time utility by determining how deliveries can be made with proper time planning and where goods can be stored in proper locations before being delivered. Bowersox and Closs (1996) suggest logistics services are measured based on (1) availability, (2) operational performance, and (3) service reliability.

1. Availability means having consistent inventory to meet the needs of the products that customers want.

2. Operational performance relates to aspects of speed and consistency. To achieve smooth operations, companies usually prioritize achieving service consistency, and then increase delivery speed. In addition, the aspects of flexibility in meeting customer needs in particular, malfunction and recovery aspects. Malfunction refers to the possibility in logistics performance associated with failure, while recovery relates to the time it takes to recover.

3. Service reliability involves the quality of consistency of logistics measurement attributes.

Logistics is one of the indicators in the change and improvement of economic indicators. The logistics industry is one of the macro and micro contributions to the national economy (Sezer and Abasiz, 2017).

Logistic Transportation

Transportation is part of integrated logistics management and is very important. According to the Council of Logistics Managements (1991). Transportation is not only limited to the flow of goods across space and not only functions as a link in the distribution of a product (Topolšek, 2018). Therefore, the function of transportation has undergone structural changes, which are reflected in the development of transportation logistics. Today, transportation is one of the most important components of distribution and logistics systems. In other words, another major focus in transportation logistics is that in a supply chain there is a planned business and operational framework to organize and manage the movement or transportation of goods to be carried.

Quality Function Deployment

Quality Function Deployment or short QFD is a planning process that is used to determine customer needs into what is produced by the company. QFD was developed in the early 1970s and was applied to Mitsubishi Heavy Industries in Japan (Liu et al., 2021). Then QFD developed again in the United States in the mid-1980s in the automotive industry. Currently, QFD is often applied in various industrial sectors and in its implementation starting from products and services, B2C (business to consumer), high technology, and so on.

According to Yoji Akao (1990), QFD is a design made to design a product or service process by adjusting customer demand or what is called the voice of customer (VoC). In line with this opinion, Hauser et al. (2010) argue that QFD is a product development methodology with the aim of involving customer desires in the entire process of developing a product or service. This is often done within cross-functional teams that create and add to a series of matrices called Houses of Quality (HoQ).

HoQ is used to translate customer desires into requirements that must be met in a series of supply chains. The QFD method is very useful for facilitating communication, planning, and decision-making within product development teams.

3. METHODS

A trucking company, PT Lookman Djaja Logistics was chosen to carry out the empirical analysis. The sample for this study was from PT Lookman Djaja Logistics's customers in Indonesia. Primary data were collected by using questionnaire, interviews and focus group discussion. Respondents were selected using convenience sampling method.

In the process of analyzing service quality at a trucking company that integrates Servqual and QFD. The first step is to create logistic service quality instruments or attributes that are adapted and translated into Indonesian from Baki et al. (2009). The attributes consist of 27 attributes in Servqual. Five-point Likert scales were used in the measurement.

In the second phase, customer's evaluations about the current situation of the company and their expectations for the company were obtained through 15 questions using five-point Likert scale, and representing a range of attitudes: so bad, bad, neutral, good, very good. The scale was tested by six customers of PT Lookman Djaja Logistics Company customers who selected using convenience sampling method. Necessary clarification for the questionnaire result by interview.

Third phase, priority levels assigned by customer's responses were defined in the previous phase. As a result, six attributes of the result has found as the voice of customers were taken into account. Then, the office managers with the researcher discuss to obtain the company's technical response to the voice of customer, and the HoQ was completed.

4. RESULTS

As mentioned above, service quality attribute which were assigned by the respondents was analyzed by averages for evaluation and interpretation goals. In

Table 3 shows the average customer perception of the company situation and Table customer expectation to the company.

Table 3. Service quality of the company

No.	Atribut Service Quality	Gap Score
1.	Providing proper package to product specifications	0,00
2.	Keeping transaction records accurately	-0,11
3.	Providing their services at the time they promised to do so	-0,11
4.	Employees willingness to help customers	-0,56
5.	Fast service providing	-0,33
6.	Meeting customers requests and complaints as a satisfactory way	-0,22
7.	Solving problems as soon as possible	-0,67
8.	Tolerant, respectful, patient staff	-0,11
9.	Employing staff expert for their positions	-0,56
10.	Informing customers about delivery time before sending	-0,22
11.	Delivering packages to customers as free of damage	-0,22
12.	Providing safety and confidence of package (warrants, etc)	-0,56
13.	Fast service without waiting customers on queuing line	-0,11
14.	Customer's feeling of received personalized attention to their specific needs	-0,33
15.	The branch offices easy to access	-0,22

As can be seen in Table 2, six of the total service quality attributes (4, 5, 7, 9, 12, 14) have weak service quality performance. Then the attributes with a low gap score value. While attributes that are not categorized as gaps or gap values of zero, then these attributes must be maintained and improved again in meeting customer needs.

Table 4. Service quality of the company

	Customer priority level	Increase employee numbers	Inform customers in detail about the customer services offered	Memberikan dukungan pelatihan kepada karyawan yang terkait dengan bidang pelayanan	Provide training support to service-related employees	Implementation of goods delivery safety standards	Training of truck drivers	Improving the technology used when shipping goods	Special standard offer to cutomers	Increase truck transportation fleet	Customer satisfaction survey
Employees' willingness to help customers	5	3		9	1						3
Fast service providing	5	9		9			3			9	9
Solving problems as soon as possible	5	9	9	3	3						9
Employing staff expert for their positions	3			9	3						9
Providing safety and confidence of parcels (warrants, etc.)	4		3		9	9	3	9	3		9
Customer's feeling of received personalized attention to their specific needs	4		9			9			9	9	9
Averages		7	7	7,5	4	9	3	9	6	9	8
Target technical score (0-100)		50	100	100	70	100	100	85	70	90	100
Technical Importance Level		105	93	132	65	72	27	36	48	81	204
Technical Importance Level (%)		12%	11%	15%	8%	8%	3%	4%	6%	9%	24%

From a methodological perspective, it can be concluded that the company has service quality performance that needs to be improved. As can be seen on Table 4, there are two reasons explaining. First, customers have high expectations for responsive, fast, and informative services. The gap in fast service to help customers who are less responsive when customers experience problems both in fulfilling their needs that require responsiveness, as well as time-related constraints. In addition, customers expect to be secure for the packages to achieve maximum quality service, such as the warranty given to the packages delivered if there is damage or delay in delivery, as well as certain standards that need to be applied to certain products. Customer expectations for the form of service provided by the company can adjust their product specifications, especially for certain products with a high level of risk. While the company still has not implemented security in certain product specifications with standards that adapt these products. The company still enforces the standards they have implemented, such as ISO 9001 which is related to international standards in quality management systems, and PERMENHUB RI (Regulation of the Minister of Transportation of the Republic of Indonesia) number PM 85 of 2018 regarding safety management systems for public transport companies.

Second, in the Servqual method (Baki et al., 2009) the service quality attribute is indicated in the company's human resource management related to employee development. Responsive actions and methods of providing good service visually, and communication that gives customer convenience are the customer's expectations for the company. In its application, the communication network that occurs is still standard or has not reached what the customer wants. So that customers will ask to provide an explanation. Not only that, when responding back to complaints about a transaction, they expect the service to be delivered patiently,

informatively, so that customers feel a closeness that is able to resolve their complaints.

5. CONCLUSIONS

In QFD process, the three most important attributes were found to be prompt service; providing security for goods; and providing personalized attention to customer needs. The first attribute implies competitive priorities related to speed and time. The second attribute implies operational to technical standards related to the security of goods. In addition to the implementation of standards requested by customers, one of them is strengthening the technology and information infrastructure, which is the most important technical requirement with a high level. And at the attribute when implying the provision of personal attention to customer needs which emphasizes the company offers VIP class services. Customers feel that they get special attention during the transaction process.

The technical response provided by the company is closely related to service quality attributes that emphasize the services expected by customers. Providing training support to employees related to the service sector is a technical response that is considered important. In addition, increasing the number of employees also has an influence on the speed of service quality attributes. Employee development support is also provided to truck drivers by providing mechanical skills training in addition to truck driving to ensure safe driving. As a result, technical requirements are highly related to customer satisfaction until the delivery of goods.

This research is the first step in the application of the method applied to trucking companies using the design framework. In the context of this research, it highlights some limitations of the study. Firstly, the sample representing all customer groups makes for a better comparison and more accurate evaluation. In addition, the content of the instrument, which is still general in its discussion, needs to be studied so that it can be applied to the transportation industry sector in particular.

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UNDERSTANDING CUSTOMER'S CONTINUANCE INTENTION TOWARD ONLINE SHOP:LOGISTIC SERVICE QUALITY, PERCEIVED AGILITY, AND COMPANY REPUTATION PERSPECTIVE

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ABSTRACT

Maintaining customer continuance intention is very important for online shop. Customers' continued use is a form of their loyalty to the service. Understanding the factors that influence customer continuance intentions will provide a number of benefits for companies. Satisfaction has been recognized as a strong antecedent of customer continuance intentions. However, recently the topic of customer engagement has also been increasingly found in research. This study identifies the role of logistics service quality, perceived agility, and corporate reputation in online shop customer continuance intentions, considering customer engagement. The Structural Equation Modeling (SEM) analysis method was used because it is considered appropriate in providing a measure to explain the relationship between multirelated variables. 224 online shop customers participated in this study. The results showed that logistics service quality operationally and relationally made important contributions to the perceived agility of online shop customers. In addition, company reputation and perceived agility are factors that are able to motivate customers to engage with online shop, thereby encouraging their continued use intentions in the future. Thus, it can be concluded that it is important for online businesses to pay attention to the aspects of reputation and perceived agility due to their influence on customer engagement. Finally, the quality of operational and relational logistics services is cited as a factor that can increase customers' perceived agility towards online shop.

Keywords: Customer engagement, company reputation, continuance intention, logistics service quality, online shop services, perceived agility.

1. INTRODUCTION

Technology has developed rapidly in recent years (Ashfaq et al. 2019). This technological development has made the business operating system different from the previous one. Online shop is one illustration of a business by utilizing technology as a supporting tool for operational activities to provide goods in order to meet the needs of its customers. This technological capability provides several major benefits, such as ease of communication and expanding market networks globally. APJII data shows that in 2021, 77.02% of Indonesia's total population is known to be connected to the internet (APJII 2022). The large number of internet users in Indonesia is one of the reasons for the increase in online transactions and encourages the growth of the number of online companies in Indonesia (Saputra 2017). With the increasing number of online businesses

that stand today, of course, customers will also have more variations of online shopping places to choose from. This matter encourages companies to increasingly try to retain existing customers and attract new customers (Adaji and Vassileva 2017; Oracle 2011).

Customers often do not have a strong rationale for their choice of one retailer over another, with customers tending to rotate purchases among several companies (Al-Maghrabi et al. 2011). Therefore, companies now no longer focus only on customer satisfaction, but also on strategies that can encourage customers' intention to continue using their company's services on an ongoing basis. Thus, continuance intention is a type of behavioral intention that can appear in various forms, such as intention to repurchase or intention to recommend to others (Hepola, Leppäniemi, and Karjaluoto 2020; Montazemi and Qahri-Saremi 2015). Based on this, the intention of continued use in this customer will bring several benefits to the company, one of which is from costs. Therefore, in addition to satisfaction, customer continuance intention to use a service is also an important aspect that needs to be considered.

Customer satisfaction is highly emphasized in a large number of companies because of its perceived role as a key determinant of online customer continuation intentions and improving business sustainability (Hepola et al. 2020; Shang and Wu 2017; Susanto, Chang, and Ha 2016; Taherdoost and Madanchian 2021). In a business-to-business case, it was found that customers often have a decision to leave a service due to responses that are considered inadequate (Bitner, Booms, and Tetreault 1990; Lu, Lu, and Wang 2012). In another case, a survey showed that 53% of respondents had problems with online shopping and the other 47% of respondents showed satisfaction or had no problems with online shopping (Rajendran et al. 2018).The perceived dissatisfaction will potentially cause customers to have negative decisions in the future, which is not only about future purchasing decisions such as refusing to buy again, but also the decision to complain and spread negative news which will then damage the reputation of a business (Ferguson and Johnston 2011). This is because reputation is what customers expect before they support a business (Loureiro and Kastenholz 2011; Pool, Pool, and Taghipourian 2016).

For first time customers who have never had experience in making a purchase before, their initial trust can be formed quickly by indirect experience based on available information such as reputation, recommendations, effective communication, and quality of information from the seller (Kim, Ferrin, and Rao 2003; Sadeghi, Ghujali, and Bastam 2019). Based on this reputation, customers have expectations of the company to be able to get products or services with high quality, where service and quality have been understood as antecedents of customer satisfaction (Herbig and Milewicz 1993; Pool et al. 2016). Some studies say that company reputation and customer satisfaction have a relationship with each other (Helm, Eggert, and Garnefeld 2010; Walsh et al. 2009; Walsh, Dinnie, and Wiedmann 2006). Varma et al. (2020) revealed that privacy, trust, security and organizational reputation significantly affect the purchase intention of e-commerce online customers and suggested to always pay attention to these factors if they aim to increase sales in e-commerce business. In other words, it can be said that organizational reputation has led to customer satisfaction and electronic trust, but has not led to customer loyalty with a specific research population. The quality of service perceived by customers is the aspect that forms the basis of judgment and loyalty.

2. LITERATURE REVIEW

2.1 Logistics Service Quality

Muljono et al. (2021) revealed that service quality and delivery are considered aspects that are able to have a positive influence on online customer attitudes. Research by Mentzer et al. (2001) shows that timeliness, delivery accuracy, and product condition are important indicators of

operational logistics services that affect customer satisfaction. The research also shows that personal contact such as personnel knowledge, empathy with the customer's situation, and helping solve customer problems are important indicators of relational logistics services that can affect customer satisfaction. This matter is shown by one study which found that fulfillment problems can affect the overall assessment of the quality of electronic services (Rita, Oliveira, and Farisa 2019). A study says that focusing on logistics capabilities can help companies to develop their supply chain agility (Roy, Raju, and Mandal 2017).

H1 : Operational logistics service quality has a positive effect on perceived agility of customers

H2 : Relational logistics service quality has a positive effect on perceived agility of customers

2.2 Perceived Agility

According to Roy (2017), as more customers view the e-retailer's agility capabilities positively, there will be a higher chance that they will be satisfied because they understand that the e-retailer will be able to meet all their delivery schedules even if there are certain last-minute dynamics. Pantouvakis and Dimas (2013) say that customer satisfaction, product or service quality are no longer enough for companies to gain an edge as the service environment is now increasingly uncertain. There is research that shows that simply creating fan page content and interactions that appeal to customers is not enough to promote customer engagement, but the brand's fan page must also be agile to the changing needs of customers and the movements of competitors (Chuah, Aw, and Tseng 2020). To fully understand agility, the customer's point of view also plays an important role. Although it is agreed that the customer's point of view has an important role, there is still a small number of studies that try to understand or measure this company's ability from the customer's point of view (Atapattu et al. 2016).

H3 : Perceived agility has a positive effect on customer engagement

H4 : Perceived agility has a positive effect on customer satisfaction

2.3 Company Reputation

From a management point of view, corporate reputation is a critical construct that is interpreted as the overall stakeholder perception of the company (Islam et al. 2021; Walsh and Wiedmann 2004). Reputation is able to shape customer expectations before they provide their support for a particular business, where customers will have high expectations of a product or service in a company with a good reputation (Herbig and Milewicz 1993; Loureiro and Kastenholz 2011; Pool et al. 2016). Research by Ferreira and Zambaldi (2019) explains that more than half of the effect of reputation on loyalty is mediated by satisfaction so that to achieve customer loyalty, organizations or companies need to create both, namely a good reputation and high satisfaction.

H5 : Company reputation has a positive effect on customer engagement

H6 : Company reputation has a positive effect on customer satisfaction

2.4 Customer Engagement

Customer engagement is said to be a mechanic of adding customer value to the company, either through direct or indirect contributions (Hepola et al. 2020; Pansari and Kumar 2016). In several studies, it was found that customer engagement has a positive and significant effect on customer satisfaction and reuse (Al-Dmour, Ali, and Al-Dmour 2019; Hollebeek, Glynn, and Brodie 2014; Marino and Presti 2018; Zaid and Patwayati 2021). In other words, good experiences felt by customers when interacting with the company can increase customer engagement with the company. Bowden's (2009) research also proposes that the issue of engagement and its

measurement should be considered as a fundamental concern for managers who want to move beyond the idea of aiming only to satisfy customers, namely to build stronger emotional bonds between their service brands and their customers.

H7 : Customer engagement has a positive effect on customer satisfaction

2.5 Customer Satisfaction

Customer experience when they make a purchase at an electronic retailer, becomes an evaluation material that customers use in making decisions to continue or not to make purchases at a particular electronic retailer (Zaid and Patwayati 2021). In general, there are several studies that conclude that satisfaction is a major factor that also significantly influences the intention of continued use in customers (Hepola et al. 2020; Shang and Wu 2017; Susanto et al. 2016). Alam et al. (2021) who say that customers are the main source of company revenue, therefore researchers and academics always attach importance to customer satisfaction research. Several other studies have concluded that there is a correlation between customer satisfaction and repurchase intentions in the context of online purchases (Abrar, Zaman, and Satti 2017; Rita et al. 2019).

H8 : Customer satisfaction has a significant effect on the intention to continue using service

2.6 Continuation Intention

According to Mohamed (2014), focusing on online customer retention is a strategy that needs to be developed because with it retailers can find useful insights into customer intentions to continue to make purchases or use. In some literature, it is said that the customer's decision to continue using a particular product or service is the driving force for the company to have good survival in the long term (Bhattacherjee 2001; Han et al. 2018; Lee and Kwon 2011). Chen and Li (2017) conducted a study on the continued use of mobile payment services, where the results showed that user satisfaction with mobile payment services and perceived post-adoption benefits have a substantive positive impact on the intention to continue the service.

3. METHODS

3.1 Development of Measuring Tools

The Structural Equation Modeling (SEM) method was used in this study because it is considered capable of explaining the relationship between multirelated variables (Hair et al. 2014). This study adopted AMOS 26 software in the process. Thus, SEM analysis techniques are applied to variables that are directly or indirectly related to continuance intention. To determine whether a model has reached the absolute fit stage, a fit index measurement is carried out or called Goodness of Fit (GOF). According to Hair et al. (2014), three to four indices are said to be sufficient to provide evidence of adequate model fit, but at least one incremental index and one absolute index must be reported.

The measuring instrument is designed based on indicators that have been developed by previous research. The measurement tools for operational and relational logistics service quality variables are based on the research of Hüseyinoğlu et al. (2018) and Vasić et al. (2021). Indicators of operational logistics service quality include information quality, delivery reliability, product quality and condition, and product availability. Relational logistics service quality indicators include understanding the customer's situation, solving customer problems, and employee knowledge and experience. The perceived agility variable measuring instrument was adopted from Roy et al. (2017). Indicators of perceived agility include meeting dynamic needs, being responsive to unexpected requests, adapting to external changes, and being responsive to disruption and

uncertainty. The measuring instrument for the company reputation variable was adopted from Sadeghi et al. (2019). Indicators of company reputation include reputable companies, well known companies, and recognized companies. The customer engagement variable measuring instrument was adopted from Bruneau et al. (2018) and Hepola et al. (2020). Indicators of customer engagement include attracting customer interest and curiosity, attracting a lot of customer attention, spending a lot of time in its use, and attracting customer enthusiasm. The customer satisfaction variable measurement tool was adopted from Hepola et al. (2020) and Thakur (2019). Indicators of customer satisfaction include satisfaction with the services provided, being the customer's choice, and a satisfying shopping experience. The measurement tool for the continuation intention variable is adopted from Hepola et al. (2020) and has a role as an endogenous variable in this study. Indicators of continuance intention include the intention to continue using online store services and choosing to use certain online store services.

Research data will be obtained through a survey conducted online. This research distributes questionnaires through social media with the help of Google Form, so that the questionnaire can be accessed anywhere. Whatsapp media was utilized in this study to distribute research questionnaires. Respondents can access the questionnaire by using the link provided. This study involved a total of 224 respondents who had experience with online store services. Customers answered the questionnaires submitted related to the research variables and indicators that had been previously determined. The questionnaire submitted to respondents was a total of 28 questions. In this study, the validity and reliability of indicators were tested through confirmatory factor analysis (CFA) with AMOS software. After conducting validity and reliability tests on each indicator, it was found that there were certain indicators that were unable to meet the predetermined standard value requirements. Thus, corrections were made to the measuring instrument, where the total questionnaire became a total of 23 questions. The method of answering the questionnaire in this study is to use a six point likert scale, which starts from point one with a statement of strongly agree to point six with a statement of strongly disagree. This questionnaire is intended to measure customer continuance intentions for online store services and determine the effect of customer engagement on customer satisfaction, which has been recognized as a strong antecedent in explaining customer continuance intentions in several previous studies.

3.2 Sample Characteristics

In this study, respondents were divided into six characteristics, namely gender, age, type of work, the most frequently used online store service, the amount of time spent, and the length of experience using online store services. The acquisition data based on gender shows that 51.8% are female and 48.2% are male. In terms of age, 41.1% showed ages ranging from 20 to 30 years, 22.3% were respondents over 50 years, 17.4% were respondents ranging from 41 to 50 years, and the rest were respondents with ages less than 20 years. In terms of employment type, most respondents were private employees and students, which amounted to 40.2% and 25.4% respectively. This was followed by SOE employees, self-employed people and civil servants, at 9.8%, 7.6% and 2.2% respectively.

The analysis in this section is carried out to provide information about customer profiles consisting of the choice of online store service, the amount of time spent when using online store services, and the number of years of experience using online store services. Based on the customer's preferred online store service, Shopee has a percentage of 57.1%, Tokopedia with 34.4% and Lazada with 4.5%. This is followed by Bukalapak (1.8%), other online stores (1.8%), and Blibli (0.4%). These results are not much different from the order based on the number of website visitors conducted by iPrice Indonesia in the second quarter of 2022, including Tokopedia,

Shopee, Lazada, Bukalapak, and Blibli. In terms of the amount of time spent when using online store services, most respondents spend between 5 minutes to 15 minutes and 15 minutes to 30 minutes with online stores, amounting to 38.8% and 36.6% respectively. The rest were followed by the amount of time more than 30 minutes and less than 5 minutes, which amounted to 21% and 3%. In addition, this study also shows that 67.9% of respondents have had experience in using online store services for 2 years to 5 years. This is followed by respondents with more than 5 years of experience and less than 1 year of experience, at 18.8% and 13.4% respectively.

4. RESULTS

4.1 Measurement Model and Structural Model Results

The first step is to test the measurement model to determine the relationship between variables and their indicators. Through confirmatory factor analysis (CFA), the validity and reliability of each variable indicator will be known. Validity test will include convergent validity and discriminant validity. The standard value for AVE is to exceed the standard value of 0.5 (Hair et al. 2014). The result shows that the AVE value for all variables has exceeded 0.5 with the lowest AVE value being 0.54 for the operational logistics service quality variable, which means that the standard value has been met. In addition, the factor loading results ranged from 0.687 to 0.956, which is greater than the standard value, which is 0.7 (Hair et al. 2014; Santoso 2021). With reference to the same source, the CR value obtained for all indicators has also met the standard value of 0.7 with the lowest value being 0.82 on the operational logistics service quality variable. Thus, it can be concluded that all indicators and variables have met convergent validity and reliability.

The results of data processing using the AMOS program show that the CFA model has reached the goodness of fit standard, namely by obtaining the CMIN / DF value = 2.071, RMSEA = 0.069, GFI = 0.858, and CFI = 0.946 (Bollen 1989; Hair et al. 2014; Schermelleh-Engel, Moosbrugger, and Müller 2003). After all indicators have been declared valid, the next step is to test the structural model. The goodness of fit results show that the acquisition value of the structural model has reached the standard value specified in several studies (Bollen 1989; Hair et al. 2014; Schermelleh-Engel et al. 2003). The results show the acquisition value of CMIN/DF = 2.143, RMSEA = 0.072, GFI = 0.846, and CFI = 0.939. Thus, this model was established to confirm the theory based on observational data.

4.2 Hypothesis Testing and Research Model

The results of hypothesis testing show that all hypotheses are supported. Operational logistics service quality and relationship have a significant effect on perceived agility. Company reputation and perceived agility have a significant effect on customer engagement and satisfaction. Customer engagement has a significant effect on customer satisfaction, which then predicts continuation intentions. Relational logistics service quality is a factor that has a greater effect on perceived agility of online shop customers than operational logistics service quality. Relational logistics service quality in this study refers to the notion of the ability to understand customer needs and expectations (Bouzaabia, Bouzaabia, and Capatina 2013; Hüseyinoğlu et al. 2018). On the other hand, operational logistics service quality refers to the ability to deliver services as promised reliably and accurately (Hüseyinoğlu et al. 2018; Mentzer et al. 2001).

This study also found that perceived agility is one of the factors that have a significant effect on customer engagement and satisfaction. This result is similar to previous research by Roy (2017), which states that perceived agility of e-retailers has a positive influence on customer satisfaction. The ability of agility in a company is a very important aspect, without exception to

the online store business. This ability aims to be able to ensure that all customer needs can be met in a fast way, even if these needs are dynamic (Brusset 2016). Company reputation is another factor that has a significant influence on customer satisfaction and engagement. These results are similar to previous research by Sadeghi et al. (2019) which revealed that organizational reputation can affect customer satisfaction in the context of electronic commerce. The study also said that satisfaction can be described as an emotional reaction to the service experience, where reputation will be a tool used by customers to get an overview of the services of a company. On the other hand, the significant relationship between customer reputation and customer engagement in this study is supported by the statement by Hadi and Indradewa (2019) which explains that the way how customers perceive the company's reputation can have an influence on their future behavior and relationship with the company.

In a marketing context, by engaging customers in relationships, companies can encourage more positive word of mouth (Bruneau et al. 2018). This study found that customer engagement in turn has a positive effect on customer satisfaction. Several other studies have similar statements, which reveal that engagement has a positive and significant effect on customer satisfaction, so it can be considered as one of the antecedents of service reuse (Al-Dmour et al. 2019; Hollebeek et al. 2014; Marino and Presti 2018; Thakur 2019; Zaid and Patwayati 2021). Thus, customer engagement is key to providing satisfying customer experiences, where these experiences can influence the relationship between satisfaction and customer loyalty (Lee et al. 2019; Thakur 2019). This statement is also similar to the research of Hepola et al. (2020) which reveals that satisfaction is one of the strong drivers that can influence service continuation intentions in customers.

5. CONCLUSIONS

This study aims to understand the role of customer engagement on satisfaction to increase the intention to continue using online store services. The results show that the quality of operational and relational logistics services in fact contributes importantly to the perceived agility of online shop customers. Where, perceived agility along with company reputation is said to be one of the factors that can have a positive influence on customer engagement. Finally, this study also shows that customer engagement is proven to be one of the drivers of continuance intention due to its positive influence on the antecedent of customer continuance intention, namely satisfaction.

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ANALYSIS OF THE INFLUENCE OF PERCEIVED VALUES, PERCEIVED RISK, AND CUSTOMER SATISFACTION ON WILLINGNESS TO PAY MORE: A Case Study on Netflix

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ABSTRACT

The increasing development and variety of Video Streaming services in Indonesia causes companies to optimize various factors that can encourage customers to remain interested in subscribing and using their services. Competition between streaming service providers is getting tougher, causing video streaming service providers needs to present and produce films or series that can attract the interest of their customers. Netflix, as one of the largest digital media streaming service providers in the world has a variety of shows, series, films, and documentaries that exceed other service providers, one of the programs that has succeeded in attracting the interest of its customers is Netflix Original. Netflix Original content is produced, co-produced, or distributed by Netflix exclusively and not on any other streaming service provider. This makes Netflix subscriptions more expensive than competitors. This study aims to determine whether perceived value, customer satisfaction, and perceived risk affect willingness to pay more. The analysis method was carried out quantitatively by distributing questionnaires which were then analyzed by Structural Equation Modeling (SEM). The data used in this study are the results of a questionnaire survey addressed to 106 Netflix subscribers in Surabaya aged 18 – 40 years old. Based on the results of this study, it was found that perceived functional value, perceived price value, and perceived emotional value, have a positive and significant influence on Customer Satisfaction. Meanwhile, Customer Satisfaction have a positive and significant effect on Willingness to Pay More.

Keywords: Perceived Values, Perceived Risk, Customer's Satisfaction, Willingness to Pay More, Structural Equation Modeling.

1. INTRODUCTION

Internet users in Indonesia has always increased every year. As of January 2022 internet users in Indonesia have reached 204.7 million people out of a total population of 272.2 million people. The increasing number of internet users in Indonesia has resulted in many new innovations from service providers such as e-commerce, e-news, e-learning, social media, messaging platforms, as well as many platforms that offer streaming services such as video and music. In the field of internet-based entertainment, there is a variety of television content that can now be accessed easily via internet-connected mobile devices. Several internet-based entertainment

services whose popularity is now growing rapidly are on-demand digital streaming services such as Netflix, Disney+, HBO Go, and Viu.

With the COVID-19 pandemic, many people are looking for entertainment at home. This makes streaming services one of the online entertainment services that are needed by the public. To take advantage of the huge growth potential in online video consumption, many content providers such as Netflix, Disney+, HBO Go are starting to provide an alternative model of subscription-based video on demand (SVoD) services.

With the many choices of streaming services available in the world, streaming service providers are competing to present films or series that can attract the attention of customers. Netflix has a wider variety of shows, series, films, and documentaries than any other service provider. Netflix has a program that has succeeded in attracting the interest of its subscribers, which is called Netflix Original. Netflix Original is content produced, co-produced, or distributed by Netflix exclusively and not available on other streaming service providers. As of August 2021, Netflix Original makes up around 40% of all content available on Netflix in the United States. Netflix Originals cover a wide range of categories namely comedies, dramas, foreign films and shows, documentaries, stand-up comedy specials, and reality competition.

In addition to the very varied content that Netflix has, the ease of accessing Netflix is another factor that can attract a lot of interest from the Indonesian people. Netflix can be accessed through an internet browser on a computer, or through application software installed on smart TVs, smartphones and several other devices. The amount of content available and the ease of access are the reasons Netflix subscribers are willing to pay more. This is in accordance with the results of research by Nagaraj, Singh and Yasa (2021), namely 5 reasons for subscribing, namely content, convenience, features, price and quality. Apart from that, the willingness to pay more is also influenced by the quality of accessibility and monetary value (Azzahro, Ghibran and Handayani, 2020).

With more content being made available and easy access to Netflix, these are perceived values and factors that can satisfy customers as well as perceived risks. First, perceived value is defined as the consumer's overall evaluation of the usefulness of a product or service based on perceptions of what is received and what is given (Zeithaml, 1988). Perceived values are divided into 4, namely: Functional values, Price values, Social values, and Emotional values (Sa'nchez et al., 2006). Second, namely customer satisfaction in using streaming service applications. Satisfaction with a product is a person's feelings of pleasure or disappointment resulting from comparing the perceived performance when using the product and expectations before using the product. Third, perceived risk. When customers want to subscribe, they may experience the consequences of making a mistake. Risk can appear in many ways such as fear of lack of desired attribute, uncertainty about product performance.

The factors that influence willingness to pay more can be analyzed using the Structural Equation Modeling (SEM) method. The SEM method is used to explain the relationship between variables in a complex way, both directly and indirectly (mediating variables) from one or more variables to other variables (Ferdinand, 2006). The application of the SEM method can measure latent variables and carry out three activities simultaneously, namely checking the validity and reliability of the instrument (equivalent to path analysis). Hair et al. (2011) said that PLS-SEM is the preferred technique when the main goal of a study is to evaluate the predictive accuracy of a complex model that exhibits many indicators and constructs.

Based on previous research, it has not fully provided information on the influence of perceived values using the dimensions of perceived functional value, perceived price value,

perceived emotional value and perceived social value, perceived risk and customer satisfaction on the willingness to pay more in the Netflix video streaming service industry.

2. LITERATURE REVIEW

Perceived value is defined as the consumer's overall assessment of the usefulness of a product or service based on perceptions of what is received and what is given (Zeithaml, 1988). Lovelock (2001) stated that perceived value can be increased by adding benefits to a product and service or by reducing expenses related to the purchase and use of a product or service by customers. The concept of values is the perceived utility that exists in the relationship between the company and the customer. Enriching relationships with consumers can increase their loyalty, for example, namely the customer's intention to continue shopping (Rubio et al., 2013). Perceived values are divided into 4, namely: Functional values, Price values, Social values, and Emotional values (Sa'nchez et al., 2006).

According to Sheth, Newman, and Gross's Theory of Consumption Values (1991), perceived functional value is defined as the perceived value derived from the capacity of a product or service in terms of functional performance, usability, or physical form of the product or service. When the customer feels that the quality of the product or service meets expectations, the customer will feel satisfied in using the product or service. Therefore, the quality of a product or service will be an evaluation of customer satisfaction.

According to Sweeney and Soutar (2001), perceived price value is defined as the value obtained from a product or service due to perceived short-term and long-term cost reductions. When the customer feels that the price given is in accordance with the quality obtained, the customer will consider the price fair because he feels that what is issued is in accordance with what is received by the customer, this can cause the customer to be satisfied.

According to Sheth, Newman and Gross's Theory of Consumption Values (1991), perceived social values are defined as perceived social values obtained from the customer's association with one or more specific social groups, such as demographic, socioeconomic, and cultural-ethnic groups that are stereotyped positive or negative. This shows that customers consider social value as an important factor in the satisfaction they feel when using a product or service.

According to Sheth, Newman, and Gross's Theory of Consumption Value (1991), perceived emotional value is defined as the perceived value obtained from the capacity of a product or service to evoke feelings or affective states of customers. This shows that when customers can connect emotional feelings to a product or service, the customer will feel satisfied in using the product or service.

H1: Perceived Functional Value (PFV) has a significant influence on customer satisfaction.
H2: Perceived Price Value (PPV) has a significant influence on customer satisfaction.
H3: Perceived Social Value (PSV) has a significant influence on customer satisfaction.
H4: Perceived Emotional Value (PEV) has a significant influence on customer satisfaction.

Theory of Expectancy disconfirmation developed by Oliver (1980) proposes that the level of customer satisfaction is the result of the difference between the expected and perceived performance of a product or service. According to Zeithaml et al. (1996), the level of customer satisfaction depends on the supplier's ability to meet the norms and expectations of customers. Meanwhile, Churchill and Surprenant (1982) define customer satisfaction as the result of the

purchase and use resulting from the customer's comparison of the rewards and costs of a product or service in relation to the consequences that have been anticipated.

Satisfied customers will behave positively and show positive intentions. One of the positive behavioral intentions is the willingness to pay a higher price for a product (Cronin and Taylor, 1992). Customer satisfaction or dissatisfaction with the product will influence subsequent behavior and high satisfaction will create an emotional bond for the customer, not just a rational preference. If the customer is satisfied, the customer will show a higher probability of purchasing (Lin, 2003).

H5: Customer satisfaction with products or services has a positive influence on willingness to pay more.

Bauer (1967) defines perceived risk as a combination of the uncertainty and seriousness of the results associated with an activity. Perceived risk is the expectation of loss that will result from purchasing a product and this will become an obstacle to buying behavior (Peter and Ryan, 1976). Li et al., (2020) in their research found that if the perceived risk is too high, then the purchase of a product will be abandoned or the customer will take steps to reduce the level of risk. Perceived risk can also occur when customers feel that there is hidden information regarding the product to be purchased. This information asymmetry can result in losses to customers.

Willingness to pay more is defined as the customer's willingness to pay higher costs for a product or service compared to competitors' costs (Baker and Crompton, 2000). Aaker (1991) argues that the more positive and the higher the values perceived by customers, the higher the customer's willingness to pay more for a product or service. Yodpram and Intalar (2020) argue that customers' willingness to pay a premium price is a condition in which customers are willing to pay a higher price for their favorite product or service. This is because customers feel that the product or service provides higher values to them compared to products or services from competitors.

Risk can present itself in many ways such as fear of a lack of desirable attributes, uncertainty about product performance or social approval of the product. This perceived risk theory proposes that customers perceive risk because they experience uncertainty and potentially unwanted consequences with the purchase or use of a product or service (Bauer, 1960). This shows that the higher the perceived risk, the lower the customer's desire to buy a product or service. Customers try to reduce risk by spending more time on surveys about the desired product or service.

H6: Perceived risk has a significant influence on the willingness to pay more.

3. METHODS

This study uses a quantitative approach. Quantitative data collection techniques are carried out by distributing questionnaires online to customers who have subscribed to Netflix using the Google form media. In this study, the number of samples used was 106 people who had subscribed for more than 6 months and worked in Surabaya. This study uses the Partial Least Square – Structural Equation Modeling method. The software used to assist the data analysis process is SmartPLS 3.2.9. Data analysis using the PLS-SEM method consists of two stages, namely the outer model and the inner model.

4. RESULTS

4.1. Respondents's Characteristics

Here are the respondent's characteristics based on multiple categories as follows :

Table 4.1 Characteristics of Respondents by Gender

Gender	Total	Percentage
Male	**52**	**49%**
Female	**54**	**51%**
Total	**106**	**100%**

Table 4.2 Characteristics of Respondents by Age

Age	Total	Percentage
18-23 years old	**21**	**19%**
24-29 years old	**71**	**67%**
30-35 years old	**11**	**10%**
36-40 years old	**3**	**4%**
Total	**106**	**100%**

Table 4.3 Characteristics of Respondents Based on Spending Levels Per Month

Monthly Income	Total	Percentage
Less than 1 millions	**12**	**12%**
1 millions – 3 millions	**41**	**39%**
3 millions – 5 millions	**28**	**26%**
More than 5 millions	**25**	**23%**
Total	**106**	**100%**

Table 4. 4 Characteristics of Respondents Based on Occupation

Occupations	Total	Percentage
Students	**22**	**21%**
Government employees	**15**	**14%**
Private sector employee	**47**	**44%**
Entrepreneur	**8**	**7%**
Others	**14**	**14%**
Total	**106**	**100%**

4.2. Outer Model

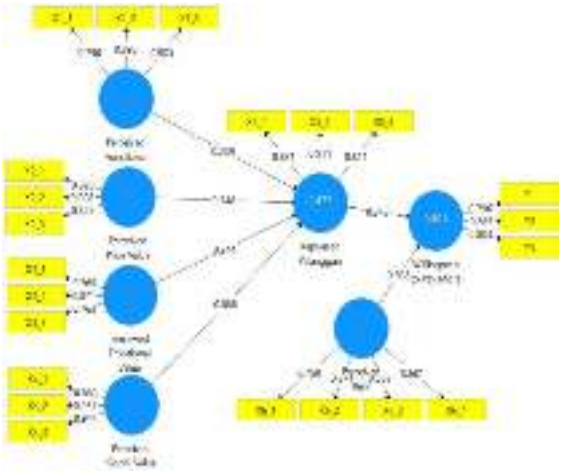

Figure 4.1 Outer Loading

Based on Figure 4.1 it can be seen that all indicators are valid because they have a loading factor value above 0.5. This shows that all indicators used in the research model as presented in Figure 4.1 above are able to measure all variable dimensions accurately.

Table 4.5 Reliability Test Results

	Composite Reliability
PFV	**0.899**
PPV	**0.924**
PEV	**0.844**
PSV	**0.944**
KP	**0.888**
PR	**0.834**
WPM	**0.862**

Based on Table 4.5 above, each variable has a composite reliability value above 0.7. This shows that all these variables meet the minimum standard of composite reliability, so that all variables are declared reliable.

4.3. Inner Model

Table 4. 6 Path Coefficient dan T-Statistics

	Original Sample (O)	Sample Mean (M)	Standart Deviation (STDEV)	T-Statistics (|O/STDEV|)	P Values
KP -> WPM	0.343	0.327	0.168	2.038	**0.042***
PEV -> KP	0.244	0.240	0.094	2.602	**0.010***
PFV -> KP	0.239	0.240	0.094	2.538	**0.011***
PPV -> KP	0.348	0.351	0.087	4.005	**0.000***
PR -> WPM	0.308	0.336	0.177	1.743	**0.082**
PSV -> KP	0.088	0.090	0.075	1.182	**0.238**

There is a significant positive influence on the variable perceived functional value on customer satisfaction variables. The results of the calculation of the parameter coefficients between perceived functional value and customer satisfaction. Shows a positive influence (0.239) with a statistical T value of 2.538, which means more than 1.96. With results like these, the research hypothesis H1 is accepted.

There is a significant positive effect on the variable perceived price value on customer satisfaction variables. The results of the calculation of the parameter coefficients between

perceived price value and customer satisfaction variables. Shows a positive influence (0.348) with a statistical T value of 4.005, which means more than 1.96. With results like these, the research hypothesis H2 is accepted.

There is a positive effect on perceived social value variables on customer satisfaction variables. The results of the calculation of the parameter coefficients between perceived social value and customer satisfaction. Shows a positive influence (0.088) with a statistical T value of 1.182, which means less than 1.96. With results like these, the research hypothesis H3 is rejected.

There is a positive and significant influence on perceived emotional variables on customer satisfaction variables. The results of the calculation of the parameter coefficient between perceived emotional and customer satisfaction. Shows a positive influence (0.244) with a statistical T value of 2.602, which means more than 1.96. With results like these, the research hypothesis H4 is accepted.

There is a significant positive effect on customer satisfaction variable on willingness to pay variable. The results of the calculation of the parameter coefficient between customer satisfaction and willingness to pay. Shows a positive influence (0.343) with a statistical T value of 2.038, which means more than 1.96. With results like these, the research hypothesis H5 is accepted.

There is a positive effect on the perceived risk variable on the willingness to pay variable. The results of the calculation of the parameter coefficient between perceived risk and willingness to pay. Shows a positive influence (0.308) with a statistical T value of 1.743, which means less than 1.96. With results like these, the research hypothesis H6 is rejected.

5. CONCLUSIONS

Perceived functional value is the quality of a product or service. When the customer feels that the quality of the product or service meets expectations, the customer will feel satisfied in using the product or service. Therefore, the quality of a product or service will be an evaluation of customer satisfaction. Perceived price value is the economic side of a product or service. When the customer feels that the price given is in accordance with the quality obtained, the customer will consider the price fair because he feels that what is issued is in accordance with what is received by the customer, this can cause the customer to be satisfied. This is supported by the results of research from Sung et al. (2014) which states that perceived price value has a positive and significant influence on customer satisfaction. Research by Demirgunes (2015) states that perceived emotional value has a positive influence on customer satisfaction. Perceived social value is the ability of a product or service to enhance social concepts. This is supported by Hur, Kim and Park (2013) which states that perceived social value positively influences customer satisfaction. Research conducted by Demirgunes (2015) shows that perceived emotional value has an important role in customer satisfaction and has a major influence on a product or service. This research shows that when customers can relate emotional feelings to a product or service, the customer will feel satisfied in using the product or service.

Companies get several benefits from satisfying customers. One of them is to produce higher profitability. Satisfied customers will behave positively and show positive intentions. One of the positive behavioral intentions is the willingness to pay a higher price for a product (Cronin and Taylor, 1992). Customer satisfaction or dissatisfaction with the product will influence subsequent behavior and high satisfaction will create an emotional bond for the customer, not just a rational preference. If the customer is satisfied, the customer will show a higher probability of purchasing (Lin, 2003). Risk can present itself in many ways such as fear of a lack of desirable attributes, uncertainty about product performance or social approval of the product. This perceived risk theory proposes that customers perceive risk because they experience uncertainty and

potentially unwanted consequences with the purchase or use of a product or service (Bauer, 1960). This shows that the higher the perceived risk, the lower the customer's desire to buy a product or service. Customers try to reduce risk by spending more time on surveys about the desired product or service.

The results of this study reveal that satisfaction is an important mediating determinant between the perceived value dimension and willingness to pay more. The findings show that maintaining a positive customer perception not only contributes to satisfaction but also leads to a willingness to pay more behavior. Therefore, Netflix is advised to build a positive perception of its products.

Similar to Peng and Liang's research (2013), this study found that the emotional value of customers plays an important role in product satisfaction and has the strongest influence. Emotional value is positively related to satisfaction. It is important to understand consumers' emotional desires and pay more attention to this dimension. From this study it can be concluded that consumers associate their feelings with Netflix. This study contributes that not only price as an ordinary finding influences behavioral intention but also emotional attractiveness drives behavioral intention. So, companies must focus on the emotional side of consumer decision making. Based on a situation where users pay more attention to sentimental value, they should be able to impose more emotional value on Netflix. Similar to this study, Ivanauskiene et al. (2012) show in their study that emotional value is overvalued than price and price is not always a highly valued factor. This shows that customers really want the product to make them feel comfortable and give pleasure.

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ENHANCEMENT OF ENERGY EFFICIENCY THROUGH BLOWDOWN BOILER CYCLE ANALYSIS WITH FMEA (CASE STUDY IN PT ADF)

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ABSTRACT

PT ADF has a natural gas boiler with a 2 tons/hour capacity to produce steam. The observations focused on energy loss during the boiler blowdown cycle. For cause and effect analysis, FMEA (Failure Mode and Effect Analysis) was used to evaluate a process to identify where and how it might fail and to assess the relative impact of different failures. Seven factors' problems in the boiler are identified from data collection and analysis of risk factors. The problem effect is increased energy loss in the boiler. PT ADF has six technical recommendations from critical analysis to increase the efficiency and effectiveness of the operational boiler. The result of this study is that by implementing six technical recommendations. The improvements for increased boiler performance include reusing boiler blowdown for heating in the feed water tank and returning boiler condensate water to the feed water tank as make-up water. In addition, potential savings can also occur in other parameters, such as the use of natural gas, water consumption, and waste management costs.

Keywords: Blowdown Boiler, Feed Water Tank, Energy Efficiency, FMEA, Cause and Effect Diagram.

1. INTRODUCTION

The use of oil and natural gas in the industrial sector is used to support utilities in supporting production operations. Several sectors of the food and beverage industry have utility support in supporting production in the form of steam boilers. PT ADF is one of the food processing industries that focuses on making seasonings (Ingredients) that utilize natural gas and boilers, which are an essential part of the principal operational supporting utilities. PT ADF's most significant energy use is divided into three types: gas, electricity, and diesel.

PT ADF's most significant energy consumption is natural gas at 50 percent, electricity at 49.2 percent, and diesel at 0.8 percent. Natural gas consumption at PT ADF is used for the cooking system in the fryer production line. It is used to produce steam in the boiler, which is then sent to production as a supporting medium for production equipment. The use of boilers at PT ADF is the leading utility support tool.

Senthur (2019) suggested that boiler efficiency is influenced by several parameters such as boiler type, oxygen supply, blowdown rate, boiler feed water (BFW) conditions, and others. Sunudas & Prince (2013) suggested that besides that blowdown rate and cycle, are operating

parameters that can be optimized to increase energy efficiency in boiler systems. Arunkumar (2014) suggested that monitoring the quality and amount of blowdowns aims to maintain the concentration of boiler efficiency at standard. The more blowdown output, the less energy efficiency because the steam that comes out of the blowdown carries the contained heat energy into the environment.

According to Islam (2010), another study related failure modes with the FMEA method for fire tube boilers in steam process plants. This study examines system failures in various boiler equipment and their effects. Research using the FMEA method to analyze critical components in the boiler system. According to Igboanugo, Asalor, and Egbiremon (2013), this study focuses on the analysis of system failures and the impact of these failures on the performance of the boiler system as a whole. According to Erajati, Subekti, and Khairansyah (2017), research on equipment risk in boilers used the FMEA method and obtained 3 top events as high-risk categories.

2. LITERATURE REVIEW

Cause & Effect Diagram

Foster (2007) suggested that cause and effect diagram or Ishikawa diagram, as shown in Figure 1, is a tool that describes problems and then looks for solutions. This diagram is shaped like a fishbone with problems that appear on the head. The leading cause lies in the ribs of the fish until the minor root cause is in most small fish spines. The method of identifying these causes uses the why question up to 5 times, often called five whys. This tool is used in a six-sigma project's analysis and improvement stages.

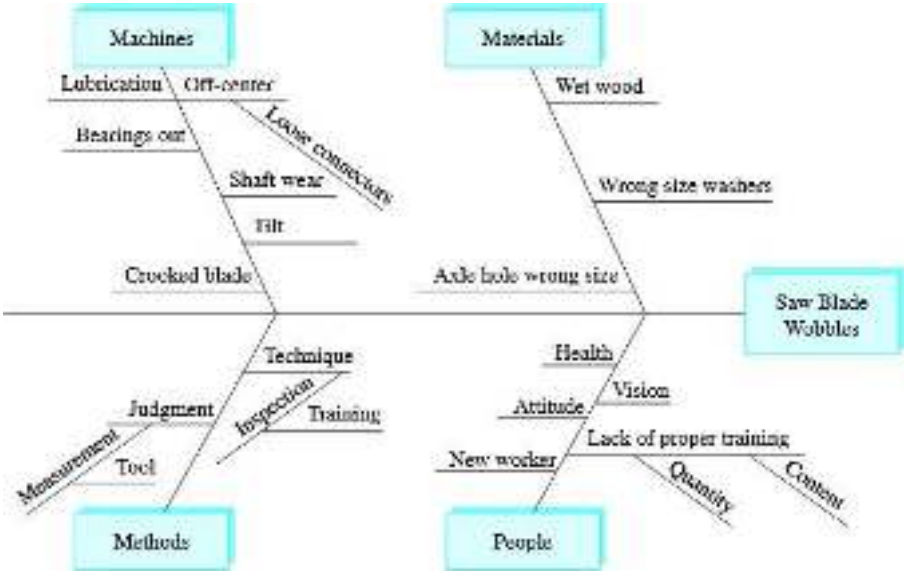

Figure 1. An Example Cause & Effect Diagram
(Source: Foster, 2007)

***Failure Mode and Effect Analysis* (FMEA)**

Kocabaş, Ceyda, and Ahmet Fevzi Savaş. (2021) suggested that FMEA is an analysis technique to prevent everything. The types of design and process errors that may occur in a process. All types of errors/mistakes are analyzed according to their possible impact on the customer. All of these analyzes are performed before and during the process. FMEA is a technique used to prevent potential errors before they occur. This method consists of four stages: a critical examination of the system, identification of possible factors, the hazard causing the malfunction, classifying the consequences of failure, and each potential failure. When analyzing errors with FMEA, three indicators are considered. This: Occurrence: frequency of failure Severity: The impact rate of the failure Detection: error detection The Risk Priority Number (RPN) is combined.

Shekari & Fallahian, (2007) suggested that implementation FMEA in an organization will produce synergies, eliminating everything that causes product failure and process problems.).A three-factor effect was calculated by multiplying the incidence, severity, and detection scores. When applying the FMEA method, the RPN determines the criticality of every possible error. The references should be listed based on the alphabetical order of the first author's last name. See examples at the end of these guidelines.

3. METHODS

The data collection used in this study, as well as the processing stages and data analysis, regarding the factors causing the inefficient work of the boiler at PT ADF. The method used in this study is root cause analysis and failure mode and effect analysis (FMEA). Based on the analysis of the results obtained will become the basis for recommended action and an analysis of the potential resulting from recommendations for improvement.

4. RESULTS

Identification of problems

From the results of observations on each boiler process activity, several categories are obtained in identifying problems using fishbone diagrams. The following results from categorizing the problem: machine, environment, man, material, and method.

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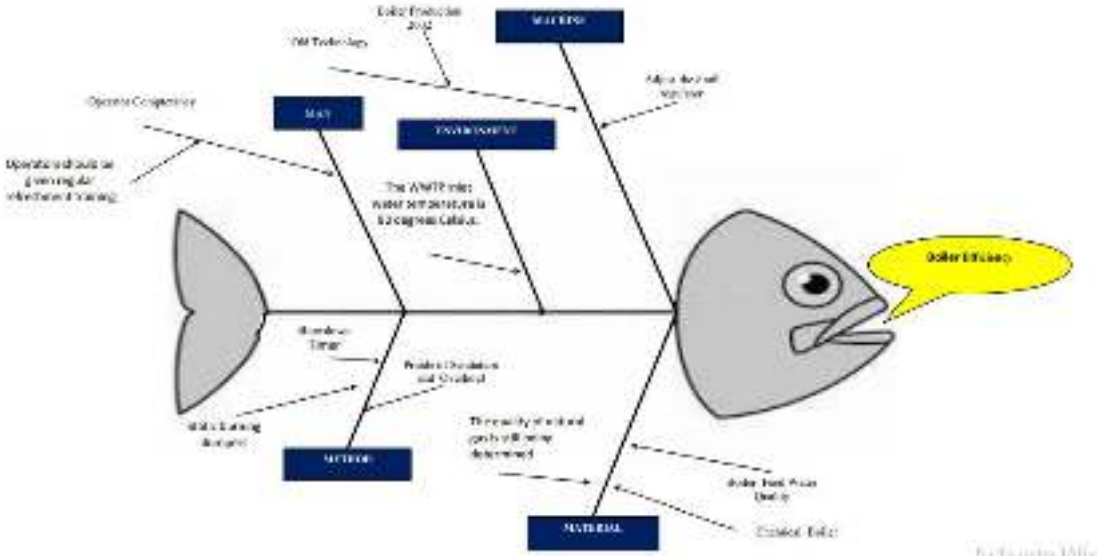

Figure 2. Fish Bone Diagram Identification of boiler problems at PT ADF

Failure Mode and Effect Analysis

According to Shekari & Fallahian, (2007), after finding the root cause of the problem occurring in the boiler in the PT ADF unit, a failure mode and effect analysis (FMEA) was prepared, which is one of the lean methodology tools that need to be combined with FMEA. Previous research has explained that implementing FMEA in an organization will produce synergy, eliminating everything that causes product failure and process problems. However, it cannot correctly analyze the identification of failures and processes. In the preparation of this FMEA, it will be known the priority of improvement that can be carried out based on the risk priority number (RPN). to get the risk priority number, Severity (S), Occurrence (O), and Detection (D) are first determined. Rating ratings are carried out by brainstorming the company according to the root causes of waste. Each value is obtained for occurrence, severity, and detection from the assessment results. Then the risk priority number is obtained, as shown in the following table.

Table 1. Title of table 1

Identification	***Failure Cause***	**Mean**			**RPN**	**%RPN**
		(S)	**(O)**	**(D)**		
Machine	Not equipped with Fuel Modulating	6	10	4	240	16%
Environment	The WWTP inlet water temperature from the boiler is 80 degrees Celsius.	7	10	6	420	29%
Man	Operators should be given regular refreshment training	5	6	1	30	2%
Material	The quality of natural gas is still being determined	4	4	7	112	8%
	Boiler feed water quality	6	5	7	210	14%
	Chemical Boiler	5	7	5	175	12%
Method	Static burning dumpers	7	10	4	280	19%

Based on the RPN critical values above, 4 (four) critical risks with the highest RPN values are obtained. Then an FMEA worksheet is made to determine the failure effect and Recommended actions for the four resulting wastes which can become the root cause of the problem. The effect must be analyzed, and recommendations sought as a mitigation effort and prevention so that failure in the form of waste does not recur.

Recommendation

FMEA identifies 5 alternative improvements based on Table 1:

1) Investment and installation of fuel modulating spare part.
2) Investment of back up spare part TDS sensor for replacing timer on blowdown boiler
3) Evaluation of resin condition at overhaul moment
4) Chemical cleaning for treatment of inside dumper
5) Reuse of boiler blowdown output for heating in the feed water tank and returning boiler condensate water to the feed water tank as make up water.

Potential Savings on Gas Usage

Recycle of boiler output from condensate water and blowdown boiler could reduce gas usage. It's used for preheating in the feed water tank. Potential saving cost calculation is:

a. The price of natural gas/ MMBTU in the East Java area is USD 10,03 (based on Desember 2022 with an exchange rate of Rp 15.247,00)
b. Operational time = 21 hours/day; 24 days/month; 288 days/year
c. Calorific value of fuel 9.000 kcal/kg or 37.800 kj/m^3
d. The water temperature in the inlet of feed water tank is 30^{o}C
e. The temperature after recycling is 70 ^{o}C.
f. Total return is 55% or 1.100 kg/hour.
g. Boiler efficiency at 80 %, then
h. The total energy recovery that can be obtained is.
   = {Total return of condensate x 4.2 x (T recycle – T inlet)}: Boiler Efficiency
   = {1.100 kg x 4.2 x (70-30)}: 80%= 231.000 kg/hour
i. Total Fuel Savings
   = Total Energy recovery: Calorific value of fuel
   = 231.000 kg/hour: 37.800 kg/m^3= 6,11 m^3/hour= 128 m^3/day = 36.960 m^3/year
j. Potential savings in natural gas usage for a year
   = Total Fuel Savings x Natural gas prices
   = 36.960 m^3/year x Rp 5.510 Rp/m^3= Rp 203.661.401 / year.

Potential Savings on Water Usage

Recycle of boiler output from condensate water and blowdown could reduce water usage. Its good suggestion for area where have poor quality of water resources or expensive treatment of water treatment process. Potential saving cost calculation is:

a. Cost of feed water PT. ADF = Rp 3.000/m^3
b. Cost of feed water treatment PT.ADF = Rp 2.000/m^3
c. Operational time = 21 hours/days; 24 days/month; 288 days/years
d. Total return of 55% or 1.100kg/hour = 6.652,8 m^3/tahun
e. Potential saving of water usage for a year:
   = Saving of water/year x (cost of feed water – cost of feed water treatment)
   = 6.652,8 m^3/tahun x (Rp 3.000/m^3 - Rp 2.000/m^3) = Rp 6.652.800 /year

Potential savings on wastewater treatment management

Reuse of boiler blowdown output for heating in the feed water tank should be potential saving in wastewater treatment management. Inlet water temperature decrease from 80^{o}C to 30-40^{o}C. It causes inhibitor at aerobic system in wastewater treatment plant. Potential saving cost calculation is:

a. Sludge IPAL reduction: 1.457 kg
b. Contents/box: 15 kg/box
c. Treatment cost/ box: Rp 850.000,00
   Treatment Cost total = (1.457kg: 15 kg/box) x Rp 850.000,00
   = Rp 83.300.000,00
d. Transport Cost/pallet: Rp 750.000,00
e. Contents/pallet: 2 box/pallet
   Transport Cost Total = (130box: 2 box/pallet) x Rp 750.000,00
   = Rp 48.750.000,00
   Saving Cost Total = Rp 132.050.000,00

6. CONCLUSION

The results of the data collection, data processing, data analysis and group discussion such as:

1) Root cause analysis with fish bone diagram shows 4 from 7 risk priority noticed are:
    a) No provide fuel modulating.
    b) Inlet water temperature less than 80oC
    c) Quality of make-up water boiler
    d) Cleaning and overhaul dumper method not clearly
2) PT ADF have 5 alternative suggestions for improve operational boiler and energy efficiency, for example:
    a) Investment and installation of fuel modulating part
    b) Investment of back up spare part TDS sensor for replacing timer on blowdown boiler
    c) Evaluation of resin condition at overhaul moment
    d) Chemical cleaning for treatment of inside dumper
    e) Reuse of boiler blowdown output for heating in the feed water tank and returning boiler condensate water to the feed water tank as make up water.

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RAW MILL PARAMETER OPTIMISATION TO REDUCE POWER CONSUMPTION USING RESPONSE SURFACE METHODOLOGY (RSM)

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ABSTRACT

In this study, parameter optimisation was done on industrial scale Vertical Roller Mill (VRM) for cement plant Raw Mill of PT. X. Response Surface Methodology with Box Behnken Design has been implemented to derived mathematical model of SEEC (Specific Electrical Energy Consumption) and product fineness effect due to VRM process key variables such as differential pressure mill, recirculation load, separator speed and hydraulic ratio. The obtained optimum parameters are 58.3 mBar differential pressure mill, 18.7 kW recirculation load, 1020 rpm separator speed and 0.35 hydraulic ratio. Confirmation test with optimised parameters affirming the responses prediction value. This indicates that the procedure in this study is reliable for reducing specific electrical energy consumption.

Keywords: Fineness, Optimisation, Response Surface Methodology, Specific Electrical Energy Consumption, Vertical Roller Mill.

1. INTRODUCTION

Efficient operation and good product quality are main targets for manufacturer since years. Now, due to the COVID pandemic and tight competition, these two become more and more important. This is also what happened in Indonesia's cement industry. All cement company try to maintain their customer by providing high quality product with competitive price. These can be fulfilled with stable and efficient operation.

Cement industry is one kind of industry that need a lot of energy. Variable cost of typical cement industry showing that 25 % of the cost is coming from electrical energy cost. Grinding section (Raw Mill and Finish Mill) in the cement plant is responsible for 50 – 75 % of the electrical consumption. This is indicating that grinding section should become a target for electrical efficiency program. Efficient use of electrical energy become a key factor that cement industry can operate with low cost.

Some literature showing that optimisation study on Vertical Roller Mill (VRM) already done by researchers. Chang Liu (2022) had a research using RSM on Laboratory Scale Vertical Roller Mill (VRM). It found that working pressure has significant effect to the grinding efficiency and power consumption compared to the table speed and moisture content. While in Industrial Scale VRM, several methods already implemented. Pareek (2021) found that stable operation parameter is a key to achieve better productivity for Vertical Roller Mill in cement plant. Reasons for process disturbances and break downs could be addressed using seven QC tools to achieve

stable operation. VRM improvement in Ghalandari (2021) is using energy and exergy analysis to evaluate efficiency and improve power consumption in Vertical Roller Mill. It found that parameters such as separator speed, roller pressure and air flow give significant effect to the operational efficiency of Vertical Roller Mill. From above literature, it is important for having optimum parameter setting to achieve efficient Vertical Roller Mill operation.

This study will be focus on optimising operational parameter for Raw Mill VRM of PT. X. It uses Response Surface Methodology (RSM) Box Behnken Design to find the relationship of process parameters (differential pressure mill, recirculation load, separator speed and hydraulic ratio) on the grinding performances of VRM. In this study, VRM grinding performances are represented by power consumption (SEEC; Specific Electrical Energy Consumption) and product fineness. For the optimisation, it uses desirability function approach and overlaid contour plot.

2. LITERATURE REVIEW

2.1 Raw Mill Vertical Roller Mill

There are several types of Raw Mill in cement plant. The latest technology is the Vertical Roller Mill type. It is known for its efficiency and compactness. VRM has several functions such as: grinding, separating, mixing, drying and transporting. In VRM, material is fed on the centre of the mill table. Due to the centrifugal forces, material is spread all around the table passing through between roller and mill table. Roller for VRM is equipped with hydraulic system that transmit pressure force to material. Grinding process (size reduction) is occur during this process. After passing through the roller, material comes to the edge of table and caught by hot vertical gas flow. During this process, drying is happen.

Coarse material that cannot be lifted by gas is falling down to scrapper and mechanically circulated back to the VRM feeding chute as material recirculation. While fine material is lifted up to the classifier that separating fine material (product) and the coarse one. Coarse material sent back to the VRM centre table, mixed together with material feed.

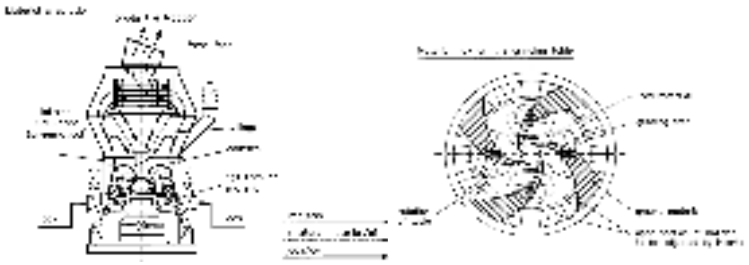

Figure 1. Grinding Process Inside Mill
(Grinding Manual in Cement Industry, 2009)

2.2 Vertical Roller Mill Process Parameters

Vertical Roller Mill main objectives is to achieve optimum production rate into certain fineness target at lowest power consumption. Polysius (2012), in the VRM Manual Operation, explain that there are several key parameters important to achieve VRM efficient operation. The parameters mentioned such as differential pressure mill, feed rate, working pressure, separator speed and recirculation load. Some parameters are explained below:

- Differential pressure of the mill is negative pressure (draught) that measured on the mill inlet and mill outlet. Differential pressure mill depends on the amount of the material inside mill (internal recirculation) and on the air flow through the mill.

- Feed rate is the amount of material that fed to the mill. The product (raw meal) has to achieve certain fineness target.
- Working pressure is the amount of pressure that implemented to roller of VRM. Higher working pressure will result higher grinding force to material.
- Separator speed is a controlled variable that determines fineness of product. Higher separator speed will result finer product.
- Recirculation load is the amount of material that falling through in the edge of the mill table (not lifted up by gas to classifier). The material is mechanically transported back to the feed chute of the mill. Recirculation load is not defined by the flow rate of material (tph) but the power absorbed by mechanical equipment transporting the material.

Parameters mentioned above are monitored and maintained to achieve low power consumption and as per target product fineness. Power consumption in the Raw Mill VRM is described as Specific Electrical Energy Consumption (SEEC). SEEC is a result of total power consumed by VRM system (main drive, fan, separator, auxiliary system etc) divided by mill production. Meanwhile, product fineness in Raw Mill is described as product residue in 90 um screen.

2.3 Response Surface Methodology and Optimisation

Referring to Montgomery (2013), Response Surface Methodology is a collection of mathematical and statistical techniques that could be used to analysis problem in which a response of interest is influenced by several variables. Based on the simulated data, RSM is used to establish relationship between operation parameters and its response. This relationship is then used to find optimum operation parameters and responses.

There are several design of experiment that can be used to collect data for RSM but the most common design is Central Composite Design (CCD) and Box Behnken Design (BBD). Both experimental design is suitable for second order polynomial but CCD contain *star point* (α) that need high operating parameter setting level.

Many RSM problem involves analysis and optimisation of several responses. Montgomery (2013) explain that in multiple response optimisation, RSM could use overlaid contour plot and desirability function to find optimum. Overlaid contour plot is a straight forward method of optimisation by using responses contour plot figure. This method works well when there are only a few process variables. Meanwhile, desirability function is a method that convert each response to a dimensionless measure of performance that can be defined as follow:

Objective function is to be minimized

$$d = \begin{cases} 1 & y < T \\ \left(\frac{U-y}{U-T}\right)^r & T \leq y \leq U \\ 0 & y > U \end{cases}$$

Objective function is to be on target

$$d = \begin{cases} 0 & y<L \\ \left(\frac{y-L}{T-L}\right)^{r_1} & L \le y \le T \\ \left(\frac{U-y}{U-T}\right)^{r_2} & T \le y \le U \\ 0 & y>U \end{cases}$$

The desirability objective function D is a combination from individual desirability

$$D = (d_1 . d_2 . \dots d_m)^{\frac{1}{m}}$$

d_i : individual desirability

U : upper limit

L : lower limit

r : weight of response

D : composite desirability

m : response number

3. METHODS

This study attempted to determine optimum operation parameter for Raw Mill VRM operation. Raw Mill VRM used for this study is Polysius QMR 45/23. The specifications of VRM is as follows : mill table diameter 4.5 m, mill roller diameter 2.3 m, roller width 0.75 m, number of roller 4 pcs, roller inclination 0°. Material feeding composition during trial is 78 % limestone, 15 % clay, 3.5 % high grade limestone, 2.5 % silica and 1 % copper slag.

Differential pressure mill (DP Mill), recirculation load, separator speed and hydraulic ratio are the input parameters used in this study. Hydraulic ratio is the ratio of working pressure divided by the feed rate. Data used for this study is stable operation data 8 hours running of Raw Mill. Table 1 shows how each parameters divided into three levels. In here, two responses will be optimised. These are Specific Electrical Energy Consumption (SEEC) and product fineness.

Table 1. Operating Parameters and Experiment Design Level

No	Parameters	Level		
		Low (-1)	**Middle (0)**	**High (1)**
1	DP Mill (x_1)	52 mBar	55 mBar	58 mBar
2	Recirculation Load (x_2)	19 kW	20 kW	21 kW
3	Separator Speed (x_3)	1000 rpm	1020 rpm	1040 rpm
4	Hydraulic Ratio (x_4)	0.31 bar/tph	0.33 bar/tph	0.35 bar/tph

Box Behnken Design was chosen method for the RSM design of experiment. This is due to its simplicity and less experiment need to generate information. Meanwhile, for optimisation of responses, desirability function and overlaid contour plot method is employed. Optimum parameters then verified through confirmation test and analysed the benefit that obtained.

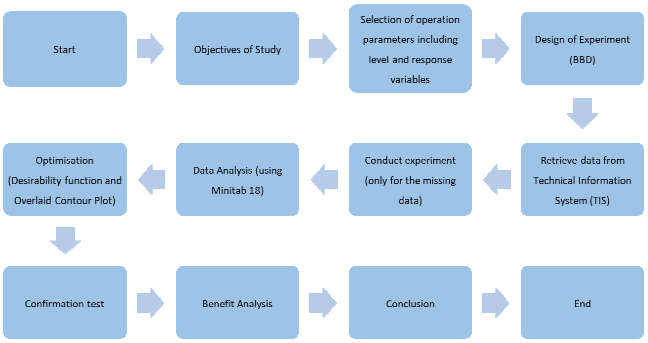

Figure 2. Research Flow Chart

4. RESULTS

4.1 Design of Experiment

To get a representative result, operation parameter data for BBD table is taken from 8 hours running continue Raw Mill operation. The Box Behnken Design parameters and responses are showed in Table 2.

Table 2. Box Behnken Design Experiment

No	x_1	x_2	x_3	x_4	x_1 (mbar)	x_2 (kW)	x_3 (rpm)	x_4 (Bar/tph)	y_1 (kwh/t)	y_2 (%)
1	0	-1	1	0	54.23	19.24	1050	0.32	15.32	14.14
2	0	0	-1	1	54.39	20.33	1010	0.34	14.92	13.81
3	0	0	-1	-1	55.99	20.36	1000	0.31	14.92	15.58
4	0	0	1	1	54.35	20.13	1040	0.34	15.72	14.67
5	0	-1	-1	0	55.88	18.8	990	0.33	14.41	14.06
6	0	1	0	1	55.6	20.64	1018	0.36	15.68	14.34
7	-1	-1	0	0	52.03	19.31	1020	0.33	15.94	13.76
8	0	1	1	0	55.77	20.52	1040	0.32	14.56	11.98
9	0	-1	0	1	55.99	18.81	1030	0.35	14.25	13.4
10	0	-1	0	-1	54.18	18.67	1020	0.32	14.02	12.2
11	1	-1	0	0	57	19.5	1030	0.34	14.18	13.37
12	0	0	0	0	54.44	19.83	1015	0.33	15.54	12.46

13	0	0	0	0	55.14	19.56	1025	0.34	14.45	13.07
14	-1	0	0	1	52.35	19.85	1020	0.34	15.55	15.17
15	1	0	1	0	57	20.12	1040	0.32	14.42	14.54
16	0	0	0	0	55.8	19.73	1015	0.32	15.08	13.98
17	0	1	-1	0	54.58	20.5	1000	0.33	15.57	13.77
18	-1	0	1	0	52.72	20.28	1033	0.32	15.24	13.85
19	1	0	-1	0	57.01	20.22	1000	0.32	15.07	15.69
20	1	1	0	0	58.29	21.23	1020	0.32	14.58	14.34
21	-1	0	-1	0	51.76	19.79	1000	0.33	15.94	15.56
22	-1	1	0	0	52.48	20.8	1012	0.33	16.44	15.83
23	1	0	0	1	57.34	19.76	1030	0.35	15.4	15.3
24	-1	0	0	-1	52.54	20.13	1030	0.30	14.74	13.3
25	0	1	0	-1	54.45	21.1	1020	0.32	16.1	13.57
26	1	0	0	-1	58.17	20.42	1030	0.30	14.08	14.74
27	0	0	1	-1	54.15	19.94	1050	0.32	15.28	14.19

Parameters used in this study is a process variable. Due to the nature of Raw Mill process operation, the value of parameters is not exactly the same as the parameters level setting as BBD. T test with $\alpha = 0.05$ was taken to ensure the data for all level is relevant with the level setting. Resume of the T test is showed in Table 3 below.

Table 3. T test for Experimental Data

Level	Differential Pressure Mill (x_1)		Recirculation Load (x_2)		Separator Speed (x_3)		Hydraulic Ratio (x_4)		Notes
	μ_0	P value T test	μ_0	P value T test	μ_0	P value T test	μ_0	P value T test	
-1	52	0.083	19	0.706	1000	1	0.31	0.695	P value T test > 0.05 Data on the range μ_0
0	55	0.984	20	0.670	1020	0.175	0.33	0.096	P value T test > 0.05 Data on the range μ_0
1	58	0.084	21	0.168	1040	0.461	0.35	0.363	P value T test > 0.05 Data on the range μ_0

4.2 Analysis of Variance (ANOVA)

Analysis of Variance is used to explore the influence of each parameter to SEEC and product fineness responses. The analysis start with second order polynomial equation which consist of main factor (linear), interaction factor and also quadratic. Insignificant polynomial factors are then eliminated based on the influence of factor to the response. The significant influence of the factor can be seen from the P value (F function) on the ANOVA result. The

elimination of the polynomial factor should result on better relationship equation which having lower standard deviation (S) and higher R-sq (adjusted). Level of significance (α) 0.05 is used on ANOVA analysis.

4.2.1 ANOVA of Specific Electrical Energy Consumption (SEEC) Response

Figure 3 gives optimum ANOVA result for Specific Electrical Energy Consumption result.

Regression Analysis: Y1 versus X1; X2; X3; X4

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	6	8,3597	1,3933	8,53	0,000
X1	1	5,2554	5,2554	32,18	0,000
X2	1	3,4125	3,4125	20,89	0,000
X3	1	0,6393	0,6393	3,91	0,062
X4	1	0,3488	0,3488	2,14	0,159
X3*X3	1	0,4717	0,4717	2,89	0,105
X3*X4	1	0,3620	0,3620	2,22	0,152
Error	20	3,2664	0,1633		
Total	26	11,6261			

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	851	403	2,11	0,047	
X1	-0,2558	0,0451	-5,67	0,000	1,12
X2	0,599	0,131	4,57	0,000	1,18
X3	-1,344	0,680	-1,98	0,062	17885,49
X4	-917	627	-1,46	0,159	12686,48
X3*X3	0,000512	0,000301	1,70	0,105	14651,40
X3*X4	0,912	0,612	1,49	0,152	13645,60

Regression Equation

Y1 = 851 - 0,2558 X1 + 0,599 X2 - 1,344 X3 - 917 X4 + 0,000512 X3*X3 + 0,912 X3*X4

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0,404129	71,90%	63,48%	50,73%

Figure 3. ANOVA for SEEC Response

Some of polynomial factor in ANOVA result, that indicating higher than 0.05 P value, still kept on the equation because the elimination of this factor resulting worst standard deviation and lower R-sq adjusted. R-sq adjusted of this equation is 63.48 %. It means that 63.48 % of the responses could be explained with this equation. This is considered as a good relationship between input and response variables. The prediction model SEEC can be given as:

$$y1 = 851 - 0.2558\,x1 + 0.599x2 - 1.344x3 - 917x4 + 0.000512x3 * x3 + 0.912x3 * x4$$

y_1 = Specific Electrical Energy Consumption (SEEC)

x_1 = Differential Pressure Mill

x_2 = Recirculation load

x_3 = Separator speed

x_4 = Hydraulic Ratio

Equation resulted from ANOVA should follow several residual assumption to ensure the prediction is valid and not biased. The residual assumption could be evaluated through graphic and numeric. Figure 4 below showing the residual graphic for SEEC. Graph indicates the residual is following normal distribution (top-left and bottom-left). Linearity assumption is indicating

in the top- right graph. There is no pattern of residual and it is distributed evenly for positive and negative residual throughout prediction value. Independent assumption is indicating in the bottom right graph. Residual is distributed on positive and negative residual throughout observation order. Table 4 is displaying numerical residual evaluation. It needs to be noted that the equation resulted here is not applicable to other equipment and materials due to different equipment physical condition and material composition.

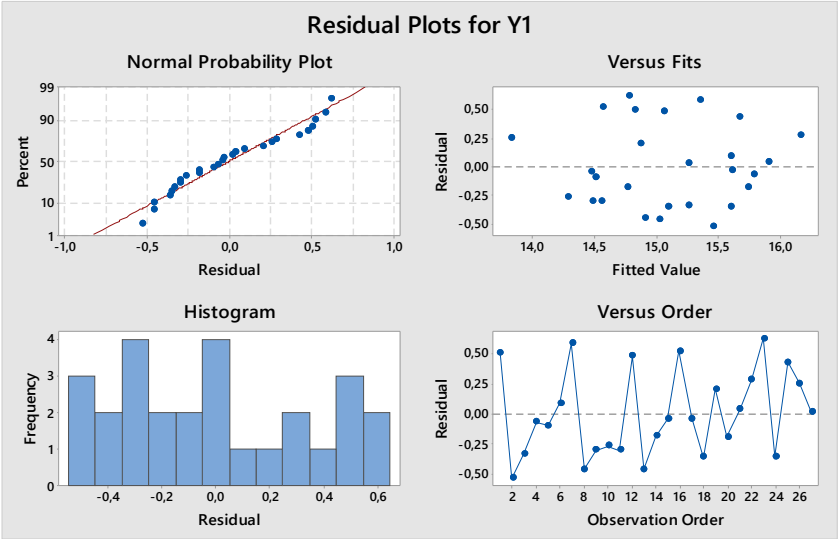

Figure 4. Residual Plots for SEEC Response

Table 4. Residual Assumption Test for SEEC Response

Assumption	**Test**	**P value / Durbin Watson value**				**Notes**
Linearity	Spearman rho	x_1	x_2	x_3	x_4	No correlation (homoscedasticity)
		0.943	0.37	0.642	0.964	
Independent	Durbin Watson	2.216				No autocorrelation
Normal Distribution	Kolmogorov Smirnov	> 0.150				Normal distribution residual

4.2.2 ANOVA of Product Fineness Response

Same treatment also done with ANOVA for the product fineness response. Figure 5 below gives optimum ANOVA result for product fineness.

Regression Analysis: Y2 versus X1; X2; X3; X4

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	12	23,8313	1,9859	7,25	0,000
X1	1	3,0185	3,0185	11,02	0,005
X2	1	1,3018	1,3018	4,75	0,047
X3	1	6,8219	6,8219	24,90	0,000
X4	1	3,8551	3,8551	14,07	0,002
X1*X1	1	10,4776	10,4776	38,25	0,000
X3*X3	1	6,7438	6,7438	24,62	0,000
X4*X4	1	0,9858	0,9858	3,60	0,079
X1*X2	1	2,8462	2,8462	10,39	0,006
X1*X4	1	1,5933	1,5933	5,82	0,030
X2*X3	1	1,0241	1,0241	3,74	0,074
X2*X4	1	1,7266	1,7266	6,30	0,025
X3*X4	1	3,9782	3,9782	14,52	0,002
Error	14	3,8354	0,2740		
Total	26	27,6667			

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	3406	740	4,61	0,000	
X1	-14,66	4,42	-3,32	0,005	6419,25
X2	32,7	15,0	2,18	0,047	9213,73
X3	-5,10	1,02	-4,99	0,000	24141,86
X4	-4363	1163	-3,75	0,002	26005,35
X1*X1	0,2386	0,0386	6,18	0,000	5919,89
X3*X3	0,002166	0,000436	4,95	0,000	18345,95
X4*X4	843	444	1,90	0,079	1643,64
X1*X2	-0,397	0,123	-3,22	0,006	4409,09
X1*X4	-11,14	4,62	-2,41	0,030	1970,11
X2*X3	-0,0238	0,0123	-1,93	0,074	7549,07
X2*X4	42,0	16,7	2,51	0,025	2733,87
X3*X4	3,515	0,922	3,81	0,002	18449,56

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0,523408	86,14%	74,25%	46,79%

Regression Equation

Y2 = 3406 - 14,66 X1 + 32,7 X2 - 5,10 X3 - 4363 X4 + 0,2386 X1*X1 + 0,002166 X3*X3 + 843 X4*X4 - 0,397 X1*X2 - 11,14 X1*X4 - 0,0238 X2*X3 + 42,0 X2*X4 + 3,515 X3*X4

Figure 5. ANOVA for Product Fineness Response

Polynomial factor elimination based on significance also applied to the relationship equation for product fineness. Some of polynomial factor having P value slightly higher than 0.05 still kept on the equation to maintain standard deviation and R-sq adjusted. R-sq adjusted of this equation is 74.25 %. It means that 74.25 % of the responses could be explained with this equation. This is considered as a good relationship between input and response variables. The prediction model fineness can be given as:

$$y2 = 3406 - 14.66x1 + 32.7x2 - 5.10x3 - 4363x4 + 0.2386x1 * x1 + 0.002166x3 * x3 + 843x4 * x4 - 0.397x1 * x2 - 11.14x1 * x4 - 0.0238x2 * x3 + 42x2 * x4 + 3.515x3 * x4$$

y_2 = Product fineness

x_1 = Differential Pressure Mill

x_2 = Recirculation load

x_3 = Separator speed

x_4 = Hydraulic Ratio

Figure 6 below showing the residual graphic for product fineness. Graph indicates the residual is following normal distribution (top-left and bottom-left). Linearity assumption is indicating in the top- right graph. There is no pattern of residual and it is distributed evenly for positive and negative residual throughout prediction value. Independent assumption is indicating in the bottom right graph. Residual is distributed positive and negative residual throughout observation order. Table 5 is displaying numerical residual evaluation.

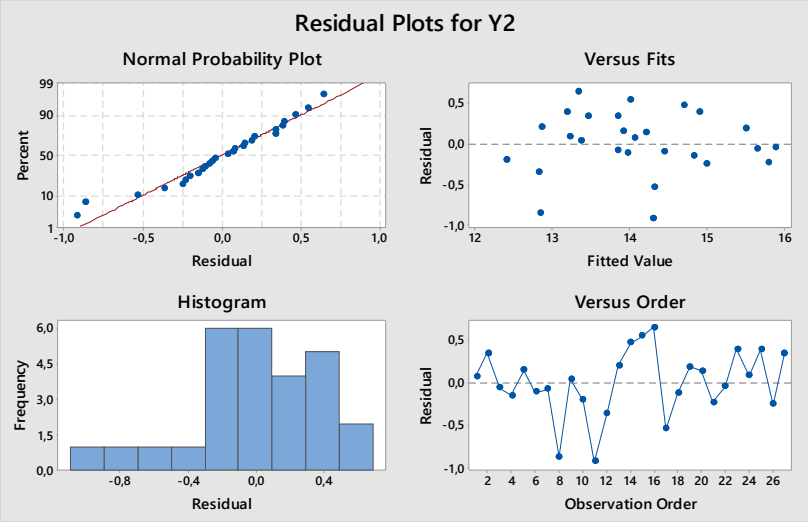

Figure 6. Residual Plots for Product Fineness Response

Table 5. Residual Assumption Test for Product Fineness Response

Assumption	**Test**	**P value / Durbin Watson value**				**Notes**
Linearity	Spearman rho	x_1	x_2	x_3	x_4	No correlation (homoscedasticity)
		0.274	0.923	0.627	0.779	
Independent	Durbin Watson	1.591				Inconclusive
Normal Distribution	Kolmogorov Smirnov	> 0.150				Normal distribution residual

4.3 Multi Objective Optimisation

In this study, optimisation was done by using desirability function in Minitab. The weight and importance of the responses is adjustable depend on the need. In this case both of the responses sett as balance weight and importance. The overall desirability simultaneously consider SEEC and product fineness. Table of the desirability function and the result is presented on Table 6 and Figure 7. Optimum desirability achieved on parameter with x_1 = 55.8 mBar, x_2=18.6 kW, x_3=1050 rpm, x_4=0.30 bar/tph.

Table 6. Desirability Function Setting Value

Response	**Objective**	**Lo Value**	**Target**	**Hi Value**	**Weight**	**Importance**
y_1	Minimise	12	12	15.8	1	1
y_2	On Target	14	15	16	1	1

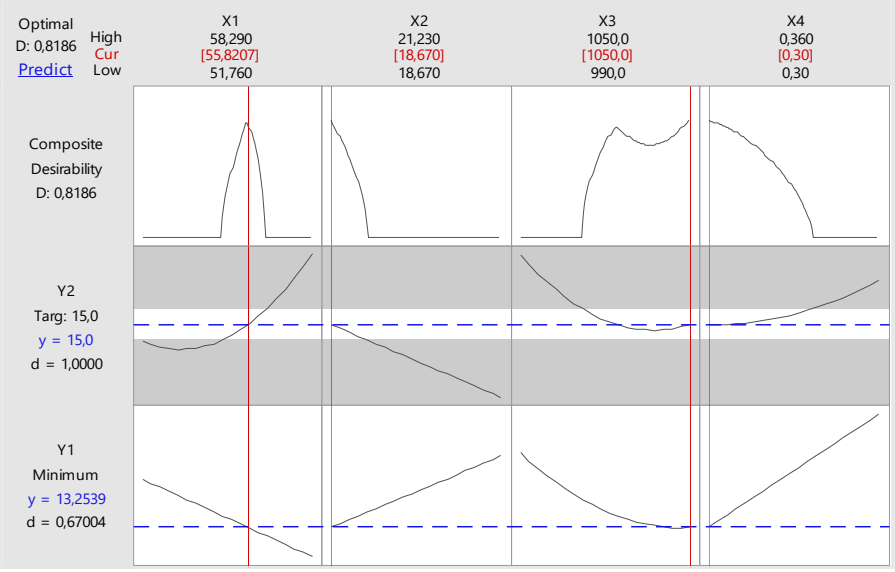

Figure 7. Desirability Function Optimisation Result

The optimisation result is then verified by an experiment. The result of the experiment is not satisfying due to high error in the prediction value. Operation analysis indicating that the material processed currently is having low grindability (harder to grind). This is making optimum setting from desirability function that have low hydraulic ratio is not applicable.

Table 7. Confirmation Test for Desirability Function Parameters

Trial	**Power Consumption y_1**			**Fineness y_2**		
	Trial	**Predict**	**Error**	**Trial**	**Predict**	**Error**
Trial 1	16.14	13.36	17 %	14.3	17.1	-20 %
Trial 2	16.23	13.36	18 %			

Next optimisation was done by using overlaid contour plot with high setting of hydraulic ratio. Contour plot is displayed on Figure 8. Overlaid contour plat resulting optimum value on parameter with x_1 = 58.3 mBar, x_2=18.7 kW, x_3=1020 rpm, x_4=0.35 bar/tph. The optimisation result is then verified by an experiment. The result of experiment is displayed on Table 8. It is showing low prediction error (less than 10 %) and the average power consumption is 14.31 kWh/t. This number is 0.78 kWh/t (5 %) less than average BBD experiment data (15.09 kWh/t).

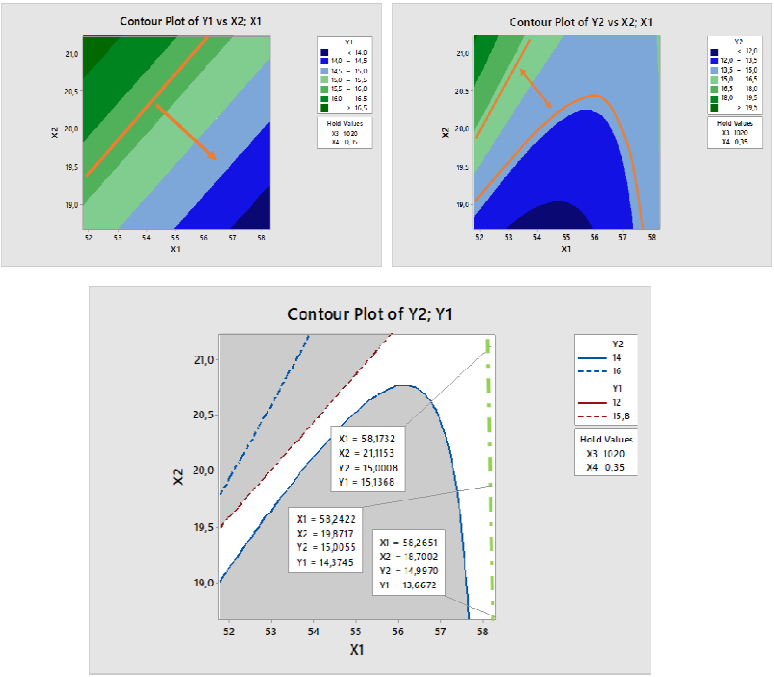

Figure 8. Overlaid Contour Plot Optimisation Result

Table 8. Confirmation Test for Overlaid Contour Plot Parameters

Trial	**Power Consumption y_1**			**Fineness y_2**		
	Trial	**Predict**	**Error**	**Trial**	**Predict**	**Error**
Trial 1	14.31	13.36	6.6 %	14.8	16.2	-9.4 %
Trial 2	14.16	13.61	3.9 %	15.3	16.4	-7.1 %
Trial 3	14.46	13.95	3.5 %	15.9	16.3	-2.4 %
Average	14.31		4.6 %	15.3		-6.3 %

6. CONCLUSIONS

Response Surface Methodology (RSM) was used in the industrial Raw Mill VRM to investigate the influence of operating parameters such as differential pressure mill, recirculation load, separator speed and hydraulic ratio to Specific Electrical Energy Consumption (SEEC) and product fineness. Equation models result from RSM is having good R-sq (adjusted) and low standard deviation thus indicating both equation models are representative and RSM is valid to develop equation model.

Furthermore, the developed equation models is then optimised using desirability function and overlaid contour plot. The optimal parameters for SEEC and product fineness are as follow x_1 = 58.3 mBar, x_2=18.7 kW, x_3=1020 rpm, x_4=0.35 bar/tph. Confirmation test with optimised parameters affirming the responses prediction value. The procedure implemented in this study is confirmed to be reliable for reducing specific electrical energy consumption.

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SOCIAL MEDIA MARKETING STRATEGY TO INCREASE BODY CARE PRODUCT' BRAND AWARENESS

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ABSTRACT

More than two billion internet users have used social media. This makes various companies compete to offer their products or services on the platform. Every effort is made to get the attention of active users of social media, causing a competitive environment among similar companies. Body lotion products have almost the same general benefits when offering their products. This study aims to design a marketing strategy in an effort to increase brand awareness through social media for the body lotion product with salmon DNA as the main composition. The marketing mix and triangulation technique that aligns with the results of interviews, questionnaires, and observations is used to formulate a SWOT for the product. The SWOT is then used as input in the TOWS matrix to obtain alternative strategies. There are six alternative strategies related to increasing brand awareness of the body lotion product, including utilizing social media advertising and SEO features, creating AI filters, creating interactive content, offering giveaways, creating taglines or something easy to remember, and using influencers in various circles.

Keywords: Social media marketing, brand awareness, marketing mix, SWOT, TOWS matrix

1. INTRODUCTION

Today, almost everyone with internet access has used social media. Social media keeps everyone connected in real time and facilitates the sharing of information. This is a great opportunity for companies to market their products (Arora & Sharma, 2013). Social media networks have become an important part of people's lives. which is then used by marketers to expand the scope of their customers (Akbar & Özgül, 2018). Social media is becoming an important part of their online marketing strategy. Social media marketing is a commercial marketing activity that utilizes social media to influence consumer buying (Chen & Lin, 2019). The main objective of marketing activities is to increase product sales. As a result, businesses must understand customer needs and seize market opportunities by developing a marketing mix. The marketing mix has evolved from the 4Ps (product, price, place, and promotion) to the 4Cs (customer, cost, convenience, and communication). The 4Ps are a classic marketing strategy in which distribution channels and sales patterns for products or services are determined from the company's perspective. In contrast, the 4Cs are the four components of the marketing mix seen from the customer's perspective (Jianting & Feng, 2012). Currently, customers not only buy and use products but also participate in new product development (Kang & Kim, 2018). By combining

these two concepts (4Ps and 4Cs), the company can find out the product criteria that the market wants.

In addition, to enable the selection of a brand by customers, companies must ensure that customers know about the brand. This is known as brand awareness (Seo & Park, 2018). Brand awareness indicates that customers are aware of the existence of products bearing specific brands on the market, allowing these brands to be considered by customers (Macdonald & Sharp, 2000). Various studies state that brand awareness is obtained by companies using social media channels (Dabbous & Barakat, 2020) (Nguyen & Nguyen, 2020) (Stojanovic, Andreu, & Perez, 2018). Social media helps companies build relationships with customers and potential customers. Active use of social media has a positive influence on brand awareness (Bilgin, 2018). A Marketing strategy is needed if a company wants to use social media to increase brand awareness. This study used a body lotion product with the main content of salmon DNA as a research object. The research objective is to formulate alternative strategies related to increasing brand awareness through social media marketing. This strategy will be created by conducting marketing mix and SWOT analysis on the product.

2. LITERATURE REVIEW

2.1 Social Media Marketing

Social media marketing is a marketing activity carried out through an online communication platform where people share thoughts, knowledge, information, comments, their daily lives, and experiences (Bilgin, 2018). Social media marketing can influence other people to carry out an activity, such as purchasing a product, and influence their beliefs about a brand or product (Godey, et al., 2016). This is due to positive comments or feedback from customers that can be seen by other social media users.

The benefit of social media is that it removes space and time barriers to interacting with one another, making information delivery and feedback more effective and widespread. In addition, companies can establish relationships with individual customers and access information about customers or markets. information such as likes, jobs, and personalities from customers and others (Seo & Park, 2018). Furthermore, social media marketing can be used to educate potential consumers about brands (Akbar & Özgül, 2018). Social media is a smart way to build brands. Social media platforms are known to be one of the most powerful and fast means of branding (Arora & Sharma, 2013).

2.2 Brand Awareness

Brand awareness refers to the ability of customers to identify or recognize certain brands (Seo & Park, 2018). Brand awareness is the customer's ability to recognize a brand when given instructions, for example, a logo (Berry, 2000). With brand awareness, there is a chance that customers will buy the brand, or it can be said that brand awareness has a role in the purchasing decision-making process (Huang & Sarigöllü, 2014). The purchasing decision-making process consists of five stages, starting with the process of need recognition, information search, alternative evaluation, purchase, and post-purchase process (Stankevich, 2017). This framework is similar to the hierarchy of effects (HOE) model, which focuses more on customer relationships with certain brands (Figure 1).

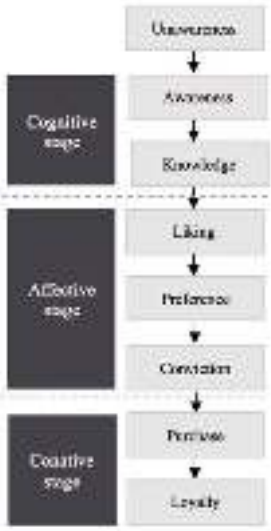

Figure 1. HOE framework

The HOE model explains that customers will first achieve awareness and knowledge about a brand or product, then develop positive or negative feelings towards the brand, and finally decide to buy or avoid the brand (Hutter, Hautz, & Fuller, 2013). In the HOE model, brand awareness is important because it represents the first step in reaching the next stage. Products with good brand awareness can win customer preference and increase their purchase intention (Graciola, Toni, Milan, & Eberle, 2020).

2.3 Marketing Mix

Marketing mix is a conceptual framework used by businesses to translate marketing plans into offers that meet the needs of their customers (Goi, 2009). The shift from a marketing-oriented company to a customer-driven company changed the concept of the 4Ps to the 4Cs (Sefudin, 2017). The 4Cs were first introduced in 1990 by Professor Lauterborn, who redefined the four basic components in the marketing mix, namely: customer solution, cost, convenience, and communication. 4Cs is a marketing mix model that makes customer satisfaction a top priority (from the consumer's perspective). In practice, the 4Ps and 4Cs are not interchangeable with each other, but it is possible to flexibly combine the two concepts. If the 4Ps are used as a basic approach to reach the target market and meet market needs, then the 4Cs can strengthen the 4Ps concept by emphasizing the approach to consumers. The following is a combined concept between the 4Ps and 4Cs (Jianting & Feng, 2012):

1) Product - oriented model based on customer need (from customer to product)
2) Price - oriented model based on consumers' ability to pay (from the cost to the price)
3) Placement based on convenience (from the convenience to place)
4) Products promotion based on communication (from communication to promotion)

2.4 SWOT Analysis

SWOT is an acronym for strengths, weaknesses, opportunities, and threats. SWOT analysis is a tool for effectively analyzing the environment, whose structure is grouped into internal (strengths and weaknesses) and external (opportunities and threats) environments. SWOT analysis is usually carried out in complex business environments to formulate or plan business strategies (Helms & Nixon, 2010). SWOT analysis is a situational analysis that is used to determine strengths that can be built, weaknesses that must be covered, opportunities that can be captured, and threats that must be fought (Duarte, Ettkin, Helms, & Anderson, 2006).

2.5 TOWS Matrix

The TOWS matrix is a conceptual framework for identifying systematic relationships among threats, opportunities, weaknesses, and strengths and offers a structure for generating strategies on the basis of these relationships (Aslan, Çınar, & Kumpikaitė, 2012). The strategy is made by maximizing strengths (S) and opportunities (O) and minimizing weaknesses (W) and threats (T). The TOWS matrix (Table 1) has four types of strategies that can be formulated, namely (Ravanavar & Charantimath, 2012):

1) Strength-Opportunity Strategy (Maxi-Maxi) is a strategy that uses internal strengths to take advantage of opportunities.
2) Weakness-Opportunity Strategy (Mini-Maxi) is a strategy to overcome organizational weaknesses by taking advantage of opportunities.
3) Strength-Threat Strategy (Maxi-Mini) is a strategy that utilizes strengths to avoid or reduce the effects of threats.
4) Weakness-Threat Strategy (Mini-Mini), namely defensive tactics aimed at reducing internal weaknesses and avoiding external threats.

Table 1. TOWS matrix

TOWS MATRIX	Strengths (S)	Weaknesses (W)
	S1 S2 S3 . . SZ	W1 W2 W3 . . WZ
Opportunities (O)	**SO Strategy**	**WO Strategy**
O1 O2 O3 . . OZ	SO-1 SO-2 SO-3 . . SO-Z	WO-1 WO-2 WO-3 . . WO-Z
Threats (T)	**ST Strategy**	**WT Strategy**
T1 T2 T3 . . TZ	ST-1 ST-2 ST-3 . . ST-Z	WT-1 WT-2 WT-3 . . WT-Z

3. METHODS

The data in this study were obtained using a triangulation technique. Triangulation offers a variety of techniques to support research findings that focus on increasing validity by varying data (Ashour, 2018). The data collection technique used in this study involved interviewing several body lotion product owners, distributing online questionnaires to 110 random respondents, as well as observing similar competitors and relevant journals. The results from the three sources are used to formulate the company's SWOT analysis which is also supported by marketing mix.

4. RESULTS

4.1 Respondent Profile

The majority of respondents are between 24-39 years (64,5%). The rest is 27,3% <24 years, 8,2% >39 years. Next, 72,7% of respondent are females and the rest is males. By jobs, private sector employees are the most dominant (29,1%), students (23,6%), government employees (10,9%), self-employed (9,1%), and 27.3% many kinds of profession.

4.2 Analysis and Discussion

1. Marketing Mix

1) Product - oriented model based on customer need (from customer to product)
   More than 50% of respondents chose a body lotion size with a composition of 100–200 ml. From the results of the questionnaire, the main benefit you want to get from using body lotion products is that they protect you from the sun and make your skin look brighter. Salmon DNA has the main function of making the skin more luminous.
2) Price - oriented model based on consumers' ability to pay (from the cost to the price)
   From the results of the questionnaire, the willingness of customers to buy body lotion products is in the price range of IDR 25,000 – IDR 50,000 with a percentage of 55.5% of respondents. Considering the various costs, various body lotion products containing salmon DNA cannot be offered at that price range. The price offered ranges from IDR 51,000 – IDR 100,000. When viewed from the results of the questionnaire, there were as many as 27.3% of the respondents who were willing to buy body lotion products in that price range.
3) Placement based on convenience (from the convenience to place)
   Customers still prefer to purchase body lotion products from marketplaces and physical stores. Product placement in a relatively easy marketplace provides an opportunity for companies to reach customers who are more comfortable shopping online. Placement in physical stores that are easy for customers to reach, such as Indomaret and Alfamart, is still a challenge. Therefore, the distribution strategy of utilizing the reseller system is expected to reach customers who are more comfortable buying products directly.
4) Products promotion based on communication (from communication to promotion)
   Social media is one of the most popular promotional media that can be used to communicate interactively with customers. Utilizing various social media platforms to reach customers on their favorite platforms is the best option.

2. Triangulated Data

The triangulation data shown in Table 2 is data that compares the results of interviews, observations, and questionnaires.

Table 2. Triangulated Data

Interviews Data	Questionnaires Data	Observations Data
BPOM permission already exists before the product is distributed	83.6% of respondents stated that BPOM permits were very important	The main consideration in choosing beauty products is product safety (Zap, 2021)
The main function of body lotion with a special ingredient of salmon DNA is to lighten the skin	Bright skin is the reason for using body lotion	The thing that makes a woman feel beautiful is having fair skin (Zap, 2021)

The product price is not more than IDR 100,000	Affordable prices are the reason customers choose the brand in question	Making body lotion with tolling services requires a small amount of capital (Author, 2020)
Various brands of body lotion only issue body care products	85.8% of respondents are currently using body lotion products	Public awareness of caring for the body increases (Culliney, 2020) (Rahmadianti, 2021) (Gerstell, Marchessou, Schmidt, & Spagnuolo, 2020)
To optimally promote their products, various social media platforms will be used	75% of respondents use social media to get information about a product	Social media is the most frequently used source of information (Ameliah, Negara, & Rahmawati, 2021)
To maintain relations with resellers, a distribution system and price regulations will be made	50,9% of respondents consider price as a consideration in choosing a product	There are differences in prices for the same product specifications carried by resellers
Salmon DNA body lotion is widely issued by individual businesses (local products)	70 out of 110 respondents have used body lotion products sold by well-known companies	The top product in the body lotion category is dominated by products issued by well-known companies, namely Vaseline (Ramadhani, 2022)

3. SWOT Analysis

Based on triangulation data, the SWOT analysis of salmon DNA body lotion can be described as follows:

1) Strengths
   - Have BPOM legality
   - Diversification of unique products
   - Concentration on a single product line
   - Competitive pricing
   - Prioritizing customer and reseller satisfaction
2) Weaknesses
   - Dependence on suppliers is very high
   - Human resources and management are inexperienced
   - Difficulties conducting market research
   - Mastery of technology is lacking
3) Opportunities
   - The market opportunity is getting bigger
   - Information submission is more effective
   - The cost of social media advertising is relatively cheap
   - Rapid technological development
4) Threats
   - New players are easy to appear
   - Replacement or similar products are easy to find
   - Unfair price competition
   - Lack of trust in individual new products
   - Products can be counterfeited

4. TOWS Matrix

The TOWS matrix is used to develop strategies on the basis of a systematic relationship between the company's strengths, weaknesses, opportunities, and threats. From this matrix, there are four categories of strategies that can be generated:

Table 3. TOWS matrix body lotion product

TOWS MATRIX	***STRENGTHS (S)***	***WEAKNESSES (W)***
	S1: Have BPOM legality S2: Diversification of unique products S3: Concentration on a single product line S4: Competitive pricing S5: Prioritizing customer and reseller satisfaction	W1: Dependence on suppliers is very high W2: HR and management are inexperienced W3: Difficulties conducting market research W4: Mastery of technology is lacking
OPPORTUNITIES (O)	***SO Strategies***	***WO Strategies***
O1: The market opportunity is getting bigger O2: Information submission is more effective O3: The cost of social media advertising is relatively cheap O4: Rapid technological development	1) two-way interactions to the content created (S5, O2) 2) Utilizing AI technology that is currently in demand by social media users, such as creating unique and interesting filters (S5, O4) 3) Make a tagline, jingle, or something easy to remember (S3, O2, O3) 4) Using influencer services in various circles to further convince customers (S2, S5, O3)	1) Utilizing social media to find out the latest market trends, consumer behavior, and their wants or needs (W3, O2) 2) Divert advertising budgets for HR development (W2, W4, O3) 3) Utilizing video tutorials or information from social media as a tool to optimize the use of technology, such as social media SEO and advertising features on social media (W4, O2)
***Threats* (T)**	***ST Strategies***	***WT Strategies***
T1: New players are easy to appear T2: Replacement or similar products are easy to find T3: Unfair price competition T4: Lack of trust in individual new products T5: Products can be counterfeited	1) Develop creative ideas to create unique products that are difficult to imitate (S2, T1) 2) Offers various attractive facilities, such as providing guarantees, prize draws, giveaways, and others (S4, S5, T2) 3) Educating customers about products with BPOM permits that have been guaranteed (S1, T4) 4) Establishing sustainable relationships with resellers and forming a solid team (S5, T3)	1) Collaborate with suppliers to innovate new products regularly (W1, T1) 2) Improve management systems and make maximum use of technology so that they can compete with domestic and foreign competitors (W2, W4, T4) 3) Utilizing technology to prevent fraud, such as using QR codes on products (W4, T3, T4, T5)

From the alternative strategies that have been formulated in the TOWS matrix, there are six strategies related to increasing brand awareness of salmon DNA body lotion. The alternative strategies are:

1) Engage customers in social media activities or apply two-way interactions to the content created. Companies can take advantage of social media by creating creative content to grow brand awareness. This content can be in the form of entertainment such as games, challenges, anecdotes, or dynamic animations. Quality content and high levels of interaction between

brands and social media users make it easier for marketers to grow brand awareness (Dabbous & Barakat, 2020).

2) Utilizing AI technology that is currently in demand by social media users, such as making filters. Companies can create unique and attractive filters by incorporating brand elements into them, like the famous brand L'Oreal Paris did
3) Make a tagline, jingle, or something easy to remember. Examples: L'Oreal (because you're worth it), MS Glow (magic for skin), Wardah (inspiring beauty), and others.
4) Using influencer services in various circles to further convince customers. Influencers are influential people who have many followers and can influence their audience.
5) Optimizing the use of search engine optimization (SEO) technology and advertising features on social media. Instagram SEO is the process of optimizing content to rank profiles higher in Instagram search results. By utilizing this SEO, accounts or content have the opportunity to appear at the top of search results, making it easier to grow social media user brand awareness. In addition, advertising features are also useful in growing brand awareness if the advertisements delivered are interesting and creative and recognize the criteria of the intended customers
6) Provides a variety of appealing features such as guarantees, prize draws, giveaways, and so on. This method can increase interaction with customers and even make sales.

6. CONCLUSIONS

Social media marketing clearly affects brand awareness. Based on the findings and discussion, the alternative strategies obtained from the TOWS matrix are 14 and consist of four SO strategies, three WO strategies, four ST strategies, and three WT strategies. Meanwhile, six alternative strategies are related to increasing brand awareness through social media. Alternative marketing strategies should be implemented while keeping the company's budget in mind and in line with its business plan. Internal parties are expected to be able to compile the results of each implementation of alternative strategies so that the implementation of the strategy can be evaluated. For future research, Strategy formulation through the TOWS matrix is carried out with a qualitative and subjective assessment. So, it is suggested for further research to conduct focus group discussions between researchers, company internal parties, and business consultants in formulating strategies.

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ANALYSIS OF INVESMENT DECISIONS IN THE POWER SUPPLY PROCUREMENT PROJECT ON THE PHE-30 PLATFORM AT PT PHE WMO WITH AHP AND TOPSIS METHODS

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ABSTRACT

PT PHE WMO as an oil and gas company with one of the production fields offshore platform PHE-30 plans installing power supply in this platform replace power barge rental. With its main function as a production system and high investment value, this investment project is expected to be carried out well. It's necessary to carry out investment decisions so the investment limit of the project is known, it's is still economical to proceed or not.

Making project decision can be subjective and creating any conflict of interest. In order to get the best and objective decision this research will apply AHP and TOPSIS methods. These criterias are financial criteria and technical criteria. Financial criteria consists of total goverment income, NPV and POT. And technical criteria consists of delivery time, conventionality, flexibility, design and integrity.

Based on calculation, financial criteria that's 0,75 of weight more important than technical criteria that's 0,25. NPV that's highest weight, that's 0,425, and flexibility has the lowest weight, that's 0,025. With AHP method, the highest weight 0,15, and has relative closeness from ideal solution based on TOPSIS. The changes of the financial more important than technical criteria, that is install DEG by building extension deck platform.

Key words : Oil & Gas Offshore; Power Supply Investment; Project Alternative; AHP; Topsis

1. INTRODUCTION

PT Pertamina Hulu Energi (PT. PHE) is a Cooperation Contract Contractor (KKKS) company with a production sharing system that carries out business activities in the upstream oil and gas sector. One of the fields owned by PT. PHE is the West Madura Offshore (WMO) field which consists of the PHE-30 Platform located in Madura district, East Java. The WMO Platform PHE-30 field has two types of production wells, namely natural flow wells and artificial lift types with a total oil production of 230 Barrel Oil Per Day (BOPD) and gas of 0.5 Million Sufficient Cubic Feet per Day (MMSCFD).

In each oil well with an artificial lift type, the ESP pump requires electricity to drive an electric motor as an auxiliary tool for oil and gas production from inside the production well. The availability of electric power currently uses a set of Power Barges installed together with Variable Speed Diesel (VSD) in each well. The need for Power Barge is provided by a third party with a rental system.

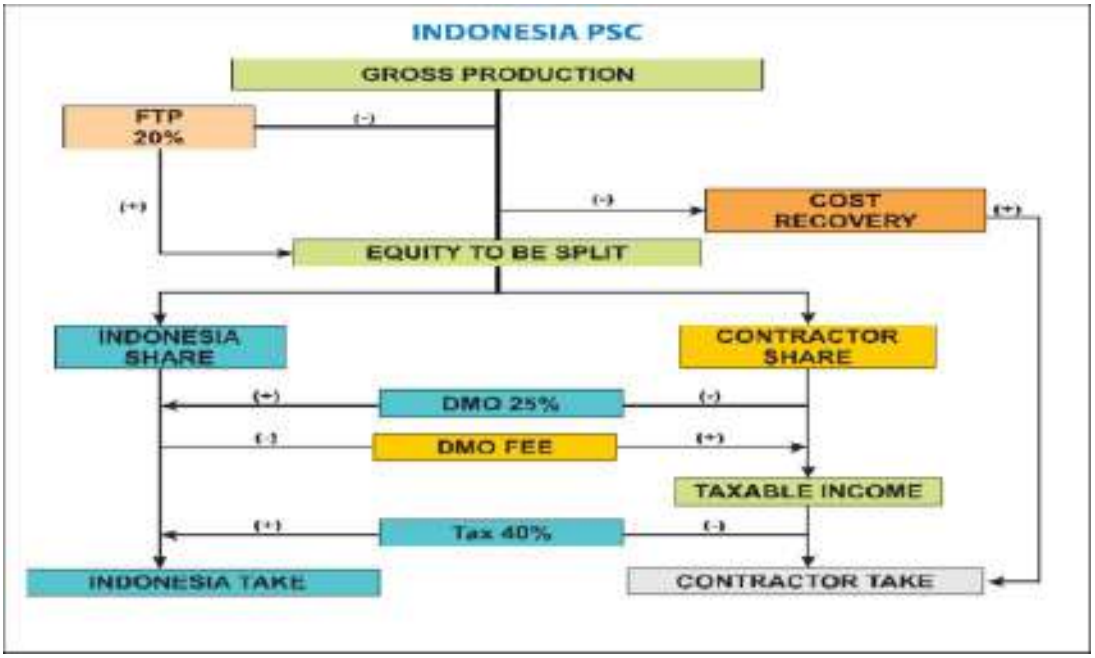
In order to maintain continuity of production and reliability of the electric power system, in March 2022 a budget proposal was made using the Authorization for Expenditures (AFE) to the Oil and Gas Special Task Force (SKK Migas) for the PHE-30 PHE WMO Power Supply project. The project objective is to have Surface Facilities Equipment installed, including a Power Genset, on the PHE-30

platform, it will ensure the availability of electricity to supply ESP's needs and continuity of production can be maintained.

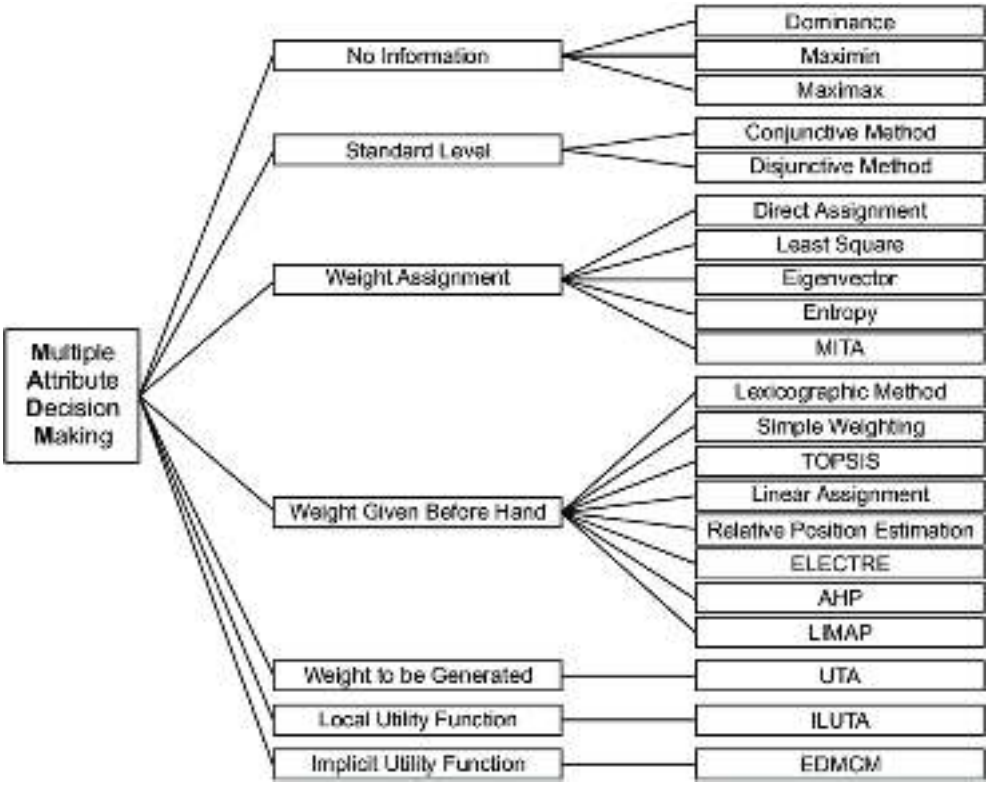
This power supply system will used as the main oil and gas production system in this platform replace power barge rental. With its main function as a production system and high investment value, this investment project is expected to be carried out well. Things that can affect this investment include variable production figures which continue to decline each year. Then the uncertain oil price variable fluctuation will certainly affect this investment. So that it's necessary to carry out investment decisions so that the investment limit of the project is known, at what level the investment is still economical to proceed or not.

2. LITERATURE REVIEW

In calculating the cash flow of oil and gas industry projects with a production sharing contract (PSC) system between oil and gas companies and the Indonesian government, there is a separate calculation method. The Production Sharing Contract (PSC) calculation model with a cost recovery system is regulated according to Law No. 22 of the Republic of Indonesia (2001) and can be explained in Figure below:



The process of selecting power supply investment project has become a problem with multiple criteria in contradictive situation. Existing methods in solving problems on Multi Attribute Decision Making (MADM), reference from the book Multiple Criteria Decision Support in Engineering Design, Pratyush Sen and Jian Bo which can be seen in the Figure below:



The Analytical Hierarchy Process (AHP) was introduced by DR Thomas L Saaty in the early 1970s. At that time AHP was used to support decision making in several companies and governments. Decision making is done in stages from the lowest level to the top. In the decision-making process with AHP, there are problem-solving objectives with several levels of criteria and alternatives.

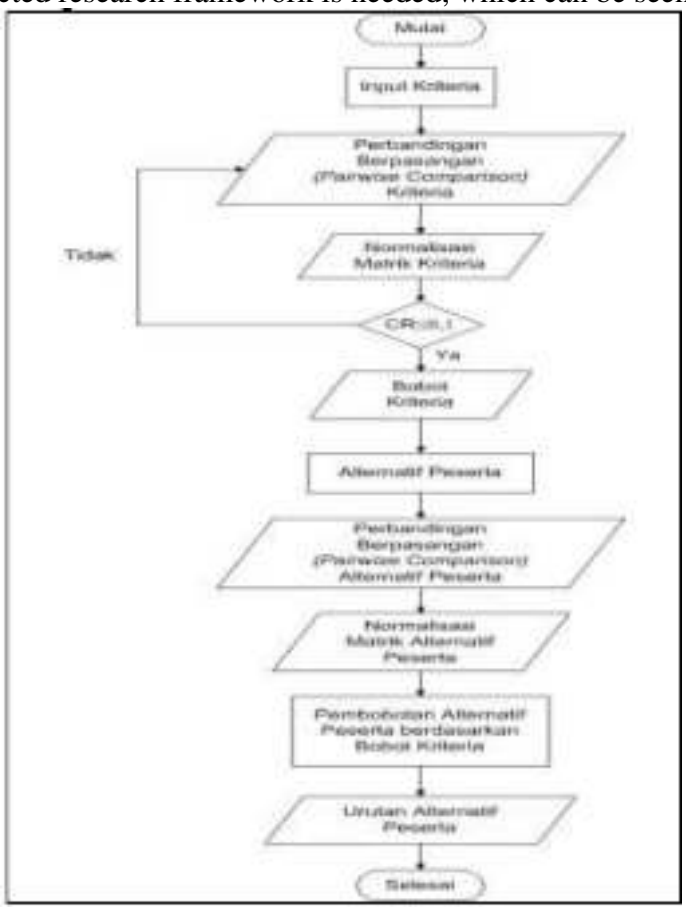
TOPSIS is a multicriteria decision making method that was first introduced by Yoon and Hwang (1981). TOPSIS uses the principle that the selected alternative must have the shortest distance from the positive ideal solution and the farthest from the negative ideal solution from a geometric point of view by using Euclidean distance to determine the relative proximity of an alternative to the optimal solution.

3. METHODS

Literature study is carried out by collecting various relevant information that can be used, either in the form of theoretical concepts, methods, or previous studies. The results of this literature study can come from textbooks or research reports in the form of journals that can be used as research references, including research on the analysis of construction project decision making both onshore and offshore, the theory of the Analytical Hierarchy Process (AHP) method and the theory of the Technique method for Order Preference by Similarity to Ideal Solution (TOPSIS).

In somecases of company, making a project decision can be subjective and creating any conflict of interest. In order to get the best and objective decision and comply good corporate governance principal, this research will apply Analytical Hierarchy Process and TOPSIS methods. These criterias are considering in this research's decision are financial criteria and technical criteria. Financial criteria consists of total goverment income, net present value and pay out time. And technical criteria consists of delivery time of project, conventionality, flexibility, process design and integrity.

This research methodology is useful as a reference so that research can run systematically, in accordance with the objectives and time of research. To obtain results that are right on target, a systematic, clear and directed research framework is needed, which can be seen in the Figure below:



Reasons and Description of Financial Evaluation Criteria are:

- Total Goverment Income
- NPV (Net Present Value)
- POT (Pay Out Time)

Reasons and Description of Technical Evaluation Criteria are:

- Project Schedule
- Conventionality
- Flexibility
- Process
- Integrity

The pairwise comparison matrix is made by referring to the comparative judgment data that has been made on each criterion and sub-criteria.

	Financial Criteria	Technical Criteria
Financial Criteria	1	1/3
Technical Criteria	1/3	1

By using the Expert Choice software, from the two tables pairwise comparisons for financial and technical criteria can be calculated consistency index as follows:

No.	Matrix	CI
1	Criteria	0.00
2	Financial Criteria	0.00
3	Technical Criteria	0.08

Sub-Criteria	CI
Total Goverment Income	0,05
NPV	0,06
POT	0,09
Schedule / Delivery Time	0,08
Conventionality	0,02
Flexibility	0,06
Process	0,05
Integrity	0,04

Alternative Global Weight With AHP Method Approach

Alternative	Weight	Rank
1	0,095	6
2	0,132	3
3	0,063	8
4	0,128	4
5	0,053	10
6	0,147	2
7	0,077	7
8	0,150	1
9	0,057	9
10	0,098	5

With the TOPSIS Method Approach

Alternative	Weight	Rank
1	0,095	6
2	0,132	5
3	0,063	8
4	0,128	3
5	0,053	7
6	0,147	2
7	0,077	9
8	0,150	1
9	0,057	10
10	0,098	4

4. RESULTS

Based on calculation, showed that financial criteria which has 0,75 of weight is more important than technical criteria which has 0,25 weight in getting decision from some provided alternatives. In sub criteria level, NPV has the highest weight, that is 0,425, and sub criteria flexibility has the lowest weight, that is 0,025. The best alternative decision from some provided options is alternative-2, that is to install Diesel Engine Generator (DEG) which has by building extension deck offshore platform. Based on AHP method, that alternative has the highest weight, that is 0,15, and has relative closeness from ideal solution based on TOPSIS method. Sensitivity analysis showed that the changes of the financial criteria is equally important with technical criteria, investment project alternative-2 is the best choice.

Global Weight

No	Description	Weight
1	**Financial Criteria**	**0.75**
a	Total Goverment Income	0.107
b	NPV	0.429
c	POT	0.214
2	**Technical Criteria**	**0.25**
a	Schedule / Delivery Time	0.024
b	Conventionality	0.097
c	Flexibility	0.021
d	Process	0.055
e	Integrity	0.053

5. CONCLUSIONS

The proportion of weighted criteria that influences the selection of alternative investment projects is financial criteria with a weight of 0.75 and technical criteria with a weight of 0.25. This can be interpreted that financial criteria are more important than technical criteria. In terms of financial criteria, the most influential sub-criteria is Net Present Value with a weight of 0.429; then Pay Out Time with a weight of 0.214 and Total Government Income with a weight of 0.107. On technical criteria, the most sub-criteria effect is conventionality with a weight of 0.097; furthermore process design with a weight of 0.055; integrity with a weight of 0.053; schedule/delivery time project with a weight of 0.024 and flexibility with weight 0.021.

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FEASIBILITY STUDY OF PT X PROPERTY BUSINESS DEVELOPMENT

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ABSTRACT

The property business is an activity carried out by individuals and companies engaged in the field of asset ownership, especially property assets such as buildings and land and the infrastructure in it. This property business is categorized as a long-term business whose activities include buying and selling land and buildings, leasing land and buildings and working on vacant land into housing. XYZ City is the second largest city in Indonesia. The growth of the property market in XYZ City in 2022 has doubled compared to the same period in 2020, and when compared to 2019 sales have grown 20%. The development of the landed house market in XYZ City itself is still quite strong. The development of landed houses is carried out as an effort to anticipate the development trend of the property market and the increasing needs of the people in XYZ City.

This research aims to see how much the region needs residential property, identify PT.X's strategic plan in business development, and evaluate the feasibility of PT.X's property development. The method used quantitatively using Discounted Cash Flow (DCF) analysis is based on the design of a financial model that presents the initial investment/outlay required, annual cashflow and terminal value which will then be used as a basis for seeing the feasibility of the investment. Based on the analysis conducted, the results show that the property development investment is feasible with a positive NPV of 93,962,975,228 and an IRR of 27%.

Keywords: Housing Needs, Feasibility Study, PESTLE, DCF

1. INTRODUCTION

Business activities carried out by individuals and companies engaged in the field of asset ownership, especially property assets, such as buildings and land as well as all facilities and infrastructure in it as a unit is the definition of the property business. This property business itself is categorized as a long-term business whose activities include buying and selling land and buildings, leasing land and buildings and working on vacant land into housing or other buildings (Aridiyawan, 2022).

The residential property business is a very popular business in Indonesia today. Examples of property products for this category include residential housing, flats, apartments, hotels, dormitories or messes.

XYZ City is the second largest city in Indonesia with an area of 33,451.1 Km2. XYZ City is known as a trade and service city with large companies located in XYZ City Center. The Gross Regional Domestic Product (GRDP) in 2021 at Constant Prices of Surabaya City is IDR 407.7 Trillion, while the Regional Original Income of XYZ City in 2021 is IDR 8,649,815,762,648, - from the 2021 Regional Budget of XYZ City of IDR 8,966,428,340,891. Based on data from the Population and Civil Registry Office of XYZ City, the population of XYZ City in 2021 is 2,970,952 people.

By considering the growing regional needs for housing and supporting products and also seeing the strengths and PT. X plans to carry out further business development by expanding the scope of the business which not only manages the assets currently owned by the company, but furthermore strives to provide various property products needed by the community and affordable according to the purchasing power of the people in XYZ City.

In this study, researchers also looked at how much property needs in XYZ City and whether the development plan is feasible in XYZ City.

2. LITERATURE REVIEW

Business Property

To know the characteristics of the property business, what needs to be known from the property business itself is the definition of the property business and the property business process. According to (Supriyanto,2011), property is a legal / non-physical concept such as proof of ownership of rights in the form of land certificates or the like. Meanwhile, according to the Decree of the Minister of State for Public Housing No. 5/KPTS/BK4PN/1995 in (Waluyo,2014) property is defined as land rights or permanent buildings that are the object of ownership and development (article 1 number 4).

In general, according to Boston (2014), property can be classified into 4 types based on its intended use, namely residential, open space, commercial, and industrial. This classification is commonly used in conducting assessments of property objects such as determining property values or tax assessments of property.

Types of Property

Based on the function and purpose of use according to (Santoso,2009), property can be classified into 4 groups, namely Commercial, Housing, Industry, Public Facilities.

Financial Aspect

Financial feasibility analysis is a tool used to assess the possible benefits of an investment. The purpose of financial feasibility analysis is to avoid spending too much capital on activities that turn out to be unprofitable (Husnan and Suwarsono, 1997). Financial aspects are related to determining the need for the amount of funds as well as their allocation and finding sources of funds that are related efficiently so as to provide maximum profit (Suratman,2002).

NPV

Net Present Value is a financial analysis method that pays attention to changes in the value of money due to the time factor; projected cash flows can be valued now (the initial period of investment) through value deduction with a deduction factor associated with the cost of capital

(interest percentage) (Subagyo,2007). The project will be considered feasible if the NPV is positive and not feasible if the NPV is negative.

$$NPV = \sum_{(n)}^{n} \frac{(C)t}{(1+i)n} - \sum_{(n)}^{n} \frac{(Co)t}{(1+i)n}$$

Description:

NP : Net present value
(C)t : Year t cash inflow
(Co)t : Cash outflow in year t
N : age of the business unit resulting from the investment
I : Rate of return
T : time

IRR

Internal Rate of Return is a method of assessing project feasibility using the extension of the present value method. In the position of NPV = 0, a certain percentage rate will be obtained. The project is considered feasible if the IRR is greater than the percentage of the cost of capital (credit interest) or in accordance with the percentage of profit set by the investor, and vice versa, the project is considered unfeasible if the IRR is smaller than the cost of capital or lower than the investor's wishes (Subagyo, 2007).

$$IRR = i_2 \frac{NPV_2 x(i_2 - i_1)}{NPV_1 + NPV_2}$$

Payback Period

Payback period is the period of time needed to pay back all the costs that have been incurred in investing in a project with the results obtained by the investment (Gitosudarmo and Basri, 1989). The basic reason for the payback period method is that the faster an investment can be recouped, the more desirable the investment is. If the investment will be assessed using the payback period assessment criteria, the maximum payback period is determined in advance. In decision making, it is compared between the maximum payback period that has been determined with the payback period of the investment to be carried out, if the payback period of the investment to be carried out is shorter in time than the required maximum payback period, the investment will be carried out (Gitosudarmo and Basri, 1989).

Discounted Cash Flow (DCF)

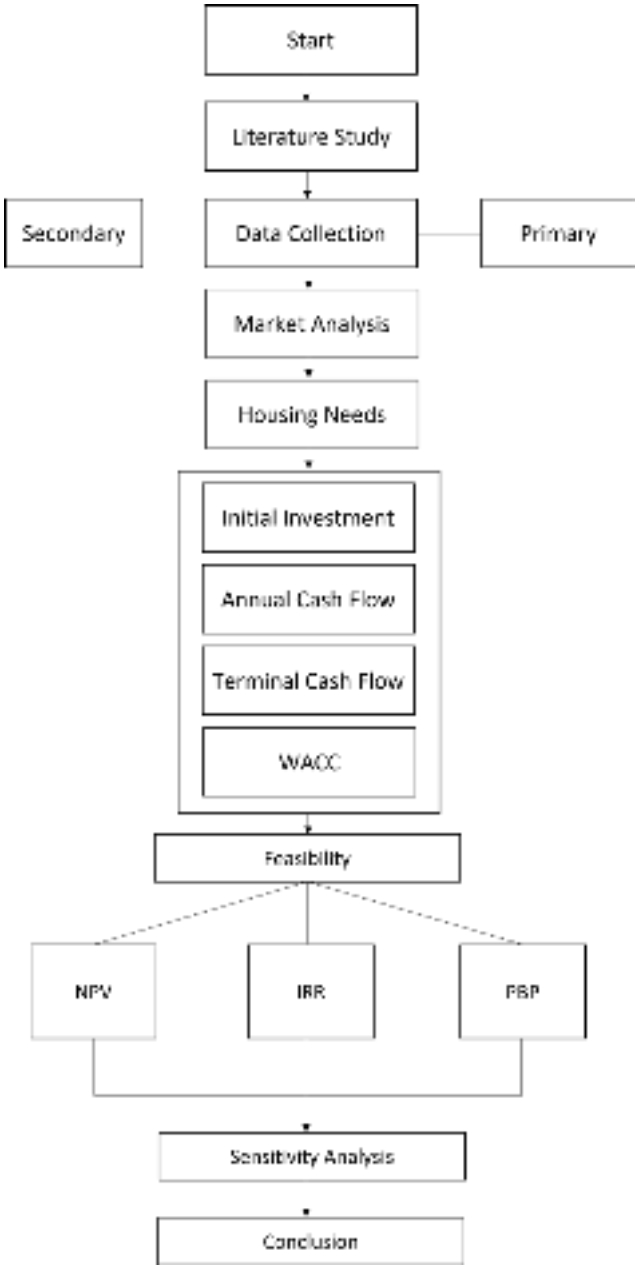
The Discounted Cash Flow (DCF) method is a valuation method that uses the concept of time value of money. According to Damodaran (2002), Discounted Cash Flow is a stock valuation method that uses Future Free Cash Flow (FFCF) and discounted Weighted Average Cost of Capital (WACC) to obtain potential future value in carrying out investments. Damodaran (2002) also argues that Discounted cash flow is used to value equity in a business, to value the company as a whole, and to value a small part of the company.

Discounted Cash Flow aims to estimate the present value of future expected returns on an investment. DCF estimates the present value of an asset by discounting the company's expected future operating cash flows to determine intrinsic value and determine whether the price is sufficient to compensate investors for the risks taken. So it can be concluded that DCF is an evaluation method used by investors to estimate the present value of future cash inflows from an investment to determine whether the investment is feasible or not.

Analysis using discounted cash flow is the most thorough way to conduct business valuation. To find discounted cash flow, requires the calculation of the free cash flow of the object of valuation. After knowing the free cash flow for each period, then calculate the net present value for each period. To find out the discount rate value that is suitable for the object of valuation, it is necessary to calculate the weighted average cost of capital (WACC) which will be used as a discount rate or discount rate of the value obtained.

3. METHODS

Framework



Data Collection

In the market and marketing analysis, questionnaires will be distributed online using google form media. The questionnaire distributed uses a multiple choice model. Respondents for the questionnaire from this study are Surabaya residents with an age range of 20 to 64 years and work as laborers / employees / workers based on XYZ City data in 2022 figures.

Market Analysis and Housing Needs

At this stage, the calculation of housing needs (backlog) will be carried out both in Surabaya City and Gresik Regency. The calculation of housing needs is carried out with the assumption that each dwelling is inhabited by one household consisting of 4 people, namely father, mother, and 2 children. The backlog calculation method is to determine the number of housing needs per sub-district and then subtract the number of available dwellings. As a limitation, available dwellings are landed houses.

Financial Aspect

Calculating initial investment, annual cash flow, terminal cash flow, and WACC.

Feasibility

Based on the business development plan to meet the needs of the community, a feasibility analysis will be carried out by calculating NPV, IRR, and payback period.

Sensitivity Analysis

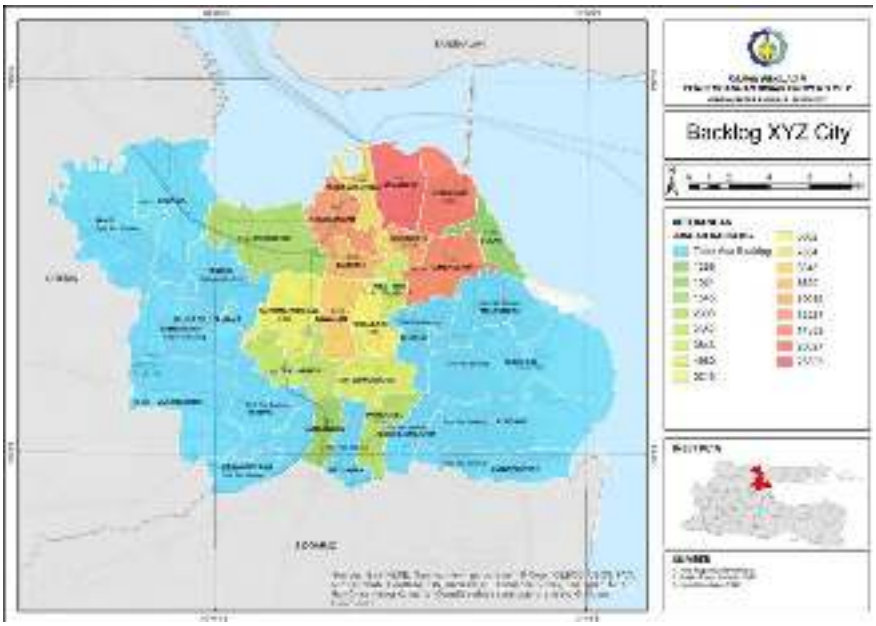
Sensitivity analysis is used to determine how much influence a decision has on changes in the parameters that influence it. In this analysis, the parameters that are changed are the percent increase in price and the number of units sold.

4. RESULTS

Market Analysis

The data obtained from distributing questionnaires shows that the respondents of this questionnaire are male as much as 44.1% and female as much as 55.9%. 74.5% of respondents live in XYZ City. 53.1% of respondents already own a house / place of residence. The age of respondents ranged from 26-30 years old. The average respondent's job is a private employee with a monthly income of 5 - 10 million. 57.9% of respondents are looking for housing with data that 86.2% of respondents want to buy housing in XYZ city with an area above 100m2 and have a minimalist design with a price range of 100-500 million.

Housing Needs



Residential property demand in XYZ City is 22%

Initial Investment

The initial investment in this project is the construction cost of building a flat that will be implemented in 2023, which is Rp. 131,869,235,506 obtained from GBA of 17,400m2 with a construction cost of Rp. 6,470,000 per square meter.

Annual Cash Flow

For valuation using the Discounted Cash Flow (DCF) method, there are 3 choices of cash flow to discount, namely dividends, net cash flow for equity and net cash flow for the company. In this study, the Net Cash Flow that will be used as Economic Income discounted to be an indication of business value is the net cash flow for the company (Free Cash Flow Firm). The definition of net cash flow is that the cash flow obtained is free of liabilities for providing capital expenditure, both to maintain the company's current operations and to provide reserves for replacement, working capital, and for growth through the provision of additional funds for capital expenditure.

The reason for choosing net cash flow for calculation at PT X is because the company's leverage level changes every year. Under these conditions, it is necessary to calculate adjustments to the optimal capital structure mix which is a mix of equity and loans that will optimize the rate of return to shareholders.

Terminal Cash Flow

At this stage, the determination of the terminal cash flow that occurs during the PT X property investment period is carried out. The calculation of terminal cash flow can be done through several approaches, one of which is the cash flow approach. In the cash flow approach, one component that often gets attention is net income. Thus, the expected trend of increasing the value of net income from time to time must be clearly identified.

It can be seen that the Terminal Cash Flow in this project is 425,984,715,938.

LAPORAN ARUS KAS

DESKRIPSI	2021	2022	2023	2024	2025	2026	2027	2028	2029
Arus Kas dari Aktivitas Investasi									
Dana yang dibatasi penggunaannya	6,547,306,875	-	-	-	-	-	-	-	-
Tanah untuk pengembangan	1,679,592,615	(18,264,000,000)	(16,667,000,000)	(15,750,000,000)	(14,511,000,000)	(13,851,000,000)	(9,977,000,000)	-	-
Properti investasi	(24,941,383,250)	-	-	-	-	-	-	-	-
Pembelian aset tetap	(968,015,659)	-	-	-	-	-	-	-	-
Uang muka pembelian tanah	(203,500,000)	-	-	-	-	-	-	-	-
Aset lain-lain	(108,450,484)	-	-	-	-	-	-	-	-
Kas bersih diperoleh dari (digunakan untuk) aktivitas inve	(17,994,449,903)	(18,264,000,000)	(16,667,000,000)	(15,750,000,000)	(14,511,000,000)	(13,851,000,000)	(9,977,000,000)	-	-
Arus Kas dari Aktivitas Pendanaan									
Dividen	(6,547,116,727)	-	-	-	-	-	-	-	-
Kas bersih digunakan untuk aktivitas pendanaan	(6,547,116,727)	-	-	-	-	-	-	-	-
Kenaikan/(penurunan) arus kas	(14,598,752,220)	(117,993,255,158)	(71,504,846,521)	79,155,845,836	119,797,986,627	65,639,946,745	(8,158,807,362)	(24,285,428,566)	244,033,278,437
Arus kas awal tahun	153,898,748,121	139,299,995,901	21,306,740,743	(50,198,105,778)	28,957,740,058	148,755,726,685	214,395,673,430	206,236,866,067	181,951,437,501
Saldo kas akhir tahun	139,299,995,901	21,306,740,743	(50,198,105,778)	28,957,740,058	148,755,726,685	214,395,673,430	206,236,866,067	181,951,437,501	425,984,715,938

WACC

In the calculation of WACC, the beta used is 0.83 which is obtained from the average beta of developers in Surabaya such as Pakuwon, Citraland, PP Properti, Modernland, and Agung Podomoro. The risk free used is 8.25 so that the WACC value is obtained at 13.8%.

WACC = [{e/(e+b)}x ke] + [{b/(e+b)} x kb x (1-t)]

WACC = 8.25+(0.83*(15-8.25))+0

= 13,8%

NPV

The NPV calculation will use the formula:

$$NPV = \sum_{t=0}^{N} A_{t\,(P/F i\%\, t)}$$

Which is then run in Excel so as to get the NPV result of 93,962,975,228 using a WACC of 13.8%.

IRR

The IRR calculation will use the formula:

$$\sum_{t=0}^{N} R_{t\,(P/F,\, i\%, t)} - \sum_{t=0}^{N} E_{t\,(P/F\,, i\%\,, t)=0}$$

Which is then run in Excel to get an IRR result of 27%.

PBP

The payback period calculation will use the formula:

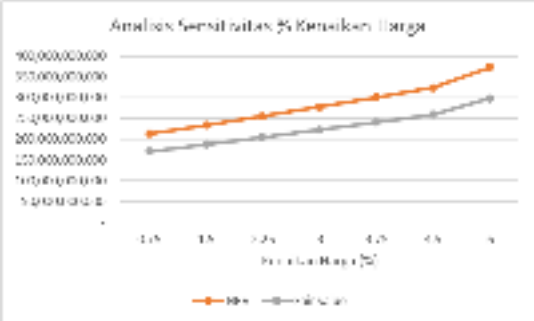
$$0 = P + \sum_{t=0}^{N} A_{t\,(P/F, i\%\, t)}$$

Which is then run in Excel so as to get the result that the Payback Period of the PT X project is 6.78 years.

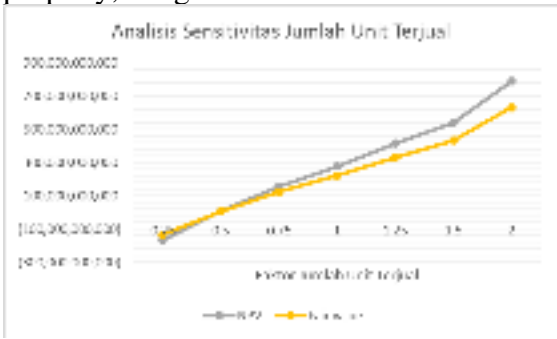
Sensitivity Analysis

Sensitivity analysis is used to determine the impact of changes in several factors on decision making. Factors that have a high enough influence need to be controlled so that the

project continues to run well. In this section, we will analyze the sensitivity of percent price increase and number of units sold.



In the graph above, it can be seen that the greater the price increase that occurs, it will affect the increase in NPV. so that the greater the percentage increase in the selling price of PT.X property, the greater the NPV obtained.



In the graph above, it can be seen that the more sales that occur will affect the increase in NPV, so that the greater the sales of PT.X property, the NPV obtained will also be greater.

6. CONCLUSIONS

1. The need for residential property in XYZ City is still high due to a backlog of 22%.
2. The property sector has a high multiplier-effect, both in terms of forward-linkage, and backward-linkage to 174 industrial sub-sectors, both directly and indirectly. Direct labor absorption in the property industry even reaches 19 million people.
3. Housing needs are the main business line of PT X. The greater the need for housing, the more target market.
4. The feasibility analysis conducted on the net cash flow of this development project, resulted in an NPV of 93,962,975,228, an IRR of 27% with a cost of capital of 13.8%. Based on these investment criteria, the PT X property development project is feasible.

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WASTE ANALYSIS USING VALUE STREAM MAPPING AND FAILURE MODE & EFFECT ANALYSIS METHODS: CASE STUDY OF CIGARETTE HIGH TAR COMPANY PT XYZ

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ABSTRACT

Every company has a production target that must be achieved during a certain period. The key indicators used by cigarette industry in achieving production targets is a low production loss. The XYZ is a company that produces high tar cigarettes that has a high production loss problem up to 993.531.985 packs in 2021. According to the output data of high tar cigarette production it is indicated that there are many defects and delays in the products. Based on that background, the aim of this research is to eliminate and reduce the waste of high tar cigarette that produced by XYZ company. The initial analysis of this research was carried out by identifying the production process using Value Stream Mapping, Process Activity Mapping, the next process is looking for critical waste using the Borda Count Method, then analyzing the root of the problem using Root Cause Analysis 5Why's. By using Failure Mode and Effect Analysis it is found that the root cause of the highest waste is the cigarettes weight out of tolerant, lost cigarette printing or shifted, tipping turn back and machine start-up time. The proposed improvement recommendations are by implementing the Poka Yoke method, including replacing the trimmer disk, installing high speed camera sensor and dividing the cleaning task list, which can reduce XYZ company production lost up to 4.3%.

Keywords: Waste, Value Stream Mapping, Process Activity Mapping, Borda Count Method, Root Couse Analysis, Failure Mode and Effect Analysis.

1. INTRODUCTION

XYZ is the second largest cigarette company in Indonesia, in addition to market share in Indonesia, XYZ cigarette companies also produce export cigarettes with international quality which are distributed to several countries in the world such as Paraguay, Malaysia, Japan, Singapore, Saudi Arabia, and the Netherlands. Suprihanti et al. (2018) The market share of clove cigarettes in Indonesia is quite large, this is based on data on the development of clove cigarette production which shows an increasing trend every year, from 2013 to 2016 the development of clove production reached almost 350 billion cigarettes per year. In the production process of high tar content cigarette companies, XYZ company runs with a make to stock system and operates three shifts or 24 hours with five working days a week. The process flow starts from raw material input then the process of feeding, filter, maker, packer, baller, case packer then the finished product is stored in the automatic warehouse and for products that are rejected due to defects are sent to the Ripping machine which separates tobacco and non-tobacco materials, can be seen in **Figure 1**.

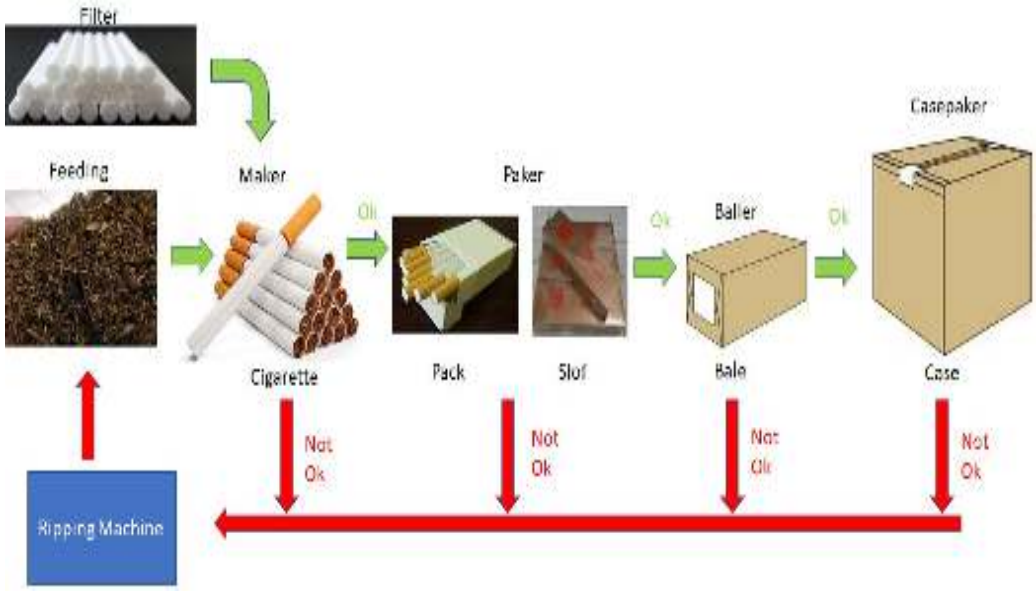

Figure 1. High Tar Process Flow of XYZ Company

The process of making filters in high tar content cigarettes starts from the raw material of acetate tow (fiber from wood) which is given trecetin liquid, this liquid will glue the acetate tow filaments which are wrapped using plug wrap (wrapping paper) then cut according to the desired filter length. Then the process of making cigarette sticks with various combinations of materials including tobacco, paper cigarettes, tipping cigarettes, filters, tobacco aroma and sweetener. Followed by the process of packing cigarette sticks with supporting materials such as alufoil, innerframe, blank, all of which become cigarette packs, then wrapped again in wrapper plus excise tape material, packet wrap and forming packets into outer packaging (slof). In the baller process, the slof from the packer machine is packaged in bale form in the baller unit, and then the case packer process is packaged in case form in the case packer unit. In the ripping machine process, all reject defect products from maker, packer, baller and case packer are processed in the ripping machine to be separated between tobacco and non-tobacco materials, so that tobacco materials can be processed and reused for basic production materials to the feeder process. Meanwhile, the finished goods will go to the storage process in the automatic warehouse.

During the operation of the high tar cigarette factory at XYZ Company, it has a production loss problem that reaches up to 993,531,985 packs in 2021, which is indicated by product defects and production delays. the existence of defective products causes a rework process in the ripping machine area which means increasing production costs for manpower allocation and product completion time which will exceed the existing schedule. The average percentage of product defects in high tar content cigarettes in 2021 is 28.35%, while the problem of delay will extend the company's lead time, high operational costs, decreased productivity, and will affect the performance of a company, this indicates the potential problems that occur at XYZ company.

2. LITERATURE REVIEW

Lean manufacturing is a philosophy that derived from the Toyota Production System (TPS) to deliver better quality products at lower costs and on time with less effort. Dennis (2015) the only way to increase the company's profit is to reduce costs, so it takes continuous efforts to

reduce costs. By using the Toyota Production System (TPS) consistently can reduce and eliminate waste (Mura) which involves team members in increasing their production productivity so that it can reduce costs. The best method of identifying waste is to observe work in the workplace to pay attention to the process, and defines waste into seven types for easy understanding, namely: Excessive Transportation, Waiting, Over Production, Defects, Inventory, Unnecessary Motion, Inappropriate Processing.

2.1 Value stream mapping (VSM)

Value stream mapping is one of the tools in the Toyota Production System (TPS) known as "material and information flow mapping" designed to look at waste and its causes by describing the flow from end to end throughout the production process and showing how value is created to fulfill customer desires. Once waste and flow bottlenecks are understood, a plan to eliminate waste can be made to determine the future state. King & King (2015) Four wastes that can be seen using VSM are overproduction, inventory, defects and waiting which are generally the most common wastes in the production process, while the remaining three require other tools and more detailed analysis.

- *Takt time* (T/T)
  The word Takt comes from German language, which means to eliminate, or it can be interpreted as the speed of the value stream that must be executed to meet customer demand.
  Takt Time = Time Available / Demand ……..…....(1)
- *Cycle time* (C/T)
  Normal time, which is required to complete one stage of the activity to achieve the expected production target.
  Cycle time = Time Available / Quantity ot Products ……..(2)
- *Process Lead Time* (PLT)
  The total expected time, starting from when raw materials are received until the finished goods are delivered to the customer.
  Process Lead time = total inventory + total cycle time …….….(3)

2.2 Process Activity Mapping (PAM)

Hines & Rich (1997) value stream analysis tools are tools that used to map in detail the value stream that focuses on the value adding process and is used to find the cause of waste that occurs. one of the tools, Process Activity Mapping, is used to record all production floor activities by classifying all activities into three types of activities, namely value-adding activities, non-value-adding activities and necessary non-value-adding activities.

2.3 Borda Count Method (BCM)

Borda Count Method (BCM) was discovered by Jean Charles de Borda for ranking calculations on several alternative choices, Singh and Sharan (2015) stated that the approach in ranking Borda can be done by, each voter filling in a list of candidates. then the first top candidate ranking choice gets m points, the second top candidate gets m - 1 points, the third top candidate gets m - 2 points, and so on. The sum of the points obtained by each voter gives the final result points.

2.4 Root cause analysis (RCA)

Root cause analysis is the process of finding the root cause of problems that can result in failure or unwanted events. The 5 Why method in RCA is used to dig deeper until the true root cause of an

event is identified. Root causes can be sought by asking why continuously, or the process can be broken down when an event can have multiple causes. Imai (1997) states that 90% of all quality improvements on the production floor can be implemented quickly if managers use the 5 Whys. Unfortunately, people often go straight to the obvious answer and do not take the time to use the 5Why.

2.5 *Failure Mode and Effect Analysis (FMEA)*
Failure modes can be interpreted as anything that includes defects or failures in design, conditions outside the limits of predetermined specifications, or changes in the product that cause disruption of the function of the product. Gaspersz (2002) by eliminating these failure modes, FMEA will increase the reliability of products and services resulting in increased customer satisfaction using products and services.

2.5.1 *Severity*
Severity is the rating number associated with the most serious effect on the failure mode that affects the process output.

2.5.2 *Occurrence*
Occurrence is the rating number, which is related to the likelihood that the failure mode or cause will occur.

2.5.3 *Detection*
Detection is the rating number associated with the control of the failure that can occur based on the criteria of the detection scale.

2.5.4 *Risk Priority Number*
Risk Priority Number (RPN) is a numerical ranking of the risk of each potential cause of failure, by multiplying the three elements (severity, occurrence and detection) to give a risk priority number. Failure modes that have a high RPN are considered more important and are given a higher priority for solution than those with a lower RPN.
$RPN = Severity\ x\ Occurrence\ x\ Detection$……(4)

3. METHODS

This study aims to identify and analyze the causes of waste and reduce lost production by eliminating and reducing waste in the production process of high tar content cigarettes at XYZ company, This research methodology is divided into 4 stages, namely:

Stage 1 Data Collection
Collecting data which includes the physical flow of raw materials, manufacturing process time data, distance time between areas, production output data, product defect data, machine performance data, machine layout data and questionnaire data.

Stage 2 Data Processing
The data that has been obtained will be mapped through Value Stream Mapping (VSM) to make the flow of information and physical cigarette production process of XYZ company, identify and classify the stages of the production process into Value Added (VA), Non Value Added (NVA) and Necessary but Non Value Added (NNVA) activities through Process Activity Mapping

(PAM), looking for critical waste to be resolved first with Borda Count Method (BCM), then continued by finding the root causes of critical waste with 5Why's Root Cause Analysis (RCA). The last stage is to prevent critical waste failure modes using Failure Mode and Effect Analysis (FMEA) at XYZ Company.

Stage 3 Analysis and Improvement Results

After critical waste is identified, then an analysis of the results of the previous data processing is carried out, the analysis is carried out using Value Stream Mapping, Process Activity Mapping, Borda Count Method, Root Cause Analysis, Failure Mode and Effect Analysis. Then proceed with implementing the results of improvements to reduce production lost packs by reducing and eliminating the causes of critical waste using the Poka Yoke concept.

Stage 4 Conclusion

The final stage of this research is to draw conclusions and suggestions related to waste that occurs, determination of critical waste, root causes of critical waste and recommendations for reducing and eliminating waste in the cigarette production process at XYZ company.

4. RESULTS

According to the mapping of the flow of materials and information at XYZ Cigarette Company which has been illustrated in the Value Stream Mapping in **Figure 2**, the defect rate with the highest value is in the maker production process at 1.27% which means it indicates the presence of waste defects in the maker area.

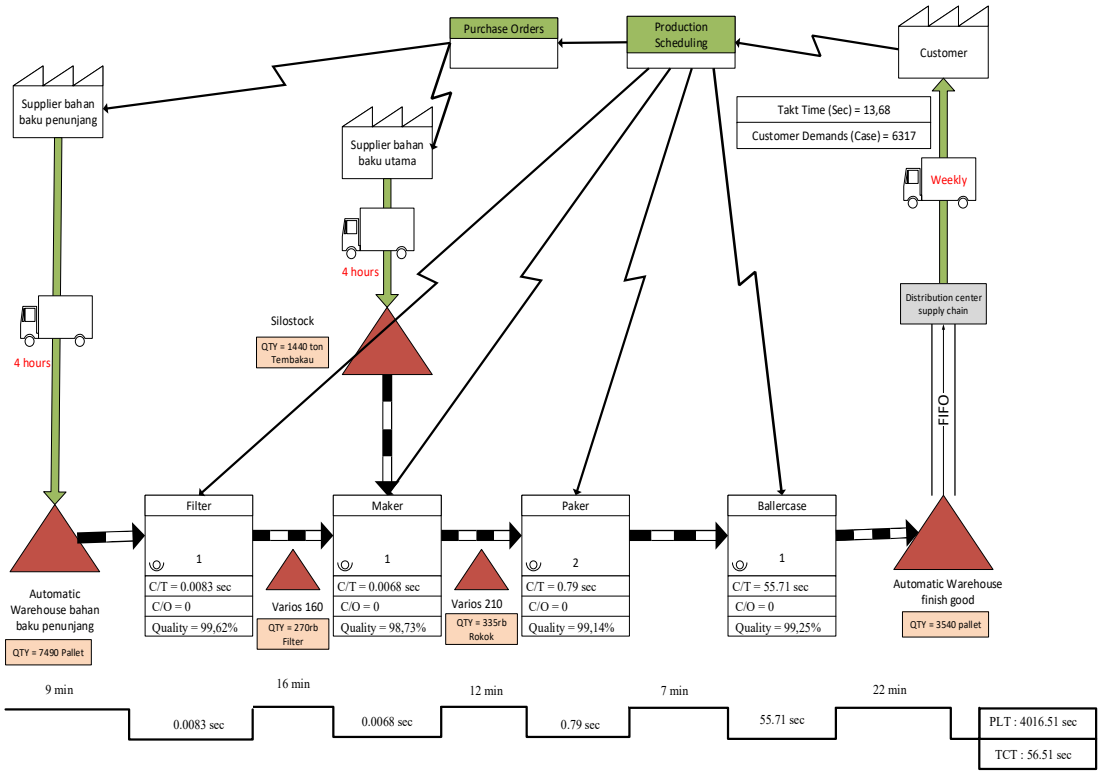

Figure 2. Value Stream Mapping of XYZ Company

The percentage of activities based on the number of activities and activity time can be seen in **Table 1**, the total number of activities is 41 activities, value-added activities (VA) 15 activities,

this activity is an operation activity with a percentage of 36.59%, while non-value-added activities (NVA) are only 5 activities, this activity is a delay activity with a percentage of 12.20%, then non-value-added but necessary activities (NNVA) there are 21 activities including transport, storage, inspection activities with a percentage of 51.22% with a total distance of 973 meters and a total time of 2457 seconds. In the maker area, cigarette making process at the beginning of the week there was 480 minutes of downtime caused by the process of completing the machine cleaning task, the number of tasks that were too many stopped the activity for 1 shift.

Table 1. Process Activity Mapping PT XYZ

No.	Activities	Machine	Distance (Meters)	Waktu Minute	Activities					Classification		
					O	T	I	S	D	VA	NVA	NNVA
Silostock Bahan Baku Utama												
1	The arrival of bin tobacco to Silostock building	Truk	-	240		√						√
2	Bin manual inspection and recording, vehicle number, tobacco quantity	-	-	2			√					√
3	Disassembling the tobacco bin into the transit area	Forklift	15	4	√							√
4	Transportation of tobacco bins from the transit area to the dumper type area	Forklift	25	2		√						√
5	Tobacco bin pouring in the dumper type area	Tipper	-	1	√							√
6	Tobacco weighing	Weight belt	-	1	√							√
7	Tobacco goes to silo stock	Conveyor belt	246	17				√				√
Automatic Warehouse Bahan Baku Penunjang												
8	Material delivery from Automatic Warehouse to Transit Warehouse	SRM, Trolley	216	14		√						√
9	The Transit Warehouse prepares materials according to the specifications and quantities requested	-	-	4					√			√
Filter												
10	Request and delivery of acetate tow, triacetin, plugwrap, hot glue, cold glue materials from the Automatic Warehouse to the filter machine area	HMI, SRM, Trolley, Hand Pallet electric	103	9		√				√		
11	Cleaning banding jets, slice sensor, roller, chamber, drum, change garniture, check knife and glue	-	-	17	√							√
12	Filter Production Process	KDF M	-	0.0008	√					√		
13	Sampling filter dry and filter wet	KDF M	-	1			√					√
14	Handover and report generation of filter production	-	-	5					√		√	
15	Filter go to buffer and HCF to Filtromat	Conveyor Chain	110	23				√				√
Maker												
16	Request and delivery of tobacco main raw material materials from silostock	HMI, Conveyor belt	294	16		√				√		
17	Request and delivery of filter material from filtromat machines	HMI, pipa filtromat	133	2		√				√		
18	Request and delivery of supporting materials for tobacco aroma, ink, cigarette paper, tipping paper, cold glue, sweetener from transit warehouse to area machine	HMI, Forklift	35	3		√				√		
19	Cleaning early in the week	-	-	450	√							√
20	Garniture replacement in SE and suction tape in VE	-	-	19	√							√
21	Cigarette Production Process	Protos M	-	0.0006	√					√		
22	Physical and visual cigarette sampling	Protos M	-	1			√					√
23	Handover and preparation of production reports maker	-	-	5					√		√	
24	Cigarettes to Buffer Cigarette	Conveyor Chain	9	2				√				√

No.	Activities	Machine	Distance (Meters)	Waktu (Minute)	Activities					Classification		
					O	T	I	S	D	VA	NVA	NNVA
Paker												
25	Request and delivery of cigarette material from cigarette buffer	HMI, Conveyor Chain	165	10		√				√		
26	Permintaan dan pengiriman material penunjang inner frame, blank etiket, alufoil, cold glue, opp film, tear tape, outer, hot glue dari gudang transit menuju paker	SRM, Trolley, Hand Pallet electric	35	3		√				√		
27	Take Pita Cukai	-	52	4	√					√		
28	Cleaning packet track, tunel, roller outer	-	-	21	√							√
29	Slof Production Process	Focke	-	0.07	√					√		
30	Sampling stamp and slof product date code	Focke	-	1			√					√
31	Handover and preparation of reports on the results of paker production and the use of excise stamps	-	-	5					√		√	
Baller Case												
32	Request and delivery of sloof material from the packer machine	HMI, Conveyor Chain	157	7		√				√		
33	Request and delivery of supporting materials for ballcraft paper, labels, case blanks, cold glue, tape, ink from AW to the packing machine area	SRM, Trolley, Hand Pallet electric	350	13		√				√		
34	Ball case production process	Focke	-	0.55	√					√		
35	Sampling ball dan case	-	-	1			√					√
36	Handover and preparation of ballercase production reports	-	-	5					√		√	
37	Delivery of cases from the baller case machine to the Palletizer	Conveyor Roller	162	9		√						√
38	stack 32 case in 1 pallet	Fanuc	-	27	√					√		
39	The pallet goes to the wrapping area	ROV	35	4		√						√
40	wraping pallet	Wrapping	-	3	√					√		
Automatic Warehouse Finish Good												
41	Pallet goes to Automatic Warehouse finish good	SRM, Trolley	315	22				√			√	

In the results of the questionnaire, which was made to rank critical waste using the Borda Count Method shown in **Table 2**, it can be seen that the 2 highest critical waste rankings are waste defects with a score of 40 and waste waiting with a score of 37 which immediately need to be resolved on the production floor of XYZ company. The impact caused by these 2 wastes is quite significant, where the losses caused by waste defects amounted to 639,593,985 packs and waste waiting amounted to 353,938,850 packs in 2021.

Table 2. Critical waste ranking result

No	Waste	Total Score
1	Overproduction	11
2	Defect	40
3	Unnecessary Inventory	17
4	Inappropriate Processing	29
5	Excessive Transportation	17
6	Waiting	37
7	Unnecessary Motion	20

With the use of 5Why's Analysis, the root cause of the problem is found in the sub-waste for waste defects, such as weight that does not meet specifications, cigarettes that have holes, cigarette ends

that fall off and are porous, rod breaks, missing filters, folded tipping, and missing or shifting printing. Meanwhile, the sub-waste for waste waiting includes the process of starting up at the beginning of the week, machine adjustment, and the machine cannot be run for production. **Table 3** shows the results of the RPN recap for each potential cause in each critical waste sorted by the highest RPN. The potential cause with the highest RPN will be prioritized for improvement recommendations.

Table 3. FMEA Highest RPN Result of all Critical Waste

Waste	Potential Failure Mode	Potential Effect	Severity	Potential Cause	Occurrence	Control	Detection	RPN
Defect	Weight is not within specifications	There are product defects that reach 0.81% - 1%	9	Trimmer material is not from OEM	8	Returns the trimmer to its standard material	6	432
	Printing is missing or shifted	There are product defects that reach 0.51% - 0.6%	7	There is no process of checking the nozzle gap to the roller distributor	6	Added shift print detection sensor	9	378
	Tipping folded	There are product defects that reach 0,51% - 0.6%	7	Quantity of glue to the tipping is too much	5	Added folded tipping detection sensor	9	315
Waiting	Startup process at the beginning of the week	Production stopped for 301 minutes up to 480 minutes	8	Task list for cleaning all put together at the beginning of the week	6	Divided the task list for cleaning, which was then assigned at the beginning of the shift within a week.	5	240
	Adjustment of the machine	Production was stopped for 31 minutes to 60 minutes	5	Spare parts replacement	7	Checking and replacement of parts	6	210

The improvements that have been made are using Poka Yoke, which means mistake-proofing or error prevention by using the prevent mistakes approach, which is an approach to prevent errors before errors or quality problems actually occur, Meanwhile, the prevention of mistakes has two methods, which are the control method and the warning method.

1. Returns the trimmer to its standard material
2. Add a periodic inspection task list at 1000 hours
3. Add High Speed Camera Inspection for Cigarette Print Mark and Tipping Turnback

4. Divided the task list for cleaning, which will then be accomplished in 15 minutes at the beginning of the shift.

The results of these improvements can reduce production loss from 94,825,868 packs per month to 64,291,308 packs, or decreased by 4.3% during August to December 2022, XYZ company's production loss 2022 can be seen in **Figure 3**.

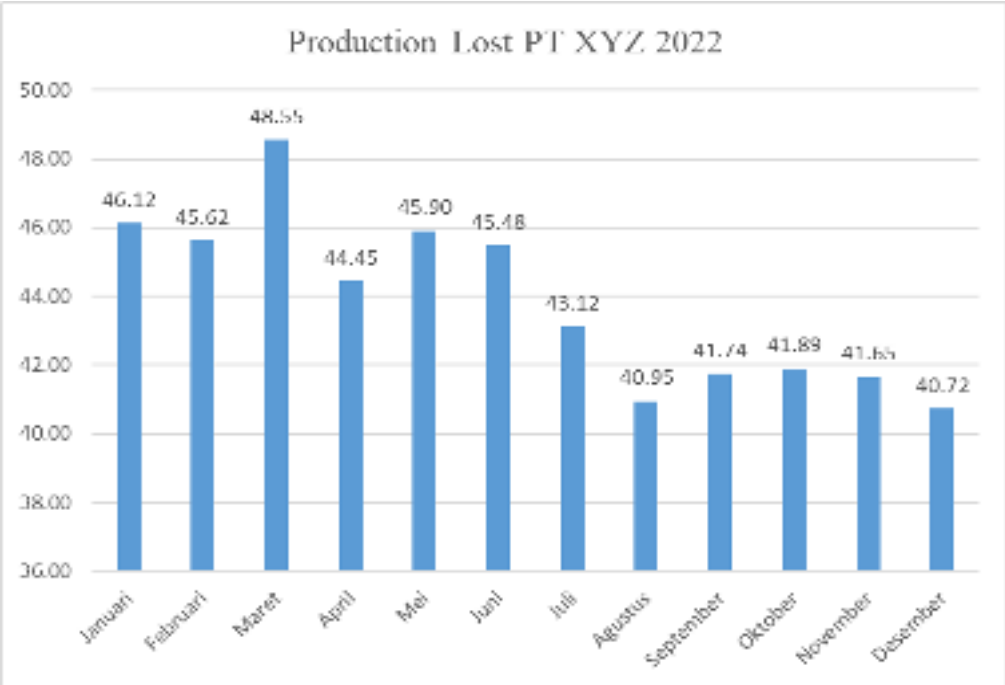

Figure 3. XYZ Company Production Lost 2022

6. CONCLUSIONS

The results of identifying waste problems that occur based on VSM, PAM and BCM on the cigarette production floor of XYZ company are critical waste waiting and critical waste defects. Waste defects that occur are caused by the weight of cigarettes that do not meet specifications, because the material used in the cigarette profile shaper or trimmer disk is not material from the default machine vendor, cigarette printing that lost or shifted because there is no built-in machine indicator that indicates there is a gap in the nozzle and distribution roller, folded cigarette tipping paper occurs because the quantity of tipping glue is too little. Waste waiting that occurs is caused by the length of the start-up process at the beginning of the week which takes up to 480 minutes or more, due to the large number of cleaning task lists that must be carried out by the operator. The improvement recommendations proposed for the problem of cigarette weight that does not meet specifications are the addition of the SOP for replacing the trimmer disk and the application of the Poka Yoke method by proposing to make a high speed marker tool in addition to the original built-in inspection sensor of the machine, while for the startup process at the beginning of the week which takes up to 480 minutes by dividing the cleaning task list into 15 minutes at the beginning of the shift for one week in 3 production shifts which can cut the startup time at the beginning of the week by 240 minutes, so as to reduce production loss by 4.3% in September to December 2022.

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DETERMINATION OF FUEL DISTRIBUTOR LOCATION IN PAPUA PROVINCE USING SPATIAL MULTI CRITERIA DECISION ANALYSIS

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ABSTRACT

Fuel oil distributors are one of the facilities whose existence is very vital in today's society. Papua Province, which is located in the eastern part of Indonesia, has complex geographical conditions and limited transportation infrastructure facilities, which results in the distribution process of fuel oil distribution to the community not being optimal. This study was conducted to determine the best location that will be used as a consideration in the establishment of fuel distributors. The locations that can be recommended consider land cover, road sections and weighting criteria using Spatial Multi Criteria Decision Analysis with the Weighted Overlay method. The analysis was carried out using ArcGIS software and the weighting of each criterion/layer using the Analytical Hierarchy Process (AHP) method with the criteria of proximity distance between fuel distributors, proximity to supply points, proximity to main roads, proximity to economic activities and topographic conditions. The results of this study show that there are 3 out of 29 districts/cities in Papua Province that need new fuel distribution agencies where there are 17 alternative locations in Jayapura City, 31 alternative locations in Jayapura District, and 28 alternative locations in Mimika District.

Keywords: Fuel Distributor, Optimal Location, ArcGIS, Spatial Multi Criteria Decision, Weighted Overlay, Analytical Hierarchy Process

1. INTRODUCTION

Fuel distributor is one of the most vital facilities for the community today whose function plays a role in fulfilling the availability of fuel for the community. This is because fuel is one part of the basic needs of the community which has a very important role in supporting every activity of life and supporting economic activities in urban communities for household needs, fishermen and entrepreneurs, as well as fuel is very important for various industrial and transportation sectors.

Papua is the largest island in Indonesia, covering 21.9% of Indonesia's total land area, or 421,981 km^2. Fuel distribution in eastern Indonesia experiences logistical problems, some of which are caused by low accessibility, especially perceived by the Papuan people. Papua's topography varies from lowland wetlands to highlands with dense rainforests, grasslands and Papua is the largest island in Indonesia, covering 21.9% of Indonesia's total land area, or 421,981 km2.mostly in the

form of islands and mountains, it has its own challenges for the implementation of logistics delivery in the context of the fulfillment and distribution of Fuel Oil (BBM). This has an impact on the slower economic growth in the 3T (Terdepan, Terpencil, Tertinggal) areas.

The establishment of a fuel distribution facility requires various factors to be taken into consideration. These factors include good service, facilities provided, strategic location selection, and others. Among these factors, the most important is the selection of an optimal and strategic location. By considering the factors, the determination of the location of fuel distributors is chosen based on the priority/weighting criteria using a spatial analysis approach on alternative land available in the study area, namely in Papua Province. The spatial analysis conducted is based on a Geographic Information System (GIS/GIS) that was built using a base map, several thematic maps and digitization

2. LITERATURE REVIEW

Spatial Analysis

The spatial analysis is an analytical process that involves a number of calculations and logical (mathematical) evaluations carried out in order to search or find patterns or potential relationships that may exist in geographic elements (Prahasta, 2009). This spatial analysis is a representation of a model that is a simplification of complex phenomena that occur in the real world. Therefore, by simplifying reality through existing spatial elements, it will help analysts to understand, describe or predict how these phenomena work in the real world.

Geographical Information Systems (GIS)

The technological approach defines GIS as a tool for data storage and retrieval input, manipulation and analysis of spatial data output. Cowen (1998) states that GIS is a decision support system that involves the integration of spatially referenced data as the scope of problem solving, reality is represented as a series of geographic features defined according to two data elements. So this system is deliberately designed to support various analyses of geographic information (Prahasta 2009).

Spatial Multi Criteria Decision Analysis

The spatial multi criteria decision analysis is a significant departure from conventional MCDM techniques due to the involvement of geographical components that can be further processed. Unlike conventional MCDM, spatial multi criteria analysis requires data on alternative criteria values and their geographical locations (Gunarta, 2013). The spatial multi criteria decision analysis can be considered as a process that combines and transforms geographic data (input) into a final decision (output). An important aspect of spatial multi criteria analysis is that it involves the evaluation of geographic events based on criteria values and decision-maker preferences that relate to a number of evaluation criteria.

Analytic Hierarchy Process (AHP)

The analytical hierarchy Process is a decision-making system that uses mathematical models. The Analytical Hierarchy Process helps prioritize multiple criteria by performing a pairwise comparative analysis of each criterion. Hierarchy is about understanding a complex problem, breaking the problem down into related parts, organizing those parts in a hierarchy, and finally evaluating those parts to determine what decision to make. The Analytical hierarchy process method uses weighting techniques to generate weighting factors. These weighting factors represent the relative importance of one item compared to another.

3. METHODS

In the early stages of research, there are literature studies and field studies which are used to explore research whose problems have been formulated previously. This research involves dependent variables and independent variables. The dependent variable is the location of the BBM Distribution Institution. Independent variables are the proximity of the distance between existing BBM Distribution Institutions (buffer area), proximity to the supply point, proximity to the main road, proximity to economic activities, topographic conditions, and quotas and realization of JBKP and JBT subsidized fuel.

Spatial Data

The spatial analysis is used to assist in performing some calculations related to spatial attributes along the fuel supply chain and spatial relatedness between the elements of the supply chain. This analysis is intended to determine the potential areas that do not have or have not been accessed by the existing fuel distribution system and to analyze the spatial projection of demand and the infrastructure required during fuel distribution. The potential areas will be selected in accordance with the priorities and capabilities of the region to build a new fuel distribution location.

Analytical Hierarchy Process

The method of collecting data on the weighting of criteria to be used in AHP is purposive sampling by conducting FGDs and/or interviews. The following Table 1 is the design of AHP criteria weighting data collection.

Table 1. AHP Criteria Weighting Data Collection Plan

Method	Description	Respondents
Purposive Sampling during FGDs and/or Interviews	The criteria have been determined by the author	• Experts in optimization, supply chain, logistics distribution • Related stakeholders (BPH Migas and Pertamina) • Expert in spatial field
	The respondents assessed the urgency and relativity of the criteria	
	There may be new criteria based on suggestions from the respondents.	
	Receive suggestions regarding the criteria and weighting criteria that have been determined by the author.	

Weighted Overlay Analysis

Weighed Overlay method of BBM Distributor Location is used to determine alternative recommendation of BBM Distributor Institution Plan. There are several stages including, Analysis of Alternative Fuel Distributor Location Plan, Weighted Overlay Based on AHP Criteria, and Recommendation of Distributor Location Based on Urgency Level (Rank). The placement of fuel distributors is suggested to be located in the zone with the highest score based on the weighted overlay. However, if the situation in the field cannot be implemented, it will be found relatively at the value below the highest score.

Interpretation of Analysis and Validation Results

The interpretation aims to test the data and analysis used whether it can be used as input and recommendations for relevant stakeholders. Interpretation of the analysis results will be conducted together with validation in the form of input and suggestions from relevant stakeholders to finalize the results of this study. Validation is conducted by conducting a short presentation virtually or sharing the results of the analysis with relevant stakeholders in order to get input and suggestions.

4. RESULTS

The Fuel Distribution Institution Requirement Plan

Based on the FGD with Regulatory and Business Entity, it was agreed that each distributor has 1 dispenser with 2 nozzles. The filling discharge is 135 liters in 5 minutes. If the operational hours of SPBU services are 8 hours a day, it is known that the average intensity of SPBU in distributing fuel is 8 x (60/5) x 135 = 13000 liters or 13 KL. Based on this analysis, the requirements for each fuel distribution institution are Jayapura City requires 18, Jayapura Regency requires 4, and Mimika Regency requires 8.

The Alternative Location of Planned Fuel Distribution Institutions

Based on the location suitability analysis of the fuel distribution institutional Plan, Jayapura City has 17 alternative locations. All locations have different areas ranging from 103,441 m^2 to 4066332 m^2. The locations are spread throughout the Jayapura City with a tendency to cluster in the Abepura Urban Area. Jayapura Regency has 31 alternative locations. The locations have different areas ranging from 96,746 m^2 to 4546171 m^2. The locations are scattered around the Sentani area, which is the center of economic activities, offices, and education in Jayapura Regency. Mimika Regency has 28 alternative locations. All locations have different areas ranging from 96,545 m2 to 3,423,613 m2. The locations are scattered around Timika City. Timika City has an Urban Hierarchy System as a National Activity Center because is the closest city to the activities of PT Freeport Indonesia. Alternative locations in Jayapura City, Jayapura Regency and Mimika Regency are shown in Figure 1.

(a) (b) (c)

Figure 1. The Alternative Locations of Fuel Distribution Institution Plan
(a) Jayapura City
(b) Jayapura Regency
(c) Mimika Regency

Analytical Hierarchy Process

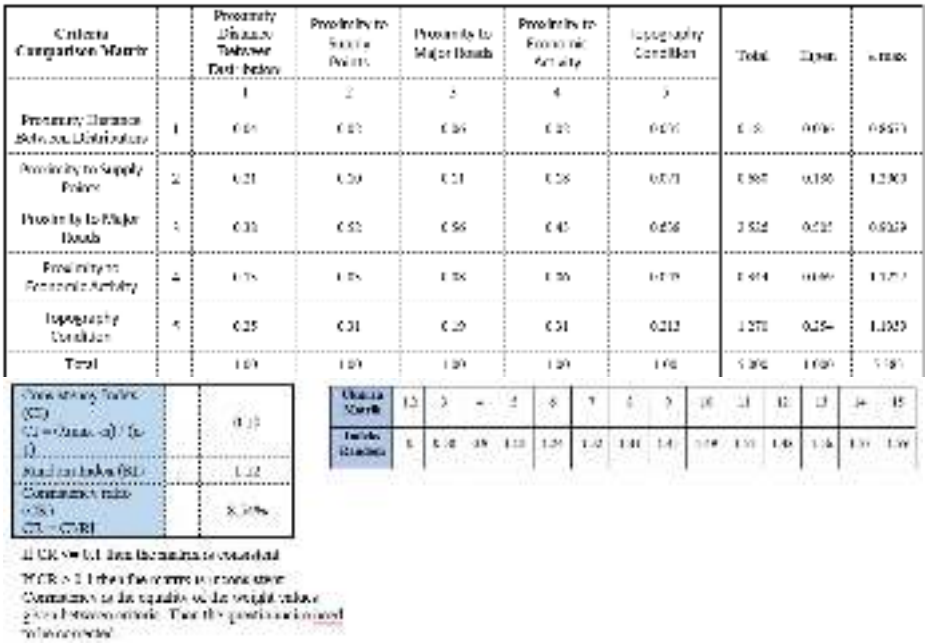
The spatial analysis model in determining the optimal location of subsidized fuel distributors by considering 5 criteria, which are the proximity of distance between distributors, proximity to supply points, proximity to main roads, proximity to economic activities, and topographic conditions. Scoring the 5 criteria that have been determined. The following is a matrix of criteria comparison with the AHP method shown in Table 2.

Table 2. Criteria Comparison Matrix

Criteria Comparison Matrix		Proximity Distance Between Distributors	Proximity to Supply Points	Proximity to Major Roads	Proximity to Economic Activity	Topography Condition
		1	2	3	4	5
Proximity Distance Between Distributors	1	1.00	0.20	0.11	0.33	0.17
Proximity to Supply Points	2	5.00	1.00	0.20	3.00	0.33
Proximity to Major Roads	3	9.00	5.00	1.00	7.00	3.00
Proximity to Economic Activity	4	3.00	0.33	0.14	1.00	0.20
Topography Condition	5	6.00	3.00	0.33	5.00	1.00
Total		24.00	9.53	1.79	16.33	4.70

Based on the comparison matrix, the value of each criterion, consistency index (CI), random index (RI) and consistency ratio (CR) are calculated. The following calculation is shown in Table 3.

Tabel 3. Calculation of Consistency Index (CI), Random Index (RI), and Consistency Ratio (CR) Values



Based on the criteria value matrix above, it is known that the consistency index (CI) is 0.1 and the consistency ratio (CR) is 8.54%. It can be concluded that the criteria weights obtained during the FGD have consistency. The order of criteria with the largest to the smallest value is shown in Table 4.

Table 4. Criteria Weighting Results

Rating	Criteria	Value
1	Proximity to Major Roads	0.505
2	Topography Condition	0.254
3	Proximity to Supply Points	0.136

Rating	Criteria	Value
4	Proximity to Economic Activity	0.069
5	Proximity Distance Between Distributors	0.036

Weighted Overlay Analysis

Based on the weighted overlay analysis using AHP scoring, the overall suitability level of locations in Jayapura City is 5 (highly suitable). Therefore, the recommended location can be used by considering the available location area. The weighted overlay analysis map of 5 criteria in Jayapura City is shown in Figure 6.

Figure 6. The Map of Weighted Overlay Analysis of 5 Criteria: Jayapura City

Based on weighted overlay analysis using AHP scoring, the overall suitability level of locations in Jayapura Regency is 4 (suitable) and 5 (very suitable). However, after being overlaid, the entire Fuel Distribution Institution Plan is in a location with a suitability weight of 5 (very suitable). The map of the weighted overlay analysis of the 5 criteria in Jayapura Regency is shown in Figure 7.

Figure 7. The Map of Weighted Overlay Analysis of 5 Criteria: Jayapura Regency

Based on weighted overlay analysis using AHP scoring, the overall level of location suitability in Mimika Regency is 4 (suitable) and 5 (very suitable). After being overlaid, the Fuel Distribution

Institution Plan is in a location with a suitability weight of 4 (suitable) and 5 (very suitable). The map of Weighted overlay analysis of 5 criteria in Mimika Regency is shown in Figure 8.

Figure 8. The Map of Weighted Overlay Analysis of 5 Criteria: Mimika Regency

Analysis and interpretation of distribution institutions

The Fuel Distribution Institution Plan is determined through several stages of spatial, tabulation, and statistical data processing with quantitative and qualitative data types. Determination of Alternative Plan Sites is made using the model builder. After determining the next district/city is to buffer the road section (national road, provincial road, and district/city road) by 50 m. The aim was to assure that the location of the plan was close to the road. In parallel, land suitability was performed using land cover data. Based on the results of FGDs with stakeholders, the appropriate land cover for the Distributor Institution is settlements, open land, and transmigration areas. Furthermore, conversion to polygon as well as area calculation using a field calculator. The spatial data builder model is shown in Figure 10

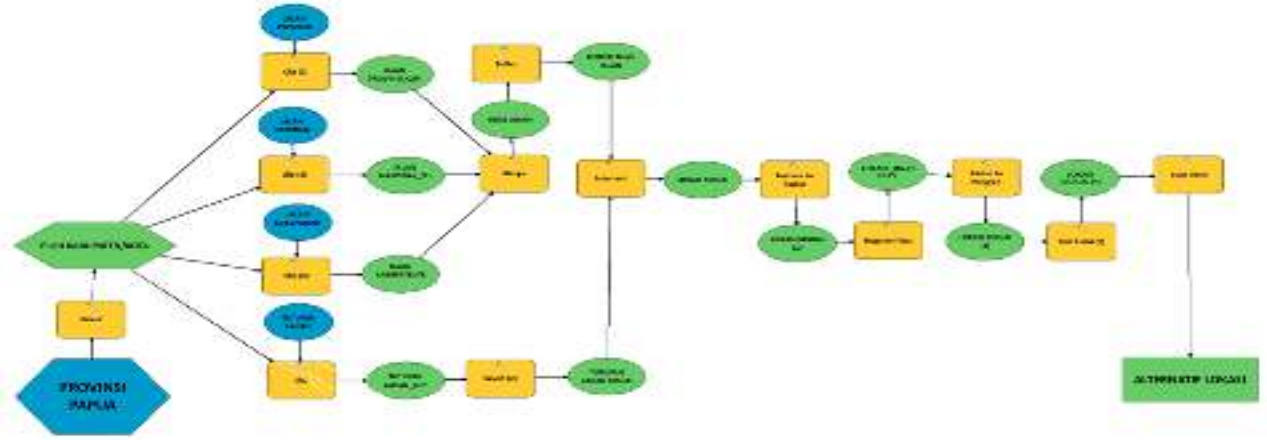


Figure 10. The Spatial Data Builder Model Determining Alternative Plan Locations

Weighted Overlay Criteria

Euclidean Distance analysis was conducted on the criteria of distance between distributors, supply points, proximity to main roads and proximity to economic activities to obtain the distance of each criterion to the Papua province area. This automatically classifies the distance into 10 classifications in raster format. Furthermore, area screening is done based on Papua Province through the extract by mask process. The last stage is to determine the value of the raster by reclassifying it into 5 classes of values automatically. The processing of the Proximity to Supply Point criteria is shown in Figure 11 to Figure 14.

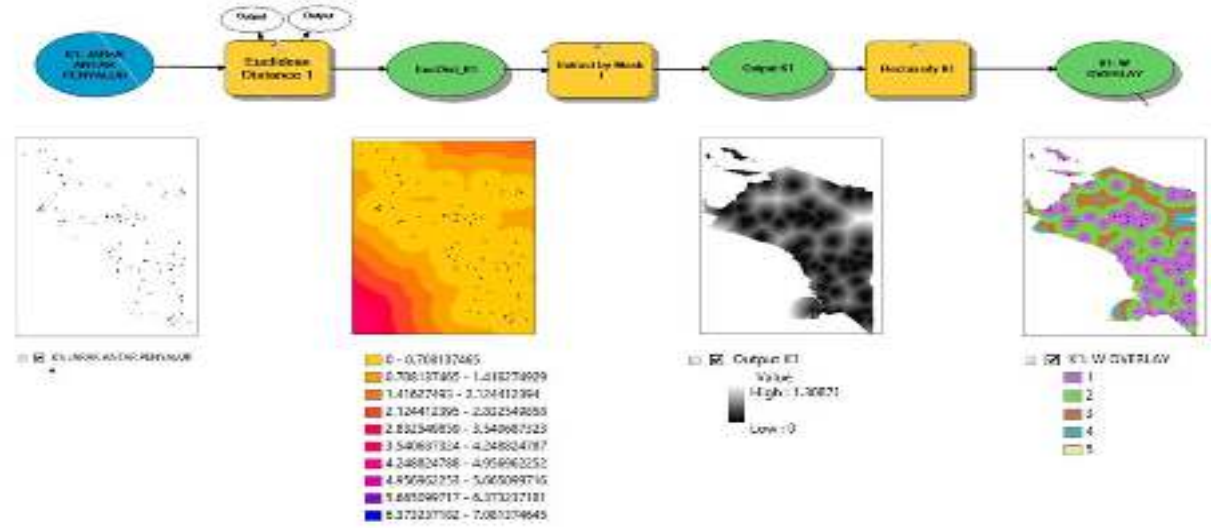


Figure 11. The Model Builder Proximity Analysis of Distance Between Distributors

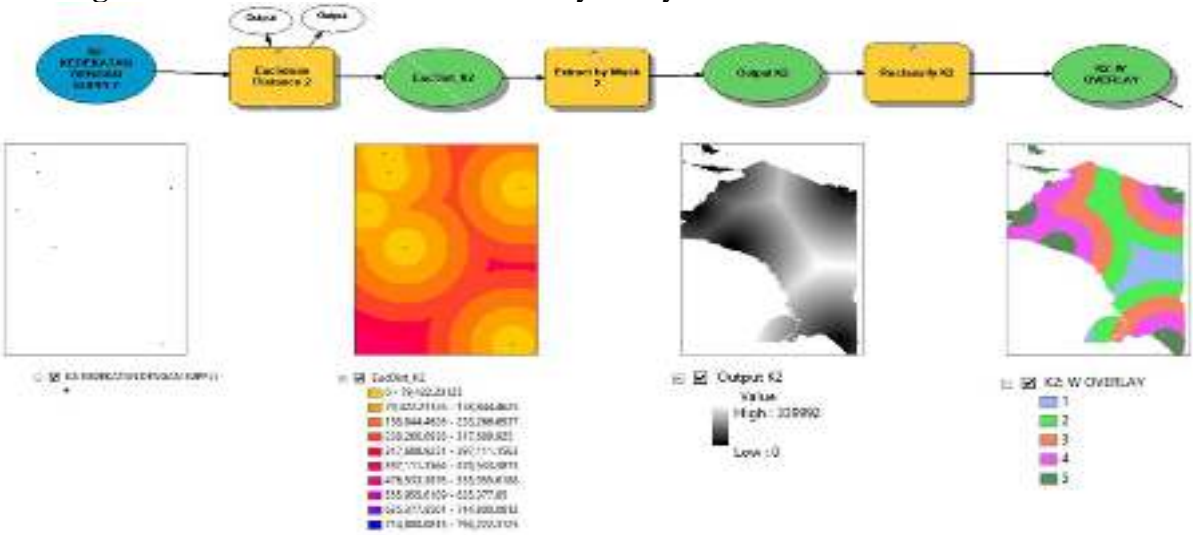


Figure 12. The Model Builder Analysis of Proximity to Supply Points

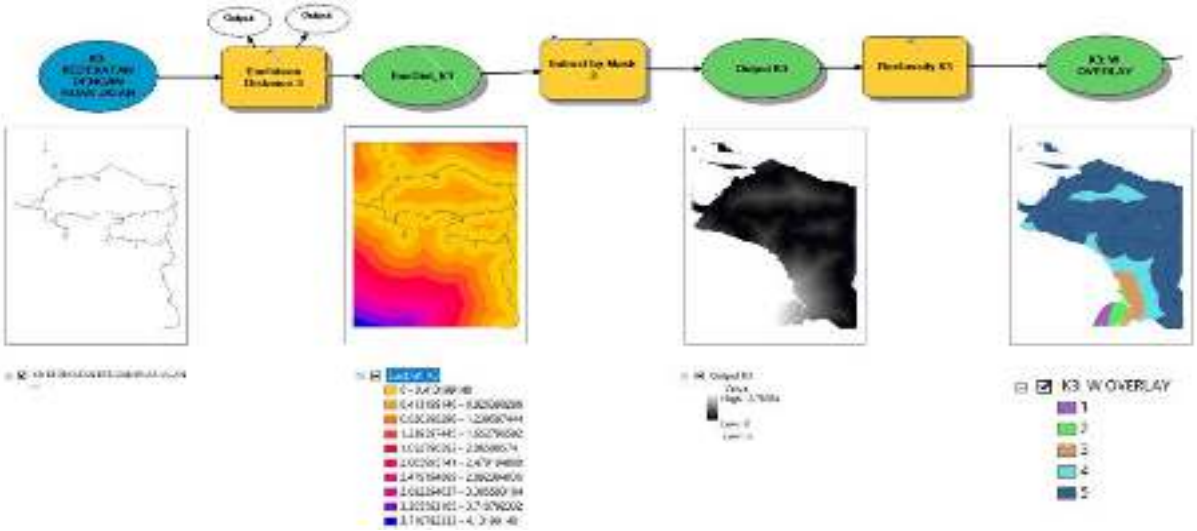


Figure 13. The Model Builder Analysis of Proximity to Major Roads

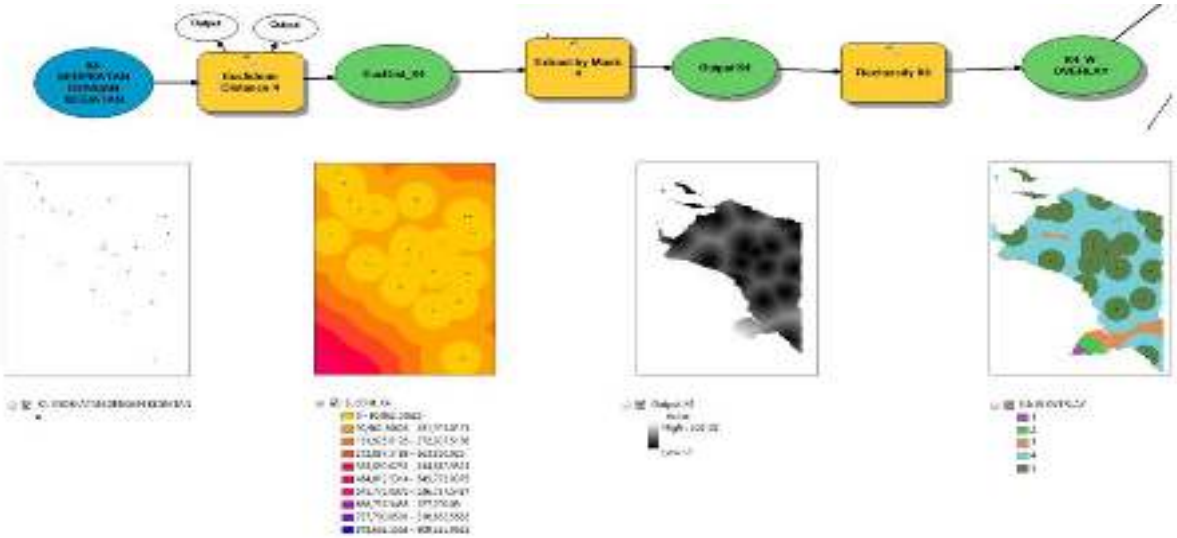


Figure 14. The Model Builder Analysis of Proximity to Economic Activity

Topographic Condition analysis begins with processing 30M SRTM DEM data. Furthermore, area screening is conducted based on Papua province through the extract by mask process. The last stage is to determine the value of the raster by reclassifying it into 5 classes based on the slope class criteria. The slope class is divided into 0-2% (flat) with a score of 5, 2-15% (sloping) with a score of 4, 15-25% (moderately steep) with a score of 3, 24-40% (steep) with a score of 2, and >40% (very steep) with a score of 1. The Topographic Condition criteria processing process is shown in Figure 15.

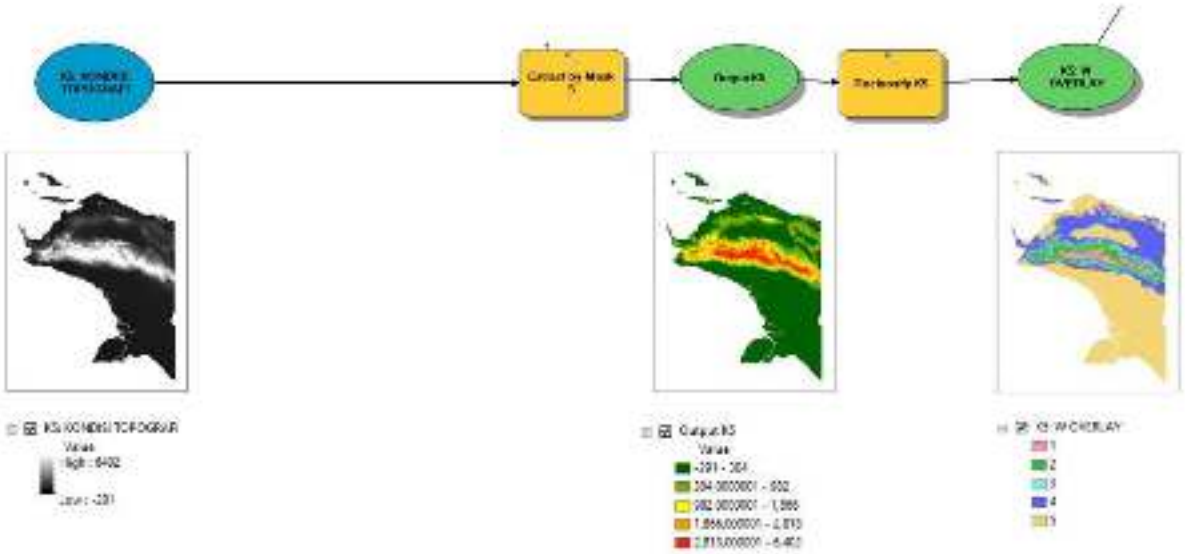


Figure 15. The Model Builder Analysis of Topographic Condition

6. CONCLUSIONS

This research has created a spatial analysis model in determining the optimal location of subsidized fuel distributors by considering five criteria, which are the proximity of distance between distributors, proximity to supply points, proximity to main roads, proximity to economic activities, and topographic conditions. Based on Weighted Overlay analysis, the order of criteria that influence the selection of the location of the BBM Distribution Institution plan in Papua Province is proximity to the main road (0.505), topographic conditions (0.254), proximity to supply points (0.136)

proximity to economic activities (0.069), and proximity distance between distributors (0.036). Based on the analysis of the needs of the Distributor Institution, there are 3 out of 29 regencies/cities in Papua Province that need new BBM Distribution Institutions, which are Jayapura City, Jayapura Regency, and Mimika Regency. Some alternative locations obtained based on location suitability analysis are 17 locations in Jayapura City, 31 locations in Jayapura Regency and 28 locations in Mimika Regency.

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DESIGN-THINKING-BASED INNOVATION STRATEGY FOR THE PARENTING COMMUNITY PLATFORM DEVELOPMENT

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ABSTRACT

The presence of an online community platform facilitates the exchange of information and knowledge. Parents also take advantage of this online community platform to discuss and support each other as they face parenting challenges. This study aims to find the types of potential users and the parenting community regarding the behavior and needs of parents using a design thinking approach. The first stage was empathizing, which begins with user interviews to gain an understanding of users, followed by the description of an empathy map and a user journey map. The empathize stage produces three types of online community platform user personas: observers, endorsers, and contributors. Observer users aim to gain access to the latest developments in trusted parenting information. Endorser users aim to make the community a place to validate information, get inspiration, and participate in various events. Contributing users aim to gain support systems, strengthen relationships, and join specific communities. This persona typology is the basis for developing ideas tailored to each persona type's needs. Three innovative strategies can meet the needs of users of this online parenting community, namely: user personalization to present communities, topics, and activities based on behavior and preferences, interactive group chats that allow users to discuss and communicate intensely, and strategy gamification by implementing member badges and rewards that aim to provide motivation and goals to users so that they can form a supportive community and improve the quality of the information shared.

Keywords: community platform, parenting community, design thinking, innovation strategy

1. INTRODUCTION

The possibilities of digital technology can improve the efficiency of human communication, the accessibility of the most recent information, and the viability of establishing communities outside of existing ones (Jati et al., 2022). Virtual or online communities are made up of individuals who share the same practices, aims, or interests and who transfer knowledge for the group's benefit. Virtual communities enable the flow of information and knowledge inside online communities, allowing users to use them as platforms for retrieving and disseminating knowledge through virtual debates and interactive sharing (Fauzi et al., 2019).

Community members frequently contribute valuable and helpful information to other community members on various topics; as a result, this contact helps customers save money, builds

trust, and enriches the community experience (Algharabat et al., 2021). Then, at some points, such as the choice stage to purchase an item, community members from a specific social media platform might be effectively persuaded by other members who are similar to them, even though the community members are strangers. By enhancing user contact, interactions between users will, on average, aid brands and companies in establishing and launching new brands (Algharabat et al., 2021).Then, one of the most developed communities is the parenting community, as seen by the tendency of parents, particularly moms of young children, to spend a great deal of time on digital platforms in search of parenting-related information (Alamiyah, 2020).

This study was conducted at the Indonesian technology company 'X,' which had just released a group chat application for a parenting community. During the development phase, the company concentrates solely on establishing the interface design and technology. However, it needs an in-depth understanding of the needs and difficulties of parents with the community and the types of possible users who would utilize the parenting community platform.

So that from these problems, a method or approach is needed that focuses on user needs. According to (Vijayakumaran, 2019), software developers have developed dramatically. The main focus of any software development company is to empathize with customers by understanding and providing enduring solutions as consumers require. Design thinking can be used to understand user needs and find guidance in the product development process. This study found that design thinking can improve product development quality and ultimately provide the right product to clients or customers. In order to address these challenges, a strategy or approach centered on the users' needs is required; one of the possible solutions is to employ the design thinking method. This study uses design thinking to map the different sorts of potential users, identify user behavior, and define user demands. In order to ensure that the newly introduced community services cannot only fulfill the users' requirements but also enhance the business's overall performance.

2. LITERATURE REVIEW

Online communities are communication among online social groups based on group interactions or purchases and trades amongst individuals with similar interests. (Kang et al., 2016). Numerous online communities are distinguished by their operational objectives, scope of activity, manner of establishment, and constituent entities. There are two types of communities: company-led and customer-led. Businesses create company-led communities to promote favorable customer views toward a specific brand, product, or service. By building customer-led communities, customers interested in a specific brand or product can share their experiences and knowledge or make collective purchases.

The power of customer-led communities is expanding since word-of-mouth may rapidly send positive or negative information to prospective customers (Kang et al., 2016). Customer-led communities attract people with similar interests, such as parenting topics. Parents also take advantage of this online community platform to discuss and support each other as they face parenting challenges.

Motivating factors for parents to join the community

(Alamiyah, 2020) studies how parents in Indonesia utilize online platforms to learn about parenting. Parents utilize the internet to get more empirical and credible parenting material. Additionally, they look for peer support and develop ties with other online community members. In addition, (Shpakovskaya, 2015) discovered that Russian mothers, particularly those from the middle and upper classes, enrolled in online parenting programs because they believed that government-sponsored parenting workshops were insufficient to meet their informational demands. Therefore,

they are willing to pay for parenting programs to acquire more information. (Shpakovskaya, 2015) argues that these mothers actively discuss and negotiate their conceptions of parenting and self-care. This process is frequently completed online.

Parental behavior and challenges

(Xie et al., 2021) discovered that mothers exhibited normal behavior and had the same sense of the informational values of society. Additionally, it was shown that interactions between online groups persisted offline. (Plantin et al., 2009) discovered that moms utilized search engines to find health and parenting-related information. Pregnancy, bleeding, and other postpartum difficulties, worry and anxiety of first-time parents, guidance on parenting, child behavior, parental disagreements, sleep problems, and illness are some topics discussed on parent-related websites: teeth and the most affordable diapers. The vast majority of parents view the material available on the Internet favorably. According to (Hall et al., 2009), there was a tremendous degree of conflict in society between moms from different cultural groups with differing parenting styles. This tension results in competition regarding the optimal parenting approach. (Kothari et al., 2020) conducted a study utilizing a formative assessment approach to construct mobile application-based programs and discovered that information-containing parenting applications are valuable for moms; however, women need help with design issues and usability.

Double-diamond design thinking

Design Thinking was developed with the express purpose of being utilized in situations that are both dynamic and complicated, with requirements that are both fluid and largely unidentified or hidden (Hehn et al., 2019). The Double Diamond technique is one of the methods that may be utilized when engaging in Design Thinking (Design Council, 2015). This method is broken down into four parts, which are discovery, definition, development, and implementation. At this point, the cycle of divergence and convergence that is fundamental to design thinking is brought to light. When applied to the process of software development, design thinking is something that can be included in the development procedures that are already in place. According to (Levy et all., 2019) applying design thinking methodologies can foster dialogue among diverse stakeholders and enable different voices to be heard. If this is the case, then design thinking can also be used to overcome obstacles businesses face. The design thinking method has the potential to stimulate creativity and innovation while at the same time being capable of handling both technological and human issues.

Community engagement

Customer engagement is the continual interaction between a business and a customer in an interdisciplinary context. Additionally, friendship and emotional connection have a monetary worth. During this process, customers form and communicate their views, attitudes, aspirations, wishes, and concerns about brands, products, services, and policies (Belyakov, 2020). For members to engage in community activities, developing a strong community commitment is crucial. This emotion also converts inactive members to active ones and stimulates value creation (Zoé et al., 2022)

3. METHODS

This study uses the U.K Design Council-popularized double diamond design thinking technique, which consists of four stages: find, define, develop, and deliver (Design Council, 2015). The first part of this study was a discovery, commencing with establishing the target demographic of users based on the company's internal data. There were various user demographic criteria,

including age 27-45, female, having at least one child, and being a member of at least one parenting community. After determining the target users, proceed to the user interview step, which aims to map the types of users, the challenges encountered, and the demands of parents within the parenting community. Various visualization methods, such as affinity diagrams, user personas, and user journey mapping, will be used to depict the results of this approach. The second stage is called define. It is based on the synthesis results in the form of information on constraints, needs, and user expectations obtained during the discovery process. After that, defining user needs in the form of a point of view analysis and the question "how might we" will come next. The next step is called "develop," Its purpose is to investigate possible solutions to the challenges and requirements of the users identified in the previous stage, "define." In the final step, the outputs of the ideas carried out throughout the development stage will undergo an initial validation process. This stage makes use of a feedback collection grid architecture in order to obtain input on the concepts that have been proposed.

4. RESULTS AND DISCUSSION

Discover Stages

The research begins with an analysis of the stakeholders**.** The purpose of stakeholder analysis is to identify individuals or groups who will engage directly or indirectly with the research object. The influential or powerful and highly interested important players in this study are users of the parenting community. This study will focus on users of online parenting groups who meet the following criteria: they are above 27 years old, already have children, and belong to or are in the process of joining a parenting community.

After finding respondents who meet the requirements, the user interview procedure is continued online and offline in the subsequent phase. Seven respondents were used in the user interview procedure; all were female, 85.7% were between the ages of 27 and 34, 72.7% had children aged 0 to 5, and 71.4% were housewives. Then, six primary questions were formulated to simplify the discussion process to investigate user activity, difficulties, reasons, methods, and user requirements within the parenting group. User interviews performed with each respondent yielded qualitative information. Then, the data are mapped to the various user types shown in table 1. The mapping of distinct sorts of users is based on various factors, including the users' primary goal, their involvement, communication, activities, and interactions.

Table 1 User Type

Information	**User Type**		
	Observer	**Endorser**	**Contributor**
Primary goal	Get access to the most recent information on reliable parenting advice.	Validate information, gain inspiration, and attend various events.	Find a group of people who share similar interests, broaden the circle of friends, and immerse themselves in a niche community.
Nature of their involvement	Rarely, only when there is free time.	Often involved when there is a need.	Engage regularly and actively.
Communications	The tendency is to avoid direct communication.	Occasionally, members communicate with one another.	Take time regularly to communicate with one another.

Sample of Action/Interaction	Observe the conversation occurring on social media or in the WAG community.	Participate in several events and challenges.	Participate in book review conversations, engage in weekly discussions, and take the time to interact directly with other community members.

Affinity Map

Then, the insights gleaned from the user interviews are divided into three groups based on the type of user. Affinity mapping is categorized into topics: discussion context, behavior, pain points, gain points, and user needs.

The first type of user is the observer. Observer users' primary motivation for joining the community is to stay up to date on parenting information and knowledge. Observer users tend to only observe discussions on various platforms and rarely interact or communicate with other community members. The primary challenge for observer users is that the quantity of information shared by other members has not yet been validated. When valid information and parenting topics are categorized based on the child's developmental phase, Observer users find it useful. Then, observer users require a community platform that covers all parenting and community-related topics and is managed by physicians or specialists.

The second type of user is endorsers. The primary objective of endorser users is to join the community as a place to validate information, gain inspiration, and participate in a variety of events and challenges. Endorser users will occasionally participate in community-provided discussions and challenges. The main obstacle for endorser users is that they still find a great deal of unverified information, followed by a lack of free events or seminars and a community with too many members that inhibits the interaction between members. Then, endorsing users find it useful when they receive accurate and up-to-date information and can join the community of parents with children of the same age. Then, endorser users require a community that hosts numerous free events and challenges with monetary prizes.

The third type of user is a contributor. Contributing users' primary motivation for joining the community is to obtain a support system, expand relationships, and join more specialized communities. Contributing users typically participate actively in community-organized activities, such as book review discussions, offline activities, and WhatsApp group discussions. Constraints for contributor users include difficulty participating in WhatsApp group discussions because they are frequently interrupted by questions and overwritten by other discussions and difficulty locating a community with the same guiding principles and vision. Then, contributor users are ecstatic when they discover new supportive friends and consistent activities, such as book reviews. Contributor users require a community where information can be validated, community members who can serve as support systems, and communities that discuss specific topics in depth.

Users Persona

In this study, the user persona is utilized to picture the imaginary character of the prospective user in order to construct an online parenting community platform based on user requirements. User personas are separated into three categories: Observer, Endorser, and Contributor.

The user persona of the observer user type demonstrates a personality that tends to be reserved, blends emotions, and is simple to comprehend within the community. The primary objective should be to join the community to gain access to reliable and up-to-date parenting information. The user persona of the endorser user type demonstrates a personality that is typically

open, emotional, and easy to comprehend among community members. Therefore, the primary objective should be to join the community to validate knowledge, gain inspiration, and participate in various activities and challenges. The contributor user persona demonstrates a highly receptive personality to novelty and is highly methodical in thought and action. The primary objective should be to join a community to obtain a support system, expand relationships with other groups, and join communities that discuss specific issues in depth.

Users Journey Map

The subsequent step is to visualize the information summarized in the affinity map and the user persona in the form of a user journey mapping. This phase tries to map what users do, their feelings, and their pain areas in the parenting community. Phases or user activities are categorized into five phases: the phase of searching for or locating a community, the phase of joining the community, the phase of searching for subjects or information, the phase of debating and interacting, and the phase of engaging in activities.

The user journey map observer reveals that users encounter annoyance and bewilderment while looking for subjects or information, followed by obstacles such as an abundance of invalid information and trouble retrieving previously read content. Then, during the phase of following the activity, the user is ecstatic because he can immediately witness the activity. In addition, during this period, users frequently overlook information regarding the community's agenda.

The user journey map of endorser users depicts four periods in which users encounter problems. Users need more support throughout joining the community; they report that they are first hesitant to join a community since it is not pertinent to their needs. While searching for subjects or information, it is difficult for users to separate information contributed by other members. During the time of conversation and interaction, consumers experience sensations of uncertainty and anticipation. In the final phase, when users are engaged in activities, they are ecstatic because they can participate in events and want to accomplish challenges. However, they frequently encounter obstacles, such as many paid events or seminars, and frequently stop or fail while attempting to complete challenges.

The contributor user journey map reveals that users encounter numerous challenges practically every phase. During joining a community, users need more certainty since it is difficult to identify a community that discusses a given issue in-depth and shares the same vision. Then, during the information or information-seeking phase, people frequently face dissatisfaction and uncertainty because they must check information from various sources and mediums. Finding the time to read books to develop their information or knowledge can be challenging. Finally, during participating in activities, people are ecstatic because they frequently conduct offline activities or events. When the user community engages in offline activities, obtaining information on the availability of gathering places or offline venues is frequently challenging.

Define Stage

The Define stage defines user problems utilizing multiple frameworks, such as the Point of View (PoV) framework, which describes user obstacles as actionable problem definitions. The second framework is the How Might We (HMW) inquiry structure, which will assist in generating fresh ideas for resolving customer issues. The analysis of PoV and HMW will then be divided into three sections based on the type of user, namely observer, endorser, and contributor.

Several how might we question formulations mapped according to user categories have similarities in the context of the problems to be solved. The following is a summary of queries from all categories of users regarding 'how might we.'

1. How might we make it simpler for people to access information or topics?
2. How about we encourage people to participate actively in discussions?
3. How might we guarantee that every user gets all activity agenda information?
4. How might we make it simpler for people to join appropriate and relevant communities?
5. How might we make it simpler for consumers to identify legitimate data?
6. How might we persuade consumers to accomplish all the subsequent challenges?
7. How might we make it simpler for readers to comprehend the main idea of a book?
8. How about we develop a forum where members can participate without being distracted by other forums?

Develop Stage

Following the formulation of the how might we question; the next stage is the development process. This stage will consist of several parts, beginning with the ideation stage, followed by the feature recommendations resulting from the ideation stage. Finally, the feature recommendations are visualized as architectural information and a storyboard user interface.

The ideation process is conducted based on the how might we questions that have been prepared in advance; the ideation process generates multiple ideas to address the demands and challenges of users. Then, a selection of concepts will be made, which will be summarized into some feature development strategies; the selected ideas are as follows: list history based on the user's last visit, leaderboards/user rankings based on most discussions, recent agenda reminder widget on the main community page, community recommendations based on user preferences, user badges, rewards in the form of points, book review discussion thread, multi-thread discussion in a chat room, and active discussion widgets are followed on the main community page. The next step, following the collecting of potential ideas, is to establish multiple strategies for developing parenting community application features.

The initial strategy for feature creation is to generate user-specific customization based on preferences and behavior. This strategy attempts to address the need for pertinent community recommendations, the convenience of obtaining material that has been read or discovered, and community needs for the most recent agenda updates. The intensity of connection between the firm and its customers is increased through personalization, which, in turn, increases consumer loyalty and pleasure with the business. In fact, eighty percent of people who use the internet are really drawn to individualized services (Kang et al., 2016).

The second feature development strategy entails the creation of a gamification system using multiple techniques, including leaderboards, user badges, points, and awards. This strategy intends to satisfy users' requirements to remain motivated to participate in conversations and complete challenges. Virtual currency in the form of points aims to serve as a means of exchange for users to acquire admission to paid events. Using gamification as a design method can be quite effective in enhancing the user experience, this paradigm can construct a product-service system that considers real and virtual circumstances (Ning, 2018).

The third strategy for feature development is to create an interactive group conversation. This strategy attempts to make it simpler for users to participate in discussions on various issues by increasing access to communication and interaction with other members.

Information architecture

After developing three feature strategies, the next step is to visualize the features as an information architecture, as depicted in Figure 1. This application will be composed of three major pages and various subpages.

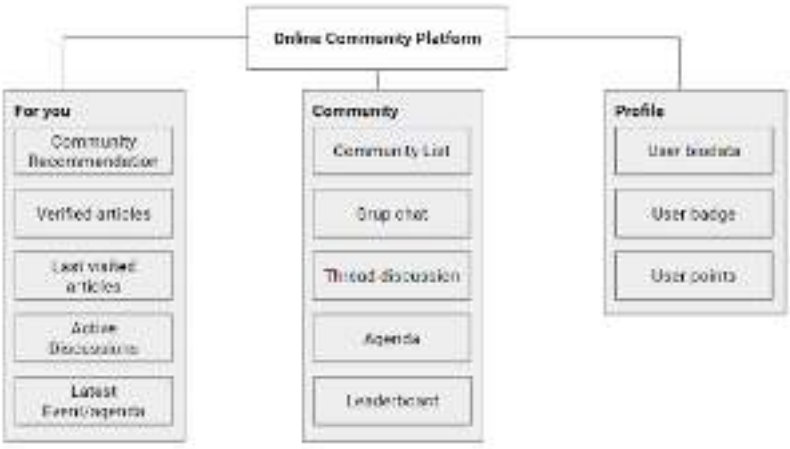

Figure 1 Information architecture online community platform

User interface storyboard

The user interface for storyboards is organized into three sections, as depicted in Figure 3: user personalization storyboards, interactive chat storyboards, and user gamification storyboards.

The first storyboard depicts the flow of user personalization, beginning with the user entering profile information, followed by the system processing, and recommending content based on the user's profile. In addition to advising depending on the user's choices, this storyboard describes personalization based on the user's actions. The second story of the storyboard describes the flow of interactive chat features. To make it easier for users to explore interactive chat features, several functions are separated into sections, such as functions for chat, functions for creating discussion threads, functions for viewing community agendas, and functions for viewing achievement boards or leaderboards for each community member. The third storyboard depicts the flow of a gamification system employing multiple techniques, including user badges, points, and awards. On this page, users may check and edit their profile information, view the status of their badges, view the number of points they've earned, view the activities that can be followed to earn points, and view the vouchers or gifts that can be traded for points.

Deliver stage

The delivery stage is intended to validate the results of the development stage's work on ideation. The validation process will be conducted on prospective users and will utilize a feedback capture grid to map user comments. The opinions of prospective users will be summarized and categorized into four categories: what is preferred, what needs to be altered, what is questioned, and what is advised. Table 2 below displays the results of the feedback capture grid.

Table 2 Feedback capture grid results

Work well	**Need to change**
• Form for filling in profile data that is not too long. • Get community recommendations. • a collection of widgets on the page for you to make it easier for users to explore all the features.	• Display of community recommendation widgets because of the large number it will be difficult to navigate if the visual form is in the form of a slider. • Leaderboard feature and mechanism for submitting verified members.

• Signs live and have ended in the discussion thread. • Mechanisms for earning points and exchanging them.	
Unanswered questions	**New ideas to try**
• What is the verification mechanism for articles with a verified badge? • What is the leaderboard ranking calculation based on? • What is the submission of a verified member like? • When changing preference data on the profile page, will it affect the results of the recommendations on the page for you?	• Chat feature between users • Differentiate the section between events and challenges. • Added a function to view members in each community. • Allows the discussion thread widget to be added to the chat room. • Points earned can be exchanged to Rupiah.

The results of the feedback received from prospective users can serve as input to polish the strategy guiding the development of a community platform focused on parenting.

5. CONCLUSIONS

According to the research and discussion, each user type has unique interactions with the parenting community. However, they all require the opportunity to join a community that can serve as a platform for sharing knowledge, creating communication, and acquiring reliable information about parenting. The creation of a community platform development plan involves three main strategies. The first is utilizing personalization to increase user engagement by recommending material, topics, and communities based on user interests and requirements. The second strategy entails enhancing the appeal of chat rooms so that users may converse and discuss with other members more effectively and efficiently. The third strategy is developing a gamification system based on badges, points, and awards. With badges, users can easily recognize the authenticity of members and the integrity of the information offered; therefore, points and awards can encourage users to continue participating actively in the community.

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Evaluation of Information Security Management in Micro, Small, and Medium Enterprises (MSMEs) using Penilaian Mandiri Keamanan Informasi (PAMAN KAMI)

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ABSTRACT

This study will evaluate the management of information security in Micro, Small, and Medium Enterprises (MSMEs) using Penilaian Mandiri Keamanan Informasi (PAMAN KAMI). Micro, Small, and Medium Enterprises (MSMEs) use Information Technology (IT) to run their business. MSMEs are potential targets for cybercriminals to cause economic and reputational damage. One thing that can be done to minimize the security risk is to evaluate the information security management. The evaluation process can help company to know the level of information security management implementation. In this study, an evaluation process will be applied using Penilaian Mandiri Keamanan Informasi (PAMAN KAMI) framework. The method used in this study is quantitative research based on questionnaire that collect data from digital-based MSMEs. The results indicate that 50.48% of total surveyed MSMEs have reached adequate indicators. All MSMEs that have been surveyed have implemented more than 50% of all the protection measure clauses in the PAMAN KAMI framework. There is a gap between the application of information security from all 103 MSMEs that have been surveyed with the PAMAN KAMI standards. The biggest gap is in the PR-24 clause, while the smallest gap is in the PR-01 clause.

Keywords: Information Security, Security Management, Security Evaluation, PAMAN KAMI, MSMEs.

1. INTRODUCTION

Companies depend on IT to support their business in our increasingly digital world. Large enterprise companies and even MSMEs use the information system to support their business (Kabanda et al., 2018). Along with the development of MSMEs that use IT, the threat of cyber security for MSMEs is also increasing (Corallo et al., 2020). Losses caused by cybersecurity, such as fraud in cyberspace, system errors in helping businesses, and a lack of information security culture, significantly impact MSMEs (Osborn, 2015). If this happens to MSMEs, they can immediately lose money and close their businesses because of small assets. In contrast, large companies have significant assets that can be used as reserves. When a loss occurs, MSMEs with small assets immediately lose money when they ignore the information security aspect (Benz & Chatterjee, 2020).

In general, information security management is created by implementing a framework in a company (Podrecca et al., 2022). One of the frameworks usually used for information security management in MSMEs is PAMAN KAMI. The framework is an information security

management standard published by the National Cyber and Crypto Agency or Badan Siber dan Sandi Negara (BSSN) Indonesia. PAMAN KAMI provides a list of security control objectives and recommends a set of security controls specific to MSMEs (Slamet et al., 2020). The use of PAMAN KAMI for digital-based MSMEs has yet to be widely discussed. The digital-based MSMEs environment is considered suitable for implementing PAMAN KAMI for its information security audit. This research will evaluate the application of information security management using PAMAN KAMI on MSMEs. The expected output can measure the level of information security implementation in MSMEs.

2. LITERATURE REVIEW

This section will explain about literature review of MSMEs' information security management in Indonesia. This section also explains about PAMAN KAMI framework. The related work and contribution of this research are explained in this section to conclude the literature review.

A. MSMEs characteristic in Indonesia

MSMEs have different organizational structures and assets from large enterprise companies. The economic strength of MSMEs is also different from large enterprise companies. Based on data from research (Osborn, 2015) which can be seen in Table 1, it is stated that the categories of MSMEs abroad have different valuations of money and number of workers. If the company is said to be an MSME, then the number of workers cannot be more than 250, with financial conditions between 50 and 43 million euros.

Table 1. Comparison table for medium, small, and micro businesses abroad.

Company Category	Employees	Turnover or Balance Sheet (EUR)
Medium	<250	≤ 50m or ≤ 43m
Small	<50	≤ 10m or ≤ 10m
Micro	<10	≤ 2m or ≤ 2m
Medium	<250	≤ 50m or ≤ 43m

Based on research (Reza et al., 2008) MSMEs in Indonesia have different valuations and characteristics. According to Article 6 of Law in Indonesia No. 20 of 2008 concerning the criteria for MSMEs in the form of capital like Table 2.

Table 2. Capital Comparison of MSMEs in Indonesia.

Company Category	Net value	Annual sales
Micro	IDR 50,000,000	IDR 300,000,000
Small	IDR 50,000,000 - IDR 500,000,000	IDR 300,000,000 - IDR 2,500,000,000
Medium	IDR 500,000,000 - IDR 10,000,000	IDR 2,500,000,000 - IDR 50,000,000,000

B. Information security management for MSMEs in Indonesia

The poor degree of digital literacy in Indonesia is one of the problems of digitizing MSMEs. One of the characteristics that renders MSMEs vulnerable to cyber-attacks is a lack of literacy. Education regarding cyber security is critical for increasing cyber security knowledge and culture in MSMEs (Riswanti et al., 2020). According to data from the Indonesian Ministry of Cooperatives and SMEs (2020), around 10.2 million MSMEs utilized digital technology in their

commercial activities in 2020. This figure climbed by almost 13% over the previous year. (Fintech.id, 2021).

Although digital technology enables MSMEs to stay connected to customers, reach new customers, and increase income, it also carries risks, including cyber risks such as online fraud, hacking, identity fraud, and consumer data leakage. MSMEs can suffer material and non-material losses as a result of cybercrime (Singgalen et al., 2021). External and internal issues, according to research (Kabanda et al., 2018), also affect the implementation of information security management in developing countries. The external and internal problem diagrams can be seen in Figure 1. On external factors, we find technicians from MSMEs with low experience in technical matters such as IT. In addition, other technical, educational, and cultural problems significantly hinder the implementation of information security management in MSMEs.

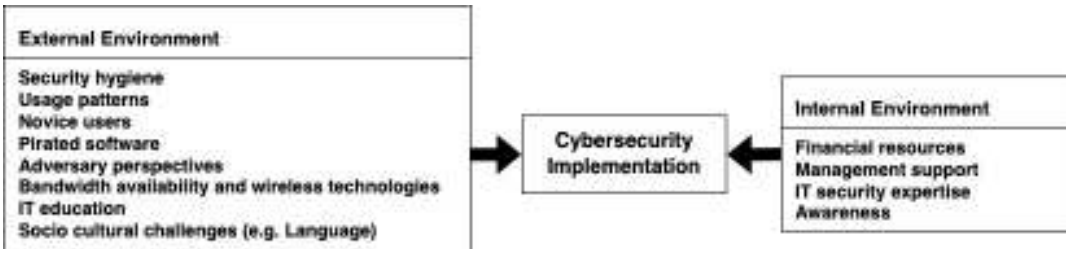

Figure 1. External and Internal factor for Cybersecurity implementation on MSMEs.

C. Penilaian Mandiri Keamanan Informasi (PAMAN KAMI)

In 2020, BSSN launched the PAMAN KAMI framework for MSMEs. PAMAN KAMI is a practical solution offered by BSSN for MSMEs in Indonesia as a first step to checking the security status of their business information. PAMAN KAMI is a contribution of BSSN for participation in realizing national security and increasing national economic growth. PAMAN KAMI is expected to be the basis for formulating strategies and efforts to prevent, minimize and overcome cyber-attack incidents for MSMEs. It is hoped that cyber-attack incidents can be prevented and addressed early on. PAMAN KAMI form contains short questions that focus on 25 steps of information security. Filling out the PAMAN KAMI questionnaire only takes approximately five minutes. PAMAN KAMI framework is free to download and use by any MSMEs. PAMAN KAMI framework can be downloaded for free via the link: https://cloud.bssn.go.id/s/2TqsacBESPHky4A#pdfviewer. The MSMEs can build and develop their business smoothly and safely from cyber-attacks to realize national security and increase national economic growth at a minimal cost. There are two conditions that MSMEs must meet when using the PAMAN KAMI framework. First, business organizations do not have servers or network equipment that requires complex setups. Second, the business organization develops no application software independently and only uses commercially available/third-party application/platform software. (BSSN, 2020).

D. Related Work

Research (Ponsard et al., 2020) is researching to produce a lighter framework for cybersecurity governance in small and medium enterprises in Belgium. The framework was developed with the inspiration of ISO 27001 for MSMEs in Belgium and performed exceptionally well. Although it needs improvement in the future, the framework can already be used. Research (Benz & Chatterjee, 2020) using the NIST framework to perform risk calculations before

implementing cybersecurity governance in MSMEs. It took some modifications and adjustments to the NIST framework when implemented because the MSMEs environment was different from that of large enterprise companies. Research (Armenia et al., 2021) examine MSMEs that wish to manage their cybersecurity risks and for insurance companies to evaluate their economies against the risks caused by MSMEs. This research helps better define the profile of cybersecurity risks and the target profile that MSMEs should align with, taking the dynamics of the elements modeled through the NIST Cybersecurity Framework.

Research (Valdevit & Mayer, 2010) presents the methods and research undertaken to design, experiment, and improve gap analysis when MSMEs implement ISO/IEC 27001. The experimental results show that the time required to conduct a gap analysis is reduced, and the questions are scored homogeneously by the analyst based on the auditee's answers. The tools and recommendations designed in this study can improve the efficiency of the gap analysis task. Research (Slamet et al., 2020) presents the methods and research undertaken to design, experiment, and improve gap analysis when MSMEs implement PAMAN KAMI. The data is obtained from MSMEs around the university. PAMAN KAMI is suitable for the valuation of MSMEs in Indonesia. This research has not discussed using PAMAN KAMI for digital-based MSMEs in Indonesia.

Based on related research, it can be concluded that the application of the ISO 27001 and NIST frameworks is suitable to be applied abroad but based on Article 6 of Law No. 20 of 2008, it cannot be applied in Indonesia because the valuation of MSMEs is not suitable. The use of PAMAN KAMI for digital-based MSMEs has also yet to be widely discussed. Therefore, this study chose PAMAN KAMI to evaluate information security management for digital-based MSMEs.

3. METHODS

This section will explain the methodology of this research. This study is quantitative research with questionnaire. The methodology starts with the sample and procedure section to explain how to get the data. Then in questionnaire implementation section will explain how to create the questionnaire for the data acquisition process from the respondent. The data analysis section will explain how to analyze the data after the acquisition process from the respondent. All of the methodology process is inspired by research (Slamet et al., 2020), (Williams & others, 2007), (Oroviogoicoechea & Watson, 2009), and (Bandopadhyay et al., 2011).

A. Sample and Procedure

MSMEs that will be made for surveys and case studies in this research are according to Article 6 of Law No. 20 of 2008 in Indonesia. The detail from MSMEs' profiles and demography is also can see on the PAMAN KAMI framework assessment tool. This research will survey MSMEs that use digital technology for running their business. The digital technology used to help the MSME business process can be super-apps such as E-commerce, Digital Transportation, Digital Logistics, Digital Point of Sale, and social media.

This study collects respondent data by distributing surveys to MSME community groups. In addition, the author also disseminates to MSMEs individually through known partners. The media used by the author to distribute the survey is Whatsapp and Telegram. The survey was conducted from September to November 2022. After collecting the data, the data will be checked first. Checking the data is done before analyzing the data. If there is incorrect or empty data in the components to be analyzed, justification and confirmation of data will be carried out on the respondents. The total number of respondents who filled out the survey was 103 people. Details of

the demographics of respondents who have filled out the survey can be seen in Table 3. Detailed results of responses from respondents who filled out the survey can be seen at this link: https://www.kaggle.com/datasets/auliaarifwardana/umkm-paman-kami. The published detailed result data does not contain personal or confidential information.

Table 3. Respondent Demography.

No	Demography	Detail	Total Respondent	
			%	Number
1	Enterprise Scale	Micro	69,90	72
		Small	19,41	20
		Medium	10,67	11
2	Asset	< IDR 50 Million	69,90	72
		IDR 50 - 500 Million	20,38	21
		IDR 500 Juta – 10 Billion	9,70	10
		> IDR 50 Billion	0	0
3	Turnover	< IDR 300 Million	74,75	77
		IDR 300 Million – 2,5 Billion	15,53	16
		IDR 2,5 Billion – 50 Billion	9,70	10
		> IDR 50 Billion	0	0
4	Staff Number	< 10 People	72,81	75
		11 – 30 People	25,24	26
		30 – 300 People	1,94	2
		> 300 People	0	0
5	Social Media	Facebook	31,06	32
		Instagram	95,14	98
		Line	5,82	6
6	Market Place	Bukalapak	1,94	2
		Shopee	41,74	43
		Blibli	0,97	1
		Tokopedia	11,65	12
		Lazada	1,94	2
		JD.ID	0	0
		Zalora	0	0
		Bhineka	0	0
7	Individual Website		6,79	7
8	Individual Mobile Phone app		1,94	2

Figure 2. Assessment process for MSMEs using PAMAN KAMI Framework.

In this research, the steps taken to carry out the security evaluation process on digital-based MSMEs based on the PAMAN KAMI framework can be depicted in Figure 2. The process carried out in this study has a larger scale for collecting data on several respondents to examine and assess

the level of information security in a demographic. It takes not only MSMEs individually but as a group.

B. Questionnaire Implementation

The PAMAN KAMI assessment form contains short questions that focus on 25 steps of the information security aspect. Filling out the PAMAN KAMI assessment form only takes approximately five minutes. The detail of the question and security aspect or threat can see in Table 6.

Table 4. Answer and grading in PAMAN KAMI framework.

No	Answer	Description	Grade
1	Completely Applied	if the assessment item is applied thoroughly to all employees, both personally and organizationally.	4
2	Partially Applied	if the assessment item is only applied by part of the employee or organization.	2
3	Not Applied	if the assessment item has not been applied at all by the employee or the organization.	0
4	Don't know	if you don't understand the assessment item.	0

Table 5. Level of Security Implementation in PAMAN KAMI framework.

No.	Total Point and Level	Description
1	100 (PERFECT)	The information security measures MSMEs have implemented are perfect. Plan steps to move up to the next level.
2	90-99 (GOOD)	It's almost perfect, but there are some steps that haven't been fully implemented, so further security implementation is needed.
3	70-89 (ADEQUATE)	The security measures are quite good. Implement existing protection measures to increase the security of MSMEs information.
4	50-69 (DEFICIENT)	There are areas where there is an explicit lack of security measures.

The respondent must choose the answer for each question, and each answer has a score. The detail of the answer and grading value can see in Table 4. After filling the form with the chosen answer, the following process is total all scores from the answer. The total score is indicated the level of information security management in the MSMEs. The detailed meaning and description of each point and security level can see in Table 5. The evaluation procedure in this research begins with transforming the PAMAN KAMI for assessment into a Google Form so that MSMEs actors can easily access it. After that, the MSMEs respondents will fill out the form. After getting the answer, it will be checked and analyzed the data.

Table 6. PAMAN KAMI framework security threat and Protection Procedures.

Question	Clause Code	Threat	Protection
1	PR-01	Weak important asset protection.	Asset identification.
2	PR-02	Not calculated risk.	Risk identification.
3	PR-03	Doesn’t have policy and procedure for information security.	Create policy and procedure for information security.

4	PR-04	Not use password on company devices.	Password on company devices.
5	PR-05	Not use password for company account.	Password for company account.
6	PR-06	Weak protection for important document.	Policy and procedure for important document.
7	PR-07	Information theft on working area.	Access control on working area.
8	PR-08	Electrical failure on company devices.	Use surge protector or UPS for keep device availability.
9	PR-09	Information theft from recover deleted data.	Prevent recover deleted data using specific tools.
10	PR-10	Information theft after using public internet network.	Policy and procedure for using public internet network.
11	PR-11	Social engineering.	Verification and restriction in any information.
12	PR-12	Out of date operating system and software.	Operating system and software update.
13	PR-13	Information theft or virus from untrusted software.	Download application from trusted application store.
14	PR-14	Malware or virus from internet connection.	Internet control policy.
15	PR-15	Uneducated employee about information security.	Information security education for employee.
16	PR-16	Business partners misuse confidential information.	Business partner security regulation.
17	PR-17	Insider attack from employee.	Employee access control.
18	PR-18	Information theft from the company network.	Firewall implementation.
19	PR-19	Unprotected WiFi connection.	Password and encryption for WiFi.
20	PR-20	Virus on company device.	Antivirus implementation.
21	PR-21	Email phishing.	Verification and restriction in email.
22	PR-22	Does not know activity on the company network or device.	Log monitoring on firewall or antivirus.
23	PR-23	Delays after information security incident happen.	Incident response policy and procedure.
24	PR-24	Information or data lost.	Backup.
25	PR-25	Not update about latest information security threat.	Continuation study on information security.

C. Data Analysis

This phase will perform calculations on the value of applying information security to each respondent who has been surveyed. The goal is to see how many MSMEs achieve the value of implementing information security with PERFECT, GOOD, ADEQUATE, DEFICIENT, and POOR indicators. After that, this research will perform gap analysis. Based on research (Jennings, 2000) and (Aedah & Hoga, 2020), a gap analysis compares current performance to potential or projected performance. This approach is an evaluation tool that focuses on the performance gap between present and previously targeted performance. Gap analysis may be used to determine the activities required to close gaps or achieve the expected performance. It can also be used to estimate the time, money, and resources required to attain the desired scenario.

4. RESULTS

The first data analysis is to calculate the value of implementing information security for each respondent surveyed. The total number of respondents who filled out the survey was 103 people. After calculating the information security assessment, we can see the number of MSMEs that scored PERFECT, GOOD, ADEQUATE, DEFICIENT, and POOR. Details of the data can be seen in Table 7.

Table 7. The number of MSMEs that scored PERFECT, GOOD, ADEQUATE, DEFICIENT, and POOR indicators.

No.	Indicators	Total MSMEs	
		Number	%
1	100 (PERFECT)	7	6,79
2	90-99 (GOOD)	15	14,56
3	70-89 (ADEQUATE)	52	50,48
4	50-69 (DEFICIENT)	22	21,35
5	49 or less (POOR)	7	6,79

Based on the MSME data that responded to the survey, most of them achieve ADEQUATE indicator with a total of 52 MSMEs or 50.48% of the total surveyed MSMEs. That indicates that most of the MSMEs surveyed have implemented information security management quite well according to PAMAN KAMI standards. However, MSME actors must apply existing protection measures to improve information security. If we compare the number of MSMEs that score GOOD and PERFECT and the number of MSMEs that score DEFICIENT and POOR, then there are still more MSMEs that score DEFICIENT and POOR. That indicates that 29 MSMEs or 28.14%, still need to implement information security according to PAMAN KAMI standards. Only 22 MSMEs apply information security standards with GOOD to PERFECT indicators or around 21.35% of the total respondents.

Table 8. Rate the implementation of information security for each clause.

Clause Code	Current Implementation Value	Target Implementation Value	Percentage of Implementation
PR-01	380	412	92,2%
PR-02	334	412	81%
PR-03	340	412	82,5%
PR-04	348	412	84,4%
PR-05	346	412	83,9%
PR-06	336	412	81,5%
PR-07	328	412	79,6%
PR-08	306	412	74,2%
PR-09	334	412	81%
PR-10	296	412	71,8%
PR-11	356	412	86,4%
PR-12	306	412	74,2%
PR-13	310	412	75,2%
PR-14	300	412	72,8%
PR-15	298	412	72,3%

PR-16	290	412	70,3%
PR-17	290	412	70,3%
PR-18	302	412	73,3%
PR-19	284	412	68,9%
PR-20	268	412	65%
PR-21	326	412	79,1%
PR-22	260	412	63,1%
PR-23	270	412	65,5%
PR-24	244	412	59,2%
PR-25	272	412	66%

The second data analysis is measuring the percentage of information security management in surveyed MSMEs. In Table 8, the "Code" column is obtained based on the protection measures clause or ideal conditions for implementing information security in accordance with Table 6. The "Current Implementation Value" column is calculated based on the number of Completely Applied and Partially Applied answers on each question from a total of 103 MSMEs that have been surveyed. The ideal conditions for implementing information security in accordance with Table 6 has Completely Applied answer or a score of 4. If all (103) MSMEs surveyed produce Completely Applied in each question, then the ideal score for each clause is 412. If there are questions that obtain a total score 412 means that all surveyed MSMEs have implemented clauses on protective measures or ideal conditions in accordance with the PAMAN KAMI framework. This is the basis for the "Target Implementation Value" column with a maximum value of 412. The "Percentage of Implementation" column describes how many percent of each protection measure clause of the KAMI PAMAN framework has been implemented by the 103 MSME actors who have been surveyed.

In Table 8, the PR-01 clause code has the largest percentage of implementation of all 103 SMEs that have been surveyed. Meanwhile, the PR-24 clause code has the smallest percentage of implementation of all 103 MSMEs that have been surveyed. In Table 8, all protection measures clauses have been implemented more than 50%. This indicates that out of a total of 103 MSMEs that have been surveyed, more than 50% of all the protection measure clauses in the PAMAN KAMI framework have been implemented.

Table 9. The average value of implementing information security for each clause.

Clause Code	Current Implementation Value (Average)	Target Implementation Value (Average)	Gap Value (Average)
PR-01	3,6	4	0,4
PR-02	3,2	4	0,8
PR-03	3,3	4	0,7
PR-04	3,3	4	0,7
PR-05	3,3	4	0,7
PR-06	3,2	4	0,8
PR-07	3,1	4	0,9
PR-08	2,9	4	1,1
PR-09	3,2	4	0,8
PR-10	2,8	4	1,2
PR-11	3,4	4	0,6
PR-12	2,9	4	1,1

PR-13	3,0	4	1
PR-14	2,9	4	1,1
PR-15	2,8	4	1,2
PR-16	2,8	4	1,2
PR-17	2,8	4	1,2
PR-18	2,9	4	1,1
PR-19	2,7	4	1,3
PR-20	2,6	4	1,4
PR-21	3,1	4	0,9
PR-22	2,5	4	1,5
PR-23	2,6	4	1,4
PR-24	2,3	4	1,7
PR-25	2,6	4	1,4

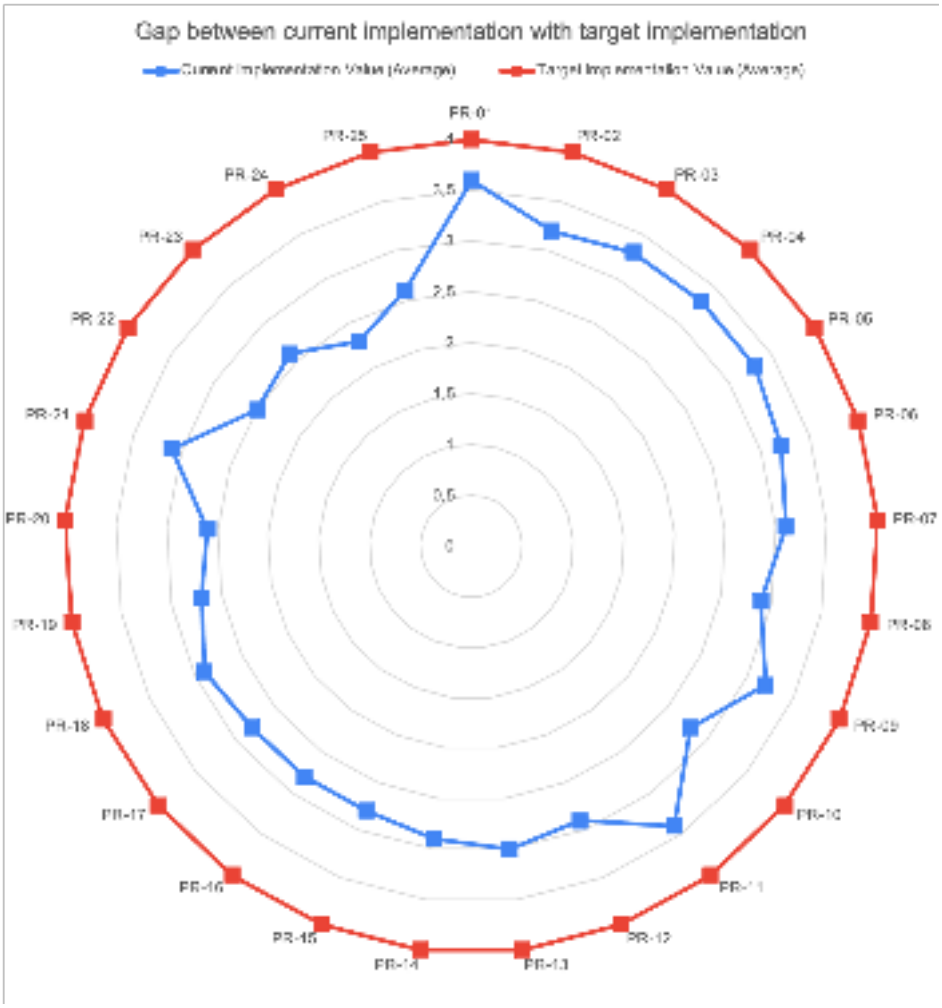

Figure 3. Gap Analysis Visualization.

The third analysis is calculating the average value of the gap in each question. This value is used to rank any security principles that have not been implemented according to PAMAN KAMI standards for the surveyed MSMEs. In Table 9, the column "Current Implementation Value

(Average)" is obtained based on the average results from the "Current Implementation Value" column in Table 8. The column "Target Implementation Value (Average)" is determined based on the highest answer score in the PAMAN KAMI framework, which is Completely Applied or has a score 4. If the respondent has answered Completely Applied and produce a value of 4, then each clause in Table 6 has been implemented thoroughly. The "Gap Value (Average)" column is calculated based on the subtraction between the Current Implementation Value (Average) and Target Implementation Value (Average). The next step is to visualize using a diagram based on the data obtained in Table 9. The visualization results of the gap analysis can be seen in Figure 3.

The results of the visualization in Figure 3 and the data in Table 9 show that the clause with the smallest average gap value is the PR-01 clause. While the clause that has the largest average gap value is PR-24. This indicates that the biggest gap between the application of information security from all 103 MSMEs that have been surveyed with the PAMAN KAMI standard is in the PR-24 clause. Meanwhile, the smallest gap between the application of information security from all 103 MSMEs that have been surveyed with the PAMAN KAMI standard is in the PR-01 clause.

6. CONCLUSIONS

The implementation of information security management in digital-based MSMEs have been evaluated based on PAMAN KAMI standards from BSSN. The survey variables and indicators in the evaluation framework apply the KAMI PAMAN standards. The evaluation framework uses an online survey method to collect data on 103 respondents of digital-based MSMEs. The results indicate that 50.48% of total surveyed MSMEs have reached adequate indicators. All MSMEs that have been surveyed have implemented more than 50% of all the protection measure clauses in the PAMAN KAMI framework. There is a gap between the application of information security from all 103 MSMEs that have been surveyed with the PAMAN KAMI standards. The biggest gap is in the PR-24 clause, while the smallest gap is in the PR-01 clause.

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RISK ANALYSIS OF STATIC EQUIPMENT IN THE CORROSION LOOP OF CO_2 REMOVAL OF AMMONIA PLANT BY IMPLEMENTING *RISK BASED INSPECTION*

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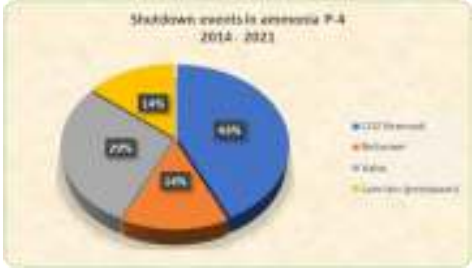
ABSTRACT

In the process of producing Urea fertilizer, the Ammonia plant is part of it. Inside the ammonia plant, there is a CO_2 removal unit that functions to purify process gas from CO_2 while at the same time producing CO_2. The CO_2 removal corrosion loop consists of several static equipment and rotational and electrical devices which are often the cause of unscheduled shutdowns at the ammonia plant. It is certain that the inspection and repair especially on static equipment during scheduled and unscheduled shutdown require great power. Meanwhile, the inspection of static equipment such as pressure vessels and heat exchangers at the plant where this research was conducted is still based on condition-based and time-based. In this inspection, all static equipment is checked, both critical and non-critical equipment consisting of 5 types of columns and 6 heat exchangers, with the same inspection time frame/interval, which is 2 years.The implementation of Risk-Based Inspection (RBI) in loop corrosion of CO_2 Removal with Area-based consequence and Financial consequence resulted in 5 equipment with high risk, 6 equipment with medium risk. As for the inspection schedule, 5 equipment must be inspected immediately (high risk), 1 equipment will need to be inspected in 3 years, 2 equipment will need to be inspected in 7 years and 3 equipment will need to be inspected more than 20 years from now. The inspection will be conducted using a method that focuses on the damage mechanism in each equipment including Visual Testing, Ultrasonic Testing (UT), Radiography Test (RT), Eddy Current Test, Steel Testing, Alternating Current Field Measurement (ACFM) and Magnetic Flux Leakage (MFL).

Keywords: Corrosion loop, inspection schedule, inspection method, Risk Based Inspection (RBI), static equipment, unscheduled shutdown.

1. INTRODUCTON

In all fertilizer industries, maintaining the performance and integrity of plant equipment is important so that plants can operate optimally according to the expected targets. Inspection is a way or method to check the technical condition of equipment so can be operated efficiently and safely. In carrying out an inspection, it is necessary to have an appropriate inspection interval to minimize shortage inspection or excess inspection. PT. Pupuk Kaltim, one of the largest fertilizer companies in Asia has 7 fertilizer plants, each of which consists of a Utility, Ammonia , and Urea plant. Plant – 4 is one of The Pupuk Kaltim plants with an ammonia factory capacity of 1000 Metric tons per day. In the period 2014 -2021 Plant – 4 experienced several shutdowns as shown in the graph below.



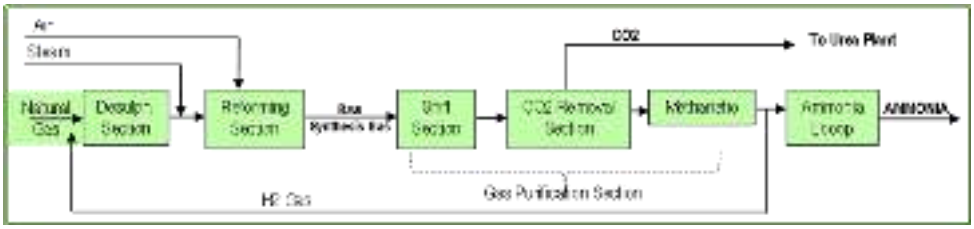
Source : Operations Department of Plant-4

Figure 1. Shutdown events at the 2014-2021 Ammonia plant - 4

From the data above, it can be explained that static equipment in the CO_2 removal corrosion loop is often the cause of shutdowns in ammonia. Thus, it is very important to know the level of risk of static equipment in corrosion loop CO_2 removal so that it is properly inspected. Inspection of static equipment such as pressure vessels and heat exchangers at the plant where this research was conducted is currently still based on condition and time based.

The purpose of this research is to determine the risk level of static equipment in corrosion loop CO_2 removal based on the parameters of Risk-Based Inspection consisting of: Damage factor, Probability of Failure (PoF) and Consequences of Failure (CoF).) comprehensive level-1 (area-based and Financial-based). In addition to determining the level of risk, also to determine the schedule for inspection of each equipment. All calculations based on API RP 5813rd ed.add.2019 and API RP 5803rd ed. 2016

2. LITERATURE REVIEW

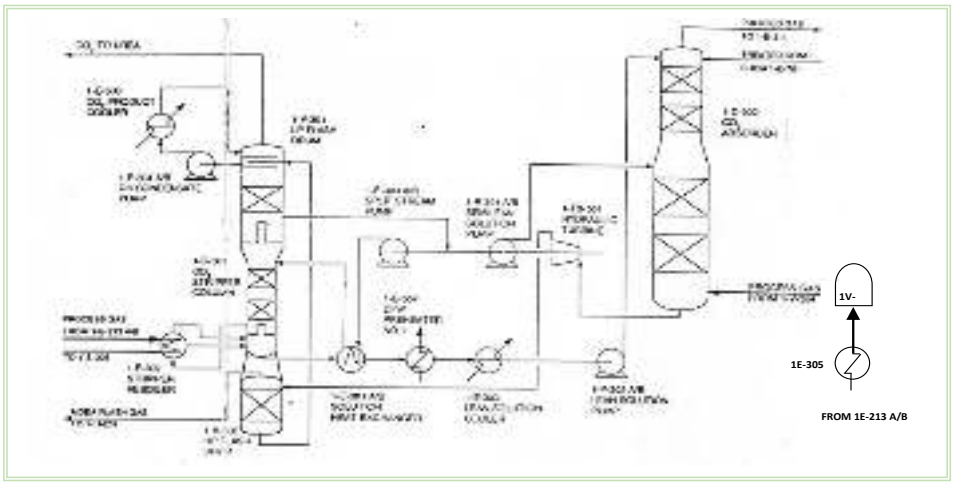


Source : Operating Manual, Kaltim 4 Project, Vol.1, 2002

Figure 2. Ammonia Production Process

In the Ammonia plant, Corrosion Loop CO_2 Removal is a gas purification section, CO is converted to CO_2 and H2 by steam to increase the amount of H_2 with the chemical equation as below.

$$CO + H_2O \quad \Longleftrightarrow \quad CO_2 + H_2 \quad + 9.800 \text{ kcal/kgmol.}$$



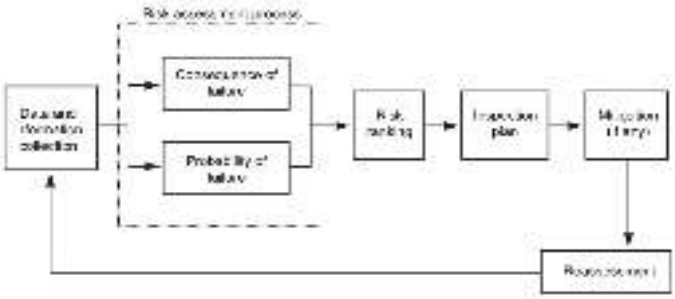
Source : Engineering Data Book, Kaltim 4 Project, Vol.2, 2002

Figure 3. CO_2 *Removal* Corrosion Loop

The CO_2 removal system is based on *two-stage activated MDEA* process by BASF. The *solvent used for CO_2 absorption* is aMDEA 03 (*activated Methyl Di Ethanol Amine*). The main process system consist of a two-stage CO_2 Absorber, a CO_2 Stripper and two Flash Vessels.

Bhatia,et.al (2019) Inspection and maintenance activities are necessary to ensure continuous operation and to avoid losses and damage to the reputation of the company. In the competitive market, major failures like leakages and spills could cost an organization much more than just repair expenditures, and this has made industries lean towards predictive maintenance policies.. Historically, inspections have been a vital tool for detecting potential failures. Inspection intervals are scheduled on dates of a predetermined duration or specified suitability for service life.

API 581 (2019). Risk-Based Inspection (RBI) is a risk assessment and management process that focuses on loss of containment from pressurized equipment resulting in loss of containment to the atmosphere or rupture of pressurized components in processing facilities due to material degradation. Risk-Based Inspection provides guidance for static equipment in refineries, petrochemicals, chemical process plants, and oil and gas production facilities. The RBI procedure can be applied qualitatively, quantitatively (as in this study), or by using aspects of both (ie semi-quantitatively).



Source : API 580, 2016

Figure 4. RBI process workflow

Corrosion loop is one of the most important parts of a good RBI program and it needs to be as accurate as possible. Corrosion loop must be identified at the PFD level and then at the P&ID level. The Corrosion Loop is used to group assets with similar damage mechanisms based on: materials of construction, insulation/coating, operating parameter (pressure, temp.,pH etc), Process condition (fluids, composition etc). The RBI assessment was performed under normal operating conditions. The following data must be obtained in conducting an RBI assessment:

- Type of equipment
- Process Flow Diagram system
- Composition of Fluid Contained
- Piping and Instrumentation Diagram system
- Previous Inspection Reports
- Materials and Construction
- Design and operation of the equipment
- Safety System

In general, the calculation of risk is determined in accordance with Equation below, as a function of time. The equation combines the POF and the COF

Risk = POF x COF or as a function of time $\mathbf{R(t) = P_f(t) \times C_f}$

Two methods of calculating POF are used within the text: the GFF method and a two-parameter Weibull distribution method. The GFF method is used to predict loss of containment POF from pressure boundary equipment. The Weibull distribution method is used to predict POF for heat exchanger bundles.

PROBABILITY OF FAILURE (POF) ANALYSIS

Probability of failure (PoF) analysis is analyzed by identifying the damage mechanism, assessing PoF, and identifying the causes of the risk occurring, in order to determine strategies to mitigate risks. After the damage mechanism is determined as the one that has the most influence on the failure of a pressure vessel, a probability of failure analysis will be carried out.

GFF method

A POF developed for specific component types based on a large population of component data that does not include the effects of specific damage mechanisms. Suggested Component Generic Failure Frequencies especially for this research (pressure vessel and heat exchanger bundle) as describe in Table 1**.** The POF using the GFF method is calculated with formula below.

$P(t) = PoF = gff\ .\ FMS.\ Df(t).$ Which are :

PoF : Probability of failure ; gff : generic failure frequency
FMS : management systems factor ; DF : damage factor

Table 1. Suggested Component Generic Failure Frequencies

Equipment type	Component Type	GFF as a function of hole size (failures/yr)				gff_{total} (failures/yr)
		small (0 – ¼ in)	medium (>¼ – 2 in)	large (>2 – 6 in)	rupture (> 6 in)	
Heat Exchanger	HEXSS, HEXTS	8.00E-06	2.00E-05	2.00E-06	6.00E-07	3.06E-05
Vessel/ FinFan	KODRUM, COLBTM, FINFAN, FILTER, DRUM, REACTOR, COLTOP, COLMID	8.00E-06	2.00E-05	2.00E-06	6.00E-07	3.06E-05

Damage Factor (DF)

The calculation of the damage factor value is determined from the damage mechanism that has been obtained as described in Table 2. For multiple damage factors, it is necessary to calculate each influential

damage factor value. After each damage factor value is obtained, then the total damage factor value can be calculated using the formula given in API 581. Damage mechanism indicates the type of damage that most influences the success of the pressure vessel. API 581 provides 7 types of damage mechanisms that occur in pressure vessels. To determine the type of damage mechanism can be done by conducting screening criteria based on API 581. Here are 7 types of damage mechanisms that occur in pressure vessels:

1. Thinning – $\mathbf{D_{f\text{-}gov}^{thin}}$
2. Stress corrosion cracking – $\mathbf{D_{f\text{-}gov}^{SCC}}$
3. External Damage – $\mathbf{D_{f\text{-}gov}^{extd}}$
4. High Temperature Hydrogen Attack (HTHA) – $\mathbf{D_{f}^{htha}}$
5. Mechanical fatigue (hanya pada pipa) – $\mathbf{D_{f}^{mfat}}$
6. Brittle – $\mathbf{D_{f\text{-}gov}^{brit}}$
7. Mechanical and Metallurgical – $\mathbf{D_{f\text{-}gov}^{mmet}}$

The damage factor is computed using the most influential type of damage mechanism. If there are more than one damage mechanism, the damage factor is computed using the damage factor formula for multiple damage mechanisms, which is shown below:

$$D_{f\text{-}total} = max[D_{f\text{-}gov}^{thin}, D_{f\text{-}gov}^{extd}] + D_{f\text{-}gov}^{SCC} + D_{f}^{htha} + D_{f}^{mfat} + D_{f\text{-}gov}^{brit} + D_{f\text{-}gov}^{mmet}$$

Management System Factor (FMS)

The management system factor shows the quality of mechanical integrity and the process safety management program at a facility. For the purposes of analyzing the FMS value of 1 or the equivalent of a score of 500 (50% of the maximum total score that can be obtained).

Table 2. List of equipment, Operational Data and Damage Mechanisms

Equipment		Fluid	Damage Mechanism
1E-301A	Shell side	Lean MDEA Solution	CUI, Amine Corrosion, Amine SCC
	Tube side	Semi lean MDEA Sol.	Erosion-corrosion
1E-301B	Shell side	Lean MDEA Solution	CUI, Amine Corrosion, Amine SCC
	Tube side	Semi lean MDEA Sol.	Erosion-corrosion
1E-302	Shell side	Lean MDEA Solution	CUI, Amine Corrosion, Amine SCC
	Tube side	Process Gas	CUI, Erosion-corrosion
1E-303	Shell side	Lean MDEA Solution	Amine Corrosion, atmospheric corrosion Erosion corrosion Amine SCC
	Tube side	Cooling Water	Cooling water corrosion, Erosion-corrosion, atmospheric corrosion
1E-304	Shell side	Lean MDEA Solution	Amine Corrosion, atmospheric corrosion, Erosion-corrosion Amine SCC
	Tube side	DFW	Cooling water corrosion, Erosion-corrosion, atmospheric corrosion
1E-305	Shell side	DFW	Cooling water corrosion, Erosion-corrosion, atmospheric corrosion
	Tube side	Process Gas	CUI, Erosion-corrosion
1C-301	Top Shell	aMDEA sol. + Stripped CO2	CUI, , Erosion-corrosion
	Bottom Shell	aMDEA sol. + Stripped CO2	CUI, Amine Corrosion,CO_2 Corrosion, Erosion-corrosion , Amine SCC
	Top Head	aMDEA sol. + Stripped CO2	CUI, Erosion-corrosion
	Bottom head	aMDEA sol. + Stripped CO2	CUI, Amine Corrosion,CO_2 Corrosion, sour water corrosion, Amine SCC.
1C-302	Top Shell	aMDEA sol. + Process gas	CUI, Amine Corrosion, Amine SCC, CO_2 Corrosion,
	Botom shell	aMDEA sol. + Process gas	CUI, Amine Corrosion, Amine SCC, CO_2 Corrosion.
	Top head	aMDEA sol. + Process gas	CUI, Amine Corrosion, Amine SCC, CO_2 Corrosion,
	Bottom Head	aMDEA sol. + Process gas	CUI, Amine Corrosion, Amine SCC, CO_2 Corrosion, sour water corrosion.
1V-301	Top Shell	aMDEA sol. + Flash gas	CUI, Erosion-corrosion, atmospheric corrosion, CO_2 Corrosion
	Bottom shell	aMDEA sol. + Flash gas	CUI, Erosion-corrosion, atmospheric corrosion, CO_2 Corrosion
	Top head	aMDEA sol. + Flash gas	CUI, Erosion-corrosion, atmospheric corrosion, CO_2 Corrosion
	BottomHead	aMDEA sol. + Flash gas	CUI, Erosion-corrosion, atmospheric corrosion, CO_2 Corrosion
1V-302	Top Shell	aMDEA sol. + Flash gas	CUI, Erosion-corrosion
	Bottom shell	aMDEA sol. + Flash gas	CUI, Amine Corrosion,CO_2 Corrosion, Erosion-corrosion , Amine SCC,
	Top Head	aMDEA sol. + Flash gas	CUI, Erosion-corrosion
	Botom Head	aMDEA sol. + Flash gas	CUI, Amine Corrosion,CO_2 CorrosionErosion-corrosion , Amine SCC,
1V-304	Shell	Process Gas	Erosion-corrosion, atmospheric corrosion
	Head	Process Gas	Erosion-corrosion, atmospheric corrosion

As shown in Table 2, the damage mechanisms that occur in corrosion loop CO_2 removal equipment are internal thinning, external damage (CUI), and amine cracking. For CUI, determine the base corrosion rate based on the driver and operating temperature using the table corrosion rate in API RP 581. The uncertainty in the corrosion rate varies, depending on the source and quality of the corrosion rate data.

For internal thinning, the corrosion rate data used is the measured corrosion rate data, inspected by third parties with the criteria of low confidence information sources for Corrosion Rates.

The extent of reduction in the POF depends on the effectiveness of the inspection to detect and quantify a specific damage type of damage mechanism. Therefore, higher inspection effectiveness levels will reduce the uncertainty of the damaged state of the component and reduce the POF. API 581 provides examples of the levels of generic inspection plans for a specific damage mechanism. Inspections are ranked according to their expected effectiveness at detecting damage and correctly predicting the rate of damage. The actual effectiveness of a given inspection technique depends on the characteristics of the damage mechanism.

Table 3. Inspection Effectiveness Categories

Inspection Effectiveness Category	Inspection Effectiveness Description	Description	Uncertainty (%)
A	Highly Effective	The inspection methods will correctly identify the true damage state in nearly every case (or 80 % to 100 % confidence)	5
B	Usually Effective	The inspection methods will correctly identify the true damage state most of the time (or 60 % to 80 % confidence)	10
C	Fairly Effective	The inspection methods will correctly identify the true damage state about half of the time (or 40 % to 60% confidence)	20
D	Poorly Effective	The inspection methods will provide little information to correctly identify the true damage state (or 20 % to 40 % confidence)	30
E	Ineffective	The inspection method will provide no or almost no information that will correctly identify the true damage state and are considered ineffective for detecting the specific damage mechanism (less than 20 % confidence)	50

Amine cracking is defined as the cracking of metal under the combined action of tensile stress and corrosion in the presence of an aqueous alkanolamine solution at an elevated temperature. The main assumption in determining the DF for amine cracking is that the damage can be characterized by a susceptibility parameter that is designated as High, Medium, or Low based on the process environment, the material of construction, and component fabrication variables (i.e. heat treatment) as described in API RP 581. Based on the susceptibility parameter, a Severity Index is assigned that is a measure of the component susceptibility to cracking (or the probability of initiating cracks) and the probability that the crack will result in a leak, and in this research the index is low.

Table 4. Susceptibility and *Severity Index* – S_{VI} for Amine SCC

Susceptibility	*Severity Index* – S_{VI}
High	1000
Medium	100
Low	10
None	0

Two-Parameter Weibull Distribution Method

The POF for a heat exchanger bundle may be expressed using a two-parameter Weibull distribution using equation below.

$$P_{(t)}^{tube} = 1\text{-}R(t)=1 - \exp\left[-(t/\eta)^{\beta} \right], \text{ where}$$

$P_{(t)}^{tube}$ is the POF as a function of time or the fraction of bundles that have failed at time, t. β is the Weibull shape factor that is unitless and η is the Weibull characteristic life in years, and t is the independent variable time in years.

Another important point is defining tube bundle failure. A tube bundle is defined as a failure if a tube leaks, the remaining thickness is ≤ 40% (wall losses ≥ 60%) and there is a leak in the tube to tube sheet joint (welding, expanding, etc.). The calculation of probability is done using a spreadsheet.

CONSEQUENCE OF FAILURE (POF) ANALYSIS

The impact that would arise if the equipment fails is known as a consequence of failure (CoF). The consequences of failure can be demonstrated both quantitatively and qualitatively. CoF analysis in the RBI program is used to categorize equipment based on how significant the damage will be if a failure occurs. In this discussion, the consequence value to be discussed is the consequence of the area or area of impact and financial impact.

Pressure Vessel Consequence Of Failure

a. Area based Consequence

API 581 defines two types of consequences: component damage area consequences and personnel injury consequences. API RP 581 provides a choice of several scenarios of leak holes, namely up to 0.25 inch, >0.25 to 2 inch, >2 to 6 inches, and >6 inches. The scenario of the hole on the Pressure Vessel by using a 0.25-inch hole is the smallest leakage hole scenario. The calculation of consequences is done using a spreadsheet. The calculation of the consequences is carried out with the following steps:

1) Identify the representative fluids as well as their associated properties.
2) Selecting the Size of the Release Hole
3) Calculation of the Release Rate
4) Calculate the amount of fluid inventory that can be released.
5) Decide on the kind of release (Continuous or Instantaneous)
6) Calculate the detection impact and isolation systems on the magnitude of the release
7) Calculate the Release Rate and Mass for the Analysis of Consequences
8) Determine Flammable and Explosive, Toxic and Non-Flamable and Non-toxic Consequence
9) Determine Componen Damage and Personel Injury Consequence Areas
10) Determine the Financial Consequence

The consequence of failure area calculated using equations:

$$CA = max[CA_{f,cmd}, CA_{f,inj}]$$ Which are:

$CA_{f,cmd}$ = component damage consequence area (m2); $CA_{f,inj}$ = personel injury consequence area (m2).

Component damage consequence area magnitude counted with 3 equations below :

$$CA_{f,cmd} = max\left[CA_{f,cmd}^{flam}, CA_{f,cmd}^{tox}, CA_{f,cmd}^{nfnt}\right]$$ Which are:

$CA_{f,cmd}^{flam}$= flammable/explosion consequence area (m2); $CA_{f,cmd}^{tox}$= toxic consequence area (m2)

$CA_{f,cmd}^{nfnt}$= non-toxic non-flam consequence area (m2).

Meanwhile, personnel injury consequence area counted with 3 equations below :

$$CA_{inj} = max\left[CA_{inj}^{flam}, CA_{inj}^{tox}, CA_{inj}^{nfnt}\right]$$ Which are :

CA_{inj}^{flam}= flammable/explosion consequence area(m2); CA_{inj}^{tox} = toxic consequence area (m2)

CA_{inj}^{nfnt}= non-toxic non-flam consequence area (m2)

b. Financial_based Consequence

API 581 defines The FC of a loss of containment and subsequent release of hazardous materials by equation:

$$\boldsymbol{FC_f = FC_{f,cmd} + FC_{f,affa} + FC_{f,prod} + FC_{f,inj} + FC_{f,env}}$$. Which are :

FC_{cmd} = the financial consequence of component damage, $

FC_{affa} = the financial consequence of damage to surrounding equipment on the unit, $

FC_{cmd} = the financial consequence of component damage, $

FC_{inj} = the financial consequence as a result of serious injury to personnel, $

$FC_{environ}$ is the financial consequence of environmental cleanup, $

Tube Bundle Consequence Of Failure

Financial consequences are determined based on the bundle criticality, which includes costs associated with lost opportunity due to production downtime, environmental impact costs, and costs associated with maintenance and replacement of the bundle. The consequence of an unplanned shutdown due to a bundle tube failure is determined using :

$$C_f^{tube} = \text{Cost}_{prod} + \text{Cost}_{env} + \text{Cost}_{bundle} + \text{Cost}_{maint}$$. Which are:

Cost_{prod} = the production losses as a result of shutting down to repair or replace a tube bundle, $

$Cost_{env}$ is the environmental costs due to a bundle fail, $

$Cost_{maint}$ is the cost of maintenance till ready for inspection or replacement, $

RISK CATEGORIES

The risk category, area-based and financial-based for Pressure Vessel as shown in Table 5. and the Risk category financial-based for Tube Bundle as shown in Table 6 below.

Table 5. POF and COF Categories for Pressure Vessel

Category	Probability category		Consequence Category		
	Probability range	DF Range	Category	Financial Range, $	Area range,m^2
1	≤ 3.06E-05	Df_{total} ≤1	A	COF ≤ 10.000	CoF ≤ 9.29
2	3.06E-05 < *PoF* ≤ 3.06E-04	1 < Df_{total} ≤10	B	10.000 < COF ≤ 100.000	9.29<CoF ≤ 92.9
3	3.06E-04 < *PoF* ≤ 3.06E-03	10 < Df_{total} ≤100	C	100.000 < COF ≤ 1.0E6	92.9<CoF ≤ 929
4	3.06E-03 < *PoF* ≤ 3.06E-02	100<Df_{total}≤1000	D	1.0E6< COF ≤ 10.0E6	929<CoF ≤ 9290
5	*PoF* > 3.06E-02	1000> Df_{total}	E	COF > 10.0E6	CoF > 9290

Table 6. POF and COF Categories for Tube Bundle

Probability Category		Consequence Category	
Category	Probability range	Category	Financial Range, $
1	POF ≤ 0.1	A	COF ≤ 10.000
2	0.1 < POF ≤ 0.2	B	10.000 < COF ≤ 100.000
3	0.2 < POF ≤ 0.3	C	100.000 < COF ≤ 1.0E6
4	0.3 < POF ≤ 0.5	D	1.0E6< COF ≤ 10.0E6
5	0.5 < POF ≤ 1	E	COF > 10.0E6

3. METHOD

Briefly explaining the methodology process flow, starting from identifying problems at Plant -4, then carrying out the bordering or implementation of corrosion loop. Then conduct a literature review from various references, especially from API RP 581/580, data sheet equipment, history, PFD, PnID, Heat and Mass Balance, International Journals and relevant codes/standards. Then the implementation of RBI until the risk level is obtained and determines the schedule and inspection method, ending with a conclusion.

4. RESULT

The pressure vessel consists of a column, separator, and shell side and tube side of the heat exchanger, while the tube bundle is assessed separately based on the Weibull method. The calculation is done using a spreadsheet and the results for POF and COF for pressure vessels and tube bundles are shown in Table 6 to Table 9 below.

Table 6. Pressure Vessel POF

Equipment		**Damage factor Total**			**POF** (Gff x Df Total x F_{MS})	**Cat.**
Item No.	**Part**	**Thinning**	**Cracking**	**Total**		
1E-301A	Shell side	0.11858	45.95	46.07	1.38E-03	3
	Tube side	0.15909	-	0.15909	4.77E-06	1
1E-301B	Shell side	0.12193	45.95	46.07	1.38E-03	3
	Tube side	0.73768	-	0.73768	2.21E-05	1
1E-302	Shell side	0.17485	45.95	46.07	1.38E-03	3
	Tube side	1.15045	-	1.15045	3.45E-05	2
1E-303	Shell side	0.11592	45.95	46.07	1.38E-03	3
	Tube side	0.12472	-	0.12472	3.74E-06	1
1E-304	Shell side	0.128	45.95	46.07	1.38E-03	3
	Tube side	0.1939	-	0.1939	5.82E-06	1
1E-305	Shell side	0.24586	-	0.24586	7.38E-06	1
	Tube side	0.277	-	0.277	8.31E-06	1
1C-301	Top Shell	0.27824	-	0.27824	8.35E-06	1
	Bottom Shell	1.1426	27.57	28.71	8.61E-04	3
	Bottom head	1.37363	27.57	28.71	8.61E-04	3
1C-302	Top Shell	0.10484	27.57	28.71	8.61E-04	3
	Botom shell	0.10492	27.57	28.71	8.61E-04	3
	Top head	0.3663	27.57	28.71	8.61E-04	3
	Bottom Head	0.10445	27.57	28.71	8.61E-04	3

1V-301	Top Shell	0.2134	-	0.2134	6.40E-06	1
	Bottom shell	0.47821	27.57	28.71	8.61E-04	3
	Top head	0.16441	-	0.16441	4.93E-06	1
1V-302	Top Shell	0.32	-	0.32	9.60E-06	1
	Bottom shell	0.15459	27.57	28.71	8.61E-04	3
	Top Head	0.24853	-	0.24853	7.46E-06	1
	Botom Head	0.1193	27.57	28.71	8.61E-04	3
1V-304	Shell	0.01809	-	0.01809	5.43E-07	1
	Head	0.2708	-	0.2708	8.12E-06	1

Table 7. Pressure Vessel COF.

Equipment		11. Determine Final Consequence Area, CA (m^2)					12. Potential Injury Costs, FC_{inj}			14. Financial Consequences ($)				Cat
		Final Injury Damage, CA_{inj} (max.: personal inj., final toxic)		Final Componen Damage, CA_{cmd}	Final Consc. Area, CA.	Cat.	Popdens (Person/m^2)	Inj.cost ($)	Final ($)	Componen damage cost, FC_{cmd}	Business Interruption Costs	FC_{ENV}	Total FC	
No Item	Part	Inj.	toxic						a	b	c	d	a+b+c+d	
1E-301A	Shell side	FLUIDA NON FLAMABLE DAN NON TOXIC = LOW CONSEQUENCE				2	FLUIDA NON FLAMABLE DAN NON TOXIC = LOW CONSEQUENCE							2
	Tube side					2								2
1E-301B	Shell side					2								2
	Tube side					2								2
1E-302	Shell side					2								2
	Tube side	1296.8	38.9	682.6	1296.8	3	6.460.E-04	64,671.3	5,033	12,967.320	6,550,467.79	22.15	6,568,490.26	4
1E-303	Shell side	FLUIDA NON FLAMABLE DAN NON TOXIC = LOW CONSEQUENCE				2	FLUIDA NON FLAMABLE DAN NON TOXIC = LOW CONSEQUENCE							2
	Tube side					2								2
1E-304	Shell side					2								2
	Tube side					2								2
1E-305	Shell side					2								2
	Tube side	1393.2	39.6	735.2	1393.179	3	6.460.E-04	64,671.3	5,407.13	2,967.320	6,550,467.79	25.1285	6,558,867.37	4
1C-301	Top Shell	FLUIDA NON FLAMABLE DAN NON TOXIC DENGAN KONSEKUENSI RINGAN				2	FLUIDA NON FLAMABLE DAN NON TOXIC = LOW CONSEQUENCE							2
	Bottom Shell					2								2
	Bottom head					2								2
1C-302	Top Shell	1840.1	291.1	983.6	1840.1	3	6.460.E-04	64,671.3	7,141.85	77,385.621	9,423,741.2	1511.97	9,509,780.6	4
	Botom shell	2037.8	318.1	1092.6	2037.8	3	6.460.E-04	64,671.3	7,908.96	24,183.007	9,423,741.2	2237.7167	9,458,070.8	4
	Top head	1840.1	291.1	983.6	1840	3	6.460.E-04	64,671.3	7,141.85	77,385.621	9,423,741.2	1511.97	9,509,780.6	4
	Bottom Head	2037.80	318.1	1092.6	2037.8	3	6.460.E-04	64,671.3	7,908.96	24,183.007	9,423,741.2	2237.7167	9,458,070.8	4
1V-301	Top Shell	FLUIDA NON FLAMABLE DAN NON TOXIC = LOW CONSEQUENCE				2	FLUIDA NON FLAMABLE DAN NON TOXIC = LOW CONSEQUENCE							2
	Bottom shell					2								2
	Top head					2								2
1V-302	Top Shell	747.4	0	400.302	747.4	2	6.460.E-04	64,671.3	2,900.59	77,385.621	9,423,741.2	579.234	9,504,606.6	4
	Bottom shell	820.2	0	441.002	820.2	2	6.460.E-04	64,671.3	3,183.29	24,183.007	9,423,741.2	857.266	9,451,964.7	4
	Top Head	747.4	0	400.302	747.4	2	6.460.E-04	64,671.3	2,900.59	77,385.621	9,423,741.2	579.2339	9,504,606.6	4
	Botom Head	820.2	0	441.002	820.2	2	6.460.E-04	64,671.3	3,183.29	24,183.007	9,423,741.2	857.266	9,451,964.7	4
1V-304	Top Shell	1501.8	36.1	793.352	1501.8	3	6.460.E-04	64,671.3	5,828.61	77,385.621	9,423,741.2	31.943	9,506,987.3	4
	BTM Head	1501.8	36.1	793.452	1501.8	3	6.460.E-04	64,671.3	5,828.62	133,856.209	9,423,741.2	47.2757	9,563,473.3	4

Table 8. Eta (η), beta (β) value and POF of Tube bundle.

No.	Equipment no.	Life Extention	Time in service (year)	η	β	POF	Nilai
1	1E-301 A	NA	22	21.497	2.650	0.655	5
2	1E-301 B	NA	22	21.497	2.650	0.655	5
3	1E-302	NA	19	18.626	6.201	0.677	5
4	1E-303	Retubing 2018 (2018-2002)x50% = 8 yrs	11	18.626	**6.201**	0.037	1
5	1E-304	NA	19	18.626	6.201	0.677	5
6	1E-305	NA	22	20.289	4.381	0.759	5

Table 9. Tube Bundle COF

No.	Equipment no.	Financial Consequences ($)				Cat.
		Cost Prod	Cost Bundle	Cost maint.	Total	
1	1E-301 A	6,550,467.79	45,935.48	5,318.04	6,601,721.31	4
2	1E-301 B	6,550,467.79	45,935.48	5,318.04	6,601,721.31	4
3	1E-302	6,550,467.79	82,000	5,318.04	6,637,785.83	4
4	1E-303	6,550,467.79	45935.48	5,318.04	6,601,721.31	4

5	1E-304	6,550,467.79	45935.48	5,318.04	6,601,721.31	4
6	1E-305	6,550,467.79	57,935.48	5,318.04	6,613,721.31	4

The risk matrix used is based on internal Pupuk Kaltim Risk Matrix (*Pedoman Manajemen Risiko).*

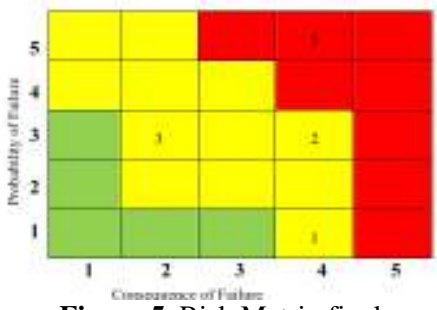


Figure 5. Risk Matrix final result

The final risk, especially for heat exchangers, is chosen between a pressure vessel or tube bundle which has a higher level of risk.The results of a risk assessment using Risk-based Inspection on corrosion loop CO_2 Removal found 5 equipment with high risk, including 1E-301 A, 1E-301 B, 1E-302, 1E-304 and 1E-305 while equipment with medium risk included 1E-303, 1C-301, 1C-302, 1V-301, 1V-302 and 1V-304

Table 10. Inspection Scheduling for Pressure and Tube Bundle

No.	Equipment no.	Pressure Vessel					Tube Bundle			
		COF	POF	Df_{total}	Df Target	Insp. time	COF	POF	POF Target	Insp. time
1	1E-301 A	2	3	46.07	>1000	> 20 years	4	0.655	0.3	At the moment
2	1E-301 B	2	3	46.07	>1000	> 20 years	4	0.655	0.3	At the moment
3	1E-302	4	2	46.07	> 100	> 20 years	4	0.677	0.3	At the moment
4	1E-303	2	3	46.07	>1000	> 20 years	4	0.037	0.3	17-Aug-2026
5	1E-304	2	3	46.07	>1000	> 20 years	4	0.677	0.3	At the moment
6	1E-305	4	1	0.277	> 100	30/11//2026	4	0.759	0.3	At the moment
7	1C-301	2	3	28.71	>1000	> 20 years				
8	1C-302	4	3	28.71	> 100	30/11//2030				
9	1V-301	2	3	28.71	>1000	> 20 years				
10	1V-302	4	3	28.71	>100	30/11/2030				
11	1V-304	4	1	28.71	>100	> 20 years				

Siswantoro (2020) Inspection is an evaluation of the quality of several characteristics related to standards or specifications. Inspection consists of several activities comparing with specifications, assessing suitability, classifying according to cases, classifying not according to cases, and recording and reporting of data obtained. An inspection plan is developed and implemented for the RBI object equipment. One of the goals of inspection is to reduce uncertainty. Song (2020) Reducing uncertainty when evaluating possible damage levels of equipment depends on the effectiveness of inspection methods.

Table 11. Pressure Vessel Inspection Method For Each Damage Factor

Damage factor	Inspection Effectiveness Level	Intrusive Inspection	Non-Intrusive Inspection
General Thinning	C (Fairly Effective)	For the total surface area: >5% visual examination AND > 5% of the spot ultrasonic thickness measurements	For the total surface area: >50% spot UT or random UT scans (automated or manual) OR Random profile radiography of the selected area(s)
Local Thinning	C (Fairly Effective)	For the total surface area: >50% visual examination AND 100% follow-up at locally thinned area UT wallthickness	For the total suspect area: >50 % coverage of the CMLs using ultrasonic scanning or profile radiography
Cracking	C (Fairly Effective)	For selected welds/weld area: >35 % ACFM with UT follow-up of all relevant indications	For selected welds/weld area: >35 % automated or manual ultrasonic scanning OR >35 % radiographic testing

Table 12. Tube Bundle Inspection method

Material tube	Method	Inspection Effectiveness Level	Inspection%
A213TP304L	Eddy Current Testing	A	100 %
A 179	Magnetic Flux Leakage	A	100 %

Basically, RBI is a risk assessment and management process that focuses on the loss of containment from pressure equipment. In reality in the field, for static equipment, the failure of equipment is not only due to leakage (loss of containment) but often occurs damage to internal parts even though they are not leaking. Internal damage to this part, of course, will disrupt operations or reduce product quality

5. CONCLUSION

Based on the analysis that has been done, it is obtained as follows:

1. The results of a risk assessment using Risk-based Inspection on corrosion loop CO_2 Removal resulted 5 equipment with high risk, including 1E-301 A, 1E-301 B, 1E-302, 1E-304 and 1E-305 while equipment with medium risk included 1E-303, 1C-301, 1C-302, 1V-301, 1V-302 and 1V-304.
2. Scheduling for high risk equipment must be carried out by this check (RBI date) or when the opportunity arises *shutdown* closest. While the scheduling for equipment with medium risk varies based on the POF value of each equipment, among others 1 equipment on August 17th, 2026, 2 equipment on November 30th, 2030 and 3 equipment over the next 20 years.

SUGGESTION

Internal part damage of a static equipment is recommended to be considered as a failure even though it does not lead to loss of containment and POF can be calculated using the Weibull method as well as the Tube bundle

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FACTORS INFLUENCING THE APPLICATION OF ENERGY EFFICIENCY IN BUILDINGS

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ABSTRACT

Increasing global warming is now an issue in sustainable development. One of them is related to energy use. Energy is an essential factor in achieving sustainable development. The increase in energy consumption brings many concerns, such as a shortage of primary energy sources and environmental impacts, significantly increasing greenhouse gas emissions. In the building aspect, the Green Building concept is a building with a sustainable concept that can be one of the solutions in creating buildings that pay attention to environmental aspects. The application of energy efficiency and energy conservation can be a solution to minimize the impact of development on the environment. However, in its application, there are inhibiting factors in the energy efficiency implementation. This paper aims to identify the factors that hinder the application of energy efficiency. Economic, market, government, technological and social factors can influence the implementation of energy efficiency. In this case, identifying these factors can help optimize the application of energy efficiency.

Keywords: green building, energy efficiency, buildings

1. INTRODUCTION

Energy is crucial for sustainable development (Khan et al., 2020). According to the World Energy Council, global energy demand is estimated to double by 2050. The availability of this energy source will run out if it continues to be taken because its formation takes thousands of years (Prasetyo & Kusumarini, 2016). Increasing global energy consumption makes society increasingly concerned about the sustainability of the global energy supply (Jiang, 2008). The increase in energy consumption brings many concerns, such as a shortage of primary energy sources, environmental impact, the search for new energy sources, and a significant increase in greenhouse gas emissions (Zhang & Wang, 2013).

For many years the industrial sector has been the energy conservation target, as it is considered the sector responsible for most of the energy consumption. However, energy consumption has shifted over time toward the building sector, namely residential, commercial and public buildings (Zhang & Wang, 2013). With the increased number of buildings, the resulting energy consumption is too severe (Chen et al., 2022). The construction sector has a crucial role in achieving sustainable development, not only because of its contribution to the national economy but also because of the significant influence of the built environment on aspects such as comfort, health, and quality of life (Zabihi et al., 2012). The construction sector has the most significant

potential to reduce GHG emissions significantly compared to other major emitting sectors (Christoffersen et al., 2006).

In Indonesia, buildings generate 50% of total energy expenditure and more than 70% of total electricity consumption. Buildings are responsible for 30% of greenhouse gas emissions and raw materials produced (Gunawan, 2012). In various forms of anticipation and concern for environmental problems, there are programs related to the environment. This is also stated in the Presidential Regulation of the Republic of Indonesia Number 61 of 2011 concerning the National Action Plan for Reducing Greenhouse Gas Emissions. which has stimulated the movement toward sustainable development.

In the building aspect, the Green Building concept is one of the solutions for creating buildings that pay attention to environmental aspects. The Green Building Council Indonesia (GBCI) states that a building that follows the Green Building standard, which refers to Greenship, can save between 26% and 40% of energy every month. The building sector has played a crucial role in energy consumption over the last few decades, requiring action to reduce it (Cristino et al., 2021). Research by an Institute in America shows that 30% -40% of total greenhouse gas emissions are produced by high-rise buildings (Yuliani, 2018).

The rapid growth of high-rise buildings in Surabaya will impact increasing energy consumption and greenhouse gas emissions. Therefore energy efficiency is the main target of energy policy and is the key to mitigating climate change and achieving sustainable development (Pérez-Lombard et al., 2013). However, in implementing energy efficiency, several obstacles can result in the failure to implement energy efficiency in buildings. These obstacles can come from economic, institutional, technological, and behavioral barriers. Barriers stand in the way of achieving policy targets and energy efficiency measures.

With the existence of various problems and obstacles to the implementation of energy efficiency in buildings. So the research aims to determine the factors that hinder energy efficiency implementation. In this process, it is crucial to understand the barriers associated with implementing energy efficiency measures. The purpose of this study is to explore what inhibiting factors influence the implementation of energy efficiency in high-rise buildings.

2. LITERATURE REVIEW

a. Sustainable Development Concept

According to Suparmoko (2020), sustainable development, in principle, states that the development of the current generation should not be at the expense of future generations in the form of lower social welfare than the welfare of the current generation. The social welfare in question is economic welfare, which includes health and education, and environmental welfare. Sustainable development is a human effort to improve the quality of life while still trying not to go beyond the ecosystems that support life (Jaya, 2004). The pillars of sustainable development are economic sustainability, social sustainability, and environmental sustainability, all three of which must develop in a balanced way (Suparmoko, 2020).

The construction of green buildings is a way for the construction industry to achieve sustainable development. The concept of green building development prioritizes the integration of a healthy and safe environment with social welfare and economic improvement. The application of sustainable construction starts from the planning stage and continues until the project closing stage (Ismail et al., 2016).

b. Green Building

Green Building or green building is a building that, in its planning, construction, operation, and maintenance, pays attention to saving, reducing, and protecting the use of natural resources. Maintaining the excellent quality of the building from indoor air quality and paying attention to the health of its occupants, all of which are based on the principles of sustainable development (GBCI, 2012). As part of sustainable development, green building is also responsible for achieving resource energy efficiency (GBCI, 2012).

The green building concept aims to save energy consumption in multi-story commercial buildings. According to Armstrong (2008) quoted from (Triwidiastuti, 2017), a green building strategy can be achieved from the five stages of Go Green which are:

1. Reducing consumption of resources (energy and water).
2. Reduce waste and make recycling efforts.
3. Building materials (eliminate hazardous materials, choose environmentally friendly materials, use materials that do not cause holes in the ozone).
4. Environment in the building (air quality, room temperature, maintenance of air conditioning, and air ducts).
5. Concern for occupants or building users (communication between owners and occupants/users of buildings). This communication is critical to reducing negative environmental impacts. For example, if the building owner is going to change the AC system or waste disposal, the building owner must communicate with the occupants/users in advance so that the results are compelling.

c. Energy Efficiency as a Goal of Sustainable Development

The ultimate goal of sustainable development is to create sustainable environmental development with resource efficiency. According to Geen Building Council Indonesia (2015) one of its goals is to minimize the impact of development on the environment. Energy efficiency is one form of the concept of implementing green buildings. The concept of energy efficiency can reduce the negative impact on the environment.

Efficiency is achieving the desired results with the minimum wastage of resources. The concept of efficiency relates to the desired results and the required resources (Pérez-lombard et al., 2013). The concept of energy efficiency is to reduce energy use without affecting the quality of services provided. If the same energy is used to provide more service output, energy is not saved, but efficiency is increased. This can also be called "energy productivity".

According to Rusdy and Jiang (2011), the conservation of electrical energy is focused on the behavior of human energy users, which can be shortened to 3M, namely Turning Off, Revoking, and Regulating. Meanwhile, energy efficiency in the building sector is introduced as a critical element in energy conservation and emission reduction success.

In short, energy conservation is more associated with activity, and structural and behavioral effects, whereas energy efficiency is usually used to denote technological improvements to reduce energy intensity. The optimal choice is to combine energy conservation and energy efficiency to save energy.

D. Aspects of Factors that Hamper the Implementation of Energy Efficiency

1) Economy

Economic barriers are related to the investment required for energy-saving applications (Zhang L et al., 2018). Investment in technology adoption is higher than conventional technology, thus affecting the adoption rate of energy-efficient building technologies.

Energy-efficient building projects have a more extended payback period than conventional building projects. This obstacle arises because the return on investment occurs in the medium to long term (Gliedt & Hoicka, 2015). This makes investors tend to ignore energy-saving investments (Shukla et al., 2018).

2) Market conditions

Aspects of market barriers play an essential role in applying energy-saving technologies. Market bottlenecks are more often associated with low customer demand (Stevenson & Baborska-Narozny, 2018). This arises because many buyers are not concerned with the sustainable performance of a building, which makes the market unsupportive of adopting the technology (Du et al., 2014).

Many investors and owners are not interested in energy-efficient building technologies due to a lack of knowledge and awareness of the market potential of energy-efficient building projects (Shukla et al., 2018). Limited knowledge about the benefits of energy-efficient buildings reduces the demand for energy-efficient building projects, which can affect the market (Du et al., 2014).

3) Technology

Technological barriers arise because of the belief that there is no appropriate technology for efficient energy use in buildings (Amoruso et al., 2018). Thus there is a fear that energy-efficient building technologies will not achieve the desired performance (Persson & Grönkvist, 2015).

4) Technical

The main technical barrier is the need for more professionals specialized in developing energy-efficient building projects (Stevenson & Baborska-Narozny, 2018). This obstacle arises from the need for institutions to offer courses for professional training (Du et al., 2014). Most practitioners must be qualified in energy-saving technologies and must become more familiar with the principles required to implement energy efficiency measures (Häkkinen & Belloni, 2011).

5) Government policy

The main barriers related to inconsistent policies and poor governance standards can delay the adoption of energy-saving technologies (Ding et al., 2018). Inconsistent government policies in energy efficiency can affect the choice of appropriate technology for buildings (Amoruso et al., 2018). Lack of consistency in government standards precludes better guidance on energy saving, effective energy management, and motivation to choose more cost-effective technologies (Alreshidi et al., 2018).

6) Social

Social factors there are obstacles related to cultural, social, and behavioral aspects. Cultural/social/behavioral barriers characterize occupant behavior and its relationship to energy consumption. Such barriers can arise from a need for more information and education about energy efficiency that prevents occupants from adopting energy-saving measures (Palmer et al., 2013). Residents need help to obtain adequate information about relevant energy efficiency options, and even when information is available, residents often find it difficult to analyze it (Dadzie et al., 2018). Occupants show a certain reluctance to adopt energy-efficient technologies, as there is a need for maintenance over the useful life of the building.

3. METHODS

This research begins by conducting a literature review of previous research. The data collection method in this study was carried out through a questionnaire survey given to respondents. Then the data were analyzed using descriptive methods. In the descriptive analysis, the processed data is data with a likert scale. Descriptive statistics provide an overview of the

object to be studied through data from samples and make valid conclusions. Furthermore, the data is processed using factor analysis methods.

4. RESULTS

Based on the literature review results, several factors become obstacles to implementing energy efficiency. The elements and variables that hinder the application of energy efficiency can be explained in the following table.

Table 1. Research variable

Factor	Variable	Reference
Economy	Hight Investment	Zhang Y and Wang Y (2013); Dadzie J et al (2018); Zhang L and Zhou J (2015);
	Lack of incentive economy	Gupta P et al. (2017); Dadzie J et al. (2018); Yeatts DE et al. (2017); daddzie et al. (2018);
	Period long return	H¨akkinen T and Belloni K (2011); Bond S (2011); Gliedt T et al (2015); Zhang L and Zhou J (2015);
	Financing difficult accessed	Gupta P et al. (2017); Palmer K et al. (2013); Zhang L and Zhou J (2015); Addy MN et al. (2014)
	Limitations finance owner	Li J et al (2009); Adeyeye K et al (2007)
	Risk investment	Djokoto SD et al (2014); Chmutina K et al (2013)
Market	Lack of market for technology Building energy-efficient	Du P et al (2014); Addy MN et al (2014); Stevenson F et al (2018); Zhou L et al (2013)
	Lack of investors in the project Building energy-efficient	Addy MN et al. (2014)
	Knowledge limited market potential	Shukla AK et al (2018)
	Strategy marketing is not good enough	Dadzie J et al (2018)
Technology	Technology Building energy-efficient no adequate	Yeatts DE et al. (2017); Zhang L et al. (2018); Alanne K and Saari A (2004); Ding Z et al. (2018)
	Not enough information	Wang T et al (2016); Castleberry B et al (2016); ACADEMIC PO (2015)
	Lack of demonstration technology	Zhang L and Zhou J (2015); Bruce T et al. (2015)

Factor	Variable	Reference
Expert Team	Lack of competent team expert	H¨akkinen T and Belloni K (2011); Zhang L and Zhou J (2015); Du P et al (2014); Zhang L et al (2018); Djokoto SD et al (2014); Tuominen P et al (2012); Wang T et al (2016);
	Lack of involvement in team expert	Du P et al (2014); Kangas H et al (2018); Tuominen P et al (2012; Chmutina K et al (2013); Ding Z et al (2018); Holloway S and Parrish K (2015); Hopkins EA (2016)
	Distrust on the part of the designer	Du P et al (2014); Hopkins EA (2016)
Government	Regulations/standards Building energy-efficient no efficient	Persson J and Gr¨onkvist S (2015); Gupta P et al (2017); Zhang L and Zhou J (2015); Du P et al (2014); Addy MN et al (2014);
	Lack of Support from the government	Zhang Y and Wang Y (2013); Kangas H et al (2018); Zhang L et al (2018); Djokoto SD et al (2014); K et al (2013); Bertone E et al (2016); Jin Z et al (2009)
	Policy disrupted economy	Gliedt T et al (2015); Li J et al (2009); Goodier CI and Chmutia K (2014); Alanne K, Saari A (2004); Durdyed S et al (2018); Zhou L et al (2013)
	Procedure certification complex	H¨akkinen T and Belloni K (2011); Du P et al (2014); Paiho S (2017)
	Policy no discuss involvement in finance	Adeyeye K et al (2007); Curtius HC (2018)
	Lack of knowledge of efficient energy with legislators and regulators	Liu X et al (2015); Chmutina K et al (2013)
	Lack of socialization efficient regulation	Goodier CI and Chmutia K (2014)
Social	Not enough information/education about technology Building energy-efficient	Greenough R (2014); Bond S (2011); Gupta P et al. (2017); Dadzie J et al (2018); Palmer K et al (2013); Addy MN et al (2014); Djokoto SD et al (2014); Tuominen P et al (2012);
	Afraid to change	Zhang L and Zhou J (2015); Goodier CI and Chmutia K (2014); Marefat Adkk (2019); Bruce T et al (2015);
	Lack of motivation	Yeatts DE et al (2017); Bertone E et al (2016); Ruiz RR (2005)

Factor	Variable	Reference
	Lack of awareness occupants	Chmutina K et al (2013); Alreshidi E et al (2018)

6. CONCLUSIONS

Based on the studies and discussions that have been carried out, several factors that can become obstacles to implementing energy efficiency are economic, markets, technological, expert team, government, and social, with a total of 27 variables.

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MARKETING STRATEGY THROUGH INSTAGRAM REELS CONTENT IN IMPROVING CUSTOMER ENGAGEMENT IN LOCAL FASHION UMKM BASED ON CULTURE

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ABSTRACT

The massive development of digital media has facilitated fashion Micro, Small and Medium Enterprises (*Usaha Mikro, Kecil, dan Menengah* or abbreviated as UMKM) to survive and compete with both local and international competitors. Customer engagement through social media, especially Instagram reels, can potentially increase customer loyalty. The engagement will lead a buyer to become regular customers who purchases the offered products or services continuously. This study aims to determine the extent to which Instagram reels content increases customer engagement from local fashion UMKM based on culture with the result that they can produce a marketing strategy plan through Instagram reels in the future. The research will be carried out in two stages where the researcher will analyze the visual content of local fashion UMKM based on culture Instagram reels in the first stage using the qualitative descriptive method. The second stage will be covering an in-depth interview with local fashion UMKM based on culture businesses. The results of the interview will be analyzed with five dimensions of customer engagement. This research recommends 5 Instagram reel contents that can be used by culture-themed fashion local businesses to increase the customer engagement.

Keywords: Instagram, Reels Content, Customer Engagement, Local Fashion UMKM based on Culture.

1. INTRODUCTION

Micro, Small, and Medium Enterprises (Usaha Mikro, Kecil, dan Menengah or abbreviated as UMKM) activities are one of the business fields that can develop and be consistent in the national economy (Nurhaliza, 2022). The Indonesian Creative Economy Agency also said that the UMKM fashion sector is the second sub-sector that contributed 17% of income in 2020 and absorbs a workforce of more than 4.4 million people in Indonesia (Runiasari, 2021). UMKM are also one of the activities or businesses contributing to preserving local culture because many UMKM engage in crafts based on local culture (Wulandari & Parameswara, 2019). This condition has led to the development of several local culture-based fashion UMKM in Indonesia, which

promote traditional cloth as the material for the fashion products they create. In this digital era, there is much competition with both local and international competitors causing UMKM, especially local culture-based fashion UMKM, to be digitally literate by making the most of digital media as promotional media. According to Arianto (2020), UMKM that utilize digital platforms only reach 16% of UMKM in Indonesia (Arianto, 2020). Building customer engagement in a company is very important because maintaining customer engagement can affect the number of loyal customers. Meanwhile, loyal customers are vital in most companies' value-creation process (Hapsari, Clemes, & Dean, 2017). However, in Indonesia, many culture-based local fashion UMKM still need to be made aware of the importance of building broader customer engagement through digital social media platforms, especially on Instagram, and maximizing the use of Instagram features, especially reels. Besides, quoting from Thunderclap, the reels users worldwide will reach 80% in 2022; this can be a platform for marketers to use the Instagram reel feature in marketing and building consumer interactions (Thunderclap, 2022). It is essential to develop a digital marketing strategy through the Instagram platform and utilize the Instagram reels feature as a medium to build customer engagement and preserve Indonesian culture, especially the traditional fabrics. This strategy can maintain consumer loyalty and affect sustainability and sales obtained by local culture-based fashion UMKM. Based on the description of the condition of culture-based local fashion UMKM above, the researcher sees an opportunity to examine more deeply the elements that can influence culture-based local fashion UMKM in increasing customer engagement through Instagram reels content. The expected results of this research are the findings and an identification of the influence of Instagram reels content in improving customer engagement. Moreover, it can be a reference for strategies for creating reel content for the next culture-based local fashion UMKM.

1. LITERATURE REVIEW

The literature review describes the literature relevant to this study. Also, this study uses mostly references from international journals. When citing references, the researcher uses the authors' names, and the year of publication is preferable. Here is an example. Smith (2005) suggested that the referencing style is one of the writing aspects that most students ignore when preparing a paper.

Correspondingly, the references should be listed based on the alphabetical order of the first author's last name. See examples at the end of these guidelines.

2.1. Micro, Small, and Medium Entreprises (Usaha Mikro, Kecil, dan Menengah or abbreviated as UMKM)

Micro, Small, and Medium Enterprises (UMKM) are types of activities or small, micro businesses that business entities can manage. The Law Number 20 of 2008 defines UMKM as stand-alone productive economic activities carried out by individuals or a business entity. Products that UMKM can produce in this field are not only products but also cultures such as batik, handicrafts, art, and others. Recorded in the total business units in Indonesia, UMKM have as many as 62.92 million business units and contribute 61% to the Gross Domestic Product (GDP) (Paramita, Rizal, Sulistyan, Taufiq, & Dimyati, 2021).

2.2. Based on Culture

Culture is a noble conception related to the way of human life itself. In general culture is the values adopted or believed by a particular society and these values often reflect the customs and arts of a society (Anugerah & Prasetia, 2015). The appearance of cultural trends has

influenced Indonesian local fashion which has led to the appearance of several designers and brands that carry the theme of localism which is also culture-based.

2.3. Social Media Instagram

Instagram is one of the most popular social media today, with 1.39 million active Instagram users appearing every month (Surfarama, 2022). Instagram comes from the words "instant" and "telegram," combined into the word " Instagram," which means quickly providing information in the form of photos to other people. Instagram is an application that allows users to share short photos and videos. The demographics of using Instagram are proliferating for personal and business marketing purposes. Instagram is the market leader in social media activity, with more than 1 million Instagram users every month (Herman, 2014).

2.4. Visual Reels Content

The reels content consists of videos created in such a way by users that aim to share activities or promote a product or service with a duration of 15 seconds to 90 seconds to fellow Instagram users. The reels feature also allows users to develop their creativity: add text, filter in the form of augmented reality (AR), and mix the audio (Huyen, 2021). Promotional content in the form of videos is an effective way to market or advertise a product or brand. There are several essential elements in creating video content, namely: having clear images and text, proportional components (images, text, audio), storytelling, appropriate copywriting (adding hashtags and calls to action), adding proper audio, animation, or motion graphics.

2.5. Customer Engagement

Bonson and Ratkai in Kusumasari (2018) argue that engagement is a psychological condition of the user, which is categorized by the interactive, creative experience of the user with an agent and object (Kusumasari, 2018). Engagement can also be interpreted as communication between consumers and a brand that allows changes in customer behavior, from regular customers to loyal customers and customers willing to recommend a brand in their environment. According to So et al. (2016), five dimensions reflect psychological aspects and consumer behavior to measure customer engagement (So, King, Sparks, & Wang, 2016). The five dimensions are:

1. Enthusiasm: reflecting a feeling of interest and excitement when consumers are connected to a brand.
2. Attention: showing a consumer's attention, either consciously or unconsciously, towards a brand.
3. Absorption: describing a consumer's feelings of pleasure so that they concentrate or devote their time when connected with a brand to the point of forgetting the time used when interacting.
4. Interaction: an interaction outside purchases that occur online and offline between consumers, brands, or other consumers.
5. Identification: describes the level of unity of consumers with brands where consumers feel they have something in common with a brand when interacting with it.

2. METHODS

The type of research used in this research is descriptive qualitative. This research was conducted by conducting in-depth interviews with ten female respondents who are followers and consumers of three local culture-based fashion brands: Jauh Mata Memandang, Ikat Indonesia, and Lulu Lutfi Labibi. Through the results of the in-depth interviews, an analysis of the level of customer engagement will be carried out through the five dimensions of customer engagement

which will produce several criteria for each dimension. This study also took samples of reels for each of the three local culture-based fashion brands. Then, it made observations on the elements of the visual reels content to find out which elements are effects that can be used in creating reels content as a marketing medium to increase customer engagement.

3. RESULTS

4.1. Reels Content Analysis

This research analyzed uploaded content reels from three culture-based Indonesian local fashion brands: *Sejauh Mata Memandang, Ikat Indonesia,* and *Lulu Lutfi Labibi*. The contents analyzed were based on the preferences of the respondents who follow the accounts of the three local fashion brands. The selected content was uploaded from January 2022 to October 2022. The content analysis is as follows:

Figure 1. *Sejauh Mata Memandang* Reels Content

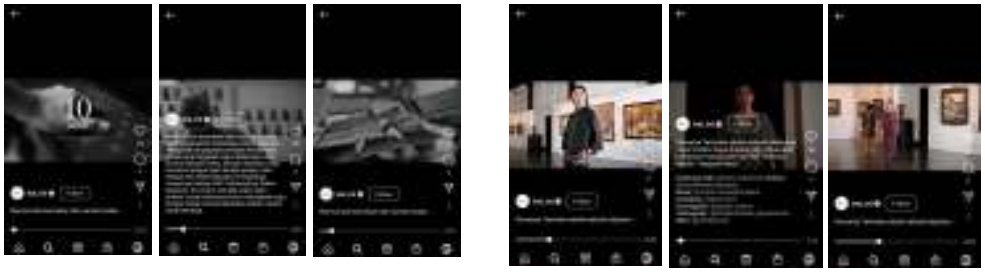
The first content from the *Sejauh Mata Memandang* brand is educational content that shows the various products and provides insight into styling. Also, the second content is inspirational. Besides, the concept of the Sejauh Mata Memandang reels content uses storytelling to build the netizens. The content also contains captions and hashtags that clearly explain and reflect the idea that this brand wants to tell. *Sejauh Mata Memandang* also often uses original audio specially made for the reels content. *Sejauh Mata Memandang* collaborates with influencers, celebrities, and social figures. From these two contents, there was an interaction where this brand recorded 115k to 148k viewers. Therefore, it can produce 1,691 to 2,252 likes and 13-18 comments.

Pigure 2. Lulu Lutfi Labibi Reels Content

Both of these contents are included in the educational content, where the first content displays the styling of the product collection owned by *Lulu Lutfi Labibi*. The second content provides storytelling about our differences, which can be strengths. In submitting content, *Lulu Lutfi Labibi* only inserts the concept title and hashtag related to the concept video. The owner emphasizes conveying messages through visuals. *Lulu Lutfi Labibi's* original sound adapted to the concept. Visually, the color tones match almost all content and use neutral or natural tones. Lulu Lutfi Labibi often collaborates with art activists. From the two contents, there was an interaction

where this brand recorded 8,663 to 12.4k viewers; it can produce 417 – 596 likes and 7 – 11 comments.

Figure 3. *Ikat Indonesia* Reels Content



Both of these contents are included in the type of educational content. The first content explains Ikat Indonesia's journey of ten years of growing into a culture-based local fashion brand in Indonesia. In the second content, *Ikat Indonesia* displays a collection of products made from traditional fabrics from West Southeast Maluku, displayed through a fashion show. In the two content reels, captions and hashtags are inserted, which briefly explain the meaning of the content. The audio uses *Ikat Indonesia's* original sound, adapted to the concept. The user can also see Ikat Indonesia's Instagram uploads uploading anyone who uses their work, from celebrities to officials in Indonesia. From the two contents, there was an interaction where this brand recorded 2026 to 4332 viewers; it can produce 109 – 128 likes and 8 – 11 comments.

4.2. Customer Engagement Analysis

Based on the interviews conducted with the respondents, the three brands that became the respondents' preferences were the *Sejauh Mata Memandang* and *Lulu Lutfi Labibi* brands. On the other hand, five dimensions were grouped to determine the level of customer engagement of the two brands. The five dimensions of customer engagement were grouped in the form of an Affinity Diagram chart, explained in the following figure.

Gambar 4. Five Dimensions of Customer Engagement

The first dimension of enthusiasm describes the feelings of interest and excitement when consumers are connected to a brand. Based on the results of interviews with respondents, the criteria that can build this dimension are as follows:

- Cinematography focuses on models or products.
- There is storytelling (Behind the scene, business journeys, etc.).

- Raise a topic that can be told.
- There is collaborative content with influencers or figures that are currently viral or already have a public image.
- There are variations in content (styling content, product content, product creation process content).
- Creative or trending audio selection.

The second dimension of attention shows a consumer's conscious or unconscious towards a brand. Based on the results of interviews with respondents, the criteria that can build this dimension are as follows:

- Respondents intend to know more about the brand.
- Respondents are willing to pay close attention to the content they watch from that brand.
- Respondents hacked the brand's Instagram account themselves.
- Respondents can get brand information from other users that have been shared.

The third dimension is absorption. At this stage, the user is concentrated, happy, and enjoys playing his role. They feel time flies when interacting on social media. Based on the results of interviews with respondents, the criteria that can build this dimension are as follows:

- The use of educational and inspirational content types.
- The existence of supporting information such as captions or voiceover.
- It recommends that the average length of the video is 40-50 seconds maximum.

The fourth dimension of interaction refers to the various interactions and relationships between users and brands and users with users. Based on the results of interviews with respondents, the criteria that can build this dimension are as follows:

- There was a positive response from respondents by liking, commenting, saving, and sharing with other users.
- There is feedback from the brand.

The fifth dimension is identification, which describes the level of consumer unity with a brand where consumers feel they have something in common with a brand when interacting with that brand so that users can recognize the brand when they see it. Based on the results of interviews with respondents, the criteria that can build this dimension are as follows:

- It is recommended that the content use visuals such as color tones, music, and ambiance that describe the brand image.
- There is a brand signature that is displayed on each piece of content.

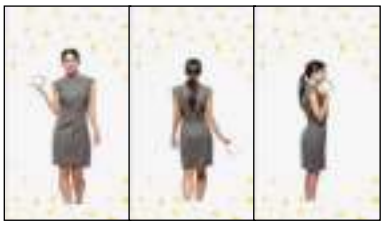
4.3. Content as a Marketing Strategy Recommendation via Instagram Reels

Table 1. Five Reels Content Recommendations

1	Photo: Pexels.com Barion McQueen Editing: The author	Photo: Pexels.com Miriam Alonso	Photo: iStock/Ariwasabi	Photo: Freepik

	Photo: Shutterstock Photo: Getty Images/Gradyreese Photo: Thinkstock Photo: iStock/Franckreporter
	Project: Styling Content with Influencers/Celebrities This content tells about Influencer/celebrity activities from when he wakes up in the morning to get ready to work/go through the day's activities. Insert a brand name, celebrity name, and title: "Start the day," use the type of typography that matches the brand's typography, insert captions and hashtags in uploads, use instrumental music that fits the concept (original sound from the brand or can use morning instrumental music).

2	Photo: ANTARA Photo Ahmad Subaidi Editing: The author Photo: Diana Timoria Editing: The author Photo: Diana Timoria Editing: The author Photo: Reno Setiawan, & Faunda Liswijayanti Editing: The author Photo: Reno Setiawan & Faunda Liswijayanti Editing: The author Photo: Hypeabis Harjan Pratama Editing: The author
	Project: Educational Content for Making Woven Fabrics It tells about the process of making woven fabrics, from dyeing to being woven into cloth. Using the type of typography that matches the brand typography, inserting the brand name and title: “Artists of Fabrics,” inserting captions and hashtags in uploads, using the natural sound of each cloth-making process (Example, the sound of yarn dyeing, the sound of a loom machine), inserting a voiceover at the end of the content.

3	Photo: Shutterstock Editing: The author Photo: Shutterstock Editing: The author  Photo: Shutterstock Editing: The author Photo: Shutterstock Editing: The author Photo: The author
	Project: Product Styling (Stopmotion) Content It tells the styling concept, which is delivered with stop-motion, in which the model seems to be walking and then posing in several different positions to display the product when it is used. Using upbeat instrumental music, inserting animations/motion graphics in brand signature motifs as content frames, captions and hashtags in uploads, and text call to

	action: “Get Your Style Now” at the end of the content.

4	Photo: Akar Media Editing: The author Photo: Etnis.id Putu Riana Pertiwi Editing: The author Photo: Etnis.id Putu Riana Pertiwi Editing: The author Photo: Wayan Adnyana Editing: The author Photo: Anis Hidayah & Kemenparekraf Public Relationship Editing: The author Photo: Instagram/ Rai_Nyoman Editing: The author Photo: Nadya Elianna, Travel detik.com, Murni Ridha Editing: The author
	Project: Educational Content for the Beauty of Textile Culture in Tenganan Village It tells about the activities of Tenganan Village and the typical Tenganan weaving, which is one of the tourist attractions in the village. Using the type of typography that matches the brand's typography, inserting the brand name and title: "*Elok*," inserting a caption (a short story about the cultural beauty of Tenganan Village, Bali) and hashtags on uploads, using instrumental music that fits the concept (calm Balinese instrumental strains), inserting a voiceover: "The beauty of cultural heritage that is full of meaning needs to be preserved" at the end of the content.

5	Photo: Beautynesia.id Editing: The author Photo: Instagram/Tantri Namirah Editing: The author Photo: Beautynesia.id Editing: The author Photo: Beautynesia.id Editing: The author Photo: Beautynesia.id Editing: The author Photo: Instagram.com/ Zahratuljannah Editing: The author Photo: Instagram/Rai_Nyoman Editing: The author
	Project: *Styling in Every Moment Content* It tells these clothing products can be used anytime, for activities at home, hanging out with friends, to travel, and exhibited by influencers. Using typography adapted to brand typography, inserting the title: "Styling with Brand Name," inserting captions and hashtags related to styling in uploads, inserting voiceover: "let's try styling with us every moment you do!", using upbeat instrumental music and is trending for styling content, inserting a call to action "voiceover: Stay elegant in every moment you do with us.”

6. CONCLUSIONS

Based on the research results, the researcher can produce recommendations for content reels strategies to increase customer engagement by properly packaging concepts and elements of visual reels content. It can start from the type of content. Where through analysis, it is known that the kind of content that can attract audience interaction well: educational and inspirational content, clear pictures and text, storytelling, copywriting according to the theme raised, adding audio according to the theme raised/trending at the time, involvement or collaboration with celebrities/influencers, variety of content (styling content), product content, and product manufacturing process content). Therefore, it is better if the content uses visuals such as color

tones, music, and ambiance that describe the brand image, as well as the existence of a brand signature that is displayed in each content so that users get to know the brand better. From this research, further research is still needed regarding the factors influencing customer engagement in marketing through content reels and marketing strategies through Instagram social media that are more effective and user-oriented for MSMEs.

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ANALYSIS OF THE INFLUENCE OF MACROECONOMIC FACTORS AND FOREIGN EXCHANGES ON THE JCI WITH THE SUPERVISED MACHINE LEARNING METHODS

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ABSTRACT

Indonesia is a developing country that has rapid economic growth which gives a positive image for investors to invest. One of the most popular financial instruments today is stocks. This is evidenced by the performance of the JCI over the last 20 years, which has increased by 15.15 %/year. These conditions do not only attract foreign investors but domestic investors. Some of the factors that influence the movement of the JCI include commodities, domestic economic conditions, movements in foreign stock indices, and others. In this study, correlation analysis was carried out to provide an overview of the factors that influence the movement of the JCI, followed by data processing of the factors that influence the JCI to predict the movement of the JCI the following day using supervised machine learning methods including Linear Regression, Gradient Boosted, Random Forest, and Tree Ensemble. The results of the correlation analysis in this study show that foreign exchange factors consisting of the Dow Jones index, Hang Seng index, Kospi index, Nikkei index, Nasdaq index, and the dollar exchange rate have a positive effect on the JCI, then commodity factors consisting of crude oil, coal, and gold also has a positive influence on the JCI. Meanwhile, the rest, namely crude palm oil, has a negative effect with a small value. The evaluation results of the 4 methods used to predict the actual value of the JCI using the MAE, RMSE, and MAPE parameters show that the tree ensemble method is the right method in this study. Finally, the deployment test was carried out with the model that was obtained and resulted in MAE, RSME, and MAPE values of 258.8780; 279.1176; and 0.0364. This value is greater than when selecting the method, which is equal to 45.5301; 63.2720; and 0.0082.

Keywords: Correlation, JCI, Stock, Tree Ensemble

1. INTRODUCTION

The growth value of the Asian continent's GDP (Gross Domestic Product) increased by 9.61% from 2000 to 2019. This was inversely proportional to the European and American continents which experienced a successive decline of 4.09% and 6.84% in same time span. Growth in the value of GDP provides an attraction for investors to invest in the Asian continent. Indonesia is a country located in Southeast Asia. Based on the value of GDP growth, Indonesia

occupies the 5th position in the Asian continent in 2017. This is in line with Indonesia's GDP growth of 4.23% since the crisis that hit the world in 1998. The Indonesian government continues to implement various policies and strategies to maintain economic growth which is indicated by the value of GDP.

The Indonesian government has provided investment products in the form of Government Bonds (SUN) consisting of Retail State Bonds (ORI), Retail Saving Bonds (SBR), savings bonds, retail bonds, and waqf bonds. In addition, there are several financial products/instruments available for investment, including precious metals in the form of gold, mutual funds, stocks, property, deposits and others. Fadly (2021) suggest that buying and selling activities of various financial instruments, both long and short term, are in a market called the capital market.

This study aims to analyze the factors that influence the movement of the JCI including commodities, domestic economic conditions, foreign stock index movements, and others. Correlation analysis can provide an overview of the factors that have dominance over the movement of the JCI, followed by data on factors that influence the JCI which can predict the movement of the JCI the next day with supervised machine learning using the Linear Regression, Gradient Boosted, Random Forest, and Tree Ensemble methods.

2. LITERATURE REVIEW

Several publications have been published regarding statistical analysis of stock index movements both in Indonesia and internationally. Akhtar er al (2022) simulated the stock market prediction using SVM and random forest classifier, Chhajer er al (2022) presented the insight of machine learning application for stock prediction with ANN, SVM, and LSTM methods, Yun (2021) did stock price prediction using GA-XGBoost Hybrid for KOSPI index, Murwaningsih (2008) studied about the effect of trading volume, deposit, and exchange rate to the IHSG value using GARCH and ARIMA, and Mutakif (2012) also did the studied like Murwaningsih but with an added variable namely Index Hang Seng. Based on the publications above, the use of machine learning to predict the JCI value with the influence of foreign stock exchanges such as Dow Jones, Kospi, Nikkei, Nasdaq as well as macroeconomic factors such as dollar exchange rates, interest rates, inflation rates, etc. can speed up data processing. and yield predictions as well as providing valid information about the relationship of foreign exchange movements and macroeconomic or domestic factors to the movement of the JCI value.

According to Doshi, et al. (2022), there are several ways to evaluate the performance of a regression model including evaluating and validating forecasting and knowing how well the model that has been developed can be done based on the statistical summary of the residual value calculated from the model used (training data) and forecast error values calculated from the prediction results. To evaluate using an error value, there are 3 criteria for conducting a general assessment, namely: based on the value of the Mean Absolute Error (MAE), Root Mean Square Error (RMSE), and Mean Absolute Percentage Error (MAPE). MAE, RMSE, and MAPE values can be written using the equation 1, 2, and 3.

$$MAE = \left(\frac{1}{N}\sum_{i=1}^{N}\left|P_{actual,i} - P_{predicted,i}\right|\right) \quad (1)$$

$$RSME = \left(\frac{\sum_{i=1}^{N}\left|P_{actual,i} - P_{predicted,i}\right|}{N}\right) \quad (2)$$

$$MAPE = \left(\frac{1}{N}\sum_{i=1}^{N}\frac{\left|P_{actual,i} - P_{predicted,i}\right|}{P_{predicted,i}}\right) \quad (3)$$

Annotation:

N : Number of days

$P_{actual,i}$: The actual value of the dependent variable on day i

$P_{predicted,i}$: The predicted value of the dependent variable on day i

According to Wei (2006), A good model is a model with the smallest MAEP, RMSEP, and MAPEP values which are in accordance with the objective of forecasting to obtain forecast values with the smallest error.

3. METHODS

The data used in this study comes from Yahoo Finance and Markets Business Insider from January 2010-2021. The software used to carry out the simulation is KNIME. Where the response variable is the JCI value and the independent variable in this study consists of the Dow Jones index, Hang Seng index, Kospi index, Nikkei index, Nasdaq index, dollar exchange rate, coal price, gold price, petroleum, and the price of crude palm oil (CPO). This research was conducted in the following way below,

1. Data Reader
   This step is the process of reading data consisting of independent and dependent variables.
2. Exploratory Data Analysis
   This step describes the correlation analysis between the dependent and independent variables which has the aim of finding out which independent variables have a significant influence on the dependent variable.
3. Check Missing Values
   This step aims to find out whether there are missing values in the existing data. This is done to prevent errors in the simulation process. Differences in holidays on foreign exchanges cause missing values to occur. There are 2 ways to overcome missing values, namely eliminating or deleting missing data and filling in missing data values. In this research, to overcome this, a method was chosen by filling in the missing data by deleting rows that contained missing values.
4. Partitioning Data Test and Train
   At this step the data is divided into 2 data, namely training data used to build the learner model and test data used to test the learner model produced using training data, the variable percentage of training and test data sets is 70:30. Distribution of training and test data sets can be done in several ways, namely Linear Sampling, Draw Randomly, and Stratified Sampling. In this research, the division between training and test data uses linear sampling. This is because the data used is time series. In this step, the results of the accuracy of each method are compared. The best results will be used in the next step.
5. Conduct deployment or predictive analysis of the selected method in the previous step using new independent variable data with a range of 10 days.
6. Comparison of predicted results and real JCI data over a span of 10 days.

4. RESULTS

4.1 THE RESULT OF CORRELATION ANALYSIS

Correlation testing will provide an overview of the relationship between each variable. The results correlation analysis of each factor that influences JCI movement can be seen in Figure 1. A positive sign indicates the independent variables consisting of the Dow Jones index, Hang Seng

index, Kospi index, Nikkei index, Nasdaq index, dollar exchange rate (USD/IDR), CPO price, gold price, crude oil price, and coal price are directly proportional on the dependent variable, namely the JCI value. While a negative sign indicates the independent variable is inversely proportional to the dependent variable, namely the JCI value. In addition, the values listed show how strong the relationship between variables. When, the value is closer to 1, the stronger the relationship between these variables.

	Dow Jones	Hang Seng	Kospi	Nikkei	Nasdaq	USD/IDR	CPO Price	Gold	Crude Oil	Coal Price	IHSG
Dow Jones	1,000	0,454	0,782	0,922	0,980	0,695	-0,255	0,821	0,471	0,596	0,758
Hang Seng	0,454	1,000	0,573	0,543	0,415	0,212	0,013	0,238	0,403	0,419	0,577
Kospi	0,782	0,573	1,000	0,842	0,753	0,391	-0,068	0,611	0,522	0,686	0,685
Nikkei	0,922	0,543	0,842	1,000	0,913	0,671	-0,255	0,672	0,497	0,573	0,688
Nasdaq	0,980	0,415	0,753	0,913	1,000	0,755	-0,273	0,832	0,386	0,545	0,670
USD/IDR	0,695	0,212	0,391	0,671	0,755	1,000	-0,469	0,514	0,187	0,350	0,354
CPO Price	-0,255	0,013	-0,068	-0,255	-0,273	-0,469	1,000	-0,065	-0,280	-0,298	-0,289
Gold	0,821	0,238	0,611	0,672	0,832	0,514	-0,065	1,000	0,207	0,319	0,539
Crude Oil	0,471	0,403	0,522	0,497	0,386	0,187	-0,280	0,207	1,000	0,706	0,661
Coal Price	0,596	0,419	0,686	0,573	0,545	0,350	-0,298	0,319	0,706	1,000	0,766
IHSG	0,758	0,577	0,685	0,688	0,670	0,354	-0,289	0,539	0,661	0,766	1,000

Figure 1. JCI Correlation with various variables

In Figure 1 it can be concluded several things. First, the foreign stock indices among the Dow Jones, Hang Seng, Kospi, Nikkei, Nasdaq have a strong influence and are directly proportional to the JCI. This is in accordance with several studies reported by Indarto & Santoso (2016), Aditya, et al (2018), and several journals on state of the art. Second, the macroeconomic factors represented by the dollar exchange rate against the rupiah show a positive influence on the JCI value. This is inconsistent with Indarto & Santoso (2016), Aditya, et al (2018), and several state-of-the-art journals which state that the dollar exchange rate is inversely proportional to the composite stock price index. However, Chen (2020) reports research on the effect of the USD exchange rate on the Rupee and its effect on the Indian stock market. This research has the same phenomenon as in this study. This happens because the movement of a country's currency against other countries depends on the conditions of the two countries. Thus, the weakening of the rupee against the dollar in a short span of time will be inversely proportional to the movement of the Indian market. Meanwhile, if viewed over a long period of time, the USD exchange rate against the rupee is directly proportional to the increase in the Indian stock market. Third, commodity factors consisting of gold, crude oil and coal have a positive influence and are directly proportional to the JCI value. This increase was caused by the market share of gold, crude oil and coal commodities in Indonesia which was quite large, so that the increase in prices for the three commodities had a positive impact or positive sentiment on the Indonesian economy. The crude palm oil commodity has a small correlation value to the JCI.

4.2 Analysis of the Effect of the Machine Learning Method on the Prediction of JCI Movement

The results of the simulation using the KNIME software using the gradient boosted, random forest, tree ensemble, and linear regression methods can be seen in Figure 2. The data presented is in 2014-2022 while the time range listed in data mining is 2010-2022. The difference in the time span between data mining and simulation data is because there are many missing values in data mining. Missing value processing is done by deleting data rows if there are missing values. In addition, Figure 4.4 is the combined result of training data predictions of 70% from 2014-2019 and 30% testing from 2019-2022. In Figure 2, it can be seen that the prediction results of each method have quite good results and are followed by a numerical performance evaluation consisting of 3 parameters including Mean Error Absolute (MEA), Root Mean Squared Error

(RMSE), and Mean Absolute Percentage Errors (MAPE). The results of the numerical evaluation of the simulation using the gradient boosted, random forest, tree ensemble, and linear regression methods can be seen in Table 1.

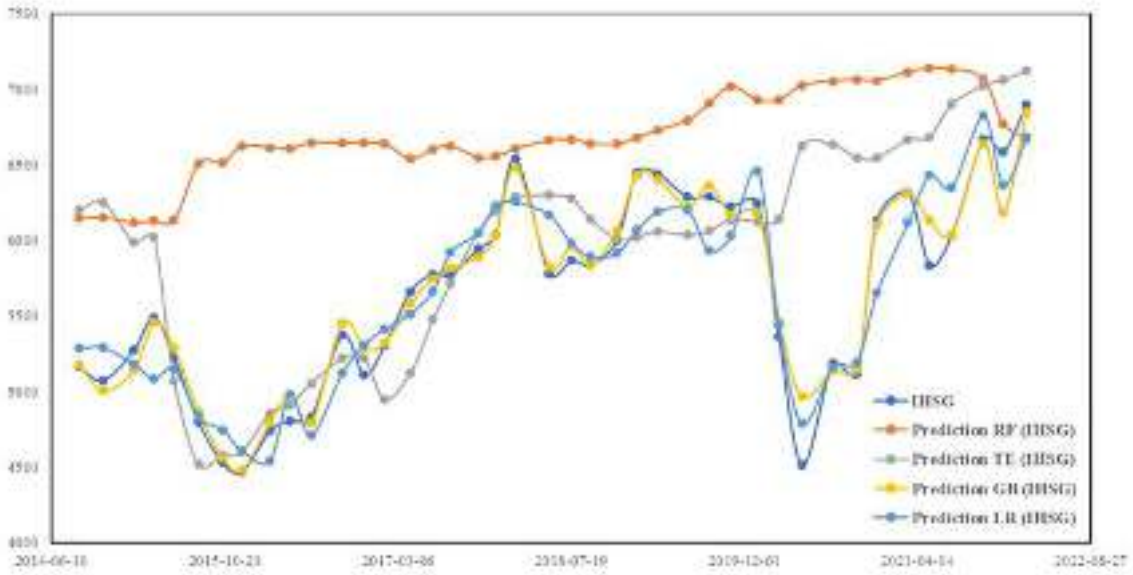

Figure 2. JCI Prediction Results with 4 Machine Learning Methods

Table 1 describes the 3 numerical results of the four methods written in mean absolute error, root mean squared error, and mean absolute percentage error. The first explanation is the mean absolute error (MAE) value which shows on average, the distance or difference between the predicted value or forecast value and the actual value or actual value. The smaller the MEA value, the better the prediction results of a model. The MAE values of the gradient boosted, tree ensemble, random forest, and linear regression methods in table 4.1 are 45.7098 respectively; 45.5301; 73.3709; and 169.5567.

Table 1. Simulation results of the numerical scores of each method

Parameter	Random Forest	Tree Ensemble	Gradient Boosted	Linear Regression
Mean Absolute Error	45,7098	45,5301	73,3709	169,5567
Root Mean Squared Error	63,1046	63,2720	108,2684	211,336
Mean Absolute Percentage Error	0,0082	0,0082	0,0132	0,0296

.

Based on MAE values, the tree ensembles method is the best method. Second, the root mean squared error (RMSE) value, which is a value that represents the error of the predicted results of a model against the actual value. The smaller the RMSE value, the higher the accuracy of the model in predicting data. The RMSE values of the gradient boosted, tree ensemble, random forest, and

linear regression methods were respectively 63.1046; 63.2720; 108.2684; and 211,336. Based on the RMSE value, the best method is random forest. Third, the mean absolute percentage error (MAPE) is a value that indicates the accuracy of the forecasting method expressed in percentages. The smaller the MAPE value, the better the method is in forecasting or predicting a value. The MAPE values of the boosted gradient, tree ensemble, random forest, and linear regression methods were 0.0082; 0.0082; 0.0132; and 0.0296. Based on the MAPE value, there are 2 methods with the same value, namely gradient boosted and tree ensemble.

Based on the three parameters as discussed previously, there are 2 methods that fitted to this study which namely random forest and tree ensemble. First, the MAE value of the random forest method has a higher value of 0.394% compared to the MAE value of the tree ensemble method. Then, the RMSE value of the tree ensemble method has a higher RMSE value of 0.265% compared to the boosted gradient method RMSE value. Meanwhile, the MAPE value of the two methods has the same value. Therefore, it was concluded that the appropriate method used for this study was the tree ensemble. This is because the difference in the MAE value of the two methods is greater than the difference in the RMSE value of the two methods. This indicates that the tree ensemble method has an accuracy value that is not much different from the random forest method.

4.3 Analysis of JCI Value Prediction Test Results using the Tree Ensemble Method

The best method for predicting the JCI value in this study is the tree ensemble method as discussed previously. Then, A prediction test is carried out using data outside the existing timeframe. The prediction results are shown in Figure 3.

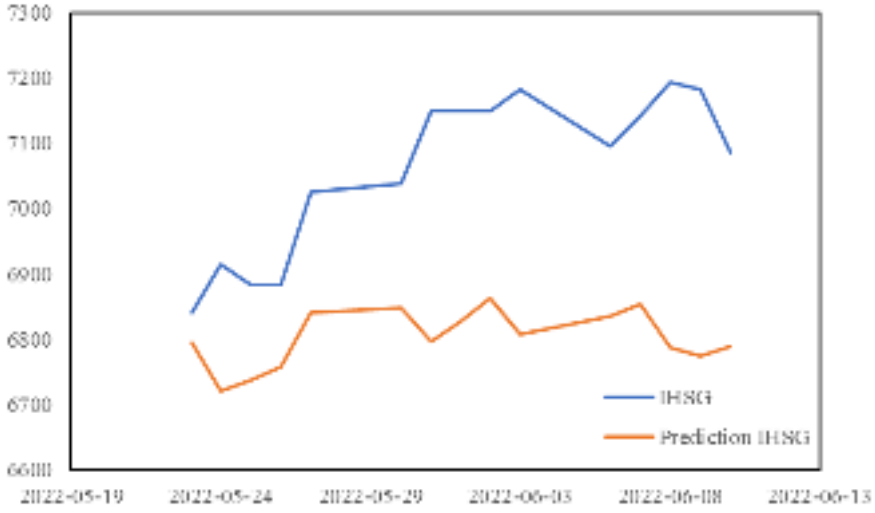

Figure 3. Prediction results of the JCI value using the Tree Ensemble method

In Figure 3. it can be seen that several times the model used is capable for predicted the direction of JCI movement as the actual did. However, in Figure 3 it can be seen that the prediction results with the model that has been made in subchapter 4.2 have lower results compared to the actual value of the JCI. This is also reflected in the numerical scoring results including MEA, RMSE, and MAPE. Meanwhile, the results of testing this model using 20 data from 23 May 2022 – 13 June 2022 can be seen in table 2 below.

Table 2. Numerical Scoring of the Deployment Test with the Tree Ensemble Method

Parameter	Value
Mean Absolute Error	258,8780
Root Mean Squared Error	279,1176
Mean Absolute Percentage Error	0,0364

In table 2, it can be seen that the MAE value in the deployment test is approximately 6 times larger than the MAE value in sub-chapter 4.2. this happens, on RMSE and MAPE values. So, the greater the difference between the actual and predicted values will increase these three parameters. This big difference is due to the model being built based on historical data over a certain period of time and there was no change in the model during the deployment test, while the movement of the JCI occurred day to day. Therefore, it can be seen in Figure 3 that the first few days, the model was able to predict the movement of the JCI and then there was a decline in performance which was marked by a larger gap between the predicted value and the actual value of the JCI.

6. CONCLUSIONS

The conclusions obtained in this study are 3 main factors were divided, namely foreign exchange, commodity, and macroeconomic factors. Foreign exchanges consisting of Dow Jones, Nasdaq, Hang Seng, Nikkei, and Kospi have a strong influence and are directly proportional to the JCI value, Commodities consisting of gold and coal have a strong influence and are directly proportional to the JCI value, crude oil commodities) has a strong and inverse effect on the JCI, while the Crude Palm Oil (CPO) commodity does not significantly affect the JCI value. The last factor, namely macroeconomics, which is represented by the dollar price, shows a positive influence and is directly proportional to the value of the JCI. The machine learning method that is appropriate for this case is the tree ensemble. This is reviewed from the values of MEA, RMSE, and MAPE. The ensemble tree has small MEA, RMSE, and MAPE values with values of 45.5301 respectively; 63.2710; and 0.0082. The results of the prediction test (deployment) show that the model generated using the tree ensemble method can have a smaller predictive value than the actual value. This is reflected in the MEA, RMSE, and MAPE values of 258.8780 respectively; 279.11786; and 0.0364. This research needs to be developed further so that continuity in learning new data can run automatically. In addition, the consistency of the selected method can be evaluated continuously.

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CRITICAL SUCCESS FACTOR ANALYSIS THAT AFFECTS THE SANITATION DEVELOPMENT PROGRAM INCLUDING SEPTIC-TANK INSTALLATION IN SURABAYA CITY

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ABSTRACT

Some communities in Indonesia are still not realize about the importance of the healthy life habit with clean water and sanitation. The Access to clean sanitation services is a basic need of every person. That program is aimed to achieve Sustainable Development Goals (SDG's). According to the SDG's document, there are 17 goals with 169 targets, which one of the targets is about clean water and sanitation. However, there are still people who have the habit of open defecation (BABS). This is a common problem that could impact whole society, that is why the role of government is needed to solve these problems. The local government has some programs to solve the sanitation problem, one of the programs is called "Sanitation development program including septic-tank installation", through the local government regulation number 32/2019. An organization is needed to identify critical success factors to the program, to be more efficient. This study is aimed to determine and identify the critical success factors (CSF) in the implementation of "Sanitation program including septic-tank installation", with the study area is Surabaya City. The number of variables used in this study are 4 variables with 21 indicators.

The data collection used a Linkert-scale questionnaire, distributed to 80 respondents, who were the recipients of the program sanitation development and septic-tank installation in 2022. The methodology used in this study is the SEM-PLS method. The applied SEM-PLS test used the outer and inner model. In quantitative testing, there are three hypotheses, which are government variable (X1) effects towards program management (Y1), community variable (X2) effects towards program management (Y1), and policy variable (X3) effects towards program management (Y1). The results of the analysis concluded that the community variable (X2) has a positive and significant effect to the success of program management, while the government variable (X1) and policy variable (X2) have no effect on the success of program management. The Influential community variable indicators are community cooperation (X2.3), responsive community (X2.4), and communication between communities and governments (X2.6). The results of this study are expected to help the Surabaya City Government in carrying out the "Sanitation Development Program including Septic-Tank Installation in the City of Surabaya"

Keywords: *Critical Success Factor (CSF), Sanitation, SEM-PLS*

1. INTRODUCTION

Access to clean sanitation services is one of the goals in the SDGs/SDGs document consisting of 17 goals. But in reality, there are still people in the city of Surabaya who have the habit of open defecation (BABS). In 2022, the total number of BABS houses in the city of Surabaya is are 8,221 houses. The Surabaya area with the largest number of BABS houses is the North Surabaya area with 2,742 houses. One of the Surabaya city government treatments to overcome this problem is conduct the latrine construction program and proper sanitation through Mayor Regulation number 32 of 2020 concerning the amendments to Surabaya Mayor Regulation number 14 of 2019 concerning the implementation of latrine construction in the City of Surabaya. The number of latrine beneficiaries in 2019 were 850 units, in 2020 were 250 units, in 2021 were 400 units, and in 2022 will be targeted at 300 units.

As stated in the 2021-2026 Surabaya City RPJMD, the third mission is to strengthen the integration of urban spatial planning through the availability of world-class and sustainable modern city infrastructure and utilities, with the aim of fulfilling the integration of urban planning supported by quality infrastructure to encourage social and economic connectivity of the community. Through this mission, there is a water quality improvement index where the index is influenced by open defecation behavior. Observing this, the Surabaya City Environmental Agency has a vision of reducing the community with BABS behavior through the latrine construction and septic-tank installation program. Based on this explanation, it is considered necessary to know the factors that affect the success of program implementation. According to Pinto (1986) in Wilson (2012) the project has a series of key success factors, which if handled and cared properly, will improve the success of its implementation. An organization needs to identify the main factors determining success to be more efficient to focus on those factors. Therefore, this research was conducted to find out and recognize the critical success factors (CSF) in the implementation of latrine construction and septic-tank installation Program, with a study area in Surabaya City.

2. LITERATURE REVIEW

A. Surabaya City Latrine Construction and Septic-tank Installation Program

The Surabaya City Government through the Surabaya City Environmental Agency (DLH) has an Activity to Improve the Quality of Residential Sanitation Facilities where its activities are better known as constructing latrines including *septic-tank* installation program. The making of this latrine is carried out as an effort to control water pollution caused by E.coli, bacteria from fecal waste (human feces). With these activities, it is expected that it could improve the quality of sanitation facilities and can actualize healthy living behaviors. The Surabaya City Government has carried out the manufacture of latrines in 46 Districts in 2019 as many as 850 units, while in 2020 as many as 250 units in 25 Districts. There are several parties in Surabaya City involved to actualize this program besides the city government, namely Community Groups, Districts manager, and sub-districts manager. According to Sylvia (2020), there are several roles of the Environmental Agency, namely:

1. Role in *Conducting Surveys* and Verification of Prospective Latrine Recipients
2. Role in Carrying out Socialization of Latrines Making Activities
3. Role in Activity Planning
4. Role in Activity Preparation
5. Role in the Implementation of Activities
6. Role in Activity Supervision
7. Role in Reporting and Accountability of Activities

8. Role in the Submission of Activity Results

B. Sanitation Development Programs in Other Cities

Several cities in Indonesia are also implementing Sanitation development programs to support the Sustainable Development Goals. Each of these cities has different determinants of success and obstacles depending to the local government and the existing community. According to Dhiyas (2019), in a study entitled Analysis of the Effects of Community Participation on the Success of the Community-Based Sanitation Program (Sanimas) in Paciran village, Paciran District, Lamongan Regency, the success factors in the program are:

1. Variable Form and Level of Community Participation
   a. Factors form community participation: variables of energy, mind, expertise, material, and money
   b. Factor level of community participation: variables of attendance in meetings, involvement in physical activities, activeness in discussions, membership in organizations
2. Variabel factors influencing the success of sanimas programs
   a. Internal factors: variables of education, income, livelihood, age, gender, and knowledge
   b. External factors: variables of community leaders, local governments, village governments, facilitators / consulars, and legal regulation

Meanwhile, according to Dades (2007), in a study entitled Determining Factors for Success in the Process of Building and Managing Community-Based Sanitation Facilities, the influential factors that are very strong and have significance effects in the program are:

1. The existence of local institutions
2. The existence of external parties involved
3. The ability of the community to guarantee or maintain sustainability

C. Critical Success Factor

Critical success factors or CSF's are critical factors for the successful implementation of a project that must be carried out, without these factors, the project will not be successful or successful in achieving certain targets or goals in a project or work. According to Suanda (2013) specifically on projects, there are at least five elements that are of concern in determining *critical success factors* (CFSs), namely:

1. *Project Manager*. In this case, it is a special competency requirement that must be possessed by a project manager related to the characteristics of the project he leads in addition to the standard competency requirements that must be possessed in leading the project.
2. Project Team. It is almost similar to a project manager, the core competencies of the project team related to the characteristics of the project become a critical factor in the success of the project. But not only this competence, but also good communication and cooperation in the project team is an important thing to be considered
3. The project itself. In this case, it is the factors that become very important related to the conditions and characteristics or type of project to be worked on. Each type of project has certain critical factors, which are not always the same but tend to have their own peculiarities that differ based on the type of project.
4. Organization. The form of top management support is a critical factor based on many research results. A project will only succeed if the project manager can guarantee the real support of the senior manager or his or her boss.
5. External Environment. The form of the external environment is the political, economic, socio-cultural, and technological situation (PEST) in the context of the project. Other

conditions are weather factors, government supports, work accidents, clients outside the organization, competitors, and some others may also be important factors that must be considered according to project conditions.

In the research of Josanty and Anton (2018) in the journal Factors that affect the success of the implementation of national road projects in North Maluku, there are several *critical success factors* that influential, namely the ability of technical expertise of the project manager; Implementation of effective quality assurance programs; Project manager experience; Scheduling; Communication systems; Control mechanisms; Commitment of all parties involved in the project; Project manager involvement from the beginning to the end of the project; KDP's emphasis on high quality of construction; and Technical expertise ability of the supervision team. Meanwhile, according to Mardiasmo in Rachmawati (2013: 5), *Key Variables* or *Critical Success Factors* have several characteristics of success triggers, including Explaining the triggering factors for organizational success and failure; It is *volatile* and may change quickly; The changes are unpredictable; In the event of a change, it is necessary to take immediate action; and Variables can be measured, either directly or through intermediate measures *(surrogate).*

3. METHODS

In this study, variables were divided into endogenous variables and exogenous variables. The table below ~~following~~ is a table of variables and indicators that have been determined in this study (Table 3.1 and Table 3.2).

Table 1. Table of Exogenous Latent Variables (Influencing)

Variable	Symbol	Indicators
Government (Suanda, 2013) in this case the government as a Project Team)	$X_{1.1}$	- Role in Conducting Surveys and Verification of Prospective Latrine Recipients (Sylvia, 2020)
	$X_{1.2}$	- Role in Carrying out Socialization of Latrines Making Activities (Sylvia, 2020)
	$X_{1.3}$	- Role in Activity Planning (Sylvia, 2020)
	$X_{1.4}$	- Role in Activity Preparation (Sylvia, 2020)
	$X_{1.5}$	- Role in the Implementation of Activities (Sylvia, 2020)
	$X_{1.6}$	- Role in Activity Supervision(Sylvia, 2020)
	$X_{1.7}$	- Role in Reporting and Accountability of Activities (Sylvia, 2020)
	$X_{1.8}$	- Role in the Submission of Activity Results (Sylvia, 2020)
Society (Dhiyas, 2019; Dades, 2007)	$X_{2.1}$	- Existing condition of the location of the house (completeness of utilities) (Perwali No 32/2020)
	$X_{2.2}$	- Community participation through the formation of community organizations (Dhiyas 2019)
	$X_{2.3}$	- Community cooperation (Dhiyas 2019)
	$X_{2.4}$	- Responsive (Dhiyas 2019)
	$X_{2.5}$	- Informative society (Dades, 2007)
	$X_{2.6}$	- Communication between communities and governments (Dhiyas 2019)
Policy (Surachman et al, 2020)	$X_{3.1}$	- Policy on the requirements for beneficiaries of latrine making assistance (Perwali No 32/2020)
	$X_{3.2}$	- Policy related to residential property rights (Perwali No 32/2020)

Table 2. Endogenous Latent Variables (affected)

Variable	Symbol	Indicators
Program Management	$Y_{1.1}$	- Schedule of implementation of appropriate activities (Josanty and Anton, 2018)
	$Y_{1.2}$	- Timely program budget (Surachman et al, 2020)
	$Y_{1.3}$	- The size of the program budget (Surachman et al, 2020)
	$Y_{1.4}$	- *Controlling* (Josanty and Anton,2018)
	$Y_{1.5}$	- Worker expertise in development (Suanda, 2013)

Given that in this study PLS analysis was used, the sample size must follow the rules as stated by Ghozali (2006: 6) the research sample for the PLS method is 30 to 100 cases. In 2022, there are 35 urban villages, and the number of beneficiaries is 300 houses. The sampling of 80 people is consisted of beneficiary communities and related stakeholders. The data collection method used the primary data collection method through **a** *Linkert* scale questionnaire.

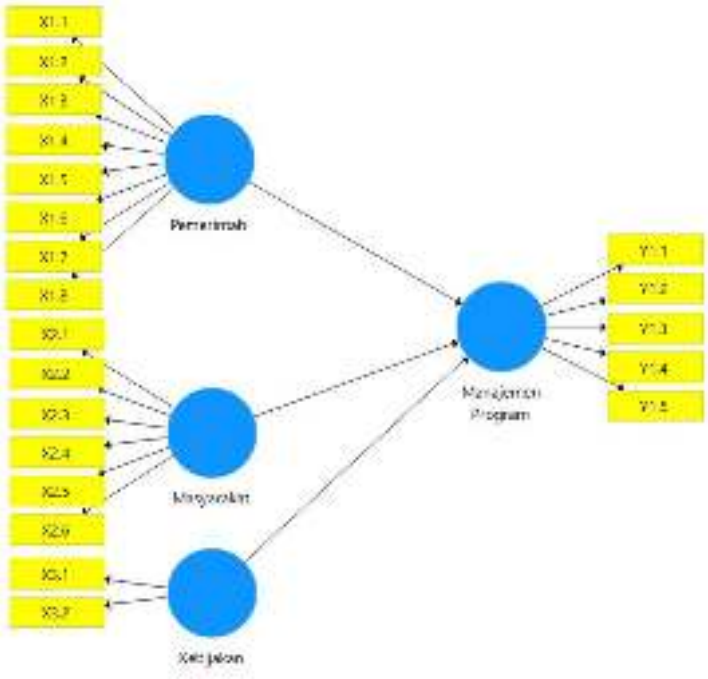

Figure 1. ***Path Diagram***

The preparation of path diagrams is very important to develop hypotheses that have been formulated in conceptual model development in the previous arrangement. In this study, the path diagram shows endogenous latent variables consisting of government, society, and policy, each influencing the endogenous latent variables consisting of program management. As a result of the literature review, the relationship between variables can be seen in Figure 3.1 below:

1. Government with Program Management
   H_0: Government variables have no significant effect on Program Management
   H_1 : Government variables have a significant influence on Program Management
2. Communities with Program Management
   H_0: Community variables have no significant influence on Program Management

H_1: Community variables have a significant influence on Program Management

3. Policies with Program Management
   H_0: Policy Variables have no significant effect on Program Management
   H_1: Policy Variables have a significant influence on Program Management

The analysis steps identify the *critical success factors* that affect the implementation of latrine construction and *septic-tank* installation using SEM-PLS:

1) Identifying variables through literature review
2) Compiling a questionnaire with a linkert scale
3) Distributing questionnaires to respondents
4) Perform a questionnaire validity test
5) Perform a questionnaire reliability test through *Croncbach's alpha* coefficient.
6) Perform descriptive statistical analysis with curves and tables
7) Perform *path diagram* construction
8) Constructing *a diagram path* to a system of equations
9) Evaluating the *measurement model (outer model)* through validity and reliability testing to see the relationship between indicators and latent variables
10) Evaluate the structural model (*inner model*) by looking at the value of *R-Square* and Q^2
11) Perform hypothesis testing with tests $T_{statistics}$
12) Drawing conclusions from the formed model

4. RESULTS

Evaluate and Test the Outer Model Hypothesis

Convergent Validity

The following are the results of *Convergent Validity* in the indicators of each variable in this study (Table 4.3)

Table 1. ***Convergent Validity Testing***

Variable	Variable Indicators	*Loading Factor*	AVE	Information
Government (X1)	$X_{1.1}$	0,667	1,00	Invalid
	$X_{1.2}$	0,815		Valid
	$X_{1.3}$	0,484		Invalid
	$X_{1.4}$	0,810		Valid
	$X_{1.5}$	0,771		Valid
	$X_{1.6}$	0,864		Valid
	$X_{1.7}$	0,809		Valid
	$X_{1.8}$	0,401		Invalid
Society (X2)	$X_{2.1}$	0,368	0,669	Invalid
	$X_{2.2}$	0,627		Invalid
	$X_{2.3}$	0,726		Valid
	$X_{2.4}$	0,785		Valid
	$X_{2.5}$	0,547		Invalid
	$X_{2.6}$	0,812		Valid
Policy (X3)	$X_{3.1}$	0,862	0,629	Valid
	$X_{3.2}$	0,123		Invalid

Variable	Variable Indicators	*Loading Factor*	AVE	Information
Program Management (Y)	$Y_{1.1}$	0,864	0,677	Valid
	$Y_{1.2}$	0,519		Invalid
	$Y_{1.3}$	0,862		Valid
	$Y_{1.4}$	0,789		Valid
	$Y_{1.5}$	0,695		Invalid

In Table 4.3 which is the test result of *convergent validity* in the *outer model* test that has been carried out and produces several invalid indicators judging from the *loading factor value < 0.7.* These indicators are indicators on government variables (X 1.1, X 1.3, and X 1.8), community variables (X 2.1, X 2.2, and X 2.5), policy variables (X 3.2), and program management variables (Y 1.2 and $Y_{1.5}$). The variables are gradually eliminated starting with the smallest value and reanalyzed, resulting in c*onvergent validity* in Table 4.4.

Table 2*Convergent Validity* Retesting Results

Variable	Variable Indicators	*Loading Factor*	AVE	Information
Government (X1)	$X_{1.2}$	0,806	0,667	Valid
	$X_{1.4}$	0,818		Valid
	$X_{1.5}$	0,794		Valid
	$X_{1.6}$	0,873		Valid
	$X_{1.7}$	0,818		Valid
Society (X2)	$X_{2.3}$	0,770	0,629	Valid
	$X_{2.4}$	0,707		Valid
	$X_{2.6}$	0,891		Valid
Policy (X3)	$X_{3.1}$	1,000	1,000	Valid
Program Management (Y)	$Y_{1.1}$	0,789	0,677	Valid
	$Y_{1.3}$	0,875		Valid
	$Y_{1.4}$	0,866		Valid
	$Y_{1.5}$	0,733		Valid

Based on Table 4.4, the results of all indicators are valid by showing the results of *loading factor* > 0.7 and AVE > 0.5, namely indicators on government variables (X 1.2, X 1.4, X 1.5, $X_{1.6}$ $X_{1.7}$), community variables (X 2.3, X 2.4, $X_{2.6}$), policy variables ($X_{3.1}$), and program management variables ($Y_{1.1}$, Y 1.2, Y 1.3, $Y_{1.4}$, $Y_{1.5}$). After getting a valid indicator, the *path diagram is* redrawn according to the valid indicator as follows.

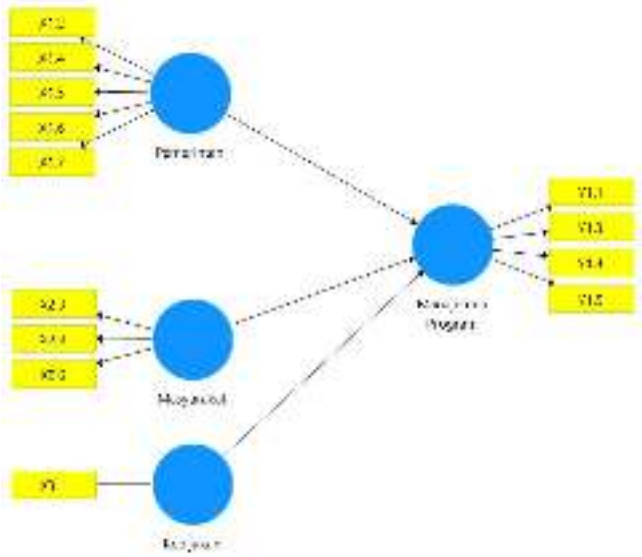

Figure 2. Structural Model Results (after indicator reduction)

Test the Outer Model Hypothesis

Hypothesis testing on *the outer model* is done by looking at p-values with hypotheses:

H_0: The indicator has no significant influence on the variables

H_1: Indicators have a significant influence on variables

H 0 is accepted if the p-value > α = 0.05. Here are the results of the outer model hypothesis test.

Table 5. Significance of the relationship between indicator variables and their latent variables

Relationship of Indicator Variables and Latent Variables	***P-Value***
$X_{1.2}$→ Government	0,036*
$X_{1.4}$ → Government	0,006*
$X_{1.5}$ → Government	0,004*
$X_{1.6}$ → Government	0,020*
$X_{1.7}$ → Government	0,005*
$X_{2.3}$ → Society	0,046*
$X_{2.4}$→ Society	0,017*
$X_{2.6}$→ Society	0,000*
$X_{3.1}$→ Policy	0,000*
$Y_{1.1}$→ Program management	0,000*
$Y_{1.3}$→ Program management	0,000*
$Y_{1.4}$→ Program management	0,000*
$Y_{1.5}$→ Program management	0,000*

*Significant at α = 0.05

Based on Tabel 4.6, all indicators have p-values < α which means H_0 is rejected or each indicator has a significant influence on each of the latent variables.

Evaluation and Testing of the Inner Model Hypothesis

If the proposed model is valid and *reliable*, then the next stage of the test is *the inner* model (structural model) which is carried out by predicting the relationship between independent variables and dependent variables. Inner *model* testing is carried out by paying attention to *the coefficient of determination* (R^2). *R-Square* shows how much an exogenous latent variable can explain an endogenous latent variable. The results of the *R-Square* test obtained can be seen in table 4.7.

Table 6. R-Square Test Results

Variable	Original Sample (O)	Information
Program Management (Y)	0,171	Weak

Based on the table above, the *R-Square* value of the dependent variable Program Management (Y) is 0.171 which means Program Management (Y) can be explained 17.1% of the research model while the remaining 92.9% is explained by other variables outside the study. The higher the *R-Square* value, the better the prediction of the proposed research model.

Inner Model Hypothesis Test

Inner model hypothesis test is performed using bootstraping tests that generate path coefficient values. The value can be an evaluation of the *inner model*. Hypothesis test is carried out by looking at the *t-value* of the analysis results. Path *coefficient* evaluation is used to show the strength of the effect, or the influence of independent variables on dependent variables. If *t-statistics* > *t-tables,* it can be said that the variables have a significant influence. Or it can also be seen from the *p-value* < 0.05, then the variable has a significant effect. To ascertain whether an influence of exogenous variables on endogenous variables, see the following Table 4.8.

Table 7. Coefficient *path results*

Relationship of Variable X and Variable Y	Original Sample (O)	Sample Mean (M)	STDEV	T-Statistics	*p-value*
Government (X1) Program Management (Y)→	0,105	0,119	0,179	0,585	0,559
Community (X2) Program Management (Y)→	0,370	0,397	0,187	1,975	0,049
Policy (X2) Program Management (Y)→	-0,080	0,056	0,103	0,777	0,438

Hypothesis:
H_0: Variables have no significant influence on other variables
H_1: Variables have a significant influence on other variables

6. CONCLUSIONS

The results of the SEM-PLS analysis concluded that the community variable (X2) has a positive and significant effects on the success of program management. This means how the community manages and cooperates in the latrine construction and septic-tank installation program. The program is a government program that requires direct community involvement and cooperation. The registration of the community as a BABS community is based on public awareness to register with the nearest Puskesmas. Public readiness and awareness are also one of the main factors in the success of the program. In this program, people who are aware of environmental hygiene and health

are needed. The initial requirement for verification of prospective latrine recipients is the existence of community groups (pokmas) to integrate between the community and the government. This group is needed to control the residents during the planning until development period. In addition, the existing condition of the location of the latrine recipient's house also affects the ease of construction. Easy location access, making it easier for teams to mobilize. In accordance with Prinandes's research (2007), there are three factors that influence the success rate of the process of building and managing community-based sanitation facilities, namely the factor of the existence of local institutions, the presence of external parties, and the factor of community ability to ensure or maintain sustainability. Meanwhile, government variables (X1) and policy (X2) have no effect on the success of program management. An influential indicator of community variables is the community partnership ($X_{2.3}$), responsive society ($X_{2.4}$), and communication between communities and governments ($X_{2.6}$).

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QUALITY IMPROVEMENT OF 50 KG GAS CYLINDER USING SIX SIGMA IN PT. PINDAD

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ABSTRACT

A quality product is a product characteristic that can satisfy the needs of consumers. Manufacturing companies often need help providing good quality products with low production costs. PT. Pindad, by its vision and mission, apart from carrying out an integrated business in the field of defense and security equipment, is also engaged in the industrial sector, for example producing 50 kg gas cylinders owned by PT. Pertamina. Improvements are carried out in determining the root cause using the six-sigma method (DMAIC (Define, Measure, Analyze, Improve, Control)). The results of the analysis of the defect factor on the tube significantly affect the welding process of the 50 kg gas cylinder material. There are four critical factors: machine settings, material cleanliness for welding, sand cleanliness for welding, and inspection methods. To reduce these defects, repairs are made by changing the welding machine settings according to the material used, cleaning the material before welding, cleaning sand before welding, and auto-control by welding operators in production according to the new SOP. The improvements that have been made show an increase in the sigma level, which was originally 2.616 to 2.965. The cost savings generated by improvements over three months amounted to Rp. 75,433,209,-.

Keywords: Cost Saving, Defect, Level Sigma, Quality Management, 50 Kg Gas Cylinder

1. INTRODUCTION

PT. Pindad is a State-Owned Enterprise engaged in manufacturing industrial and security defence equipment. Defence and security equipment products include weapons, ammunition and special vehicles, while industrial products include heavy equipment, marine equipment, air brake systems for trains, gas cylinders, Etc. Following the vision and mission of PT. Pindad, namely carrying out integrated efforts in the field of defence and security equipment and industrial equipment to support national development and specifically to support national defence and security as well as the BUMN synergy program encouraging PT. Pindad can synergize with other SOEs. One of them with PT. Pertamina is related to the production of 3 kg, 5.5 kg, 12 kg and 50 kg gas cylinders.

Quality is important to pay attention to in the production process and for competitive global competition. In addition, performance within a company can be measured by the level of efficiency and effectiveness in the production process. According to (Kotler P. et al., 2016), a quality product or service is the overall characteristics of a product or service that can satisfy the needs of consumers. The problem most often faced by manufacturing companies is how to provide high-quality products at a low cost. Therefore it is necessary to continuously improve the production process to produce products with good quality and efficient processes to increase the company's sales and profit margins

of PT. Pindad. Companies need to control and supervise the quality of raw materials, the production process, and the final product so that they can be immediately identified and resolved if unwanted things occur and result in greater losses.

Defects were obtained based on observational data on the production of 50 kg gas cylinders. Namely, in April 2022, there were 276 tubes with a total production of 1952 (1 work shift). In May 2022, there were 213 cylinders with a total production of 1558 (1 work shift), and in June, there were 658 tubes with a total production of 5550 tubes (2 work shifts). The results of these defects make the production process inefficient because it can impact operating costs. For this reason, in determining the root cause of the problem of suppressing defects, the six sigma method (DMAIC (Define, Measure, Analyze, Improve, Control)) is used.

The objectives to be achieved in this research include identifying the types of product defects that exist in the production process of 50 kg gas cylinders, making programs, and providing potential solutions to improve quality to minimize the number of product defects of 50 kg gas cylinders, determining the sigma level in the process. Production of 50 kg gas cylinders before and after repairs and the resulting cost savings.

2. LITERATURE REVIEW

ISO 9001:2015 Quality Management System

ISO 9001:2015 is a quality management system standard that contains all the requirements and conditions that must be met by an organization or manufacturing company.

Quality

According to Kotler & Armstrong (2012), quality is a product or service attribute that shows reliability, accuracy, ease of repair operations, and other value-added attributes.

Six Sigma

The six sigma method can be applied using the DMAIC (Define, Measure, Analyze, Improve, and Control) approach. Define is the first stage in six sigma, which is used to define a problem that exists in the process, then measure Critical to Quality (CTQ) to know the current state of the company so that it can be used as a reference in making improvements. Furthermore, the analysis stage determines the root problems encountered, which will be carried out with improvement plans. The improve stage tests the causal factors and makes improvements; the last is the control stage. According to Monika Smetkowska (2018), the application of DMAIC is one of the quality improvement methods used in the Six Sigma concept, which can increase effectiveness while solving problems that arise. According to El-Kassas et al. (2017), six sigma is used to reduce variation, measure defects, and produce quality processes and products.

LPG Steel Tubes

Based on SNI 1452: 2011, steel LPG cylinders are pressure tubes made of sheet steel, plates, and hot rolled coils (BJ TG) for LPG cylinders and are equipped with valves. The components of the LPG cylinder include a body, handguard, neck ring, valve, rubber seal of LPG steel valve, and foot ring.

3. METHODS

This section will explain the research methodology, which contains the stages and methods that will be carried out, starting from the stages of the DMAIC cycle (Define, Measure, Analyze, Improve, and Control).

4. RESULTS

1) Define Stage

Based on the defect data from April to June 2022, the Pareto chart is obtained as follows:

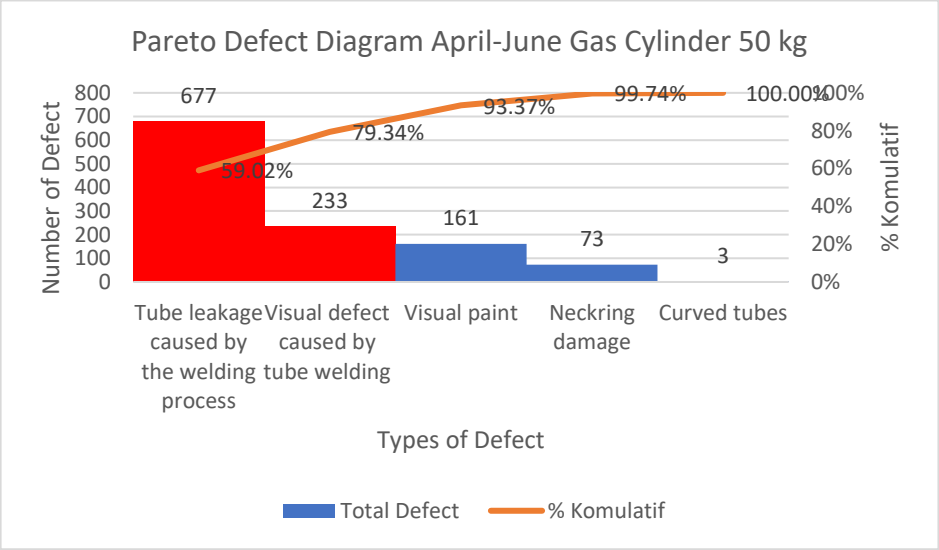

Figure 1. Pareto Defect Diagram for 50 Kg Gas Cylinders April-June 2022
Source: Author (2022)

Based on the picture above, it can be seen that most of the defects occur due to leaks in the tube plate welding. Defects for tube leaks have a proportion of 59,02% of the total defect in 50 Kg gas cylinder products, while defects in tube leaks and defects from visual results of tube welding have a proportion of 79,34% of the total defect. Defects related to leaks and visual defects resulting from tube welding on 50 Kg gas cylinders are caused by imperfect welding processes on the body plate of 50 Kg gas cylinders. This can be detected during hydrostatic or leak test testing so that the defect's cause is further known. Leaks and defects in 50 Kg gas cylinders will be analyzed at the Analyze stage.

2) Measure Stage

The value of losses due to product defects of 50 kg gas cylinders before repairs are carried out are as follows:

Calculation of Current Sigma Level

Based on the results, the P-value was >0.150, which means that the P-Value was > α (P-Value > 0.05), so it can be concluded that the data is normally distributed. Next, the sigma level measurement is carried out. The first step is determining the probability distribution of the 50 kg gas cylinder defect before improvement. Based on data, the average ratio for defects of 50 kg gas cylinders from April to June 2022 is 13.22%. Product-level calculations are performed using the Standard Normal Distribution equation. The results of these calculations produce an initial sigma level of 2.616052. The DPMO value for the sigma value has a probability value of 0.1322, which is 132,200 product units. This means that the 50 kg gas cylinder production process can produce a defective product of 132,200 units out of the 1,000,000 units produced.

Current Product Cost of Defective Calculation

Based on the data, the value of the cost of a defective product is Rp. 181,427,406. This value is 1.99% of the product output of both the 50 Kg gas cylinders produced.

Process Capability dan Control Chart

In the welding process, product defects that occur due to the welding process can be seen visually in the results of the welding width and the results of the porosity values on the significant X-ray test,

so the data normality test is carried out on measurements on the width of the welding straight and the porosity results on the 50 Kg gas cylinder sample. Based on the data normality test results, the width of a 50 kg tube welding straight has a P-value of 0.068, and porosity has a P-value of 0.078, where both values are greater than the confidence level of 0.05. So both data are normally distributed. This means that the data has an even distribution of data and can represent a population of 50 kg gas cylinders. Furthermore, a process capability was made for the width of the welding straight and the porosity of the 50 Kg gas cylinder using Minitab 19 software.

Based on the results, the shape of the histogram in the process is wide, so it can be interpreted that this process has many variations, and the resulting process is not working properly. The Cp and Cpk values for the welding width of 50 kg gas cylinders are 0.64 and 0.61, respectively. At the same time, the Cp and Cpk values for the porosity of a 50 kg gas cylinder are 0.87 and 0.22. The two process capabilities in the next stage will be compared with process capability after improvement has been carried out to see whether there has been an increase in process capability. Furthermore, a control chart was made for the width of the welding straight and the porosity of a 50 Kg gas cylinder using the Xbar-R chart using Minitab 19 software. Based on the results, all processes can be said to be in statistical control. The difference in UCL and LCL values for the straight width of a 50 kg gas cylinder is 1.268, while the difference in UCL and LCL values for the porosity of a 50 kg gas cylinder is 1.515. The difference in value will be compared in the next stage with the difference in value on the control chart after improvement. Based on the control chart, it can be seen whether the process variation is reduced, indicating a more uniform process.

3) Analyze Stage

The first step is to classify the types of defects that occur in the 50 Kg gas cylinder production line from April to June 2022. Then a Pareto diagram is made to find out the causes of defects that occur in 50 Kg capacity gas cylinder products, shown in Figure 1.

Based on the Pareto diagram in the Figure 1, it can be seen that leakage in welding holds the most significant proportion of defects, namely 59.02%. Furthermore, the visual on the welding results holds 20.32% of all defects on a 50 Kg gas cylinder. This means that 79% of these defects are in the welding process. Meanwhile, defects in the visual painting process had a proportion of 14.03%. Furthermore, defects in the neckring fitting process hold a proportion of 6.37%, and defects in 50 kg gas cylinders in the form of dented or notched tubes of 0.26%. Furthermore, determining the factors that cause defects is done by interviewing and brainstorming with the managers and related field staff. Based on that, the expert staff and related field managers concluded that several critical factors caused defects, especially in the welding process or welding on 50 Kg gas cylinders. The explanation for each of these critical factors is as follows:

1. Machine Settings

Based on interviews and brainstorming with an expert staff and related field managers and the Anova-oneway test, there is an effect of difference in amperage and speed on the width of welding and porosity

2. Material Cleanliness

Based on interviews and brainstorming with an expert staff and related field managers, some of the things that affect poor welding results are the presence of dirt, rust, oil, and paint.

3. Sand Cleanliness

Based on the results of interviews and brainstorming with an expert staff and related field managers, it is essential to maintain the cleanliness of the sand used so that it is not contaminated with outside air and produces good quality welding results.

4. Inspection Method

Based on the results of interviews and brainstorming with an expert staff and related field managers, no SOP or regulations governing this matter. An SOP or regulations are needed for the operator's auto control inspection method.

4) Improve Stage

Two main processes require improvement, namely, the welding and inspection processes. From these problems, improvements that can be made are as follows:

1. Welding machine settings
   a. The welding parameter is a critical factor causing the biggest defect problem in the 50 Kg gas cylinder welding process.
   b. Visual controls related to welding parameters and problems that often arise due to wrong parameter settings are installed around the welding area as learning materials and reminders for the welders.
   c. The control sheet monitors the welder's work when welding the product.
   d. There needs to be a special procedure or work instruction whose content is simpler regarding the welding parameters following the material being welded and installed in each welding machine or around the welding site.
   e. Conduct socialization by posting on the visual control board of the welding work area.
2. Material cleanliness
   a. Welding as much as possible in a closed area so that cleanliness and humidity can be maintained and controlled and wind disturbance can be avoided.
   b. The procedure for cleaning the material before welding is done to prevent dirt from sticking to the material.
3. Cleanliness of sand
   Sand material is useful as a protector against contamination of the material being welded, which creates sparks to protect the arc during the welding process.
4. Inspection method
   a. Adding periodic checks or inspections to work procedures or SOPs.
   b. The updated procedures/SOPs are re-socialized to all operators, especially welding operators, and posted on the visual control board of the welding area so that they can be socialized more optimally.

Improvement Result

The data normality test was carried out for welding width and porosity on the 50 gas cylinder production sample. The following results were obtained:

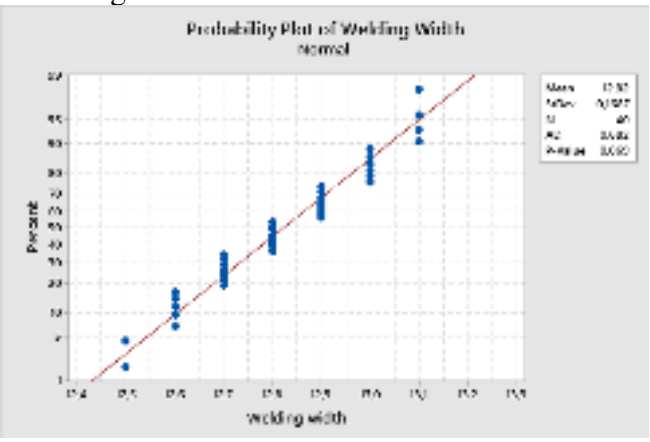

Figure 2. Probability Plot of Welding Sample Gas Width of 50 Kg After Improvement
Source: Author (2022)

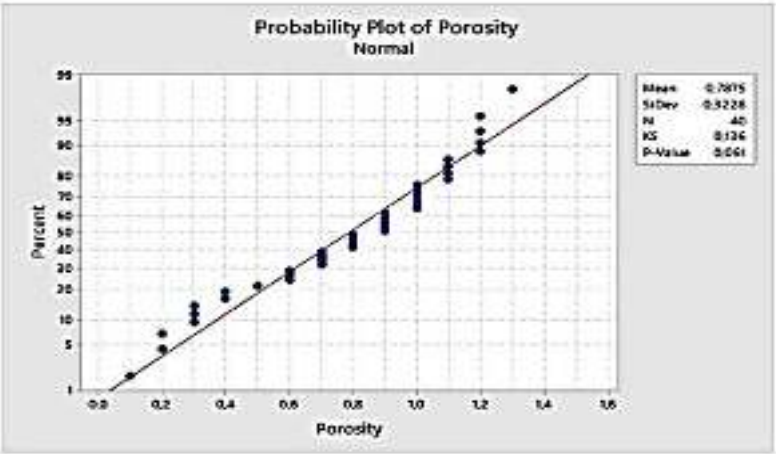

Figure 3. Probability Plot Porosity Sample Gas 50 Kg After Improvement
Source: Author (2022)

Based on the results, it is known that the data is usually distributed, which has a p-value of 0.069 and 0.061. So both data are typically distributed. This means that the data has an even distribution of data and can represent the population of 50 kg gas cylinders. Next, a process capability was made for the width of the welding straight and the porosity of a 50 Kg gas cylinder using Minitab 19 software. The processing capability for the width of the welding straight and the porosity of a 50 Kg gas cylinder can be seen in Fig 4 and Fig 5.

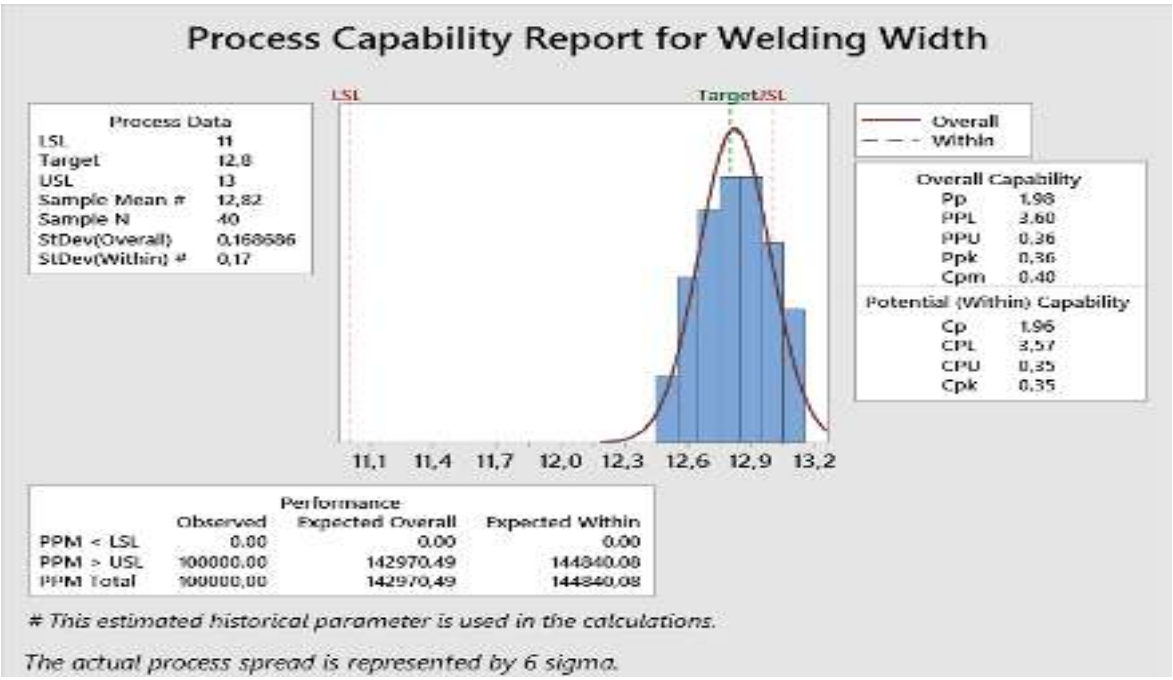

Figure 4. Process Capability of Straight Welding Width of 50 Kg Gas Cylinders After Improvement
Source: Author (2022)

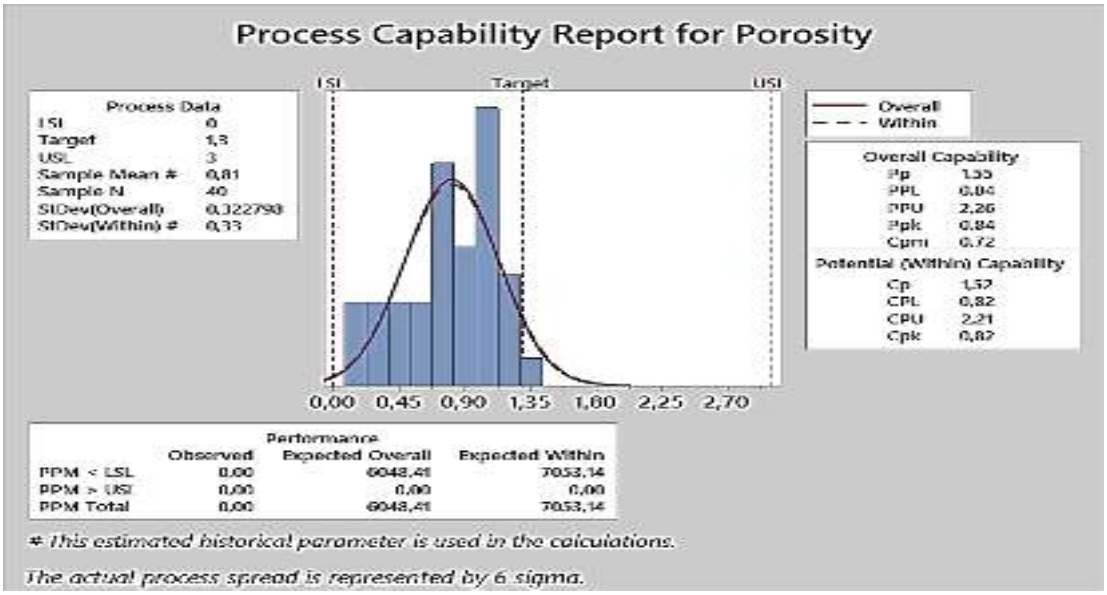

Figure 5. Process Capability Porosity of 50 Kg Gas Cylinders After Improvement
Source: Author (2022)

Based on the Figure 4, it can be seen that in the process capability of a 50 kg gas cylinder straight welding width, Cp = 1.96 and Cpk = 0.35. When compared with the stage before the improvement, where Cp = 0.64 and the Cpk value = 0.61, it can be seen that the Cp value has a significant difference indicating that the process capability is getting better. However, the Cpk value on the welding width before and after the improvement does not show a significant difference. Meanwhile, based on the Figure 5, in the process capability porosity of 50 kg gas cylinders, Cp = 1.52 and Cpk = 0.82, when compared to the stage before improvement where Cp = 0.87 and Cpk = 0.22, it can be It can be seen that higher Cp values and Cpk values much better mark the process capability in the after-improvement phase on porosity results. This indicates that the process is more precise and more accurate. Although the Cpk value on the welding width does not increase, the tube width is considered to be within the specified limits, and there are more important things when the leaks in this tube are mostly caused by porosity.

Next, a control chart was made using Xbar-Rchart using Minitab 19 software. The results of the control chart for the width of the welding straight and the porosity of 50 Kg gas cylinder are shown in Figures 6.

Figure 6. Control Chart of Straight Welding Width of 50 Kg Gas Cylinders After Improvement
Source: Author (2022)

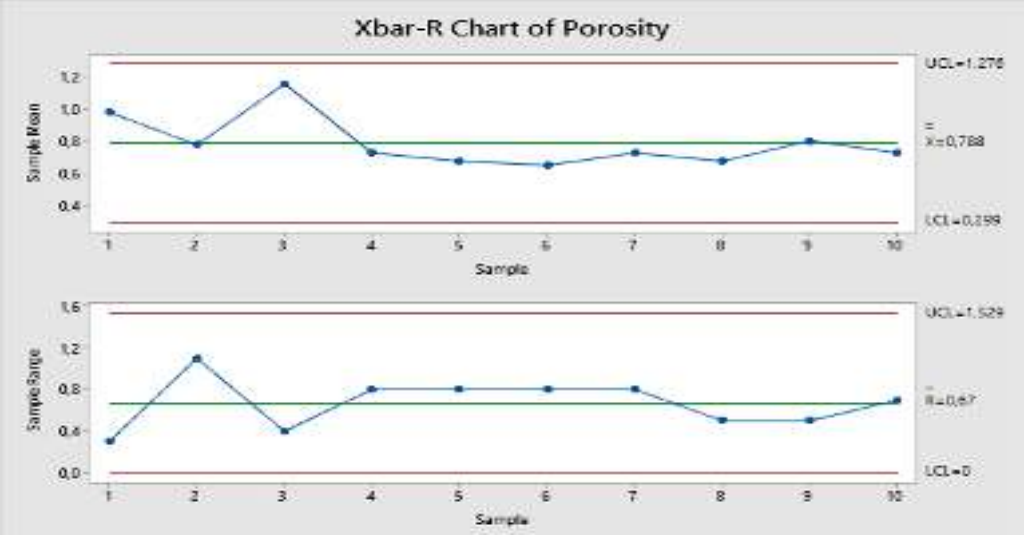

Figure 7. Porosity Control Chart for 50 Kg Gas Cylinders After Improvement
Source: Author (2022)

Based on the control chart, it can be seen that the whole process is statistically controlled, where the phase after improvement produces a more uniform process. This can be seen from a distance between the UCL and LCL in the after-improvement phase, which is tighter, and the reduced variation indicates that the process after improvement is more stable.

Based on the results, for the straight width of the 50 Kg gas cylinder, the Cp value has a significant difference indicating that the process capability is improving. However, the Cpk value on the welding width before and after the improvement does not show a significant difference. This can happen because, with the limited time available, the inspection of the width of the welding in this study was carried out by a judgmental sampling method. Therefore, in this study, the capability process only supports data to see a brief picture of whether the improvements made will give better results.

Meanwhile, the Cp value before and after the improvement for the porosity parameter of a 50 kg gas cylinder before and after the improvement was 0.87 to 1.52. The cpk value before improvement was 0.22 to 0.82. This cp value and cpk value indicate that the data distribution is good and has a better level of accuracy. Furthermore, if viewed from the control chart, both the width of the welding straight and the porosity of the 50 Kg gas cylinder show that the process is more stable in the conditions after improvement, which is indicated by the smaller difference in UCL and LCL values. So, the 50 kg gas cylinder production process after the improvement is concluded that the 50 kg gas cylinder production process produces products of better quality compared to the process before the improvement. In addition, the tube body welding process after the improvement experienced a faster time. At first, with a speed of 30 Hz, it took 1 minute 30 seconds, while after the 33 Hz improvement, it took 1 minute 24 seconds. This is not significantly changed, but product defects can be minimized.

5) Control Stage

Sigma Level Calculation After Improvement

Based on defect data for July 2022 there were 215 tubes with a total production of 3358 (2 work shifts), in August 2022 there were 311 tubes with a total production of 4321 (1 work shift), and in September there were 112 tubes with a total production of 1560 tubes (1 work shift), are as follows :

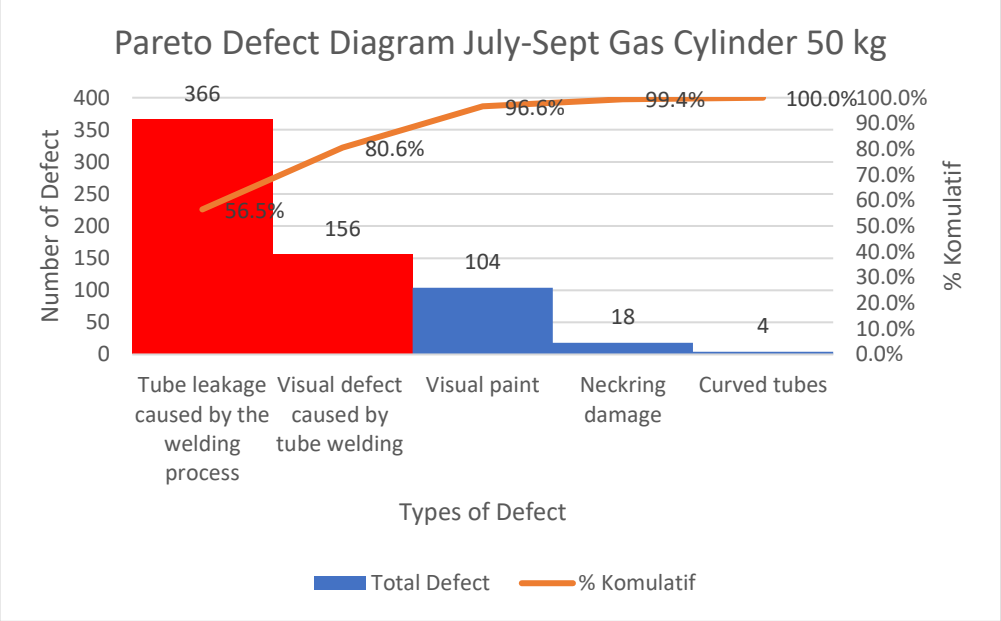

Figure 8. Pareto Defect Diagram for 50 Kg Gas Cylinders July - September 2022
Source: Author (2022)

The next step is to measure the sigma level. The first step is to determine the probability distribution of product defects of a 50 kg gas cylinder before improvement. The average value of the ratio for defects in 50 Kg Gas Cylinder products from July 2022 to September 2022 is 7.14%. The results of these calculations produce an initial sigma level of 2.965443. The DPMO value for the sigma value has a probability value of 0.0714, 71,400 product units. This means that the 50 kg gas cylinder production process has the opportunity to produce a defective product of 71,400 units out of the 1,000,000 units of product produced. From the results, it can be concluded that there was a decrease in the percentage of defects and an increase in the sigma level in this study. Thus, improvements in the improvement stage can be standardized into new SOPs that can be used as standards in subsequent production processes.

Calculation of Improvement Cost Assumptions

If viewed from an economic perspective, the repair price is meager, IDR 680,000. This is very profitable compared to the cost-saving results obtained after the improvement.

Calculation of Cost Savings

In this case, related to the calculation of cost saving, the costs contained in the period before the improvement are approximated by using the average cost of the defective product for good products after the improvement after being carried out without any corrective steps. The results of the improvements that have been made show that the cost savings generated on a 50 kg gas cylinder are Rp 77,231,062 over three months. However, there is a greater electricity consumption due to the ampere setting increasing at a cost of Rp. 1,797,853,- , then the resulting cost saving is Rp 75,433,209 over a 3-month period.

6. CONCLUSIONS

Based on the results of the research that has been done, it can be concluded that:

1. The highest defect found in the 50 Kg gas cylinder production process was tube leakage caused by the welding process, which had the highest percentage, 59% of the total defects in the 50 Kg gas cylinder product. The second was a visual defect caused by tube welding has a proportion of

20% of the total defects, and the rest are defects in visual paint, neckring damage, and curved tubes, with a total percentage of 21%.

2. From an analysis of the factors that cause defects in 50 Kg gas cylinders, there are four critical factors, including machine settings, material cleanliness for welding, sand cleanliness for welding, and inspection methods. The factor causing the defect that has a significant or highest effect on the defect is the welding process of the 50 Kg gas cylinder material. Based on this, the improvements made include:
   a. Make changes to the welding machine settings according to the material used
   b. Perform material cleaning before welding
   c. Perform sand cleaning before welding
   d. Autocontrol by welding operators in production according to the new SOP
3. From the results of the improvements that have been made, an increase in the sigma level, which was originally 2.616 to 2.965, and the cost savings generated by carrying out improvements over three months from July 2022 to September 2022 is Rp. 75,433,209,-.

Further research researchers suggest conducting further research on the types of unresolved defects and better monitoring the overall production process of 50 kg gas cylinders to suppress the occurrence of defects and obtain even higher product sigma level values.

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PRODUCT DESIGN INNOVATION BASED ON PRIVET'S CUSTOMER PREFERENCES

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ABSTRACT

The footwear industry in Indonesia grew along with Indonesia's economic development that occurred in the early 1980s. The development of the footwear industry is also supported by the role of the government with various facilities provided to MSMEs. The local brand is currently growing, one of which is women's footwear products. Product consistency and innovation are important factors in enlarging the brand in the local and international markets. Privet is a business that manufactures women's footwear since 2018. This business was born in a class New Venture Creation at Business Management ITS. The problem of product innovation at Privet is how to produce products based on customer preferences. This research uses the five stages of the design thinking model proposed by the Hasso-Plattner Design Institute at Stanford, namely empathize, define, ideate, prototype, and test. Tests were carried out using the Capture Matrix and Net Promoter Score (NPS). From this research, it was found that the factors of customer preference in buying footwear are comfort, design, and product value. Therefore, it is recommended to create products innovation in shoes, slippers, and sandals category based on customer.

Keywords: Footwear, Local Brand, Privet, Product Innovation, Design Thinking

1. INTRODUCTION

The footwear industry in Indonesia grew in line with Indonesia's economic development that occurred in the early 1980s. The development of the footwear industry is also supported by the government's role with the various facilities provided to MSME actors today. From world footwear data (APICCAPS) there are the 10 largest producers of footwear including China, India, Vietnam, Brazil, Indonesia, Pakistan, Turkey, Bangladesh, Mexico and Italy which are responsible for nearly 90% of the world's footwear needs (Judianto & Hapsari, 2018).

Currently, the development of the local-based fashion industry is indeed in full swing, one of which is shoes for women. The local pride trend that is often campaigned for in various media is one of the reasons local brands are increasingly recognized in society. However, as a business actor, one must not forget that the quality and consistency of product innovation are important factors in enlarging the brand in the local and international markets.

Innovation is the key to success in facing an increasingly open economic globalization. In fact, the number of MSMEs that can enter the international arena is still relatively low. This is in accordance with data owned by the Coordinating Ministry for Economic Affairs of the Republic of Indonesia that the export capability of MSMEs is still limited, which is only around 15.65% of the total existing exports (Limanseto, 2021). Therefore MSME actors must be able to strive to increase product competitiveness by being more creative and innovative in developing new products.

Privet is a footwear industry that was established in 2018. This business was born from a course in ITS Business Management, namely New Venture Creation. Various series have been released by Privet with a wide selection of footwear types ranging from shoes, slippers, and sandals. Based on the current conditions, Privet intends to be able to increase product competitiveness by referring to customer preferences. This is because in the end only products that are in accordance with customer wishes will make these products more quickly accepted by the market. In addition, in carrying out product development it was only limited to the internal ideation process by the Privet designer team which did not have specific standards in carrying out product development. Therefore, having a customer preference parameter in buying footwear will make it easier for the designer team to design products in the future.

This research uses the five stages of the design thinking model proposed by the Hasso-Plattner Design Institute at Stanford, namely empathize, define, ideate, prototype, and test. Tests were carried out using the Feedback Capture Matrix and Net Promoter Score (NPS). From this research, it was found that the factors of customer preference in buying footwear are comfort, design, and product value. Then create three innovations for Privet footwear products based on categories, such as shoes, slippers, and sandals with consideration to customer preference factors.

2. LITERATURE REVIEW

In a study conducted by Tian et al. (2021) aims to propose a footwear design framework for the elderly in China that contributes to the design of user-placed literature by hiding a logical and comprehensive design flow. In this study, findings related to visual elements as a limitation of footwear product designs. Visual elements are elements that can usually be directly processed by the user in his perceptual cognition. These elements are divided into two, namely aesthetic requirements which include lines, colors, materials, shapes and decorations, and functional requirements which include anti-slip, waterproof and shock absorbent.

The research conducted by Putrityas (2016) aims to reveal the role of consumer preferences on performance and non-performance attributes in lifestyle shoes using several respondents spread across the Netherlands, Indonesia, Australia, Malaysia, and Italy. The results of this study are divided into 2 attributes, namely performance and non-performance attributes, where the results obtained are performance attributes which include cushioning, stability, and shoe weight have a significant effect, while non-performance attributes such as price and image use also have a significant effect. However, the design of shoe packaging in this research does not affect consumer preferences (Putrityas, 2016).

Kurniawan et al. (2019) researched creating product development at the Soul Sepatu startup. The research was conducted using the design thinking method. The results of this study are in the form of new product design proposals for local businesses. In this study, it is known that the application of design thinking can help the success of business in product development.

The research conducted by (Salame (2020) examines the perception of design thinking in influencing the responsible behavior of fashion brand designers by conducting in-depth and exploratory interviews. Knowing the characteristics of design thinking helps in increasing the social sustainability of brands in the fashion industry. This research is based on the assumption that design

and sustainability need each other. Therefore, applying design thinking throughout the process of creating a new product helps to sustain and achieve better things going forward. In addition, design thinking provides great support for creating empathetic, relevant, and flexible solutions.

Furthermore, research conducted by Alcantra et al. (2005) aims to present the application of differential semantics to compose the semantic space of casual shoes. From this research, a result is obtained, namely the comfort and quality that is felt or felt independently by the user.

3. METHODS

This study used the five stages of the design thinking model proposed by the Hasso-Plattner Design Institute at Stanford, namely empathize, define, ideate, prototype, and test (Plattner, 2010). This model is used because it can be a reliable framework for designing something that is customized based on customer preferences, which in this case describes product design innovation proposals for the Privet footwear industry.

3.1 Participants

Ten women participated in this study consisting of two criteria, namely non-Privet customers and Privet customers. The ratio of respondents based on criteria is 80% non-Privet customers and 20% Privet customers. This percentage based on the Pareto principle, namely the 80/20 principle. The age range of the respondents is 20-35 years. Then five respondents consisting of one expert and four customers became respondents during the test.

3.2 Instruments

Figma, digital rough sketch, google form, prototype, feedback capture matrix, Net Promoter Score (NPS), and mobile devices were used for this research. For in-depth interviews, interviews are conducted online via the zoom platform. The overall duration of the interview was 20 hours 45 minutes with the average time of each respondent being 90 minutes. Then for testing 3 respondents were tested offline and 2 other participants were tested online via the zoom platform.

3.3 Procedures

The stages of in-depth interviews with 10 respondents began with brief introductions and explaining the purpose of the interviews, then asking for permission to conduct a recording and documentation session during the interview. Furthermore, the resource person was given a brief explanation regarding the matters explored in the interview, then the resource person was given questions according to the question indicators that had been prepared. After a series of questions have been answered, the interview process is closed by saying thank you because the respondent has taken the time to be interviewed. Furthermore, for the testing phase, 5 respondents tried to directly prototype 3 products, namely shoes, slippers, and sandals while providing feedback using the feedback capture matrix instrument. Furthermore, respondents were asked to provide an assessment according to the indicators tested on the Net Promoter Score (NPS) form that had been prepared.

4. RESULTS

4.1 Customer Preferences

In knowing customer preferences in buying footwear, what was done was to conduct in-depth interviews with 10 respondents. The results of the in-depth interviews were recapitulated based on the categories of questions asked, then the results were obtained which could be grouped into the form of affinity diagrams to determine the factors that influence customers in buying footwear. An

affinity diagram is a collection of data that is arranged in certain groups or themes based on the relationship between data (Dam & Siang, 2022). The data obtained from the interview results were divided into 2 groups of affinity diagrams according to the type of respondent, namely affinity diagrams for Privet footwear customers and affinity diagrams for non-customers of Privet footwear. From the grouping of affinity diagrams that have been done, three parameters of customer preference are obtained, namely convenience, beauty, and product value. Based on the results that are customer preference parameters that will be used in designing Privet product design innovations, where three factors exist in customer preferences, namely 1) convenience to provide a sense of comfort when used by customers, 2) design to increase customer confidence, and 3) product value to give an impression or a different value from the product offered to customers.

4.2 Empathize

The first stage in the data processing process in this study begins with the initial stages of design thinking, namely empathizing or empathizing with potential customers to design innovative footwear designs based on customer preferences. The process involved is observing what users do and how they interact with footwear, giving clues about what they think and feel, and learn about what they need. The user persona in this study aims to describe a fictional character from each prospective customer as a basis or description for designing footwear designs based on customer preferences.

Figure 1. User Persona a) Non-Privet Customers; b) Privet Customers

Figure 2. Empathy map a) Non-Privet Customers; b) Privet Customers

Overall, users consider several things that need to be considered, namely that customers consider the shape of footwear important because in addition to affecting appearance, it can also affect comfort when used. In addition, customers also still feel the lack of neatness and strength of the product and the installation of accessories that are not strong enough so that they are easily separated when used.

Processing the interview results into the customer journey map which in this study is used to help determine the focus point of customer needs in the design of Privet footwear design innovations. The customer journey maps in this study are divided into two categories, namely non-

Privet customer journey maps and Privet customer journey maps. The description of the two customer journey maps is as follows.

Figure 3. User Journey Map a) Non-Privet Customers; b) Privet Customers

Based on Figure 3, the results of the user journey map above show similarities and differences that arise in the emotional level phases felt by each customer. The stages of the user journey map aim to compile a customer scenario when choosing a product. So that at this stage the designer team can understand and know which part of the customer's needs will be more focused on designing an innovative Privet footwear design.

4.3 Define

In this process knowing how to determine the problem by focusing on specific users based on their needs. The process of determining the problem is done by defining the problem based on the Point of View (PoV) Analysis obtained from the empathy map synthesis of each category. Based on the PoV Analysis that has been carried out from the two categories, the results obtained are seven needs and insights that have similarities between the two categories, such as requiring a more diverse product to be adjusted based on needs, the uniqueness of the product, the choice of colors that can be Goes into all outfits, soft base, shapes that can minimize injury, as well as installation of detailed accessories that don't come off easily. This PoV Analysis was then converted into a problem statement as outlined in the Madlib PoV and How Might We (HMW) Question, which then concluded the HMW Question from the two categories to be processed at the next stage, namely as follows.

1. How can we provide diversified products?
2. How can we display the uniqueness of a product?
3. How can we provide products that can be used in various outfits?
4. How can we provide a soft base for a product?
5. How can we provide a product shape that can prevent injury?
6. How can we provide accessories which can be installed firmly?

4.4 Ideate

The ideate stage is a process for creating various design alternatives that aim to explore a wide range of solutions and various ideas from the ideas of a team of designers who have different scientific backgrounds. At the ideate stage, a brainstorming process is carried out, and then the results of this brainstorming are described on a post-it board. The results of the brainstorming of researchers obtained from answering the conclusions of the HMW Question in the define stage were 49 ideas. From the results of the brainstorming, several innovation recommendations were found and curated that could be implemented in Privet footwear design innovations. The recommendation

findings from this stage are divided into three aspects based on customer preferences which include comfort, beauty, and product value.

4.5 Prototype

The Prototype design is done in a participatory manner. After making the digital rough sketch as shown in Figure 4, then have done the A/B testing process. A/B testing is carried out aiming to narrow down the most appropriate design from each category for further user testing stages. So that from several design alternatives that was made, 3 types of products were selected from each category which was processed to become physical prototypes ready to be tested as shown in Figure 5.

Figure 4. Rough Sketch Digital

Figure 5. Final Prototype a) Shoe Category; b) Slipper Category; c) Sandal Category

4.6 Test

The testing process is carried out offline and online according to the time availability of the users involved in this process. Both offline and online testing use final prototypes that can be seen and tried directly by respondents. Conducting interviews with respondents using the feedback capture matrix to be able to see the things contained in the quadrants in the feedback capture matrix. Furthermore, after the interview process was completed, respondents were asked to fill out the Net Promoter Score (NPS) form that had been prepared to provide an assessment according to the indicators tested on the NPS formula. The two methods used in this test were differentiated according to the type of respondent, namely the cognitive walkthrough method for 1 expert and the usability testing method aimed at 5 users in prototype testing. Overall the evaluators liked the Privet footwear design in which the evaluator mentioned the order of assessment for each category, namely the first order was given to the designs in the sandal category, then the second order was the design in the slipper category, and the last order was the design in the shoe category. The sequence of these designs is based on the evaluator's tendency to choose the category of footwear that is frequently used and the details displayed in each design, starting from the selection of raw materials, the combination of choosing fabrics and accessories, as well as details of tidiness and comfort. Then based on the results of feedback from users who like designs that are considered modern and show a feminine style, besides that the combination of material selection makes the product seem unique and not monotonous. The user also said that choosing the right color is considered to be able to make the skin bright when used and choosing the right accessories and the product feels comfortable when used.

Furthermore, the results of the NPS score in measuring customer preference parameters are shown in Table 1-3.

Table 1. Shoe NPS Score

No	Indicator	Detractors (Total Detractors/ Total Respondents x100)	Passive (Total Passive/Total Respondents x100)	Promoters (Total Promoters/ Total Respondents x100)	NPS (Promoters - Detractors)
1	Cosiness (Shoes can provide a sense of comfort when used)	0	33,33	66,67	66,67
2	Fineness (Shoes can increase self-confidence)	0	33,33	66,67	66,67
3	*Product Value* (Shoes have given a different impression)	0	33,33	66,67	66,67
4	Recommend Products to Others (On a score of 1-10 how likely are you to recommend to others such as colleagues, friends, relatives, etc.)	0	16,67	83,33	83,33

Table 2. Slipper NPS Score

No	Indicator	Detractors (Total Detractors/ Total Respondents x100)	Passive (Total Passive/Total Respondents x100)	Promoters (Total Promoters/ Total Respondents x100)	NPS (Promoters - Detractors)
1	Cosiness (Slipper can provide a sense of comfort when used)	0	33,33	66,67	66,67
2	Fineness (Slipper can increase self-confidence)	0	33,33	66,67	66,67
3	*Product Value* (Slipper have given a different impression)	0	16,67	83,33	83,33
4	Recommend Products to Others (On a score of 1-10 how likely are you to recommend to others such as colleagues, friends, relatives, etc.)	0	16,67	83,33	83,33

Table 3. Sandal NPS Score

No	Indicator	Detractors (Total Detractors/ Total Respondents x100)	Passive (Total Passive/Total Respondents x100)	Promoters (Total Promoters/ Total Respondents x100)	NPS (Promoters - Detractors)
1	Cosiness (Sandal can provide a sense of comfort when used)	16,67	33,33	50	33,33
2	Fineness (Sandal can increase self-confidence)	0	50	50	50
3	*Product Value* (Sandal have given a different impression)	0	33,33	66,67	66,67
4	Recommend Products to Others (On a score of 1-10 how likely are you to recommend to others such as colleagues, friends, relatives, etc.)	0	16,67	83,33	83,33

It can be seen according to the table above that the results of calculating the NPS score of each category in assessing the factors that influence customer preferences in buying footwear as a whole get a score that is considered good, namely a score above 0. This shows a positive assessment from customers of product innovation has been designed, and customers also have a high potential to recommend Privet products to others because the NPS score obtained from shoes, slippers and sandals has the same score of 83.33. The assessment obtained from this NPS score can not only measure the level of satisfaction based on customer preferences based on the product design but can also be used as a future reference for measuring the business in looking at future improvement strategies. Hotjar's opinion (2022) is that NPS is a way to predict business growth, which with a product design innovation at Privet can be a strategy that can be implemented to further grow Privet's business going forward.

5. CONCLUSIONS

This research resulted in a product design innovation based on Privet customer preferences, with a qualitative research strategy to determine customer preference factors in buying footwear and then used as a reference in designing product innovations. Based on the results of the analysis and discussion that has been done, it can be concluded that the factors of customer preference in buying footwear are comfort, beauty, and product value. These three factors are used as things that are of concern to customers in determining the footwear they will buy. Then create three product innovations for Privet footwear based on categories, namely shoes, slippers, and sandals by taking into account the factors of customer preference in purchasing footwear. As an indicator of comfort, use materials that do not cause blisters when scratched by the skin of the feet, so choose materials that are soft and not textured on the inside, then add the thickness of the insole which has a function of increasing thickness on the heel so that it feels soft when used, and pay attention to the closed

end of the model to avoid blisters on the toes. Furthermore, the beauty indicator gives the appearance of a physical design that still pays attention to the image of the Privet, namely modern, elegant and feminine, combined with the selection of materials and accessories that complement each product. As for the product value category, namely having and combining basic materials using eco-friendly fabrics as a value that you want to highlight, and creating a product characteristic, namely selecting materials that have a type of shimmer and pearl-shaped accessories, which are the characteristics and differentiators of each product. in the future.

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EFFICIENCY OF DISTRIBUTION ROUTE IN KOPI BANYUATIS THROUGH VEHICLE ROUTING PROBLEM USING CLARKE AND WRIGHT'S SAVING HEURISTICS METHOD

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ABSTRACT

Responding to the customers' demands vastly is important for the company to survive in the competition with others in the same industry. The Vehicle Routing Problem is believed to solve the problem regarding the distribution of demands. To achieve efficiency in saving distribution cost and distance mileage, this research uses Clarke and Wright's Saving Heuristics to save the cost and reduce the number of routes, thus achieving shorter distance mileage. CV. Pusaka Bali Persada spends Rp1,448,102.00 a day with a total distance of 365.38 kilometres from the Singaraja warehouse, with a total of 10 (ten) routes for 2 Canvas (pickup vans) and 8 Motoris (motorcycles). Current routes focus on the distribution of Regular and 2-in-1. The distribution cost managed to be saved through the Analysis of the Saving Matrix only, but the distance mileage gets longer than the current routes. By continuing to the Analysis of the Nearest Neighbor, this research achieved 7 (seven) proposed routes of 1 Canvas and 6 Motoris, which reduced the cost by 14% to Rp1,220,763.00 and the distance by 16% to 313.89 kilometres.

Keywords: Clarke and Wright's Saving Heuristics, Cost, Distance, Nearest Neighbor, Saving Matrix

1. INTRODUCTION

Coffee is a high-demand agricultural commodity in the home country and abroad, as stated by International Coffee Organization [ICO] (2021). Coffee, with palm oil, cocoa, tea, and coconut, became the primary commodity after its contribution of US$ 579.80 million to Indonesia's foreign exchange in 2018. Adding the research by Toffin Indonesia (2020), the emergence of coffee shops across the archipelago from only 1,000 outlets in 2016 to 2,950 outlets in August 2019, supports the growth the coffee production reaching a 9,5% rate from 2017 to 2021 (Ministry of Agriculture, 2022). The spread causes intense competition and demand for coffee business players to develop strategies to adapt to the market (Wijaya et al., 2021). Improving the quality of service to consumers is a way that companies must respond immediately to stay in the round of similar industries. One way to achieve this is by streamlining the distribution process, supported by the current advances in science and technology (Putrafi & Sahari, 2020).

Indonesian coffee has many variants in each region, including coffee from Bali, because it has a signature taste and aroma. Buleleng is one of the largest coffee-producing areas in the Province

of Bali, located in the island's northern part. It has an area of approximately 1,365.88 km^2. Buleleng generally grows two types of coffee, namely Robusta and Arabica (Saldiman et al., 2021). CV. Pusaka Bali Persada is one of the well-known coffee companies in Buleleng, Bali, known as Kopi Banyuatis. Kopi Banyuatis has three warehouses in Singaraja, Denpasar, and Lombok, which have the authority to distribute the product. Other than Kopi Banyuatis, several other companies also take part in the coffee industry in Bali, such as the Kupu-Kupu Bola Dunia, Bali Kintamani Coffee, and many other coffee products (Dewi et al., 2016).

Considering that the Kopi Banyuatis marketed their product within the same area as the Kopi Kupu-Kupu Bola Dunia, the company faces tight competition in its marketing, potentially impacting the selling performances and market dominance of each company. But for its enthusiasts, the coffee produced by Kopi Banyuatis has a unique taste and aroma. In June 2022, the average sales of Kopi Banyuatis were at least 32,000 kg of the total types of products sold by the company. Singaraja warehouse (depot) carries out distribution activities to retails (consumers) through 10 (ten) distribution routes with 8 (eight) *Motors* (motorcycle) with a total of 100kg each and 2 (two) *Canvas* (pickup vans) with a capacity of 500kg. These vehicles are applied on the distribution of Regular and 2-in-1. One salesperson is responsible for one distribution route where the company only provides a benchmark for distribution areas, and then the salesperson will determine where to move in a week. The distribution happens between 08.00 and 14.30 WITA. The number of routes needs to be better organised and overlap with other ways. This situation causes several salespeople to intersect in one lane even though the shops visited differ. The vehicle capacity needs to be fully used to its maximum capacity, which causes inefficiency in the distribution process. For one cycle a day, the company has to spend at least Rp188,000 for each *Canvas* (pickup van) and Rp134,000.00 for each Motoris (motorcycle) to distribute their products.

Problems in distribution activities require a strategy that can reduce costs yet meet the company's main objectives. One of the problems included in the *Vehicle Routing Problem* can be solved using *Clarke and Wright's Saving Heuristics* method. Combined with *Saving Matrix* and *Nearest Neighbor* within the analyses, Clarke and Wright's Saving Heuristics are expected to develop an efficient distribution route with a more optimal quantity of vehicles. The new routes will minimise the distance and time taken by the vehicle and affect the decrease in distribution costs incurred by the company.

2. LITERATURE REVIEW

2.1. Vehicle Routing Problem

Laporte (1992) describes Vehicle Routing Problem (VRP) as a problem in determining the optimal route from one or more depots to geographically dispersed demand points. Firstly being researched by Dantzig & Ramser (1959), they introduced VRP to find the optimal route and schedule for gasoline trucks. Research continued through research that created a method called the Saving Algorithm conducted by Clarke & Wright (1964).

VRP is a circumstance where *n*-vehicles have the same capacity at a depot that serves the retails. Salespersons deliver goods to retailers who request them through several routes. VRP is used to minimise the total cost of the trip. The specified way must meet the constraints also described with its mathematical formulation, which set, index, parameters, and decision variable referred to the application of VRP will be explained as follows.

Sets and Indexes

$\boldsymbol{G\ (N, A)}$ (1)

defined as a directed graph

$\boldsymbol{N = \{v_0, v_1, v_2, v_3, \dots, v_n\}}$ (2)

is a set of nodes representing *n* customers and v_0 representing depot(s)

$\boldsymbol{i, j = 0, 1, 2, 3, \dots, n}$ (3)

is an index for nodes and customers

$\boldsymbol{A = \{(v_i, v_j) | v_i, v_j \in N, i \neq j\}}$ (4)

is a set of edges that connect nodes, symbolized as a connecting road between the depot(s) and the customer and also the liaison between customers

$\boldsymbol{k = 1, 2, 3, \dots, m}$ (5)

is the set of *m*-vehicles that have a capacity of *U*

Parameters

$\boldsymbol{q_i}$: required node *i*

$\boldsymbol{c_{ij}}$: cost of travel from node *i* to node *j*

$\boldsymbol{t_{ij}}$: travel time from node *i* to node *j*

$\boldsymbol{U}$: vehicle capacity

$\boldsymbol{UT}$: maximum travel time for each route

Decision Variable, the variable of the expected value

$$x_{ij}^{k} = \begin{cases} 1, \text{if there is a vehicle trip from i to j on route k} \\ 0, \text{if there is no vehicle trip from i to j on route k} \end{cases}$$

2.2. Clarke and Wright's Saving Heuristics

Clarke and Wright's Savings Heuristics calculates savings, measured by how much the distance travelled and the time used by linking existing nodes (location of warehouse and retailers) and using a route based on the most significant saving value that can be reduced (Clarke & Wright, 1964). The distance between the warehouse (source node) and the retailers (destination node). This method uses distance as a parameter and time to obtain the most significant saving value and then arranges it into the best route (Octora et al., 2014). In supporting the process, the analysis of Distance Matrix, Saving Matrix, and Nearest Neighbor is utilized to reach the optimum alternative to the related problem. Based on Figure 1 (a), retailers *i* and *j* are visited through separate routes. An alternative to this problem is to visit two retailers on the same route as shown in Figure 1 (b).

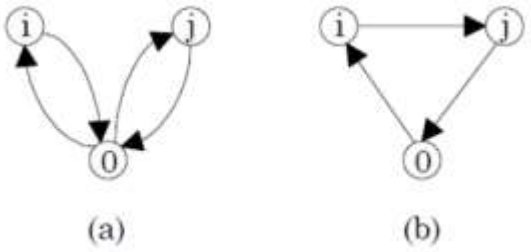

Figure 1. Changing Routes in Saving Algorithm

2.2.1. Saving Matrix

A Saving matrix is used as a strategy to utilize the decision to remove, course, time, or take a toll in carrying out each conveyance of merchandise from the warehouse (depot) to retailers (consumers) (Suparjo, 2019). This strategy points out the ride of inventory based on the agreement with client orders. It can be carried out viably and proficiently so that the company can decrease costs, vitality, and conveyance time of goods distribution (Istantiningrum, 2010). The advantage of utilizing this strategy lies in its ease of alteration. If the vehicle capacity is restricted, the number of vehicles, conveyance time, or other impediments can give a speedier and more down-to-earth arrangement (Yuniarti & Astuti, 2013). A few presumptions must be considered when using the saving matrix. Among them, the street navigated by vehicles may be a two-way road, so separating from the put of root to the goal or bad habit versa is the same. The conclusive presumption is that activity conditions, such as lights, blockage, etc., do not influence vehicle speed.

2.2.2. Nearest Neighbor

The Nearest Neighbor is used to find the nearest location after visiting one location in the distribution process. The early stage is entering the destination of distribution from the warehouse, and finding where goods need to be distributed. If every destination has been visited once, the algorithm process is claimed as finished (Solomon, 1987).

3. METHODS

Problem identification is carried out through field surveys by tracing sample routes passed by salespersons daily. Reviewing literature and collecting data on-site are compulsory to get a broad view before the analysis is carried out. Data tabulation is later done by sorting the demands data of each route into 13 (thirteen) days of distribution in June 2022, which is chosen for its high demand near the Hindu ceremony of Galungan and Kuningan. In Bali, not only do people drink coffee, but people also use coffee as an offering to prosper God. This special occasion makes the demands higher than another ordinary day. Data on route distance and travel costs are also tabulated.

The analysis is done using Clarke and Wright's Saving Heuristics method, where the demand used in the calculation is the average demand to reduce the company's distribution route. The method is done through several steps: Distance Matrix, Saving Matrix, and Nearest Neighbor. After the analysis, the distance and cost between the current and the proposed distribution routes are compared to achieve savings in both aspects. The steps of analysis are detailed as follows.

a. Identify Distance Matrix *(kilometres)*

At this stage, the data needed is the distance data from the warehouse (depot) to each consumer (retail) and the distance between retailers (consumers). The formula is as follows.

$$d = \sqrt{(x_j - x_i)^2 + (y_j - y_i)^2}$$

Indexes:

d = distance
x_i = x coordinate of point i
x_j = x coordinate of point j
y_i = y coordinate of point i
y_j = y coordinate of point j

b. Identify Saving Matrix

The Saving matrix is done through several iterations until the maximum saving solutions are achieved. The road proposed from this step is done using the Milk-Run Strategy. The strategy puts route in another with the demand that can still be combined depend on the vehicle's capacity. The formula is as follows.

$$S_{i,j} = C_{depot,i} + C_{depot,j} - C_{i,j}$$

Indexes:

Si,j = saving value of location point i and j

x_i = x coordinate of point i

x_j = x coordinate of point j

y_i = y coordinate of point i

y_j = y coordinate of point j

c. Identify the Routes with Nearest Neighbor

The proposed routes in Saving Matrix need to be in order. The following location could be very far away, while the one after the next could be very close. The Nearest Neighbor is utilized to turn the location the salesperson must visit in ascending order. The analysis starts with measuring the distance from the warehouse to one retailer to the warehouse again. The salesperson will first visit the customer's location with the closest distance mileage after departing from the warehouse. The analysis is done after re-arranging every location in every route.

4. RESULTS

The research results can be obtained through the Analysis of Saving Matrix alone. Routes got shortened from 10 (ten) routes to 7 (seven) proposed routes, however, if you look at the analysis results on Table 1, the distance of the new route has a longer total length compared to the current routes of 365.38 kilometers to 480.52 kilometers. Although the analysis fulfilled the fulfilment demand for each route and reduce distribution costs from Rp1,448,102.00 to Rp1,339,338.00, further research is needed to reduce distances more efficiently.

Table 1. Analysis of Saving Matrix

Vehicle	Code	Saving Matrix Route	Fulfilled Demand (kg)	Distances (km)	Cost (IDR)
Motoris	PM1	W – M53 – M41 – M52 – M51 – C15 – C14 – W	71.5	187.65	Rp293,737.00
Motoris	PM2	W – C13 – C12 – W	98.0	52.31	Rp173,967.00
Motoris	PM3	W – C11 – M43 – M34 – M42 – M33 – M62 – W	89.9	118.99	Rp232,976.00
Motoris	PM4	W – M71 – M21 – M72 – M12 – W	93.3	75.06	Rp194,100.00
Motoris	PM5	W – M73 – M61 – M81 – M23 – M11 – W	91.2	32.61	Rp156,534.00
Motoris	PM6	W – M22 – C22 – M31 – M32 – W	58.5	12.85	Rp139,047.00
Canvas	PM7	W – C21 – W	106.5	1.06	Rp148,976.00
TOTAL			**608.9 kg**	**480.52 km**	**Rp1,339,338.00**

Analysis of the Nearest Neighbor is chosen by determining the nearest retail location from the warehouse or from the retail location that was last visited. The proposed routes are sorted by the shortest distance from each point that has been visited. The result from this analysis is then compared with the result from Analysis of Saving Matrix, as seen on Table 2. Result on Table 3 further explain that the distance mileage is shorten to 313.89 kilometers and the distribution cost is decrease even more to Rp1,220,763.00. Comparison in percentage can be seen through Figure 2.

Table 2. Proposed Routes through Analysis of Saving Matrix and Nearest Neighbor

Vehicle	Code	Saving Matrix Route	Nearest Neighbor Route
Motoris	PM1	W – M53 – M41 – M52 – M51 – C15 – C14 – W	W – M51 – M41 – C14 – C15 – M52 – M53 – W
Motoris	PM2	W C13 C12 W	W C12 C13 W
Motoris	PM3	W – C11 – M43 – M34 – M42 – M33 – M62 – W	W – C11 – M43 – M34 – M42 – M33 – M62 – W
Motoris	PM4	W – M71 – M21 – M72 – M12 – W	W – M12 – M71 – M72 – M21 – W
Motoris	PM5	W M73 M61 M81 M23 M11 W	W M11 M23 M81 M73 M61 W
Motoris	PM6	W M22 C22 M31 M32 W	W M31 M32 C22 M22 W
Canvas	PM7	W – C21 – W	W – C21 – W

Table 3. Comparison in Distance and Cost of Current and Proposed Distribution Routes

Vehicle	Code	Current Route		Vehicle	Code	Saving Matrix Route		Nearest Neighbor Route	
		Distance	Cost			Distance	Cost	Distance	Cost
Motoris 1	M1	22.69	Rp131,458.00	Motoris	PM1	187.65	Rp293,737.00	132.04	Rp244,525.00
Motoris 2	M2	40.50	Rp134,425.00	Motoris	PM2	52.31	Rp173,967.00	52.32	Rp173,976.00
Canvas 1	C1	59.43	Rp221,847.00	Motoris	PM3	118.99	Rp232,976.00	61.79	Rp182,357.00
Canvas 2*	C2	4.20	Rp154,636.00	Motoris	PM4	75.06	Rp194,100.00	56.52	Rp177,693.00
Motoris 3	M3	34.43	Rp133,414.00	Motoris	PM5	32.61	Rp156,534.00	32.65	Rp156,569.00
Motoris 4	M4	39.37	Rp134,239.00	Motoris	PM6	12.85	Rp139,047.00	10.16	Rp136,667.00
Motoris 5	M5	101.69	Rp144,624.00	Canvas	PM7	1.06	Rp148,976.00	1.06	Rp148,976.00
Motoris 6	M6	25.70	Rp131,859.00						
Motoris 7	M7	27.25	Rp132,215.00						
Motoris 8	M8	9.65	Rp129,285.00						
TOTAL		**365.38 km**	**Rp1,448,102.00**	**TOTAL**		**480.52 km**	**Rp1,339,338.00**	**313.89 km**	**Rp1,220,763.00**

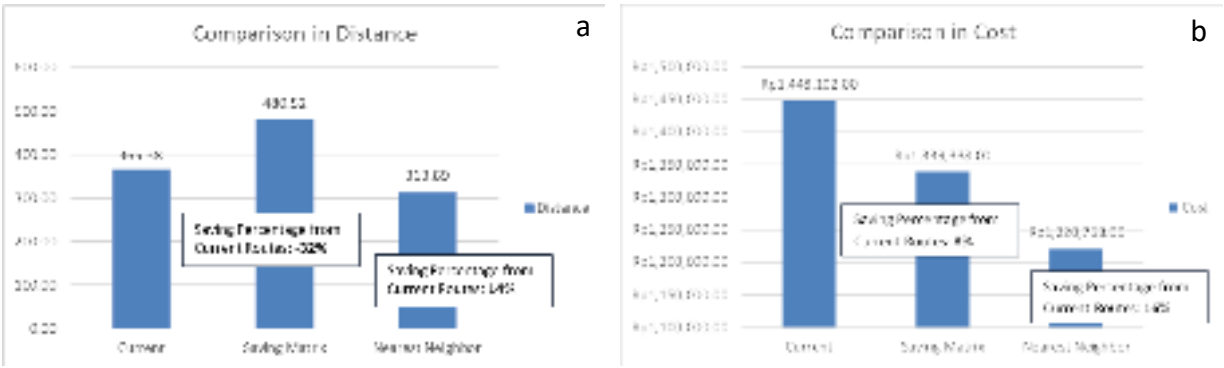

Figure 2. Comparison in Percentage of Distance (a) and Cost (b) between Current Distribution Routes with Saving Matrix and Nearest Neighbor

6. CONCLUSIONS

Problems in distribution activities require a strategy so that the costs incurred by the company can be reduced but still meet the main objectives of the company. Clarke and Wright's Saving Heuristics method is conducted through several analysis of Distance Matrix, Saving Matrix, and Nearest Neighbor, to minimize the distance that will be taken by the vehicle and decrease the distribution costs incurred. The variable in determining VRP is based on the distribution distance, the capacity the vehicle can hold, and the distribution costs. The distribution cost is affected by salespersons' fees, type of vehicles, total gasoline consumption, vehicle tax, vehicle maintenance costs, and other effects depending on what costs the company would probably spend. Kopi Banyuatis have 8 (eight) units of motorcycles (Motoris) with a total capacity of up to 100 kilograms and 2 (two) units of pickup cars (Canvas) with a capacity of up to 500 kilograms. The total distance mileage for all distributions is 365.58 kilometers daily, costing Rp1,448,102.00.

By conducting research through the Clarke and Wright's Saving Heuristics method, ten of the current distribution routes can be saved into seven routes. Since the distribution process depended more on a motorcycle because they could reach retailers primarily located in remote areas of Buleleng Regency, distribution in six routes uses motorcycles because the fulfilled demands for each route did not exceed the capacity of 100 kilograms. One route is using pickup car because the demand for the route exceeds 100 kilograms by one location only. Cost decreased from Rp1,448,102.00 to Rp1,339,338.00, but the distance mileage increased from 365.58 kilometres to 480.52 kilometres. Further analysis of the Nearest Neighbor optimizes the distance by 51.49 kilometers from 365.38 kilometers to 313.89 kilometers. The cost is saved by Rp227.339.00 per day from Rp1,448,102.00 per day to Rp1,220,763.00 per day.

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ANALYSIS OF WASTE PRODUCTION LAYOUT USING THE LEAN SIX SIGMA METHOD CASE STUDY: DIGITAL BABY SCALE AT PT. XYZ

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ABSTRACT

The domestic medical device manufacturing industry is in an effort to improve the government's vision and mission regarding efforts to advance national independence. One of the medical device manufacturing companies, PT. XYZ, has problems dealing with waste that occurs in the production system of digital baby scales. Long production duration causes delays in fulfilling orders. This research was conducted to analyze the existing condition of the layout of the digital baby scales production system at PT. XYZ using the lean six sigma DMAIC method. The main focus in this study includes waste factors related to the layout of the production floor which is analyzed using the tool from to chart. Meanwhile, the root cause tool uses a fishbone diagram to analyze the factors that cause waste in the production of digital baby scales. The solutions offered for these problems include recommendations for improvements to the production layout to minimize the waste factor. The results of the study showed a decrease in the total cost of moving material down to 36% of the total cost of moving the existing material.

Keywords: Lean Six Sigma, Root Cause Analysis, From to Chart, Medical Device, DMAIC

1. INTRODUCTION

Medical device manufacturing industry was one of the import sectors which is a top priority developed by the government in handling impacts caused by covid-19. Domestic demand for medical devices is projected to reach 153 trillion in 2030 with details of imports of 131.8 trillion and exports of 35 trillion by Directorate General of Pharmacy and Medical Devices Ministry of Health Republic Of Indonesia (2020). Currently, as much as 94% of the need for medical devices circulating in the country are imported products by ASPAKI (2020). This situation is not in line with the government's vision and mission in promoting national self-reliance. So that the government seeks to increase self-sufficiency in domestic production of medical devices by reducing efforts to import medical devices.

PT. XYZ is a medical device manufacturing industry which is in line with the government's efforts to focus on domestic medical device production. The government's target to increase domestic production has had a positive impact on PT. XYZ, but this opportunity has not been fully utilized by the company. This is evidenced by the discovery of cases of delays in fulfilling orders such as digital baby scales amounting to 30.27% of total product sales. in field analysis, the distance between departments is far apart in the production system of digital baby scales and the area used is large. one of the delay factors that is often found is the buildup of

material, semi-finished goods or finished goods that affect the capacity of each area related to the production system.

To minimize the occurrence of delays in the production system of digital baby scales caused by waste factors related to the production layout, this research implements the lean six sigma method. George (2002) suggested that lean six sigma method with the DMAIC tool has advantages in improving productivity, reducing cycle times, and reducing product defects. One of the literature uses the lean six sigma method carried out by Guleria et al (2022) by applying lean tools such as VSM, 5s, DMAIC in an effort to reduce non-value added processes so as to obtain higher quality products. However, a review based on layout analysis was not carried out in this study.

This study combines lean tools used in layout analysis such as from to chart to design an improvement recommendation and conducts a validation stage related to the efficiency of the improvement recommendation by comparing the existing conditions with simulations that are similar to the original state. So it is hoped that this research will become a recommendation in modeling the DMAIC method to find out the root cause of one of the factors of material accumulation that occurs in the production line and find recommendations for appropriate improvements to reduce waste.

2. LITERATURE REVIEW

2.1. Lean Six Sigma

Franchetti (2015) suggested that Lean Six Sigma is a managerial concept in combining 2 concepts, namely: Lean and Six Sigma. Lean Six Sigma has the main goal of improving quality and reducing costs in a company, product, or manufacturing process. The first time this concept was coined by Michael George in 2002 with the theme "Combining Six Sigma with Lean Production Speed".

George (2002) suggested that Lean Six Sigma is a method aimed at shareholders by achieving rapid improvements related to aspects of customer satisfaction, cost, quality, process speed, and invested capital. The Lean and Six Sigma methods are combined on the basis that each of these methods is complementary.

2.2. DMAIC

DMAIC stands for Define, Measure, Analyze, Improve, and Control is one of the methods owned by Lean Six Sigma. Voehl et al. (2013) suggested that DMAIC is a method that is often used in manufacturing processes related to improving the quality of products, processes, or services contained in companies. The define stage is a mechanism related to the improvement objectives to be achieved. For example, efforts to increase production throughput, reduce defects on certain projects (Voehl et al., 2013). The measure stage is the stage for measuring the system that has been running or the system that will be proposed for improvement. The initial step can be to set valid parametrics to facilitate the analysis of exploratory and descriptive data so that they are easy to understand (Franchetti, 2015).

The analyze stage is the stage of using tools and statistical analysis in analyzing the capability and speed of the process. Can determine the source of variation and time bottlenecks and qualify value added and value not added (Franchetti, 2015). The improve stage is the stage of generating ideas that make a basis for improvement or eliminating non-added value. Examples of implementation related to methods of improving quality and reducing operational costs, process changes, conducting experiments and developing data validation stages related to improved processes, and developing SOPs and plans properly (Franchetti, 2015). The control stage is the

stage for making a control plan, ensuring the performance of the process runs smoothly, and anticipating errors that will occur (Franchetti, 2015).

2.3. Material Handling

Material handling has principles including the function of moving the right material to the right place, with the right amount, in sequence, and at the right conditions in minimizing production costs (Stephens and Meyers, 2013). The arrangement in material handling includes some involvement in 5 dimensions, namely: movement, quantity, time, space, and control. According to (Stephens and Meyers, 2013), states that there are 10 principles in material handling including planning principles, standardization principles, work principles, ergonomic principles, unit load principles, space utilization, system principles, automation principles, environmental principles, and life cycle costs principle.

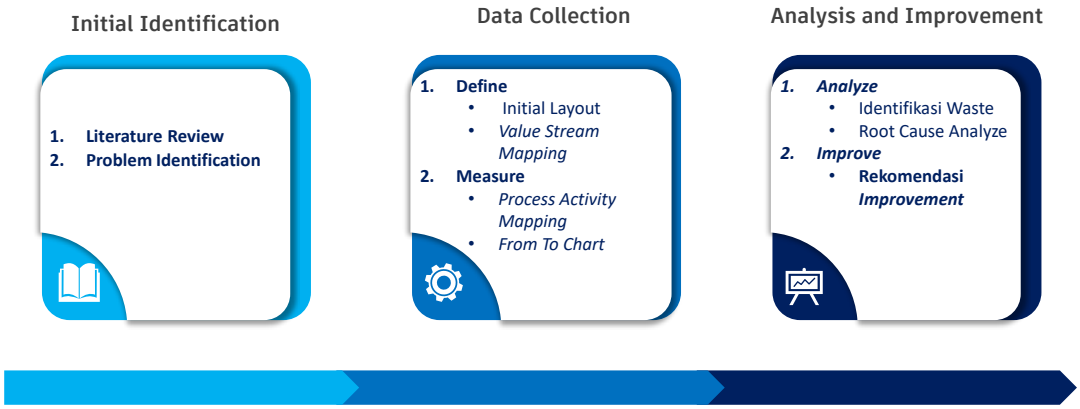
3. METHODS

Initial identification was carried out to identify problems that focused on analyzing production waste of digital baby scales which were reviewed based on the production layout. The stages of data collection were carried out using direct observation methods, interviews, as well as some company data related to the issues raised as research topics. The define stage is the initial stage of the lean six sigma method to identify problems and research objectives by determining initial identification such as initial layout and current value stream mapping.

The measure stage is part of calculating and measuring related systems that have been running in order to gain effectiveness in a production system. The data contained in the define process is processed using process activity mapping tools and from to chart. In this analyze phase determine and analyze the root cause using RCA (root cause analysis) tools. One of the tools contained in RCA is a fishbone diagram with a focus on the root causes of waste related to the production layout of digital baby scales.

At this stage it is intended that after getting the root cause of the waste that has occurred, then providing recommendations related to improvements that can be made. Improve recommendations given are in the form of a layout design that is determined based on the right solution to overcome the causal factors.

This research was carried out until the improve stage so that it did not carry out the control stage because the research output was in the form of recommendations so that implementation had not occurred. Based on Figure 1 as flow process of reasearch methods.



Figur 1. Flow process of research methods

4. RESULTS

4.1. Define

Flow in the baby scales production process in several areas includes: Material Warehousing, Finishgood Warehouse, Preproduction Area, SMD Area, PPIC Area, Assembly Area, Testing and Calibration Area, and Packing Area. Based on Figure 2 initial layout production process digital baby scale. The flow of material handling for the initial digital baby scales production includes several work areas for the production of digital baby scales that are interrelated with an overall work area of around 250 m2. There are several work areas that are passed by the material handling flow for the production of digital baby scales including the material storage area, material loading area, material preparation area, smd area, assembly area, testing and calibration area, packing area, and finished goods storage area. Figure 3 as value stream mapping digital baby scale production.

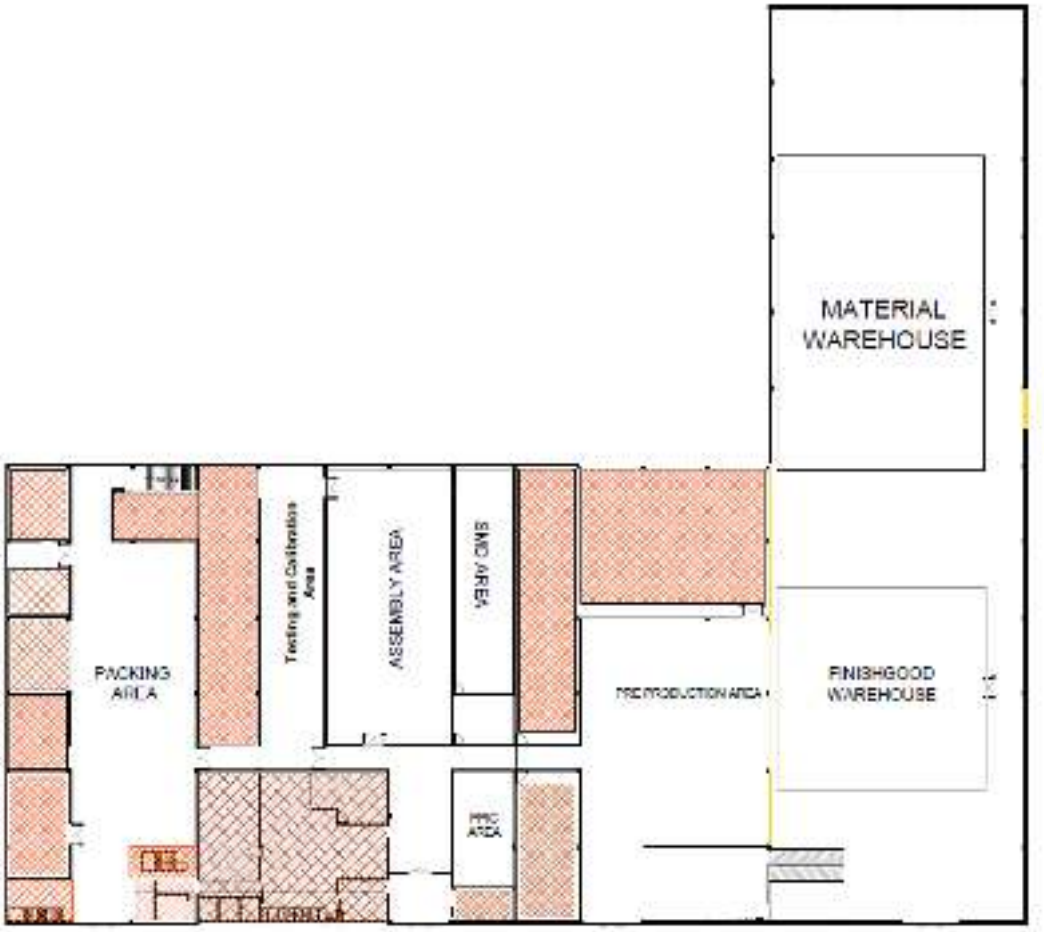


Figure 2. Initial layout

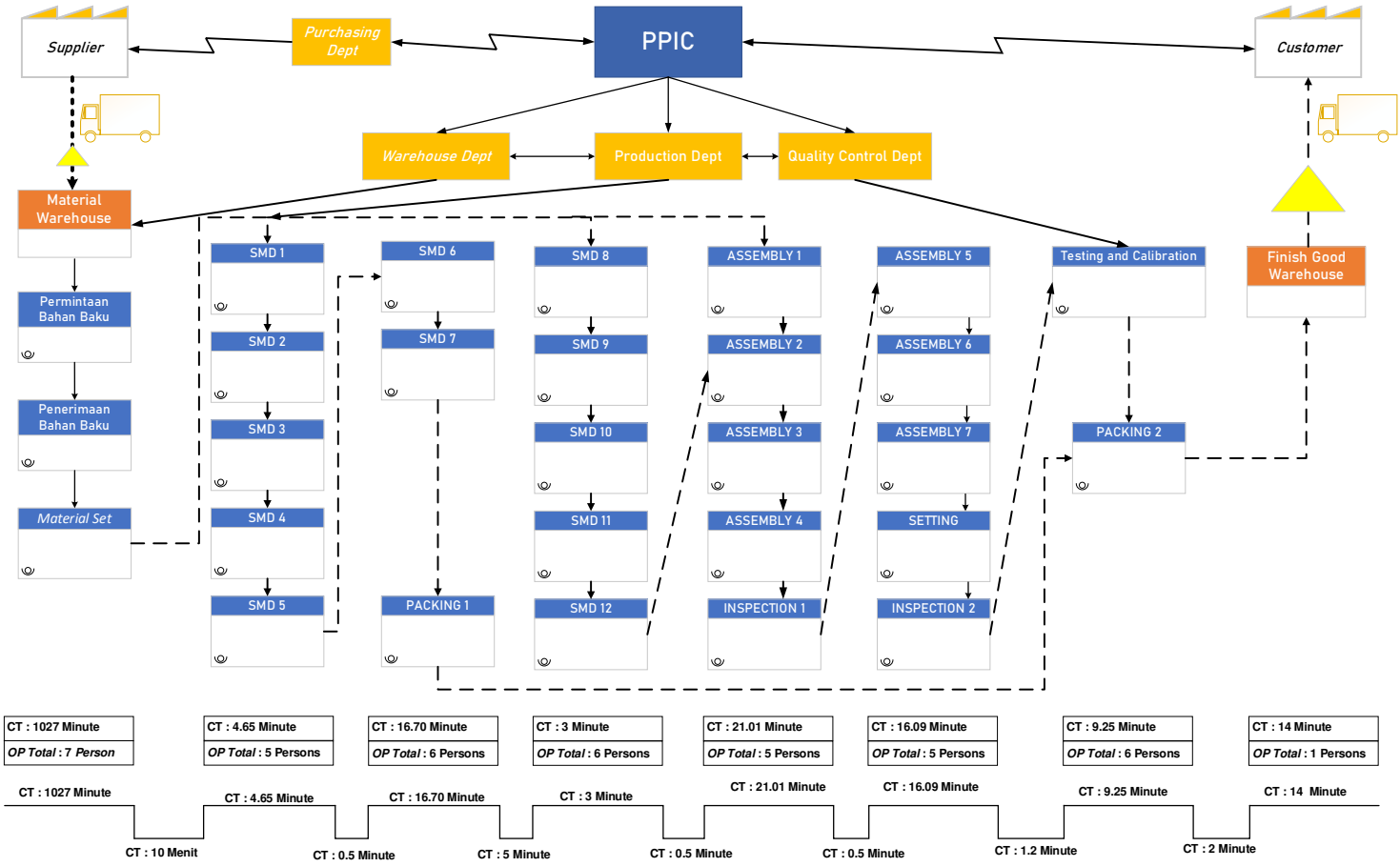


Figure 3. Value stream mapping digital baby scale production

4.2. Measure

Transfer of material handling in the production process of baby digital scales PT. XYZ was carried out using 1 unit of electrical stakers, 2 units of hand pallets, and 2 units of trolleys. The calculation of material handling costs includes the calculation of depreciation costs (shrinkage), maintenance costs, and operator daily costs. Based on Table 1 is the total cost of moving materials.

Table 1. Total cost of moving materials

No	*From*	To	Distance (meters)	Frekwensi	Tool	OMH	Total Cost
1	A	B	110.5	187	Electrical Stacker	Rp. 204,27	Rp. 4.220.991
2	A	C	101.5	4	Handpallet	Rp. 275,34	Rp. 111.790
3	B	C	55	8	Trolley	Rp. 828,19	Rp. 364.402
4	B	D	64.5	91	Handpallet	Rp. 275,34	Rp. 1.616.135
5	B	F	118	96	Handpallet	Rp. 275,34	Rp. 3.119.103
6	C	D	10	4	Trolley	Rp. 828,19	Rp. 33.127
7	C	F	46	10	Trolley	Rp. 828,19	Rp. 380.966
8	D	E	22	49	Handpallet	Rp. 275,34	Rp. 296.821
9	E	F	21	49	Handpallet	Rp. 275,34	Rp. 283.329
10	F	G	91.5	49	Handpallet	Rp. 275,34	Rp. 1.234.507
						Total	**Rp. 11.661.171**

4.3. Analize

Based on the analysis of the process activity mapping, it was found that there were 94 activities including 31% value added activities and 69% non value added activities. Based on Table 2. is total activity and digital baby scale production time. The type of storage activity that takes the most time is the type of activity for calculating material parts and classifying part shipments in each process.

The from to chart analysis uses total material handling movement data combined in a road map of material handling in each department. The departments involved are listed in the code in Table 3. The results of the analysis using from to chart show that the highest costs incurred in moving materials are from the preparation area which costs Rp. 5.099.639,00. Furthermore, inflow and outflow analysis is carried out to determine the priority of closeness between departments based on Table 4.

For inflow analysis of the priority scale table by prioritizing the largest to the smallest coefficient. While the outflow analysis of the priority scale by sorting the coefficients smallest to largest. The priority scale table for inflow and outflow for the production of digital baby scales is explained sequentially in Table 5. The results of the inflow and outflow analysis are used as a recommendation in proposing the latest layout for the production of digital baby scales.

Table 2. Total activity and digital baby scale production time

Type of Activity	Activity		Time (seconds)			Percentage
	Total Activity	**Activity Percentage**	**VA**	**NVA**	**NNVA**	
Operation	55	59%	21109	102	668	18%
Transportation	14	15%	15900	1290	327	14%
Inspection	13	14%	456	122	0	0%
Storage	6	6%	0	38692	0	32%
Delay	6	6%	0	43934	0	36%
Total	**94**		**37465**	**84140**	**995**	

Table 3. Department code

No	Area	Code
1	Material Warehouse	A
2	Preparation Area	B
3	SMD Area	C
4	Assembly Area	D
5	Quality Control Area	E
6	Packing Area	F
7	Finishgood Warehouse	G

Table 4. Inflow and outflow analysis of digital baby scales production

Inflow							
From	**A**	**B**	**C**	**D**	**E**	**F**	**G**
A		1.00	0.23				
B			0.77	0.98		0.82	
C				0.0201		0.1007	
D					1.00		
E						0.0749	
F							1.00
G							
Outflow							
From	**A**	**B**	**C**	**D**	**E**	**F**	**G**
A		0.97	0.03				
B			0.07	0.32		0.61	
C				0.080		0.92	
D					1.00		
E						1.00	
F							1.00
G							

Table 5. Priority Scale Table Analysis

Inflow					
No	Area	Code	Priority Scale		
			I	II	III
1	Material Warehouse	A	B	C	
2	Preparation Area	B	D	F	C
3	SMD Area	C	F	D	
4	Assembly Area	D	E		
5	Quality Control Area	E	F		
6	Packing Area	F	G		
7	Finishgood Warehouse	G			
Outflow					
No	Area	Code	Priority Scale		
			I	II	III
1	Material Warehouse	A	C	B	
2	Preparation Area	B	C	D	F
3	SMD Area	C	D	F	
4	Assembly Area	D	E		
5	Quality Control Area	E	F		
6	Packing Area	F	G		
7	Finishgood Warehouse	G			

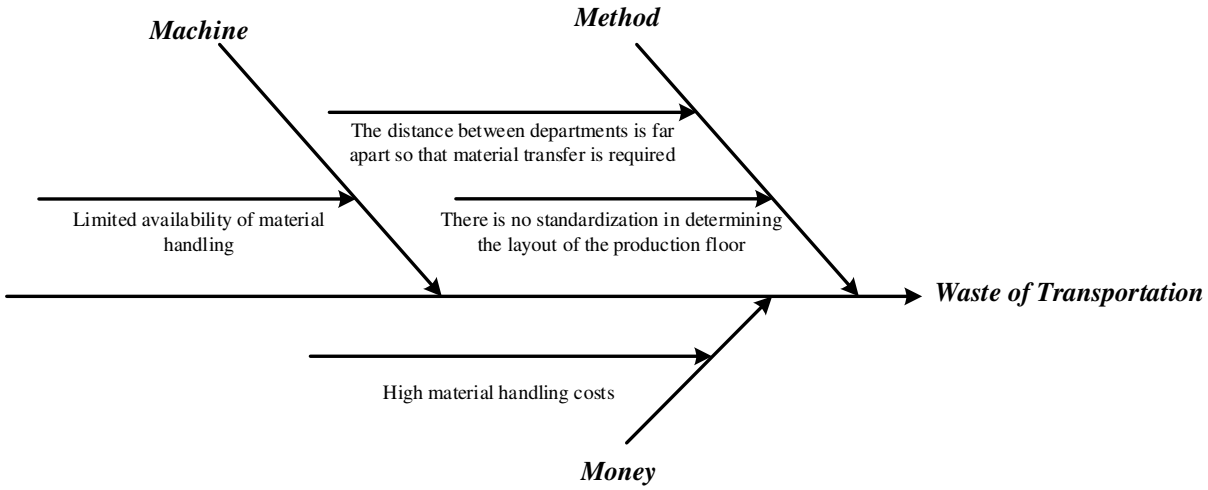


Figure 4. Waste of transportation

4.4. Improve

Identification of waste focuses on waste related to production floor layout analysis including waste of transportation based on Figure 4. Recommendations for improvements to each of the root causes of waste of transportation based on Table 6 include a review from the method side, stating that the distances between departments are far apart resulting in material transfers. Moving material over long distances can be concluded to be a waste because it will have an effect on increasing costs for material handling costs. In the review of the machine, it is stated that the limitation of material handling is the root cause of waste of transportation. And the last causal factor occurs on the money side which states that material handling transfer costs are categorized as high.

Table 6. Recommendations for Improvement of Waste of Transportation

Cause of Waste		Improvement Recommendations
Method	The distance between departments is far apart so that material transfer is required	1. Evaluate the layout for the production of digital baby scales that pay attention to OMH in each process 2. Pay attention to the closeness of each sub-process between lines
	There is no standardization in determining the production floor	1. Establish standardization of the layout for the production of digital baby scales
Money	High material handling costs	1. Evaluate the layout for the production of digital baby scales that pay attention to OMH in each process 2. Evaluate the long distances between lines
Machine	Limited availability of material handling	1. Doing budgeting for material handling requirements and requirements specifications by considering the distance traveled for each type of material handling

Table 7. Comparison of Total Material Moving Costs

No	From	To	Total Cost Before Improvement	Total Cost After Improvement
1	A	B	Rp. 4.220.991	Rp. 1.1455.970
2	A	C	Rp. 111.790	Rp. 83.705
3	B	C	Rp. 364.402	Rp. 344.525
4	B	D	Rp. 1.616.135	Rp. 526.183
5	B	F	Rp. 3.119.103	Rp. 1.110.189
6	C	D	Rp. 33.127	Rp. 33.127
7	C	F	Rp. 380.966	Rp. 82.819
8	D	E	Rp. 296.821	Rp. 67.459
9	E	F	Rp. 283.329	Rp. 67.459
10	F	G	Rp. 1.234.507	Rp. 863.480
Total			**Rp. 11.661.171**	**Rp. 4.324.918**

The recommended departments to be brought closer include the layout between the material warehouse and the preparation area, the preparation area and the assembly area, the SMD area and the packing area, the quality control area and the packing area, and the packing area and the finish good warehouse. In the proposed material handling flow, there are changes related to minimizing moving distances, effective utilization of assembly and packing rooms, as well as the proximity between the material warehouse area and the preparation area. While the packing area and calibration area become 1 with the assembly area to streamline the area of the assembly room. The latest recommendation for layout improvement shows a price reduction starting from Rp. 11.661.171,00 to Rp. 4.324.918,00. The decrease reached Rp. 7.336.253,00 without reducing the frequency of repetition of each process.

From the calculations, it was found that the VA activity on the Future State Value Stream Mapping increased from 31% for a total time of 37465 to 92% for a total of 36817 seconds. While the NVA value decreased, which initially reached 69% with a total time of 84140 reaching 8%. Thus, recommendations for improvements that take into account process and layout analysis can overcome the waste that occurs in the production of digital baby scales.

5. CONCLUSIONS

Based on the results of the analysis carried out, the conclusions obtained in this study are DMAIC modeling in the production process of digital baby scales includes the results of material handling analysis, it was found that the total cost of moving material for the production of digital baby scales is Rp. 11.661.171,00 with the highest cost of moving from the material warehouse area to the preparation area at a cost of Rp. 4.220.991,00.

The factors that cause waste in the production system of digital baby scales related to waste of transportation include Method: distance between departments are far apart, Money: high transfer costs, and Machine: limited material availability and recommendations for improvement have been able to reduce time wastage and increase value added from 31% to 92%.

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ALTERNATIVE INVESTMENT SCHEMES ON KRIAN-LEGUNDI-BUNDER-MASNYAR (KLBM) TOLL ROAD

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ABSTRACT

Toll road construction projects are infrastructure projects that are sensitive and vulnerable to risk and uncertainty. In addition, from a business perspective, toll road construction projects require very large capital outlays with long-term investment returns. Therefore, the decision on capital investment in toll road concessions is a very strategic decision that requires a comprehensive study and analysis, as well as rational and accurate considerations. This study aims to analyze the investment feasibility of the KLBM toll road, to determine what financing alternatives are the most profitable for the KLBM toll road project and to analyze the most profitable financing scheme.

The design of this research is mixed methods (mixed methods). The research subject is the 38.39 kilometers (km) Krian – Legundi – Bunder Manyar Toll Road Investment Project. owned by Waskita Bumi Wira (WBW). The data collection was carried out to obtain secondary data and primary data. Samples and respondent selection technique using purposive sampling method. Data analysis consists of identifying possible alternative investment schemes, which will then be carried out in each scheme a feasibility analysis through NPV and IRR indicators.. Determination of the financing scheme is carried out using qualitative analysis. Qualitative data were obtained from in-depth interviews and expert judgments about the best investment financing alternatives. The selection of financing schemes is done by calculating the NPV of each alternative according to the Decision Tree and scenario modeling, then calculating the probability to generate EMV.

The results of the research are expected to determine the investment feasibility of the KLBM toll road the most profitable alternative financing scheme for the KLBM toll road project investment.

Keywords: Investment, toll road and financing.

1. INTRODUCTION

Road infrastructure development aims to expedite the flow of distribution of goods and services, as well as play a role in improving the quality of life and human welfare. The construction of roads and bridges as transportation infrastructure refers to spatial planning, is integrated with the national transportation system (strands), meets road safety standards, and is environmentally sound. Road infrastructure development must also pay attention to three important aspects at once, namely economic, social, and environmental (pro-green) parts.

Infrastructure development supports the economic sector, including paid highways or toll roads. The benefits are used in the distribution of goods and services, as well as facilitating community mobilization activities to a place so that the construction of highways has an important role in increasing economic growth in a country.

The construction of toll roads is urgently needed because it looks at considerations of operating costs when vehicles stop, walk, or move at very low speeds due to the varied roles of roads, comfort, travel, and travel time (Berawi et al. 2019). So, movement actors think toll roads are very profitable because they can be a choice of road infrastructure apart from the existing main public roads.

The toll road development in Indonesia, both from the achievements and targets of toll road construction in 1978-2024, is explained in Figure 1.1 below.

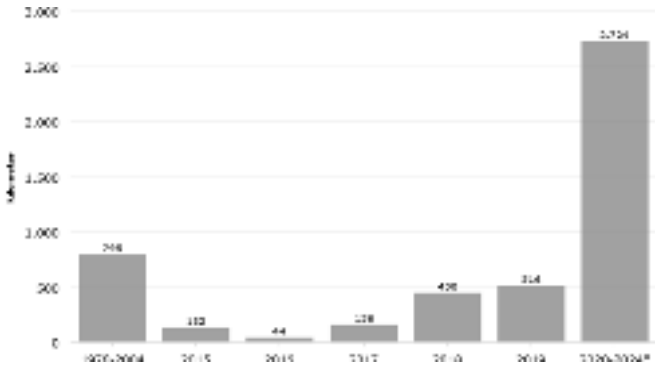


Figure 1.1. Achievements and Targets for Development of RI Toll Roads in 1978-2024
Source: Ministry of PUPR, 14 October 2020

Figure 1.1 explains that the Ministry of Public Works and Public Housing (PUPR) targets to build 4,817 kilometers (km) of toll roads throughout Indonesia in 2024.
In addition, the development of toll roads being built with the length of toll roads that will operate until October 2020 is explained in Figure 1.2 below.

Determination of the City of Surabaya and its surroundings as a National Strategic Area (KSN) as outlined in Government Regulation Number 26 of 2008 concerning RTRWN (Appendix X) from the point of view of economic interests in East Java, namely the Kertosusila Gate Area (Gresik, Bangkalan, Mojokerto, Surabaya, Sidoarjo, Lamongan) encourages acceleration in the provision of infrastructure, in this case, road infrastructure. One of the main areas is the Java Integrated Industrial Port Estate (JIIPE).

A toll road construction project is an infrastructure project with a sensitive character and is prone to risk and uncertainty. In addition, from a business perspective, toll road construction projects require considerable funds (high capital outlays) with a long-term investment return. Therefore, investing money in toll road concessions is a very strategic decision that requires comprehensive study and analysis and rational and accurate considerations. Such studies, research, and references are required from the initial project appraisal stage to where an investment decision will be made.

Toll road/BUJT investors with a BOT (built operate transfer) scheme experience problems obtaining maximum revenue with all risks during operation (concession period). Efforts to realize the business plan require funds to finance development. The involvement of the private sector or business entities in financing the construction of toll road infrastructure includes investing in the construction and operation of roads as well as management of toll tariffs for return on investment for the private sector. This involvement is bound by cooperation with the BOT (Build Operate Transfer) scheme. This BOT form of collaboration is carried out on toll road sections that are economically and financially feasible, with the government mechanism assisting in the form of land acquisition. At the same time, business or private entities are responsible for the toll road construction and maintenance phase. Revenue generated from the BOT scheme in toll tariff revenue is influenced by several uncertain factors, namely LHR growth, O & M costs, applicable taxes, and government regulations related to toll road operations.

In the Krian - Legundi - Bunder - Manyar Toll Road project, Waskita Bumi Wira (WBW) as the Toll Road Business Entity (BUJT) can carry out its duties during the concession period, namely, as long as the right to manage the toll road granted by the government is still valid. During the concession period, it is hoped that the BUJT will receive a return on investment funds and make a profit.

Previously, the BUJT usually conducted a financial feasibility study, where this study served to avoid overly significant investment for activities that turned out to be unprofitable. The KLBM toll road is one of the PPPs with the BOT scheme in which the investment tender contains VGF to work on the toll road section in Terbanggi (Lampung). The VGF is used to work on the 25 km-long Terbanggi toll road.

Based on the gap between toll road financing alternatives and empirical facts, it is necessary to conduct a study regarding toll road infrastructure financing schemes, which begins with an analysis of financial feasibility. Financial accounting is measured using the NPV and IRR indicators. Hartoyo and Utomo's (2020) NPV values are very sensitive to changes in investment costs. Aulia and Buana (2019) stated that a road feasibility study with NPV and IRR indicators was conducted to obtain economic and financial benefits. In this study, an analysis was also carried out for several alternative financing schemes considering the financial burden that must be borne by the BUJT and the financial risks that occur during the investment period.

2. LITERATURE REVIEW

2.1 Construction Industry

The construction industry is a construction work planning consulting service, construction work implementation services, and construction work supervision consulting services (Law of the Republic of Indonesia Number 2 of 2017 concerning Construction Services). From the above understanding, three parties are interested in this construction service: planning consultants, construction executors or contractors, and supervisory consultants.

Whereas what is meant by construction work according to Law of the Republic of Indonesia Number 2 of 2017 is the whole or part of a series of planning and implementation activities along with supervision which includes architectural, civil, mechanical, electrical, and environmental planning work respectively along with their accessories, for creating a building or other physical form. In this construction work, there is a service user or owner, an individual or entity whose business activities provide construction services.

2.2 Infrastructure Development

Infrastructure is the primary public infrastructure in supporting a country's economic activities, and the availability of infrastructure determines the efficiency and effectiveness of the economic activity. Infrastructure development is a Public Service Obligation, which should be the Government's obligation. The existence of infrastructure is crucial for development so that in the initial phase of development in a country, this will be entirely borne by the Government, which is funded from the pure APBN. A reasonably significant investment is required in fulfilling public infrastructure or facilities and returns on investment in a relatively long time. In addition, operational management also requires high costs. This problem is an obstacle for most developing countries in fulfilling infrastructure. However, the limited funding constraints from the Government can be resolved through a Public Private Partnership approach that benefits the parties involved in the collaboration.

The need for road infrastructure will continue to increase along with increasing ownership of motorized vehicles and a variety of community activities that are increasingly congested. Smooth traffic flow also helps the growth of an area. To support economic, social, and political growth between regions, meeting the need for adequate road infrastructure.

2.3 Toll Road

Toll roads are an alternative to existing public roads. A toll road section is a part or part of a specific road network where certain Business Entities operate it. The design of this toll road plan is higher than the existing public roads, which are intended to improve service, safety, and comfort for road users; besides that, toll roads must be able to serve long-distance traffic flows with high mobility. The design speed for inter-city toll roads is at least 80 kilometers per hour, and the lowest for toll roads in urban areas is 60 kilometers per hour.

2.4 Stakeholders and Toll Road Development Projects

Stakeholders in toll road development projects are almost the same as in other projects. Only the involvement of several parties is different because each project is unique and different. Stakeholders involved in the toll road construction project can be seen in the organizational structure, as shown in Figure 2.4 below.

Figure 2.4. Toll Road Project Organizational Structure
Source: Abednego and Ogunlana (2006)

Based on Figure 2.7, the relationship is different from the project organizational structure in general. Usually, the relationship between the owner, contractor, and supervisory consultant is described as a triangular relationship, where the owner oversees the contractor and supervisory consultant. At the same time, the supervisory consultant and contractor have the same or parallel positions.

2.5 Infrastructure Financing

Infrastructure is a physical system that provides transportation, irrigation, drainage, buildings, and other public facilities, which are needed to meet basic human needs, both social and economic needs. In this case, matters related to infrastructure cannot be separated from one another. Environmental systems can be connected because of the supporting infrastructure between the social and economic systems. The availability of infrastructure has an impact on the social system and financial system that exists in society. So infrastructure needs to be understood as the basis for making policies (Lamari et al., 2018)

Before the economic crisis, the need for investment in infrastructure was estimated at 6.8 percent of GDP to support the economic growth of 7 percent. At that time, the public sector, through the APBN development budget, could provide around 3.0 to 3.4 percent of GDP. This means that the private sector must cover the shortfall. Currently, the APBN's ability to provide funds for infrastructure has declined, only around 1-1.2 percent of GDP.

Therefore, the policy steps presented earlier, especially those that meet the needs of the sector and corporate restructuring and reform in the infrastructure sector, are strategic steps to create an attractive and conducive investment climate for increasing the participation of the business world and the private sector in infrastructure development. A clear regulatory framework or rules of the game will create lower risks for the private sector because there is

certainty and clarity in the procedures and mechanisms. Investment costs by the private sector are currently high due to high stakes, especially those involving long-term loans.

It was burdening risks, among others, regarding tariff adjustments and the obligation to produce service performance stipulated in the contract. If the government cannot provide guarantees (guarantees), this will likely result in a higher risk premium. A higher premium means a higher financial return to properly carry out debt service obligations. This will result in higher service rates which will burden consumers. As a result, only some infrastructure projects are financially viable.

2.6 Investment Feasibility

To determine whether or not an investment is feasible from a financial perspective, it is necessary to measure it using several criteria. Each assessment should be given a standard value for similar businesses by comparing it with industry averages or predetermined targets. Investments made in various fields of business (business) and, of course, require a certain amount of capital (money) and other skills. Means are used to financing a business, starting from pre-investment costs, investment costs in fixed assets, and working capital. To meet investment needs, money can be sought from various existing funding sources (Kasmir and Jakfar, 2003:95).

The source of funds sought can be chosen by using their capital or borrowed capital (foreign capital). Each piece of money depends on the purpose of using the capital, the period, and the amount desired by the company. Each capital has advantages and disadvantages. This can be seen in terms of cost, time, requirements to obtain it, and the amount that can be fulfilled.

The problem that needs attention related to capital acquisition is the payback period of capital within a certain period. This rate of return depends on the agreement and estimated profits from the future.

It is necessary to estimate income and costs before starting the business. All of this, of course, uses certain assumptions which will eventually be poured into the company's cash flow during the business period. By making the company's cash flow, then the feasibility of the investment is assessed through investment feasibility criteria.

2.7 Financing Investment Schme

The infrastructure financing scheme is part of the infrastructure financing system, which is an attempt to regulate how appropriate financing sources fund an infrastructure development project according to the characteristics of the project and its funding requirements. The purpose of creating an infrastructure project financing scheme is to find and determine the right source of funds for infrastructure project financing so that the continuity and smoothness of infrastructure project development can be guaranteed and the project can be completed on time as planned. To properly determine an infrastructure project financing scheme, it is necessary to know the characteristics of the project, the feasibility of the project, and the criteria and requirements for sources of funding. The suitable financing scheme can reduce the risk of the infrastructure project, both in terms of business risk and the risk of delays in project implementation.

2.8 Characteristic of Non-Governmental Financing Sources (PPP)

PPP is a collaboration between the government and Business Entities in the Provision of Infrastructure for the public interest by referring to the specifications previously set by the Minister/Head of Institution/Head of Region/State Owned Enterprise/Regional Owned Enterprise, which partially or wholly uses the resources of the Business Entity taking into account the distribution of risks among the parties**.**

Government Cooperation with Business Entities (PPP) is an activity that often occurs in Indonesia—chosen to do the PPP because there is a difference in funding or a funding gap that arises due to limited funds for infrastructure development. A PPP scheme was formed to avoid a funding gap, or what can also be called PPP, which stands for Public Private Partnership.

The new forms/schemes of PPP for government support include:

a. *Availability Payment* (AP)

Availability Payment (AP) has characteristics and financing requirements, such as implementing business entities that receive funds from the government regularly. Capital returns on investment to business entities do not come from user fees. Availability payment funds come from the government; if they are insufficient, they can be assisted through the Viability Gap Fund (VGF).

b. *Viability Gap Funding (VGF)*

Viability Gap Funding has characteristics and financing requirements such as the existence of a guarantee institution; The government provides feasibility support for part of the construction costs (funds come from the government, the remaining budget, and others). In this VGF, the private sector receives direct benefits from user fees.

2.9 Build Operate Transfer (BOT) Contracts

Build Operate Transfer (BOT) is a pattern of cooperation between landowners and investors who have capital/funds and then construct facilities (Build) (Riyanto, 2018). Investors get concessions to operate and collect results (Operate) within a particular time. After the accommodation is completed, the facility is returned to the Owner (Transfer). The difference lies in the concession period required for return on investment. So it needs a contract to build, operate, and restore the facility, commonly called a BOT contract or Concession contract. In a concession contract, it is preferable to include a construction period so that there is an incentive to accelerate development. In addition, it needs an operation & maintenance contract to guarantee the facility is returned to the owner in a condition that still has value.

BOT is one of the financing options for development projects in which investors must provide their capital or funding, including bearing the procurement of materials, equipment, and other services needed to complete the project. The investor has the right to operate and benefit from the project's economic development (management and operations) as a replacement for all costs incurred for a specific time (generally 25 years or more).

2.10 Uncertainty in Investment

In toll road project investment, it is difficult for investors to decide on the risks that will occur. The risk faced by investors in investment projects is more excellent than investment in current assets. This significant risk is not only due to a large amount of tied-up funds but also because of the long period needed to reap the benefits required to return the funds that have been invested (Siswanto, 2000).

The key to success in attracting investors in infrastructure investment, in this case, toll roads, which is long-term in nature, is proper risk allocation, in which the risk is borne by the party that can best control it. It should also be realized that the government still owns land and toll roads built by investors, while investors only get concession rights during the concession period, which ranges from 30-40 years. All assets invested by investors directly belong to the government from the first day it was built, so it is impossible to use them as collateral.

Before starting and deciding to invest in toll roads, investors must carry out a risk response planning process that aims to develop options and determine actions to get great opportunities and minimize threats to the target, namely toll road investing. In this way, investors carry out risk identification, define the impact and probability of risk, assess the ability to handle these risks, then finally determine the risk status.

3. METHODS

This study uses a mixed method, namely quantitative and qualitative. A qualitative approach is used to analyze the development of financing schemes and select investments with

BOT with concession or divestment periods. In addition, a qualitative approach is also used to analyze calculation indicators, as well as benchmarks for choosing alternatives and the probability of financing schemes.

The quantitative approach as a support is applied to the calculation analysis in determining cash flow until the end of the concession period. This cash flow model shows the present value of the annual payment (annual payment), which will be paid as the life cycle cost of infrastructure in toll road operations in cooperation through a PPP scheme.

The method used is to conduct library research and projections based on assumptions influenced by traffic growth, interest rates, etc. The selection of the financing scheme is carried out by calculating the NPV of each alternative. Each of these financing schemes will produce an NPV, the base model. Then from the base model, it will be developed into several scenarios and modeled using the Decision Tree and calculating the probabilities with EMV.

4. RESULTS

The research subject is the Krian - Legundi - Bunder - Manyar Toll Road Investment Project, with a length of 38.39 kilometres (km). owned by Waskita Bumi Wira (WBW). This activity will cover the analysis area of Sidoarjo Regency and Gresik Regency in particular and East Java Province in general as the surrounding area.

Variables, indicators and variable measurements in this study are explainedin **Table** 4.1

No	Variable	Indicator	Variable Measurement	Information
1	The cost of capital is a costcostthat should issued to fund somethinginvestmenttoll road projects in rupiah units	1. Construction costs 2. design fee 3. Supervision costs 4. Equipment costs 5. PPN 6. Financial costs 7. overhead costs	1. Cost of work or activity which based on on various components of toll road construction 2. Planning service fees 3. Management consulting fees constructionon developmenthighway construction 4. Cost whichrelated to the purchase of toll road project equipment. 5. Value of taxes issued on toll road projects. 6. The funds issued were relatedwith the financial affairs of toll road projects. 7. Additional expenditures that are not directly related to the toll road construction process.	Secondary Data
2	The annual fee is a fee which issued in the construction of toll roads issued	1. Cost tax Earth and building	1. Cost of multiplication of rates0.5% with NJKP (Selling Value hitTax), Whereas NJKPearned 20% of the NJOP.	Secondary Data

No	Variable	Indicator	Variable Measurement	Information
	periodically in one year.	2. Cost taxincome 3. Cost operation and maintenance 4. Cost depreciation	2. Costs incurred to pay income tax received in toll road projects. 3. Sacrifices that must be made so that the production process or toll road activities can continue to move 4. Costs incurred due to the use of fixed assets or fixed assets (fixed assets)	
3	Revenue is all income from toll road investment	1. Direct revenue from toll rates 2. Direct income from the managemen t of the rest area (rest area) 3. Revenue from advertising 4. Incomefrom bank interest	1. Income received from toll road tariffs in one year. 2. Income from the management of toll road rest areas. 3. Income from advertising sponsors from partner companies. 4. Income from bank investment interest	Secondar y Data
4	Probability is the chance of making a decision on an alternative that has its own risks	Percentage of opportunities for selecting alternative toll road investment schemes	Results of interviews/interviews with stakeholders regarding the opportunity to choose alternative toll road investment schemes	Primary data

Determination of alternative financing schemes is obtained using qualitative analysis, namely by conducting initial identification of existing alternative financing schemes for toll road investments and strengthened by in-depth interviews and expert judgment.

Table 4.2 Identification of Determination of Alternative Financing Schemes.

No	Aspect	Scheme			
		S-BOT (concession period)	S-BOT (divestment)	BOT	Construction Contract (D&B)
1	Responsibility for funding (BU/government)	-	-	-	-
2	Responsibility for Land Acquisition (BU/government)	-	-	-	-

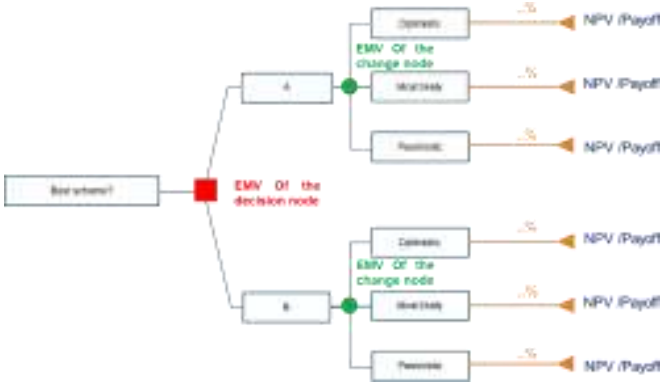
3	Responsibility for Design (BU /government)	-	-	-	-
4	Construction (BU/government)	-	-	-	-
5	O&M (BU/government)	-	-	-	-
6	Revenue (Toll Collection) (BU/government)	-	-	-	-
7	Investment Period (long/medium/short)	-	-	-	-
8	Capital (high/medium/low)	-	-	-	-
9	Uncertain Risk (yes/no)	-	-	-	-

From the results of the above identification it is possible to determine the appropriate financing scheme in terms of fulfillment aspects and advantages/benefits.

The results of structured interviews with informants will reinforce a basis for consideration in determining the financing scheme.

Decision Tree analysis is used to determine the probability of each alternative decision in toll road investment.

The design of the decision tree model can be seen in the following figure, where there will be 2-3 alternative financing schemes, each of which already has an NPV value in the optimistic, most likely and pessimistic scenarios in each scheme.



5. CONCLUSIONS

Based on The research results determine the investment feasibility of the KLBM toll road, the most profitable alternative financing scheme for the KLBM toll road project investment.

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FORMULATION OF A HUMAN RESOURCES FULFILLMENT STRATEGY IN ACCORDANCE WITH THE COMPANY'S BUSINESS STRATEGY

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ABSTRACT

The Development of the era requires a company to work efficiently, effectively and productively to compete and maintain its business. Therefore, companies need to optimize human resources, namely the workload efficiency of each employee. The workload can be seen from the activities carried out, the time to complete each task, etc. PT. X, located in Balikpapan City, is a company engaged in the construction, electrical and mechanical sectors. During 20 years of existence, PT. X realizes the need for a strategy to fulfil human resources aligned with the company's business strategy. The strategy for fulfilling human resources in this study will be formulated based on job analysis with descriptive analysis and mental workload analysis. The method used is NASA-TLX. The analysis results are then processed using the SWOT method to obtain a strategy for fulfilling human resources aligned with the company's strategy. The results of this study are the workload at PT. X average is high, and each aspect has its problems. Based on these problems, the time aspect has the highest workload value and the lowest performance aspect. The result of the SWOT analysis is the formulation of PT. X, fulfilling human resources in capacity and quantity to support its business strategy.

Keywords: workload, human resources, company strategy

1. INTRODUCTION

The era of development requires a company to work efficiently, effectively and productively to compete and maintain its business. Therefore companies need human resources both in terms of quality and quantity. Optimization of human resources needs to be done to achieve efficiency goals. The efficiency referred to in this is the workload of each employee. The workload of each employee can be seen from the activities carried out, the time to complete each task, and so on. If a job is done with a large number of workers, it's may create less/minimum workload to each workers and can burden the company from a financial standpoint.

PT. X, located in Balikpapan City, is a company engaged in the construction, electrical and mechanical sectors. PT. X has various divisions according to its line of business. However, the human resources in the field are not optimal because the number is not proportional to the tasks being carried out, so the company's targets cannot be achieved. According to Miner et al. (in Freddy Rangkuti, 1998), human resource planning is a plan that aims to maintain and improve the ability of the organization to achieve its goals through a strategy for developing the contribution of its workers in the future. That every company needs to carry out strategic planning to support the goals and strategic plans of the company, both short and long-term, so it is important for PT. X to develop

a strategy to fulfil human resources aligned with the company's business strategy and in accordance with current developments.

PT. X requires calculating workload based on job descriptions with existing conditions and requires human resource planning in accordance with the company's business plan in re-planning his business plan. This study aims to formulate a human resource planning strategy to support company development. The strategy for fulfilling human resources in this study will be formulated based on job analysis with descriptive analysis and mental workload analysis.

2. LITERATURE REVIEW

This research was conducted based on job and workload analysis. According to Sirait (2006), job analysis is a process for obtaining detailed information about the facts that occur that are needed to complete the tasks in a position. Job analysis is a decision-making process that translates task, human, and technological factors into a job design (Gibson, Ivancevich, and Donelly, 1993). The function of job analysis is to systematically collect data and make judgments about all the important information related to a particular job.

The workload is a term used to describe the effort required to meet job demands. The effort arises from the relationship between a job and its workers. The relationship between workload and performance depends on the worker's strategy for getting the job done, the extra effort to perform better, and various other environmental factors. According to Manuaba (2000), factors affecting workload are internal and external factors. Internal factors originate from within the body due to external workload reactions. In contrast, the external factors in question come from outside each individual. External factors that affect individuals such as physical tasks around the work environment and psychological influences.

The NASA Task Load Index (TLX) is the most widely used workload measurement method. This method was developed by Hart and Staveland (1988) by using six dimensions to measure workload. Quantitative measurement of the six dimensions is carried out by setting a scale from 0-100 with details as shown in Table 1. In addition, weighting is carried out on the level of relevance of each dimension to the job description. The six dimensions in detail consist of the following:

a. mental demands indicating how much thinking, deciding, or calculating activity is required to perform a task;
b. Physical demands indicating the amount and intensity of physical activity required to complete the task;
c. The temporal demands or the amount of time pressure used in completing the task;
d. effort, i.e. how hard a person has to work to maintain their level of performance;
e. performance that shows success in completing tasks; and
f. The frustration level indicates the degree to which a person feels during a task, for example, how insecure, hopeless, or secure.

Table 1. Workload Category

No.	Value Range *Weighted Workload*	Category
1.	0 – 9	Very low
2.	10 – 29	Low
3.	30 – 49	Moderate
4.	50 – 79	High
5.	80 – 100	Very High

Source: Simanjuntak (2010)

Every company can grow, develop, and compete in running a business to achieve a definite advantage by having a business strategy. According to Wheelen and David (in Maryani and

Chaniago, 2019), strategy is a goal taken before taking action and shows a shared understanding of the company's vision and mission. A company's business strategy is a deliberate choice about how it should carry out key activities that support its value chain to create unique value. In addition, it is the company's way of seeing its position with its competitors. The effectiveness of the business strategy depends on the opportunities and threats in the company's external environment and on the strengths and weaknesses derived from the company's resource portfolio. Therefore, companies need to choose a business strategy based on opportunities and threats from external companies and the company's internal strengths.

Analysis of company strategy can be done with a SWOT analysis. SWOT analysis is an assessment of the results of identifying a situation where the results of identifying the situation are categorized into strengths, weaknesses, opportunities or threats. This SWOT analysis can provide in-depth information about the company's internal conditions and external environment so that the company has an overview in making company decisions.

3. METHODS

This research uses qualitative and quantitative approaches (mixed method) in case studies on the four divisions of PT. X. The four divisions are the main business wheels of PT. X to achieve its targets. The divisions in question are the construction, electrical, mechanical, and human resource divisions.

The data used in this study are primary and secondary. Primary data collection was carried out by interviewing and using a questionnaire. At the same time, secondary data collection is done by collecting data, information, and related literature studies. Research respondents were selected using a purposive sampling technique, namely a sampling technique with certain considerations determined by the researchers themselves (Darmawan, 2013). The criteria for respondents in this study were employees who had worked for at least three years in one of the four selected divisions. This criterion is set because, with sufficient experience, the employee has felt the workload.

Table 2 is a research variable obtained from the results of a literature review, either from books or previous research. Job analysis data collected through questionnaires and interviews were processed using descriptive analysis methods in the form of tables. Workload analysis data is processed using the NASA-TLX method. Furthermore, determining the company's strategy, namely fulfilling human resources based on business strategy and developing the company's organization using SWOT analysis.

Table 2. Research Variabel

No	Aspect	Variabel	Source
1.	Job Analysis	Job Description	Suprapto (2011), Tanumiharjo (2013), Giyarto (2015), Sukwadi dan Oktevany (2016)
		Job Specifications	Giyarto (2015), Tanumiharjo (2013), Sukwadi dan Oktevany (2016)
2.	Workload Analysis	Time	Hart dan Staveland (1988), Anisa dan Prastawa (2012), Suryanto (2020), Mayasari dan Gustomo (2014)
		Mentally	Hart dan Staveland (1988), Rubio et al (2004)
		Phusical	Hart dan Staveland (1988), Teo et al (2019)
		Performance	Hart dan Staveland (1988), Rubio et al (2004)
		Effort	Hart dan Staveland (1988), Rubio et al (2004)
		Frustration	Hart dan Staveland (1988), Rubio et al (2004)

4. RESULTS

The results of the descriptive analysis of the data obtained for each variable in the job analysis indicators are presented in tabular form in Table 3.

Table 3. Job Description

No.	Job Type	Job Description	Job Specifications
1.	Team *leader* HVAC, *mechanical*, and *electrical*	1. Determine work plans and priorities 2. Evaluate the results of work (effectiveness, work methods, etc.) in maintenance activities for an equipment 3. Evaluate the occurrence of equipment damage (root causes, predictable or not, technical repairs, etc.) 4. Evaluate the relationship between personnel (technicians, technicians, assistant technicians or assistant technicians) in order to create a solid and harmonious work environment	1. Bachelor degree Mechanical Engneering/ Electrical Engneering, 3-year diploma Mechanical Engneering/ Electrical Engneering, 2. Have 5 years experience in their field 3. Have expertise certification in accordance with the field 4. Man 5. Be honest 6. Be responsible 7. Able to work under pressure
2.	Technician HVAC, *mechanical*, and*electrical*	1. Determine the equipment and materials needed in a job according to existing SOP 2. Carry out maintenance of equipment according to the existing SOP 3. Carry out repairs to damage to equipment according to the existing SOP 4. Remind the assistant technician in terms of safety in carrying out work. 5. Propose a review of the SOP if there is a safer, more precise, or more effective work implementation technique	1. 3-year diploma Mechanical Engneering/ Electrical Engneering, Vocational high School (Machine Department, automotive, or electrical) 2. Have 3 years experience in their field 3. Have expertise certification in accordance with the field 4. Have Central AC expertise (special for HVAC) 5. Man 6. Be honest 7. Be responsible 8. Able to work under pressure

Table 3. Job Description (Continue)

No.	Job Type	Job Description	Job Specifications
3.	Technician Assistant HVAC, *mechanical*, and *electrical*	1. Prepare the equipment and materials needed for a job according to the technician's direction 2. Help mobilize and demobilize equipment and materials needed in a job 3. Assist technicians in carrying out maintenance of an equipment 4. Help repair technicians to damage to an equipment 5. Remind technicians in terms of work safety	1. Vocational high School (Machine Department, automotive, or electrical) 2. Have 1 year experience in their field 3. Man 4. Be honest 5. Be responsible 6. Able to work under pressure
4.	HRD	1. Conduct employee assessments based on agreed KPI 2. Carry out job rotation 3. Conduct employee recruitment	1. Bachelor degree psychology /Master degree professional psychology 2. Have 2 year experience for Master degree professional psychology/ 2 year experience for Bachelor degree in psychology 3. Female/ Male 4. Be honest 5. Be responsible 6. Able to work under pressure
5.	Construction Technician	1. Make a drawing plan 2. Make a budget plan calculation 3. Perform structural analysis 4. Make Detailed Engineering Design (DED), concept design, 3D design 5. Make a schedule for the implementation of work	1. Bachelor degree civil Engineering/ Bachelor degree Architecture, Vocational high School at civil 2. Have 2 years experience in their field 3. Have expertise certification in accordance with the field 4. Has landscape capabilities 5. Male/ Female 6. Be honest 7. Be responsible 8. Able to work under pressure
4.	Administration	Make daily, weekly monthly reports of each activity carried out by each division	1. Senior High School/ Vocational high School All major technic 2. Have 1 years experience 3. Able to operate Microsoft Office properly 4. Able to communicate well 5. Female 6. Be Honest 7. Be responsible 8. Able to work under pressure

The NASA-TLX workload analysis method is used to determine the level of workload load. The workload level is calculated based on the weighted workload value of each employee; this value is the result of multiplying the weighted value of the workload analysis indicator with the workload rating felt by employees in each indicator. 11 employees filled in the questionnaire as respondents. Based on the results of the weighted workload calculation, it was found that the workload level of each respondent was found. The determination of workload level categories is based on the range of weighted workload values outlined in Table 1. A list of weighted workload values and workload levels is obtained in Table 4 below.

Table 4. Workload Analysis Scoring Results

Respondent	*Weighted Workload*						Total	Everage	Workload Category
	Times	Mental	Physical	Performance	Effort	Frustration			
1	255	152	364	96	160	0	1027	68,47	High
2	258	0	400	1	200	445	1304	86,93	Very high
3	279	279	0	15	285	77	935	62,33	High
4	500	83	180	24	285	0	1072	71,47	High
5	360	455	180	20	172	90	1277	85,13	Very high
6	200	364	180	56	288	0	1088	72,53	High
7	500	156	364	2	178	0	1200	80,00	Very high
8	100	500	400	2	300	0	1302	86,80	Very high
9	500	85	200	20	258	0	1063	70,87	High
10	285	90	200	50	360	0	985	65,67	High
11	388	76	285	78	243	76	1146	76,40	High
Total	3625	2240	2753	364	2729	688			
Everage	241,67	149,33	183,53	24,27	181,93	45,87			
Presentage	29%	18%	22%	3%	22%	6%			

Based on the calculation results, it is known that four respondents have a very high level of workload and seven respondents with a high level of workload, with the highest score of 86.93 and the lowest score of 62.33. Employees with a very high workload are from the mechanical and HVAC divisions due to the considerable time pressure in maintaining and checking equipment every day. Apart from that, some admins have to work on work reports from the mechanical division and work reports from other divisions. The employees who were the respondents represented all fields of work at PT. X, covering the fields of human resources, electrical, mechanical, HVAC, and construction.

The bottom three rows in Table 4 are comparisons between workload indicators. The calculation method is by adding up all the values from each aspect to obtain the total value. Then this value is divided by 15 and becomes the average value of the weighted workload. Based on the sum and percentage results for each aspect, it can be seen that the aspect that most influences the amount of mental workload at PT. For example, x is the aspect of time equal to 29%. The aspect of time has great value due to the limited time for maintenance and checking of equipment which is quite a lot for the mechanical and HVAC divisions. The construction division also needs more time to complete, from DED calculations to visualizing images in 3D. Meanwhile, the human resources division must conduct an assessment and conduct an assessment of employees. To overcome the problems in the aspect of time, it is necessary to plan activities at the beginning of the work in accordance with the order given. In addition, the company is preparing equipment that can make

work easier according to suggestions from employees and adding the number of employees or standby shifts that are focused on doing work caused by sudden equipment damage.

The physical and effort aspects are high because the work is carried out in the field, and the distance is quite far from one unit of equipment to another, so the efforts made to achieve the target of completing work must be extra for the mechanical and HVAC divisions. Jobs in the construction and human resources divisions deal more with computers, so they must try to have a high focus. So to overcome the problems that exist in the physical aspect of the mechanical and HVAC division, PT. X needs to increase the number of employees and add one shift for standby employees if there is additional work (outside the job desk) so that it does not interfere with the main shift. In addition, PT. X needs to make a job safety analysis and implement it properly because the job location is in difficult areas such as heights and adjacent to dangerous situations. In the construction division and human resources division, PT. X needs to add employees and divide the job desk properly for each employee so that there is no overlapping of work for certain employees.

To overcome the problems in aspects of effort in the mechanical and HVAC divisions, PT. X needs to add equipment that can facilitate technical and job security. In the construction division and human resources division, PT. X needs to make the office atmosphere more comfortable and add facilities to support work in terms of hardware and software. To overcome the problems that exist in the mental aspect of the mechanical and HVAC divisions, PT. X needs to gradually evaluate each problem and schedule regular meetings to find solutions together so that employees feel supported if there are difficulties at work. To overcome the problems that exist in the performance aspect, PT. X can evaluate every month by holding a sharing forum between employees so that employees can learn from each other to improve their performance. To overcome the problems that exist in the frustration aspect, PT. X can implement the awarding of bonuses based on performance targets. In addition, PT. X can raise wages and rotate employees periodically according to company needs. This solution is hoped to reduce employee stress because the company values their performance.

Then formulate a strategy for fulfilling human resources based on business strategy and development of the company's organization with a SWOT analysis. Finally, identification is carried out based on job analysis, workload analysis, and company strategy results. The following identifies strengths, weaknesses, opportunities, and threats.

a. Strengths (strength):

1. The company has attempted to adapt to the conditions of the COVID-19 pandemic by making strategic adjustments.
2. The company's efforts to avoid layoffs of employees.
3. New business plans and company promotion innovations in developing company scale.

b. Weaknesses (weaknesses):

1. The company's innovative strategy has not been supported by a job description that can answer the company's innovation needs.
2. There is no strategy to improve employee capabilities.
3. Innovation in the company's promotion strategy has not been supported by increased employee capacity.

c. Opportunities (opportunities):

1. There are employees with specifications above the minimum specifications for their positions.
2. Employees of PT. X can develop his abilities.

3. Almost all employees of PT. X assesses the performance and efforts made very well.

d. Threats (threats)

1. Workload of employees of PT. The X mean is in the high range.
2. Employee welfare satisfaction with the efficiency strategy implemented by the company.
3. Job Description: Most employees require physical activity, so there is a high risk of work accidents.

Based on SWOT identification, nine strategies for fulfilling human resources are obtained.

a. S-O strategy

1. The S-O strategy is a strategy that is analyzed by utilizing potential to seize opportunities or optimize strengths.
2. Implementing employee capability self-assessment in determining HR development requires a strategy.
3. Development of a strategy for determining employee incentives based on self-assessment of employee capabilities and performance appraisal results.

b. S-T Strategy

The S-T strategy is a strategy that utilizes the potential to deal with threats or utilizes the company's strengths to minimize the threats that will be faced.

1. Development of the company's business plan by prioritizing the division of labor according to employee capacity and employee capacity development.
2. Development of job safety analysis as part of the company's strategy in ensuring workplace safety.
3. Implementation of Key Performance Indicator (KPI) reviews and work assessments regularly.

c.W-O strategy

The W-O strategy is a strategy that seeks to overcome weaknesses by seizing existing opportunities.

1. Development of job descriptions needed to support the implementation of the company's strategy.
2. Development of company HR capacity through Training for Trainers (ToT) and knowledge sharing.

d. W-T Strategy

The W-T strategy is a strategy that tries to minimize weaknesses to overcome the threats that will be faced.

1. Increasing human resources' capacity to increase employees' capacity and ability to support the implementation of innovation and company strategy.
2. Increasing the number of employees to reduce the high workload and answer the company's strategy.

The results of the HR fulfilment analysis are not only quantity fulfilment but also quality fulfilment and capacity to support the company's business strategy. The strategies found are aligned with the company's strategy with the following groupings.

a. Doing risk management.

Development of job safety analysis as part of the company's strategy for ensuring worker safety.

b. New business plan.
1. Development of the company's Business Plan by prioritizing the division of labor according to employee capacity and employee capacity development.
2. Development of job descriptions needed to support the implementation of corporate strategy.
c. HR management and optimizing costs.
1. Development of company HR capacity through Training for Trainers (ToT) and knowledge sharing.
2. Increasing the number of employees to reduce the high workload and answer the company's strategy.
3. Implementing employee capability self-assessment in determining HR development requires a strategy.
4. Implementation of Key Performance Indicator (KPI) reviews and work assessments regularly.
5. Development of a strategy for determining employee incentives based on self-assessment of employee capabilities and performance appraisal results.

d. Respect and strengthen relationships with customers.
No strategy can answer the company's strategy related to the relationship between the company and the customer.

e. Do promotions.
HR capacity building to increase employee capacity and ability to support the implementation of innovation and company strategy.

f. Do creative marketing methods.
HR capacity building to increase employee capacity and ability to support the implementation of innovation and company strategy.

g. Manage business finances well.
There is no strategy to answer the company's strategy regarding managing the company's business finances properly.

After grouping the SWOT analysis strategies based on the seven company strategies, five strategies were answered, and two strategies were not answered. The cause of the missed two strategies is that no SWOT analysis results are related to the company's strategy.

5. CONCLUSIONS

The conclusion obtained from the results of this research analysis is the workload at PT. X average is high, and each aspect has its problems. The time aspect has the highest workload value and the lowest performance aspect. Then the results of the SWOT analysis are that there are nine HR fulfilment strategies which are then aligned with the company's strategy. The result is that the HR fulfilment strategy can answer five of the seven corporate strategies: risk management, new business plans, HR management and optimizing costs, promotions, and implementing creative marketing methods. Two unanswered corporate strategies are respecting and strengthening customer relationships and managing business finances well.

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RE-PLANNING OF QUALITY CONTROL SYSTEM TO RESPOND CUSTOMER REQUIREMENTS CHANGES

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ABSTRACT

Customer needs have changed over time. In the past, the function is the only quality that customer requires. Now, nonfunction or aesthetics like hardness, bad printing, bad plastic color, and inappropriate outer pack become one of the quality criteria for the customer. So, nonfunction or aesthetics will add to the criteria of quality control. This research aims to re-plan the quality control system to counter the change in customer needs. The plan for the quality control system adopts Quality Functional Deployment Method and Acceptance Sampling Plan. This research started by identifying voice of customer and deploying it in House of Quality. Using Focus Group Discussion, we identify criteria like the color of plastic bags, the outer pack color, and the packaging product that will add quality control characteristics. Rearrange the quality control mechanism by making a new check sheet and sampling method. Sampling Plan Method is determined by applying Military Standard 105 E and Single Sampling Method. This rearrangement will standardize by making Work Instructions for incoming material, quality control, setting the printing process, and Standard Operating Procedure of quality control. This standardization can use as a reference for the quality control division and management.

Keywords: planning, quality functional deployment, quality control, sample, work instruction

1. INTRODUCTION

Maqtari (2014), Plastics are a polymer compound developed in 1970 and have gained acceptance among buyers and sellers. Spokas (2007) reported that humans had used 500 billion plastic bags because plastics have unique features like versatility, affordability, availability, and minimal cost. Ruban (2012) stated that plastics have many functions in daily life, such as packaging products, wrapping food, packaging materials, carrying goods, and covering technical equipment and cables. Joshua (2020) reported the prevalent uses of polyethylene bags in various supermarkets and shop outlets, food items, commodities, etcetera.

A plastic bag company in the Jombang district has produced recycled plastic bags since 2016. Since the first operation of this company, the management has run quality control, which

only focuses on product performance. Basterfield (2013) stated that *Quality control* is the use of techniques and activities to achieve and sustain the quality of a product or service. This company has a mass production system with customization based on demand and for inventory stock, with ± 250 types of products. Traditional, modern, and industrial markets are three types of customers. Traditional markets are the largest consumers, with 68.25% of shipments. Modern markets are 30.59%, and industrial market consumers are 1.14%. Traditional market consumers consist of plastic shops, warehouses, distributors, and retailers with a minimum purchase of 5 tons. Modern markets include minimarkets, supermarkets, franchise beverage products, franchise food products, beauty clinics, stationery, office shops, and clothing stores. The modern market usually requests a unique design printed on plastic bags. At the same time, the industrial market is an order from other companies for its production process.

The plastic bag company received many complaints in the last two years. Based on company reports, 17.86% indicated complaints regarding functional aspects, and 83.14% indicated complaints regarding non-functional aspects. 60.4% of complaints came from modern market consumers and the others from traditional markets. The complaints prove that the modern market also requires an attractive display of products to retain customers besides the function of products. Complaints about the nonfunction aspect accompanied by product returns requiring rework and sorting. According to the company's waste database, the results of sorting products return at least 50% to be waste. Thus, even though the second-largest market dominates non-functional complaints, quality improvements still need to be made so as not to cause losses to the company. The functional aspect describes the strength of the plastic bags, and the nonfunction aspect relates to the appearance of the plastic bag product. Montgomery (2013) described how a product performs certain specific functions and determines how well it performs, called performance in the quality dimension. Moreover, In the quality of plastics bag, this performance is similar to the function aspect. Montgomery (2013), The non-functional aspect describes one of the dimensions of quality, namely aesthetics, which shows the product's visual appeal and considers some factors such as style, color, shape, alternative packaging, touch characteristics, and other sensory features.

Based on changes in customer desires regarding the non-functional quality of plastic bag products, need replanning quality control to suit consumer desires. Considering the high number of complaints and returns from modern markets, which impact waste, the plan must do carefully. Planning is a process for determining the goals and objectives and strategic actions to obtain these goals (Amirullah & Budiyono, 2004). So, this study aims to rearrange the quality control system to respond to the changes in customer desires at a plastic company in Jombang. This planning includes planning for non-functional quality characteristics based on consumer wants using quality functional deployment. Determining quality characteristics to be controlled in the incoming material and production process, planning inspection mechanisms to be carried out, and standardizing inspection mechanisms by made work instructions.

2. LITERATURE REVIEW

This section consists of some literature review used in this research

2.1 Dimensi of Quality

Describing and evaluating a product's quality can be done in several ways, so need the correct definition to differentiate the different dimensions of quality. Garvin (1987) discusses eight components or dimensions of quality: performance, reliability, durability, serviceability, aesthetics, features, perceived quality, and conformance. Performance describes how a product will perform certain specific functions and determine how well it satisfies consumers. Moreover,

aesthetics describes how the product looks. The product's appearance, such as style, color, shape, packaging alternatives, tactile characteristics, and other sensory features, becomes very important to differentiate the product from competitors.

2.2 Acceptance Sampling by Attribute

Acceptance sampling by attribute design for attribute data types. Namely, data resulted from observations of the conformity of quality characteristics to predetermined specifications. There are various retrieval techniques, one of which is the military standard 105 E. Military standard 105 E or MIL STD 105 E has three inspection properties: normal inspection, tightened inspection, and reduced inspection. Mil standard 105 E main focus is the acceptable quality level / AQL. The steps used in MIL implementation STD 105E are as follows:

1. Determine AQL (Acceptable Quality Level).
2. Determine the level of inspection (Special I, Special II, Special III, Special IV, General I, General II, or General III).
3. Determine the lot size (N).
4. Determine the letter code corresponding to the level inspection selected (2nd step) and lot size (step 3) using the code letters table.
5. Determine the type of sampling (single, double, or multiple sampling plans) and the nature of the examination (reduced, normal, or tightened).
6. Finding the sample size (n), acceptance number (c), and the corresponding rejection number (Re) in the MIL-STD table 105E based on letter code (4th step) and properties examination to be used (step 5).
7. Application of sampling design on inspection based on the number of products that are defective/not according to specifications (d), acceptance number (c), and rejection (Re).

2.3 Check sheet As Tools of Statistical Process Control

This research uses a check sheet. Montgomery (2013), the primary purpose of check sheets is to ensure that data are collected carefully and accurately by operating personnel for process control and problem-solving. Data should have been present so that it can be quickly, easily used, and analyzed. When designing a check sheet, it is important to specify the type of data to be collected, the part or operation number, the date, the analyst, and any other valuable information in diagnosing the cause of poor performance. If the check sheet is the basis for further calculations or a worksheet for data entry into a computer, then it is crucial to ensure that it will be adequate for this purpose. Sometimes, a trial run to validate the check sheet layout and design may be helpful.

2.4 Quality Function Deployment

Quality Function Deployment is a systematic method for carrying out product design and development according to the criteria required by customers and for structured evaluation of the capabilities of a product or service in meeting customer desires. The purpose of making QFD is to meet customer expectations and exceed customer expectations as a form of competition with similar companies. The main point of QFD is the interests and desires of customers, so it is necessary to translate customer desires into corrective actions by utilizing specific quality characteristics. Making a QFD is identical to the stages of collecting Voice of Customer (VOC) and making a House of Quality (HOQ). The HOQ describes customers' overall needs and expectations and the ways to meet those needs and expectations. HOQ chart consists of several rooms, including customer needs and benefits, the planning matrix, technical response, relationship, and technical matrix.

2.5 Work Instruction and Standard Operating Procedure

ISO 9001 (2015) defines work instruction as a more detailed part of a procedure that describes how to complete a task. Using work instructions can provide precise details about how

to carry out and what needs must exist in carrying out a task to achieve the final goal. Work instructions will display the sequence of steps or flows that must do to complete a task. The format of work instructions can be visual but also text, sometimes requiring hyperlinks to lead to a more detailed step. Work instructions or work instructions will attach to the procedural process document.

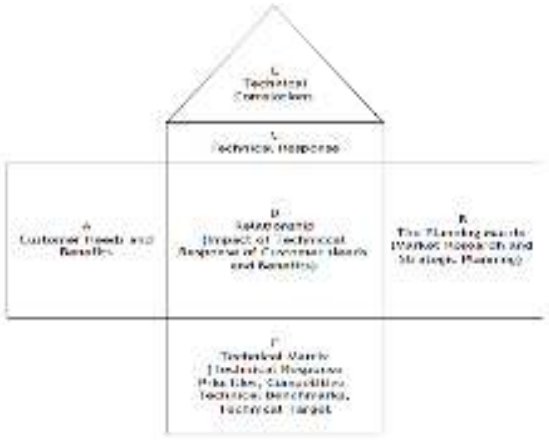

Figure 1. House of Quality

Standard Operating Procedures (SOP) makes guidance for repetitive activities. SOP is a standard guide for the implementation of an action. The SOP provides a detailed explanation of how an activity must do or a policy must implement. The purpose of making a Standard Operating Procedure (SOP) is to become a framework for a task carried out in an organization, for written documentation, to explain who, what, how, when, and why an activity must do, and provide a basic guideline for job descriptions, activities corrective, work discipline and performance appraisal. Making SOP takes criteria and format for document standardization. No regulations regarding the length or shortness of SOP make it easy for an organization to make SOPs according to needs. A concise SOP will make it easier for users. In preparing SOP, attention must be clear, structured, and detailed.

3. METHODS

The data used in this research is secondary data, which takes from inspection data and complaint data collected by the quality control division, period 2021 to 2022. This plan aims to provide a general quality control plan for all plastic bags. First, questionnaires form using google form. Questionnaires are distributed to some customers-based regions and from group discussions with the production team. Nonfunction aspects of plastics bag or aesthetic dimensions become the primary variable asked in the questionnaire. These questionnaires help the company to know the voice of customers about plastic bags from their company and other company that translated to the value of the degree of customer importance and customer satisfaction performance.

The collected data from questionnaires tested the validity and reliability. Valid and reliable data is vital to make the house of quality with six rooms. Data from questionnaires as customer requirement in the house of quality. For planning matrix, technical response, relationship to technical matrix created and filled based forum group discussion with production and marketing team. The technical response will continue to become improvement process control for quality control. The improvement process control will be a plan by making a new check sheet and

acceptance sampling. Then standardize this procedure by making work instructions and standard operating procedures.

So, the gap analysis in this study compared to other studies which use the QFD method is the continued control of the house of quality results and the resulting managerial impact. Without continuous control of the house of quality results, the voice of the customer regarding the addition of non-functional aspects as one of the quality criteria for plastic bags will apply to all parts of production.

In this study, the house of quality resulted in some technical responses that will control continuously by creating a new checksheet. Therefore, the applicable standard operating procedures and additional work instructions will be revised. From the company's management point of view, making proposals for changing appropriate standard operating procedures and adding work instructions will assist management in providing information and uniforming the stages of employees in completing work. Moreover, the quality control objectives of QFD results can achieve quickly and produce changes correct to management's expectations.

4. RESULTS

4.1 Quality Functional Deployment

From distributing questionnaires using a google form, thirty customers were identified based on market region. There are nine customers' voices about the aesthetic product, which specified the packaging of the plastic bag, and the color of the plastic bag. All collected data from questionnaires were tested for validity and reliability by using SPSS software. In this study, the r table at a significance value of 0.05 and a degree of freedom of 28 is 3.61. From the results of the validity test, all questions meet the validity test because the significance value of each question is less than 0.05 and more than the R table. For the reliability test, classify to be reliable if the Cronbach's Alpha value is more than 0.7; the result was 0.774 and declared reliable.

The voices of customers consist of nine problems. Customers' voices are about roughness, smell, porous print, and the unstable color of the plastic bag. And the other Customers' voices are about The color of the plastic transfers to the hand, the print from the outer pack falling off quickly, the size of the outer pack do not match, the seal of the outer pack being easy to open, and lousy method of tying as. The voice of the customer translated to become the degree of customer importance and customer satisfaction performance, shown in Table 1.

Table 1. Data for customer needs and matrix planning house of quality

Voice of Customer	Degree of customer importance	Customer satisfaction performance	Customer satisfaction performance (Competitor 1)	Customer satisfaction performance (Competitor 2)
Plastic roughness	4	3,83	3,7	4,2
The smell of plastics bag	4,5	4,27	4,33	4,37
Porous print	4,1	4,17	4	4,13
Unstable color of plastics bag	3,97	3,67	3,67	3,83
The color of the plastic transfers to the hand	3,93	3,57	3,5	3,7
The print from the outer pack falls off easily	3,9	3,6	3,63	3,57
The size of the outer packaging does not match	3,67	3,63	3,6	3,7
The seal of the outer pack is easy to open	4.07	4,03	3,83	4,07
Lousy method of tying when packaging product	4,1	4,07	3,87	4,0

Customer requirements statement data must be translated into technical data by the company or, in other words, how the company responds to customer needs through determining technical parameters, shown in Table 2.

Table 2. List of Technical Response

Voice of Customer	Technical Response
Plastic roughness	Choose clean pellets
	Choose solid pellets
The smell of plastics bag	Choose odorless pellets
Porous print	Setting the ink-drying temperature
	Setting ink viscosity
Unstable color of plastics bag	Recomposite the masterbatch percentage for each ingredient composition
The color of the plastic transfers to the hand	Choose colored pellets with good density
The print from the outer pack falls off easily	Adjust the degree of inclination of a doctor's blade.
	Added additive ink thinner
The size of the outer pack does not match.	Make the size of the outer pack bigger than the size of the plastic
The seal of the outer pack is easy to open	Cleaning the welding machine seal area of dirt
Lousy method of tying when packaging product	Make standard sizes of raffia and how to tie raffia.

Figure 2 is the result of the forum group discussion to complete all sections in house quality, from technical correlation, relationship, and the technical matrix.

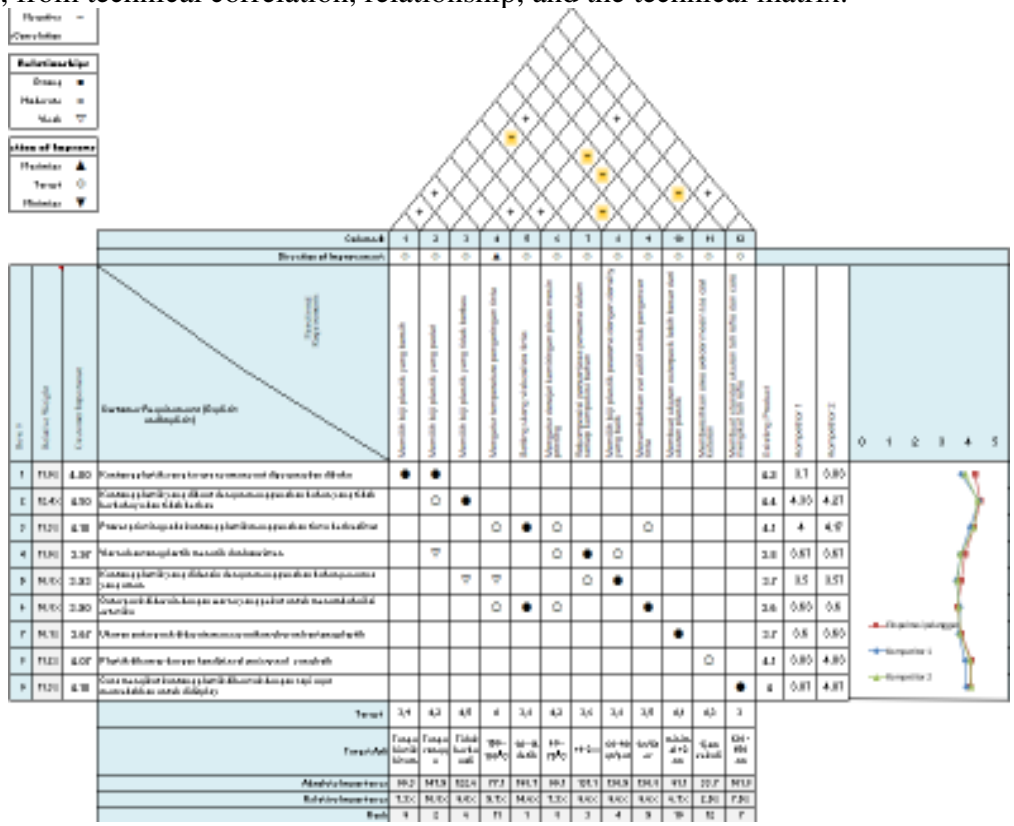

Figure 2. House of Quality

4.2 Analysis and Quality Control Planning

Identify related processes from all technical responses resulting from QFD, shown in Table 3. This table shows some processes that will improve by making a new check sheet for improved process control to respond to the customer change about aesthetic products.

Table 3. Identification of Quality Characteristics, Technical Response, and Related Processes

Voice Of Customer	Technical Response	Related Process
Plastic roughness	Choose clean pellets	Incoming process
	Choose solid pellets	Incoming process
The smell of plastics bag	Choose odorless pellets	Incoming process
Porous print	Setting the ink-drying temperature	Printing process, Blowing process
	Setting ink viscosity	Printing process, Blowing process
Unstable color of plastics bag	Recomposite the masterbatch percentage for each ingredient composition	Blowing process
The color of the plastic transfers to the hand	Choose colored pellets with good density	Incoming process
The print from the outer pack falls off easily	Adjust the degree of inclination of a doctor's blade	Printing process
	Added additive ink thinner	
The size of the outer pack does not match.	Make the size of the outer pack bigger than the size of the plastic	Printing process
The seal of the outer pack is easy to open	Cleaning the welding machine seal area of dirt	Cutting process, Incoming packing process from Subcon
Lousy method of tying when packaging product	Make standard sizes of raffia and how to tie raffia	Cutting process, Incoming packing process from Subcon

Figure 3. New Check Sheet

From identifying related processes, a quality control mechanism planning will do with planning a new check sheet and the number of samples and acceptance procedures for inspection. Moreover, in the incoming section, adding quality control on odor, color, cleanliness, and density of plastic pellets will apply to a new check sheet. For the extruder process, add quality control to the color of the plastic bag. The printing process adds quality control to image solidity and

adhesion in the Cutting and Incoming packing process from Subcon quality control on the size of the outer pack, welding or sealing the outer pack, and the length of the raffia rope. All of these quality control additions can see in Figure 3.

For the standard of acceptance of samples from several added quality controls, it will use the military standard 105 E sampling acceptance, using a level III general inspection level with a single sampling type and an AQL at 4 for pellets. The planning for receiving defective products in sack form will use the Military Standard 105 E, general inspection level II with single sampling type and agreed on AQL of 4. For planning acceptance of products in pack form using general inspection level I with sampling type singles and an agreed AQL at 4.

Figure 4. Using table military standard 105 E for pellets inspection

Work instructions will describe the manner or sequence and the need or tools to carry out the identified technical response. Three work instructions will be created for incoming, quality control checking, and work instructions or production guidelines for the printing process. There is a new recommendation for Standard Operating Procedures and work instructions for the quality control division by adding product aesthetics to the quality control process.

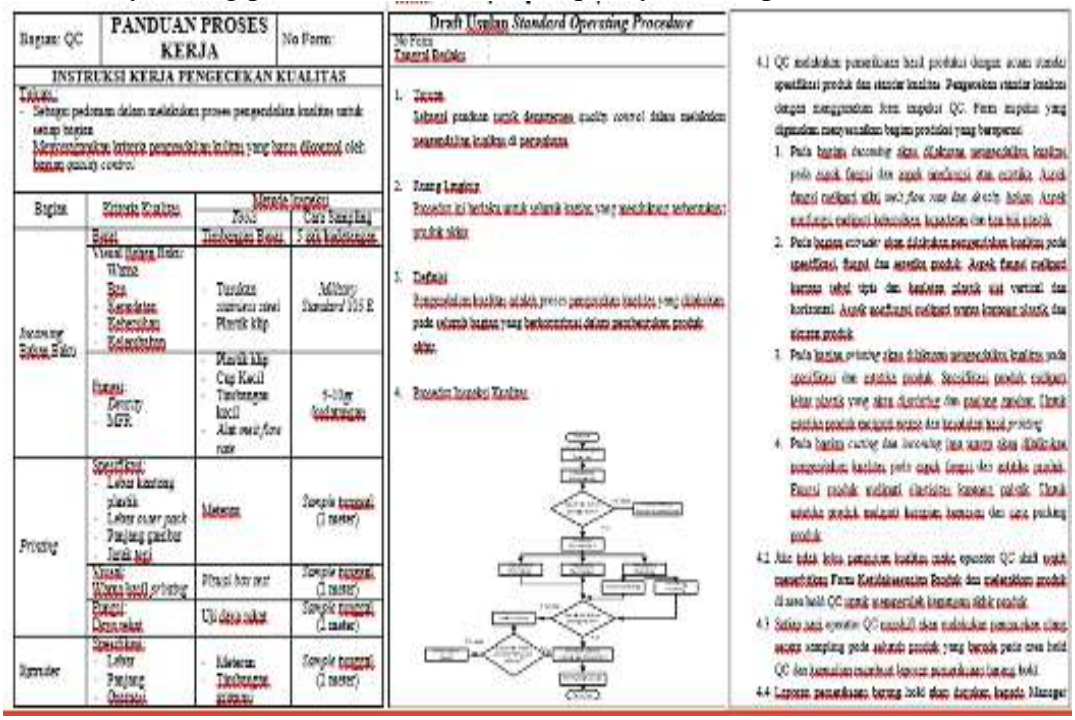

Figure 5. Work instruction and SOP for quality control

6. CONCLUSIONS

Five relevant divisions identify from identifying quality characteristics: the incoming division and the production division, which includes the extruder division, the printing division, the Cutting division, and the Incoming packing process from the Subcon. The incoming and production division added additional aesthetic aspects to quality control activities. The incoming division added quality characteristics in the form of cleanliness, density, and odor of plastic pellets. The production section added quality characteristics such as the color of the plastic bag, the color of the printing, the method of tying, and the tidiness of the product packaging. Adding these quality criteria will create a new check sheet and standardize it through work instructions and standard operating procedures.

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DEVELOPMENT OF MICROSERVICES ARCHITECTURE MODEL IN XYZ HIGHER EDUCATION BY UTILIZING THE DOMAIN DRIVEN DESIGN METHOD IN DETERMINING THE IMPLEMENTED SERVICES LIST

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ABSTRACT

Information systems have become essential today, and because organizations need to develop information systems rapidly, monolithic architecture has become the first choice. However, the monolithic architecture has some flaws, and the most critical flaw is system stalling due to high user traffic. These weaknesses eventually made developers start switching to information systems with microservices architecture. But moving to a microservices architecture contains high complexity, which needs to break down the processes in the monolithic architecture into smaller, independent processes called services. This research was conducted based on existing business processes at an XYZ university that still uses information systems with monolithic architecture and wants to switch to microservices architecture. To help XYZ University, the Domain Driven Design (DDD) method was chosen because this method can describe the service that will be made closer to the actual university business process. Through the information system created with the microservices architecture model from the results of this study, it is hoped that it can increase the reliability and scalability of the XYZ college information system when providing services to users in small numbers or large numbers of users at once.

Keywords: Microservices, Monolithic, Domain Driven Design, DDD, Higher Education.

1. INTRODUCTION

Monolithic architecture is still the leading choice in developing higher education information systems because of the ease and speed of development. But because more and more administrative and academic processes are using information systems, the monolithic architecture is starting to experience difficulties in serving significant user traffic simultaneously. This difficulty is caused by one of the weaknesses of the monolithic architecture, which has limitations in increasing the hardware capacity of the server or so-called vertical scaling. From that weakness arises the microservices architecture with its ability to scale horizontally(Yan et al., 2021) which increases resource requirements by adding some servers.

But changing the monolithic architecture to microservices is not an easy process and has high complexity because the microservices architecture needs to break all processes in the monolithic architecture into smaller and independent processes called services. The Domain Driven Design (DDD) method has been chosen as a strategy to address difficulties in breaking down

applications into microservices(Waseem et al., 2021). Domain Driven Design (DDD) is a model-based methodology that captures knowledge from domain experts and turns it into information system design (Rademacher et al., 2018)so that the information system created can follow the actual business processes that occur.

To test the capabilities of the microservices architecture, the Domain Driven Design (DDD) method was used to change the monolithic architecture of the XYZ academic information system. The list of services generated from Domain Driven Design (DDD) is then implemented and tested with existing monolithic information systems. So, the result then can approve that the microservices architecture can help XYZ college get a reliable information system to serve users, especially students in large numbers simultaneously.

2. LITERATURE REVIEW

2.1. Monolithic Architecture

Monolithic architecture is widely used to develop information systems, consisting of a User Interface (UI), Business logic, and Data access layer, which are packaged together in one application so that each function is very tightly integrated(Cen et al., 2022). Monolithic architecture is inefficient because when only a few services need to be scaled, all services must be scaled simultaneously (Karabey Aksakalli et al., 2021). An approach with a monolithic architecture is more suitable if:

1. The number of group members is small.
2. The program code is relatively small and will remain that way for many years to come.
3. Group members work nearby for accessible communication.

But of all these conditions, domain complexity is the most influential in determining whether a monolithic architecture is suitable (Kalske et al., 2018).

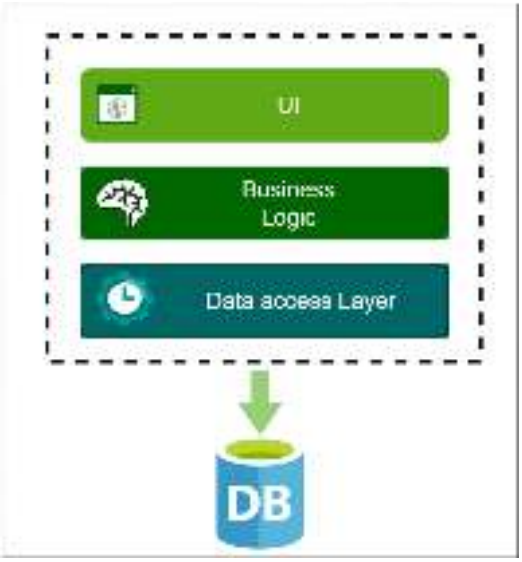

Figure 1 Monolithic Architecture

2.2. Microservices Architecture

In contrast to monolithic architectures, where all functions for various business processes are packaged in one application with strong attachments, information systems with microservices architecture break down large systems into smaller units to provide better modularity(Karabey

Aksakalli et al., 2021). The small units in microservices are commonly referred to as services, where each service handles only one part of the information system and each of these services also communicates with each other between one service and another (Elyyani et al., 2022)

The microservices architecture has characteristics that distinguish it from monolithic architecture; the main characteristics of the microservices architecture are:

1. Small where one service to run one business capability.
2. Autonomous where one unit that is run contains all the data needed to run independently.

These characteristics make microservices more resistant to errors or failures, more scalable, and more flexible than monolithic architectures (Waseem et al., 2021).

The microservice architecture implements a communication method with a lightweight mechanism to communicate with each other between one service and another. RESTful API (Lewis and Fowler, 2014) is a type of communication widely used because known by various types of program languages with different platforms, faster because it's simple, and because RESTful APIs are simple, they're easy to learn.

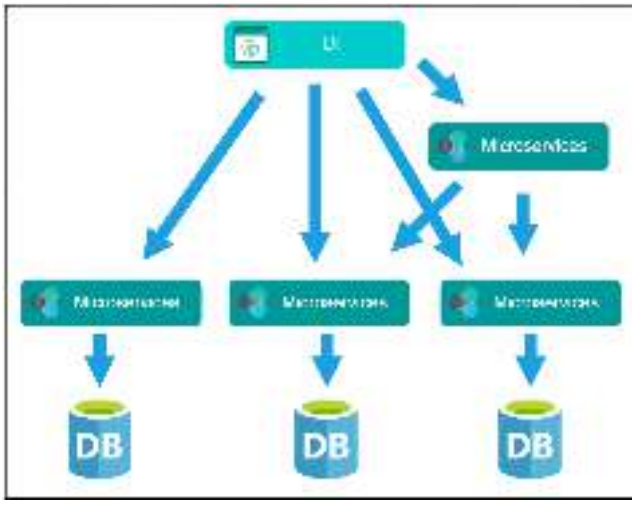

Figure 2 Microservices Architecture

2.3. Domain Driven Design (DDD)

In 2003, a software designer named Eric Evans introduced a method or approach for developing complex information systems by focusing on business regardless of the technology used, called Domain Driven Design (DDD) (Evans, 2004). The development of information systems using the DDD method changes programmers' perspective to see applications from the top of the domain perspective (Farsi et al., 2021) so that the creation of information systems can be integrated because connections between domains of business processes can be seen clearly.

In practice, DDD development is divided into two stages of the design model, namely strategic design and tactical design, where strategic design is a more strategic approach that is taken to see the domain or subdomain of business processes directly. Tactical design is a stage that is closer to the domain or subdomain programming process. The strategic design has several components like ubiquitous language, bounded context, context map, shared kernel, continuous integration, customer/supplier teams, conformist, open host service, published language, separate ways, and anti-corruption layer. Whereas Tactical design itself consists of several components commonly used in programming languages, such as value objects, services, entities, repositories, and factories (Petter Holmström, 2020).

3. METHODS

By the Domain Driven Design (DDD) method, the research started by collecting data on the academic processes of XYZ college by looking at existing monolithic information systems and interviewing domain experts to get the flow of academic business processes. The process continues with strategic design by establishing a ubiquitous language to determine the important words used by the domain expert, then proceed to the boundary context to find service candidates and the context map to show the relationship between one boundary context and another.

After the strategic design, the process continues to tactical design to change the results of the process from strategic design to a model more suitable for programming. The tactical design process starts with determining the entity that will be used as a database model. After deciding the entity, tactical design defines a value object as an object that does not have a unique identity but is usually used to describe the context of the entity. The tactical design also determines an aggregate root as an entity that is a reference for other aggregated objects. The aggregate root obtained will be the new boundary context and a separate service.

After the Domain Driven Design (DDD) process is complete, all services from the study plan registration process are implemented as a program and installed on the container orchestration system. The implemented system was tested by flooding the system with 100, 200, 800, and 4000 users sequentially for each architecture.

4. RESULTS

The first test was completed by flooding a monolithic information system with 100 users. The same thing was done for the microservices information system that uses four worker nodes, and the results show that both architectures can still serve the 100 users with a response success rate above 99%.

The number of users was increased to 200 in the second test and tested against monolithic architecture and microservices. In the information system monolithic architecture, a success rate of 99% is still obtained, but the average response times have decreased from the previous test of 414.49ms to 786.74ms or 52.68%. The success rate in the microservices information system drastically reduced to 40.26%, but the average response times increased from 2765.43ms to 2129.71ms with the same number of worker nodes.

The next test is carried out by flooding the monolithic architecture and microservices with 800 users. In the monolithic architecture, the success rate decreased from 99.92% for 200 users to 77.28%, and the average response times fell from 786.74ms to 2023.31ms. Meanwhile, the microservices architecture with four worker nodes obtained a success rate of 11.4% and the average response times increased from 2129.71ms to 1481.95ms. Microservices architecture was tested again with the same number of users but with a doubled number of worker nodes or as many as eight worker nodes. The results show an increase in the success of the response to 12.52% and the average response time to 1076.2ms.

Further tests were carried out with 4000 users for monolithic and microservices architecture. From the test results obtained for the monolithic architecture, the response success rate decreased drastically to 7.32% with an average response time of 3771.98ms. Meanwhile, the microservices architecture experienced an increase that beat the monolithic architecture with a successful response of 8.95% and an average response time of 3101.6ms.

Table 1. Test Results

Specification			Executions			Response Times (ms)			Throughput
Number of test	users	worker node	Success %	FAIL	Error %	Average	Min	Max	Transactions/s
1	100	*monolithic*	99.98%	3	**0.02%**	**414.49**	4	14205	349.07
2	100	4	99.08%	66	**0.92%**	**2765.43**	14	17643	47.6
3	200	*monolithic*	99.92%	22	**0.08%**	**786.74**	3	47297	353.84
4	200	4	40.26%	5814	**59.74%**	**2129.71**	2	55667	46.12
5	800	*monolithic*	77.28%	20369	**22.72%**	**2023.31**	0	143359	447.58
6	800	4	11.4%	29812	**88.60%**	**1481.95**	2	67978	56.38
7	800	8	12.52%	29546	**87.48%**	**1076.2**	2	54565	101.12
8	4000	*monolithic*	7.32%	251008	**92.68%**	**3771.98**	0	36785	857.05
9	4000	8	8.95%	150851	**91.05%**	**3101.6**	0	76164	315.05

6. CONCLUSIONS

From the results of testing, the information system with monolithic architecture has better average response times than the microservices architecture, but this advantage stops at testing with 800 users. In testing with 800 users, the microservices architecture can beat the average response times of the monolithic architecture with a value of 1481.95ms compared to 2023.31ms resulting from the monolithic architecture. From testing with 4000 users, it can be seen that microservice architecture can beat the monolithic architecture to serve many users even though it has to sacrifice a lot of computing resources. Still, results indirectly prove that the Domain Driven Design (DDD) method succeeds in producing services that can be used to form the microservices architecture. Of all these things, the XYZ university needs to consider first whether its information system needs to serve thousands of users, so it needs to change the current monolithic architecture to a microservices architecture which requires preparation of time and considerable computational resources. Considering the time and use of computing resources, XYZ college can take other ways to serve many users. XYZ college can split the time or the number of information system users or conduct trials by changing the information system to a microservices architecture on a small system first with optimal settings so that optimal computing resources are obtained acceptable.

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STRATEGY TOWARD SUSTAINABLE SUPPLY CHAIN: A CASE STUDY OF LNG PRODUCTION COMPANY

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ABSTRACT

LNG is a cleaner energy source than other fossil fuels. The LNG supply chain in Indonesia does not yet have a balance between supply and demand. This issue is coupled with the environmental impacts arising from the construction and operation of the LNG plant and LNG transportation as well as increasing public awareness of environmental issues, so it is necessary to develop a sustainable supply chain strategy. In this study, a sustainable supply chain strategy is developed using the Modified Quality Function Deployment (QFD) and Analytical Hierarchical Process (AHP) approach. This strategy focuses on economic, environmental, and social indicators that refer to the Triple Bottom Line (TBL) theory. TBL was then developed using Modified House of Quality (HOQ) to obtain Customer Requirements (CR) and Technical Response (TR). Based on the Analytical Hierarchical Process (AHP) shows Total Cost, Reliability and Safety as the most influential aspects. The highest 10 TR weighting was taken from these results, which was then developed in a SWOT analysis. The proposed short-term strategy includes adaptive planning, preventive maintenance, and increasing the effectiveness of the LNG production process. The long-term plan includes system integration, national capacity building supported by relevant agencies, and cooperation in developing PLTMG/PLTG, LNG hub terminals and small-scale LNG terminals.

Keywords: LNG, Sustainable Supply Chain, Triple Bottom Line, QFD, HOQ, AHP

1. INTRODUCTION

The worldwide concern for environmental issues such as climate change, global warming, energy crisis and food crisis is increasing. The first initiative started by the 2005 Kyoto Protocol, an international agreement for industrialised countries to reduce collective greenhouse gas emissions by at least 5% from 1990 emission levels. The next initiative is the Paris Agreement, a joint agreement of 195 countries to deal with climate change in various aspects and is committed to low-emission development. The growing concern for the environment, society and ethics and the existence of regulations related to carbon emission and waste management has increased pressure on companies to adopt a sustainable way of thinking in company operations and continue to benefit stakeholders (Chaabane, Ramudhin, & Paquet, 2011). Energy sectors are taking the major hit because fossil fuel is the highest source of carbon emission. The world's earliest solution for cleaner energy is natural gas, or as we know it, Liquefied Natural Gas (LNG) (International Gas Union (IGU), 2021).

Indonesia has great potential for exploiting natural gas as an energy source. Indonesia's natural gas production is the fourth largest in the Asia Pacific, contributing 1.6% of the total world natural gas production, reaching 3854 billion m3(BP, 2021). LNG, the fastest-growing cleaner energy in Indonesia, still faces many problems, such as (1) an imbalance between LNG supply and demand; (2) environmental damages arising from LNG supply chain activities such as construction, exploration, refinery production, LNG transportation and distribution; and (3) international environmental regulation to reduce carbon emission. The company in the LNG supply chain faces the urgency to survive in the world of uncertainty. Therefore, a sustainable supply chain management (SSCM) strategy is required for LNG operators to meet energy needs in a safe, affordable, and sustainable manner for Indonesia.

This study aims to identify the factors that influence the LNG supply chain and propose strategies to pursue the sustainability of the LNG supply chain in Indonesia. The research objective is to contribute to developing LNG supply chain sustainability in Indonesia. This study only discusses production and shipping activities in the LNG production company.

2. LITERATURE REVIEW

SSCM is a transparent, integrated strategy for achieving the organisation's social, environmental and economic targets to improve the company's long-term financial performance and supply chain (Carter & Rogers, 2008). SSCM considers economic, environmental and societal sustainability when designing and optimising supply chains (Gold, Stefan; Seuring, Stefan; Beske, 2010). The focus concept to enable sustainability is the triple bottom line theory, whereby practical, sustainable supply chain management must incorporate social, environmental and economic aspects (Ahi & Searcy, 2015)(Büyüközkan & Berkol, 2011). A sustainable supply chain will not harm the environment and society (Pagell, 2009). It will provide profit in the long term (Kot, 2018). Non-economic aspects (environmental and social) must complement the economic dimension and vice versa. SSCM aims to provide maximum value for all stakeholders and to meet customer needs by achieving a sustainable flow of products, services, information and capital and enabling collaboration between supply chain participants (Abdelaziz, Ben; Saeed; Benleulmi, 2015). This study examines the strategies to achieve SSCM in the LNG sector using the modified Quality Function Deployment (QFD) (Carter & Rogers, 2008)) and Analytical Hierarchy Process (AHP) methods(Saaty, 2008). Modified QFD able to determine market needs/design criteria/customer requirements/customer needs related to supply chain sustainability and technical response/what factors shape it. AHP will prioritise SSCM criteria, whose results will later become a reference for strategy development.

3. METHODS

This research uses questionnaires and interviews to gather the customer's voice from prespective of Subject Matter Expert (SME) who is experienced and works in a natural gas/LNG-producing company in Indonesia. We use the result from the questionnaire to develop a Modified House of Quality (HOQ) to identify Customer Requirements (CR) and Technical Response (TR). The three (3) aspects/indicators that form supply chain sustainability, such as economic, environmental, and social (Joshi, 2022)(Felisia, 2014). It will be translated into sub-criteria that will become Customer Attributes/Customer Needs/Customer Requirement or "WHAT", as shown in Table 1.

Based on the Customer Requirement data, an analysis was carried out to determine priority criteria using the AHP method. The first stage is defining Modified Voice of Customer priorities and performing HOQ analysis. The top 10 priority TR will be developed into a strategy. In this

research, we use the SWOT analysis to identify the Strength, Weaknesses, Opportunities and Threats of the LNG production company in general. The strategy was developed using the TOWS matrix. The mapping of the system later will be grouped into the short-term plan (within 5 years period) and long-term strategy (within 15 years period).

4. RESULTS

The customer requirement with global weightage criteria for SSCM LNG describes in Table 1.

Table 1. Modified voice of customer global weight criteria (Customer Requirements)

Modified Voice of Customer / 3BL Factor & Local Weights	CR/ sub-factors		Local Weights (%)	Global Weights (%)	Rank
Economy 63.34%	CR 1	Total Cost	40.42	25.60	1
	CR 2	High Reliability	25.95	16.44	2
	CR 3	Production Volume	18.20	11.53	4
	CR 4	Production Quality	2.68	1.69	13
	CR 5	Economy Benefit	8.57	5.43	6
	CR 6	Flexibility	4.18	2.65	9
Environment 26.05%	CR 7	Environmental Management	4.34	1.13	15
	CR 8	Resource Utilisation	6.63	1.73	12
	CR 9	Fuel Usage	23.82	6.21	5
	CR 10	Pollution and Emission Rate	18.15	4.73	7
	CR 11	Safety	44.50	11.59	3
	CR 12	Natural Environment	2.56	0.67	17
Social 10.62%	CR 13	Health and Security	23.61	2.51	10
	CR 14	Work Condition	11.19	1.19	14
	CR 15	Social Commitment	4.09	0.43	18
	CR 16	Customer Expectation	17.24	1.83	11
	CR 17	Business Practices	7.04	0.75	16
	CR 18	Law and Regulation	36.83	3.91	8

The technical responses were developed based on discussions with LNG experts in Indonesia. The following sequences use to get priority of TR for the LNG supply chain: to develop technical responses related to the production and shipping aspects of the LNG supply chain, such as: to determine the relationship between CR and TR using a pairwise matrix, to calculate the TR's weightage, to perform normalisation of the weightage of TR, to develop Modified HOQ that shows a relationship between TR, CR and its weightage for production and shipping aspects, and to determine prioritisation TR, rank the weightage from the highest to the lowest. The authors implement Pareto Principle to obtain an 80% impact towards Sustainable Supply Chain Management (SSCM), as shown in Table 2.

Table 2. Technical Response for SSCM LNG

Rank	TR	Description	Weight (%)	Acum Weight (%)
1	TR 4	To avoid Unplanned Shutdown	34.00	34.00
2	TR 7	To attract investors to invest in a new LNG plant	3.32	37.32
3	TR 5	To develop an LNG plant with high technology	3.23	40.56
4	TR 1	To fulfil the commitment to meet local requirement	3.22	43.78
5	TR 11	To provide access to gas resources and build an LNG plant in a remote area	3.02	46.80
6	TR 27	To increase the number of Indonesian flags LNG tanker	2.99	49.79
7	TR 39	To increase the Seating Plan Capacity of the LNG tanker	2.96	52.75
8	TR 13	To adapt to customer demand, shift to other energy sources	2.93	55.68
9	TR 15	To reduce dependency on foreign suppliers/manufacture	2.90	58.58
10	TR 14	To increase the government budget for Exploration & Production activities	2.89	61.47
11	TR 43	To provide LNG tanker service engineer in local	2.73	64.20
12	TR 41	To reduce the operational cost of LNG tanker	2.72	66.92
13	TR 42	To provide LNG tanker spare parts in local	2.72	69.64
14	TR 18	To check the condition of the gas reservoir	2.69	72.33
15	TR 37	To develop the capability of Indonesian shipyard	2.59	74.93
16	TR 2	To improve LNG Plant Performance	2.54	77.46
17	TR 32	To increase the efficiency of LNG tanker	2.53	79.99
18	TR 20	To avoid production losses	2.51	82.50
19	TR 8	To apply carbon tax regulation	2.48	84.98
20	TR 29	To optimise LNG tanker utilisation	2.40	87.38
21	TR 26	To control inventory level (to avoid tank top)	2.34	89.72
22	TR 22	To control the emission rate of LNG Plant	2.33	92.05
23	TR 34	To implement Cabotage	2.22	94.27
24	TR 21	To optimise train capacity	2.15	96.41
25	TR 38	To increase the number of discharge ports for LNG tanker	2.12	98.54
26	TR 19	To check the environmental parameters related to the geographical position of the plant	2.08	100.62
27	TR 9	To provide alternative contract types (Gloss Split, Cost Recovery, etc.)	2.05	102.67
28	TR 10	To avoid delay in plant start-up	2.02	104.69
29	TR 33	To reduce the boil-off rate	2.00	106.69
30	TR 17	To review the size of the LNG plant area (including affected areas)	2.00	108.68
31	TR 24	To increase the use of reusable parts	1.99	110.68
32	TR 12	To look for new gas reserves	1.99	112.66
33	TR 31	To optimise LNG tanker speed	1.95	114.61
34	TR 25	To develop people competency in the LNG plant location	1.92	116.53
35	TR 3	To define the accurate Shutdown time	1.89	118.42
36	TR 30	To use the optimal LNG tanker type to meet the needs and conditions of the receiving terminal tanker type	1.84	120.26
37	TR 40	To reduce investment costs to buy/build LNG tanker	1.73	121.99

Rank	TR	Description	Weight (%)	Acum Weight (%)
38	TR 16	To check the composition and variability of the feed gas	1.69	123.68
39	TR 6	To provide maintenance service of critical/leading equipment	1.60	125.28
40	TR 28	To optimise the number of berths	1.58	126.86
41	TR 23	To reduce waste production	1.51	128.37
42	TR 36	To increase the opportunity to get experience in operating an LNG tanker	1.32	129.70
43	TR 35	To engage Indonesian crew for senior level (Chief Eng., Chief Officer and Master)	0.90	130.60

Ranks 1-31 contribute to an 80% impact on the SSCM. We sort it out into the highest ten (10) technical responses to develop the strategy for the LNG SSCM. The technical response related to the production plant or internal stakeholders includes TR4, TR5, TR1, TR11, and TR15. In contrast, the external stakeholder factor, such as shipping companies and the government, is included in TR7, TR27, TR39, TR13, and TR14. The TOWS strategy was generated considering the internal and external factors in the highest Technical Response strategy. Table 3 shows the SWOT analysis by mapping internal and external factors.

Table 3. TOWS Matrix Strategy

Internal	**Strength - Opportunities (S-O)**	**Weakness - Opportunities (W-O)**
• TR4 • TR5 • TR1 • TR11 • TR15	• Improving production efficiency and operational terminal • Adaptive planning for production plant and terminal • Cooperation with the government to develop gas-fired power plants [9] • Develop LNG hub domestic/international • Develop LNG small-scale terminal	• Improving strategic partnerships with the government • Improving business processes with environmentally focused • Improving partnerships with qualified domestic vendors • Diversification business: bunkering and ship services (cooldown, gassing up)
External	**Strength - Threats (S-T)**	**Weakness - Threat (W-T)**
• TR7 • TR27 • TR39 • TR13 • TR14	• Reducing LNG prices to compete with other fuel • Route and schedule optimisation for LNG Tanker • Flexible contract for LNG transport • Looking for affordable technology in collaboration with a domestic vendor [10]	• Cleaner energy production • Transition function for a terminal to handle ammonia, methanol, and hydrogen • Increase capturing Boil of Gas (BoG) and utilise BoG • Developing Carbon Capture Storage (CCS) for natural gas

To achieve sustainability, developing the new LNG terminal should pay attention to community development around the port location as an opening for new jobs. Corporate Social Responsibility (CSR) should include residents' employment programs, where sustainability training needs to be added to the human resources management system (Mittal, Baveja, & Krishnan, 2015).

Selection of LNG-supporting infrastructure requires selecting the most appropriate infrastructure in terms of economies of scale and investment costs. It is necessary to carry out a demand projection analysis to determine the scale of demand for the selected LNG location area. The choice of infrastructure can use the concept of decision tree analysis by considering the technical, environmental, risk and investment cost factors used. The evaluation of financial aspects during the feasibility study use tools such as IRR (Internal Rate of Return), NPV (Net Present Value), and PP

(Payback Period). The company should carefully determine the construction methods suitable for the surrounding marine ecosystem and adequately manage the dredging material disposal location.

The interview suggests that the main problem of less optimum LNG transport capacity on tankers in Indonesian waters is essential to note. In the procurement of the current LNG tanker fleet, it is still dominated by shipyards from foreign countries with limited domestic spare parts and shipyard capabilities in Indonesia. The government should also support shipbuilding companies to improve shipyard conditions in Indonesia to produce more Indonesian's flag tankers, dual-fuelled LNG vessels, and mini-LNG ships. The government must also enforce the cabotage principle to provide the broadest possible business opportunities for national sea transportation companies. It needs to be utilised as best as possible to increase the number of national sea transportation fleets. The long-term strategy for the shipping sector is continuously implementing the short-term strategy by optimising the shipping operation related to routing planning, fleet sizing, schedule optimisation, bunker fuel management, and maximising tanker utilisation ratio.

Domestic shipping operators must have a new mindset from initially working individually to being more open to collaborating with other companies, even from the same industry, to strengthen the capital aspect and expand into the global market.

The table below summarises the proposed strategy to develop LNG SSCM in Indonesia.

Table 4. SSCM LNG Strategy in Indonesia

Aspect	**TR**		**Strategy**		**Dimension**	**Key Performance Indikator** (Al-Haidous & Al-Ansari, 2020)
			Short Term (5 years)	**Long-term (15 years)**		
Planning	TR1	TR11	Adaptive Planning	Adaptive Planning (Expansion or New Built)	ESL	Prediction Accuracy
	TR1	TR7	Evaluation of Demand Prediction	Transition to Receiving Terminal	ESL	Planning Cycle
	TR7	TR13		Transition to RE terminal/refinery	ESL	Number of projects
Production & Storage	TR1	TR5	Optimisation Production LNG	Optimisation Production LNG	EL	Order vs Prediksi
	TR1	TR5	Integrated System between Refinery and Terminal	Expansion/Transition Refinery Plants	E	Data Operasional Harian & Mingguan, Production Lead Time, Production Loss
	TR1	TR13	Optimisation Storage Process	Expansion/Transition Terminal	E	Storage Occupancy
		TR 13		Carbon Capture Storage Technology development	EL	New Product
Operation & Maintenance	TR5	TR4	Monitoring Equipment Condition	Evaluation Technology	EL	Production Lead Time
	TR13	TR4	Monitoring Carbon Emission	Transition fuel energy	L	Carbon Emission Level (NOx, SOx, Cox)
	TR14	TR15	Evaluation of local vendor quality	Increase local content	ESL	Vendor Lead time, Material Quality
	TR1	TR4	Optimisation Operation Processes	Reduction of *TCO (Total Cost of Ownership)*	E	Vendor Fill rate
	TR5	TR4	*Preventive Maintenance*	*Risk-Based Maintenance*	EL	Jumlah unplanned shutdown

Aspect	TR		Strategy		Dimension	Key Performance Indikator (Al-Haidous & Al-Ansari, 2020)
			Short Term (5 years)	**Long-term (15 years)**		
	TR1	TR5	Digitalisation Operation & Maintenance	Digitalisation & Semi Automation	ES	Auto Purchase Order
Stakeholder Management	TR5	TR6	Human Resource Quality Management	*Sustainability Training*	ESL	Awareness level (safety and green environment)
		TR13	Improving awareness of waste management	Improving skills related to renewable energy	ESL	Productivity rate
	TR14	TR15	Cooperation with the government on gas-fired power plant	Cooperation with the government on gas-fired power plant	ESL	Number of projects
		TR27	Cabotage principle	Cabotage principle	ES	Number of Indonesian flags LNG tanker
Shipping	TR1	TR39	Route and schedule optimisation for LNG tanker	Route and schedule optimisation for LNG tanker	E	On-time Shipment, On Time Delivery
	TR7	TR39	Land Storage utilisation and schedule optimisation	Terminal LNG Hub development	EL	Perfect Order Fulfillment, In Stock Availability
	TR5	TR39	Utilisation optimisation for LNG terminal	LNG small-scale terminal development	EL	Terminal Utilisation (Berth Occupancy Ration (BOR) and Storage Occupancy Ratio (SOR)
	TR39	TR27	Utilisation optimisation for LNG tanker	Utilisation optimisation for LNG tanker	EL	Vessel Utilisation, Bunker Rate, shipping unit cost

Note: E= Economy; S = Social; L= Environmental

6. CONCLUSIONS

This study aims to identify the factors influencing sustainable LNG supply chains in Indonesia and the priority strategies used in sustainable supply chain management. From this study, we have concluded that:

1. The economic aspect is the dominant factor that essential to LNG supply chain sustainability. There are 5 (five) CRs with the most significant weight that affects a sustainable supply chain, namely the economic aspect, namely Total Cost, Reliability, Total Production Volume and environmental aspects, namely Safety, Fuel Use. Economic aspects of reducing total costs and increasing production without affecting the reliability and safety of workers supported by fuel efficiency to reduce carbon emissions are ways to support SSCM LNG.
2. Forty-three (43) responses/TRs have been generated to respond to the 18 "Modified Voice of Customer" criteria whose relationships are described by the House of Quality matrix. The ten (10) priority TRs that most influence the sustainability of the LNG supply chain in Indonesia, namely five (5) factors involving processes in the existing LNG plant, two (2) factors related to LNG shipping/sea transportation, and three (3) factors related to external stakeholders were chosen as the basis of reference in preparing a sustainable LNG supply chain strategy.

All the sustainable strategies require the cooperation of all stakeholders in the LNG sector. The strategy includes increasing efficiency at the LNG Plant, a preventive maintenance program, and

adaptive planning with uncertainties considering the future LNG demand and regulation changes. It may be necessary to determine the utilisation of LNG terminals in the net zero carbon era.

In further research, the analysis can be deepened to discuss the development of the mini-LNG supply chain, which involves the distribution process starting from the LNG Liquefaction Plant, LNG hub, and LNG receiving terminal that can receive mini-LNG vessels. The study of a sustainable LNG supply chain is significant due to the development of a mini-LNG distribution system in eastern Indonesia to support the development of gas-fired power plants (PLTG and PLTMG). A more even distribution of electricity to the eastern part of Indonesia will help equalise the economy in all regions of Indonesia.

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SUPPORT SYSTEM IN STRATEGIC DECISION MAKING FOR THE SELECTION OF MINE TRANSPORTATION MODE AT PT XYZ USING AHP AND PROMETHEE METHODS

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ABSTRACT

The choice of mining transport mode of transportation is one of the most important things to increase the profits of companies engaged in the mining industry. Based on the Coaltech Transportation Investigation Report, it was revealed that the selection of a particular mode of transportation is not a simple economic calculation, but a complex decision based on various influencing factors including the availability of transportation infrastructure at the time, the characteristics of the transportation system, to various social and environmental conditions. This study is to help PT XYZ choose the best and most efficient mode of transportation from the five alternative modes selected, namely: Truck, Train, Mini Locomotive, Conveyor, and Slurry Pump. This study was conducted using the decision support system method in which this system contains stages starting from the Intelligence Phase, the Design Phase, and the Choice Phase. In the calculation of the Choice phase, the author uses a combination of two tools in the form of AHP and PROMETHEE, where AHP will be used to get the weight of the criteria, while PROMETHEE is used to determine the priority order of the selected transportation modes. From the results of the analysis of scoring calculations carried out in this study, the top three rankings of the five selected modes of transportation were obtained, namely Dump Truck, Slurry Pump, and Conveyor. The top three ratings given can be considered as an option to be chosen as the right mode of transportation or that can be recommended for mining transport in this case.

Keywords: Transportation Mode, decision support system method, AHP, PROMETHEE.

1. INTRODUCTION

1.1 Background

PT XYZ is a bauxite mining company in West Kalimantan, which has been carrying out bauxite ore mining activities since 2020 in three Mining Business Permits (IUP), namely one IUP located in Kab. Mempawah, and two IUPs are in Kab. Landak, West Kalimantan Province, Indonesia. Bauxite ore is the basic ingredient in the manufacture of alumina, whereas alumina is the basic ingredient of aluminum. PT XYZ mobilized its mining products from the stockpile in Kab. Mempawah to the Smelter Grade Alumina Refinery plant or factory or abbreviated as the SGAR Factory which is ± 20 km from the stockpile and ± 4 KM from the port of Kijing, West Kalimantan. PT XYZ needs to carry out an analysis related to selecting the right mode of transportation so that it can accommodate these needs. Meanwhile, it was revealed that the selection of a particular mode of transportation is not a simple economic calculation, but a complex decision based on various influencing factors including the availability of transport infrastructure at the time, the characteristics of individual systems, the possibility of integration with other modes of transportation and various social conditions and economy. This is also in line

with the criteria chosen by the company PT XYZ, at least referring to the literature study so that it does not have a significant impact on the flow of the distribution process of mining products from upstream to downstream. Therefore the author tries to make a comprehensive analytical study to examine the most effective and efficient modes of transportation in terms of technical, investment, and operating costs as a support in making decisions on choosing the best mode of transportation using a combination of two methods, namely AHP (Analytical Hierarchy Process) and PROMETHEE (Preference Ranking Organization Method for Enrichment Evaluation), where the AHP method will later be used to obtain criteria weights, and then the PROMETHEE method will be used to determine the priority order of selected transportation modes so that these two methods will later become a complementary study or complete each other.

1.2 Research Objectives and Benefits

The purpose of this study is to produce a decision analysis for choosing the right mode of transportation from the five alternative modes selected based on the selection criteria as follows:

1. Technical Aspects, including the specification of the unit used, supporting facilities needed, material handling systems, and reliability, Availability, and Maintainability (RAM) for each mode of transportation.
2. Aspects of Risk Management, including social risk impact assessment, and environmental risk impact assessment.
3. Financial Aspect, including determination of Capital Expenditure (Capex) for each mode of transportation, and determination of Operational Expenditure (Opex) for each mode of transportation.

While the benefit of this research is to assist PT XYZ in making strategic decisions regarding the selection of the most effective and efficient modes of transportation in terms of the weight of each selection criterion and the ranking or ranking of the alternatives.

2. LITERATURE REVIEW

2.1 Definition and Concept of Decision Support System

According to Herbert A. Simon (1977) there are several process stages or phases in decision-making covering three main phases, namely: intelligence, design, and criteria. then he added a fourth phase, namely implementation. Although monitoring can be considered the fifth phase, Turban et al view monitoring as an intelligence phase that is applied to the implementation phase. A conceptual picture of the decision-making process is shown in the image below:

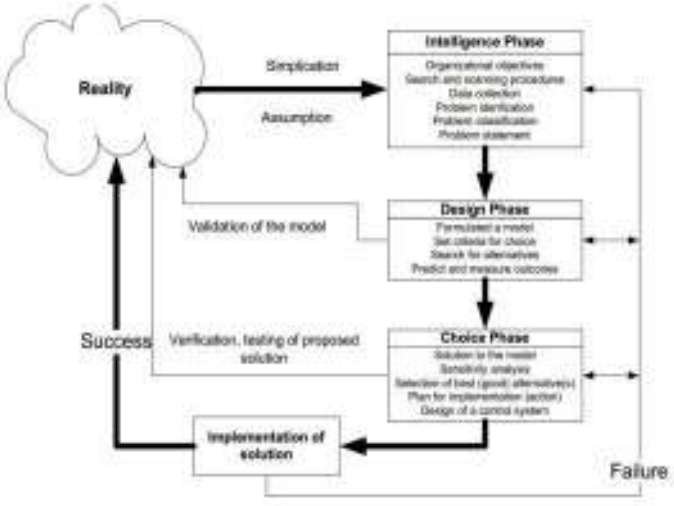

Figure 1. Phases of a decision system (Turban et al, 2005)

2.2 Analytical Hierarchy Process (AHP)

The Analytical Hierarchy Process (AHP) method was developed in the early 1970s by Thomas L. Saaty, he is a mathematician from the University of Pittsburg. AHP is basically designed to rationally capture people's perceptions that are closely related to certain problems through procedures designed to arrive at a preference scale among various alternative sets. This analysis is intended to create a problem model that does not have a structure, usually set to solve problems that are measured (quantitative), problems that require opinion (judgment) even in complex or unframed situations, in situations where statistical data is minimal or non-existent at all and only qualitative based on perception, experience or intuition.

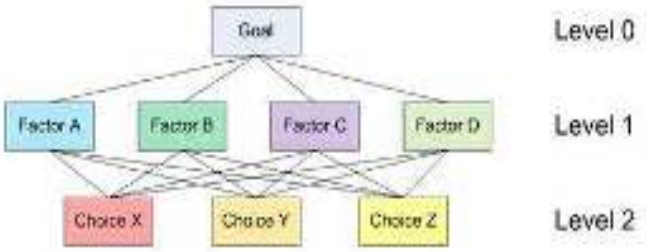

Figure 2. Example AHP Model

In the picture above, it is explained that there is an example of a simple AHP level, where level 0 is the goal of analysis, then level 1 is multi-criteria consisting of several factors, then level 2 is the alternative choice. AHP is used to determine the weight of each criterion, where the advantages of AHP are organizing information and having many alternatives, then assigning numerical values to subjective criteria. This value will determine a criterion that has the highest priority which will affect the resolution of a problem (Rusydi Umar, Abdul Fadlil, 2018). The procedure in the AHP method consists of several stages, namely:

1. Arrange Hierarchy.
2. Establish priority criteria, by:
   a. Arrange pairwise comparisons in matrix form.
   b. Fill in the matrix with numbers that represent the relative importance of one criterion to other criteria, in the form of a scale from 1 to 9.
   c. The values of each column in the matrix are added up.
   d. Look for matrix normalization by dividing each value from the column by the total of the column in question.
   e. Find the average value of each matrix.

Table 1. Saaty Table

The Fundamental Scale for Pairwise Comparisons		
Intensity of Importance	Definition	Explanation
1	Equal importance	Two elements contribute equally to the objective
3	Moderate importance	Experience and judgment moderately favor one element over another
5	Strong importance	Experience and judgment strongly favor one element over another
7	Very strong importance	One element is favored very strongly over another; its dominance is demonstrated in practice
9	Extreme importance	The evidence favoring one element over another is of the highest possible order of affirmation
Intensities of 2, 4, 6, and 8 can be used to express intermediate values. Intensities of 1.1, 1.2, 1.3, etc. can be used for elements that are very close in importance.		

3. Look for the criteria weight values by calculating the eigenvalues or eigenvectors by adding up each row and then dividing it by the number of predetermined criteria.

2.3 Preference Ranking Organization Method for Enrichment Evaluation (PROMETHEE)

The preference Ranking Organization Method for Enrichment Evaluation (Promethee) is a ranking method in Multi-Criteria Decision Making (MCDM), or it can be said a method of determining order (priority) in multicriteria analysis. The presumption of the dominance of the criteria used in Promethee is the use of values in outranking relationships, which is a method that offers a flexible and simple way for decision-makers (users) to analyze multi-criteria problems (Brans and Vincke, 1985). Promethee consists of two rankings, the first rank, the value of the outranking relationship is based on consideration of the dominance of each criterion, the preference index is determined and the outranking value is presented graphically based on the preference of the decision maker. The second rank, exploitation is carried out by considering the values of Leaving Flow and Entering Flow in the outranking graph. Partial sequence for Promethee I and complete sequence for Promethee II. According to Hunjak (1997:167), Promethee can be explained in 3 (three) stages, namely:

1. Gather all preference structures
   Describes the criteria used to obtain consideration of the deviation range in assessing an alternative from each of the existing criteria.
2. Gather dominant relationships
   Outranking relations are made according to the estimates of the alternatives from all criteria. The total level of preference is an alternative that dominates the count for each of the other alternative pairs.
3. Decision Analysis
   Promethee I is a partial ranking of actions based on positive current (Leaving Flow) and negative currents (Entering Flow). Promethee II is a complete ranking of actions based on multi-criteria flows (Net Flow).

3. METHODS

Several stages were carried out in this research, namely: problem identification, data collection, system analysis, and design, and system testing. The stages of the research procedure can be explained as follows:

1. Problem Identification
   At this stage problem identification will be carried out, determining existing problems, in this case, the problem faced is choosing the best mode of transportation.
2. Data Collection
   After the problem can be identified, the next step is to collect various data to solve the problem. The data in question can be in the form of information obtained from the company, it can also be in the form of literature such as books, journals, and other scientific sources related to this research.
3. Data Analysis Process
   At this stage, data analysis was carried out including:
   a. Analysis of routes and required infrastructure for each mode of transportation. The route data taken and the infrastructure requirements for each mode are obtained from the results of field surveys, topography, and soil investigation.
   b. Analysis of the need for modes of transportation, this analysis is calculated based on operating targets, distance traveled, effective working time, load capacity of transport, and circulation time, so that the number of modes of transportation will be obtained according to the needs of the desired operating target.

c. Analysis of the need for capital costs or investment costs (Capex) and operational costs (Opex). The calculation of this analysis is based on the data:
   i. Capital Expenditure (Capex), includes land acquisition costs, facilities/facilities needed, and civil works for infrastructure.
   ii. Operational Expenditure (Opex), including energy costs, labor costs, maintenance costs, and others.

d. Analysis of Reliability, Availability, and Maintainability (RAM). This analysis is based on the capability and reliability of each mode of transportation, where references are obtained based on data from the manufacturer or manufacturer where the mode of transportation was created.

e. Risk Analysis. This analysis is to identify the potential risks of each mode of transportation, starting from risk determination to the mitigation proposals that need to be implemented.

4. Calculation of Ranking / Scoring System

Furthermore, at this stage, the process of calculating the ranking or scoring system is carried out using the AHP and PROMETHEE methods. System design architecture starts from:

a. Selection of the mode of transportation, the mode of transportation in question is the mode of transportation of mining transport that is in accordance with geographical conditions and the type of material transported for PT XYZ production purposes from the stockpile to the SGAR (Smelter Grade Alumina Refinery) factory, as well as those that have been proven used in various countries to transport materials mine.

b. The assessment of the criteria for selecting modes of transportation uses the AHP method with the following criteria: technical specifications for each mode, operating patterns, material handling systems, RAM for each mode, social and environmental impacts directly related to the mode, investment costs, and operational costs required for each mode.

c. The results of the AHP calculation are used as input for the next process which will be carried out using the PROMETHEE method to determine the ranking between modes so that the company can find out which mode of transportation has the highest rank to choose from. The PROMETHEE method used as a preference function is a linear preference type and the output is the priority/ranking of modes of transportation.

5. Finalization

This last stage contains conclusions and recommendations from the results of the scoring system calculations that have been carried out.

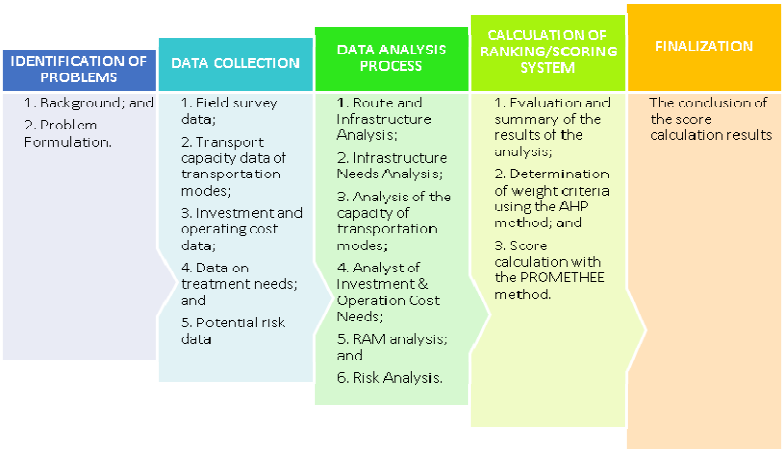

Figure 3. Research process flow

4. RESULTS

Decision Support Systems are designed to support all stages of decision making starting from identifying problems, selecting relevant data, and determining the approach to be used in the decision-making process, to evaluating alternative choices. The stages in the decision-making process include:

1. Understanding or Searching Stage (Intelligence Phase)
   In this case, the author tries to identify the problems experienced by PT XYZ.
2. The Design Phase
   At this stage, the author tries to carry out architectural designs related to the system to be carried out.
3. The Selection Phase
   The calculation process is the following stages:
   a. Determination of Criteria
      Below are the criteria that have been determined:

Table 2.Criteria & Weight scoring

Criterion	Unit	Description
Reliability	%	To deliver 3,7 ton per year
Availability	%	To deliver 3,7 ton per year
Maintenance	%	To deliver 3,7 ton per year
EPC Timeline	Month	Time required for procurement
Proven	Scale	Has been applied
Technical risk	Scale	Technology dependency
Social Risk	Scale	Security of Equipment
Environment risk	Scale	Environment Consequence
CAPEX	$	Capital Expenditure
OPEX	$	Operational Expenditure
NPV	$	Net Present Value

   b. Determine the weight for each criterion
      Determining the weight for each criterion is done by using a tool in the form of the Analytical Hierarchy Process or AHP method with the following steps:
      - Make pairwise comparisons
        Determining the intensity of interest is carried out by distributing questionnaires to 20 people consisting of experts who are competent in the field of transportation and users at PT XYZ with a level of Manager level in various divisions. Pairwise comparisons are arranged in the form of a matrix filled with numbers that represent the relative importance of one criterion to other criteria in the form of a scale of 1 to 9 as shown in the table below:

Table 3. Pairwise Comparison

ASPECT	Reliability	Availability	Maintainability	EPC Timeline	Proven	Technical Risk	Social Risk	Environtment risk	CAPEX	OPEX
Reliability	1	1	1	1/9	1/7	1/5	1/5	3	1/7	1/7
Availability	1	1	1	1/9	1/7	1/5	1/5	3	1/7	1/7
Maintainability	1	1	1	1/9	1/7	1/5	1/5	3	1/7	1/7
EPC Timeline	9	9	9	1	3	5	3	5	5	5
Proven	7	7	7	1/3	1	1/3	1/3	5	1/5	1/5
Technical Risk	5	5	5	1/5	3	1	1/5	3	1/7	1/7
Social Risk	5	5	5	1/3	3	5	1	3	1/7	1/7
Environtment risk	1/3	1/3	1/3	1/5	1/5	1/3	1/3	1	1/7	1/7
CAPEX	7	7	7	1/5	5	7	7	7	1	1/5
OPEX	7	7	7	1/5	5	7	7	7	5	1
Jumlah	43,333	43,333	43,333	2,800	20,629	26,267	19,467	40,000	12,057	7,257

      - Normalization Process
        Next is to find the normalization of the matrix by dividing each value from the column by the total column in question according to the table below.

Table 4. Normalization

ASPECT	Reliability	Availability	Maintainability	EPC Timeline	Proven	Technical Risk	Social Risk	Environtment risk	CAPEX	OPEX
Reliability	0,023	0,023	0,023	0,040	0,007	0,008	0,010	0,075	0,012	0,020
Availability	0,023	0,023	0,023	0,040	0,007	0,008	0,010	0,075	0,012	0,020
Maintainability	0,023	0,023	0,023	0,040	0,007	0,008	0,010	0,075	0,012	0,020
EPC Timeline	0,208	0,208	0,208	0,357	0,145	0,190	0,154	0,125	0,415	0,689
Proven	0,162	0,162	0,162	0,119	0,048	0,013	0,017	0,125	0,017	0,028
Technical Risk	0,115	0,115	0,115	0,071	0,145	0,038	0,010	0,075	0,012	0,020
Social Risk	0,115	0,115	0,115	0,119	0,145	0,190	0,051	0,075	0,012	0,020
Environtment risk	0,008	0,008	0,008	0,071	0,010	0,013	0,017	0,025	0,012	0,020
CAPEX	0,162	0,162	0,162	0,071	0,242	0,266	0,360	0,175	0,083	0,028
OPEX	0,162	0,162	0,162	0,071	0,242	0,266	0,360	0,175	0,415	0,138
Jumlah	1	1	1	1	1	1	1	1	1	1

- Calculating Criteria Weight Value
  The next step is to calculate the criteria weight values by finding the Eigenvalues by adding up each row and then dividing it by the number of criteria as shown in the table below:

Table 5. Eigen Vector

ASPECT	Reliability	Availability	Maintainability	EPC Timeline	Proven	Technical Risk	Social Risk	Environtment risk	CAPEX	OPEX	Jumlah Baris	Eigen Vektor Normalisasi	Bobot
Reliability	0,023	0,023	0,023	0,040	0,007	0,008	0,010	0,075	0,012	0,020	0,241	0,024	2,4%
Availability	0,023	0,023	0,023	0,040	0,007	0,008	0,010	0,075	0,012	0,020	0,241	0,024	2,4%
Maintainability	0,023	0,023	0,023	0,040	0,007	0,008	0,010	0,075	0,012	0,020	0,241	0,024	2,4%
EPC Timeline	0,208	0,208	0,208	0,357	0,145	0,190	0,154	0,125	0,415	0,689	2,699	0,270	27,0%
Proven	0,162	0,162	0,162	0,119	0,048	0,013	0,017	0,125	0,017	0,028	0,853	0,085	8,5%
Technical Risk	0,115	0,115	0,115	0,071	0,145	0,038	0,010	0,075	0,012	0,020	0,716	0,072	7,2%
Social Risk	0,115	0,115	0,115	0,119	0,145	0,190	0,051	0,075	0,012	0,020	0,956	0,096	9,6%
Environtment risk	0,008	0,008	0,008	0,071	0,010	0,013	0,017	0,025	0,012	0,020	0,192	0,019	1,9%
CAPEX	0,162	0,162	0,162	0,071	0,242	0,266	0,360	0,175	0,083	0,028	1,711	0,171	17,1%
OPEX	0,162	0,162	0,162	0,071	0,242	0,266	0,360	0,175	0,415	0,138	2,153	0,215	21,5%
Jumlah	1	1	1	1	1	1	1	1	1	1		1,000	100%

- The final result
  The final result for weighting can be seen in the table below:

Table 6. Final Result

ASPECT	WEIGHT
Reliability	2,4%
Availability	2,4%
Maintainability	2,4%
EPC Timeline	27,0%
Proven	8,5%
Technical Risk	7,2%
Social Risk	9,6%
Environtment risk	1,9%
CAPEX	17,1%
OPEX	21,5%
TOTAL	100%

c. Collecting data from the analysis of modes of transportation
Based on the results of the calculation of the technical analysis of modes of transportation, the following data are obtained:

Table 7. Summary of technical analysis results for each mode

No.	Aspect	R	A	M	EPC Timeline	Proven	Technical Risk	Social Risk	Environment Risk
1	Truck	100%	100%	100%	18	Yes	Low	High	High
2	Heavy Train	98%	88%	59%	25	Yes	Medium	Medium	Medium
3	Conveyor	95%	92%	60%	18	Yes	High	Medium	Low
4	Slurry Pump	95%	86%	58%	18	Yes	Medium	Low	Medium
5	Mini Locomotive	100%	100%	99%	20	Yes	Medium	Medium	Medium

Then from the results of financial analysis calculations related to CAPEX and OPEX, the following data are obtained:

Table 8. Summary of financial analysis results for each mode

No.	Aspect	CAPEX (Per 100 million)	OPEX/Years (Per 100 million)
1	Truck	$ 1.37	$ 3.51
2	Heavy Train	$ 3.12	$ 1.02
3	Conveyor	$ 3.89	$ 1.71
4	Slurry Pump	$ 1.53	$ 2.66
5	Mini Locomotive	$ 1.49	$ 2.52

d. Input the calculated data using the help of visual promethee software

Based on the technical and financial data above, by considering every aspect of the scoring system, the results of the calculation of the Promethee method using Visual Promethee software can be obtained as follows:

Table 9. Promethee Data Process

Scenario1	Reliability	Availability	Maintainability	ERC Timeline	Proven	Technical Risk	Social Risk	Environmen...	CAPEX	OPEX
Unit	Percentage	Percentage	Percentage	Month	y/n	Technical Risk	Social Risk	Environment	$	$
Cluster/Group	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
Preferences										
Min/Max	max	max	max	min	max	min	min	min	min	min
Weight	2,40	2,40	2,40	27,00	0,50	7,20	9,60	1,80	17,10	21,60
Preference Fn.	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual
Thresholds	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute
- Q: Indifference	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
- P: Preference	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
- S: Gaussian	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Statistics										
Minimum	95	85	58	18	5,00	1,00	1,00	1,00	$ 1,37	$ 1,02
Maximum	100	100	100	25	5,00	5,00	5,00	5,00	$ 3,89	$ 3,51
Average	98	93	75	20	5,00	3,00	3,00	3,00	$ 2,28	$ 2,28
Standard Dev	2	6	20	3	0,00	1,26	1,26	1,26	$ 1,03	$ 0,85
Evaluations										
Truck	100	100	100	18	Yes	Low	High	High	$ 1,37	$ 3,51
Heavy Train	98	88	90	25	Yes	Medium	Medium	Medium	$ 3,12	$ 1,02
Conveyor	95	92	60	18	Yes	High	Medium	Low	$ 3,89	$ 1,71
Slurry Pump	95	85	58	18	Yes	Medium	Low	Medium	$ 1,53	$ 2,66
Mini Locomotive	100	100	99	20	Yes	Medium	Medium	Medium	$ 1,49	$ 2,52

The preference type used in this case is preference type 1 (one) or the Usual Criterion. Type 1 is used because there are criteria values for each modal alternative and have different values, and also because type 1 can be used for absolute decision-making for alternatives that have better value. From the results of data processing, the results of PROMETHEE I (Partial Ranking) are obtained which are the values of Leaving Flow (Phi +) and Entering Flow (Phi -), as shown in the table below:

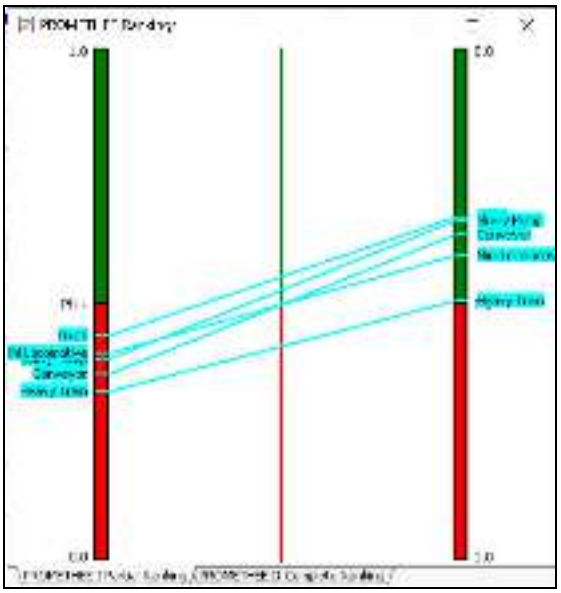

Figure 4. PROMETHEE I (Partial Ranking)

Then it can also be displayed for Net Flow (Phi) in the PROMETHEE II (Complete Ranking) image below:

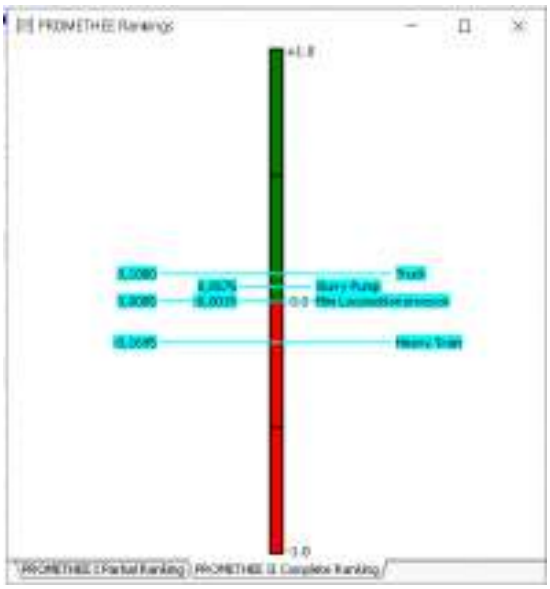

Figure 5. PROMETHEE II (Complete Ranking)

Based on the calculation results of Promethee II (Net Flow), the following scoring results are obtained:

PROMETHEE Flow Table

Rank	action	Phi	Phi+	Phi-
1	Truck	0,1080	0,4380	0,3300
2	Slurry Pump	0,0575	0,3930	0,3355
3	Conveyor	0,0005	0,3633	0,3628
4	Mini Locomotive	-0,0015	0,4040	0,4055
5	Heavy Train	-0,1645	0,3285	0,4930

Figure 6. Final Result

From the table above, it can be seen that the top 3 ratings given by Promethee can be considered the preferred mode of transportation for mining haulage. The top 3 rankings are Truck, Slurry Pump, and Conveyors.

5. CONCLUSIONS

Decision Support Systems are designed to support all stages of decision making starting from identifying problems, selecting relevant data, and determining the approach to be used in the decision-making process, to evaluating alternative choices. In this study, the authors used tools in the form of the AHP and Promethee methods to make it easier to determine the best choice based on the desired criteria according to needs, especially in minimizing the many options or alternative solutions. Then in determining the criteria or factors that can be used as a comparison in choosing the right mode of transportation, it is necessary to consider aspects of costs for operation and maintenance, safety, quality, and reliability of these modes of transportation, in order to achieve mobilization of modes of transportation with lower operating costs. especially low for conveyance systems as well as in terms of operational safety and failure risk costs.

The flexibility of the AHP and Promethee methods in determining selection criteria is one of the methods that can be used by decision-makers, one of which is in the case of determining the right mode of transportation for this bauxite mine in the West Kalimantan area. From the results of the analysis of scoring calculations carried out in this study, the top three rankings of the five selected modes of transportation are obtained, namely Dump Trucks, Slurry Pumps, and Conveyors. The top three ratings given can be considered as an option to be chosen as the right mode of transportation or that can be recommended for mining transport in this case.

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ANALYSIS OF SATISFACTION LEVEL OF PLANNING CONSULTANT SERVICE COMPANY WITH INTEGRATION METHODS OF SERVQUAL, KANO, AND QFD. CASE STUDY: PT. KONSULTAN PERENCANA

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ABSTRACT

The construction service industry in Indonesia is always required to maintain and improve the quality of its construction products and services such as work on time, work in accordance with initial planning and conformity of materials with specifications so that customers are satisfied and return to using their services. PT. Konsultan Perencana is one of the construction service industry companies, especially in the planning consulting service industry that prioritizes quality and service quality. The problem come up, there is still a low level of satisfaction, and the company wants to find out the input from their customers so far. There are 21 service attributes that are used as indicators in the questionnaire using 5 service quality dimensions, namely Tangible, Empathy, Responsiveness, Reliability, and Assurance. Measuring the level of customer satisfaction PT. Konsultan Perencana are carried out using the Service Quality, Kano, and Quality Function Deployment (QFD) methods. This research was conducted on company customers total of 30 respondents since 2021. From the results of the integration of Servqual and Kano, 3 service attributes were obtained that had a major influence and were a priority for improvement. The 3 service attributes are "Having a detailed and accurate record and document management system" has the One-Dimensional category, "Employees using ID-Cards" has the Must-be category, "Level of knowledge of company representatives" has the Must-be category. Then a QFD analysis was carried out and obtained steps to improve services at PT. Konsultan Perencana with priorities starting from the highest are "Making MOM (Minutes of Meeting) and field survey report", "Using Colored Helmets", “Briefings before meeting Customers", "Sharing knowledge related to projects that have been handled, “Making company clothes/uniforms + Employee Names” and “Softskill training”

Keywords: Servqual, Kano Model, Customer Satisfaction, QFD, Consultant, Construction.

1. INTRODUCTION

Infrastructure is the main foundation in several business sectors in Indonesia, one of them is the construction service industry or planning consulting services. The construction service industry in Indonesia is always required to maintain and improve the quality of its construction

products and services so that customers are satisfied and using their services again. A construction project can be said to be of high quality when there are guarantees related to the project that has been implemented, such as: The project is carried out according to schedule, the specifications used are in accordance with those given and there is a guarantee of Occupational Health and Safety.

PT. Konsultan Perencana one of the private construction service companies in Indonesia which was established in 2009 and is engaged in the field of planning consulting. Company experience such as building and renovating houses, offices, hospitals, mosques and cinemas, PT. Konsultan Perencana serve partner companies ranging from individuals, governments, and small, medium private companies to large private companies. PT. Konsultan Perencana always prioritize guaranteed quality, the goal is that with a guarantee of a quality from the company, it will be able to make business partners always choose PT. Konsultan Perencana as the main choice to become a planning consultant in a project by providing excellent contributions to each partner through professional and integrity services.

PT. Konsultan Perencana have worked with several companies until 2022 in total there are 30 companies that have worked with PT. Konsultan Perencana. Problems arise when there are customers who complain about the company's performance so that the company then makes initial observations related to customer satisfaction with the services that have been provided by the company. Initial studies were conducted to find out how the level of customer satisfaction by giving questions related to satisfaction with 5 indicators of satisfaction. From 15 samples of respondents obtained that the average score of customer satisfaction was 2.87 where the result still unable to meet the satisfaction of their customers and still far from the company's satisfaction target.

Table 1. Satisfaction Score

Score	**Very Dissatisfied**	**Dissatisfied**	**Quite Satisfied**	**Satisfied**	**Very Satisfied**
Response	**1**	**2**	**3**	**4**	**5**
1			✓		
2					✓
3			✓		
4			✓		
5				✓	
6				✓	
7			✓		
8			✓		
9			✓		
10			✓		
11			✓		
12				✓	
13				✓	
14				✓	
15			✓		

With this result PT. Konsultan Perencana must find ways to fulfill the satisfaction of his customers by asking for input from customers what are the hopes and wishes of customers so that improvements from PT. Konsultan Perencana can be right on target and effective. To determine

the level of customer satisfaction, it is necessary to know the dimensions that affect customer satisfaction related to the quality of services that have been provided.

2. LITERATURE REVIEW

2.1 Service Quality

The Servqual is a concise scale selection but has a high level and accuracy, so that it can be used by company management to better understand customer perceptions and expectations of the services that have been provided. The Servqual concept is used to calculate the gap between customer perceptions of services and the value of expectations. Here are the similarities:

Q = P (Perceived Service) – E (Expected Service)

Description:
Q: Quality of Service
P: Perceived service
E: Expected service

From the formula above, if the perceived score is the same as the expected score, then the service quality is perceived as good and satisfactory. If the perceived score is greater than the expected score, then service quality is perceived as an ideal quality. on the contrary, if the perception score is smaller than the expectation score, then the service quality is declared poor.

2.2 Kano Model

The Kano model was developed by Dr. Noriaki Kano. The Kano model aims to categorize the attributes of products or services that are able to satisfy the needs of customers. The Kano model is divided into 3 desired categories that can affect customer satisfaction, namely: (Kano, 1984) category Must-be, if this category is not fulfilled, then the customer will feel dissatisfied, because customers think this category should exist in a service or product, fulfilling this category will not increase customer satisfaction, category One dimensional, in this category, customer satisfaction is proportional to attribute performance. The higher the attribute performance value, the higher the customer satisfaction. This category is a category that is always demanded by customers. Attractive, this category is a product criterion that has the greatest influence on customer satisfaction if given. This category is required to exist and is also not expected by customers. Fulfillment of this category will lead to a very high increase in customer satisfaction. But if it is not fulfilled, it will not cause a decrease in the level of satisfaction.

There are two kinds of questions in questionnaires for Kano model: functional questions and dysfunctional questions: Chen et al., (2021)

- Functional questions: “Believe in the quality of consultant staff at PT. Konsultan Perencana”
- Dysfunctional questions: Do not believe in the quality of the consultant staff of PT. Konsultan Perencana

To analyze and improve relevant quality factors, the customer satisfaction coefficient has been proposed by Matzler and Hinterhuber as an internal reference index (Chen et al., 2021), so that this coefficient can help see the spread of the data obtained. The modifications that have been suggested in this study use the following formula (Suh et al., 2019):

$$Satisfaction\ increment\ index\ (SII) = \frac{(A+O)}{(A+O+M+I)}$$

$$Decreasing\ dissactifaction\ index\ (DDI) = \frac{(O+M)}{(A+O+M+I)}$$

For the SII means consumer satisfaction increases if consumer demand is fulfilled. The DDI means consumer satisfaction will decrease if consumer demand is not fulfilled. So that the results of service attributes that fall into the attractive, one-dimensional, must-be, and indifrent categories will be obtained.

2.3 Quality Function Deployment

Quality Function Deployment (QFD) has been defined as a system for translating customer requirements into appropriate technical requirements at each stage of the product life cycle, from product concept, service to sales (Akao, 1990). In essence, QFD helps to convey the voice or desire of the customer and is useful in brainstorming sessions with the development team in determining how best to fulfill the wishes of the customer. The tool used to use the QFD structure is a matrix in the form of a house, called the House of Quality.

3. METHODS

1. Identification Phase

The researcher did this research starting from the initial study and literature study, after do the initial study and literature study, a problem formulation, variable identification, and population were made.

2. Data Collection Phase

At this stage the researcher created a questionnaire based on the variables obtained from the results of the initial study. Questionnaires will later be created via Google Form to facilitate the distribution of questionnaires. The distribution of this questionnaire will later be distributed based on the customer data population of PT. Konsultan Perencana in 2021-2022. After obtaining the results of the questionnaire, the data testing phase will then be carried out to the Validity Test and Reliability Test, this stage is carried out to ensure that the questionnaire and the results of the questionnaire can be processed at the next stage.

3. Data Processing Phase

As explained in the previous stage, at this stage the results of the questionnaire are processed using 3 methods, namely the first is the Servqual method, where this method measures customer satisfaction based on 5 dimensions, then the Kano method is used to categorize service attributes, and the third is the & Quality Function Deployment which is used to get improvement suggestions.

4. Analysis Phase

At this stage an analysis is carried out related to the results of the previous stage or the data processing stage to draw conclusions from the research. Proposed improvements obtained from the previous stage will be discussed with the company's management to make decisions about which proposals can be agreed upon and implemented by the company.

4. RESULTS

4.1 Service Quality

From the questionnaire that was distributed to 30 respondents, there were 2 things that they wanted to know, namely: the level of expectation and the level of reality of the quality of service from PT. Konsultan Perencana to its customers. Values such as the level of expectation and reality are obtained from the average value of the sampling results that have been obtained from the results of the questionnaire. For measuring the value of expectations in this questionnaire aims to determine the level of customer expectations of the service attributes that have been provided by the company before the customer came to use the services of PT. Konsultan Perencana, while the

reality value on this questionnaire aims to determine whether the quality of services provided by PT. Konsultan Perencana to customers. Following are the results of the Servqual Analysis:

Table 2. Gap Analysis Service Quality

No	Service Attributes	Expectations	Reality	Gap	Number of Respondents
A	**Dimensions of Reliability**				
1	Perform actions or activities as promised during the construction process	4,67	4.77	0.10	30
2	The suitability of costs with the products produced	4,77	4.83	0.064	30
3	Show genuine interest in solving customer problems	4,60	4.53	-0.07	30
4	Have a document and record management system that is detailed and accurate	4.60	3.90	-0.70	30
B	**Dimensions of Assurance**				
1	Service level after completion of work within a certain time	4.80	4.73	-0.07	30
2	Conformity of work with the contract	4.70	4.90	0.20	30
3	Guaranteed Customer Revisions	4.10	4.73	0.63	30
4	Company Reputation	4.23	4.50	0.27	30
C	**Dimensions of Tangible/Visible**				
1	Employees use ID-Cards	4.57	3.63	-0.93	30
2	The company uses updated design software	3.87	4.67	0.80	30
3	Employees are clean and tidy	4.33	4.70	0.37	30
4	The physical/work environment of the Consultant who will assist with services during the construction process is clean and tidy	4.37	4.67	0.30	30
5	The company provides examples of finishing materials that will be used that have been approved by the customer	3.57	4.80	1.23	30
D	**Dimensions of Empathy**				
1	Services provided by consultant employees in communicating both verbally and in writing	4.60	4.83	0.23	30
2	Presence of on-site company representatives	4.80	4.77	-0.03	30
3	The company will understand the specific needs of customers in relation to their objectives	4.40	4.83	0.43	30
4	Transparency in informing about risks (cost, quality, time, etc.) that may occur during the project period	4.87	4.93	0.06	30
E	**Dimensions of Responsiveness**				
1	The company will provide prompt service to customers and construction professionals on the project	4.27	4.67	0.40	30
2	Level of knowledge of company representatives	4.63	3.80	-0.83	30
3	Responsiveness in following up on requests	4.17	4.50	0.33	30
4	Delivery speed	4.37	4.60	0.23	30

4.2 Kano Model

In this section an analysis of the Kano questionnaire will be carried out. The service attributes that will be categorized come from the Servqual questionnaire questions which are divided into 2 functional and dysfunctional questions, then the answers from the respondents will be sorted and categorization of each service attribute will be carried out using the Better and Worse Analysis method.

The answers from respondents to the Kano questionnaire will be divided into 6 categories, namely attractive; one-dimensional; must be; indifferent; reverse; and questionable. If the Better and Worse Analysis method later finds answers in the reverse and questionable categories, then these answers will be ignored. The following below is a table of results from grouping service attributes based on the Better and Worse Analysis method:

Table 3. Kano Model

No	**A**	**M**	**R**	**O**	**Q**	**I**	Total	Better	Worse	Result
1	2	12	0	14	0	2	30	0,53	0,87	One Dimensional
2	4	18	0	5	0	3	30	0,30	0,77	Must be
3	5	8	0	16	0	1	30	0,70	0,80	One Dimensional
4	5	9	0	12	0	4	30	0,57	0,70	One Dimensional
5	6	7	0	16	0	1	30	0,73	0,77	One Dimensional
6	6	14	0	8	0	2	30	0,47	0,73	Must be
7	8	6	0	14	0	2	30	0,73	0,67	One Dimensional
8	3	6	0	20	0	1	30	0,77	0,87	One Dimensional
9	6	15	0	8	0	1	30	0,47	0,77	Must be
10	14	3	0	12	0	2	30	0,83	0,47	Attractive
11	4	8	0	15	0	3	30	0,63	0,77	One Dimensional
12	2	9	0	14	0	5	30	0,53	0,77	One Dimensional
13	9	4	0	13	0	4	30	0,73	0,57	One Dimensional
14	2	17	0	8	0	3	30	0,33	0,83	Must be
15	2	21	0	5	0	2	30	0,23	0,87	Must be
16	3	7	0	17	0	3	30	0,67	0,80	One Dimensional
17	2	19	0	7	0	2	30	0,30	0,87	Must be
18	6	9	0	12	0	3	30	0,60	0,70	One Dimensional
19	4	20	0	6	0	0	30	0,33	0,87	Must be
20	4	7	0	18	0	1	30	0,73	0,83	One Dimensional
21	3	8	0	16	0	3	30	0,63	0,80	One Dimensional

4.3 Quality Function Deployment

In Quality Function Deployment Analysis, the product design process begins with the formation of a product planning matrix or often referred to as the House of Quality. At the importance of what stage, the data used is data that has a negative gap value, but selection will be carried out using the pareto principle, namely taking 80% cumulative percent of the total service attributes that are in the results table of the importance of what value, so that service attributes that have a negative value are entered. in this 80% cumulative total percent which will be a priority for improvement because these attributes are considered important by customers, but in reality the performance of the services provided is still not satisfying to customers. The following are some of the service attributes that have a negative value as voice of customer data, including the following:

Table 4. Value Importance of What of PT. Konsultan Perencana

No	**Service Attributes**	**Satisfaction Score**	***Kano Weight***		***Importance of What***	**Percentage**	**Cumulative percentage**
1	Have a document and record management system that is	-0.70	O	2	1.4	40%	40%

No	Service Attributes	Satisfaction Score	*Kano Weight*		*Importance of What*	Percentage	Cumulative percentage
	detailed and accurate						
2	Employees use ID-Cards	-0.93	M	1	0.93	27%	67%
3	Level of knowledge of company representatives	-0.83	M	1	0.83	24%	91%
4	Service level after completion of work within a certain time	-0.07	O	2	0.14	4%	95%
5	Show genuine interest in solving customer problems	-0.07	O	2	0.14	4%	99%
6	Show genuine interest in solving customer problems	-0.03	M	1	0.03	1%	100%

The table above explains that of the 6 service attributes that are negative and absolute, the top 3 service attributes are included in the 80% cumulative percent of the total which will be a priority for improvement. So that the priority that must be considered by the management of PT. Konsultan Perencana when carrying out corrective steps. This priority is based on the attributes in How's Customer Requirements, and the priority on improvement steps in What's Technical Response. as shown in Figure 1. House of Quality.

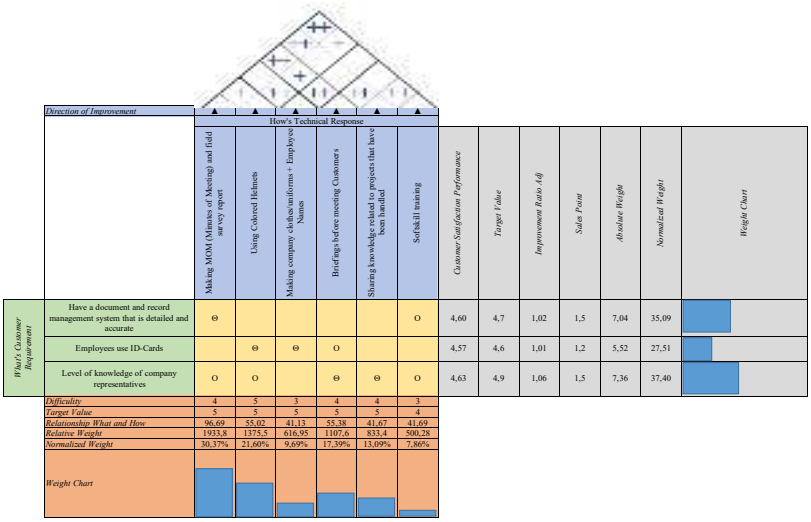

Figure 1. Results House Of Quality

Based on Figure 1, priority improvement steps based on customer satisfaction are as follows:

1. Level of knowledge of company representatives
2. Have a document and record management system that is detailed and accurate
3. Employees use ID-Cards

While the priority of improvement steps based on the Technical Response is as follows:

1. Making MOM (Minutes of Meeting) and field survey report
2. Using Colored Helmets

3. Briefings before meeting Customers
4. Sharing knowledge related to projects that have been handled
5. Making company clothes/uniforms + Employee Names
6. Softskill training

6. CONCLUSIONS

Based on the research conducted, it can be concluded several things, in the Servqual analysis, the results show that there are 6 service attributes that have negative gaps. This means that it can be stated that the performance of PT. Konsultan Perencana are still not fully able to satisfy their customers. The attribute with the highest Gap value is "Employees use ID-Cards" with a Gap value of -0.93; "Level of knowledge of company representatives" with a Gap value of -0.83; “Having a detailed and accurate record and document management system” with a Gap value of -0.70; "Shows genuine interest in solving customer problems" with a Gap value of -0.07; "The level of service after the completion of work within a certain period of time with a Gap value of -0.07; "The presence of company representatives coming to the project " with a Gap value of -0.03.

From the Kano Model analysis, there is 1 service attribute that is included in the attractive category, there are 7 service attributes that are included in the one-dimensional category, and there are 13 service attributes that are included in the must be category.

From the results of the Servqual and Kano Model integration, 3 service attributes are obtained which are priorities for improvement. The three attributes have the following priority order:

1. The Knowledge Level of Company Representatives has a Must-be category and has a Normalized Weight of 37.40%
2. Has a document and record management system that is detailed and accurate in the One-Dimensional category and has a Normalized Weight of 35.09%
3. Employees Use ID-Cards in the Must-be category and have a Normalized Weight of 27.51%

From the analysis of the House of Quality, there are steps to improve services at PT. Konsultan Perencana, in order of priority starting from the highest as follows:

1. Make MOM (Minutes of Meeting) and field survey minutes by having a Normalized Weight of 30.37%
2. Using a Colored Helmet with a Normalized Weight of 21.60%
3. Conducting briefings before meeting customers with a normalized weight of 17.39%
4. Sharing knowledge related to projects that have been handled with a Normalized Weight of 13.09%
5. Make clothes/uniforms from the company named directly on the clothes/uniforms with a Normalized Weight of 9.69%
6. Provide soft skill training with a Normalized Weight of 7.86%

From the results of the Focus Group Discussion with the management of PT. Konsultan Perencana, it has been concluded that there are 5 strategies that can be immediately implemented by the company into a work program to carry out service improvements, namely:

- The work program for the technical response "Making MOM (Minutes of Meeting) and field review minutes" is for management to make MOM formats and field review minutes and include them in draft company documents. Then the results of the MOM and field review minutes are given to the customer via WhatsApp along with the documentation.

- The work program for the technical response "Using Colored Helmets" is for the Head of Supervisor to coordinate with the management team in purchasing colored helmets and company stickers so that they are easily identified and recognized.
- The work program for the technical response "Making clothes/uniforms from the company is named directly on the clothes/uniforms" in which one of the senior staff is given responsibility for making clothing designs that match the character of the company, because the making of these clothes is for long-term use, so if after designing the senior staff can coordinate with the manager regarding the design.
- The work program for the technical response "Conducting a Briefing before meeting the Customer" is that this briefing will be led directly by the company Manager regarding the readiness of company representatives to meet customers starting from the material readiness of the entire customer project to the equipment needed.
- The work program for technical response "Sharing knowledge related to projects that have been handled" is this knowledge sharing led by company managers and senior employees, this sharing is carried out every hour when they come home from work where employees can exchange ideas and convey difficulties -difficulties experienced when conducting field reviews and dealing with customers

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3D MODELLING FLOOD USING LIDAR AND AERIAL PHOTOGRAMMETRY UAV

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ABSTRACT

Surabaya City has excessive rainfall compared to other places in Indonesia, therefore floods occur everywhere during heavy rains due to high sediment in the channel, which prevents rainwater from being accommodated then overflowing onto the road. Three-dimensional (3D) simulation and modeling are ideally suited for use in flood disaster risk management for structures because they provide a visual representation of flooding in 3D at a specific level of detail. LiDAR and aerial photogrammetry are capable of providing this data; both technologies can produce a good visual representation with accurate information. 3D modeling buildings and flood combines Digital Elevation Model (DEM) data from LiDAR and aerial photogrammetry. The unsteady flow approach is also utilized in flood modeling. In this study, three types of DEM data were used: Digital Surface Model (DSM), Digital Terrain Model (DTM), and Normalized Digital Surface Model (nDSM). Aerial photo data is used to updating LiDAR data for 3D building. There are 4,577 models of 3D buildings that have been created. Building height validation on fifty samples of buildings produced an accuracyof 0.86233 m RMSE. Flood visualization in three dimensions is possible by entering several parameters such as river surface elevation, discharge data per unit time, and terrain elevation data. Obtained results, the number of buildings affected by the flood inundation was 1,601 buildings consisting of 85 shops, 1 mosque, 3 health facilities, 4 schools, and the remaining residential buildings.

Keywords: 3D Modelling, Flood, LiDAR, Photogrammetry, DEM.

1. INTRODUCTION

Surabaya is one of the cities in Indonesia that receives a lot of rain. The average rainfall for the city of Surabaya in 2020 is around 200 mm, with the highest rainfall occurring in December 2020, that is 500 mm (Surabaya City Government, 2021).When the rainy season arrives, several areas in Surabaya City are inundated with floodwaters. According to (Surabaya City Water Resources and Bina Marga Services, 2021) inundation data, there are three locations around the study location for Pandugo Street that are also experiencing flood inundation.

Many flood models in one dimension (1D), two dimensions (2D), and three dimensions (3D) have been developed (3D). The 1D model is most commonly used to model the flow in a channel or river channel as a line with channel cross sections at each point on the channel line. The 2D model

can provide flood and inundation information in an urban area by producing several output parameters, including channel cross section, flood water level, flow velocity, flooding area, inundation depth, and inundation duration (Quirogaa et al., 2016).

For decision making, simulation and prediction of the impact of flooding on the physical aspects of infrastructure and public facilities require strong visual representations and accurate information. Three-dimensional (3D) simulation and modeling are best suited for use in flood disaster risk management for buildings in order to create a 3D visual form of flooding in varying Level of Detail (LOD) (Ardiansyah, 2017). Technologies capable of providing this data are LiDAR (Light Detection and Ranging) and aerial photogrammetry, both technologies are capable of supporting the simulation and prediction of the impact of flooding on physical aspects such as buildings, infrastructure and public facilities in order to provide strong visual representations with accurate information.

In this study, LiDAR data and aerial photogrammetry are used to perform three-dimensional modeling. The LiDAR data used was collected by the Surabaya city government in 2016, so it needs to be updated because there are some changes in last 6 years; aerial photo data is used to do so in this case. The author focuses on creating 3D building data with LOD level 2 from LiDAR Digital Elevation Model (DEM) data and aerial photogrammetry. The author also uses the unsteady flow method to simulate flood inundation with a case study on Pandugo Street in Surabaya.

2. THREE-DIMENSIONAL (3D) MODELLING

A three-dimensional city model is a digital representation of the earth's surface and related objects such as buildings, trees, vegetation, and some artificial urban features. A 3D city model is a computerized or digital representation of a city that includes graphical representations of buildings and other objects in 2,5 or 3D (Singh et al., 2013). As digital representations of urban areas, 3D city models can be used to help with many applications, including urban wind and dispersion simulations, energy studies, noise studies, and many other types of analysis that require planned architectural designs. Relevant semantic information, such as the year the building was built, the number of people who live there, and the materials used, can be included with the geometry. These semantically enhanced 3D city models have the potential to be excellent sources of integrated information for computer-based urban analysis, smart cities, and digital twins (Stoter et al., 2020).

Kolbe et al., (2005) explain CityGML (City Geography Markup Language) as a general information model for representing 3D geovirtual environments such as virtual 3D city models in his publication. CityGML has five levels of Level of Details (LOD): LOD1 - regional, landscape; LOD2 - city, region; LOD3 - city district, project; LOD4 - exterior architectural model, landmark; and LOD5 - architectural interior building model.

In this study, three types of digital elevation models were used for 3-dimensional modeling: Digital Surface Model (DSM), Digital Terrain Model (DTM), and Normalized Digital Surface Model (nDSM). Digital Surface Model (DSM) is a model of the earth's surface that includes terrain features, buildings, vegetation, and power lines, among other things. As a result, DSM can represent the topography of the earth's surface. In the meantime, the Digital Terrain Model (DTM) is used to represent the earth's terrain or ground surface. DTM is a statistical representation of the continuous ground surface derived from a large set of randomly chosen points with x, y, and z coordinates and specific references (Kennie & Petrie, 1990). DSM represents all objects on the ground, whereas DTM only represents the ground (Wikantika et al., 2015). Normalized Digital Surface Model (nDSM) is a differential model that is calculated by subtracting a digital field model (DTM), which only represents the topography of the earth in three dimensions (3D), from a digital surface model

(DSM), which represents the 3D earth surface including all terrain and non-terrain objects such as buildings, vegetation, and roads (Sefercik et al., 2017). Technologies capable of providing this data are LiDAR (Light Detection and Ranging) and aerial photogrammetry.

Table 1. LOD 0-4 of CityGML with its accuracy requirements (Albert et al., 2003)

Procedure	LOD 0	LOD 1	LOD 2	LOD 3	LOD 4
Area	regional	city, regional	district, project	Individual building / landmark	interior / model architecture
Accuracy	low		medium		high
3D point accuracy: (position/height) : better than	below LOD1	5 / 5 m	2 / 1 m	0,5 / 0,5 m	0,2 / 0,2 m
Coverage generalization (exception: landmarks)	Maximal generalisation (classification of land use)	object blocks as generalised features; > 6*6 m/3m	object blocks as generalised features; > 4*4 m/2m	object as real features; >2*2 m / 1m	constructive element and opening are represented
component / parts of the building	-	-	-	exterior form	real form
roof shape /structure	None	level/flat	rooftop type and orientation	real form	real form

3. FLOOD MODELLING

The unsteady flow method is used to modelling flood inundation with the case study Jalan Raya Pandugo in Surabaya. This method is able to simulate one dimension; two dimensional; and combined one/two dimensional unsteady flow through a full network of open channels, floodplains, and alluvial fans. It is used to calculate the water surface profile for a gradually changing flow that requires data on water discharge at regular intervals. This method is more effective for modeling water flow in watersheds (Albo-Salih et al., 2022), with a high fit between observed and simulated model values and a short computational time, making it suitable for use as a forecasting model system for inundation flood (Echeverribar et al., 2019).

4. LOCATION OF STUDY

According to Surabaya City Water Resources and Bina Marga Service (2021) inundation data, three points around the study location experienced flood inundation, namely Jl. Raya Medokan Ayu, Medokan Asri Housing Complex, and Medokan Semampir, with a height of 4 cm and an inundation time of 16 minutes. Meanwhile, according to a survey of several residents around the study location conducted by the author, flood inundation on Jalan Raya Pandugo is common, with an inundation height of about 10-15 cm and an inundation duration of up to more than one hour. The author conducted AOI research over a 120-hectare area.

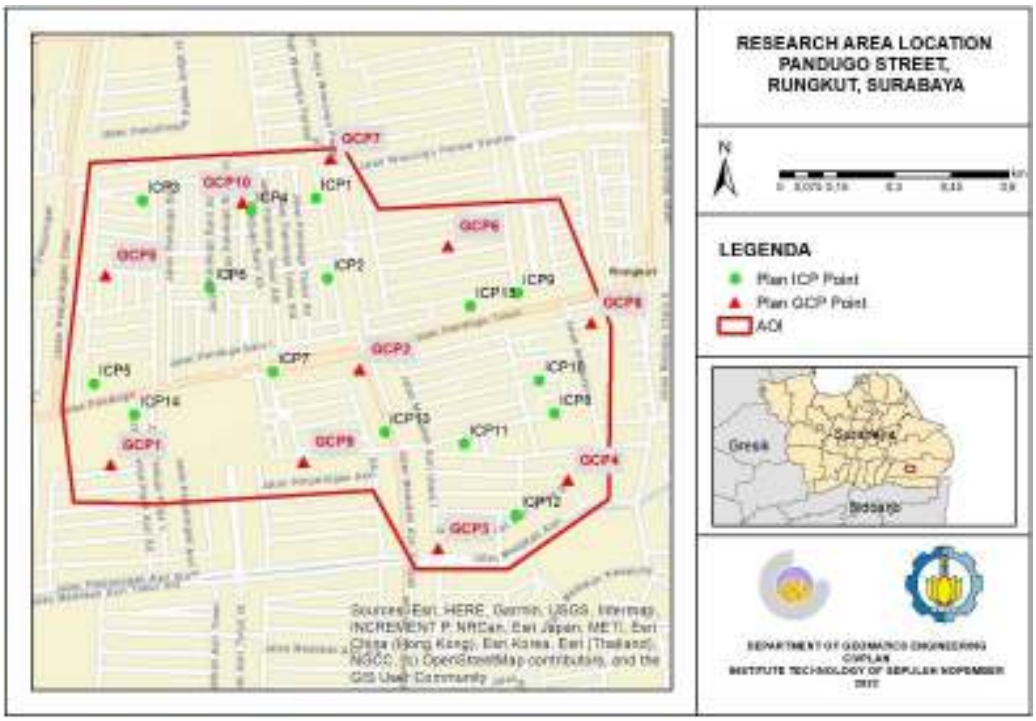


***Figure 1**. Location of Study Pandugo Street Area, Rungkut, Surabaya*

Table 2. Flood inundation in study location according to Surabaya City Water Resources and Bina Marga Service (2021)

No	Location	Sub-District	Flood Area (ha)	Flood Height (cm)	Duration (min)
1	Medokan Ayu Street	Medokan Ayu, Rungkut	0,155418317	4	16
2	Medokan Asri Housing Complex	Medokan Ayu, Rungkut	0,839132879	4	16
3	Medokan Semampir	Medokan Ayu, Rungkut	9,3	4	16

5. DATA AND METHODS

The LiDAR data used in this study are DTM and DSM data acquired by the Surabaya city government in 2016, with a spatial resolution of 25 cm/pixel for DSM and 40 cm/pixel for DTM. For the aerial photo data used in this study are DSM and Orthofoto data collected by the author with the DJI Phantom 4 Pro UAV vehicle with flying height of 120 meters and with a 70% overlap each images. The orthophoto data has a spatial resolution of 5 cm/pixel, meanwhile the DSM aerial image have the same resolution as the LiDAR DSM, which is 25cm/pixel. These data are used to visualize the building's 3D model. Furthermore, water debit data is used for flood modeling.

Figure 2 below illustrates the flow chart steps in modeling buildings and floods in three dimensions. Starting with the process of updating DSM LiDAR data with DSM aerial images, fifty points were collected to compare DSM and DTM aerial photos to LiDAR data. These points were collected on objects that have remained relatively unchanged from 2016 until the time of aerial photo data acquisition in 2022, such as buildings and roads. There are some change happen in the elevation of the object within six years from 2016 (LiDAR data acquisition) to 2022 (aerial images

data acquisition). To determine which areas have experienced elevation changes, the difference between the two DSM data sets can be calculated. Then process updating and removing noise DSM data was performed based on objects/areas that experience elevation changes.

nDSM is obtained by subtracting the DSM data value from the DTM data value so that the only remaining value is the object above the terrain surface. Building footprint data are created by digitizing/converting buildings from orthophoto data to vector data, this method also used in creating road network data. By entering the parameters (building footprint, DSM, DTM, and nDSM) into the software, three-dimensional buildings are established automatically. It is necessary to run an accuracy test to determine how well the model matches the actual situation in the field. This accuracy testing was performed on 30 samples of manufactured building models. The validation data are from field measurements of building heights using total station.

In two-dimensional flood inundation modeling, the data needed is DSM updated data, and hourly water discharge data using the unsteady flow method. Then form a three-dimensional model of flood inundation based on the two-dimensional model formed. The results of the 3D model of buildings and flood inundation are integrated into one model. Orthophoto are also added to visualize objects other than buildings.

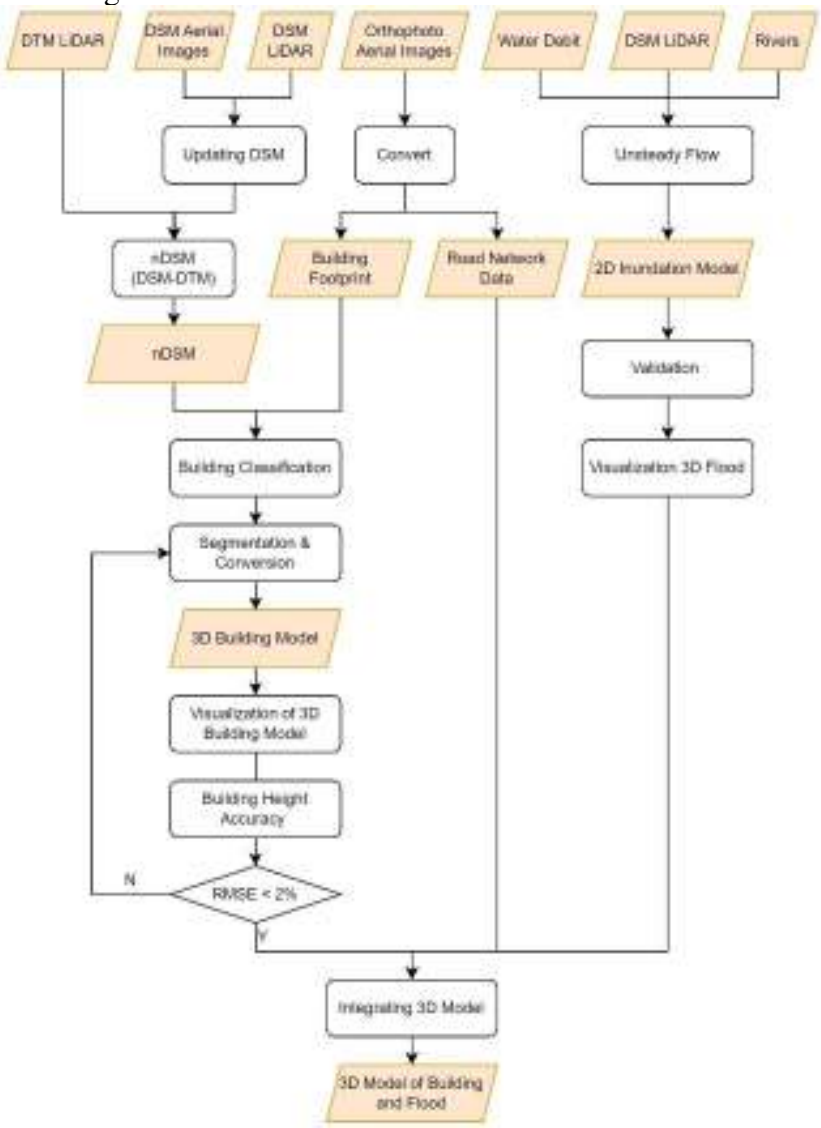
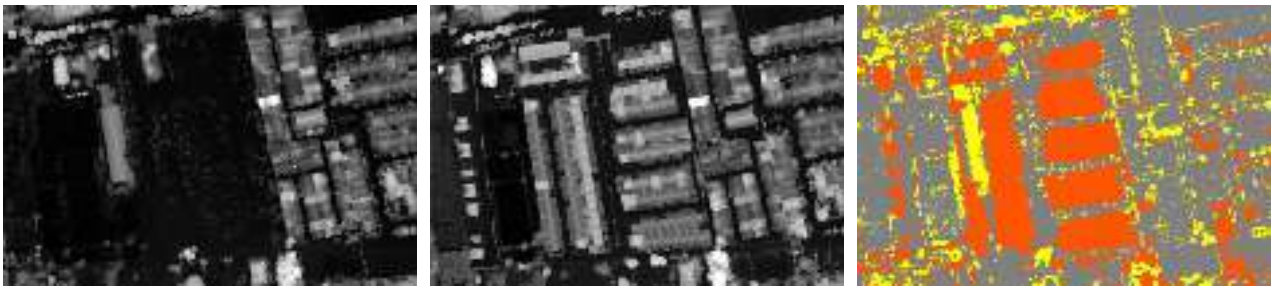


***Figure 2**. Flow chart diagram for 3D modelling*

6. RESULTS

Updating Data DSM

From the fifty points taken for comparison of DSM and DTM aerial photogrammetry against LiDAR data, the average difference between the two DSM data is 0.8295 m with the smallest value 0.3620 m and the largest value 1.3608 m. A decreasing object elevation is represented by yellow, an increase in object elevation is represented by orange, and objects that are largely unchanged in elevation are represented by gray. The majority of object elevation variations are driven by changes in vegetation and buildings, while objects with relatively constant elevation are dominated by buildings and roads.



(a) (b) (c)

***Figure 3**. DSM LiDAR (2016) (a); DSM aerial image (2022) (b); Elevation changes between LiDAR data and aerial image (c)*

Figure 4 below is the result of updating DSM LiDAR data using DSM aerial photogrammetry. The range of values obtained is from 0.642 m to 47.312 m.

***Figure 4**. DSM LiDAR updated using DSM aerial photogrammetry*

3D Model Building

The DSM data used to create the nDSM is LiDAR DSM data that has been updated with DSM aerial photogrammetry data with values ranging from 0.642 m to 47.312 m. The DTM data used is the LiDAR DTM data, with values ranging from 0.256 m to 5.213 m. The nDSM results are as shown in Figure 5 with a value range of -2.019 m to 43.051 m. All elevation data used uses the WGS1984 UTM Zone 49S coordinate system with an orthometric height system which is based on geoid.

***Figure 5**. Normalized Digital Surface Model (nDSM) result*

The formation of three-dimensional buildings is done automatically by entering the parameters into the software. The output of this process is a 3D building which has several attributes in it that explain the characteristics of the roof structure. The 3D building that is formed can be modified through the characteristic attributes of this rooftop such as changing the shape of the rooftop from a flat type to a gable type or other types of rooftops as shown in Figure 4.29. The number of 3D models of buildings formed is 4,577 buildings.

***Figure 6**. Three dimensional building model*

The accuracy test was carried out on 30 samples of building models that have been produced. The validation data are from field measurements of building heights using total station. From the results of the RMSE, a value of 0.86233 m is obtained which meets the LOD2 standard from Albert et al., (2003).

Flood Inundation Modelling

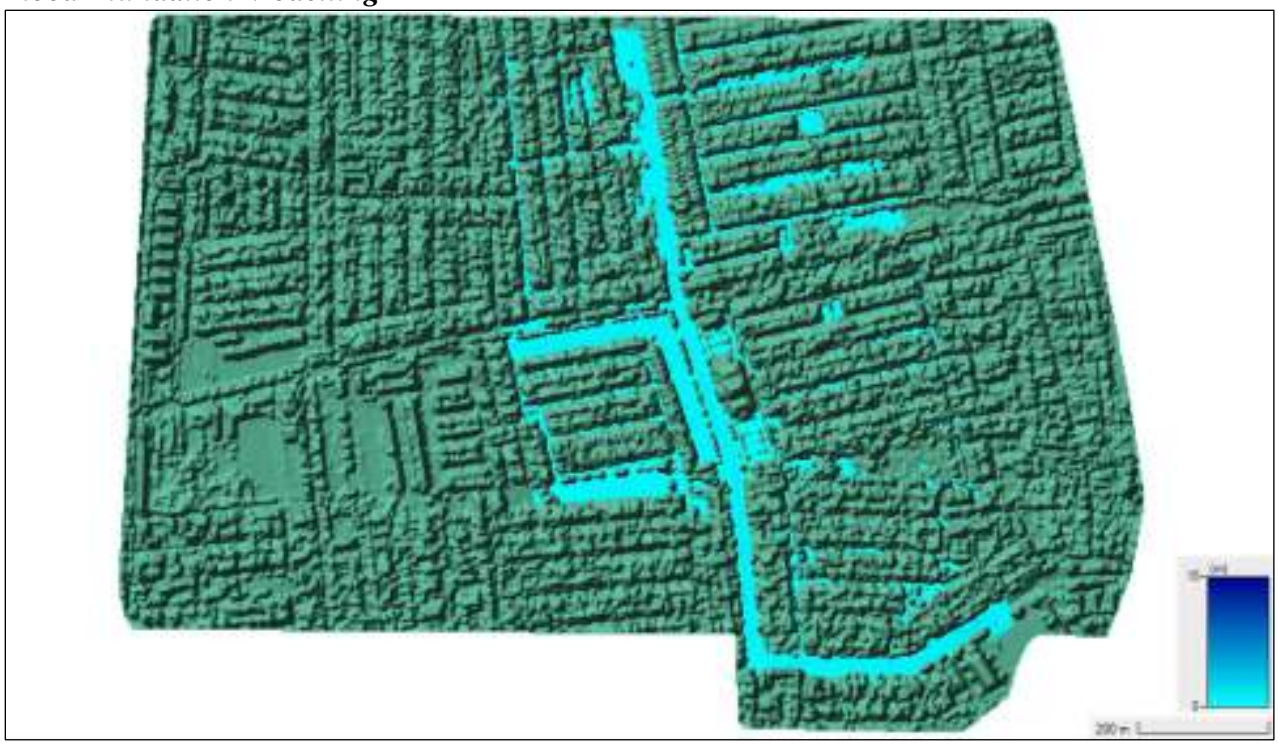


***Figure 7**. 2D flood inundation model*

The method used in this flood inundation modeling is the unsteady flow method, which is used to calculate the water surface profile for a gradually changing flow. The results of the two dimension model formed are in the form of flood raster data which has an inundation height value. Then two dimension flood inundation model raster data needs to be converted first to polygon vector data. The results of a three-dimensional flood model are obtained as shown below.

***Figure 8**. 3D flood inundation model*

Integrating 3D Model

The results of the 3D building model and flood inundation are combined into a single model. Orthophotos are occasionally used to visualize objects other than buildings as shown in Figure 9.

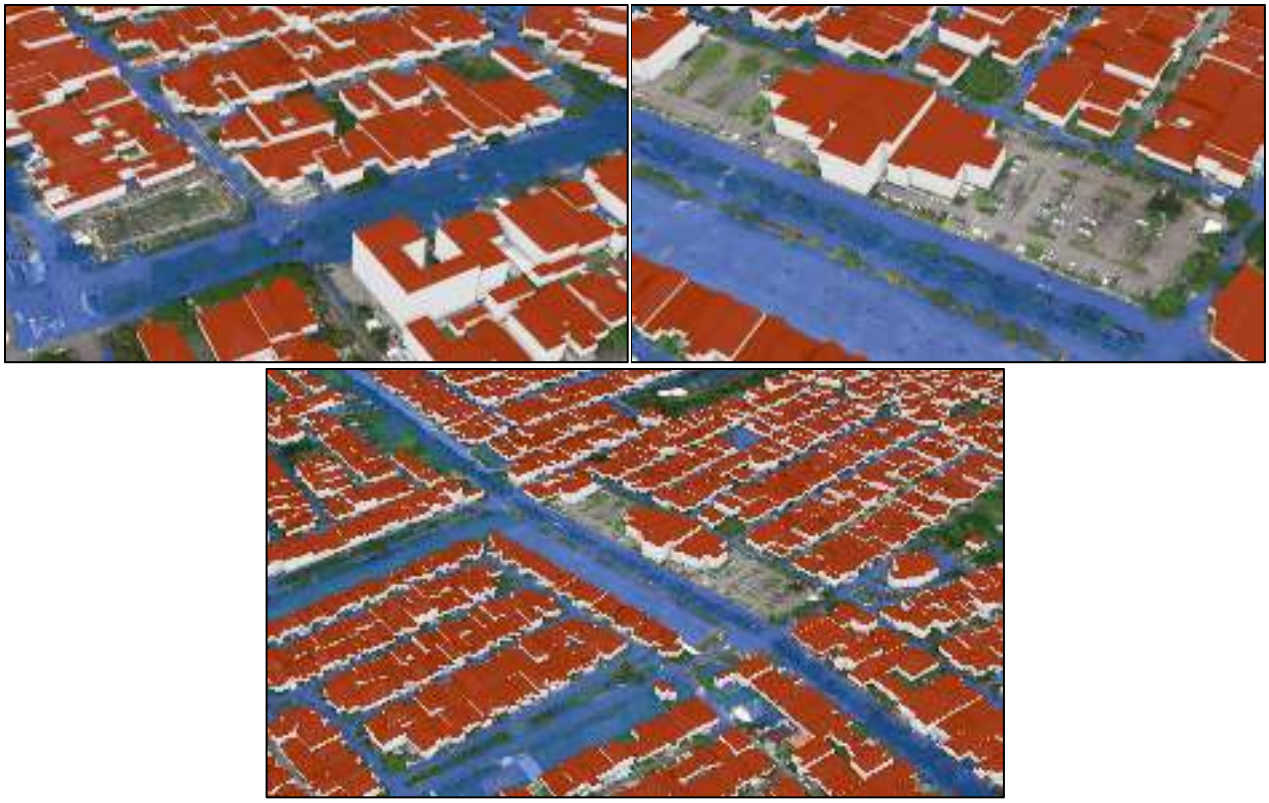


***Figure 9**. 3D building and flood inundation model*

Flood Inundation Impact Analysis

***Table 3**. Affected building by flood inundation*

Affected building	No. of building
Mosque	1
Shops	85
Residential building	1507
Schools	4
Health facilities	3
Total	1601

Based on the results of building footprint and flood models obtained, the number of buildings affected by flood inundation was 1,601 buildings affected consisting of 85 shops, 1 mosque, 3 health facilities, 4 schools, and the remaining residential buildings. Building types are identified through google maps and google street maps and entered into the building attribute table of vector data. And according to the road network and the flood model obtained, road network also affected by flood inundation as shown in Table 4.

***Table 4**. Affected road/street by flood inundation*

No.	Road/Street	No.	Road/Street
1.	Jalan Medokan Asri	8.	Jalan Raya Pandugo Timur
2.	Jalan Medokan Asri Tengah	9.	Jalan Penjaringan Asri
3.	Jalan Medokan Asri Timur	10.	Jalan Penjaringan Sari
4.	Jalan Medokan Asri Utara	11.	Jalan Wisma Medokan
5.	Jalan Pandugo	12.	Jalan Wonoayu
6.	Jalan Pandugo Baru	13.	Jalan Wonoayu Permai Selatan
7.	Jalan Pandugo Praja	14.	Jalan Pandugo Sari

6. CONCLUSIONS

By combining LiDAR data and aerial photogrammetry data which has an average difference value of 0.8295 m, we can create a three-dimensional model that can meet the LOD2 standard from Albert et al., (2003) with a building height RMSE value of 0.86233 m. So that aerial photo data can be used to update LiDAR data in the Digital Elevation Model (DEM) format through several adjustments/modifications.

Three-dimensional flood visualization is possible by entering several parameters such as river surface elevation, debit data per unit time, and terrain elevation data. Based on the results of building footprints, road network and flood models obtained, the number of buildings affected by flood inundation are 1,601 buildings consisting of 1 mosque, 85 shops, 3 health facilities, 4 schools, and the rest are residential buildings. While the public road facilities affected include: Jalan Medokan Asri, Jalan Medokan Asri Tengah, Jalan Medokan Asri Timur, Jalan Medokan Asri Utara, Jalan Pandugo, Jalan Pandugo Baru, Jalan Pandugo Praja, Jalan Raya Pandugo Timur, Jalan Penjaringan Asri, Jalan Penjaringan Sari, Jalan Wisma Medokan, Jalan Wonoayu, Jalan Wonoayu Permai Selatan, and Jalan Pandugo Sari.

However to achieve better accuracy from the three-dimensional results of the building, LiDAR data and aerial photo data should be separated because the two data can have very different elevation values. This difference may be caused by various problems such as the date of the acquisition, the change in objects in the field, the interpolation method, the sensors used for the two data are different, etc.

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ROOT CAUSE ANALYSIS OF CONSTRUCTION DELAY IN JRAGUNG DAM SEMARANG

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ABSTRACT

The problem of water availability during the dry season has not been resolved. The Jragung Dam is constructed to meet the availability of water, especially in the Semarang Regency and its surrounding. The construction of the Jragung Dam could be completed according to the contract period without a hitch if the implementation does not experience a lot of delays. To prevent delays in the construction of Jragung Dam, it is necessary to find the causes of delays and efforts to mitigate the risk of delays. The house of risk (HOR) method is used to find the causes of delays and to mitigate the risk of delays. A framework called the house of risk (HOR) method was developed by combining the failure modes effect analysis (FMEA) model and the house of quality (HOQ) model. The HOR method consists of HOR1 model and HOR2 model. The HOR1 model is used to rank each risk agent based on the aggregate risk potential (ARP_j), and the HOR2 model gives priority to effective handling by compiling preventive action against the risk agent selected in the HOR1 model. From the results of the HOR method, it was found that there are 36 risk agents and 10 risk events. The HOR1 model discovered 15 priority risk agents, and the HOR2 model obtained 14 preventive actions, which can be realized to prevent the emergence of risk agents. Errors and differences in design, and images that are not detailed (A_{22}) with high aggregate risk potential (ARP_j) values is the first risk agent that has a very large occurrence scale and triggers several risk events. Coordinating work sequences between owners, consultants, and contractors regarding the schedule for carrying out related work (PA_{11}) is a preventive action at the first level of risk response and provides effective handling for the smooth running of the Jragung Dam.

Keywords: Delays, risk agent, house of risk (HOR), risk event, preventive action, risk response.

1. INTRODUCTION

The Jragung Dam is located in Semarang Regency, Central Java Province. The Jragung Dam is constructed to meet the availability of water. BBWS Pemali Juana (2020) The implementation time of the construction of Jragung Dam on a Multi Years Contract (MYC) is for 1539 calendar days (October 14, 2020-December 31, 2024). Due to the distance of quarry material is far from the project site, the construction equipment mobilization cannot be carried out until the forest borrowing permit is issued. Additionally, the process of land acquisition and socialization coincides with the implementation time of the construction work. The work relationship between contractors is high so the delay will have an impact on other contractors. These construction problems could hinder project completion, so research was conducted on the cause of construction delays and to prevent

delays so that the Jragung Dam was completed according to a contract period. The house of risk (HOR) was discovered by Pujawan and Geraldin (2009), is used to find the causes of delays and make delay mitigation.

2. LITERATURE REVIEW

Construction Delay

Assaf and Al-Hejji (2006) argued that construction delay is defined as an excess contract period, or the project completion date was due upon the agreed time by both parties. For the owner, the delay means a loss of revenue on productive facilities and room rentals. For the contractor, the delay means increased overhead costs due to increased implementation time, increased material prices due to inflation, and increased labor costs. Nagata et al. (2018) argued that there are several definitions of delay, a situation that occurs later than expected, something that does later than planned, and a situation that exceeds the deadline. From some of these definitions, it can be concluded that delay is the lagging of work activities from the implementation time. Hanks et al. (2010) interpreted the delay as a period where something is late. Hamzah et al. (2011) the delay means excessed time or an extension of the time to complete the project. Agyekum-Mensah and Knight (2017) interpreted the delay as an inability to meet the scheduled time.

From the explanation of construction delay. A construction delay is an event where construction work cannot be completed according to the contract period for a certain reason and the impact is felt by all parties.

Risk Events and Risk Agents

Trenggonowati and Pertiwi (2017) defined risk events (Ei) are all events that may arise in the supply chain process which result in losses to the company which can be measured using a severity scale and risk agents (Aj), namely any factor that may lead to the occurrence of an identified risk events which is measured using the occurrence scale. Sibuea and Saragi (2019) explained risk agents (Aj) are the factor that causes risk events so that preventive actions need to be taken. Oktavia et al. (2013) argued risk events are an event that causes a loss during the event, while risk agents are trigger factor for the emergence of risk. PT. Waskita Karya (Persero) Tbk. (2018) in the risk management implementation guidebook, explained risk events are an event that can have a negative impact on the company both financially and non-financially, and hinder the company's goals. Risk agents are the causes of a risk event.

From the explanation of risk events and risk agents above. Thus, the researcher concludes that a risk event (E_i) is events that can cause losses as measured using a severity scale and risk agent (A_j) is factors that can cause risk events as measured using an occurrence scale.

House of Risk (HOR)

Pujawan and Geraldine (2009) discovered a new proactive risk management model. In risk management, pro-active means an attempt at preventive action against the risk agents. Several preventive actions are taken to prevent one or more risk agents. The risk management method is called a house of risk (HOR), which is a combination method between the failure mode and effect analysis (FMEA) model and the house of quality (HOQ) model. Sankar and Prabhu (2001) stated that FMEA has proven to be used in assessing and preventing potential failures. The FMEA model is known as a risk assessment method for calculating the risk potential number (RPN), which is the multiplication of the probability of occurrence value (O), severity value (S), and detection value (D). Zohrehvandi and Khalilzadeh (2019) FMEA serve to reduce the possibility of a similar occurrence, and this method is the most used in predicting risks.

Hauser (1993) stated that the HOQ model is part of quality function deployment (QFD). The QFD uses four matrices, called houses, to integrate requirements information. The HOQ model is

used to understand customers wishes and translate them. Temponi et al. (1999) argued that the HOQ model was a matrix of the QFD iteration process. The HOQ is the belief that the designed product reflects the customer's wishes. Pujawan and Geraldin (2009) argued that the stages of the FMEA model identify risks and their impacts, assess the possibility of risk agents, and calculate the aggregate risk potential for each risk agent. In the FMEA model, risk events are related to the possibility of occurrence (O) and severity (S). In the HOR model, the risk event is related to severity (S), and the risk agent is related to the possibility of occurrence (O). Pujawan and Geraldin (2009) argued that the HOQ model is used to prioritize which risk agents will be addressed first and select effective actions to reduce the occurrence of risk agents.

Pujawan and Geraldin (2009) proposed two HOR models based on the modification of the HOQ model. The HOR1 model is used to rank each risk agent based on the aggregate risk potential (ARP), and the HOR2 model gives priority to effective handling by compiling preventive action against the risk agent selected in HOR1 model.

3. METHODS

Research Data

The research data methods are interviews and questionnaires. Research data aims to obtain information about the causes of construction delays in Jragung Dam. The causes of construction delay are analyzed based on risk agent and risk event variables obtained from the literature review. Measurement of risk agent and risk event variables is based on the assessment of respondents through interviews and questionnaires. The sampling technique used nonprobability sampling with purposive sampling. The relationship between the causes of construction delay will be modeled with the house of risk (HOR).

Risk Analysis

The analysis of construction delay in Jragung Dam is carried out with the stages of the HOR1 model, namely:

a. Identify risks related to achieving objectives in each construction process of the Jragung Dam. Collect data on the sources of risk events in the business process. Risk events that affect the business process symbolized E_i.
b. Assess the severity of each risk event. The severity of the risk event symbolized S_i. PT. Waskita Karya (Persero) Tbk (2018) severity scale 1 to 4. Explanation in Table 1.

Table 1. Severity Scale

Severity Scale (S_i)	**1**	**2**	**3**	**4**
Desciption	Light	Moderate	Heavy	Very Heavy

c. Collect data on risk agents and rate the occurrence of each risk agent. The risk agents symbolized A_j and the occurrence scale symbolized O_j. PT Waskita Karya (Persero) Tbk (2018) occurrence scale of 1 to 4. Explanation in Table 2.

Table 2. Occurrence Scale

Occurrence Scale (O_j)	**1**	**2**	**3**	**4**
Desciption	Small	Medium	Large	Very Large

d. Determine the relationship between each risk event and risk agent, symbolized by R_{ij}. Pujawan and Geraldin (2009) the R_{ij} relationship is determined by numbers 0, 1, 3, and 9. An assessment of 0 means there is no R_{ij} relationship, 1 means the R_{ij} relationship is low, 3 means the R_{ij} relationship is medium, and 9 means the R_{ij}

relationship is high. Cahyani et al. (2016) The relationship between risk events and risk agents is determined by expert judgment. Explanation in Figure 1.

RISK EVENTS (E_i) / SEVERITY SCALE (S_i)	Small 1	Medium 2	Large 3	Very Large 4
4 Very Heavy	Medium 4	Medium 8	High 12	High 16
3 Heavy	Medium 3	Medium 6	High 9	High 12
2 Moderate	Low 2	Medium 4	Medium 6	High 8
1 Light	Low 1	Low 2	Medium 3	High 4
	OCCURRENCE SCALE (O_j)			
	RISK AGENTS (A_j)			

Figure 1. Risk Map Relationship Between Risk Event and Risk Agent

e. Calculate the aggregate risk potential (ARP_j) value. The ARP_j value is obtained from the calculation of the occurrence (O_j) and severity (S_i) resulting from the relationship between risk events and risk agents (R_{ij}). ARP_j value determine the priority ranking of risk agents. The calculation of the ARP_j value is as follows:

$$\boldsymbol{ARP_j = O_j \sum_i S_i R_{ij}}$$

f. Assign priority rank the risk agents based on the ARP_j value and sorting from the highest value to the smallest value. The priority ranking in the HOR1 model symbolized PP_j.

The analysis of construction delay in Jragung Dam is carried out with the stages of the HOR2 model, namely:

a. Selecting risk agents based on high aggregate risk potential (ARP_j) value and analyzing ARP_j value with a Pareto diagram.
b. Identify preventive actions that are appropriate to the risk agent. Each risk agent (A_j) can be prevented by several preventive actions. Each preventive action can reduce the probability of several risk agents (A_j) occurring. Preventive action is obtained from a literature review and the judgment expert. Preventive action symbolized PA_k.
c. Determine the relationship between preventive action and risk agent, symbolized by E_{jk}. Pujawan and Geraldin (2009) the E_{jk} relationship is determined by numbers 0, 1, 3, and 9. An assessment of the number 0 means there is no E_{jk} relationship, 1 means the E_{jk} relationship is low, 3 means the E_{jk} relationship is medium and 9 means the E_{jk} relationship is high. Cahyani et al. (2016) The relationship between preventive actions and risk agents (E_{jk}) is determined by judgment expert through interviews and discussions.
d. Calculate the total effectiveness action (TE_k) of each preventive action (PA_k). The calculation of the TE_k value is as follows:

$$TE_k = \sum_j ARP_j \, E_{jk}$$

e. Rating the degree of difficulty performing, symbolized by D_k. Pujawan and Geraldin (2009) Likert scale 3, 4, and 5. Cahyani et al. (2016) The degree of difficulty performing (D_k) is determined by judgment experts through interviews and discussions. Explanation in Table 3.

Table 3. The Degree of Difficulty of Performing

The Degree of Difficulty Performing (D_k)	3	4	5
Desciption	Low	Medium	High

f. Calculating the effectiveness to difficulty ratio, symbolized by ETD_k. The calculation of the ETD_k value is as follows:

$$ETD_k = \frac{TE_k}{D_k}$$

g. Assign the ranking of each preventive action, symbolized by R_k. The highest ETD_k value is shown in the first rank.

4. RESULTS

4.1 PRELIMINARY SURVEY

In this study, the population were employees of PT Waskita Karya (Persero) Tbk, who worked on the Jragung Dam. The sampling involved 4 experts in the preliminary survey to provide an assessment of each variable through interviews and questionnaires. Kesuma (2019) 4 experts are sufficient to determine the initial variables in the preliminary survey. The criteria for judgment experts are part of project management, knowing the problems in the Jragung Dam, at least 5 years of experience in their fields, and the last education is at least an associate degree (D3).

Table 4. Risk Events in Preliminary Survey

No.	Risk Events (E_i)	Mean	Standard Deviation	Description
1	Delay in work due to the other contractor	4.75	0.50	Relevant
2	Permit delays	4.75	0.50	Relevant
3	Force majeure events (weather conditions, natural disasters, non-natural disasters)	4.25	0.96	Relevant
4	Delay in work due to the owner	4.00	1.15	Relevant
5	Delay in work due to the consultant	3.75	0.50	Relevant
6	Material delays	3.50	0.58	Relevant
7	Delay in work due to the equipment	3.50	0.58	Relevant
8	Design delays	3.25	0.96	Relevant
9	Late payement	3.25	0.50	Relevant
10	Delay in work due to the labor	3.00	0.82	Relevant

Rohman (2017) used a questionnaire with a Likert scale to obtain research variables in the preliminary survey. Likert scale from 1 (not relevant) to 5 (very relevant). Furthermore, variable ranking is carried out based on the mean value and standard deviation. The higher mean value indicates the high relevance to measuring a variable. The mean value of 3 as the midpoint of the score is used as a cut-off point to determine the relevant research variables. Rohman and Wiguna (2019) used mean and standard deviation to analyze the level of relevance variables. Kesuma (2019)

used a mean value greater than or equal to 3, meaning that the research variables were quite relevant to the scope of the research. It found relevant research variable that there are 36 risk agents and 10 risk events in preliminary survey. Explanation in Table 4 and Table 5.

Table 5. Risk Agents in Preliminary Survey

No.	Risk Agents (Aj)	Group	Mean	Standard Deviation	Description
1	Delay in obtaining permits from government	External Factor	4.50	0.58	Relevant
2	Weather Conditions	External Factor	4.50	1.00	Relevant
3	Another Variable : Land Acquisition	Owner	4.25	0.96	Relevant
4	Late in reviewing and approving design	Consultant	4.00	1.15	Relevant
5	Infectious Disease / virus	External Factor	4.00	0.82	Relevant
6	Legal disputes with various part	*Owner*	3.75	1.26	Relevant
7	Delay in sub-contractors work	Contractor	3.75	0.50	Relevant
8	Frequent change of sub-contractors because of their inefficient work	Contractor	3.75	1.26	Relevant
9	Delay in approving major change in scope of work	Consultant	3.75	0.96	Relevant
10	Errors and differences in design, and images that are not detailed	Consultant	3.75	0.96	Relevant
11	Shortage in equipment	Equipment	3.75	0.50	Relevant
12	Unforseen ground conditions	External Factor	3.75	1.50	Relevant
13	Delay in progress payments	*Owner*	3.50	0.58	Relevant
14	Late in revising and approving design	*Owner*	3.50	1.00	Relevant
15	Delay in approving shop drawings and material	*Owner*	3.50	1.00	Relevant
16	Slowness in decision making process	*Owner*	3.50	1.29	Relevant
17	Difficulties in financing project	Contractor	3.50	1.29	Relevant
18	Conflict between consultant and design engineer	Consultant	3.50	1.29	Relevant
19	Inadequate experience of consultant	Consultant	3.50	0.58	Relevant
20	Insufficient data collection and survey before design	Consultant	3.50	1.00	Relevant
21	Changes in material types and specifications during constructions	Material	3.50	1.29	Relevant
22	Delay in material delivery	Material	3.50	1.29	Relevant
23	Late procurement of materials	Material	3.50	1.29	Relevant
24	Poor communication and coordination by owner and other parties	*Owner*	3.25	0.50	Relevant
25	Conflicts in contractors schedule in execution of project	Contractor	3.25	1.26	Relevant
26	Delay in work approval dan shop drawings	Consultant	3.25	0.50	Relevant
27	Shortage of construction materials	Material	3.25	0.96	Relevant
28	Equipment breakdowns	Equipment	3.25	0.96	Relevant
29	Traffic control and restriction at project site	External Factor	3.25	0.96	Relevant
30	Unrealistic contract duration	Owner	3.00	1.15	Relevant
31	Conflict between contractor and other parties	Contractor	3.00	1.41	Relevant
32	Ineffective planning and schedulling of project by contractor	Contractor	3.00	0.82	Relevant
33	Improper construction methods implemented	Contractor	3.00	1.41	Relevant
34	Delay in inspection and testing	Consultant	3.00	0.82	Relevant
35	Poor communication and coordination between consultant and other parties	Consultant	3.00	0.82	Relevant
36	Quality of material	Material	3.00	0.82	Relevant
37	Change orders by owner during construction	Owner	2.75	0.50	Irrelevant

Table 5. Risk Agents in Preliminary Survey (Continued)

No.	Risk Agents (Aj)	Group	Mean	Standard Deviation	Description
38	Misunderstanding of owner's requirements by design engineer	Consultant	2.75	0.50	Irrelevant
39	Price escalation of materials	Material	2.75	0.96	Irrelevant
40	Low productivity and efficiency of equipment	Equipment	2.75	0.96	Irrelevant
41	Shortage of labors	Labor	2.75	0.96	Irrelevant
42	Suspension of work by owner	Owner	2.50	0.58	Irrelevant
43	Low level of equipment-operator skill	Equipment	2.50	0.58	Irrelevant
44	Unqualified workforce	Labor	2.50	0.58	Irrelevant
45	Rework due to errors during construction	Contractor	2.25	0.50	Irrelevant
46	Poor communication and coordination between contractor and other parties	Contractor	2.25	0.50	Irrelevant
47	Low productivity of labors	Labor	2.25	0.50	Irrelevant
48	Accident during construction	External Factor	2.00	0.82	Irrelevant
49	Poor management and supervision	Contractor	1.75	0.96	Irrelevant
50	Conflicts among labors	Labor	1.75	0.50	Irrelevant

4.2 MAIN SURVEY AND RISK ANALYSIS

The sampling involved 10 experts in the main survey to provide an assessment of each variable through interviews and questionnaires. Ongkowijoyo (2017) conducted similar research in the main survey of risk assessment involving only 5 respondents. Thus, the number of 10 employees or experts are sufficient to provide the main survey assessment.

Table 6. Risk Events in Main Survey

Code	Risk Events (E_i)	Severity Scale (S_i)
E_1	Delay in work due to the owner	3
E_2	Delay in work due to the other contractor	4
E_3	Delay in work due to the consultant	3
E_4	Material delays	4
E_5	Delay in work due to the equipment	3
E_6	Delay in work due to the labor	3
E_7	Permit delays	3
E_8	Design delays	4
E_9	Late payement	3
E_{10}	Force majeure events (weather conditions, natural disasters, non-natural disasters)	4

Table 7. Risk Agents in Main Survey

Code	Risk Agents (A_j)	Group	Occurrence Scale (O_j)
A_1	Delay in progress payments	Owner	3
A_2	Late in revising and approving design	Owner	3
A_3	Delay in approving shop drawings and material	Owner	3
A_4	Legal disputes with various part	Owner	2
A_5	Slowness in decision making process	Owner	2
A_6	Poor communication and coordination by owner and other parties	Owner	2
A_7	Unrealistic contract duration	Owner	3
A_8	Another Variable : Land Acquisition	Owner	4
A_9	Difficulties in financing project	Contractor	3
A_{10}	Conflicts in contractors schedule in execution of project	Contractor	4
A_{11}	Conflict between contractor and other parties	Contractor	3
A_{12}	Ineffective planning and schedulling of project by contractor	Contractor	2
A_{13}	Improper construction methods implemented	Contractor	2
A_{14}	Delay in sub-contractors work	Contractor	3
A_{15}	Frequent change of sub-contractors because of their inefficient work	Contractor	2
A_{16}	Delay in inspection and testing	Consultant	2
A_{17}	Delay in approving major change in scope of work	Consultant	3
A_{18}	Poor communication and coordination between consultant and other parties	Consultant	3
A_{19}	Late in reviewing and approving design	Consultant	4
A_{20}	Conflict between consultant and design engineer	Consultant	4
A_{21}	Inadequate experience of consultant	Consultant	2
A_{22}	Errors and differences in design, and images that are not detailed	Consultant	4
A_{23}	Insufficient data collection and survey before design	Consultant	3
A_{24}	Delay in work approval dan shop drawings	Consultant	3
A_{25}	Shortage of construction materials	Material	3
A_{26}	Changes in material types and specifications during constructions	Material	3
A_{27}	Delay in material delivery	Material	3
A_{28}	Late procurement of materials	Material	2
A_{29}	Quality of material	Material	2
A_{30}	Equipment breakdowns	Equipment	2
A_{31}	Shortage in equipment	Equipment	2
A_{32}	Infectious Disease / virus	External Factor	2
A_{33}	Delay in obtaining permits from government	External Factor	3
A_{34}	Weather Conditions	External Factor	3
A_{35}	Traffic control and restriction at project site	External Factor	2
A_{36}	Unforseen ground conditions	External Factor	2

Cahyani et al. (2016) used the mean value and rounded the numbers. The last decimal number is more than equal to 5 then round up. The last decimal number is less than 5 then round down. Explanation in Table 6 and Table 7.

The HOR1 model is used to rank each risk agent based on the aggregate risk potential (ARP_j). Explanation in Table 8.

Table 8. The HOR1 Model

Risk Events (Ei)	Risk Agents (Aj)																																		Severity of Risk Events (S_i)
	Owner								Contractor							Consultant									Material					Equipment		External Factor					
	A_1	A_2	A_3	A_4	A_5	A_6	A_7	A_8	A_9	A_{10}	A_{11}	A_{12}	A_{13}	A_{14}	A_{15}	A_{16}	A_{17}	A_{18}	A_{19}	A_{20}	A_{21}	A_{22}	A_{23}	A_{24}	A_{25}	A_{26}	A_{27}	A_{28}	A_{29}	A_{30}	A_{31}	A_{32}	A_{33}	A_{34}	A_{35}	A_{36}	
E_1					3	3	9																	9	9										3
E_2										9	9												9												4
E_3																3		9			3			9												3
E_4												3		9												9	3	3						3		4
E_5													3	9	3														3	3						3
E_6																	9					9														3
E_7				3				9														9										9				3
E_8		9	9														9		9	9		9	9													4
E_9	9								9																											3
E_{10}																														3		9		3	4
Occurrence of Agent (Oj)	3	3	3	2	2	2	3	4	3	4	3	2	2	3	2	2	3	3	4	4	2	4	3	3	3	3	3	2	2	2	2	3	3	2	2	
Aggregate Risk Potential (ARPj)	81	108	108	18	18	18	81	108	81	144	108	24	18	189	18	18	189	81	144	144	18	360	108	81	81	81	108	24	24	18	18	24	81	108	24	24	
Priority Rank of Agent (PPj)	16	7	8	28	29	30	17	9	15	4	10	22	31	2	32	33	3	18	5	6	34	1	11	19	20	21	12	23	24	35	36	25	14	13	26	27	

Pujawan and Geraldin (2009) created a pareto diagram and selected risk agent (A_j) of about 75% percent of the total ARP_j value. 15 risk agents (Aj) sorted according to risk priority in the HOR1 model, which have a cumulative percentage of ARPj (%) below 75% are involved in the preparation of the HOR2 model, A_{22}, A_{14}, A_{17}, A_{10}, A_{19}, A_{20}, A_2, A_3, A_8, A_{11}, A_{23}, A_{27}, A_{34}, A_{33}, and A_9. Explanation in Table 9 and Figure 2.

The results of identifying risk agents (A_j) that have a high ARP_j value are errors and differences in design, and images that are not detailed (A_{22}) with an ARP_j value of 360. Risk agents (A_j) that have a high ARP value mean that the risk agents have a very large occurrence scale and trigger several risk events.

Table 9. Priority Rank the Risk Agents

Rank	Code	Risk Agents (Aj)	ARP_j	ARP_j (%)	Cumulative ARP_j (%)	Group
1	A_{22}	Errors and differences in design, and images that are not detailed	360	12.50%	12.50%	Consultant
2	A_{14}	Delay in sub-contractors work	189	6.56%	19.06%	Contractor
3	A_{17}	Delay in approving major change in scope of work	189	6.56%	25.63%	Consultant
4	A_{10}	Conflicts in contractors schedule in execution of project	144	5.00%	30.63%	Contractor
5	A_{19}	Late in reviewing and approving design	144	5.00%	35.63%	Consultant
6	A_{20}	Conflict between consultant and design engineer	144	5.00%	40.63%	Consultant
7	A_2	Late in revising and approving design	108	3.75%	44.38%	Owner
8	A_3	Delay in approving shop drawings and material	108	3.75%	48.13%	Owner
9	A_8	Another Variable : Land Acquisition	108	3.75%	51.88%	Owner
10	A_{11}	Conflict between contractor and other parties	108	3.75%	55.63%	Contractor
11	A_{23}	Insufficient data collection and survey before design	108	3.75%	59.38%	Consultant
12	A_{27}	Delay in material delivery	108	3.75%	63.13%	Material
13	A_{34}	Weather Conditions	108	3.75%	66.88%	External Factor
14	A_{33}	Delay in obtaining permits from government	81	2.81%	69.69%	External Factor
15	A_9	Difficulties in financing project	81	2.81%	72.50%	Contractor

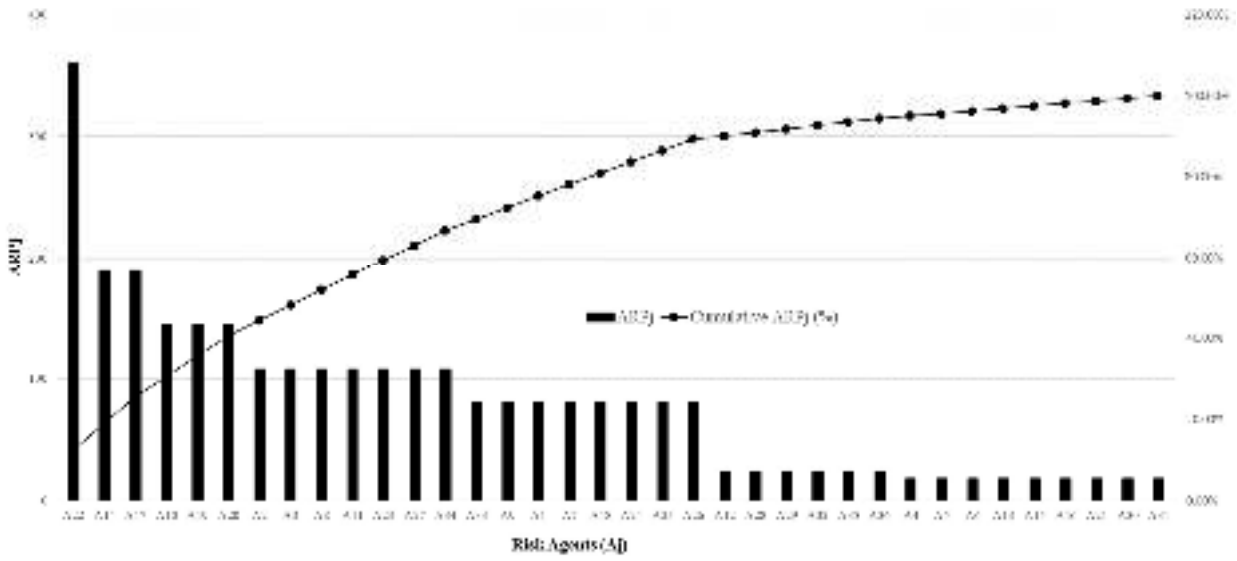

Figure 2. Pareto Diagram of the HOR1 Model

Table 10. Preventive Actions

Code	Preventive Actions (PA_k)
PA_1	The consultant prioritizes checking, reviewing, and approving the design.
PA_2	The Design Engineer creates a design completion schedule and makes corrections to the design documents.
PA_3	Design errors by designers due to ignorance of local and environmental conditions. Determining the right laboratory because design decisions are based on the results of soil investigations.
PA_4	Calling workers and motivating them to increase productivity.
PA_5	Contractors must be able to manage finances and plan cash flow by utilizing progress payments, planning, and resource requirements and time.
PA_6	The owner paid the progress payment to the contractor on time due to the contractor's limited ability to fund the work.
PA_7	Owner expedites drawing document review and approval.
PA_8	Assign engineering and administrative staff to complete the work within the required time, quality, and estimated cost.
PA_9	Hire experts or improve the ability of engineers in charge of management with training.
PA_{10}	The consultant should be flexible in evaluating performance and compromising on cost and quality.
PA_{11}	Coordinating work sequences between owners, consultants, and contractors regarding the schedule for carrying out related work
PA_{12}	The owner makes reasonable compensation payments and socializes with the community regarding the benefits of development.
PA_{13}	Contractors maximize construction work at any given time by adding tools and labor.
PA_{14}	Correspond and monitor permits related to construction work.

14 preventive actions (PA_k) were obtained from literature review and judgment experts. Explanation In Table 10.

Table 11. The HOR2 Model

To be Treated Risk Agents (Aj)	Preventive Actions (PAk)														Aggregate Risk Potentials (APRj)
	PA_1	PA_2	PA_3	PA_4	PA_5	PA_6	PA_7	PA_8	PA_9	PA_{10}	PA_{11}	PA_{12}	PA_{13}	PA_{14}	
A_{22}	1	1	3												360
A_{14}				1	9	3									189
A_{17}	3						9								189
A_{10}								3	1		9				144
A_{19}	3	3					3								144
A_{20}		3							3	3					144
A_2	3	3					3								108
A_3	1						3	3							108
A_8											3	9			108
A_{11}									1		9				108
A_{23}			9						1						108
A_{27}								1	1						108
A_{34}											1		3		108
A_{33}											3			9	81
A_9					4										81
Total Effectiveness of Action k (TEk)	1791	1548	2052	189	2025	567	2781	864	900	432	2943	972	324	729	
Degree of Difficulty Performing Action k (Dk)	3	3	5	3	4	3	4	3	3	3	3	5	3	3	
Effectiveness to Difficulty Ratio (ETDk)	597	516	410	63	506	189	695	288	300	144	981	194	108	243	
Rank of Priority k (Rk)	3	4	6	14	5	11	2	8	7	12	1	10	13	9	

The HOR2 model gives priority to effective handling by compiling preventive action against the risk agent selected in the HOR1 model. The most effective preventive action in the research HOR2 model is coordinating work sequences between owners, consultants, and contractors regarding the schedule for carrying out related work (PA_{11}), evidenced by the effectiveness to difficulty ratio (ETD_k) which is 981. Explanation in Table 11.

5. CONCLUSIONS

The HOR1 model discovered 15 priority risk agents, and the HOR2 model obtained 14 preventive actions, which can be realized to prevent the emergence of risk agents. Errors and differences in design, and images that are not detailed (A_{22}) with high aggregate potential (ARP_j) values is the first risk agent that has a very large occurrence scale and triggers several risk events. Coordinating work sequences between owners, consultants, and contractors regarding the schedule for carrying out related work (PA_{11}) is a preventive action at the first level of risk response and provides effective handling for the smooth running of the Jragung Dam. The effectiveness of preventive action is mean that preventive action can prevent the occurrence of several risk agents, and their implementation is easy for the company.

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ANALYSIS OF THE SUPPLY CHAIN FACTORS AFFECTING DELAY OF INFRASTRUCTURE PROJECTS

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ABSTRACT

Harmonized coordination and communication along the supply chain will make projects that are of the right quality, on time, and on cost. In reality, most infrastructure projects experience delay factors, and this will cause an impact on economic growth. This thesis examines the factors that cause delays along the supply chain of infrastructure construction projects. The most effective technical response to overcome these delays is using the Quality Function Deployment (QFD) method to translate consumer needs, starting with creating a House of Quality (HOQ) matrix. The results showed that there are 16 factors causing delays in infrastructure projects and 12 effective strategies to overcome these delays. However, there are 3 delay factors that have the biggest role, that is inadequate planning/procurement work programs, poor communication and coordination, and late procurement processes, and also there are 3 strategies that have the greatest effectiveness, namely making procurement program plans with related work units, managing procurement according to work plan targets and costs, and monitoring also evaluating the implementation of procurement program planning periodically.

Keywords: Infrastructure Projects, Delay Project, Supply Chain Management, Quality Function Deployment, House of Quality.

1. INTRODUCTION

Indonesia has already carried out the development 1,640 land toll roads, 124 new ports, 15 new Indonesia has already carried out development 1,640 land toll roads, 124 new ports, 15 new airports, and 22 new dams for energy generation. Infrastructure development is needed to improve inter-regional connectivity. It can strengthen the national logistics system so that economic impacts can be implemented immediately. Every construction project has targets known as project objectives. One of the parameters used to measure the success of a project is the timely completion of the project. There are many factors that can cause projects not to be completed on time. To maintain the flow of goods, information flow and financial flow, it is necessary to implement a supply chain management.

Supply chain management is a strategy to improve company performance. Performance is the result of work done by a person, group, or business entity. There are 3 criteria that measure the success of construction project management. These are cost, time and quality which is often illustrated as the project management triangle. The Indonesian government realizes the importance of building quality road infrastructure, ports, airports, and bridges to make the business and investment climate more attractive. Delays in the development of infrastructure projects will cause

losses to the national economy. Road infrastructure is one of the important infrastructures in economic development and people's welfare.

A study is needed that can identify the factors causing delays in development projects and examine what strategies are appropriate so that opportunities for construction project activities can be realized. By implementing good supply chain management, it is expected to minimize the factors that result in delays in construction projects. The supply chain concept can be applied to all types of construction projects for buildings, roads, bridges, piers, and others. It focuses on relationship management between the parties involved in the project internally and externally. The formation of the right supply chain pattern will provide added value and reduce waste.

The complexity of the project indirectly contributes significantly to the procurement management strategy from planning to determining partners. Various problems related to the availability of resources, delays in project completion time make construction projects seen as complex and dynamic processes. One of the construction services companies that will be interviewed is a state-owned company that handles building, road, bridge, dam, wharf, irrigation projects throughout Indonesia. Most project delays occur in road and bridge projects, especially projects located in remote areas. There is uncertainty about fluctuations in material prices which are influenced by foreign currency exchange rates such as diesel and asphalt. The procurement strategy has considered the need for longer material lead times so that the supply of materials and work tools can arrive on time.

For contractors, besides causing project swelling due to increased project implementation time, it can also result in a decrease in the contractor's credibility in the future. Meanwhile for owners, delays in the use or operation of construction project results often have the potential to cause disputes and claims between owners and contractors (Soeharto, 1995). The application of the concept of supply chain management in companies can provide benefits, namely increasing customer satisfaction, increasing revenue, reducing costs, increasing asset utilization, increasing profits, and getting bigger companies (Pujawan & Mahendrawathi, 2017). Supply chain management is a chain that connects every element of the manufacturing and supply process from raw materials to end users, spanning multiple organizational boundaries (Scott & Westbrook, 1991). In a construction project there are various activities. Project activity is a temporary activity and lasts for a limited period, with an allocation of certain funding sources to carry out tasks with predetermined targets. Many activities and parties involved in the implementation of construction projects give rise to many complex problems (Soeharto, 1995). Construction projects have characteristics, are unique, involve a lot of resources, and require organization. In the settlement process, three constraints must be adhered to, namely according to the specifications set, according to the time schedule and according to the set costs (Ervianto, 2002). According to other sources, a project can be defined as a sequence of unique, complex, and interconnected activities that have one purpose or objective and must be completed within a certain period, within a certain budget and with certain specifications (Miguel, 2006).

Project quality management describes the direct characteristics of a product or service such as performance, reliability, ease of use and aesthetics and so on (Gaspersz, 2001). Quality Management is all activities of the overall management function that determines the quality policy, objectives, and responsibilities for its implementation.

Project delays are often a source of disputes and demands between owners and contractors, so that it will be very expensive in terms of both the contractor and the owner. Delays in project implementation also have an impact in the form of losses for all parties involved in the project (Lipke, 2012).

In previous studies, the methods used to identify the factors of construction project delays mostly used statistical analysis to determine only the factors that most contributed to the delay in a construction project. This thesis will determine the main causes of project delay problems and continue with the QFD (Quality Function Deployment) method to determine what strategy which can be applied, carried out especially in the construction supply chain flow so that the project can be completed on time. This method has previously been used successfully in the manufacturing industry with the aim of determining company strategy to improve company performance. In the construction service industry, the QFD approach can assist in determining customer needs which illustrates a strong linkage or alignment between factors causing delays and what strategies should be applied (Delgado-Hernandez et al., 2007). The QFD approach was developed to ensure that project products that are entering the construction implementation phase run effectively and efficiently. It is hoped that fishbone diagram analysis and the QFD method can assist companies in determining business process improvement priorities more effectively and focusing on creating added value to increase customer satisfaction. QFD itself has advantages that other methods do not have, namely having the ability to find out whether there is a relationship and the strength of the relationship between the delay factor and the strategy that will be applied to overcome the delay factor. In addition to knowing whether there is a relationship between the delay factor and the strategy that will be implemented to overcome the delay factor, the QFD method also can find out how much impact is given when the strategy is implemented (Akao, 1990). This method can be implemented by building a matrix in the House of Quality (HOQ) and can be modified according to the needs and desires of consumers (Cohen, 1995).

2. LITERATURE REVIEW

In this section, the literature review will consist of infrastructure construction projects, project delay factors, supply chain, QFD, and recent research that assist current research.

In a construction project, there are various activities. Project activity is a temporary activity and lasts for a limited period, with an allocation of certain funding sources to carry out tasks with predetermined targets. Many activities and parties involved in the implementation of construction projects give rise to many complex problems (Soeharto, 1995). Construction projects have characteristics, are unique, involve a lot of resources, and require organization. In the settlement process, three constraints must be adhered to, namely according to the specifications set, according to the time schedule, and according to the set costs (Ervianto, 2002). According to other sources, a project can be defined as a sequence of unique, complex, and interconnected activities that have one purpose or objective and must be completed within a certain period, within a certain budget, and with certain specifications (Miguel, 2006).

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In the research Radujkovic, (2017), the objective of the paper is to explore elements of supply chain management within megaprojects and identify the ones that have significant influence on the megaproject performance, thereby providing an idea of the possible influence on megaproject success in general. Meanwhile in the research (Doddy, 2021), using HOR (House of

Risk) to model the risk mitigation of procurement delay. The result is providing 3 actions for the strategy. In another area, the research (Alkaff, 2018) is using supply chain management for production and distribution flow with using procurement delay analysis. For the procurement delay analysis, the research (Zuhdi, 2020) is finding out that one of the factors, supply chain management, is very significant as the main cause of the postponement, but also does not leave the other factors. One but not least, the supply chain management is proven to be further researched due to the research (Ni Putu Dina, 2021) that concluded budget delay analysis on KPPN Singaraja during Covid-19 is highly affected by supply chain management.

3. METHODS

In this section, the methods is briefly defined. Herewith the flowchart of the research as can be seen in figure 2.

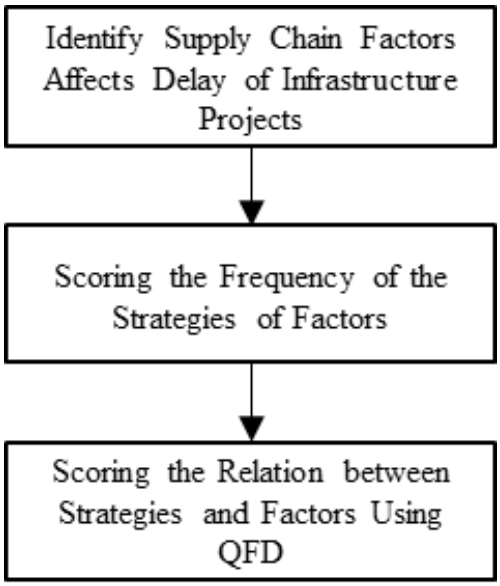

Figure 1. Research Flowchart

The data used are primary data obtained from interviews with experts (experts) who have at least 10 years of experience in handling the implementation of infrastructure projects and secondary data obtained from literature studies of articles, books, journals. Literature study is used to find and collect information related to service quality in construction projects and an explanation regarding the QFD method. Based on the results of interviews with experts from one of the state-owned companies engaged in the construction sector, most of the projects experienced delays due to delays in the procurement of goods and services. This is caused by procurement planning that is not aligned with the project implementation schedule and the information and communication system that is not good. Based on this information, the hypothesis is that there are obstacles along the flow of the supply chain related to the flow of information and the flow of goods which are the main factors causing delays in infrastructure projects, especially road and bridge projects.

Questionnaires will be distributed to at least 10 respondents who already have experience in handling an infrastructure project. The aim is to know what factors cause delays in a project procurement and what strategies are appropriate to reduce the chances of projects being executed

late. Factors that will be known are the size of the role played when procuring materials and services for road and bridge infrastructure projects.

Interviewees were asked what the right strategy is to deal with the 16 factors that affect the timeliness of infrastructure projects. A follow-up questionnaire will be made to assess the relationship between strategy and the delay factor. It is hoped that the answers from the respondents can be used as suggestions for construction companies to be able to improve systems.

This questionnaire aims to identify factors causing delays in infrastructure projects. It is hoped that the answers from the respondents will represent the actual situation in the field. Factors are sorted starting from the largest to the smallest factor indicated by a Likert scale with a value of 1 to 5. After sorting the biggest to the smallest factors causing delays in infrastructure projects, it will be followed by compiling questions that contain what the right strategy is to overcome them. A follow-up questionnaire will be distributed to assess the relationship between strategy and the delay factor. The distribution of the second questionnaire is done randomly so that the possibility of the same person filling in is twice as small.

The House of Quality (HOQ) is the initial stage in the application of the QFD methodology to identify and rank customer needs and desired technical requirements related to product or service quality. After getting the factors that cause delays from the analysis of fishbone diagrams, the data will be compiled and processed by forming a planning matrix. HOQ should be modified through the research as can be seen in figure 3.

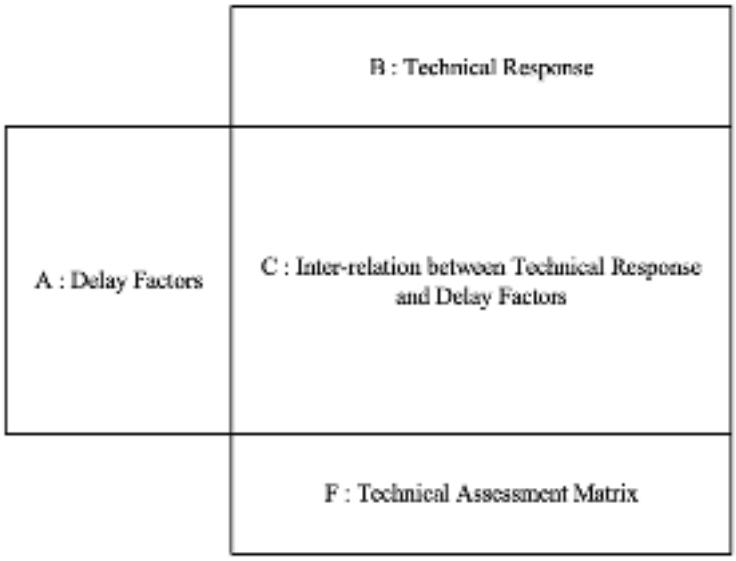

Figure 3. Modified House of Quality Matrix

The next step is to work on a matrix which aims to work out what cause delays in infrastructure projects. In part A will be filled with factors that cause delays in a project. These factors will be sorted starting from the biggest factor causing project delays to the smallest. This is done on a Likert scale, where 1 means very little role in delays and 5 means very contributed to delays.

Factor analysis will group variables in the form of delays in infrastructure projects into one factor. SPSS software will work out how many groups of factors can explain the overall data up to 50%. In part B, the appropriate strategy will be filled in to overcome the delay factor according to the respondent. This was obtained after collecting data taken from respondents through interviews.

After part C is completed, part F will look for which strategies can be applied to overcome the delay factors indicated by the weights obtained from the existing strategies. The House of Quality Matrix will look for which strategies can be applied to overcome the delay factors indicated by the weights obtained from existing strategies. The greater the weight obtained from the strategy, the more effective the strategy will be in overcoming the project delay factor. If the weight received is smaller, then the strategy is less effective.

4. RESULTS

In this section, the analysis and discussion of the results is presented. The research by create factor assumption test, total variance test, and rotated factor matrix calculation to determine which factor is affecting the most, and then continued into reliability test and validity test to determine that the survey for the research is valid and reliable.

Before being furtherly processed, the highest affecting factor acquired, if sorted from the highest to the lowest factor weight, the results are as follows:

1. Inadequate planning/procurement work program
2. Poor communication and coordination
3. Late procurement process
4. The procurement process is not systematic
5. Late issuance of contract (PO/PSMK)
6. Unbalanced cash flow position / negative cash flow
7. Availability of labor both in quality and quantity
8. Late payment of bills to partners
9. The choice of payment system is not in accordance with the project conditions
10. Procurement information that lacks detail
11. Acceptance of project inflows not according to the plan
12. Increase in material prices
13. Changes in material orders due to changes in work methods/scope
14. Limited availability of project budget
15. Management and control of claims from partners is not effective
16. Inventory turnover takes too long

The questionnaire answers then furtherly analyzed to determine strategies that should be taken. The strategy that is often chosen is taken because the more the strategy is mentioned, the more effective the strategy is in solving several delay factors. There are a total of 280 strategies and will be simplified by calculating which strategies are often mentioned by respondents. The next process is to take the most data up to 50% of the total number of strategies with the hope that the strategy which is included in half of the amount of data will represent that the strategy will be effective in overcoming delays in the procurement of infrastructure projects. So, it can be concluded that strategies a to l will be further processed. An effective strategy is as follows:

1. Make plans for the procurement of goods and services program with related work units.
2. Manage procurement according to work plan targets and costs.
3. Periodic monitoring and evaluation of procurement program planning implementation.
4. Conduct weekly monitoring and evaluation meetings of partners' performance with related work units.
5. Hold procurement planning meetings and map the procurement of goods and services.

6. Carry out effective cross-functional coordination and communication through digitalization of integrated information systems
7. Entered umbrella contracts for strategic materials.
8. Maximizing the use of non-cash loan payment facilities (SKBDN/SCF)
9. Select partners who have good equity/capital.
10. Create a standardized Material Service Control Sheet Format
11. Speed up the submission of work progress bills to the owner
12. There are clauses/articles of the contract related to the claim handling process.

Then it will be followed by a process to find out the relationship between strategy and the delay factor. This process is used to find out how much the relationship between strategy and factors is.

The next process is to determine the weight of the relationship between each strategy obtained from the 2nd questionnaire and each delay factor obtained from the 1st questionnaire. The questionnaire consists of 6 questionnaires, each of which has 2 strategies. This method is done so that respondents are expected to be able to fill out the questionnaire seriously if only 2 strategies are asked for the 16 factors provided.

The results of the study indicate that the main causes of delays are caused by delays in the procurement of goods and services which are caused by both inadequate procurement planning and procurement processes that are not timely. Improvements need to be made to the flow of the procurement process to make it more effective and systematic, starting from the process of requesting project procurement to issuing Purchase Orders of materials or Work Commencement Letters to partners so that the need for resources, both materials and services, can be met according to the needs of each project. The procurement process can be carried out in a timely manner and on target so that the project can produce optimally according to the project implementation work plan

.

5. CONCLUSIONS

After analyzing the data obtained from the previous chapter. Following are the conclusions obtained after carrying out this research:

1. There are 16 factors that play a role in causing delays in the procurement of infrastructure projects. However, there are 3 factors that must be anticipated in delays in the procurement of infrastructure projects because these 3 factors have the greatest factor weight. These factors are inadequate planning/procurement work programs, poor communication, and coordination and delays in the process of procuring goods and services. These factors are things that supply chain managers must know so that the project being worked on does not experience delays.
2. There are 12 appropriate strategies to overcome delays in the procurement of infrastructure projects. However, there are 3 strategies that have the greatest effectiveness, namely planning a procurement program with related work units, managing procurement in accordance with work plan targets and project costs, and monitoring and evaluating the implementation of the planned goods and services procurement program periodically. This strategy can be applied in the implementation of procurement of infrastructure projects so that projects that are being carried out do not experience delays.

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CUSTOMER LOYALTY ANALYSIS TOWARDS ONLINE SHOPPING IN INDONESIA

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ABSTRACT

Technological advances in the field of computers and telecommunications strongly support the development of internet technology. The emergence of internet technology has had a major impact on the business environment. The growth potential of the e-commerce business in Indonesia is estimated to be quite large in line with the increasing surge in internet use. Despite the many advantages of online shopping, some consumers are still hesitant to buy a product in e-commerce because of several factors such as product quality, security, personal data, payment and trust, and also the size of competitors in online business, to attract potential new buyers will cost 20 to 40 percent more than conventional companies that only make offline buying and selling transactions. This study aims to analyze what factors can affect loyalty in online shopping. This research uses the Structural equation modeling (SEM) method. Structural equation modeling is one of the double-changing techniques that can simultaneously analyze several endogenous and exogenous latent changers. The result of this study is that the satisfaction variable has a positive and significant influence on the commitment variable with a T^2 value of 6,256 and a p-value of 0.000 and loyalty with a T^2 value of 3,123 and a p-value of 0.002, then the trust variable has a positive and significant influence on the commitment variable with a T^2 value of 5,553 and a p-value of 0.000, and the service quality variable has a positive and significant influence on the loyalty variable with a T^2 value of 2. 006 and p-value 0.045, while the trust variable and commitment variable have a positive and insignificant relationship to the loyalty variable with a T^2 value of 1.783 and a p-value of 0.075. It can be known that satisfaction is the variable that affects loyalty the most compared to other variables. This research contributes to e-commerce in Indonesia to increase and retain consumers.

Keywords: Online Shopping, E-commerce, Structural Equation Modeling

1. INTRODUCTION

Technological advances in the field of computers and telecommunications strongly support the development of internet technology. The emergence of internet technology has an impact on the business environment, where business people no longer have difficulty in obtaining information that can support the development of their business. The insistence of business is increasingly leading to electronic media, where online shopping has not become a foreign or unusual activity. People will become more accustomed to doing or utilizing the internet network starting from buying books, buying household appliances, electronic equipment, ordering tickets and other activities. In online shopping, the process carried out will be faster and more efficient, Wibowo (2015).

Based on data from the Ministry of Communication, the growth of e-commerce in Indonesia reached 78% (percent). Indonesia is a country that is included in the top 10 e-commerce growth and is ranked 1st. E-commerce is the result of information technology that is currently developing so rapidly towards the exchange of goods, services, and information systems through the internet, television and other computer networks, Romindo, et al. (2019).

Based on APJII, 21.26% of internet users do online shopping, this indicates that there are still 1/4 of internet users who use e-commerce applications to do online shopping. Despite the many advantages of online shopping, some consumers are still hesitant to buy a product on e-commerce due to several factors such as product quality, security, personal data, payments and trust. Therefore, trust is one of the critical factors in online shopping, and lack of trust can result in consumers avoiding shopping on e-commerce. Customer satisfaction is one of the things that companies must pay attention to to improve service, but, often the goods sold are mostly not guaranteed or the warranty cannot be proven, this makes consumers dissatisfied in doing online shopping, because the service is not optimal and the impact of the high volume of transactions that occur in online purchase services, accompanied by an increase in potential problems that occur. It is evident from the report issued by the National Consumer Protection Agency that throughout 2020 there were 295 complaints such as refund problems, phishing, problematic purchases of goods, cashback that was not obtained, voucher problems, and warranty problems that could not be fulfilled, Arsyadani (2020).

Indonesia, there have been many e-commerce that have emerged where consumers will also compare one e-commerce with another from various sides where consumer loyalty is important for companies or e-commerce to always evaluate performance and also increase consumer convenience to always shop on their e-commerce platform. Due to the large number of competitors in online business, attracting potential new buyers will cost 20 to 40 percent more than conventional companies that only make offline buying and selling transactions.

In the previous research, online shopping loyalty only discussed or focused on one marketplace or e-commerce, while in this study, it will discuss various e-commerce such as JD.ID, Lazada, Tokopedia, Shopee, BliBli and Blanja. Loyalty itself is the behavior of repeated visits of consumers, consumption, and recommendations from the same website, Kartono & Halilah (2019).

2. LITERATURE REVIEW

E-Commerce stands for electronic commerce is the result of information technology that is currently developing so rapidly towards the exchange of goods, services, and information systems through the internet, television and other computer networks. E-Commerce can also be interpreted as a type of electronic business mechanism that focuses on individual-based business transactions by using the internet as a medium for exchanging goods or services both between two institutions (Business to Business (B2B)) and between institutions and direct consumers (Business to Customer (B2C)) Romindo, et al. (2019).

Structural equation modeling is one of the double-changing techniques that can simultaneously analyze several endogenous and exogenous latent changers, Bollen (1989). Structural Equation Modeling is carried out to analyze a series of relationships simultaneously so as to provide statistical efficiency. Estimation of different but related regression equations to each other was jointly performed with structural models in SEM, Hair, et al. (2018). In terms of methodology, SEM has several roles, including, as a system of simultaneous equations, linear causal analysis, path analysis, covariance structure analysis, and structural equation models, Maiyanti, et al. (2008).

3. METHODS

This study aims to analyze what factors can affect online shopping such as satisfaction, trust, commitment, service quality, and loyalty. To determine the influence of consumers in shopping online, this study uses the Structural equation modeling (SEM) method or structural modeling. Structural equation modeling is one of the double-changing techniques that can simultaneously analyze several endogenous and exogenous latent changers.

4. RESULTS

The following is data collection from customer loyalty analysis research on online shopping in Indonesia. In data collection, there is a model of collecting, disseminating and returning questionnaires and an overview of respondents. Demographic analysis of respondents was carried out to determine general characteristics based on respondent profiles, such as gender, age, education, status and e-commerce that had been used by respondents.

This study is a study that uses a reflective model, with unidimensionally formed constructs, so that outer model testing is carried out based on first order confirmatory factor analysis. The tested model is based on the proposed research model. The steps taken in this test are to determine the convergent validity value and discriminant validity of the latent variable-forming indicators. The validity of convergence itself can be determined based on the value of factor loading and average variance extracted (AVE), while the validity of discriminant is determined using cross loading. The determination of the reliability value based on the composite reliability and cronbach's alpha value of each indicator.

The validity test of the measurement model is carried out based on two stages, namely, convergent validity and discriminant validity. Convergent validity can be measured based on loading factor values and average variance extracted (AVE). If the value for the loading factor > 0.70 and the AVE value > 0.50, then in testing the validity of the convergent can be said to be valid, Afif, et al. (2017). The reliability test in this study was carried out by assessing Cronbach's alpha and composite reliability in each construct. If these values show values above 0.70, then it can be said that the tested model is reliable, Perdana (2018). The reliability test results can be seen in Table 1 below.

Table 1. Reliability

Laten Variable	Cronbach's Alpha	Composite Reliability	Description
Satisfaction (K)	0.972	0.975	*Reliable*
Trust (Ke)	0.953	0.959	*Reliable*
Service Quality (Sq)	0.957	0.964	*Reliable*
Commitment (Ko)	0.945	0.955	*Reliable*
Loyalty (L)	0.968	0.972	*Reliable*

If the proposed model is valid and reliable, then the next stage of the test is to evaluate the structural model. This test is performed by predicting the relationship between independent variables to dependent variables.

The first step in testing the inner model is to determine the value of R^2. This R^2 value is used to see what percentage of the predicted contribution of the variables – independent variables that the researcher determines to the dependent variables Hair, et al. (2018). F^2 (effect variable f-square) with the same test purpose as t-value. The test is carried out to measure the magnitude of the influence of each model path by calculating the value of f^2. Crossvalidated redundancy (Q^2) in structural models (inner models). A Q^2> value of 0 indicates that the model has predictive relevance, while Q^2< 0 indicates that the model lacks predictive relevance, Hair, et al. (2018). Path

coefficient is the next stage in the inner model test where the path coefficient is carried out to evaluate the significance of the influence between the latent variables used in the study. The process for measuring path coefficient is to use the bootstrapping process on SEM-PLS and a two-tailed type test. The path coefficient function itself is to find out the direction of the relationship between variables. The significance relationship between the latent variables used can then be seen based on the t-statistical value or p-value. The standard error value used is 1.96 or with a α value of 5%. Hypothesis Test is used to statistically test the veracity of a statement and draw conclusions whether to accept or reject the statement. The purpose of the Hypothesis Test is to establish a basis so that it can collect evidence in the form of data in determining the decision whether to reject or accept the truth of the statements or assumptions that have been made. The result of hypothesis testing refers to H_0 for all independent variables used, namely if the p-value > 0.05, then it fails to reject H_0 while if the p-value < 0.05, then H_0 is rejected. Here are the results of the hypothesis test in this study.

Table 2. Hypothesis Test

Variable Relationship	Path Coefficient	T^2	P-value	Hypothesis Result
Satisfaction → Commitment	0.502	6.256	0.000	H_0 Rejected
Satisfaction → Loyalty	0.339	3.123	0.002	H_0 Rejected
Trust → Commitment	0.448	5.553	0.000	H_0 Rejected
Trust → Loyalty	**0.002**	**0.021**	**0.983**	**H_0 Accepted**
Service Quality → Loyalty	0.386	2.006	0.045	H_0 Rejected
Commitment → Loyalty	**0.231**	**1.783**	**0.075**	**H_0 Accepted**

In Figure 1 it can be seen that the variable of trust in loyalty and the variable of commitment to loyalty have a positive and insignificant influence. When viewed in previous studies, the belief variable on loyalty and the commitment variable to loyalty have a positive and significant influence, Goutam & Goplakrishna (2018), Rafiah (2019) and Gracia, et al. (2020). But in research, Hartono (2013) said that the trust variable has a positive and insignificant influence on the loyalty variable. In this study, indicators on invalid confidence variables were based on several basic statements. After being noticed, there are still many consumers who feel that the seller is unresponsive or responds to consumer questions quickly and also consumers feel that the seller is quite indifferent (not swift) and less responsible when consumers have problems or problems with service, and this greatly influences consumers to behave loyally towards online shopping on e-commerce. Meanwhile, in the variable commitment to loyalty, the indicator on the invalid commitment variable based on the basic statement, after review, it can be said that consumers are not too happy or ordinary with the presence of official stores on the e-commerce platform and also consumers are still at a reasonable limit when using and scrolling e-commerce (do not make consumers commit to using continuously) and also consumers not only using one e-commerce platform to conduct online shopping transactions can be seen in Figure 1. Therefore, the commitment variable has only a positive but not significant effect.

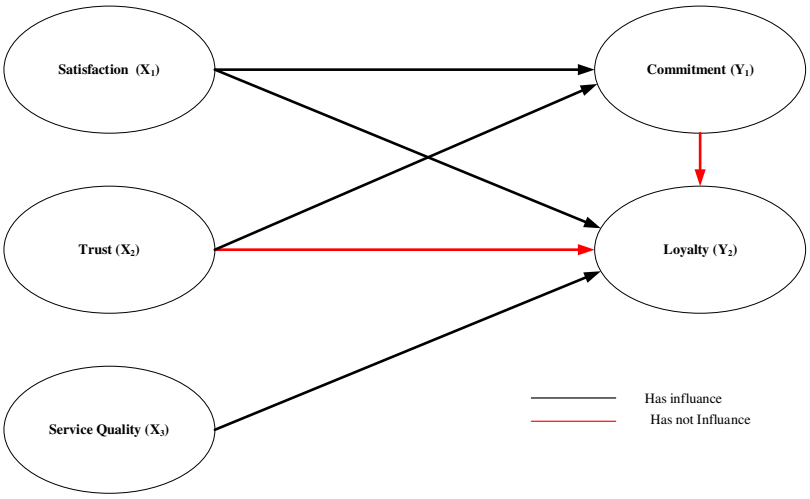

Figure 1. Final Research Model

The results of this study are considered to improve the quality of e-commerce services where consumers will remain loyal to shop on the e-commerce site, especially in the aspects of trust and commitment, because in both aspects, it only has a positive but not significant effect.
The results of this study are considered to improve the quality of e-commerce services where consumers will remain loyal to shop on the e-commerce site, especially in the aspects of trust and commitment, because in both aspects, it only has a positive but not significant effect. The results of this research can be used as a basis for making strategies in retaining loyal e-commerce customers. Based on aspects such as satisfaction, trust, commitment, service quality and loyalty, it can be an insight to find out what factors most affect consumer loyalty in shopping online. The aspect that most affects loyalty is service quality when viewed from the AVE (average variance extracted) value, with that the e-commerce platform can improve performance and also the services that have been built, so that consumers are more loyal to shop online on the platform / e-commerce.

6. CONCLUSIONS

Based on the results of the analysis that has been carried out in this study, here are the conclusions on this study. The satisfaction variable has a positive and significant influence on the commitment variable in online shopping with a T^2 value of 6.256 and a p-value of 0.000, then the satisfaction variable also has a positive and significant influence on the loyalty variable in online shopping with a T^2 value of 3.123 and a p-value of 0.002. The trust variable has a positive and significant influence on the commitment variable in online shopping with a T^2 value of 5.553 and a p-value of 0.000, but the trust variable has a positive and insignificant influence on the loyalty variable in online shopping with a T^2 value of 0.021 and a p-value of 0.983. The service quality variable has a positive and significant relationship to the online shopping loyalty variable with a T^2 value of 2.006 and a p-value of 0.045. The commitment variable has a positive and insignificant relationship to the online shopping loyalty variable with a T^2 value of 1.783 and a p-value of 0.075

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DETERMINANTS OF CONSUMER-BASED BRAND EQUITY IN LOCAL WOMEN'S CLOTHING BRANDS USING THE STRUCTURAL EQUATION MODELING APPROACH

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ABSTRACT

The fashion industry in Indonesia is a sub-sector that contributes 28,3 percent of the entire creative industry and is ranked 9th in the Global Revenue Ranking. However, in 2020 there was a decrease in GDP of 8,8 percent because the apparel and textile industries were still affected by the COVID-19 pandemic and many entrepreneurs closed retail stores and turned to social media. However, the way local fashion brands use social media is considered not always effective. Therefore, this study aims to find out what factors can affect consumer-based brand equity (CBBE), for women's local clothing brands in Indonesia. This research is a conclusive descriptive multiple cross-sectional research model with a quantitative approach. To achieve the research objectives, the processing techniques and data analysis in this study used descriptive analysis and Structural Equation Modeling. Data collection was carried out using an online questionnaire distributed to 319 samples. The results show that perceived social media marketing activities, brand community commitment, and firm-created social media brand communication are positively and significantly related to CBBE. Meanwhile, co-creation behavior has a positive and significant relationship to perceived social media marketing activities. There are managerial implications that are arranged for local women's clothing brands.

Keywords: Consumer-based Brand Equity, Local Clothing Brands, Social Media Marketing, Structural Equation Modeling, Women's Local Clothing Brands

1. INTRODUCTION

Digital marketing has become the center of attention in all marketing spheres due to the cultivation of technology that can create a very attractive environment for customers, especially on social media (Ananda et al., 2019). Social media is considered an important ingredient that has a considerable impact on the sustainability of a business (Hosseini et al., 2019). In accessing digital media, internet users in Indonesia spend an average of 3 hours and 17 minutes each day. Since 2014, social media users in Indonesia have always experienced an increase, there were 191 million social media users as of February 2022 which has increase by 12.6 percent from 2021 (Hootsuite, 2022). The social media platforms most used by Indonesians by 2022 are WhatsApp, Instagram, Facebook, TikTok, and Telegram. This shows that the use of social media platforms is encouraged in marketing communications, especially for businesses (Yadav & Rahman, 2018). A business generally survives and thrives through engaging social media brand pages and sharing information

and communication with new customers, especially existing customers with the hope of creating brand awareness and building a brand image, which in turn can increase the sales of the business (Kunja & GVRK, 2018). Social Media Marketing or SMM is a strategy for entrepreneurs to continue their business activities with the help of social media (Shareef et al., 2019). When customers feel the SMM activity of a brand positively, then brand loyalty will be strengthened by brand awareness and brand value (Ismail, 2017). Therefore, the existence of an effective SMM is very important to establish positive consumer-based brand equity (CBBE). When social media brand pages share interesting uploads and interact with their followers consistently, thus enhancing the brand experience of followers in that direction (Beig & Khan, 2018). The presence of social media for doing business can be used by entrepreneurs in various categories, for example, fashion products, culinary, photography services, and others (Dion, 2018). In Indonesia, the fashion industry is a sub-sector that contributes to the creative industry which has an important role in Indonesia's economic development (Putri, 2021).

The gross regional domestic product (GDP) of the apparel and textile industry at current prices is Rp180,22 trillion in 2021. In 2020, there has been a decline in GDP of 8,8 percent because the apparel and textile industry is still affected by the COVID-19 pandemic. However, on the other hand, demand for exports of Indonesian apparel and textiles increased by 17,74 percent. The apparel and textile industry experienced an increase of 4,08 percent in 2021 and is expected to continue to increase in the following year (Kusnandar, 2022). Due to the impact of the COVID-19 pandemic, international industries and activities must be able to operate digitally, for example by using SMM. Many local fashion brands are closing their retail stores and switching almost entirely to digital operations (Haywood, 2020). Only 46 percent of Indonesians conduct searches related to local brands, this can be optimized by adopting SMM (Haekal, 2021). In this study, Instagram will be used for research, because Instagram is the social media with the most user ratings in Indonesia, namely 84,8 percent (Hootsuite, 2022). Even though the Instagram application is considered the most effective social media with the highest engagement for consumers among other social media. The way local fashion brands, especially women's clothing, choose social media is not always effective. More than 50 percent of local clothing brands have poor to average online engagement rates. Based on the description of the condition of local Indonesian women's clothing brands above, the researcher sees an opportunity to further examine the factors that can influence CBBE for local women's clothing brands that have not fully used social media optimally and effectively.

2. LITERATURE REVIEW

2.1 Local Clothing Brand

Local clothing brands are clothing originating from certain countries which are designed and produced locally (Rahman & Mannan, 2018). Indonesia has a variety of local brand products, including in the fashion industry (Wixsite, 2015). Local clothing brands in Indonesia have become increasingly popular in recent years, because they are proud to use it.

2.2 Perceived Social Media Marketing Activities

Perceived SMM activity refers to the way consumers perceive the company's or brand's involvement in various SMM activities (Koay et al., 2020). Effective SMM activities can build value, relationships, customer population, and brand equity (Yu & Yuan, 2019).

2.3 Consumer-based Brand Equity

CBBE is a set of assets linked to brand names and symbols that add or subtract from the value provided by a product or service to customers. A brand to have value must be appreciated by consumers, if the brand has no meaning for consumers, then there is no other meaningful definition

for the brand (Keller, 1993). Positive consumer-based brand equity can lead to greater revenues, lower costs, and higher profits.

2.4 Co-Creation Behavior

Co-creation behavior is a process where shared values are expanded together (Oestreicher-Singer & Zalmanson, 2013). One of these efforts can be encouraged by advances in technology, where internet users or especially social media can produce content.

2.5 Firm-Created Social Media Brand Communication

FCSM involves brand-initiated communication with consumers (Bruhn et al., 2012). When more FCSM is available, it is easier to expose consumers to corporate and brand communications, this can result in strengthening brand awareness in consumers' minds (Schivinski & Dabrowski, 2016).

3. METHODS

This research is conclusively descriptive with a quantitative approach to find out what factors can influence CBBE on local women's clothing brands. The research data was collected using a multiple cross-sectional design which is a designs that takes more than one population sample where information is collected only once for each intended respondent (Malhotra, 2010). This research uses a probability sampling technique with a simple random sampling method. The sample in this study was 319 respondents with the criteria of being a user of local women's clothing brands who live in East Java. Data collection uses an online survey with Google Forms.

4. RESULTS

Based on demographic analysis, users of local women's clothing brands are dominated by the age of 22-26 years by 71,8 percent and the majority are domiciled in Surabaya. Then, 39,8 percent of users of local women's clothing brands work as private employees with an average monthly income of Rp3.000.001 to Rp6.000.000.

Table 1. Demographic Analysis

Respondent Demographics	Total	Percentage (%)
Age		
17-21 years	51	16
22-26 years	229	71,8
27-31 years	27	8,5
32-36 years	3	0,9
> 36 years	9	2,8
Total	319	100
Domicile		
Malang	24	7,5
Sidoarjo	29	9,1
Surabaya	237	74,3
Others	29	9,1
Total	319	100
Profession		
Student	107	33,6
Entrepreneur	38	11,9
Government Employee	9	2,8
Private Sector Employee	127	39,8
Other	38	11,9
Total	319	100
Average Monthly Income		

< Rp1.000.000	47	14,7
Rp1.000.001-Rp3.000.000	75	23,5
Rp3.000.001-Rp6.000.000	123	38,6
Rp6.000.001-Rp9.000.000	39	12,2
> Rp9.000.000	35	11
Total	319	100

Based on usage analysis, the majority of local clothing brand users purchase products in less than one month. They also prefer and buy products from brand Y more often than other local women's clothing brands because in terms of the quality provided, besides that the "other" side, they also pay attention to the quality provided and also affordable prices. This data is in accordance with a survey conducted by Rasti (2021), which states that the reason for buying local women's clothing brand products today is the quality provided and affordable prices. As much as 58,9 percent of respondents are willing to spend Rp150.001 to Rp300.000 to buy local clothing brand products in one transaction and the majority of them buy approximately two products in one transaction and prefer to buy local clothing brand products through e-commerce.

Table 2. Usage Analysis

Respondent Usage	Total	Percentage (%)
Last Time Made a Local Clothing Brand Purchase		
< 1 month	161	50,5
1-3 months	110	34,5
> 3 months	48	15
Total	319	100
Frequently Purchased Local Clothing Brand		
Brand V	41	12,9
Brand W	38	11,9
Brand X	31	9,7
Brand Y	112	35,1
Brand Z	17	5,3
Other	80	25,1
Total	319	100
Reasons to Buy Local Clothing Brand Products		
Quality provided	41	12,9
An affordable price	16	5
The information provided is very detailed	1	0,3
Testimonials from fellow users of the local clothing brand	9	2,8
Interesting promotions	1	0,3
Ease of access to purchases	5	1,6
Other	246	77,1
Total	319	100
Average Willingness to Buy Local Clothing Brand Products		
< Rp150.000	30	9,4
Rp150.001-Rp300.000	188	58,9
Rp300.001-Rp450.000	72	22,6
Rp450.001-Rp600.000	19	6
> Rp600.000	10	3,1
Total	319	100
Average Number of Products Purchased for Every Transaction		
1	139	43,6
2	170	53,3

3	6	1,9
> 3	4	1,2
Total	319	100
Where to Buy Local Clothing Brand Products		
Website	10	3,1
E-commerce (Shopee, Tokopedia, etc)	200	62,7
WhatsApp	1	0,3
Offline store	108	33,9
Total	319	100

There is one respondent who is included in the data outliers, so that the next data test uses 318 samples, instead of 319 samples. SEM analysis is used to thoroughly explain the relationship between variables in the study (Hair et al., 2009). The measurement model in this study using Confirmatory Factor Analysis (CFA). In addition, to determine the validity of a model, it can be assessed from the Average Variance Extracted (AVE) value and factor loading. As for the reliability test, it can be assessed from the Composite Reliability (CR) and Cronbach's Alpha values. From the test results, there are indicator variables that must be reduced because they do not meet the minimum criterion value. Elimination was carried out using the factor loading criteria ≥ 0,5 where there were indicator variables that had values below 0,5. Indicator variables that cause AVE and CR values below the minimum standard must be reduced so that they meet the requirements of the validity and reliability tests. After doing the reduction, it can be concluded that the latest model can be used in the next stage.

Table 3. Validity and Reliability Test

	Mean	**Std. Dev.**	**FL**	**AVE**	**CA**	**CR**
Cut-Off Value			**0,50**	**0,50**	**0,60**	**0,60**
Perceived Social Media Marketing Activities						
Personalization				0,54	0,78	0,69
PEPS1	4,02	0,83	0,71			
PEPS2	3,75	0,99	0,78			
PEPS3	3,82	0,92	0,72			
Consumer-Based Brand Equity						
Brand Association				0,58	0,83	0,70
CBBS1	3,61	0,93	0,65			
CBBS3	3,92	0,80	0,81			
CBBS4	3,89	0,79	0,82			
Co-creation Behavior				0,77	0,90	0,72
CC1	2,68	1,13	0,83			
CC2	2,55	1,11	0,95			
CC3	2,59	1,13	0,84			
Brand Community Commitment				0,57	0,84	0,75
BCC1	2,98	1,21	0,70			
BCC2	3,03	1,10	0,85			
BCC3	3,39	1,02	0,70			
BCC4	3,23	1,13	0,75			
Firm-created Social Media Brand Communication				0,67	0,89	0,77
FCSM1	3,66	0,79	0,85			
FCSM2	3,63	0,80	0,88			
FCSM3	3,71	0,82	0,84			
FCSM4	3,57	0,84	0,70			

The structural model will begin by analyzing the relationship between latent variables and their indicators. The Goodness of Fit or GOF test aims to assess the validity of the structural model in this study. After conducting the GOF test, it is known that in the Absolute Fit Indices indicator only GFI is considered marginal fit and RMSEA is considered poor fit, and the others are not fit. As for the Incremental Fit Indices indicators, there are NFI, CFI, TLI, and IFI which are considered marginal fit. Then, for the Parsimony Fit Indices indicator, the PNFI and GNFI values are considered a good fit. Therefore, the structural model in this study can be said to fit because there are already three GOF categories that meet the standard minimum values (Ferdinand, 2002). In addition, Peng & Fuzhou (2015) said if a model has a GFI, NFI, CFI, TLI, and IFI value of more than 0,7, then the model can be said to be "fair" and is feasible to proceed to the next measurement stage. So for the GOF test in this study the entire structural model can be said to be feasible for hypothesis testing.

Table 4. The Goodness of Fit Test

GOF Measurement	Cut-Off Value	Value	Remarks
Absolute Fit Indices			
CMIN/DF	1,00 ≤ CMIN/DF <3	4,814	Not fit
Goodness of Fit Index (GFI)	0,8 ≤ GFI < 0,9	0,833	Marginal fit
Adjusted Goodness of Fit (AGFI)	0,8 ≤ GFI < 0,9	0,778	Not fit
Root Mean Square Residually (RMR)	≤ 0,08	0,260	Not fit
Root Mean Square Error of Approximation (RMSEA)	RMSEA > 0,1	0,110	Poor fit
Incremental Fit Indices			
Normed Fit Index (NFI)	0,8 ≤ NFI < 0,9	0,829	Marginal fit
Compared Fit Index (CFI)	0,8 ≤ CFI < 0,9	0,859	Marginal fit
The Tucker-Lewis Index (TLI)	0,8 ≤ TLI < 0,9	0,833	Marginal fit
Incremental Fit Index (IFI)	0,8 ≤ IFI < 0,9	0,860	Marginal fit
Parsimony Fit Indices			
Parsimonious Normal Fit Index (PNFI)	> 0,6	0,701	Good fit
Parsimonous Goodness of Fit Index (PGFI)	> 0,5	0,626	Good fit

Figure 1. Research Model

The hypothesis test used a structural model and was seen from the magnitude of the p-value to see the significance of the hypothesis results and the standardized coefficient aims to determine the direction of the variable's influence. A hypothesis is said to be accepted if the p-value is less than 0,5 and the variable relationship is considered positive if the standardized coefficient is positive, and vice versa.

Table 5. Hypothesis Testing

Hypothesis	Effect	Std. Coefficient	P-Value	Remarks
H1	Perceived Social Media Marketing Activities → Consumer-based Brand Equity	0,066	0,003	Significant
H2	Co-Creation Behavior → Perceived Social Media Marketing Activities	0,048	***	Significant
H3	Brand Community Commitment → Consumer-based Brand Equity	0,056	***	Significant
H4	Firm-Created Social Media Brand Communication → Consumer-based Brand Equity	0,079	***	Significant

Hypothesis 1 shows that PSMMA has a significant positive effect on CBBE. Effective social media marketing activities will produce many positive things (Koay et al., 2020). The results of the hypothesis test reflect that users of local women's clothing brands feel that the SMM activities carried out by these brands help them in obtaining information regarding the products or brands they like. The SMM activities felt by users are the main driver of brand loyalty because they follow the brand's social media and tend to be loyal, moreover they are committed to the brand (Bagozzi & Dholakia, 2006). In addition, the existence of SMM activities is felt to be an effective tool for developing relationships between brands and customers.

Hypothesis 2 shows that co-creation behavior influences perceived SMM activities. This can be attributed to the dissemination of negative content by users who are dissatisfied with the brand's social media or they experience bad experiences which can actively spread negative content related to the brand in question. In Indonesia itself, especially users of local women's clothing brands which are dominated by young people who are more aware of the brand, they consider social media to be a more reliable source of information because it contains a lot of information in it (Ismail, 2017). Someone will find it easier to believe if there is a Key Opinion Leader (KOL) who shares brand-related content on their page, such as uploading photos and reviews to sharing information on their social media pages. Brands that often organize events or activities through their social media to attract interaction with consumers will produce positive brand equity (Pham & Gammoh, 2015).

Hypothesis 3 shows that between brand community commitment and CBBE, there is a significant influence. In customer relations with brands, brand community commitment relates to the behavior of its members or users that can build value for the company or its fellow customers. Members who participate in a brand community tend to be committed to that community (Munnukka et al., 2015). Someone will voluntarily share brand-related posts if they are already committed to the brand. This can also be encouraged because users are very motivated to participate in activities or activities held by the brand in question. The users also feel a high sense of belonging to the brand and they will indirectly exchange information and other opinions among users of the brand. A brand that already has loyal customers will find it easier to market its products.

Hypothesis 4 shows that between FCSM and CBBE there is a significant influence. The findings above are in accordance with the results of a study that shows that the FCSM variable has a positive and significant influence on CBBE (Cheung et al., 2020). The existence of social media brand communications made by the company is an important driving factor for the brand equity as a whole. This can be seen when a brand tries to communicate information related to its brand or product to build strong and profitable brand knowledge in the minds of consumers, to strengthen consumer purchase intentions. Local women's clothing brands must continue to improve their social media brand communications by utilizing the available features so that consumers can feel satisfied with the social media communications made by the brand in question which will lead to high brand loyalty.

Based on the demographics of the respondents, it is necessary to know to formulate and implement what programs can be carried out by local women's clothing brand companies so that the needs of their users can be properly met. Most of the users of local women's clothing brands were of productive age, namely 22 to 26 years. This corresponds to the age of the majority of Instagram users in Indonesia (Annur, 2021). Therefore, local women's clothing brands need to use social media as a means to grow their business. Women of productive age tend to prefer special price promos on twin dates, besides that they also follow several KOL on their Instagram to see trends. With this in mind, marketers of local women's clothing brands can work with nano influencers to mega influencers. The majority of users of local women's clothing brands are willing to spend Rp150.000 to Rp300.000 in one transaction. They also buy local clothing brand products because they pay attention to the quality provided by these brands. This is felt to be one of the factors they are willing to spend Rp150.000 to Rp300.000 for one local clothing product. On the other hand, local clothing brands can also give member cards to collect points which later these points can be exchanged for discounted vouchers, this can increase the intensity of consumer purchases of these brands. In addition, local clothing brands that have offline stores can provide a different experience for consumers to make their products. Not only in offline stores, but local clothing brands can also maximize features in e-commerce to increase consumer purchase intentions.

Several findings of managerial implications resulted from the SEM analysis which can then be used as a reference by local clothing brands. This research can combine factors, such as perceived social media marketing activities, co-creation behavior, brand community commitment, and firm-created social media brand communication which can influence CBBE. Where the equity of local women's clothing brands can be caused by these four factors and obtain effective and positive results if done properly. Therefore, local women's clothing brands need to create positive brand equity for their consumers, for example by collaborating with linear and non-linear brands. In addition, they can collaborate with KOL for products that will be launched, have brand ambassadors, and utilize big data for their brand campaigns.

6. CONCLUSIONS

The characteristics of users of local women's clothing brands can be seen from demographic aspects and usage behavior. From the demographic aspect, the majority of respondents aged 22 to 26 years and domiciled in Surabaya work as private employees, they have an average monthly income of Rp3.000.001 to Rp6.000.000. The characteristics of user behavior are dominated by those who bought local women's clothing brand products less than one month ago, the clothing brand they often buy is brand Y. They buy local clothing brand products because of the quality provided by these brands and are still willing to spend Rp150.000 to Rp300.000 to buy local clothing brand products. They also buy an average of two products in one transaction and make

purchases through e-commerce. Based on the results of the SEM analysis, it was found that perceived social media marketing activities, brand community commitment, and firm-created social media brand communication are positively and significantly related to CBBE. Meanwhile, co-creation behavior was found to be positively and significantly related to perceived social media marketing activities. With this in mind, local women's clothing brands can collaborate with KOL, implement promos that are attractive to consumers, and make good use of customer relationship management to create positive CBBE to increase a positive impact on the ecosystem of local women's clothing brands.

The limitations of this study are that respondents are only addressed to users of local women's clothing brands who live in East Java and are dominated by users who live in Surabaya by 74,3 percent, so the results of this study cannot necessarily be generalized to users of local women's clothing brands in East Java. In addition, in terms of analytical methods, this study only uses descriptive analysis and SEM, so the results obtained are not optimal from various points of view of existing analytical methods. In this study, there are several suggestions for further research, namely by expanding the scope of the research area, such as Indonesia, which is expected to obtain more data for research and more diverse local women's clothing brands. Furthermore, future research can explore other factors that can affect CBBE in local women's clothing brands in Indonesia which will later have an impact on research results. Because this research only examines local women's clothing brands from the middle class, future research should examine brands from the upper middle class that may have higher expectations of their SMM activities and brand equity. In addition, from the analytical method used, further research is suggested to add analytical methods such as ANOVA to obtain results from several points of view with the analytical method used.

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RISK MANAGEMENT OF ENGINEERING, PROCUREMENT, CONSTRUCTION (EPC) PROJECTS USING HOUSE OF RISK METHOD: A CASE STUDY OF AN EPC COMPANY

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ABSTRACT

One of the construction projects experiencing growth is the Engineering, Procurement, and Construction (EPC) project. EPC projects have a high degree of fragmentation that leads to creating a construction supply chain. Fragmentation could cause various risks that affect the sustainability and success of the project in terms of time and cost. Existing risks of a project are inevitable. However, implementing sound risk management can reduce them. This research aims to identify the risks that may occur in the EPC project and determine appropriate mitigation actions to handle them. The method used in this research is House of Risk. This method identifies risk sources and events and then provides assessments using likelihood and severity scales. The risk identification shows that 77 sources could trigger 47 risk events. The composition of risk events is 16 at the engineering stage, 16 at the procurement stage, and 14 at the construction stage. Risk identification divided risk sources into three categories with a composition of 15 risk sources in category A (high occurrence level), 20 risk sources from category B (medium occurrence level), and 42 risk sources from category C (low occurrence level). The result shows that 26 risk sources require preventive actions to mitigate risks, with 21 preventive actions that need to take to mitigate selected risk agents based on their priorities.

Keywords: Construction Supply Chain, Risk Management, House of Risk, EPC Projects

1. INTRODUCTION

Today, the world of construction continues to grow along with the economic growth in Indonesia. According to Xue et al., (2007), construction is a multiorganizational process involving client/owner, designer, contractor, supplier, consultant, etc. It is also defined as a multistage process including concept, design, construction, maintenance, replacement, and decommissioning.

One of the construction projects assumed that it will experience growth in 2021 is the Engineering, Procurement, Construction (EPC) projects. It is a project building system with the contract scopes of responsibilities including the stages of design (engineering), procurement, and construction. It usually has a big scale. Some projects included in the EPC projects are the constructions of power plants, tunnels and oil refineries. EPC industries have once experienced global decrease in project demand. Low oil price becomes the reason why the energy projects delayed due to reducing the attractiveness of investment to energy industry. Besides, the oil and gas production in Indonesia is still on the decrease continuously. Based on the Special Task Force for Upstream Oil and Gas Business Activities (*SKK Migas*)' data, oil lifting until 30 November

2020 decreased to 5.7% that was valued at 703,700 barrels per day (b/d) in comparation to the lifted production average in 2019 which was up to 746,300 b/d.

PT Pertamina as a state-owned enterprise served in oil and natural gas mining in Indonesia is presently increasing the capacity of RU (Refinery Unit) V located in Balikpapan, East Kalimantan. Project called Refinery Development Master Plan (RDMP) RU V is divided into two phases. The first phase aims at increasing the capacity of refinery production from 260 KBPD to 360 KBPD which is targeted to be completed in 2024. Meanwhile, the second phase is targeted to be completed in 2026. In the second phase, RDMP project will increase the flexibility of crude oil supply with the aim of that the refinery is able to process more crude oil. Furthermore, RDMP project also aims at improving the quality of from what was originally Euro II to Euro V. It relates to the fulfillment of oil-fuel-based product demand which is more eco-friendly.

EPC project commonly has interrelationships and dependencies between disciplines in its process, so does RDMP project so that the project plan is dynamic nature, tends to be inconstant; and the change of material specification depends on existing supplies in market. The ones involved in RDMP project are service users and providers consisting of owner, consultant, subcontractor, subconsultant, and supplier. Due to these numbers of disciplines and stakeholders involved, a supply chain is formed.

According to Pujawan and Mahendrawati (2010), supply chain is a network of companies which mutually work together to create and deliver a product to end user. To manage the supply chain very well, a method called Supply Chain Management is necessary. Supply Chain Management is an integrated approach in managing the flows of product, information, and money which involve all parties from upstream to downstream, and it consists of supplier, factory, distribution network, and logistics service until end user (Pujawan, 2005). Supply chain management in the sector of construction is used for improving performance and productivity so as to be able to reach the efficiencies of quality, time, and cost in construction implementation.

Construction Supply Chain Management is defined as a management strategy of information, activity, duty/task, and process flows involving independent organization and everything related (upstream to downstream) which generate a value delivered to an owner in the form of a finished project. The project upstream activity involves owner and engineering design team in the stage of preparing construction process, while the downstream activity involves material supplier and subcontractor who interacts with main contractor in the stage of construction (Benton and McHenry, 2010).

According to Tucker and Johnston (2001), in the world of construction, collaboration and teamwork are so necessary. Collaboration and teamwork implementation is useful to reduce errors, delay, disconnect reworking time. Furthermore, it may make material and service procurement more effective. One of the important aspects in this project is in terms of time, because a project has a limited time of carrying it out. If a project experiences delays, it will result in additional cost outside of what has been already stipulated in the contract. It may incur loss to the stakeholders. These relation and involvement between supply chain actors and many disciplines are potential to pose many risks which will affect the project activities to achieve the success of a project.

According to Bennett (2004), the factors of project success are efforts and elements which contribute to the achievement of project (time, cost, scope). Furthermore, the criteria of project success are the standard used to assess project results (use of project result value, market value, performance, etc.). Another thing that becomes the standard for the success of a project is to meet what a customer or client wishes for the construction product result which has been made. To achieve an overall performance improvement, a construction activity needs to develop a new culture focusing on giving a good value for customers sustainably by building good risk management risk activity (Liu et al., 2007). Risk management is not only about identifying, assessing, and implementing mitigation strategy and contingency, but it is also about an ability to be fast and effective in dealing with threats perceived when they arise (Aloini et al., 2012).

Existing risks in a construction project becomes a major concern for investors, especially in the oil and gas sector. It needs proper consideration and extensive research to overcome this problem due to its close relation to operational activities and production processes (Kassem et al., 2020)

According to Panova and Hilletofth (2018), underestimating the factor of risk in the stage of project feasibility study for a project particularly for a full-capital project does not only lead to unexpected financial loss, but also delay in the aspect of project commissioning.

RDMP project in its implementation uses Joint Operation (JO) system or integration of some organizations or companies. PT X is a consultant as well as a contractor of state-owned enterprises engaged in construction services which focuses on construction, infrastructure, and EPC. PT X with other organizations joined in JO are asked to carry out all project stages starting from the Engineering, Procurement, and Construction stage. Based on the data of PT X, RDMP RU V project does not reach expected target yet. In June 2022, its progress reached based on the S-Curve is 53%, while the initial target has reached 95%. S-Curve is a graph presenting data between project agenda schedule, progress, and future target plan that should be reached by a project based on the schedule.

Based on the problems of the research, it is so important to carry out risk management and mitigation action for an EPC project, so that supply chain activity of a project may run well.

Previous researches regarding risk management design employ different methods in every stage. Risk quantification stage is conducted by using Failure Mode and Effect Analysis (FMEA) method, and risk evaluation stage uses House of Quality (HOQ) to select risk sources which are necessary to be handled in the first place, and to determine the most effective mitigation action to reduce risk potential caused by risk sources. The last stage of response to risk can be conducted manually through the existing recommendations.

However, this research will use a new method which is a development of FMEA and HOQ called House of Risk (HOR) developed by Pujawan and Geraldin (2009). The advantage of House of Risk method is that this method has included two methods as previously mentioned: FMEA and HOQ. This method is also designed proactively to mitigate risk based on its risk sources, because this method considers that a risk source can lead to the occurrence of some risk events. Therefore, preventive measures are taken against the risk sources. House of Risk consists of two stages: HOR 1 and HOR 2. HOR 1 is the risk identification stage which is a development of HOQ method, while HOR 2 is the risk treatment stage which is a development of FMEA method.

This method is initiated by determining supply chain process conducted by risk management based on the terminology of supply-chain operations reference (SCOR). This process will be useful to identify risks and its consequences that may happen. Assessment is also conducted for the risk sources and its probability. This method generates an aggregate score of risk potential which is defined as a risk potential aggregately to every risk agent as an aggregate severity of an impact caused by a risk source.

2. LITERATURE REVIEW

Risks on EPC projects

Based on the combination of literature studies as stated by Yang et al (2014), Jinring and Enyi (2011), the characteristics of EPC projects can be divided into 11 main risks that should be faced by an EPC project as follows:

1. Environment Risk

   Environment risk includes nature and environment risks as well as social and culture risks. Nature and environment risks result in material loss or injuries caused by exposure to forces of nature. Meanwhile, social and culture risks are affected by the backgrounds of society, religion, and custom which are likely to affect the project activities.
2. Political and Legal Risk

Legal and political risks include the political stability of a country, existing policies in a country, procedures, and state government reputation as well.

3. Economic Risk

   All kinds of economic factors which possibly make a project experience loss, such as: high inflation, huge debt, economic activities reduction, and financing risk.

4. Market Risk

   Market risk relates to project demand and offer which always change depending on the market circumstance. Market risk includes demand condition uncertainty, price level, and supply of energy and raw material sources.

5. Financing Risk

   Financing Risk is caused by lack of fund or high cost incurred which cause a project is not completed on time.

6. Bidding Risk

   Bidding risk is divided into two kinds: project bidding risk and auction document compilation. Project bidding risk includes inaccuracy of information source, lack of project implementation, unreliable agent, incomprehension about competitors, misplay in decision-making. Auction document compilation risk includes insufficient preparation in owner-owned preparatory work, vagueness of auction requirements, lack of design data, misunderstanding of auction documents, failure of spot investigations, construction predictions, and quoted prices.

7. Contract Risk

   Contract risk includes omitted contract requirements, inaccurate expression, inappropriate selection of kinds of contract, incorrect contract model, ineffective claim management, contract dispute, low contract management level, lack of implementation accuracy of contract term.

8. Design Risk

   Risk faced in the design phase is divided into two things: firstly, information and requirements owned by an unstandardized owner, so that it is considered as something unclear enough; secondly, the risks posed by EPC contractors are wrong technology choices, inappropriate design management, such as: product design failure.

9. Procurement Risk

   Risk in the procurement phase of EPC projects includes improper handling related to cost, quality, process, security; incomplete procurement plan, accreditation from supplier and calibration error, miscalculation of procurement costs, miscalculation of processes, forecasting and monitoring lead to a discrepancy in the results of the plan with the actual results.

10. Construction Risk

    Critical time of a project may be likely to happen in the construction stage. Main risks in this stage are construction error assessment, incomplete construction schedule and plan, working incompetently in construction quality control and management, bad construction safety management, absence of meeting schedule, problem in construction and implementation plans, lack of concern to a problem of time, having bad worker and team management.

11. Management Risk

    Risk management includes experience and ability of project management team, monitoring owner change, subcontractor management, relation between project team members and worker team coordinators.

House of Risk Model

House of Risk is a framework developed by Pujawan dan Geraldin (2009) which is used for analyzing risk potentials, making mitigation actions, and evaluation risks. In general, this

method is used for managing risks. HOR is a development as well as an integration of two predecessor methods which are Failure Mode Effect Analysis (FMEA) and House of Quality (HOQ).

Pujawan and Geraldine add the differences between HOR and FMEA method which are shown in the opportunity of the risks on risk sources happen and the effect happens in the risk events. According to Pujawan and Geraldine, one risk agent is able to cause some risk events. Therefore, it is necessary to make calculation of aggregate risk potential of risk sources. If O(j) is the possibility of risk source events, and S(i) is the level of severity if the risk i happens. R (ij) is a correlation between risk sources and risk events. i indicates how likely the source of risk j is capable of inducing risk events i. As a result, ARP (Aggregate Risk Potential) can be calculated with the formulation as follows:

$$ARP\ (j) = O(j) \sum S(i)\ R(ij)$$

Therefore, the result of which risk sources have the highest priority can be obtained, so as to be able to choose the most effective preventive act to reduce risk events which are potentially posed by risk sources. HOR model has two stages of process:

(1) HOR 1 used for determining which risk agents or risk sources are prioritized to take preventive actions.
(2) HOR 2 is a stage that giving priority to an effective act by considering reasonable resources and cost.

In the stage of HOR 2, HOQ model is adapted by giving priority level to the preventive actions determined by considering its effectivity and resources used, the difficulties faced when implementing the actions. If TE*k* is a total effectiveness value of a preventive action, and D*k* is a difficulty level of preventive action implementation, then degree of comparison between effectiveness value and difficulty level in every preventive action can be calculated by using this formula:

$$ETD\ (k) = TE(k) / D\ (k)$$

3. METHODS

Risk Identification

The risk identification stage began with identifying risk agents and risk events. A risk agent is the cause that triggers a risk event, while a risk event is when a potential loss (bad outcome) was created. At this stage risks will be identified using interviews with experts. The experts determined by the author are employees of PT. X which were involved in a series of activities reviewed in this study starting from the engineering, procurement, and construction stages. To obtain risk events and risk agents, literature studies and discussions/interviews with previously selected respondents are carried out for verification so that the risk agents and risk events will be relevant to the current project conditions. The results of identifying risk events and risk agents will be used in table HOR 1.

Risk Analysis

Risk analysis conducted with appraisal to determining probability (Occurrence) by using likelihood scale (1 to 5) and rate consequence or impact (Severity) by using severity scale (1 to 5). This value is obtained with charging completed questionnaire created by the author, this questionnaire is addressed and assessed by experts who have determined earlier on-stage identification risk. The next stage is to assess the level of correlation between risk sources and risks. The correlation values determined are 0, 1, 3, and 9. The next step is to calculate the Aggregate Risk Potential (ARP) value by adding up the result of multiplying the probability level of the risk agent and the level of impact of the risk event. At this stage, the results of the assessment will be

obtained from several informants, so that the final value of the occurrence and severity variables will be obtained by combining the values obtained by calculating the geometric average. The occurrence, severity, and ARP values that have been obtained are then used as input in the stage 1 HOR table. The ARP value is also used as input in the stage 2 HOR table.

Risk Evaluation

The risk evaluation stage is where the results of the pareto diagram and HOR table 1 which are the probability level of each risk agent are evaluated and selected for preventive action based on the highest to the lowest priority level. In this context, the risk agent to be chosen is a risk agent that contributes 75% of the total existing ARP value. The selected risk agent will be the input for the stage 2 HOR table creation.

Risk Mitigation

Risk mitigation aims to provide solutions as well as preventive actions for risk sources that have been previously selected based on the results from the stage 1 HOR table. Furthermore, the risk mitigation action design stage will use the stage 2 HOR table. The risk mitigation design will consider several aspects from how effective the preventive measures that will be given, with the availability of existing sources and the minimum possible costs. At this stage interviews will be conducted with experts who have been previously selected in the process of making the HOR table stage 1 to identify what preventive actions are considered effective in mitigating the risk agent that has been selected.

After determining several preventive actions (PA), then an assessment of the correlation between PA and the intended risk agent is carried out using a scale (0, 1, 3, and 9) from experts (expert judgment). This aims to show how effective these preventive measures are in reducing the number of incidents of a risk agent. The next stage is to assess the level of difficulty in implementing each PA that has been identified using a scale (3, 4, and 5). The results of the two assessments described above will then be compared to produce a ratio that is useful in ranking to determine the priority level of mitigation actions, with rank 1 given to preventive actions that have the highest ratio. Thus, it can be concluded what mitigation actions can be implemented by the company along with alternative recommendations.

4. RESULTS

4.1 Result analysis of risk agent identification

Based on the results of completing and evaluating the questionnaire, seventy-seven risk agents were identified from all stages of the EPC with a composition of thirty-three risk agents from the engineering stage, twenty-three risk agents from the procurement stage, and as many as twenty one risk agents from the construction stage.

The ARP calculation is the output from the HOR 1 table where ARP is the value that is owned by each risk agent. A recap of the ARP value of each risk agent results from the HOR table 1 can be seen in Table 4.1. The size of the ARP value indicates the priority level of a risk agent to be given preventive action. The greater the ARP value, the higher the priority of the risk agent for preventive action because the risk agent is considered to have the potential to trigger a risk event, resulting in a significant impact on the project.

Table 4.1 Selected Risk Agents Based on ARP Value

Rank	Code	Risk Agent	ARP Value	Process/Stage
1	**A7**	Lacking communication with parties related	1377.81	Engineering, Procurement, Construction
2	**A1**	Lacking of workers/personnel competence	1030.42	Engineering, Procurement, Construction
3	**A2**	Being careless on reviewing documents	520.41	Engineering, Procurement, Construction
4	**A44**	Late payment for workers vendor	259.72	Engineering
5	**A3**	A design change from the field and organization in upstream A	231.02	Engineering, Procurement, Construction
6	**A15**	Work sequence influence	204.90	Engineering & Construction
7	**A62**	Poor parent company cash flow	201.46	Engineering, Procurement, Construction
8	**A10**	A developed design as well as support needs for new equipment that can be finalized	181.56	Engineering & Procurement
9	**A11**	Specification change from owner	180.43	Engineering & Construction
10	**A20**	High employee turnover	178.18	Engineering
11	**A75**	Less-detailed pre-mobilization inspection	172.72	Procurement
12	**A21**	Work overload results in high resource needs	165.44	Engineering & Construction
13	**A22**	Company policy on doing budget efficiency	150.98	Engineering, Procurement, Construction
14	**A31**	Not yet having a complete in-house engineering team, engineering designs are still being subcontracted to other parties.	150.49	Engineering
15	**A32**	Having no license for specific engineering tools that are used as design calculation software (etap power system, 3d models, etc.).	150.49	Engineering
16	**A47**	Covid 19 pandemic	139.29	Construction
17	**A49**	Local labor absorption policy.	138.77	Construction
18	**A50**	having difficulty to recruit workers due to pandemic	138.77	Construction
19	**A59**	Lack of quality in our own nation	131.08	Procurement

Rank	Code	Risk Agent	ARP Value	Process/Stage
20	**A64**	Poor quality vendor selection	128.97	Procurement
21	**A8**	Delay in feeding data from other JO consortium partners	128.18	Engineering
22	**A6**	Too tight target with limited time	119.43	Engineering & Procurement
23	**A30**	resources/manpower limit on field	117.91	Procurement
24	**A76**	Materials are stored crowded in the field and the length of the stock process in the warehouse	116.05	Procurement
25	**A71**	Late forwarding time	111.51	Procurement
26	**A55**	Purchasing material which is inappropriate with ABVL (Approved Brand Vendor List).	111.01	Engineering

4.2 Result analysis of risk response

Risk responses are given to twenty-six selected risk agents which are the results of HOR1. The risk response provided is in the form of preventive actions aimed at mitigating and minimizing the emergence of risk agents. Through brainstorming activities with the management team, twenty-one preventive actions were identified to mitigate risk sources that had been selected as problems to be resolved. The results of the House of Risk phase two (HOR2) table are in the form of a rating of each preventive measure based on the ETD value. The ETD value is the result of a comparison between the level of effectiveness of a preventive action against the intended risk agent (*Tek*) with the value of the difficulty level of implementing preventive measures (Dk). Ranking of the ETD value aims to determine the priority of each identified preventive action so that you know which preventive action should be taken first based on the ranking. The results of ranking the ETD values can be seen in Table 4.2.

Table 4.2 Preventive Action's Rating based on ETD Value

Rank	Code	Preventive Action	ETD	Risk Agents
1	PA1	Routine brainstorming and workshop	6854.01	A7
				A3
				A15
2	PA2	doing workers assessment before visiting the site	1854.76	A1
3	PA4	arranging cashflow and partners payment in the beginning of project	1199.61	A44
				A62
4	PA9		921.34	A21

Rank	Code	Preventive Action	ETD	Risk Agents
		project creating workload matrix for each department in the beginning of project		A30
5	PA3	Involving experts on reviewing documents	780.61	A2
6	PA8	Appoint a third-party consultant who is experienced in feasibility inspection	777.23	A75
7	PA12	Contract with subcontractors who have experience and previous working relationships	677.20	A31
8	PA13	Form a co-19 task force team that monitors and oversees the implementation of health protocols	626.81	A47
9	PA21	Submit a new vendor approval request to the owner	499.56	A55
10	PA5	Consider adequate safety factor in design planning which is not expected to be finalized at the beginning.	408.52	A10
11	PA19	Provide tagging so that it can be tracked and regulates the release of goods based on the FIFO concept	348.16	A76
12	PA10	Evaluating pareto cost items	339.70	A22
13	PA7	Bind personnel with long duration contracts and evaluate employee welfare conditions	267.27	A20
14	PA14	Write a letter to the owner regarding the condition as a force majeure	208.15	A50
15	PA15	Mapping the types of work that can be done by local workers	208.15	A14
16	PA16	Mapping the types of materials that can be sent domestic	196.62	A59
17	PA17	Develop comprehensive and rigorous selection requirements	193.45	A64
18	PA6	Carefully review tender documents	180.43	A11
19	PA11	Conduct an inventory of software tools needed at the beginning of the project, and make purchases collectively to get lower prices	150.49	A32
20	PA22	Increase the number of personnel to accommodate time	119.43	A6
21	PA20	Make agreements in the contract regarding timeliness commitments and the consequences if it is late	111.51	A71
22	PA18	Regularly remind other JO colleagues to be able to provide data feeding	32.05	A8

6. CONCLUSIONS

At the risk evaluation stage, twenty-six sources of risk need to be given preventive action based on their respective priorities. The selected risk agent composition consisted of 11 risk agents from category A and 15 risk agents from category B. Based on the results of the risk

response stage, there were 22 actions that could be taken to prevent 26 previously identified risk sources. Preventive actions are prepared taking into account the level of effectiveness and difficulty of implementation. The twenty-one precautions can be carried out according to the order in the ranking.

Based on the results of this study, several managerial implications were obtained as follows:

1. The seventy-seven risk agents can be used for risk management activities in other EPC projects so as not to experience delays.
2. In risk mitigation activities, as many as twenty-two preventive actions can be applied from the findings of this study in accordance with the stages to minimize the possibility of sources of risk occurring in an EPC project.

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A STUDY OF CREATING ROADMAP AND ACTIVITY PROGRAM FOR CREATIVE INNOVATION CENTER STP ITS USING DESIGN THINKING METHOD PERIOD 2022-2026

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ABSTRACT

Welfare is highly determined by competitiveness and measured by the productivity of how the product can be produced by HR utilization, capital, and natural resources. According to the sixth point of the President of the Republic of Indonesia's nine-priority agenda (Nawacita), people's productivity and competitiveness in international market can be improved by building Science Techno Park (STP) in various regions. ITS becomes one of the universities which gets a mandate to support President's vision in STP development. Creative Innovation Center (CIC), one of the sub-organizations from STP, is led to keep a long-term plan of ITS transformation to become Research and Innovative University in 2025 and Entrepreneurial University in 2030. Furthermore, it should have perfect activity program to accomplish the aim. This research aims at creating existing activity program Roadmap in CIC. The method used is Design Thinking which emphasizes the interests of CIC ITS users and managers through the process of empathy and problem identification in its data collection, while EISDISR method and tools named Roadmunk used for analyzing Roadmap of activity program creation. The result obtained is an activity program Roadmap for CIC as a supporting operational CIC plan at STP ITS in 2022-2026.

Keywords: Creative Industry, Cluster, Science Techno Park, Roadmap, Design Thinking.

1. INTRODUCTION

The development of life in the world of economy and business has undergone a shift in paradigm from a resource-based economy to a knowledge and creativity-based economy. This shift occurred because more than the resource-based economic paradigm, which has long been considered effective in accelerating and accommodating various changes in the business environment, is required. Indonesia welcomes this era of globalization and creativity with the "*Indonesia Emas*" program 2045 as a 100-year milestone of Indonesian independence. This program aims to prepare the golden generation, innovative and morally upstanding Indonesians, within the National Medium-Term Development Plan (RPJMN) (Bappenas, 2019). Sepuluh Nopember Institute of Technology (ITS), with its Creative Innovation Center, is one of the active parts of society in terms

of involvement in the economy and creative industry through research, innovative products, and creative talent of the future.

Higher education institutions have a role as a national entity implementing educational activities, developing science and technology to respond to changing times, and carrying out the nation's mandate. As a contribution to the direction of national progress, ITS actively conducts innovative activities in the field of science and technology to support the economy and self-sufficiency of the nation through the transformation of the institution for the development of science, technology, and art, and by providing services to society, government, and industry through the Science Techno Park (RENIP-ITS, 2015-2040). Science Techno Park (STP) ITS or also known as the Science and Technology Area, is an area within the ITS campus that is professionally managed to improve the welfare/economy of stakeholders and the surrounding community by promoting an innovation and competitiveness culture based on science, technology, and the arts (ITS Renstra, 2021). This is in line with the strategic plan (*Renstra*) described in the ITS master plan. STP-ITS has basic principles that prioritize implementing sustainable, innovative technology, creating economic value, integrated, networked, and environmentally friendly (ITS, 2021). The Innovation and Technology Development Group in STP ITS is carried out in 4 (four) groups or clusters, namely: Creative Innovation Center/CIC, Maritime Center, Automotive Center, ICT and Robotics Center (ITS, 2018). The clustering or grouping is done because ITS has several groups with expertise in the above fields with a good outlook in technology and economy in the future. However, these clusters have some problems, one of which is because the CIC-ITS is still in its early stages, so there is a shortage of human resources and a lack of structure in the organization and planning within the CIC-ITS, causing these clusters to run independently, although each of these groups has a unique operational and business character. Therefore, one solution that can be done to address the issue is by creating a roadmap that defines the organization's values and strategic plan. A roadmap is a document that contains a strategic plan that defines desired outcomes and includes the main steps or milestones needed to achieve them. This document serves as a guide and an overall picture of when a company or organization is implementing its activities. Its main function is as a communication tool that will help articulate the strategic thoughts behind the goals and plans for achieving them. Through the Roadmap, the organization carrying out the plan will be assisted and will make implementing activities easier.

From the above issues, the researcher feels the need to develop a Roadmap that supports performance in enhancing innovation related to competitiveness in ITS's CIC. This research will discuss creating a Program Activity Roadmap focused on CIC ITS in developing the creative economy field at ITS.

2. LITERATURE REVIEW

Design Thinking

Kelley & Brown (2018), the CEO of IDEO, reveals that the definition of Design Thinking is "an innovative approach centered on people taken from a designer's toolkit to integrate the needs of people, the possibilities of technology, and the requirements for business success". Design Thinking describes a conceptual thinking framework with a process within it that is cyclical, resulting in iterations to achieve optimal results and having a wide-ranging impact on human-oriented innovation and impact.

Design Thinking is explained in 5 process steps that are related in sequence. The linear process is in the overall steps in a structured manner, but in the design step to the assessment, there is a process of iteration. The process is an embodiment of improvement, improving weaknesses in subsequent stages, as explained in Figure 1.

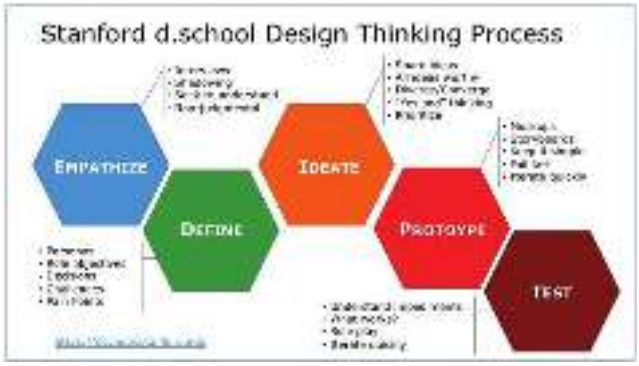

Figure 1. The Design Thinking procedure consists of empathize, define, ideate, prototype, and test phases.

1. The empathy phase (empathize) is useful for understanding the problem. The process is carried out by observing directly from a conversation or interview (Steinke et al., 2017).
2. The defining phase (define) is used to clarify a problem. The strength of a researcher's mind must be applied to understand the problem faced. After understanding this, the next step is to find a solution to overcome the problem (Steinke et al., 2017).
3. The ideation phase (ideate) is useful for solving previous problems. At this stage, the researcher uses critical, creative, and innovative logic, including a concept map, thought framework, and prototype design of the latest perception (Steinke et al., 2017).
4. The prototyping phase (prototype) is an innovation that arises from ideas to products with a physical form. The more the prototype idea is realized, the better it is discovered. In this case, the researcher needs to improve the innovative design, which can lead to the repeated formation of high-quality products (Steinke et al., 2017).
5. The testing phase (test) becomes feedback from the previous design. This means that testing allows for repeating the empathy process. Input received is useful for improving prototypes, and problems that arise will be handled more quickly and accurately (Steinke et al., 2017).

Value Proposition Canvas (VPC)

The Value Proposition Canvas is a tool that creates, designs and implements a value proposition. This tool uses an approach to align the product offered with the needs and desires of customers. According to (Osterwalder et al., 2014), the Value Proposition Canvas consists of two parts, the customer part (Customer Profile) and the company part (Value Map):

1. **Customer Profile**

   The customer profile is divided into three parts as follows:
   - Customer Jobs: Examining what jobs can be done to meet your customer's needs and what needs to be done first.
   - Customer Gain: Seeing what benefits are expected and can be obtained by the customer.
   - Customer Pain: Seeing the negative side of financing, customers dislike the risks they can get.
2. **Value Map**

   The value map is divided into three parts as follows:
   - Products & Services: Seeing the proportion of value from the products and services offered to the customer and determining which is best for the customer.
   - Pain Relievers: Seeing efforts to reduce customer losses such as saving and reducing risks.
   - Gain Creators: Seeing how your products and services can benefit the customer.

The steps of using the tool are divided into three major parts:

- Determining customers' jobs, pains, and gains. This can be done through surveys or interviews. The data in the first column should be as complete and accurate as possible to show the things that are not visible from the customer's perspective.
- Displaying the products and services offered by the company, along with the aspects or features considered pain relievers or gain creators.
- Connecting the customer and company parts to see if they are compatible (fit). If yes, then a value proposition that meets the customer's expectations can be formulated.

Roadmapping

Roadmapping is a series of planning processes in the context of an organization's specific domain or work area, driven by projected needs for future conditions deemed critical (Taufik, 2003). The outcome of this process is a "roadmap," which is a document that explains how future projections and goals (destinations) are to be achieved, what routes (alternative routes) and steps (stages) are required to reach them, who will do it and when it will be carried out, as well as what resources and capabilities are needed for all of this. The fundamental goal of road mapping is to develop a strategic and pragmatic plan with the right target, the right path, at the right cost, using the right technology and capabilities, and at the right time.

Most roadmapping involving the government or initiated by the government is a type of "science and technology" roadmapping. This is primarily related to the exploration of potential and opportunities for technology that is considered "new" (emerging) or technology considered "critical." The recommended stages are usually formulated in a "guide" from government agencies or government research institutions such as the Emerging Industries Section Department of Industry, Science, and Resources (ESIDISR) Australia method. EISDISR (2001) revealed the general process of producing roadmapping, which consists of:

1. Identifying needs and benefits. This is to answer whether a technology roadmap is necessary. If yes, what are the benefits?
2. Identifying industry champions and industry leaders. This is to answer who figures from the industry will lead the process.
3. Identifying resource needs and their sources. This determines who will provide the resources to carry out the process.
4. Determine the process: Develop the process to be used to develop the roadmap.
5. Developing the roadmap: Roadmapping implementation. This can be through an expert-based approach or a workshop-based approach.
6. Implementation: How the resulting roadmap will be followed up on.

3. METHODS

This research utilizes qualitative properties by collecting information from direct interviews, books, journals, and observations during the Design Thinking process. Subsequently, this research uses descriptive analysis, which presents the steps of Design Thinking. The Design Thinking method must be bottom-up (i.e., more "listening" to the aspirations/wishes of the users/consumers). The first step in the Design Thinking stage, empathize, is carried out through information collected using semi-structured interviews with the parties involved in the Creative Innovation Center as the research object. This interview is categorized as an in-depth interview freer than a structured one. The purpose of the semi-structured interview is to find problems more openly and freely where the interviewed informant is asked for opinions or feedback along with their ideas. At this stage, it will

be discussed what the Creative Innovation Center wants. For example, a direct interview with the Creative Innovation Center Manager. After obtaining the data obtained from the interview/FGD, the second stage is carried out, which is the Define stage. In this stage, the researcher will unpack and synthesize the findings/problems obtained from the empathize stage and provide meaningful insights from the perspective of the ITS Creative Innovation Center parties.

The results from the Empathize and Define phases of the Design Thinking process are then processed using a Value Proposition Canvas to understand the proportion of value possessed by the Creative Innovation Center. The value obtained from the Value Proposition Canvas is then used to create a Roadmap activity program to be used as a reference for developing and implementing the Creative Innovation Center. The roadmap planning uses the EISDISR method, illustrating important elements in every planning process. Technically, the stages in EISDISR are explained in simple language and can be carried out in various activities, including workshops suitable for activities/events commonly carried out in the Creative Innovation Center. The data obtained through the EISDISR method; is then translated through tools to help create the roadmap using Roadmunk. The roadmap is being made from 2022 to 2026.

4. RESULTS

a. Design Thinking Analysis

This analysis resulted in the outcome from the empathize and define the process of the ITS Creative Innovation Center based on the in-depth interviews that have been conducted with the respondents as follows:

1. Towards Vision, Mission, and Goals:

Synchronization of vision and mission among government, ITS, DIKST ITS (*Direktorat Inovasi Kawasan Sains Teknologi*), and Creative Innovation Center.

Table 1. Vision-Mision of Bekraf-Parekraf, ITS, DIKST, dan CIC ITS

VISION MISSION: BEKRAF - PAREKRAF	VISION MISSION: ITS	VISION MISSION: DIKST	VISION MISSION: CIC KST ITS
Vision: Building Indonesia into one of the world's economic powers in the creative economy	Vision ITS 2021-2025: To be a world-class higher education institution that contributes to the advancement of the nation and serves as a reference in education, research, community service and innovative development, currently in service of the industry and maritime sectors.	Vision 2020-2035 To be a leading national institution in supporting innovation and entrepreneurship through science and technology parks to achieve sustainable development and promote science, technology and arts-based economic growth	Vision "To be a Center of Excellence or Creative Industry in Indonesia"
Mission: 1. Uniting Indonesia's creative assets and potentials to achieve a self-sufficient Creative Economy 2. Creating a conducive environment for the development of the creative industry 3. Encouraging innovation in the creative field with added value and competitiveness in the international arena 4. Opening up people's perspectives and appreciation in all aspects of the Creative Economy 5. Building awareness and appreciation for Intellectual Property Rights and protection of creative copyrights. 6. Designing and implementing specific strategies to place Indonesia on the map of the world's Creative Economy	Mission: To contribute to the development of science and technology for the welfare of society through education, research, community service, and technology-based information and communication management activities	Mission: 1. To develop science and technology parks by providing business incubation services, network access, and funding opportunities to contribute to job creation and drive regional/national economic growth 2. To develop a supportive ecosystem for innovation and entrepreneurs in the successful commercialization of products	Mission : 1. Innovation Research & Commercialization 2. Transfer of Technology : IPR, Legal 3. Capacity Building : Internship, Training, Masterclass, Certification 4. Creative Business Start Up : HKI, Start Up, Start Up, Scale up 5. Marketing Communication, Branding, E-commerce & Networking 6. Industrial Advisory, Curriculum Planning, Development, 7. Event : Exhibition, Seminars, Workshop, MICE

Based on the ideation activity above, the author arranges some words that are the result of interviews with stakeholders or expert sources as follows:

Vision CIC STP ITS

To become an Indonesian IPTEKS-based Creative Industry entity that contributes to building the national innovation ecosystem to improve the well-being of society.

Mission CIC STP ITS

We are developing the Creative Industry through research, technological innovation, capacity building, and creative entrepreneurship to generate economic, social, and academic support and sustainable networking value-added.

Meanwhile, the goal of ITS R&D is also the main focus/task for CIC ITS to make ITS a Resitch University by 2025 and strive to make it an Entrepreneurial University by 2035. To achieve this goal, DIKST has issued outputs consisting of 5 stages:

Figure 2. Service and Outcomes of DIKST ITS.

However, various obstacles were found during the fifth phase of implementation. Some of the main challenges DIKST ITS and CIC face are a need for coordination, human resources, and budget.

2. Regarding Institution and Human Resources.

The DIKST has organized its organizational structure as a form of maturity of CIC and its human resources. Here is the organizational structure of DIKST ITS:

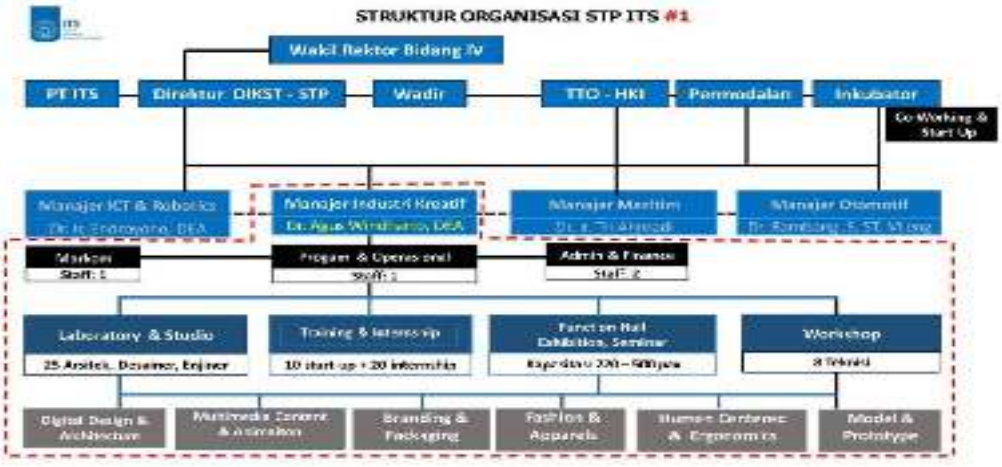

Figure 3. Organisation Structure of DIKST ITS

b. Value Proposition Canvas (VPC) Analysis

The results of the Design Thinking analysis and the data obtained from the interview are then processed in each component of the Value Proposition Canvas. The results of the study can be seen below:

1. **Customer Profile (DIKST ITS)*:***
   - Customer Jobs: Based on the interviews conducted with the DIKST stakeholders, the job to be fulfilled is making the Creative Innovation Center one of the leading Creative Centers in Indonesia.
   - Customer Pain: Based on the interviews with DIKST is a shortage of human resources, a lack of coordination, and a lack of investment and funding.
   - Customer Gain: The customer gain based on the interviews with DIKST stakeholders is the creation of increasingly innovative works, the improvement of ITS inventor's ability, increased support for innovation in ITS budget, research-oriented to innovative products, and internationalization of products.
2. **Value Map (CIC ITS)*:***
   - Product & Services: The main value proposition of the Creative Innovation Center is to be one of the leading creative centers in Indonesia that are superior and independent. The added value of the Creative Innovation Center lies in the use of technology and creativity in producing innovative products, as well as flexibility in time, environment, and human resources.
   - Pain Reliever: The pain reliever of the Creative Innovation Center is to form organizational structure and recruit personnel with expertise to support the Creative Innovation Center ITS, regularly hold meetings/discussions with DIKST and perform performance monitoring of the Creative Innovation Center, including through KPIs, seek investors and funding sources by creating innovative works to attract business partners/investors.
   - Gain Creator: Efforts to create **gain creators** from the Creative Innovation Center are to gather and facilitate a creative and innovative person to develop innovative works/products together, including by conducting innovative research for students/the public, providing training/certification domestically and internationally to each person in the Creative Innovation Center ITS, seeking investors and business partners to collaborate in supporting innovative works in the Creative Innovation Center through creative works, opening DIKST Service Office to assist in developing innovative research and forming CIC ITS clusters to produce innovative products, and collaborating in the production of products and innovations with foreign business partners.

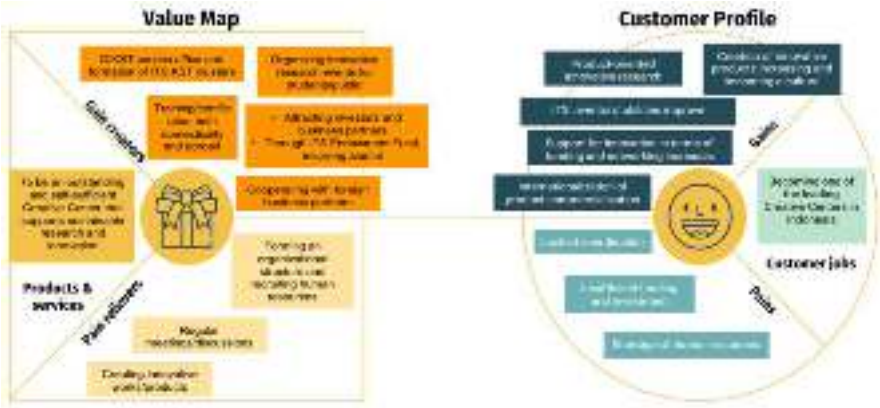

Figure 4. The Value Proposition Canvas of the Creative Innovation Center.

c. Planning Roadmap for the Program Activities of Creative Innovation Center

1. Identification of Needs and Benefits

Based on the empathy analysis conducted following the Design Thinking stages, the need and benefit of creating a Roadmap stem from the vision, mission, and objectives of CIC ITS, specifically the Creative Innovation Center. The primary market for creating this Roadmap is to support the strengthening of the existing ecosystem by helping the commercialization and product development process within the Creative Innovation Center. A well-functioning ecosystem will lead to a proper commercialization and product development process. Some benefits of creating a Roadmap for the activities of the Creative Innovation Center include the following:

- Understanding the shared vision and mission.
- Helping to prioritize programs to be carried out each year with details of each program.
- Facilitating communication among all participants in the Creative Innovation Center.

2. Identification Industry Champions dan Industry Leaders

The Vice-Chancellor IV and DIKST directly assign the manager as the head of the CIC, ITS Creative Innovation Center organization. The main task of the CIC ITS Creative Innovation Center manager is to fully responsible for leading and running the organization, producing innovative products, and ensuring that other team members fully understand the organization's vision.

3. Identification of Resource Needs and Sources

In 2021, ITS successfully secured funding from the Asian Development Bank (ADB) Loan 4110-INO: Higher Education for Technology and Innovation (HETI) Project Sovereign Project | 52332-001 (ADB, 2021). This funding is projected to last five years, from 2022 until 2026. For human resources, the personnel in charge of the activities of the CIC ITS Creative Innovation Center since 2018, officially appointed by ITS, is a cluster manager who is also an ITS lecturer, assisted by education staff. Functionally, the personnel of the Creative Innovation Center has additional duties. According to an interview with the manager of the CIC ITS Creative Innovation Center, the day-to-day activities are ideally divided among the managerial team: the manager and experts, the executors and support, and industry or community partners as research partners or partners in creative fields currently ongoing in the CIC ITS Creative Innovation Center.

4. & 5. Defining the Process and Developing a Roadmap

In this stage, we will discuss how to construct the process to develop the roadmap and then carry out the roadmap implementation. Creative Innovation Center will carry out these programs to carry out the governance, duties, and functions as part of the CIC and supporting power for ITS work program to realize the concept of the Teaching Industry to increase the nation's competitiveness. So, with the availability of existing data, then it is planned the Roadmap Program of Creative Innovation Center for the period of 2022-2026. The creation of this Roadmap uses Roadmunk tools to arrange the schedule of activities to be carried out.

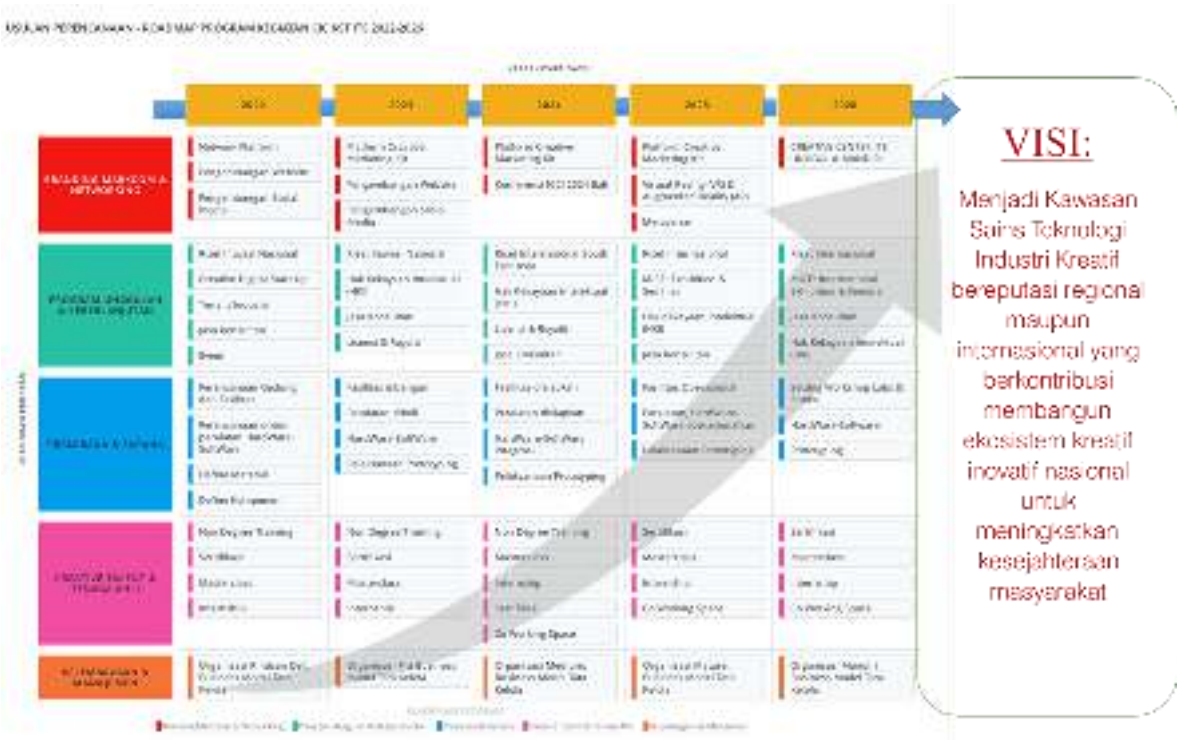

Figure 5. ITS Creative Industry Roadmap 2022-2026

Here are some explanations of the proposed program activities that have been arranged in the Roadmap:

Table 2. The proposed program activities arranged in the roadmap are connected to the five main points of the action framework.

	PROGRAM DESCRIPTION	TARGET
1	**Institutional Strengthening**	
a	FGD Creative Ecosystem in Surabaya (CI Stakeholder)	Creative Community Stakeholder
b	Legal Creative Innovation Center CIC ITS - PUI PT: Org, Mngt, HR	Intern CIC
c	Branding, Marketing Comm	Intern CIC
d	Networking & Benchmarketing (MOU, MOU, Contract)	Industries, *BUMN*, *COMM*, Association
e	Sustainability Program	CC CIC mngnt
2	**Research - Development and Prototyping**	
a	Jabodetabek LRT Research year 3	*Ristek Dikti*, Industrial Inovation
b	Research Sleeper Seat P2, Digital Signage, LRT Coupler	Program PPTI
c	Research Rotan Bike, Urban Innovation Product: Hi Craft	Program Start-Up
d	Research Hi-Speed Terrain Car body Prototyping	Rispro LPDP
e	IP (Intlec Prop) Programs	CIC Researcher
3	**Creativepreneurship**	

	PROGRAM DESCRIPTION	TARGET
a	Co-Working Spcae Collabs	Substitute, T.ID
b	Design Thinking, Business Model Training & Mentoring	SCN, Talent.ID, ADPI ADGI, Substitute, dll
c	Workshop & Prototyping	CIC's Human Resources & Partner
d	Exhibition, Branding & Marketing communication	Public
4	**Infrastructure & Equipment revitasasi**	
	Hardware, Software, Machinery, Tools, Studio, Workshop & Labs, and building revitalization.	CIC's Internal
5	**Regular Events**	
a	Organizer Bekraf Program: Bekraf Creative Labs 2019:	Government
b	World Packaging Organization (WPO) Conference Bali:	Government
c	Participate in Hakteknas Exhibition Bali, IIS Exhibition, I3E Exhibition	Government

6. Implementation

In this stage, it is explained how the resulting Roadmap will be followed up. The resulting Roadmap will guide the Creative Innovation Center in carrying out the activities that will be followed up. The Manager of the Creative Innovation Center as the leader of this cluster, is expected to be able to guide every other staff/worker to understand the resulting Roadmap so that in 2026 the vision of the Creative Innovation Center can be realized. Before the 2022-2026 Roadmap was produced, there were already several programs and products produced by the Creative Innovation Center, including:

Figure 6. Milestones Program and CIC ITS Superior Products

6. CONCLUSIONS

The conclusion that can be taken from this research are:

1. The new Creative Innovation Center Vision and Mission that can strengthen and develop the organization to remain alive, grow and be sustainable. The main objective of DIKST is not only downstream products but also to form innovation with a better-organized ed ecosystem so that products can be downstream and commercialized better.
2. In the Define stage, the main constraints that occur in CIC are the constraints/challenges from the institutional parties (lack of coordination) and incomplete organizational structure. Lack of

human resources and investment funds are also constraints due to the new age of CIC, which is the ll in the process until now.

3. The Creative Innovation Center has released several superior products/innovative works, including: Sleeper Seat Gen 1 TKT 8-9 (2018), Sleeper Seat Gen 2 TKT 7-8 (2019), Design and Construction of Medium Speed Train Exterior & Interior Carbody (2019-2020 and 2020-2022), and the creation of Integrated Digital for Medical Application-PT Bumandala (2017), Electric Motor GESITS-PT. WIKA (2021), etc.

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STUDY OF CAMPUS TV CONTENT DEVELOPMENT MODEL USING DESIGN THINKING METHOD

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ABSTRACT

During the Covid-19 pandemic, the use of campus TV has exceeded its initial capacity, which was only a media for news about campus and webinars. The large number of students who do not know and even step on campus makes the existence of this media much needed as a bridge connecting the university and students, even future students. The use of YouTube as a campus TV broadcast media should be maximized according to the dignity of social media which produces content for the audience. Building a positive institutional image in the midst of the government's push for Public University to become autonomous is also a strengthening of Campus TV in producing content that supports a positive campus image. This research is focused on developing content according to stakeholders at U State University using design thinking method by taking the perspectives of various stakeholders on campus such as the rectorate, lecturers, educators, media managers, students, and prospective students. The use of this method is expected to be the basis for determining content proposals for campus TV in the future. The aim of studying the campus TV content development model is to produce a campus TV content format that is useful for relevant stakeholders. Design thinking method in this study resulting several recommendations such as upload schedule, modifying existing content, and content suggestion based on user empathy step. The professional management of Campus TV supported by content formats that suit the audience in reaching the wishes of the campus and students, which is a big step in realizing the ideal Campus TV in the future. The results of this research are expected to be a reference for several universities and similar educational institutions in developing their campus TV.

Keywords: Campus TV, Content, Design Thinking, Media, University, YouTube

1. INTRODUCTION

The development of higher education institution which is demanded to be autonomous makes building a positive campus image to the public a must. The industry in personal image development has grown tremendously around the world, it is based on common logic by applying the same principles of marketing and branding for products and companies to individuals (Schwabel, 2009). The number of universities currently available makes universities need to develop a marketing strategy to win the tough competition. Universities with good brands can attract more and even better students, better facilities and staff, more media attention, more research funding, and more strategic partners (Joseph et al, 2012).

One of the efforts to improve the image of universities is to improve their audiovisual content. Universities are starting to increase their resources in producing audiovisual content in order to increase their reach in an increasingly dynamic environment and era (Martinez et al, 2019). Campuses are starting to compete to organize content through Campus TV which is based on the YouTube platform. The advent of social media has made it possible for almost anyone with internet access to brand themselves. Campus TV broadcasted on the YouTube channel is an alternative used by universities to build image and as a reference for the academic community and prospective students who are still considering steps towards further higher education.

Campus TV is widely used as a broadcast media event in the form of webinars, ceremonies, graduations, student reception ceremony, and several university online events that involve the academic community. Just using it is considered redundant considering the function of YouTube's social media as a medium for sharing content for the wider community. Careful planning is needed in developing Campus TV content that is in line with institutional goals and broadcasting a positive image of the campus to the YouTube audience. Content planning that is in accordance with the rules of higher education by considering various stakeholders is also an important point in this research. The resources owned by institutions are a model of sustainability that will continue to be formed with renewable assets such as intellectual property, facilities, and audiences.

This research will be conducted on K-TV at PTN U by using the design thinking method to look for the needs of relevant Campus TV stakeholders so that content and management proposal ideas emerge that can be both from the point of view of the target users and the media. This research is intended to find the right format for managing campus TV content for tertiary institutions which is still in accordance with education base and creates an appropriate and sustainable image.

2. LITERATURE REVIEW

Digital media is currently very important, digital media can be a place for people to get information, exchange ideas, and communicate with each other (Firdaus and Winarno, 2020). Campus TV is one of the media for universities to communicate with the public. The choice of communicating through social media allows for reciprocity and two-way communication between the campus and the audience. In general, the concept of communication is the process of conveying messages to a target group with the aim of providing information, changing attitudes, inviting people to do something, expressing opinions both in writing and orally (Surbakti and Barus, 2021).

YouTube is the second most visited website in the world (DataIndonesia.id, 2022) and continues to develop into one of the most relevant mass communication media platforms (Bello-Bravo et al, 2021). Based on research conducted by Google and PT. Kantar TNS Indonesia, the average YouTube viewer in Indonesia spends 59 minutes each day. As many as 92% of internet users in Indonesia state that YouTube is the first destination when searching for videos (Setiadi et al, 2019). Based on a survey report by APJII (Association of Indonesian Internet Service Providers) in the range 2019 to semester one of 2020 regarding YouTube access by Indonesians in order are film, music, sport, culinary, game, entertainment, religious content, news, vlog, and education. This research will focus on developing content that can be created by Campus TV in its design to introduce positive campus life to the community.

K-TV at PTN U, which is the study model for managing broadcast programs in this study, is an internal university work unit in the form of Campus TV which was born as one of PTN U's

steps to continue to innovate, provide learning alternatives, convey information, and provide entertainment facilities for all. academic community and the general public. Television-based programs produced by K-TV have succeeded in attracting attention from various parties, especially the academic community of PTN U. Educational, informational, and entertainment programs have become one of K-TV's tricks in providing the best broadcasts for all its viewers. Campus event broadcasts managed by the K-TV team have elicited a positive response to the continued growth of this media. So far, the content planning process has only been planned by K-TV crew with simple market research without involving input from the audiences.

3. METHODS

In this study, the authors used the design thinking method with five main stages which are empathize, define, ideate, prototype, and testing. The phases in the design thinking process are not always sequential, often running in parallel, not sequential, and sometimes repetitive (Stanford Design School, 2008). Then the researcher determines the user typology with stakeholder mapping which consists of university leaders, campus TV crew, existing audiences, and possible audiences. The first stage of the design thinking method, empathize, focuses on gaining an empathetic understanding of the user's needs. In this stage, the researcher collects information from related stakeholders in accordance with the mapping that has been done in the previous stage. The procedure carried out at this stage is to conduct a pre-survey of the K-TV audience through a digital questionnaire which is distributed to Instagram K-TV followers. The minimum target of the questionnaire is 100 respondents using a Likert scale of 4 with a range of 1-4. The questions in this questionnaire are about experience in being a K-TV viewer to be able to find specific interests that respondents have in developing K-TV content.

The next step is to conduct in-depth interviews with respondents who represent K-TV stakeholders. Interview sessions were carried out directly or indirectly through exploring situations that were in accordance with the context of the development of K-TV. Indirect interviews were conducted with the Rector, Vice Rector 2, and Vice Rector 4 tentatively according to the schedule and indirectly obtained information through Campus TV development statements during meetings, interviews in one of the programs, and the creation of K-TV annual evaluation book. This stage produces empathy maps, personas, user journey map, and affinity diagram to better understanding user. The second stage of the design thinking process is defining the problem at hand. At the define stage, exploration of various views from stakeholders is carried out to obtain a solution, the steps are point of view, point of view madlib, and how might we. The later stages are ideate, prototype, and testing which formulate empathize and define steps statement to answer the problem of campus TV content development.

4. RESULTS

4.1 Pre-Survey Result

The survey managed to collect 185 answers consisting of short answer types, multiple choices, and checkboxes. The survey is divided into 5 parts: respondent's identity, respondent's insight into K-TV, respondent's preference for K-TV content, respondent's evaluation of K-TV content, and respondent's preference for general content on YouTube.

According to the answers, 54% respondents are college students, 43% are workers, and the rest 3% are high school students. Reaching 55% of the answers that respondents know K-TV from campus events, this proves that Campus TV is still often regarded as an event broadcast media

only. As many as 73% answered that K-TV content was good, 23% answered very good, and 4% answered that it was not enough. The desired content genre for respondent, K-TV has various answers with the highest being film (web series) with 16% of respondents, 14% of respondents choosing music as a genre for K-TV content, next are culinary, entertainment, vlog genres, and education with 8%.

4.2 Empathize Stage Results

Seven personas representing the four research focus segments or stakeholder (university leaders, campus TV crew, existing audiences, and possible audiences) were generated using In-Depth Interviews and collecting data from the Pre-Survey. User personas, empathy maps, and user journey mapping results are derived from this empathy approach and are summarized as an affinity diagram as follows:

Table 1. Summary of Grouping Results of the Empathize Stage

No	Group	Empathize Summery
1	Campus TV Function	1. Campus TV as a student-campus-community bridge during a pandemic 2. Spreading the positive image of the campus 3. Documentation of campus activities 4. Become a force in terms of campus digital media 5. Become an internal campus PH 6. Broadcast event operators 7. Company Profile of universities, faculties, departments, and study programs 8. Help accreditation 9. Income generated 10. Campus TV as a means of recreation, education and information 11. Student entertainment media 12. The media exists in the academic community
2	Content Suggestion	1. Educational content in accordance with the dignity of higher education institutions 2. Display PTN U products 3. Show PTN U innovation 4. Display PTN U research 5. Display the achievements of PTN U 6. Web series 7. Show more student activity 8. UKM Activities 9. BEM or association 10. KKN 11. Quiz 12. Tips & Tricks to pass PTN U 13. Scholarship information 14. Campus life vlogs 15. Facility information 16. Culinary around campus 17. Recommended hangout places 18. Create YouTube Shorts content
3	Content Packaging	1. Less creative 2. Less explore the shooting location

		3. Highlight interesting spots on campus 4. Different hosts for each broadcast content 5. Light content 6. Implied educational content 7. Duration of content adjusted 8. Studio property is reproduced 9. Specific settings for each content
4	Habit of watching K-TV	1. Share links 2. Likes 3. Comments 4. Watch until it's finished 5. Skip-skip 6. Jump to the topic of discussion 7. Looking through the YouTube homepage
5	Pain	1. The duration is sometimes too long 2. Hosts don't put enough emphasis on watching content 3. Lacking an element of surprise from the content 4. Production deadlines are often tight 5. Sudden content makes production not optimal 6. It's difficult to manage the schedule between host-source-production crew 7. Never do thorough market research 8. Sad if the content flops 9. It's hard to attract Instagram engagement to YouTube 10. Better known for events 11. Does not have a similar benchmark where the crew is non-student workers 12. Too often talk show content 13. Too much content running at the same time
6	Gain	1. Professional crew 2. The crew is quick to respond 3. Friendly and hilarious crew 4. Professional human resources 5. Proud when the content is viral 6. Proud when it comes to Campus TV content

4.3 Define Stage Results

During the Define stage, the researcher summarizes the information that has been collected during the Empathize stage. The researcher will analyze the observations and synthesize them to determine the core problems that have been identified. The researcher seeks to identify the problem as a problem statement in a human-centered way. The Define phase will help researchers gather great ideas to build a Campus TV content concept that allows them to solve problems or, at least, allows users to solve problems on their own with a minimal level of difficulty. At this stage, the researcher used 3 stages namely Point of View (PoV), PoV Madlib, and How Might We (HMW) Question. The define stage is carried out based on the data collected in the empathy stage to generate ideas for the development of ideal K-TV content for the interests of stakeholders.

Table 2. Point of View Madlib K-TV Content Development

User		User's Need		Insight
University Leaders	Need	Branding promotion	Because	PTN-BH makes the campus independent
		Activity documentation		Exposure to community and society
		Educational content		In Accordance with the dignity of the institution
		Product Promotion		The output of research and many achievement
K-TV Crew	Need	Easy content that makes an impact	Because	Tight deadlines
		Good production schedule		Affects the quality of the content
		Dedicated content hosts		Affects the viewer's mood
		Increase YouTube engagement		Unstable
Existing Audience	Need	Entertainment content	Because	As a routine distraction
		Shows more students		Students are the main subject of the campus
		Alternate content format		Overuse of the same format
		Contribute in content		Want to be involved in campus development
Possible Audience	Need	Information on how to enter PTN U	Because	Want to study at PTN U
		Information about PTN U		For consideration on picking university
		Student daily content		Imagine college life
		Information around campus		Reference if later studying there

Table 3. How Might We (HMW) Questions

User	Insight
How Might We	Promote all the advantages of PTN U?
	Display light educational content?
	Make effective production scheduling?
	Increase K-TV YouTube Channel engagement?
	Place student in content?
	Pack information about campus?

4.4 Ideation Stage Results

Ideate (ideation) is the process of forming or creating an idea. Ideation in design thinking is the process of generating a broad set of ideas based on a particular topic without any attempt to judge or evaluate them. Researcher carried out a brainstorming and mind mapping process to generate ideas in terms of developing K-TV content.

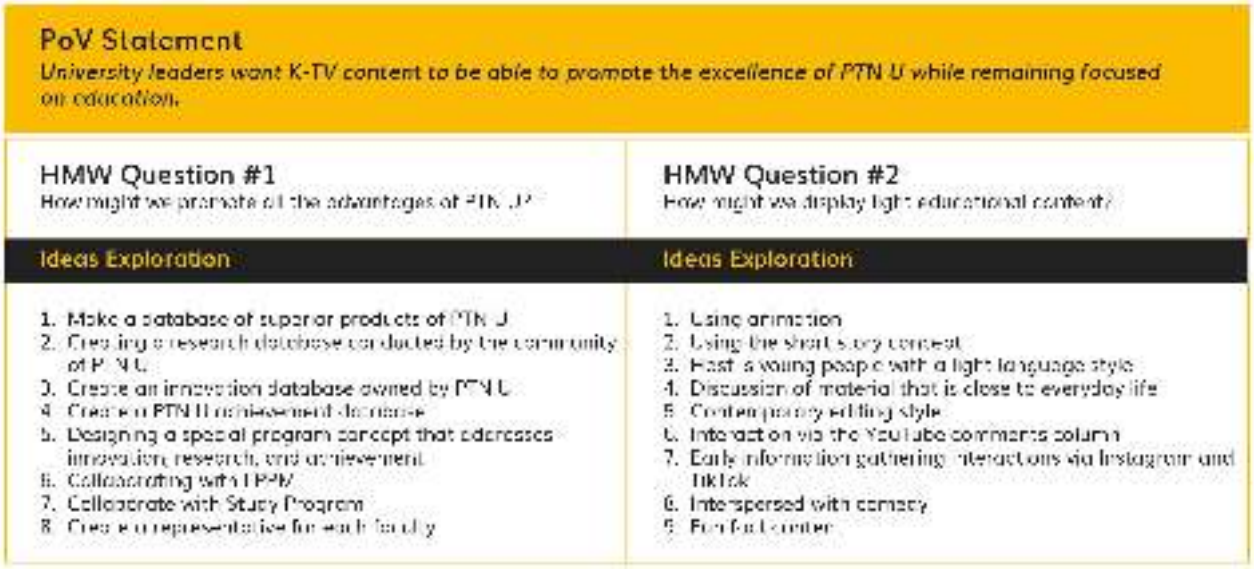

Figure 1. PoV Idea Exploration by PTN U Leaders

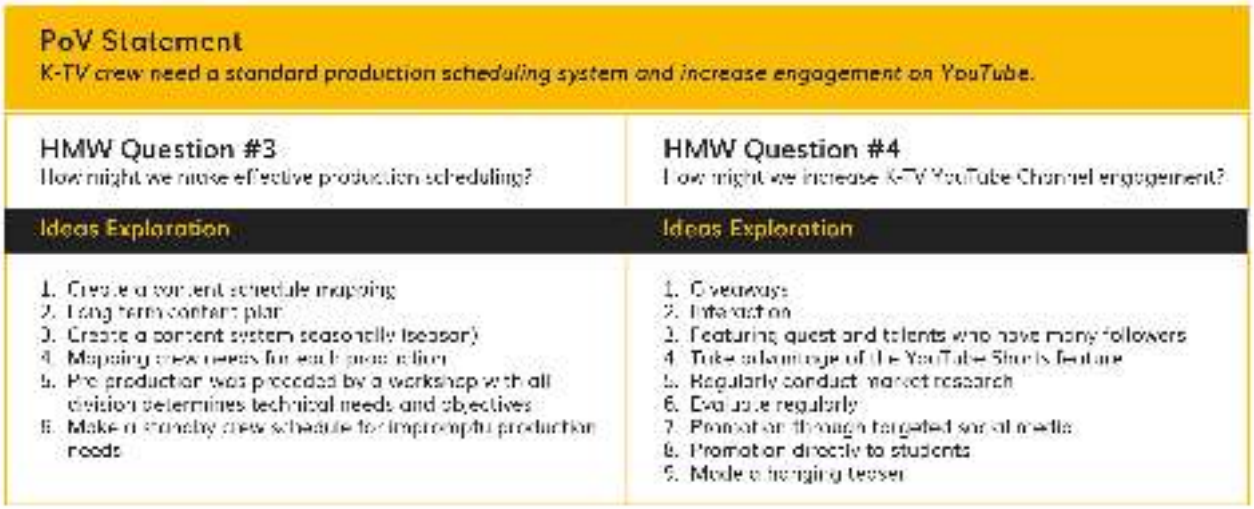

Figure 2. PoV Idea Exploration by K-TV Crew

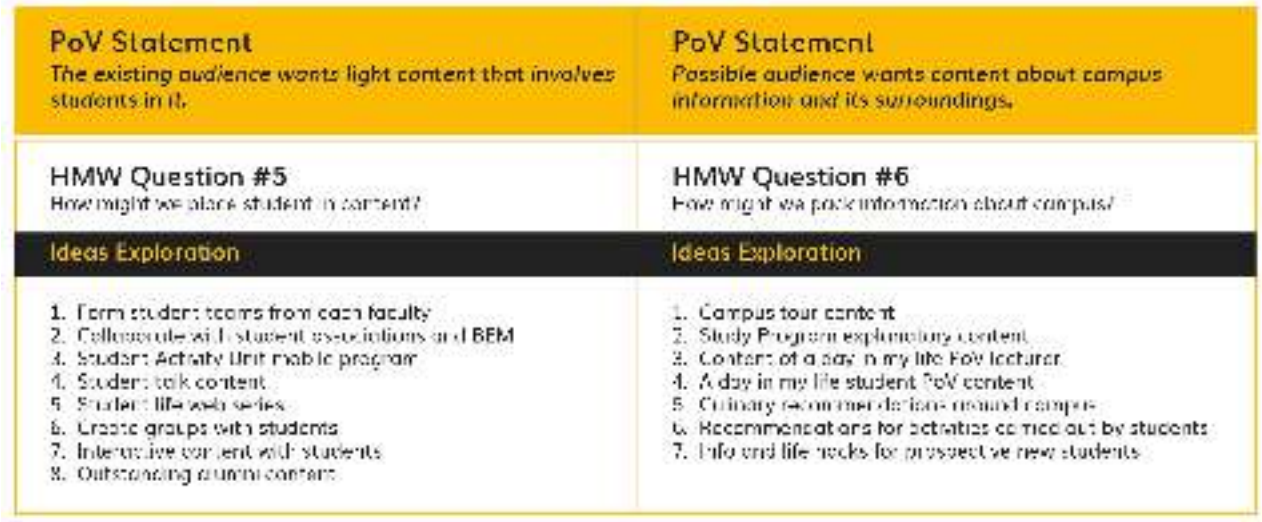

Figure 3. PoV Idea Exploration by Existing & Possible Audience

From the process of extracting ideas, various ideas were obtained that would be developed into prototype scenarios for developing K-TV content. Of the many ideas, the researchers grouped the ideas that allowed them to be executed into 3 groups:

1. Pre Production
   It contains several things that were done before content production except for drafting content because it will be discussed in other ideation groups.
2. Content Concept
   Contains content program ideas explored through the empathize and define stages. The concept of content refers to the needs of stakeholders.
3. Content Management
   Contains stages that are closely related to content management and innovation for the sustainability of content.

4.5 Prototype Stage Results

At this stage, the researcher creates scenarios from the solution ideas obtained in the previous stage. At the management concept stage, the researcher creates a broadcast schedule in a weekly scheme which can be used as a reference for the production process and content upload deadlines.

Figure 4. Recommended K-TV Content Upload Schedule

The image above is the researcher's recommendation regarding the upload schedule related to production deadlines from empathize results that accommodate managers' difficulties in managing content. There are 7 main contents recommended by researchers, namely Boncang PTN U, Median, Jendela PTN U, Entertainment Content, Study Program Content, Rilis, and Web Series. Researchers divide content into 2 types of content, namely routine content (regular) and seasonal content which is produced until it's finished according to the new season uploaded to the K-TV channel. Explanation of packaging and treatment of each content will be explained further, including:

1. Bincang PTN U
   Talk show about PTN U mainly targeting possible audience.
2. Median
   Discussing viral issues from an education perspective targeting all stakeholders. Content packaging begins with extracting opinions on a phenomenon through voxpop which is then responded to academically by experts
3. Jendela PTN U
   Jendela PTN U is a weekly news portal that documents all activities carried out by PTN U in one week.
4. Entertainment Content (S)
   Entertainment content is light content that is recommended to run on Sundays. This content is not limited in format and packaging depending on the program content to be produced. The content format can be very diverse from the results of ideas that are carried out such as quiz content, a day in my life, travel, student activities, and others.
5. Study Program Content (S)
   Study Program content is a recommendation from researchers in answering the needs of PTN U leader to introduce the advantages and specificities of PTN U. This also answers the needs of possible audiences, namely prospective students and parents of prospective students to get to know the study programs at PTN U. Study Program Content Packaging the same as in Entertainment Content which is adjusted to the brainstorming of each Study Program's characteristics.
6. Rilis
   This content is the result of discussions between researchers and the Creative Division in answering the desire to present research outputs, products, innovations, and achievements owned by PTN U. The packaging format is sound on tape interviews or documentaries from sources accompanied by animations and infographics as well as documentation of activities carried out research.
7. Web Series (S)
   The Web Series is an idealistic work of content from K-TV which at the same time answers many requests from the audience. Pre-survey respondents chose web series content as the genre they most wanted to include on K-TV with a total of 16% of all respondents. From empathizing with K-TV managers, there was also a note that they actually wanted to make a web series but were hindered by many factors such as production schedules, talent, and scripts. The results of the PoV Statement at the ideation stage found a statement that students wanted to be involved in K-TV content. The researcher then tries to connect the problems with the opportunities that exist by providing several suggestions related to making a web series, namely making it seasonal, involving the academic community in making scripts, involving the academic

community as talent, involving the academic community as a production crew, and looking for sponsors to help ease the budget.

4.6 Testing

During this process, the researcher looks at how users interact and comment with the prototype. The testing phase is carried out to detect problems from the start. Tests were carried out on representatives of stakeholders, namely PTN U leader (1 person), K-TV crew (5 people), students (2 people), high school students (1 person), and student parents (1 person). The method used is a separate presentation made by the researcher to the user by explaining the 8 recommendations of the researcher covering broadcast schedules and 7 recommended content. After going through the empathy to trial stages, the development of K-TV content with a design thinking approach resulted in improvements to Campus TV content recommendations that are in line with K-TV's target audience. The test results found that several modifications could be made in order to produce a more realistic content concept plan. Based on the feedback obtained, several modifications were made, including:

1. Regular content is run as recommended while season content is produced in stages until it is ready to go live.
2. Weekend content, namely entertainment content and web series, does not air at the same time but alternates with the format, for example, entertainment content season 1 until it is finished, then a new web series replaces it. And so on, so there are only 6 contents that are broadcast simultaneously at 1 time.
3. Utilizing YouTube Shorts as content teasers.
4. Optimizing other social media such as Instagram and TikTok as campaigns before the content broadcasted.
5. Utilizing the Spotify and Noice platforms for talk show and podcast content other than Talk PTN U.

6. CONCLUSIONS

Campus TV is an information medium between the academic community of a campus that is growing with the times. The emergence of social media has massively changed the direction of Campus TV development into a medium that can be enjoyed by all groups. The development of Campus TV content is closely related to the dissemination of a positive image of the campus to the public. Campus TV is not only a broadcast media for campus activities, but also a place for creativity in building a positive image to the public. This study took K-TV subjects at PTN U which are Campus TV with more than two years of age. The number of stakeholders that must be met regarding content segmentation makes it difficult for K-TV crew to determine what content to produce. So far, K-TV content has only come from requests from PTN U leader and the results of the K-TV crew's brainstorming without involving various stakeholders. This study uses a design thinking approach to find out the wishes and problems of four K-TV stakeholders, namely PTN U Leaders, K-TV Crew, Existing Audiences, and Possible Audiences.

Through the stages of design thinking: empathize, define, ideate, prototype, and testing, recommendations for developing K-TV content are obtained as follows:

1. Showtimes for K-TV content divided into regular and season content.
2. Bincang PTN U content is the only talk show content on Youtube K-TV.
3. Median content with the addition of voxpop as a medium for PTN U academics to have opinions on a phenomenon.

4. Jendela PTN U Content as PTN U's weekly news portal.
5. Entertainment Content (S) and Web Series (S) alternate after the season ends.
6. Study Program content collaborates with Study Program with packaging according to brainstorming to generate involvement of the academic community in K-TV content.
7. Rilis Content becomes a publication portal for the work of all PTN U members, not only for lecturers

From the studies that have been carried out, the researcher provides suggestions for further research, namely expanding the scope of data sources because the more data sources, the more accurate empathize results, more specific research on each content to be produced, evaluation and data collection is carried out regularly and periodically for the sake of continuity of content due to audience changes that occur every new academic year. Campus TV besides K-TV can implement content that allows it to be produced according to the resources they have.

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DEVELOPMENT OF USER INTERFACE AND USER EXPERIENCE DEALER MANAGEMENT SYSTEM (DMS) : CASE STUDY OF WULING MOTOR

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ABSTRACT

PT. SGMW Motor Indonesia (Wuling Motor) is one of the automotive industries in Indonesia that uses Dealer Management System (DMS) as the information system for its business operation. During the five years the system was implemented, it was still complicated to use, the display was not attractive, some of the features or menus displayed were nonfunctional, the level of efficiency in completing one job was still low. This research aims to develop a user interface display design on Dealer Management System (DMS) by adjusting the user experience side in order to provide efficient solutions for dealers in managing their daily operations more effectively. The design thinking approach method is an appropriate method for this research because it can see subjective and objective points of view in determining decisions. Through five stages of design thinking, namely empathize, define, ideate, prototype, and testing, the results of this research are a new recommendation design prototype of Dealer Management System (DMS) with UI/UX design that has been adapted to the problems and needs found which has been tested use the Usability Test. The usability test presents that the recommended design is effective and more efficient than the current design.

Keywords: Dealer Management System (DMS), Design Thinking, User Interface, User Experience

1. INTRODUCTION

Business development is inseparable from the important role of information technology, especially in the automotive industry in Indonesia. The power of information and information technology is used as a tool in winning business competition (Aziz, 2012). In automotive companies, the role of information technology is not only as a support, but also as a key operational, high potential and strategic role in business (Ward & Peppard, 2002). One of the utilizations of information technology used by automotive companies to support business processes is the Dealer Management System (DMS).

The Dealer Management System (DMS) is an integrated system that handles every business line of an automotive company and this system can provide better management information and support for customer-related activities both in sales and after-sales services (Khan et al., 2019). In implementing the Dealer Management System (DMS), a basic

understanding of the system's service operations is needed based on the fluctuations in customer needs and demands in the market to improve operational efficiency and customer satisfaction (Shashank et al., 2019).

PT. SGMW Motor Indonesia (Wuling Motor) is an automotive company that has already used a Dealer Management System (DMS) for five years in its business operations with dealer partners as the main users of the system. This system is a bridge between PT. SGMW Motor Indonesia (Wuling Motor) as an automotive manufacturing company with dealer partners who carry out sales transactions. The results of interviews conducted with active users stated that the system was still complicated to use, the interface was not attractive enough, some of the features or menus displayed were nonfunctional, and the level of efficiency in completing one job was still low. Therefore, it is necessary to change and develop the system from several sides, especially in the interface display, process flow and features to help users do their jobs more effectively and efficiently.

In developing a system, a prototype interface is needed as an initial model of a functioning system (Kompaniets et al., 2020). The prototype is inseparable from the User Interface and User Experience which are two important components that cannot be separated in the product design development process. The User Interface is what is seen in the operation of a program, while the User Experience is what is felt by the user when operating the program (Mirkowicz & Grodner, 2018). The Design Thinking approach will influence the design of the user interface and user experience of a product. This research aims to develop a user interface display design on Dealer Management System (DMS) by adjusting the user experience side in order to provide efficient solutions for dealers in managing their daily operations more effectively.

2. LITERATURE REVIEW

The Design Thinking method is a human-centered design approach method for solving problems and presenting new innovations with several stages starting from gathering information about users, what users need, creating creative solutions, building representations of the solutions offered, and testing the results. representation that has been built so as to get feedback (Sosa, 2015). User interface is a series of graphical displays that users can understand using the system, conceptually and physically (Lindberg, 2019). According to ISO 9241-210, user experience is a person's perception and response from using a product, system or service.

This research uses several references related about the Design Thinking method to develop disaster Management mobile application (Diaz Intal et al., 2020), zakat information system sedesign (Suzianti et al., 2020), information systems strategic planning (Suroso et al., 2018), P2P lending mobile application (Yusaliano et al., 2020), dental clinic ERP System (Suzianti & Arrafah, 2019), Web-based learning application (Nasution & Nusa, 2021), ironing board (Zhafira et al., 2018), and sharing food application (Putra & Suzianti, 2022). The results obtained from these studies are the design thinking method which consists of 5 stages, namely empathize, define, ideate, prototype and testing is able to provide the most appropriate recommendations for user interface and user experience in information systems in meeting user needs according to their respective roles which is supported by Usability test.

3. METHODS

The main research object is Dealer Management System (DMS). There are three types of personnel (respondents) in this study in accordance with their roles on the running of the system, namely admin dealer, sales area and IT support. This study is structured to follow the five stage of design thinking: (1) empathy, (2) define, (3) ideate, (4) prototype, and (5) test.

This research started with data collection through the questionnaire and user deep interview, then making user persona, empathy map and user journey maps in the empathy stage. At the define stage, the researchers will get information to design the system related to features, functions, and elements that can solve existing problems. To broaden the point of view of problem solving, the researchers use the How Might We (HMW) method, namely changing a statement into a question. Ideate is the stage of determining ideas through brainstorming based on the summary HMW questions obtained in the previous stage to create a solution that will be used as a guide in the development of the system to be created. After going through the three previous stages, at the prototype stage, the prototype design of the system to be made begins. In this case the researchers are assisted by Adobe XD tools in designing the visual design of digital products. In the testing stage, the prototype that has been created in the previous stage will be experimented with by users. The test uses the usability method, namely the System Usability Scale (SUS), which is a method for measuring the usability of a product (Nielsen, 1993). In addition, Cognitive walkthrough is also used to evaluate usability in the user interface with the sequence of carrying out an action, a prototype that is already running (Wilson, 2000).

4. RESULTS

4.1 Empathize Stage

In this stage, user persona was determined involving 20 respondents that consists of dealer administrator, sales area, and IT support employee as direct user for Dealer Management System (DMS). Respondents were in age of 20 to 40 years old with 60% female and 40% male employee who works for a maximum of more than 3 years. Using information from the questionnaire and the Deep Interview, three personas representing the three research target segments (dealer administrator, sales area, and IT support) were created. The following table is a summary of the user persona, empathy map, and user journey mapping results:

Table 1. Emphatize Step Results

User Persona	Emphaty Map	User Journey Map
Persona 1 is Amelia, a 24-year-old unmarried woman who works as an administrative assistant for a Wuling Motor dealer, specifically a Kumala dealer. Amelia enjoys gardening and resides in Makassar. They do daily work that is closely related to DMS. Persona 1's motivations for using the system include feeling at ease, believing that the system will always assist in completing work, the speed with which each job is completed, and being informative. Persona 1 dislikes things that are unclear, overly complicated, and unorganized or disorganized systems. While the things that captivate 1 include a system that is not a hassle, simple or simple, visually appealing, comfortable, and easy to use.	Points hear, the information obtained by the persona 1 is that the system can help the dealer's work, there is a validation process that is considered quite time consuming, requests for notifications for changing passwords every month and there is no information to see the status of a running PO. Points of pain include the long process flow and the arrangement of information from the dashboard menu that is displayed which makes it difficult to choose one menu and the appearance of the web interface is not very attractive. So for the gains points, namely the appearance of an attractive desktop web interface so that it can help the work of inputting POs ordering products from dealers to factories, menu arrangements, sub menus, better structured features and minimizing double information and long process flows and having status or tracking information on POs that have been input.	Direct expressions ranging from mediocre to dissatisfaction in inputting PO orders for Wholesales and Retail sales units, including shortening letters on the site domain to make it easier to remember, 1 time password is enough for 1 user using the ID, more appealing appearance, reducing menus and images, selecting menus, updating product type lists, simplifying the validation process, writing in corners the left is made larger, minimizes customer data that

User Persona	Emphaty Map	User Journey Map
Persona 2 is a married man named Yudi, who lives in Cikarang. Pesona 2 is a salesperson who enjoys reading. Persona 2's motivations for using the DMS as a sales area include easy access to the system, the belief that the system will always assist in completing work safely and efficiently, speeding up the process of each job, and providing informative and easy-to-understand information. They did not like the fact that the systems were old or slow, that they were difficult to access, and that there were few changes. Their goal is a faster, more stable system that is easy to use and has a more colorful, appealing appearance. Pay attention to these appearances and obtain updated information such as stock updates or unit order information.	At this time, Pesona 2 users have reported that some of the dashboard menus are difficult to find, the server is occasionally down and impedes work, and some materials and stock data on the system have not been updated. Several pain points exist, including limited access via multiple providers, difficulty retrieving data due to data overload, and data information that is out of date, resulting in double data information. So the benefits include an easy-to-use system with fast data withdrawal speeds, a more stable server, particularly during the closing/month-end period, and information that is always up to date for sales report purposes.	Persona 2 shows satisfaction, mediocre to dissatisfied when doing data collection work and analyzing Wholesales, Retail Sales and Inventory status. The need can also be known, namely using ID and password only once during registration, making it easier to find retail and wholesale menus when opening the dashboard, using the latest theme with the currently updated color logo, zooming in on the text and icons to, the size of the font and icon is enlarged for better visuals, adding the total number feature, can also display visual data charts so that sales will immediately know the amount of each daily, weekly or monthly sale, adding the export excel feature in order to be able to pull order list data from dealers to factories so that it is easier to manage into sales reports, add a filter feature to make filtering easier on the list, add a date selection feature at the top of the table, in order to be able to retrieve data according to the required date, minimize process flow in withdrawals data, omit sub menus that are not used which can confuse users, add graphical visuals or numbers that highlight the total stock available by the dealer as of today, and the font size and color for each feature / menu are made consistent so as not to confuse users
Persona 3 is Ginanda, a 27-year-old man who is not married. IT support with a passion for reading who lives in Garut. Persona 3's motivation for using the DMS as IT support includes easy access to the system, the belief that the system will always help and keep him safe, as well as the speed and updates. They dislike including things that are unclear, overly complicated, old, or poorly organized systems. Meanwhile, they prefer a simple, attractive, comfortable, and easy-to-use design. The goal of wanting an	Points here, the information obtained by the user is still the system, but when opening a web page to do certain jobs, the server is sometimes down due to a large amount of data coming in at the same time, and there is some double data information on the system, which causes confusion. Several factors contribute to pain points, including a poorly organized system that is sometimes difficult to access and a lack of system modifications/updates that make the system simpler and easier to use. As a result, for gains points that are not difficult to operate the system, the display must be more appealing in terms of color, text,	The expressions shown in Pesona 3 range from normal to dissatisfied. Pesona 3 here acts as an IT support that helps ensure that the system is running well and does its job when getting reports from dealers and sales if any problems occur. The scenario run by IT support is to check the VIN that doesn't appear in the system. The need for charm 3 when carrying out activities on the system includes a secure and stable server and internet connection, consistent and easy-to-remember ID and Password,

User Persona	Emphaty Map	User Journey Map
easy-to-use system in locating the main point of the functions that exist on each display so that it is informative and clearly arranged	menu and submenu arrangement, and user friendliness when used, as well as a faster and simpler process flow.	additional forget passwords to make changes if you forget the registered password, a more attractive, modern and up-to-date interface to date, using the latest Wuling logo, there is a main point of the menu that is displayed according to work, rearranging menus and submenus according to function priority, improving the layout of menus and sub menus and needing to emphasize the main point on options, dealers need to know the tracking PO of the unit and ensuring that they are inbound to the dealer. The need for scheduled system maintenance for data checking, so that there is no messy and untidy data which prevents some data from entering the system.

4.2 Define Stage

In the define stage the data requirements that have been obtained at the empathize stage will be analyzed to generate new ideas for the UI/UX development of the Dealer Management System (DMS). Design, Customization of feature, Work flow process, and Technical support were identified as the user needs from the results of the empathy stage. To broaden the problem-solving perspective, HMW Questions are used to assist in the brainstorming ideation process. The results of HMW Questions are as follows:

1. How to display the interface on the system attractive, modern and up to date color concept by paying attention to the aspect of visual hierarchy?
2. How to rearrange the layout of well-structured menus and submenus so that they are easy to find, highlighted and informative to make it easier to carry out each work activity?
3. How to deliver updated information to users, starting from available product information to the current unit order status?
4. How to display visualization data that can make it easier for users to make sales reports?
5. How to rearrange features capable of meeting user needs?
6. How to simplify process flow and minimize double information that can accommodate activities?
7. How to reset login page for setting username and password?
8. How to make sure the server is stable and the system runs smoothly, especially during month-end closings to make it more effective and efficient?

4.3 Ideation Stage

At this stage, the process of gathering ideas through brainstorming is carried out by answering a summary of the HMW questions identified at the define stage. Based on the results of brainstorming ideas, the researcher determines the context and content to be created on the desktop web platform from the Dealer Management System (DMS). This is achieved by considering the existing information architecture content as well as the results of the previous stage of user needs. Content will be created with a viewpoint based on the needs of the design,

appearance and features needed. After compiling and creating the content that will be created based on the findings that have been obtained, the researcher then describes the pattern of information architecture hierarchically based on the process workflow needed by the user so that it is easier to implement visually.

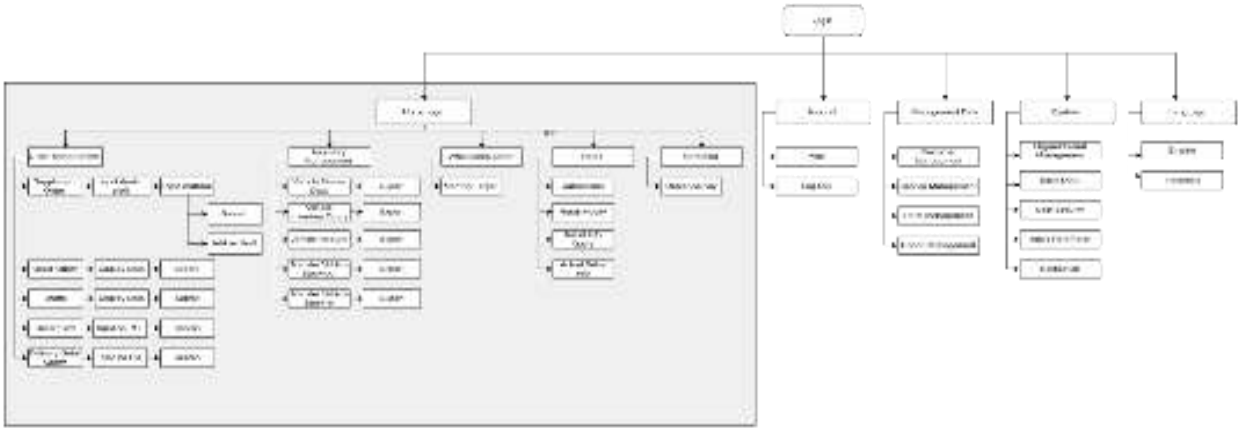

Figure 1. Designing an Information Architecture Pattern

There are several transformations with the current or ongoing information architecture based on the proposed information architecture design above. Here are some of the distinctions.

Table 2. Transformation Information Architecture

Information Architecture	**Existing**	**To-be**
Content	Content is not well classified, there is a lot of information presented. Thus, making users feel confused and not focused on their original purpose	*Content has been classified, making it easier for users to find information from menus and submenus on the system*
Pattern	The structure or pattern of information is too much and complicated. Thus spending a lot of time in reaching the required information	A simple structure or pattern uses a hierarchy composed of general information to be specific.
Navigation	There are several navigation systems, so the content is irrelevant.	The navigation system becomes one with grouping according to relevant content and displays only the most frequently searched information based on user experience.

4.4 Prototype Stage

The researchers create a display that has been tailored to the user's desires and needs, making the prototype display more appealing and functional. The color palette used in the web desktop-based Dealer Management System (DMS) development prototype is based on the previously selected theme colors, with a blend of using Wuling's most recent logo. The logo was obtained from Wuling Motor's official website and then analyzed using coolors.co.

Figure 2. Logo and Color Palletes Used

The typography or font used in the application is then poppins. This is due to the fact that this font is frequently used in interfaces and provides a lively, clean, and fun feel (Dwinawan, 2019; Putra & Suzianti, 2022; Zhafira et al., 2018). Finally, the popular style is used to determine the icon used in the application. Icons 4 Design provides icons as a plugin in Adobe XD applications.

The researchers then create a proposed display design that has been adjusted to the user's wishes and needs, so that the prototype display is more appealing and has the functions that the user expects. The following is a demonstration and explanation of the prototype that was created.

Figure 3. Current Interface Design

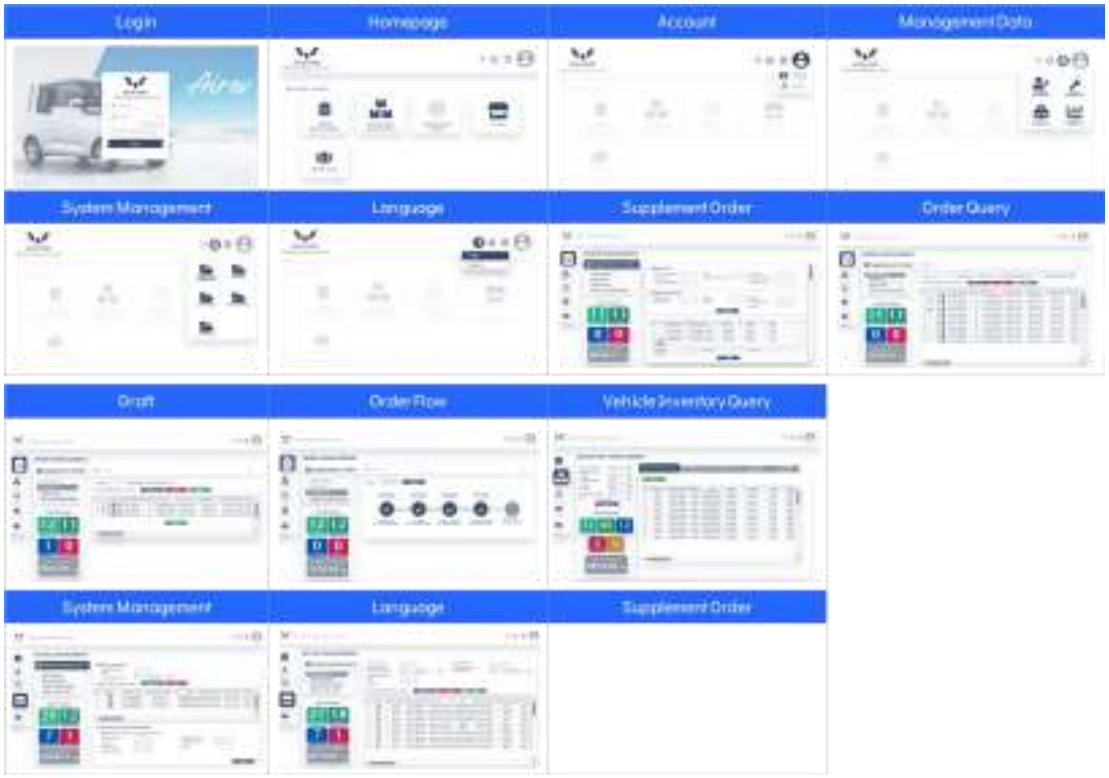

Figure 4. Proposed Interface Design

The researcher makes a proposed design from a display that has been adjusted to the wishes and needs of users based on ideas that have been obtained with several changes from the current design, including the changes include changing the red color to blue, registering the password only once, username using each ID, forget password feature, image on login page, using a variation of the password, the latest Wuling logo in the top left corner, image on the homepage removed, menu display main is the most frequently used menu, and adding an icon on each menu. Menus and submenus are not displayed on a single page. Using a box to display a menu or a submenu, the menu is organized based on work priorities. Reduce the number of potential customers on the menu, vehicle mgt because it is no longer in use. The main menu is displayed on the homepage. When you move the cursor, the menu and submenu will be highlighted. The icon minimizes the top right corner for rarely used menus, submission options, save, and search. As the focus of attention, submit is given a prominent color or size. The submenu display is easily visible. Font size and type changes, For POs that are only saved but not submitted, there is a draft feature. Only shows a list of products that are currently on the market. Product database information (model, type, color, and product code) has been updated, and the last order submission flow is only submitting and draft. On order submission, only the fill column and unit requirement are displayed. Reduce the size of the main menu feature, remove unnecessary customize order and order plan query submenus. Filtering capability, On the order query page, display the number of PO submissions. On the order query page, there is a date feature. On the order query page, you can export to Excel. Draft functionality for POs that are only saved but not submitted Document flow menu for tracking POs has been added. Reduce the size of the main menu feature. Simplify the filtering display on each submenu. Submenus should be clearly visible. Display the inventory amount on the vehicle inventory query page. The inventory menu for vehicle outbound does not need to be listed, the submenu display is clearly visible, only displays a list of products currently being sold, displays the amount of retail sales on the retail info query page, validation only when submitting an order

4.5 Testing Stage

The goal of this testing stage is to obtain product validation so that the product can be used effectively, satisfy users, and meet eligibility standards. The System Usability Scale (SUS) method was used by researchers to measure and obtain the feasibility performance value of a product. Meanwhile, the Cognitive Walkthrough method is used to identify problems encountered by users while using the prototype, so that suggestions for improvement can be generated. At this stage of testing, researchers used three respondents for each charm (dealer admin, sales area, and IT support). This is in accordance with requirements, which state that usability testing requires a minimum of three respondents for each category (Nielsen, 2000).

Respondents were asked to complete the SUS questionnaire, which contained ten questions, in order to test the system usability scale. If the design receives more than 68 SUS points, it is deemed acceptable or has good usability (Sauro, 2018). The SUS test results were 74.72, with a percentage of 100% indicating the Acceptable or acceptable category and a percentage of 20% indicating the marginal value or average limit. As a result of the testing results on the Dealer Management System (DMS) prototype design, it can be concluded that it falls into the acceptable category. This demonstrates that the prototype design is acceptable and suitable for user use.

The parameters to be used in testing using this cognitive walkthrough are task completion and the number of errors made. This is to represent a product's effectiveness. At the level of system effectiveness, which is measured by the user's success and completion of five scenarios, the results show that all respondents can complete and succeed in all scenarios with a percentage

of 100%. So, in this case, it demonstrates that the system development design concept can effectively meet the needs and desires of users.

According to the measurement results, respondents 1, 2, 3, 5, 7, and 9 did not make any mistakes while carrying out the task scenario. Respondents 4, 6, and 8 each had one error out of the total when running the task scenario. This occurs because the respondent is unfamiliar with the task at hand and forgets to enter the necessary information.

According to the measurement results, each respondent with the proposed design from the Dealer Management System (DMS) had the fastest completion time of all scenarios from scenario 1 to scenario 5 when compared to the old system design. This demonstrates that all proposed designs are more user-friendly than the current system.

Based on some of the above-mentioned tests, it can be concluded that the proposed design in the development of a Dealer Management System (DMS) can be a proposed improvement of the system to increase work productivity in supporting Wuling Motor's and dealer partners' business activities throughout Indonesia.

5. CONCLUSION

Several research conclusions were obtained based on the research conducted, as follows. The Design Thinking method can be used to generate value propositions needed by users, then finalized into a solution that is translated in the form of interface design and interaction. The proposed design for the Dealer Management System (DMS) was developed and tested on respondents, and it was discovered that the proposed design can provide user convenience, be effective and efficient in carrying out work activities to support business between PT. SGMW Motor Indonesia (Wuling Motor) and dealer partners throughout Indonesia. The test results can be used to prove UI/UX improvements to the Dealer Management System (DMS) with a proposed design where users can understand the flow of the system and carry out their tasks.

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Formal Safety Assessment for Shipping Traffic on Indonesian Territory in Straits of Mallaca and Singapore

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ABSTRACT

The Formal Safety Assessment (FSA) is a guideline set by the International Maritime Organization (IMO) in a systematic and structured manner that aims to improve maritime safety. The Straits of Malacca and Singapore are the largest trade routes in the Southeast Asian region which are passed by many ships from various parts of the world. The dense traffic of ships and the shallow and narrow geographical characteristics of the Malacca and Singapore Straits have resulted in collisions and aground incidents every year. According to data from the Tripartite Technical Experts Group (TTEG), the number of collisions and grounding incidents in the 2007-2019 period reached 64 incidents. Based on these data, research needs to be conducted to analyze risks and ensure ship safety and reduce incidents of collisions and aground crossing the waters in the Malacca and Singapore Straits in the form of a Formal Safety Assessment (FSA). Several stages are implemented in the FSA including; Hazard identification, risk assessment, risk control efforts, cost benefit assessment and lastly provide recommendations for decision making. This method is expected to construct a proactive and systematic maritime safety infrastructure.

Keywords: Formal Safety Assessment, Straits of Malacca and Singapore, Risk Assessment

1. INTRODUCTION

Indonesia is the biggest archipelago country in the world. It stretches from Sabang to Merauke. because it has a wide sea area, ships from various parts of the world pass through the Indonesian sea area, including the Malacca Strait. Straits of Malacca and Singapore is an expanse of sea that stretches 805 km (435nm) from the Andaman Sea to the South China Sea, located south of the Malacca Peninsula. Both straits have a Traffic Separation Scheme (TSS) line that stretches from One Fathom Bank to the Horsburgh Light House for 263 nautical miles (nm) where the narrowest point in the TSS is the Phillips Channel which is only about 1.9 nm wide. This strait is the main shipping route between the Indian and Pacific Oceans that pass through more than a quarter of world trade. There are 3 littoral states which borders the Malacca Strait, they are Singapore, Malaysia and Indonesia. With its status as one of the fastest routes connecting the Indian Ocean with the Pacific Ocean, making Straits of Malacca and Singapore very important in international trade.

Due to its characteristics, many researches have been carried out in these straits. For example, in a research journal from Zaman et al., (2015) which uses AIS data as a data source for hazard identification and risk assessment in the Formal Safety Assessment (FSA). In the maritime industry, Görçün & Burak (2015) stated that FSA is used as the most important risk assessment methodology and represents a systematic safety procedure. The FSA has the goal of developing a

framework for ship safety requirements in which risks are addressed in a comprehensive and cost-effective manner. This method is approved by the IM and has been introduced in the field o ship safety for several years. Hu et al., (2007) stated that FSA has proven to be a widely applicable method especially for verifying the effectiveness of proposed rules and regulations.

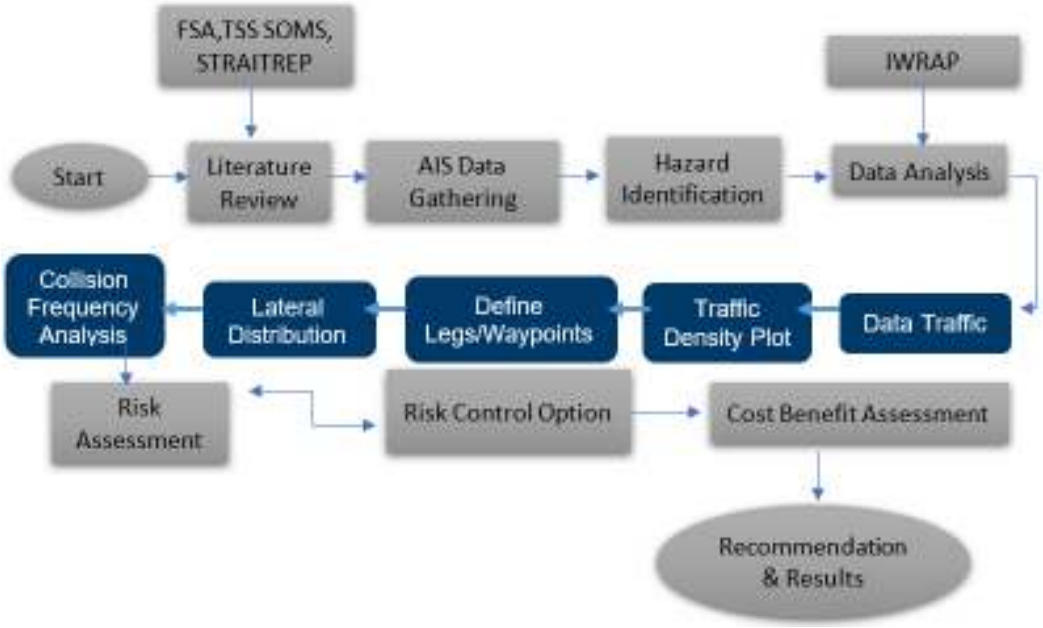
2. LITERATURE REVIEW

Zaman et al. (2013) examined the maritime safety in the Malacca Strait using AIS data and an analytic hierarchy process (AHP). This data enabled the ranking of situations based on a score that measured danger. Zaman et al. (2013) established the ship collision using FMEA FUZZY based on its AIS data. The probability calculation considered the traffic density in the channel.

Hu et al., (2007) discussed qualitative risk assessment and generic risk model in FSA, especially frequency and severity criteria in ship navigation. Then it puts forward a new model based on relative risk assessment (MRRA). The model presents a risk-assessment approach based on fuzzy functions and takes five factors into account, including detailed information about accident characteristics.

According to Görçün & Burak (2015), Formal Safety Assessment (FSA) is a very important tool for the establishment of safety systems according to marine safety. FSA methodology has been recommended to all maritime practition by the Internation Maritime Organization (IMO) as an integrated safety system. Furthermore, The FSA approach is applied in five main stages, they are Hazard Identification, Risk Assessment, Risk Control Option, Cost Benefit Assessment, Recommendation & Results.

3. METHODS



This study used IWRAP MK2 software to calculate collision and grounding frequency. Data traffic gathered from Automatic Identification System (AIS). AIS data consist of vessel length, vessel type, vessel speed, heading and vessel static data which does not change even though the ship is moving. Those data were processed to create traffic density plot. After the traffic density plot is created, legs which are lines that represent lanes passed by the ship. When the legs and waypoints have been defined, the software automatically construct a lateral

distribution from each leg to differentiate where the ship are headed. The last step for the calculation is collision frequency analysis where collision and grounding incidents were chosen to performed calculations to calculate their frequencies. After all the steps are done, IWRAP will run algorithm to compute total collision and grounding annual frequency.

4. RESULTS

This study conducted calculation for collision and grounding frequency. Type of incidents that was chosen for calculation were all incidents related to collision and grounding. After completing all the steps, IWRAP will run algorithm to calculate annual collision and grounding frequency. Next sections show frequency result for each type of incidents.

4.1 Risk Assessment with IWRAP MK2

Table 1. Frequency Index based on IMO Guidelines

Frequency Index			
FI	**Frequency**	**Definition**	**F (per ship year)**
7	Frequent	Likely to occur once per month on one ship	10
5	Reasonably probable	Likely to occur once per year in a fleet of 10 ships. i.e. likely to occur a few times during the ship's life	0.1
3	Remote	Likely to occur once per year in a fleet of 1000 ships, i.e. likely to occur in the total life of several similar ships	10^{-3}
1	Extremely remote	Likely to occur once in the lifetime (20 years) of a world fleet of 5000 ships	10^{-5}

Table 2. Total Collision Incidents

Sector	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**Total**
Area TSS	1,11, E-03	3,41, E-02	5,92, E-02	3,61, E-02	6,25, E-02	1,64, E-01	1,81, E-01	7,59, E-01	3,09, E-01	1,61, E+00
Outside TSS	0,00, E+00	1,99, E-03	5,39, E-04	1,15, E-04	2,39, E-05	2,84, E-05	5,43, E-03	3,11, E-01	4,64, E-02	3,66, E-01
Total	1,11, E-03	3,60, E-02	5,97, E-02	3,62, E-02	6,25, E-02	1,64, E-01	1,87, E-01	1,07, E+00	3,55, E-01	1,97, E+00
Weight	0%	2%	3%	2%	3%	8%	9%	54%	18%	100%

Table 1 shows the Frequency Index based on International Maritime Organization (IMO) Guidelines for each incident. Table 2 shows the total collision incidents from TSS area and outside TSS area which is 1,97 incidents/year. It can be concluded that collisions frequency occurred in Straits of Malacca and Singapore is relatively high. Sector 8 has the highest frequency among other sector since it is located between Batam Island and Port of Singapore where most ship from Indonesia cross the strait from this sector.

Table 3. Total Grounding Incidents

Sector	S1	S2	S3	S4	S5	S6	S7	S8	S9	Total
Total Grounding	0	0,0335	0	0	0,219	0	1,68	0,122	0	2,0545
Weight	0%	2%	0%	0%	11%	0%	82%	6%	0%	100%

According to table 3, Sector 7 has 82% of total grounding frequency with 1.68 incidents followed by Sector 2,5,8 with respectively 0.0335, 0.219, 0.122 incidents per year.

Figure 1. Collision and Grounding Frequency Assessment with IWRAP MK2

4.3 Risk Control Option

Risk control option aim to propose practical and effective steps or actions. Areas that have high risk are identified from the information obtained from the risk assessment. Risk control option reduce the likelihood of failure or mitigate the possible consequences. Based upon incidents result from risk assessment and to help reduce the occurrence of another incidents, training for VTS members is proposed. There are two institutions which are taken into considerations. They are AMC Search Ltd. From Tasmania, Australia and South Shields Marine School from Great Britain.

4.4 Cost-Benefit Asessment

4.4.1 Estimated Costs

Table 4. Estimation Fee for each Institution

Institution	Delivery	Total Fee (in IDR)
AMC Search Ltd	Remote	Rp 237.465.047,00
South Shields Marine School	Onsite	Rp 200.297.774,00

According to table 4, South Shield Marine School has more affordable Total Fee than AMC Search Ltd. However, this institution only has onsite delivery options and it will require extra costs if decided to train in that institution. AMC Search uses remote with video conferencing

as the delivery of training. In the current situation, delivery through online training is more cost-effective and time-efficient, resulting in more significant budget savings.

4.4.2 Benefit Analysis

After estimating costs, benefit analysis needs to be done in the form of frequency calculations with changes in the causation factor to be taken into consideration due to training. According to journal made by Chen et al.,(2019) stated that the causation factor due to inadequate competence resulted in a collision incident 0,7. At the risk assessment stage in IWRAP, the default causation factor used is 1. With the benefits of training that has been proposed, the causation factor in the form of inadequate competence is eliminated. The causation factor is entered into IWRAP calculation for each leg in the form of causation reduction factor. Initial causation reduction factor of 1 change to 1,7 due to training that have been carried out. Figure 2 is the result frequency calculation with the intervention on the causation factor due to training. The remaining risk obtained as a result of training is 1,30252 with a total collision before training was 2,769171. The risk reduction obtained reached 1,46 incidents per year.

Figure 2 Calculation frequency result with the intervention on the causation factor due to training

5. CONCLUSIONS

This study recommends actions to minimize the occurrence of collisions and grounding incidents in Straits of Malacca and Singapore that annually occurred. With thorough study, the following conclusions are obtained; AMC Search meets the criteria from a cost-benefit perspective. This conclusion was drawn because the institution provided remote training options which made participants easier to take part on the training.

By Conducting training for VTS members, it is expected to maximize supervisory performance in the coverage area of VTS Batam and Dumai. After the benefit analysis stage was carried out as a result of the training, the results of calculating the frequency that experienced a reduced risk reached 1.46 incidents per year. From these results it was concluded that the implementation of training for VTS members was able to reduce the risk of incidents occurring in the coverage area.

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RISK ANALYSIS OF COST, TIME, AND QUALITY OF THE INTERIOR CONSTRUCTION PROJECT OF HOTEL A IN SORONG CITY

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ABSTRACT

The tourism industry is a mainstay in generating foreign exchange and has also developed into the largest industry in the world. The government has made Sorong, West Papua, one of the areas in Indonesia that will be developed to support the tourism sector, one of which is the construction of hotels. The development of construction projects in Sorong City is certainly not free from problems that can hinder the achievement of construction project objectives which include cost, time and quality. Risks in construction projects cannot be eliminated but can be reduced or distributed from one party to another. This research will be conducted using a case study research method which is a type of descriptive qualitative research. In this research, risk assistance was carried out with a preliminary survey review, literature review, and focus group discussions to determine the variables used in the study. The results of this study identified 72 variables identified for relevance, 30 variables were at a medium level and 43 variables were at a low level. The risk response for risk probability is: accept 3 variables, mitigate 27 variables. While the risk response for risk impact is: transfer 4 variables, accept and mitigate 5 variables, accept and transfer 1 variable, transfer and mitigate 3 variables, and mitigate 17 variables.

Keywords: risk analysis, risk response, interior design, and interior construction.

1. INTRODUCTION

The tourism industry is a mainstay in generating foreign exchange and has also developed into the largest industry in the world. To support this, currently in Indonesia the development of construction projects is progressing with many infrastructure developments. The government designated Sorong in West Papua as one of the regions in Indonesia to be developed to support the national maritime industry. Ongoing development makes Sorong a city in the development stage, especially in the tourism industry Sorong City is currently a base for hotel development.

The construction of a building project in an operating hotel area requires a strategy to be able to minimize the disruption of construction implementation to hotel operational activities that must continue to run. Construction activities, starting from the early stages to the end will always be associated with risks that can have an impact on the three main objectives of the project namely cost, quality and time (Smith et al., 2006). Unsatisfactory handling of risk can have an adverse impact on project performance (Carr and Tah, 2001).

One of the factors that influence customers' decision in choosing a hotel is the interior design of hotel rooms. Therefore, project management risk analysis is required in interior construction projects that aim to deal with unexpected events and achieve the goal of project success, to identify the source of risk and assess the resulting impact and develop the necessary measures to deal with the risks that will arise.

This research has the scope and limitations of analyzing the risk of interior construction project implementation at Hotel A in Sorong City using case study research. The analysis technique uses descriptive and qualitative analysis of risk variables with respondents who are directly involved in the implementation of this project. Therefore, this research will be able to identify potential risks based on the probability of existing risks and other factors, as well as the responses that will be given to existing risks.

2. LITERATURE REVIEW

According to Syah (2004), in managing a project to be successful or successful, its implementation must meet 3 (three) criteria, namely: (1) Project Costs, not exceeding the planned or previously agreed limits or in accordance with the contract for the implementation of a job. (2) Quality of Work, or the quality of the final result of the work and the process / method of carrying out the work must meet certain standards in accordance with the agreement, planning, or work contract documents. (3) Time for Completion of Work, must meet the deadline agreed upon in the planning document or work contract document concerned. In reality, the 3 (three) criteria that become the nature of the project are the responsibilities that must be fulfilled by the project manager. Therefore, the role of the project manager is very dominant and determines the efforts to achieve the project objectives, so the project manager must have the authority and ability of management and administrative functions in carrying out his responsibilities in dealing with or responding to risks.

Risks can be divided into two areas, namely threats and opportunities. When calculating the total risk score, all risk points for imminent risks are added and all risk points for opportunities are subtracted. According to Mulcahy (2010) the purpose of risk response is to determine how to reduce the total project risk by reducing the likelihood and impact of threats and increasing the likelihood and impact of opportunities.

In previous research, a preliminary survey was conducted to determine what risk variables might occur in each project, followed by a qualitative descriptive analysis using FGDs by Dharmayanti and Nadiasa (2015) and Rahman and Tjendani (2022). In this research, it is necessary to search for similar research on risk analysis in the implementation of interior construction work at Hotel A in Sorong city. The research examines the risk of work from the internal scope, namely the owner, planning consultant and supervisor factors, contractor factors, labor factors, subcontractor factors and material and equipment factors. From the external scope, the study examined political and economic factors, natural factors and third party factors.

3. METHODS

In this study, primary data will be used based on the results of distributing questionnaires to respondents, namely the interior executor of Hotel A Sorong City both in the office and in the production section. At the beginning of the research, primary data is needed from focus group discussions and the results of interviews with experts in the company to determine what risks have occurred in the project and see how much the respondents understand risk management.

Secondary data used in this project is in the form of work contracts, project work schedules, project progress reports, financial reports from projects, material lists, handover

minutes and work check lists, and so on. The data collection methods in this study are as follows: Document Review, Interview, Survey (Preliminary Survey and Main Survey), then Focus Group Discussion. As a result of the first FGD, a mutually agreed risk list of risk variables occurring in the study area was determined, the probability scale and impact scale were established. The objective of the second FGD was to determine the form of risk response that is of utmost importance. For the categorization of each risk, this study used RBS. The goal is to obtain risk grouping in a logical, systematic, and structured risk hierarchy composition in accordance with the project structure. Through RBS, a hierarchical structure of risks in the project will be obtained as well as detailed information in the risk structure, these results are obtained through analysis of each risk listed on the diagram. RBS can be used for risk management planning for identified risks. In addition, the selection of resources to handle the risk and the method of resolution can be done with RBS. By knowing the potential risks that have a chance of occurring, a solution can be planned that will reduce the cause of the risk.

4. RESULTS

4.1 Preliminary Survey

The data from the risk variables obtained from the literature review are still general in nature, so to find out the relevance of the risk variables, a preliminary survey was conducted. Respondents in this preliminary survey as listed in Table 4.1 are top level management involved in the implementation of the interior construction of Hotel A in Sorong city, namely the President Director, Director of Operations, Chief Estimator, Chief Designer and Head of Production. By taking samples from personnel who have work experience in interior design and construction projects, it is expected that the risk variables obtained from this preliminary survey will be more specific and accurate in this study.

Table 1. Significant Variables

Variable	Sub-Variable	Code
1. Physical Risk	1.1 Earthquake	R101
	1.2 Heavy Rain	R102
	1.3 Flood	R103
	1.4 Pest Attack	R104
2. Personal Risks		
2.1 Technicians and Labor	2.1.1 Availability of Reliable Labor	R211
	2.1.2 Worker Productivity	R212
	2.1.3 Ability to Understand Drawings	R213
	2.1.4 Work / Manufacturing Results	R214
	2.1.5 Attendance	R215
	2.1.6 Communication	R216
2.2 Subcontractors	2.2.1 Funds for Work Costs	R221
	2.2.2 Technical Capability	R222
	2.2.3 Time to Completion	R223
	2.2.4 Quality of Work	R224
	2.2.5 Productivity	R225
	2.2.6 Coordination	R226
	2.2.7 Labor Supply	R227
	2.2.8 Time Management	R228
2.3 Staff	2.3.1 Competence	R231
	2.3.2 Responsibility	R232
	2.3.3 Experience	R233
	2.3.4 Attendance	R234
2.4 Client	2.4.1 Interference	R241
	2.4.2 Change in Demand	R242
	2.4.3 Expectation of Quality	R243
3. Engineering Risks		
3.1 Material	3.1.1 Material Price	R311
	3.1.2 Proposed Material	R312
	3.1.3 Material Availability	R313
	3.1.4 Material Quality	R314
	3.1.5 Damage	R315
3.2 Equipment	3.2.1 Work Productivity and Efficiency	R321
	3.2.2 Maintenance Costs	R322
	3.2.3 Breakdown	R323
	3.2.4 Availability	R324

3.3 Engineering	3.3.1 New Techniques	R331
	3.3.2 Quality Achievement	R332
3.4 Construction Process	3.4.1 Construction Plan	R341
	3.4.2 Coordination Problem	R342
	3.4.3 Information from Designers	R343
	3.4.4 Location	R344
	3.4.5 Climate	R345
	3.4.6 Data on BOQ	R346
3.5 Construction Site	3.5.1 Access to Site	R351
	3.5.2 Working Time	R352
	3.5.3 Local Regulations	R353
	3.5.4 Criminal Actions	R354
	3.5.5 Site investigation information	R355
	3.5.6 Invisible Problems	R356
4. Risk of Occupational Accidents	4.1 Occupational Accidents	R401
	4.2 Occupational Potential	R402
	4.3 Machinery	R403
5. Design	5.1 Design Specifications	R501
	5.2 Working Drawing	R502
	5.3 Design Scope	R503
	5.4 Construction Method	R504
	5.5 Materials and Equipment	R505
	5.6 Detail Drawings	R506
	5.7 Design Changes	R507
6. Political and Regulatory Risks	6.1 Change in Law	R601
	6.2 War	R602
	6.3 Political Circumstances	R603
	6.4 Permit and Approval Procedures	R604
	6.5 Corrupt Government Staff	R605
7. Financial Risks	7.1 Payments	R701
	7.2 Retention Fee	R702
	7.3 Additional Variation Fees	R703
	7.4 Cost Estimation	R704
	7.5 Losses	R705
	7.6 Inflation	R706
	7.7 Labor Costs	R707
	7.8 Taxes	R708
	7.9 Material Costs	R709
8. Contractual Risks	8.1 Conditions in the Contract	R801
	8.2 Enforceable Clauses	R802
	8.3 Working Conditions	R803
9. Environmental and Social	9.1 Pollution	R901
	9.2 Cultural Traditions	R902

4.2 Risk Breakdown Structure (RBS)

RBS is used in an effort to categorize each risk. RBS is grouping risks in a logical, systematic, and structured risk hierarchy composition. This risk identification stage produces a risk register, which is a component of the overall risk management plan. The contents of this risk register include a list of identified risks and updated risk categories. In the risk register, risks are also classified into several risk groups that have the same characteristics. In this research, there are 40 sub variables that will be selected as significant sub variables by experts.

4.3 Focus Group Discussion

From the discussion, it can be seen that most respondents are aware of the danger of the impact caused by the existing risk variables, but never thought of calculating the probability of risk and calculating the contingency costs for that risk when estimating. Most responses to risks are only made after they occur without any well-considered initial plans.

In the FGD, the President Director and Operations Director said that they often get information that the quality of production does not meet the standards that are usually used, so the Quality Inspection variable is added to the Technicians and Labor subcategory. In addition, delays that often occur in project completion were also conveyed by the Director of Operations and Chief Designer so that the Commitment to Implementation Schedule variable was added to the Technicians and Labor subcategory.

4.4 Main Survey

Most of the respondents have a Bachelor's degree (S-1) educational background and are from the fields of expertise of interior design, architecture, civil engineering, and electrical engineering. The respondents have work experience in handling hotel interior design and construction projects for more than 5 years, so they are expected to provide accurate values for the probability and impact of each variable. Data collection in this main survey aims to determine the probability value and impact value of the risk variables formulated in the FGD discussion results.

Table 2. Recapitulation of Calculation of Probability Value and Impact Value

VARIABLE	CODE	INDICATOR	R=(P X I)
1. Physical Risks	R103	Flood	3
	R104	Pest attack	4
AVERAGE RISK LEVEL			**3.50**
2. Personal Risk			
2.1. Technicians and Labor	R211	Availability of reliable labor	4
	R212	Worker productivity	6
	R213	Ability to understand drawings	4
	R214	Work/manufacturing results	6
	R215	Attendance	4
	R216	Communication	4
	R217	Commitment to implementation schedule	4
	R218	Quality inspection	6
2.2. Subcontractors	R221	Funds for labor costs	6
	R222	Technical capability	6
	R223	Turnaround time	6
	R224	Quality of work	8
	R225	Productivity	6
	R226	Coordination	4
	R227	Labor supply	4
	R228	Time management with other projects	6
2.3. Staff	R231	Competence	4
	R232	Responsibility	4
	R233	Experience	6
	R234	Attendance	4
2.4. Client	R241	Interference	6
	R242	Change in demand	9
	R243	Expectation of quality	4
AVERAGE RISK LEVEL			**5.26**
3. Engineering Risk			
3.1. Material	R311	Material price	6
	R312	Material proposed	4
	R313	Material availability	4
	R314	Material quality	6
	R315	Damage	6
3.2. Equipment	R321	Work productivity and efficiency	4
	R322	Maintenance costs	2
	R323	Breakdown	4
	R324	Availability	4
3.3. Technical	R331	New techniques	6
	R332	Quality achievement	9
3.4. Construction Process	R341	Construction plan	4
	R342	Coordination problem	6

	R343	Information from designers	9
	R344	Location	6
	R346	Data on BOQ	6
3.5. Construction Site	R351	Access to site	4
	R352	Working	8
	R353	Local	6
	R355	Site	9
	R356	Problems	9
AVERAGE RISK LEVEL			**5.81**
4. Occupational Accident Risk	R401	Work accidents	2
	R402	Work protection	4
AVERAGE RISK LEVEL			**3.00**
5. Design	R501	Design specifications	6
	R502	Working drawings	6
	R503	Design scope	4
	R504	Construction method	4
	R505	Materials and equipment	4
	R506	Detail drawings	4
	R507	Changes	4
AVERAGE RISK LEVEL			**4.57**
6. Political and Regulatory Risks	R604	Permit and approval procedures	2
	R605	Corrupt government staff	4
AVERAGE RISK LEVEL			**3.00**
7. Financial Risk	R701	Payment	12
	R702	Retention fee	6
	R703	Additional variation fee	9
	R704	Estimated cost	9
	R705	Losses	9
	R707	Labor cost	4
	R708	Tax	4
	R709	Material cost	4
AVERAGE RISK LEVEL			**7.13**
8. Contractual risk	R801	Conditions in the contract	4
	R802	Clauses stated	4
	R803	Working conditions	4
AVERAGE RISK LEVEL			**4.00**
9. Environmental and Social	R901	Pollution	4
	R902	Cultural traditions	2
AVERAGE RISK LEVEL			**3.00**

4.5 Determination of Risk Ranking

Risk ranking is determined based on the probability and impact matrix in Table 3.5, where the probability and impact values for each variable are entered into the matrix. So as to obtain what risk variables are included in the low, medium or high risk categories.

Table 3. Project Probability and Impact Matrix

PROBAROBAB						
	5 (almost certain to happen)					
	4 (Very Likely to Happen)					

	3 (Quite Likely to Happen)		R221, R331, R344, R353,	R242, R332, R343, R355, R356, R703, R704, R705	R701	
	2 (Less Likely to Happen)	R604	R104, R211, R213, R215, R216, R217, R226, R227, R231, R232, R234, R243, R312, R313, R321, R323, R324, R341, R351, R402, R503, R504, R505, R506, R507, R605, R707, R708, R709, R801, R802, R803, R901	R212, R214, R218, R222, R223, R225, R228, R233, R241, R314, R315, R342, R346, R501, R502, R702	R224	
	1 (Rarely Occurs)		R322, R401, R902	R103		
		1 (Not Important)	2 (Minor)	3 (Medium)	4 (Large)	5 (Fatal)
		IMPACT				
		Low				
		Medium				
		High				

4.6 Determination of Priority Risk

After obtaining the risk ranking in each project category, both residential, office and commercial projects, it can be seen what risks are included in the low, medium and high risk categories through the probability and impact matrix. Through the FGDs conducted, it was determined that the risks that became the priority to find risk responses were risks that fell into the medium and high categories. From the risk ranking calculation, there are no risks that fall into the high category.

Table 4. Project Prioritization Risk Variable

NO	KODE	VARIABEL	RANKING
1	R701	Payment	medium
2	R242	Change in demand	medium
3	R332	Quality achievement	medium
4	R343	Information from designers	medium
5	R355	Site investigation information	medium
6	R356	Unseen problems	medium
7	R703	Additional variation cost	medium
8	R704	Cost estimation	medium
9	R705	Losses	medium
10	R224	Work quality	medium
11	R221	Funds for work costs	medium
12	R331	New technique	medium
13	R344	Location	medium
14	R353	Local regulations	medium
15	R212	Worker productivity	medium
16	R214	Work/manufacturing results	medium
17	R218	Quality inspection	medium
18	R222	Technical ability	medium
19	R223	Turnaround time	medium
20	R225	Productivity	medium
21	R228	Time management with other projects	medium
22	R233	Experience	medium
23	R241	Interference	medium
24	R314	Material quality	medium
25	R315	Damage	medium
26	R342	Coordination problem	medium
27	R346	Data on BOQ	medium
28	R501	Design specifications	medium
29	R502	Working drawings	medium
30	R702	Retention cost	medium

4.7 Discussion

In table 4.14, it can be seen that the risk variables with the highest level of risk variables come from the categories of personal risk, technical risk and financial risk. In this study, quality inspection (R218), interference (R241), demand change (R242), and expectation of quality (R243), interference (R241), demand change (R242), unseen problems (R356), additional variation cost (R703), and loss (R705), payment (R701) are the highest ranked variables. Demand changes and project funding issues are the risk variables with the most significant values.

The risk variable of interference (R241) is the involvement of the client during the interior design and construction process in their project. This interference can lead to changes (R242) to the design (R507) in accordance with their wishes. Design specifications can also be changed (R501) during the design process and sometimes during furniture installation.

Quality inspection (R218) is a risk caused by the lack of personnel to be able to inspect the quality of the design and production results in accordance with the standards that have been applied. The workmanship (R214) and work quality (R224) of the workers have the possibility of being assessed below the standards that have been applied by the company. Technical ability (R222) and the availability of new techniques (R331) also have a probability of affecting the end result of the goods produced. So sometimes the client's expectation (R243) of quality also becomes another risk variable because the initial expectation they envisioned is not met with the final result of the production carried out. Worker productivity (R212) and the availability of funds from subcontractors for work costs (R221) are risks that affect the interior construction project of Hotel A Sorong City.

From the Financial risk category, there are risk variables that affect the project, namely payment (R701), additional variation costs (R703), cost estimation (R704), and losses (R705). Based on the FGD results, the probability of these risk variables must be reduced so as not to cause financial losses, while the impact of the additional cost variation variable, as much as possible, is transferred to the client because it is caused by additional costs that are not in accordance with the initial agreement. Payment variables cause consequences in terms of project time and cost, the impact of this risk must be reduced by clearly writing the payment term on the contract as stated by R1, and not continuing work to further processes before the term is paid as stated by R2. Errors in cost estimation can cause losses to the company so the impact must be reduced by being more thorough in investigating conditions in the field as stated by R3 and R5, and equalizing perceptions with designers regarding design specifications made and conducting final checks together before sending BOQ to clients as stated by R1 and R2.

Working time (R352) is a risk variable that often appears on projects. From the FGD results, this risk must be reduced so that the cost and time of project completion are in accordance with the calculated time, while the impact of this risk can be reduced by clearly calculating and asking the parties concerned about the working time allowed by the parties concerned.

Local regulations (R353) are regulations that have been set by certain parties and affect the design and construction of the project. However, the impact that occurs during the construction process should be reduced by finding out in advance the regulations that must be considered when doing design and cost estimation as stated by R1, R3, R4, and R5.

Completion time (R223) is the specified completion time that cannot be achieved by the subcontractor, and has a probability to affect the project. From the FGD results, this risk must be reduced so that the project completion time does not increase, and the impact that occurs as much as possible must be reduced as stated by R2, R3 and R5 by making an agreed agreement with a reasonable time and also considering other projects that are also being worked on.

Subcontractor productivity (R225) has a probability of affecting the project. This risk hinders the project completion time, due to the subcontractor not completing the work according

to the specified deadline. From the FGD results, this risk must be reduced so that the project can be completed on time. The impact of this risk should be transferred to subcontractors who should fulfill their obligations according to the agreement that has been made.

The price of materials (R311) has a major influence on costs because If the price of materials rises, it is certainly not in accordance with what was calculated at the beginning. From the FGD results, the probability of this risk must be reduced so that the costs incurred are in accordance with the initial calculation. The impact can be reduced by calculating the additional value when the project will be implemented, as stated by R1 and R5. The price of materials included in the cost estimate should also be checked against materials on the market, as stated by R2, R3, and R4. Material quality (R314) has a probability of affecting the project. The quality of the materials that turned out to be lower than what is usually used or experienced a decrease in quality from the manufacturer. From the FGD results, the probability of this risk must be reduced, so as not to re-work and cause additional costs. The impact of this risk must be reduced by providing the quality of materials that are in accordance with what is usually the standard of use. If there is a decrease in quality from the manufacturer that is usually used, you must look for other product comparisons.

Damage (R315) often occurs when the goods are delivered, during installation or after installing the project. From the FGD results, this risk must be reduced so that there are no more costs for repairs, it can be done by being more careful and doing good packing so that the goods are protected. The impact of this risk must be accepted if it is caused by internal companies as long as the goods have not been handed over or are still in the retention period, as stated by R1 and R2. If this risk arises due to other causes and outside of this period, this risk is transferred to the client or other party that caused the damage, as stated by R3, R4, and R5.

Site investigation information (R355) can be risky. Incomplete information leads to uninformative design and errors in the construction process, which can lead to additional costs from the work that should be done, and the completion time can also increase because of the work that must be done. From the FGD results, risks must be reduced so that the project implementation schedule and costs remain in accordance with the original calculations. Impacts can be reduced by conducting preliminary investigations before design and estimating appropriately, as stated by R3, R4, and R5. The impact can also be transferred to the client if it turns out that there are changes that must be made due to newly discovered site conditions and conditions that are not in accordance with the initial agreement that was mutually agreed upon, as stated by R1 and R2.

Retention fees (R702) that are not paid or withdrawn immediately after the retention period ends can cause losses to the project. From the FGD results, the impact of this risk should be reduced by providing an article in the contract agreement if the retention fee is not disbursed, then the company has the right to take back the goods that have been delivered (as stated by R1 and R2), or be brought to court (as stated by R3, R4, and R5), .

Information from the designer (R343) often arrives late, causing time delays and even incurring extra costs for repairs if something goes wrong. From the FGD results, this risk must be reduced so as not to cause time delays and additional project costs. The impact can be reduced by conducting periodic coordination every morning, so that it can be known directly and given a quick handling response, as stated by R2, R4, and R5.

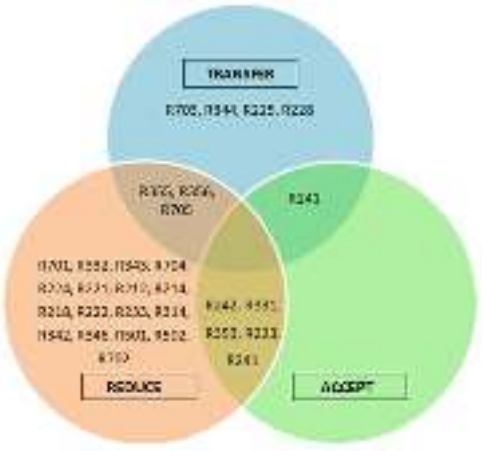
Another variable is location (R343). The unprepared location is an obstacle because the finished goods cannot be installed or must wait for the work that runs simultaneously with the furniture installation. From the FGD results, the risk must be reduced so that there is no delay in the project completion time. The impact is transferred to the client as stated by R4, and providing prior information about the installation schedule, as stated by R1 and R3.

Personnel with less experience will take a long time to complete the work and may make mistakes. Commercial projects are usually larger in size than office projects and residential projects. Therefore, experience (R233) is a variable that affects the project. From the FGD results, risks are reduced so that the project can be completed on time and does not incur costs to make repairs. The impact can be reduced by recruiting new personnel who have the expected experience, as stated by R2, R5, and R3, and providing intense mentoring at the beginning in order to know the standardization of work expected by the company, as stated by R1, and R4.

Another variable that affects the project is the data in the BOQ (R346), namely the difference in data in the BOQ with conditions in the field or with the design results. Costs will increase or decrease because there are differences that must be straightened out. The process of rectifying this difference can take time from the ongoing project. From the FGD results, the impact can be reduced by always conducting site investigations properly, as stated by R1 and R2, according to R5 with field investigations, the design made is in accordance with what is happening in the field. R4 responded to create a program that is connected between the designer and the estiamtor so that the perception received is also the same, while R3 responded by doing a final check before sending the BOQ to the client.

With the high complexity of the design, the working drawings play an important role so that the design construction is appropriate. Wrong working drawings (R502) will cause the production of furniture and interiors to be wrong and require repairs. Sometimes the mistake in making working drawings is by not paying attention to the construction method or the use of the furniture. From the FGD results, this risk must be reduced so that the project completion runs as set and without repair costs. The impact of this risk can be reduced by conducting field surveys as stated by R4, R1 and R2 said that the drawings should be scrutinized first, R3 responded to consult drawings to more experienced parties if there are difficulties and R5 responded to ask for approval from the client so that the client's expected function can be achieved.

Figure 1. Project Risk Variable Impact Response



In the interior construction project of Hotel A Sorong City, from the results of FGDs that have been carried out to determine the response to the impact on 30 risk variables as in Figure 4.6, the results obtained for the response to the impact of 4 risk variables are transferred, 5 impact risk variables are given a response to accept and reduce because it depends on the conditions and processes when the risk occurs. 1 risk variable is given a response to accept and transfer for the

impact response, 3 variables are given a response to transfer and reduce the impact, and in 17 other risk variables the impact of the risk will be reduced.

6. CONCLUSIONS

Based on the results of the research conducted in Chapter 4, the following conclusions can be drawn: (1) Respondents' understanding of risk management, most respondents are aware of the dangers of the impact caused by existing risk variables, but never thought to calculate the probability of risk and calculate contingency costs for the risk when estimating. Most responses to new risks are made after they occur without any carefully calculated initial plans. (2) There are 70 relevant variables. Of the 70 variables, there are 30 risk variables with a medium level that are given a risk response. The personal risk category has 12 variables, the engineering risk category has 11 variables, the design risk category has 2 variables, and the financial risk category has 5 variables. (3) From the results of FGDs conducted to provide responses to 30 influential risk variables, the probability response to 3 risk variables by accepting and the probability response to 27 other risk variables by reducing. From the results of FGDs that have been carried out to determine the response to the impact on 30 risk variables, the results obtained for the response to the impact of 4 risk variables are transferred, 5 impact risk variables are given a response to accept and reduce because it depends on the conditions and processes when the risk occurs. 1 risk variable is given a response to accept and transfer for the impact response, 3 variables are given a response to transfer and reduce the impact, and in 17 other risk variables the impact of the risk will be reduced.

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ANALYSIS OF DIFFERENT FACTORS OF DELAY AND MITIGATION ACTIONS IN THE COMPLETION OF THE ABC MALL DEVELOPMENT PROJECT USING THE HOUSE OF RISK (HOR) AND FAULT TREE ANALYSIS (FTA) + EVENT TREE ANALYSIS (ETA)

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ABSTRACT

In the ABC Mall development project, there were problems with delays in project completion. Previous research took the case study to identify factors causing delays using the House of Risk (HOR) method. From the research results obtained several factors of delay and selected 3 factors to be a priority. From these 3 priority factors, mitigation actions are made to prevent or reduce the risk of project delays. However, other factors that are not included in the priority are ignored so that this method is incomplete in making mitigation actions. This thesis will try to use another approach, namely the Fault Tree Analysis (FTA) method and the Event Tree Analysis (ETA) method to find out the differences in the results of HOR and FTA+ETA using comparison criteria, namely delay factors and mitigation actions. From the research results, HOR found 3 factors causing delays, namely a change in image, lack of coordination by the owner, and an addition to the scope of work. While FTA + ETA, delays in project completion are caused by the subcontractor with the delay factor, namely, there is a difference in the basic price of the material, the material payment file is not appropriate and the source of the material comes from abroad. For HOR mitigation actions, namely carrying out good communication and coordination with the Owner, making procedures for making and changing drawings and making a comprehensive check list. Meanwhile, the FTA+ETA mitigation action forms an outcome scenario of the mitigation action and the consequences of the impact of delays if the mitigation fails.

Keywords: Construction Delay Factors, House of Risk, Fault Tree Analysis, Event Tree Analysis.

1. INTRODUCTION

Previous research conducted by Ramdhan Yundra Saputra and Imam Baihaqi (2017) examined the factors causing project delays in the implementation of completing the construction of the ABC Mall using the House of Risk (HOR) to find the cause of the delay. From the results of this study, several delay factors were obtained and 3 factors were selected as priorities, namely changing images, lack of smooth coordination with the Owner and the addition of work scope. From these 3 priority factors, mitigation actions are made to prevent or reduce the risk of project delays. However, other factors that are not included in the priority are ignored so that this method is incomplete in making mitigation actions.

This thesis will try to use another approach, namely the Fault Tree Analysis (FTA) and the Event Tree Analysis (ETA). Previous research conducted by Moch. Afif Rosdianto (2017) analyzed the risk of delays in the Taman Melati Surabaya Apartment development project using the Fault Tree Analysis (FTA) approach to find the probability value of the causes of delays and the Event Tree Analysis (ETA) method used to look for the consequences of impact scenarios on delays.

In this study, we will compare the FTA and ETA methods with the results of previous research conducted by Ramadhan Yundra Saputra and Imam Baihaqi using the House of Risk (HOR) method from the stages of the method and the mitigation actions that will be obtained. From this research it is hoped that it will be able to fully explain all identified delay factors and make mitigation actions for all of these factors and be able to find out the difference in results using the HOR method and the FTA and ETA methods.

2. LITERATURE REVIEW

There is a case study of delay in completion of ABC Mall development project. Haseeb et.al. (2011) explained that delays in carrying out construction projects seep into increased costs that occur due to longer processing times, increased labor costs and increased costs of building materials.

In the previous research, they used House of Risk (HOR) method to examine the factors causing project delays. House of Risk method is a method for managing risk proactively that focuses on preventive actions, where risk agents who are identified as the cause of risk events can be managed with effective proactive measures to reduce the possibility of occurrence of risk agents, so that risk events can be reduced or prevented.

In this research, we will use different approach, using Fault Tree Analysis (FTA) and Event Tree Analysis (ETA). According to Rosyid (2007), fault tree analysis is a method for identifying all possible causes (component failure or other failure events that occur alone or together) causing system failure and providing a basis for calculating the probability of these failure events. While Event tree analysis is a method used to estimate and assess the probability of each consequence that can arise from an event. So that the reference method in anticipating various consequences.

3. METHODS

The concept of this research is re-examination using a different method, using FTA to look for delay factors and ETA to create impact scenarios from the mitigation actions taken. After that the results of this study will be compared with the results of previous studies with predetermined criteria. For more details, see the flow chart on **Figure 1**

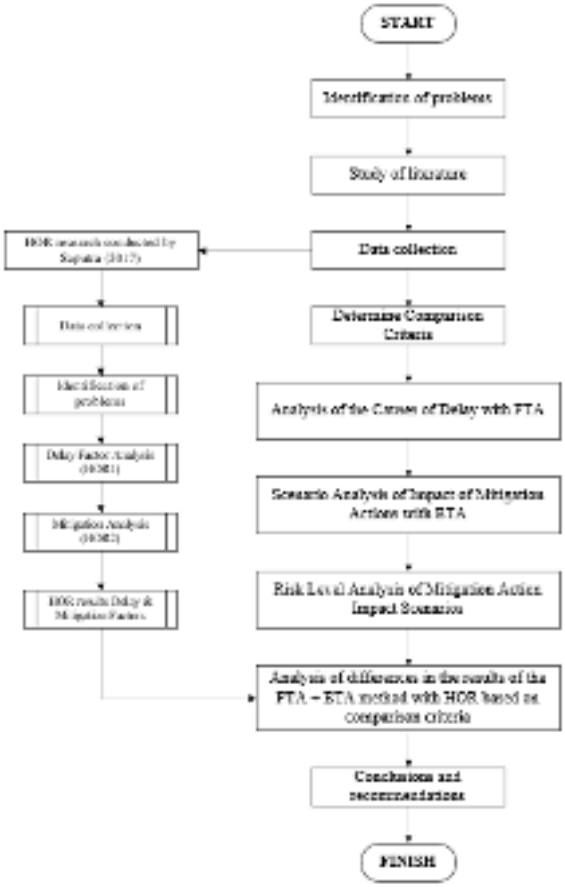

Figure 1. Flowchart of study

4. RESULTS

The first step in this research is to analyze the causes of delays using FTA. Each identified delay factor along with its probability value becomes the basic event to create a Fault Tree Diagram. The following is a Fault Tree Diagram which can be seen in **Figure 2** and for information can be seen in **Table 1**

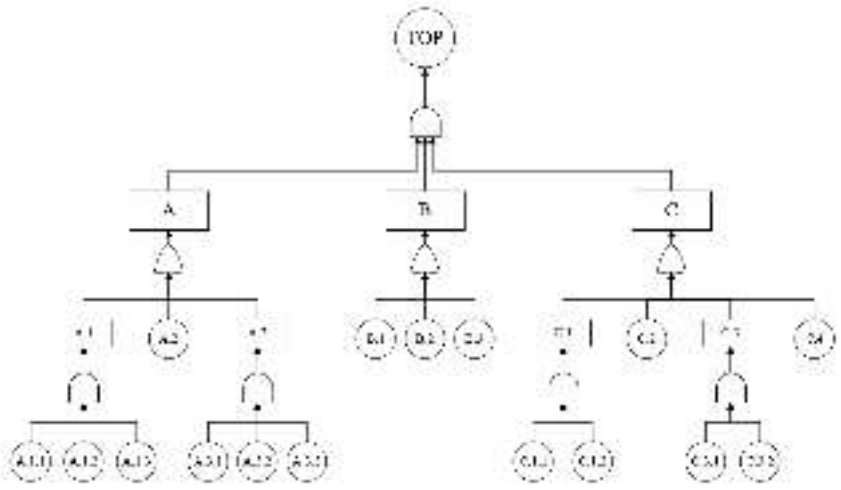

Figure 2. Fault Tree Diagram

Table 1. Code of Delay Agent

Code	Description	Probability
TOP	ABC Mall Completion Delays	
A	The delay was caused by the Contractor	
A.1	Coordination Problems	
A.1.1	There was a collision in the contractor's scope of work	0,6
A.1.2	Lack of coordination with the Owner	0,6
A.1.3	The initial survey of the contract is not in accordance with what was done	0,4
A.2	Lack of human resources on contractors	0,6
A.3	Payment Problems	
A.3.1	Administrative files are incomplete and appropriate	0,4
A.3.2	Material Payment Late	0,05
A.3.3	There is a renegotiation of new prices and volumes	0,05
B	The delays was caused by the Subcontractors	
B.1	The difference in the basic price of the material	0,4
B.2	Material payment files that do not match	0,2
B.3	Material sources come from abroad	0,2
C	The delay was caused by the Owner	
C.1	Work scope problems	
C.1.1	Additional scope of work	0,6
C.1.2	Different customer requests	0,2
C.2	The length of the contractor payment process	0,2
C.3	Planning drawing problems	
C.3.1	The difference in the volume of materials	0,4
C.3.2	Drawing plan often change	0,8
C.4	Inadequate planning	0,05

Next, determine the cut set probability value of the combination of the basic events. The results of the cut set can be seen in **Table 2**

Table 2. Cut Set Probabilitiy

Code	*Intermadiate Event*	*Cut Set*
A	The delay was caused by the Contractor	0,745
B	The delay was caused by the Subcontractors	0,8
C	The delay was caused by the Owner	0,69

The next step is the cut set from the results of the FTA analysis to create a mitigation action scenario. The cut sect value of Intermadiate Event will be the Initial Event and each mitigation action made will be the pivotal event along with the probability of success and failure in carrying out each mitigation action. The probability of success is marked “YES” while the probability of failure is marked “NO”. For more details, see the Event Tree Diagram in **Figure 3**, **Figure 4** and **Figure 5** and for information on mitigation actions can be seen in the **Table 3.**

Initiating Event (IE) A	*Pivotal Event*								*Outcome*
	PA1		**PA2**		**PA3**		**PA4**		
0,745							Yes	0,6	0,17165
					Yes	0,8	No	0,4	0,11443
					No	0,2			
							Yes	0,6	0,042912
			Yes	0,8			No	0,4	0,028608
			No	0,2					
							Yes	0,6	0,042912
					Yes	0,8	No	0,4	0,028608
					No	0,2			
	Yes	0,6					Yes	0,6	0,010728
	No	0,4					No	0,4	0,007152
							Yes	0,6	0,114432
					Yes	0,8	No	0,4	0,076288
					No	0,2			
							Yes	0,6	0,028608
			Yes	0,8			No	0,4	0,019072
			No	0,2					
							Yes	0,6	0,028608
					Yes	0,8	No	0,4	0,019072
					No	0,2			
							Yes	0,6	0,007152
							No	0,4	0,004768
Initiating Event Code A									0,74500

Figure 3. Event Tree Diagram Code A

Initiating Event (IE) B	*Pivotal Event*						*Outcome*
	PB1		**PB2**		**PB3**		
0,8							
					Yes	0,6	0,23040
					No	0,4	0,1536
			Yes	0,6			
			No	0,4			
					Yes	0,6	0,1536
					No	0,4	0,1024
	Yes	0,8					
	No	0,2					
					Yes	0,6	0,0576
					No	0,4	0,0384
			Yes	0,6			
			No	0,4			
					Yes	0,6	0,0384
					No	0,4	0,0256
Initiating Event Code B							0,80000

Figure 4. Event Tree Diagram Code B

Initiating Event (IE) C	*Pivotal Event*								*Outcome*
	PC1		**PC2**		**PC3**		**PC4**		
0,69							Yes	0,6	0,11923
					Yes	0,8	No	0,4	0,07949
					No	0,2			
							Yes	0,6	0,029808
			Yes	0,6			No	0,4	0,019872
			No	0,4					
							Yes	0,6	0,079488
					Yes	0,8	No	0,4	0,052992
					No	0,2			
	Yes	0,6					Yes	0,6	0,019872
	No	0,4					No	0,4	0,013248
							Yes	0,6	0,079488
					Yes	0,8	No	0,4	0,052992
					No	0,2			
							Yes	0,6	0,019872
			Yes	0,6			No	0,4	0,013248
			No	0,4					
							Yes	0,6	0,052992
					Yes	0,8	No	0,4	0,035328
					No	0,2			
							Yes	0,6	0,013248
							No	0,4	0,008832
Initiating Event Code C									0,69000

Figure 5. Event Tree Diagram Code C

Table 3. Code of Pivotal Event

Code	*Pivotal Event*	Probability YES	Probability NO
PA1	Create project administration checklist data	0,6	0,4
PA2	Coordinate frequently with the Owner	0,8	0,2
PA3	Recruitment of contract workers	0,8	0,2
PA4	Make material payments on time	0,6	0,4
PB1	Negotiating material prices	0,8	0,2
PB2	Complete the material payment file	0,6	0,4
PB3	Create a material ordering plan	0,6	0,4
PC1	Provide the necessary resources	0,6	0,4
PC2	Make payments to contractors on time	0,6	0,4
PC3	Make a checklist for additional work scope data	0,8	0,2
PC4	Create an drawing plan change procedure	0,6	0,4

From the Event Tree diagram, the results of the outcome scenarios of the impact of each mitigation action are obtained. Next, we can measure the risk level of the impact of each mitigation action outcome using the probability outcome. For more details, see **Table 4**, **Table 5** and **Table 6**

Table 4. Risk Level for Impact Scenario Outcome Code A

Outcome	Probability	Consequence	Frequncy	Risk Level
1	0,17165	*Moderate*	*Unlikely*	*Moderate*
2	0,11443	*Moderate*	*Unlikely*	*Moderate*
3	0,04291	*Very Low*	*Rare*	*Low*
4	0,02861	*Very Low*	*Rare*	*Low*
5	0,04291	*Very Low*	*Rare*	*Low*
6	0,02861	*Very Low*	*Rare*	*Low*
7	0,01073	*Very Low*	*Rare*	*Low*
8	0,00715	*Very Low*	*Rare*	*Low*
9	0,11443	*Moderate*	*Unlikely*	*Moderate*
10	0,07629	*Low*	*Rare*	*Low*
11	0,02861	*Very Low*	*Rare*	*Low*
12	0,01907	*Very Low*	*Rare*	*Low*
13	0,02861	*Very Low*	*Rare*	*Low*
14	0,01907	*Very Low*	*Rare*	*Low*
15	0,00715	*Very Low*	*Rare*	*Low*
16	0,00477	*Very Low*	*Rare*	*Low*

Table 5. Risk Level for Impact Scenario Outcome Code B

Outcome	Probability	Consequence	Frequency	Risk Level
1	0,23040	*High*	*Possible*	*High*
2	0,15360	*Moderate*	*Unlikey*	*Moderate*
3	0,15360	*Moderate*	*Unlikely*	*Moderate*
4	0,10240	*Moderate*	*Unlikely*	*Moderate*
5	0,05760	*Low*	*Rare*	*Low*
6	0,03840	*Very Low*	*Rare*	*Low*
7	0,03840	*Very Low*	*Rare*	*Low*
8	0,02560	*Very Low*	*Rare*	*Low*

Table 6. Risk Level for Impact Scenario Outcome Code C

Outcome	Probability	Consequence	Frequency	Risk Level
1	0,11923	*Moderate*	*Unlikely*	*Moderate*
2	0,07949	*Low*	*Rare*	*Low*
3	0,02981	*Very Low*	*Rare*	*Low*
4	0,01987	*Very Low*	*Rare*	*Low*
5	0,07949	*Low*	*Rare*	*Low*
6	0,05299	*Low*	*Rare*	*Low*
7	0,01987	*Very Low*	*Rare*	*Low*
8	0,01325	*Very Low*	*Rare*	*Low*
9	0,07949	*Low*	*Rare*	*Low*
10	0,05299	*Low*	*Rare*	*Low*
11	0,01987	*Very Low*	*Rare*	*Low*
12	0,01325	*Very Low*	*Rare*	*Low*
13	0,05299	*Low*	*Rare*	*Low*
14	0,03533	*Very Low*	*Rare*	*Low*
15	0,01325	*Very Low*	*Rare*	*Low*
16	0,00883	*Very Low*	*Rare*	*Low*

After analyzing the delay in completing the ABC Mall project using FTA + ETA and getting research results from this method, our next step will be to analyze the difference in results obtained with previous research using HOR. There are 2 comparison criteria for this analysis, namely delay factors and mitigation actions.

For the results of the delay factor, from the results of previous research, it was found that 3 factors caused the delay, namely a change in image, lack of coordination by the owner, and an addition to the scope of work. Whereas in this study, the results obtained were more specific towards who caused the delay. The delay in project completion was caused by the subcontractor with the delay factor, namely, there was a difference in the basic price of the material, the material payment files did not match and the source of the material came from abroad.

And for mitigation actions, from the results of previous research, mitigation actions are made based on 3 factors of delay which are the main priorities. Based on the delay factor, 3 mitigation actions are prioritized based on ranking, namely conducting good communication and coordination with the Owner, making procedures for making and changing drawings and making a comprehensive check list. While the results of this study, the formation of mitigation actions is not based on ranking but uses the outcome scenarios of mitigation actions and the consequences of the impact of delays if mitigation fails. Based on these scenarios, you can find out if mitigation is done or not and you can know the level of risk of impact from each outcome scenario.

6. CONCLUSIONS

From the research that has been done, it can be concluded that the differences in the results of delays using the House of Risk (HOR) method with the Fault Tree Analysis (FTA) + Event Tree Analysis (ETA) method based on criteria delay agent and mitigation action.

There were 3 delay factor found from previous research using HOR, namely a change in image, lack of coordination by the owner, and an addition to the scope of work. Whereas in this study using FTA + ETA, the results obtained were more specific towards who caused the delay. The delay in project completion was caused by the subcontractor with the delay factor, namely, there was a difference in the basic price of the material, the material payment files did not match and the source of the material came from abroad.

In forming mitigation actions, in the HOR method mitigation actions are formed based on 3 main priority delay factors and then analyzed and selected effective mitigation actions based on ranking, namely communicating and coordinating well with the Owner, making procedures for making and changing drawings and making a comprehensive check list. Whereas in the FTA + ETA method, all identified delay factors are included in the process of establishing mitigation actions. The results of the FTA + ETA obtained outcome scenarios from mitigation actions so that the consequences and level of risk can be clearly seen when mitigation is successful or fails.

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DESIGN OF A SUPPLY CHAIN PERFORMANCE MEASUREMENT SYSTEM FOR THIRD PARTY LOGISTICS COMPANIES USING SUPPLY CHAIN OPERATIONS REFERENCE AND AHP METHODS

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ABSTRACT

This study aims to design a Supply Chain Performance Measurement System and apply the system as a performance evaluation process at PT XYZ. PT XYZ is a distributor company for High-Speed Diesel (HSD) diesel fuel. The perceived decrease in productivity makes companies need to measure performance. The design results of a performance measurement system produce 14 Key Performance Indicators (KPIs) which are divided into five core supply chain processes namely Plan, Make, Source, Deliver, and Return with attribute categories namely reliability, responsiveness, cost, and asset management. Determination of indicators is carried out using the Supply Chain Operations Reference (SCOR) method and afterward supported by the Analytical Hierarchy Process (AHP) method to determine the weighting between perspectives and KPIs on a priority scale. The Scoring System is used to measure performance so that the value of achieving KPIs against targets can be identified. Furthermore, an analysis of the Traffic Light System is carried out to determine the achievement of performance based on three colors (red, yellow, and green) as indicators of achievement. As a result of implementation in 2020, there are 13 performance indicators with a green score and 1 indicator with a red score. Whereas in 2021, there will be 9 indicators with a green score, 4 indicators with a yellow score, and 1 indicator with a red score. Suggestions are also given in this study to improve performance on KPIs that are in red and yellow such as Forecast Accuracy, Orders/Lines Received with Correct Shipping Documents, Release Finished Product to Deliver Cycle Time, Delivery Performance to Customer Commit Date, Deliver Cycle Time, # of complaints regarding missing environmental documentation categories so that the KPIs in these categories reach the green category (85 - 99.99%)

Keywords: Performance Measurement, Supply Chain Operations Reference (SCOR), Key Performance Indicator (KPI), Analytical Hierarchy Process (AHP), Scoring System and Traffic Light System

1. INTRODUCTION

Performance management is a crucial aspect of supply chain management to build an effective performance management system and be able to evaluate supply chain performance as a whole (Pujawan, 2005). Customer satisfaction is a key factor in the success of a company in its operational business activities. Therefore, it is very important for companies to measure supply chain performance with the aim of creating customer satisfaction. The better the company's performance, the greater the opportunity to get more requests from customers and compete better with competitors.

PT XYZ is a developing company engaged in the distribution of HighSpeed Diesel (HSD) B-30 diesel fuel. This product with a cetane number of 45 has the function of running industrial engines, transportation engines, and diesel engines that have a mechanical pump injection system (injection pump) and electronic injection. The current marketing area for B-30 HSD diesel is Sulawesi and Jambi with an average demand of 4,500 kiloliters per year and Business to Business (B2B) consumer segmentation, namely hydropower companies, transportation, and nickel smelters. Based on their needs, business actors will buy diesel fuel for industrial activities through available authorized dealers. As a consumer, there are several factors to consider when choosing an Industrial Fuel supplier, namely price, right quality, right quantity, and right time. Decreasing demand and increasing complaints of customer dissatisfaction indicate a decrease in PT XYZ's supply chain performance due to several reasons.

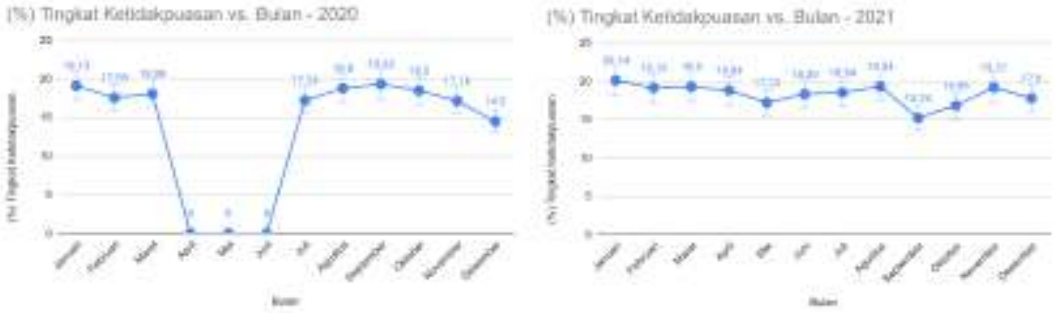

Figure 1 Satisfaction Level of XYZ Company 2020-2021

Figure 1 explains that during the 2020 – 2021 period, the level of customer dissatisfaction with the company has an average figure that is in the range of 15% - 20%, but in 2020 the company experienced the impact of a pandemic which resulted in several empty complaints accompanied by a decrease in transactions. From the results of calculating the average customer complaint, there is an increase of 0.5% from 2020 - 2021. This indicates that the company's performance in 2021 is less productive. The high level of customer complaints that occur at PT XYZ should be a separate note in routine evaluation considering that delivery is a key activity in the company's business processes.

Increasing customer dissatisfaction and also decreasing demand from customers made the management of PT XYZ start making immediate improvements to its operational activities. With the aim of no longer decreasing demand by customers and even losing customers. Therefore, company management needs to look for the causes of various problem factors in detail so that they can make improvements properly. There is a method that meets the criteria and is suitable for measuring the performance of PT XYZ, namely the Supply Chain Operation Reference (SCOR)

Model. The SCOR method provides an overall architecture for supply chain systems, high-level processes and sub-processes, management objectives, and measures that companies can use and adapt to create an ideal enterprise supply (Kottala & Herbert, 2019). According to Pujawan (2005) the SCOR Model also integrates three important elements in the intermediate supply chain, namely business process reengineering, benchmarking, and process measurement. In addition, the AHP method will also be used in this study. The AHP model is a decision-making model that is capable of dealing with problems that have contradictory decision alternatives or trade-offs and is comprehensively resolved. In this study, the AHP method is used to provide a comprehensive assessment of the performance measurement of the company.

2. LITERATURE REVIEW

Supply Chain Management

Supply chains are often explained by the direct or indirect involvement of all company lines involved in fulfilling customer requests and increasing company profits (Chopra and Meindle, 2016). The definition of a supply chain is a company network activity that regulates and is involved in the product transformation process starting from raw materials to becoming a finished product to the product distribution process to customers (Pujawan and Mahedrawathi, 2017). Of the several objectives of the concept of supply chain management, the most important goal is how companies adapt and match needs/demand with production or available supply. In addition, the problems that are often encountered in the supply chain are from the procurement of materials, suppliers, the relationship between the customer and the company, risks and many other problems. Affordable products, maintained quality, variety and timely delivery are often the main factors in becoming a winner in the market (Harto et al., 2021).

According to Schroeder et al. (2018) supply chain management is an important component for increasing business profitability today. Figure 2 illustrates a supply chain in which there are several parties involved in fulfilling customer requests starting from suppliers, production (factories), storage (warehouses), retail to the consumers themselves.

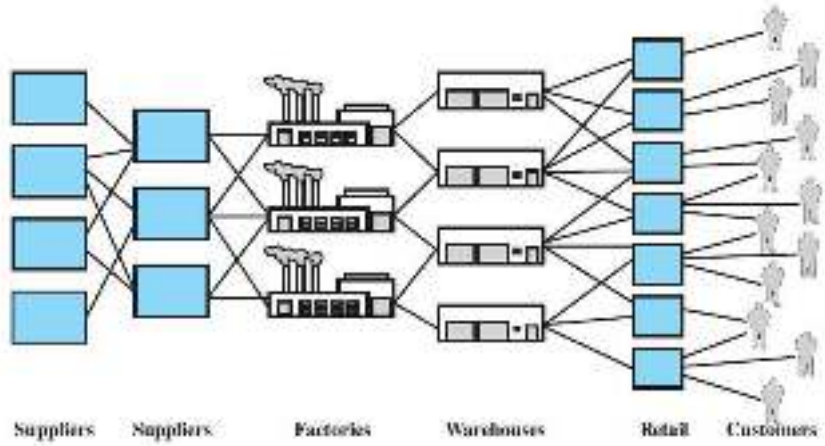

Figure 2 Supply Chain Illustration
(Source: Schroeder et al, 2018)

The picture above is also reinforced by the statement of Heizer and Render (2011) who said that supply chain management is a set of interrelated activities starting from material procurement and service delivery to going through various processes and becoming semi-finished products or finished products and sending them to customers. Therefore, according to Carmignani (2009) one of the crucial decisions at the level of supply chain management is to maintain a high

level of service in terms of efficiency and responsiveness in accordance with the characteristics of goods, markets, and planning. The four main standards that companies need to pay attention to as a start-up are as follows: (1) Customer demand analysis; (2) Information management; (3) Inventory management; and (4) Facilities and transportation management.

Supply Chain Operation Reference (SCOR) Model

The Supply Chain Operation Reference Model (SCOR) is a method that can be used to measure supply chain performance (Kazemkhanlou and Ahadi, 2014). This method can describe the complete supply chain. SCOR was developed by a non-profit organization namely the Supply Chain Council, Inc. (SCC) in 1996 as a professional forum with integrated management concepts that emerged in the wider company and established the SCOR process reference model as material for evaluation and comparison between activities and supply chain performance. SCC uses the SCOR model to provide a framework that ties business processes, metrics, best practices, and technology into an integrated structure, supports communication among supply chain partners, and facilitates effective supply chain management and improvement activities (Supply Chain Council, 2015). Binioris in Serdaris (2014) adds that the purpose of using the SCOR model is to describe, analyze and evaluate the supply chain for physical, informational, and financial flows.Pujawan and Mahendrawathi (2017) explain about SCOR where this model is divided into three main components which are integrated, namely business process reengineering, benchmarking and process measurement into a cross-functional framework in the supply chain.

Analytical Hierarchy Process (AHP)

Analytical Hierarchy Process (AHP) was developed as a method that can be used as a decision maker. Decision making is carried out by the leadership of the organization or company to obtain performance weights for the level of importance of each perspective, metric groups and Key Performance Indicators (KPI). Saaty (2013) explained that the Analytical Hierarchy Process (AHP) method can use the assumption that the objective strategy and key performance indicators (KPI) are independent from each perspective. This is represented by a hierarchy of performance measurement systems. This assumption indirectly ignores the interdependence of the designed Strategy Map. Models to support decision makers using AHP can describe the problem of multi-factor elements or multi-criteria qualitative and quantitative hierarchically (Taherdoost, 2017). Saaty (2013) explained a hierarchy which is defined as a state that represents a complex problem in a multilevel structure. This structure consists of three levels where level one relates to setting goals or objectives, level two relates to criteria factors and level three relates to alternatives. The use of the AHP method is intended to create a series of alternatives in a decision making by choosing one of the best alternatives based on the overall evaluation results on qualitative and quantitative factors. Saaty (2013) added reasons related to the advantages of using AHP, as follows:

1. In the form of a hierarchical structure that makes it easy to group systems into different levels of similar elements.
2. Can take into account validity up to the tolerance limit of inconsistency on various criteria and alternatives.
3. Can take into account the durability of the output of the sensitivity analysis in decision making.

3. METHODS

In this study, data collection was carried out through observation, interviews and documentation to clarify the existing conditions and look for the data needed to solve the problem. This data collection will involve several parties, starting from the main director of PT. XYZ, Managers who play a direct role in the company's operations and consumers who are directly related to the company's business processes. The data needed in this research process are as follows:

1) Condition data regarding supply chain company activities, especially in distribution
2) Data regarding the company's business processes.
3) Detailed data regarding the Key Performance Indicators (KPI) of the company and particularly regarding the supply chain
4) Key Performance Indicators (KPI) importance level questionnaire
5) Determination of Performance Attributes

The data that has been obtained from the respondents is then collected and the performance attributes are determined before processing other data. The determination of these performance attributes is based on the SCOR model, namely reliability, responsiveness, cost, and asset management. Determination of performance attributes is usually also asked in interviews and observations of the company's business processes.

After that, data processing will be carried out after obtaining the data needed for this research. This stage is divided into several activities starting from determining KPIs using SCOR, determining detailed KPI specifications, weighting with AHP, processing KPI scores using a scoring system, and classification of achievement results. This data processing stage aims to achieve goals one and two regarding the preparation of a comprehensive performance measurement system and the determination of weights and measurements of the application of the system. The following below is the process regarding the activities that will be carried out at this stage: (1) Determination of KPI using the SCOR model; (2) Determination of KPI specifications; (3) Weighted with AHP; (4) KPI Value Processing with a scoring system.

4. RESULTS

This section will explain Key Performance Indicators (KPI) from the company that will be used in this study. In accordance with the research objectives, this supply chain performance appraisal needs to be assessed to determine the performance of the company's supply chain. Therefore, the process of identifying Key Performance Indicators (KPI) is important because this KPI will be the basis or reference in the company's supply chain assessment. Based on the results of data collection, several indicators of supply chain performance were obtained in accordance with the scor model and also discussed by respondents. The following table 4.5 below is the result of the identification of the KPI obtained.

Model SCOR	**Metrics**
A. Plan	A.1.1 Forecast Accuracy
B. Source	B.1.1 % Orders/Lines Processed Complete (RL.3.18)
	B.1.2 % Orders/Lines Received with Correct Shipping Documents
	B.1.3 % Orders/Lines Received with Correct Content (RL.3.21)

Model SCOR	Metrics
	B.2.1 Source Cycle Time (RS.2.1)
	B.3.1 Material Transportation Cost (CO.3.010)
C. Make	C.1.1 Release Finished Product to Deliver Cycle Time (RS.3.114)
D. Deliver	D.1.1 Delivery Quantity Accuracy (RL 3.35)
	D.1.2 Delivery Performance to Customer Commit Date (RL.2.2)
	D.1.3 Fill Rates (RL.3.36)
	D.2.1 Deliver Cycle Time (RS.2.3)
	D.3.1 Transportation Cost (CO.2.005)
E. Return	E.1.1 # of complaints regarding missing environmental documentation (RL.3.1)
	E.2.1 Returns Cost (CO.2.007)

Then, it will be explained about the results of the weight calculation based on the assessment that has been carried out by the respondents which will then be processed in the Super Decision software. Respondents will fill out a pairwise comparison questionnaire table. The results of filling in the table are then entered into the software to be processed and the weight values for each component in the model are calculated. This weighting is divided into three parts starting from the criteria of the SCOR model, sub-criteria for each component of the criteria and metrics for each sub-criterion. Below are the results of the weighting for each section.

Metrics	Global Weight
A.1.1 Forecast Accuracy	0.15671 (2)
B.1.1 *% Orders/Lines Processed Complete* (RL.3.18)	0.04670 (7)
B.1.2 *% Orders/Lines Received with Correct Shipping Documents*	0.01235 (13)
B.1.3 *% Orders/Lines Received with Correct Content (*RL.3.21)	0.02942 (10)
B.2.1 *Source Cycle Time* (RS.2.1)	0.05573 (6)
B.3.1 *Material Transportation Cost* (CO.3.010)	0.14043 (3)
C.1.1 *Release Finished Product to Deliver Cycle Time* (RS.3.114)	0.07173 (5)
D.1.1 *Delivery Quantity Accuracy* (RL 3.35)	0.03748 (8)
D.1.2 *Delivery Performance to Customer Commit Date* (RL.2.2)	0.01430 (12)
D.1.3 *Fill Rates* (RL.3.36)	0.00818 (14)
D.2.1 *Deliver Cycle Time* (RS.2.3)	0.10477 (4)
D.3.1 *Transportation Cost* (CO.2.005)	0.27457 (1)
E.1.1 # *of complaints regarding missing environmental documentation* (RL.3.1)	0.01588 (11)

Metrics	Global Weight
E.2.1 *Returns Cost* (CO.2.007)	0.03177 (9)

Based on the results of the AHP assessment and the recap of the results above, it is found that the metric with the largest global weight is the D.3.1 transportation cost metric of 0.27457 and the smallest global weight is the D.1.3 Fill Rates metric of 0.00818. After obtaining the global weight, then a Scoring System is carried out to get the value of the results against the targets of each of the main performance indicators. A scoring system is needed to equalize the measurement scale for each key performance indicator. The methods that can be used in KPI measurement are Larger is better and Lower is better. In addition, to be able to understand the overall and integrated performance of the company, it is necessary to know the performance index of each KPI which is the multiplication of the KPI score and the KPI weight. In this section, the results of SCOR system calculations will be presented and the results of these calculations will be categorized according to the traffic light system. The following table below is the result of the SCOR system as well as being given a category according to the traffic light system shown in the previous table.

Metrics	2020	2021	2020	2021
A.1.1 Forecast Accuracy	60.35	84.12	9.46	13.18
B.1.1 % Orders/Lines Processed Complete (RL.3.18)	100.00	100.00	4.67	4.67
B.1.2 % Orders/Lines Received with Correct Shipping Documents	99.01	90,74	1.22	1.13
B.1.3 % Orders/Lines Received with Correct Content (RL.3.21)	100.00	100.00	2.94	2.94
B.2.1 Source Cycle Time (RS.2.1)	97.78	97.78	5.45	5.45
B.3.1 Material Transportation Cost (CO.3.010)	97.91	94.18	13.75	13.23
C.1.1 Release Finished Product to Deliver Cycle Time (RS.3.114)	100.00	100.00	7.17	7.17
D.1.1 Delivery Quantity Accuracy (RL 3.35)	98.54	96.10	3.69	3.60
D.1.2 Delivery Performance to Customer Commit Date (RL.2.2)	89.50	81.43	1.28	1.16
D.1.3 Fill Rates (RL.3.36)	93.47	86.73	0.76	0.71
D.2.1 Deliver Cycle Time (RS.2.3)	86.11	72.22	9.02	7.57
D.3.1 Transportation Cost (CO.2.005)	97.91	98.69	26.88	27.10
E.1.1 # of complaints regarding missing environmental documentation (RL.3.1)	100.00	20.92	1.59	0.33
E.2.1 Returns Cost (CO.2.007)	100.00	82.12	3.18	2.61
Company Existing Performance Achievement			91.11	90.86

It can be seen at the final performance appraisal results that have been accumulated in table above, all of the company's performance in the 2020-2021 period still reached the target and had a score of more than 85 with the smallest score of 87.147. However, even though the company's performance values all exceeded the target, there were several metric points that still did not reach the company's target in a certain month and had yellow and red indicators, namely A.1.1, B.1.2, C.1.1, D.1.2, D.2.1, and E.1.1. The number of metrics that have not reached the target, but the company's performance exceeds the target is due to the fact that the weight of the metrics that do not reach the target is not too significant for the company's performance. Therefore, the analysis of company performance here only focuses on those metrics that have not reached their targets. Below is an analysis for each of the metrics that have not reached the target.

1. A.1.1 (Forecast Accuracy) – This metric still has targets that have not been reached, namely March – December 2020 with a red indicator as shown in table 4.30. This is due to the phenomenon of the COVID-19 pandemic which makes forecast results inaccurate due to disruptions in real conditions.
2. B.1.2 (Orders/Lines Received with Correct Shipping Documents) – This metric also has targets that have not been achieved as in metric A.1.1, which is due to a lack of selecting a higher quality supplier. So far the company still cares about product sourcing in terms of cost without paying attention to the complete documents.
3. C.1.1 (Release Finished Product to Deliver Cycle Time) – Furthermore, metric C.1.1 has a different target achievement. In this metric, there are 6 yellow indicators and 2 red indicators. The yellow indicators occur in a number of months, namely February, June and October 2021, followed by January, April and October 2020. As for the red indicators, they occur in November 2021 and May 2020. This occurs because there is a surge in demand at fuel depots in the month causes the queue time to increase.
4. D.1.2 (Delivery Performance to Customer Commit Date) – Metric D.1.2 is also one of the metrics where the expected target is not achieved. In this metric, there are two months that have yellow indicators, namely July and October 2020. This is due to the inconsistent delivery in those months.
5. D.2.1 (Deliver Cycle Time) – One of the metrics that has quite a lot of red indicators is the D.2.1 metric. In this metric there are many periods where the target is not achieved starting from January – July 2021, September – November 2021, April – June 2020 and November – December 2020. This happens because the shipping operations from the company are still slow and there are processes that are often stalled thus impacting the delivery cycle time.
6. E.1.1 (# of complaints regarding missing environmental documentation) – This metric can be said to be the metric that has the worst achievement of the other metrics. This is due to the achievement of performance to a minus value. Almost all months in 2021 experience red indicators except for April and May. As for 2020, only January and February will experience a red indicator. Basically, companies often experience complaints throughout the year related to these documents because many third parties are not monitored in delivery. But in 2020 from March to December, the performance achievement for that month reached up to 200%. This is due to the lack of orders made by customers so that the complaints received by the company are also small.

After that, recommendations for improvements to the company will be presented regarding the evaluation and assessment of the metrics that have been carried out in the previous section. These recommendations are only aimed at metrics that experience target failure starting from A.1.1, B.1.2, C.1.1, D.1.2, D.2.1, and E.1.1. The following table below is a recommendation for improvements that can be given to companies to improve company performance.

Metric Index	Performance Metric	Improvement Recommendation
A.1.1	*Forecast Accuracy*	➢ There is a need for a re-forecasting mechanism for cases outside the usual cases (pandemic, disaster, extraordinary events, etc.) ➢ Learn new types/methods of forecasting to

Metric Index	Performance Metric	Improvement Recommendation
		anticipate extraordinary conditions and not rely too much on historical data
B.1.2	*% Orders/Lines Received with Correct Shipping Documents*	➢ There needs to be a re-mechanism for adjusting shipping documents if extraordinary events occur ➢ Communicating with partners to inform document changes and the need for re-administration
C.1.1	*Release Finished Product to Deliver Cycle Time*	➢ There is a need for periodic evaluations every month to find out the factors for the occurrence of targets that are not achieved ➢ Be more agile in communicating with suppliers so that they can be prioritized in carrying out product quality control
D.1.2	*Delivery Performance to Customer Commit Date*	➢ Evaluate in determining the best route so that product delivery can be on time. ➢ Perform preventive maintenance to prevent sudden repairs during product delivery
D.2.1	*Deliver Cycle Time*	➢ Evaluate the overall delivery process with the aim of reducing cycle time so that delivery is faster. ➢ Evaluating and conducting feasibility studies related to the number of fleets to suit the needs of the company in accordance with the forecasting that has been done
E.1.1	*# of complaints regarding missing environmental documentation*	➢ Improve services and monitor 3rd parties in making deliveries to customers. ➢ Improving company administration related to environmental documentation to meet customer expectations.

5. CONCLUSION

Based on the results of the research that has been done, the conclusions that can be drawn from this research are as follows. the metric with the greatest weight is transportation cost with a weight of 0.2746. While the metric with the smallest weight is Fill Rates of 0.0082. After obtaining the actual performance KPI weights and scores, it was found that the metrics that experienced target failure were metrics A.1.1, B.1.2, C.1.1, D.1.2, D.2.1, and E.1.1. Then this metric is followed by the accumulation of the final assessment by multiplying the weight by the value and it is obtained that the final company performance has all reached the target with the dark green indicator. In addition, based on the achievement of the company's overall supply chain performance, the results for 2020 were 91.11 and 90.86 in 2021. If a breakdown is carried out and reflected in the form of a traffic light system in the first period of 2020, the 14 overall performance measurement indicators yield detailed results. namely 13 performance indicators with a green score and 1 indicator with a red score. Whereas in period one of 2020, out of 14 overall performance measurement indicators, results were obtained with details, namely 9 indicators with a green score, 4 indicators with a yellow score, and 1 indicator with a red score. The yellow and red colors that are still present in PT XYZ's performance indicators indicate that the achievement of these performance indicators is still below the target, so the company needs to implement the recommendations for improvement contained in the previous discussion in order to improve the performance of each indicator to be at least vulnerable to 85 – 99.99% (Light Green).

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SERVICE ORIENTATION DELIVERY OF SERVICE TOWARD DIGITAL MARKETING AND SERVICE PERFORMANCE

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Abstract

This article aims at proposing a conceptual model that links digital marketing in the relationship between organizational learning and service performance. More precisely, there is an integration of the concept of Service Delivery Orientation on Organizational Learning Capability and digital marketing quality on Customer-oriented Organizational Learning in improving Service performance. This conceptual model is a development of previous research models related to the Service Delivery Service Orientation model in improving service performance. The purpose of this conceptual model is to find out how Service Delivery Service Orientation and digital marketing quality improve service performance. The results of this research are expected to provide various benefits for academics as the development of knowledge and operational benefits for practitioners

Keywords: organizational learning, service orientation, service delivery, digital marketing quality, service performance

1. Introduction

Organizational learning should adopt the idea of digital marketing to improve service performance. The results of research Tong dan Yee Chan (2022) show that both public relations and marketing practitioners mutually understand the market function as sales oriented, while media relations is more interpreted as a public relations function. The urgency to adopt the role of digital marketing was also raised by researcher de Amorim., *et all*., (2022) who in his study contributed to the theory of digital tourism marketing which can be transferred to organizational management to encourage discussions about the process of target audience capture, retention and loyalty. This study also presents digital marketing as a possible factor in the development of tourism and social inclusion fair and maintain the way of the inhabitants of the historical center (ie Barcelos), and the quality of life. In line with the findings of de Amorim., *et all*., (2022), the results of research Apasrawirote., *et all*., (2022) also suggest the relevance of digital marketing capabilities for business and the key to measuring business performance.

The transformation of traditional marketing to digital marketing will certainly raise questions about the extent to which it has a positive impact on the company. The results of research Kapoor dan Kapoor (2021) inform how digitalization has benefited the industry in various aspects and how it compares to traditional marketing methods. The aim is that the lessons learned from this

research will address organizational issues as to how best to disseminate new ideas on improving customer care across systems (Mullings, Lena Cay, 2007). Likewise market orientation not only makes referrals to actual, but also to potential customers. In this way marketing is no longer a function but a way of doing business (Esteban, Agueda., *et al*., 2002).

The next question is to what extent digital marketing is able to drive customer interest and purchasing decisions. The results of the study Dunakhe and Panse (2021) show that it has been concluded by many research papers that review "Digital Marketing Efforts" influencing customer purchase intentions. It can also be concluded that the distinction between “marketing” and “digital marketing” is fading fast as any type of marketing endeavor will have an element of “digital marketing” to it. Service as a marketing practice is a very complex phenomenon and can mean many things to different people (Groonros, 1990). The results of the study Rahman dan Aryanto (2014) show that first, the variable Customer-oriented Organizational Learning does not affect Service Performance but does affect the Quality of Competency Allocation and Service Delivery Orientation. Second, Organizational Learning Ability has no effect on Service Delivery Service Orientation. The three Quality Allocation of Competency has no effect on Service Performance. Fourth, Service Delivery Service Orientation influences Service Performance.

Some of the hypotheses examined in the research above have not yet adopted the development of digital-based information technology. Therefore the development of a digital-based research conceptual model is very feasible to propose. The results of this study complement a number of studies showing the theoretical debate on the results of research on the relationship between market orientation and performance. The description above shows that the relationship between market orientation and service performance is still being debated by researchers. Therefore this study seeks to obtain clarity on the relationship between market orientation and performance. On the one hand, there are several research results showing that market orientation is directly related to performance. The results of research Narver and Slater (1990) and Slater and Narver (1995) show that market orientation as an organizational culture effectively and efficiently creates all the necessary conditions to produce the best value (performance) for customers. This is in line with the findings of Kirca *et al.* (2005) which states that market orientation has an influence on overall organizational performance.

On the other hand, there are several research results which show that market orientation is not directly related to performance. The results of research Guo, Chiquan., (2002) show that market orientation and performance may not be directly related to market orientation and performance may not be directly related. The results of research Jaworski dan Kohli (1993) showed that the results of the research on both the first sample and the second sample stated that market orientation had no effect on market share. Researchers Harris (2001) conducted a study of 241 managers in England using marketing performance indicators of sales growth which were measured both subjectively and objectively. Another study conducted Deshpande *et al.,* (2000) also found that market orientation has no significant effect on sales growth. The conceptual model of this research starts from the existence of

problems in the form of theoretical contradictions in the results of research on market orientation towards performance, as summarized in the research gap mentioned above. The conceptual model of this research is different from previous research, because this study will incorporate the quality of digital marketing in explaining the elements of Organizational Learning Capability and Customer-oriented Organizational Learning as a form of market orientation in services that affect Service Delivery Orientation.

2. Proposition Development and Theoretical Model

This study builds on the basic theoretical model that was developed on the basis of an intensive literature review. The theoretical model proposed in this study is presented in the figure below:

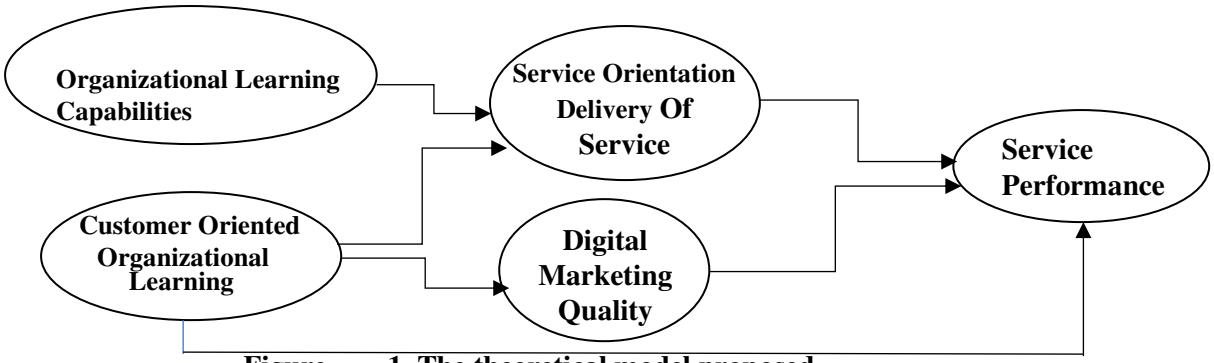

Figure 1. The theoretical model proposed

The picture above shows that Digital Marketing Quality is a connecting variable between the Customer Oriented Organizational Learning variable and the Service Performance variable. There are four propositions synthesized in the model built in this conceptual research paper. The first proposition synthesizes the relationship between Organizational Learning Capabilities and Customer Oriented Organizational Learning towards Service Delivery Service Orientation. The second proposition synthesizes Service Delivery Service Orientation on Service Performance. The third proposition synthesizes Customer Oriented Organizational Learning on Digital Marketing Quality and Service Performance. Fourth, Digital Marketing Quality synthesizes Service Performance. An explanation of the development of the model is shown in the figure described in the literature review.

2.1. Research Objective

The purpose of this conceptual research paper is to build a conceptual paper model that adopts digital marketing in an effort to improve service performance through Customer-Oriented Organizational Learning and to find out to what extent Digital Marketing Quality is able to bridge between Customer-oriented Organizational Learning and Service Performance.

2.2. Literature Review

2.2.1. Market Orientation Development

In the study of the impact of industrial competition intensity on brand performance where the intermediary role of market orientation and organizational learning conducted by Talari dan Khoshroo (2022) shows that the intensity of industrial competition has a significant effect on market orientation and

organizational learning. This is consistent with the results of research on the impact of market orientation on the performance of small firms through a configuration approach where Chaudhary., *et all*., (2021) noted that the three-way interaction between market orientation, strategic flexibility and competitive intensity explains differences in small firm performance over the contingency and direct relationship models. The findings of D'souza., *et all*., (2022) show that innovation mediates the relationship between competitor orientation and firm performance, while competitor orientation does not have a significant relationship with firm performance.

The next thing that we should prepare in carrying out market orientation is to measure market orientation, namely the scale of development and validation. Research Farooq dan Vij (2021) results show that the dimensions of market orientation show different patterns across the sample areas. The same as the study conducted Guo, Chiquan., (2002) yielded that so far it has been argued both from a logical and empirical point of view that market orientation and performance may not be directly related. The results of the study Guo, Chiquan., (2002) suggest that from a conceptual as well as empirical viewpoint that, although it may be true that market orientation is positively related to business performance, more effort should be directed at exploring what lies beneath the relationship.

2.2.2. Development of Organizational Learning

Organizational learning as a strategy in improving organizational performance is inseparable from how the strategic orientation is chosen. This is in accordance with the results of research Masa'deh., *et all*., (2018) which shows that strategic orientation is positively and significantly related to organizational performance. In organizational learning, the human factor is one of the keys. The study Urrutia-Badillo., *et all*., (2018) carried out a theoretical analysis which made it possible to propose four configurations of human capital, combining individual cognitive and non-cognitive dimensions. The relationship between organizational learning and customer values was investigated by researcher Sanchez, Jose Angel Lopez., *et al*., (2010) who conducted research with three objectives: first, to analyze the impact of organizational learning on customer value creation capabilities, second, to develop a better understanding of how organizational learning influences performance business; and third, to examine the moderating role that market turbulence plays in connection learning values. The results of this study Sanchez, Jose Angel Lopez., *et al*., (2010) suggest that producer organizational learning is a direct and positive antecedent of customer value creation capabilities, understood from a functionalist perspective.

2.2.3. Service Orientation of Service Delivery Development

Proactive market orientation and technology orientation influence explorative and exploitative innovative competencies; but only exploitative innovation competence affects service delivery innovation (Tsou., et all., 2014). The findings indicate that managers need to understand market trends and technology availability and be able to adapt service/product features accordingly which can further stimulate exploitative innovative competencies and facilitate innovation service delivery. Research Popli dan Rizvi (2015) explored the relationship between service orientation, employee engagement and perceived

leadership style. This is in accordance with the results of a study Tsou., *et all*., (2015) where the findings support the argument that the four business partner selection criteria have a positive relationship with co-service delivery innovation. The results of this study are in line with the results of research Liu dan Huang (2018) which shows that path analysis shows that information competence and coordination competence have a positive effect on both exploitative service innovation and explorative service innovation. A study Homburg, Christian., 2002 examines adopting a more comprehensive perspective on retail services by examining three important research gaps related to service-oriented business strategy, namely first outlining the dimensions of service-oriented business strategy and introducing new measures of this strategy.

2.2.4. Digital Marketing Quality Development

The use of good and quality digital marketing is a necessity in encouraging a good and quality marketing strategy as well. The results of research Katsikeas., *et all*., (2009) demonstrate the relevance and potential of the important role online resource deployment and organizational capabilities play in influencing foreign market selection and entry decisions and international marketing strategy choices, implementation and control. This is in line with the results of research found by Foroudi (2017) which were able to identify two key components of digital technology as information quality and service convenience. This is shown by the results of research Pandey., *et al*., (2020) which found that several B2B companies used digital marketing, but most were unable to take full advantage of it due to a comprehensive lack of knowledge on using digital marketing. Empirical findings in Africa such as research Herman Mkwizu (2019) reveal that digital media, content and mobile advertising are among the trends in digital marketing and, as such, provide Africa with an opportunity to market its appeal to tourists in this digital age. It is undeniable that the progress of science and information technology is able to drive the impact of its use in the realm of human life. Research Graesch., *et al.*, (2021) found a chronological structure capable of verifying the impact of information technology on marketing tools and hence, digital transformation in marketing. This is supported by a study conducted by Kumar Deb., *et all*., (2022) where the results of his research show that perceived usefulness, perceived ease of use, social media marketing and tourism business performance are important factors for adopting digital marketing in tourism.

3. Novelty Proposition

This study puts forward a proposition to propose a conceptual model that links digital marketing in the relationship between organizational learning and service performance. More precisely, there is an integration of the concept of Service Delivery Orientation on Organizational Learning Capability and digital marketing quality on Customer-oriented Organizational Learning in improving Service performance. The following is a conceptual mapping that forms the proposed novelty (Figure 2).

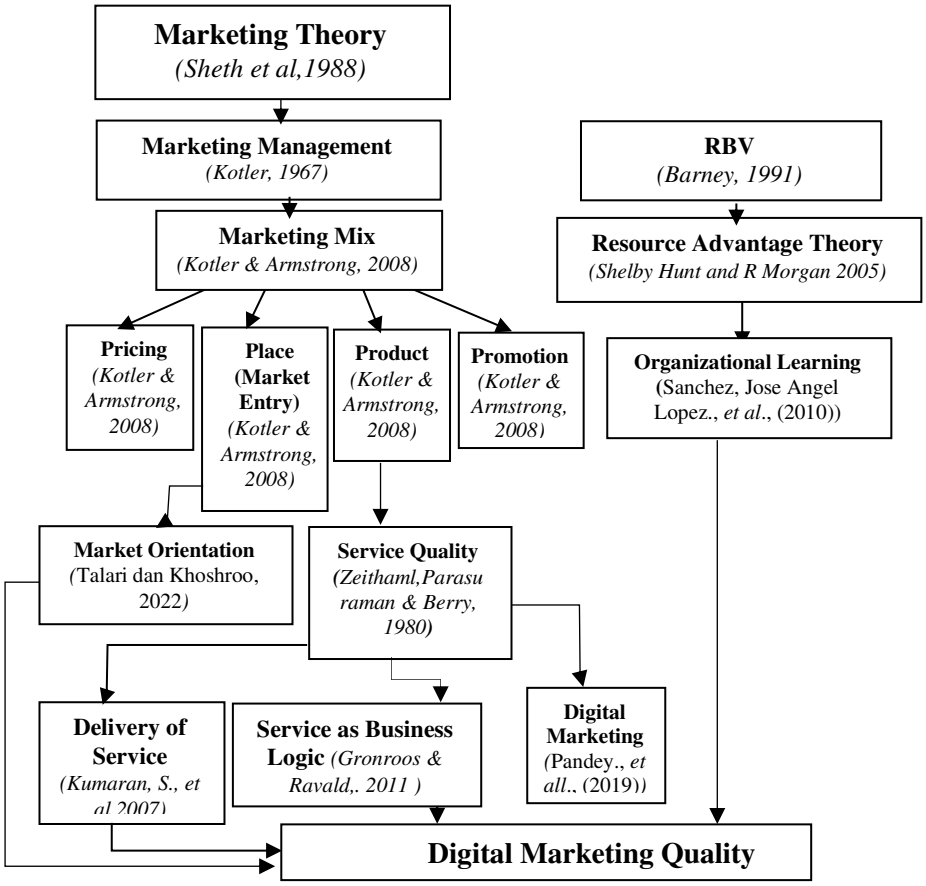

Figure 2. Conceptual mapping that forms the proposed novelty

The novelty of this proposition adopts from the thinking in its Marketing Theory by Shets, *et al*., (1988) which derives from Marketing Management which was pioneered Kotler, (1967). His Marketing Theory Shets, *et al*., (1988) also degrades Marketing Management, one of which is formulated P. Kotler (2002). In Marketing Management, The Four P Components of the Marketing Mix are also formulated P. K. Kotler, K. L. (2012). One of the components of the Marketing Mix is the Product. This product consists of Product variety, Quality, Design, Features, Brand name, Packaging, Sizes, Services, Warranties, Returns. P. Kotler (2002) suggested that people satisfy their needs and wants with products. But on the other hand, Wrigth (2000) warns that a product may contain significant errors due to problematic design processes. For this reason, Wrigth (2000) a process receives certain input from its environment.

Related to the customer needs P. Kotler (2002) also reminded that a company can carefully determine the target market but fail to properly understand customer needs. This service is a service industry where according to P. Kotler (2002), service is any action or performance that one party can offer to another which is essentially tangible and does not result in the ownership of anything, may or may not be produced associated with a physical product. Service quality is a consumer's judgment about the entity's overall superiority or superiority (Zeithaml, 1988). The market becomes one of the elements of the Marketing Mix which then reduces Market Orientation, one of which is stated by Tsou., et all., 2014. Subsequent exploratory research conducted by Parasuraman, Zeithamle dan Berry

(1985) supports the notion that service quality is an overall evaluation similar to, but not the same as, attitude. Service quality includes the way in which the service is delivered (Groonroos, 1982) such as the company's image profile, the relationship between the seller and the consumer.

Gro¨nroos (2010) updated his thinking by analyzing the scope, content and nature, value creation of services based on the view of value creation logic, addressing the customer perspective in the relationship between service providers and customers known as creation of customer value creation of customer value. The existence of services that are running well (delivery of service) gave rise to digital marketing, one of which was put forward by Pandey., et al., (2019). The novelty of Digital Marketing Quality refers to the theories mentioned above and more specifically from Delivery of Service *(Kumaran, S., et al 2007)*, Service as Business Logic (Gronroos & Ravald,. 2011), Digital Marketing Pandey., et al., (2019). On the one hand, Digital Marketing Quality is also derived from the Resource Based View Theory introduced by Barney, (1991). From the RBV theory, the Resource Advantage Theory was derived (Shelby Hunt and R. Morgan, 2005) and continued with regard to organizational learning capabilities and customer values-based organizational learning Sanchez, Jose Angel Lopez., *et al*., (2010).

4. Proposed method

This research conceptual paper can be realized through explanatory research because this research intends to explain the causal relationship between variables through hypothesis testing with quantitative research methods. The population of this study were users of hospital services in the city of Semarang with a sample of several users of hospital services in the city of Semarang. Sampling method using purposive sampling method. This conceptual paper needs to be followed up with explanatory research in which the variables need to be tested through quantitative research methods.

5. Contribution

This conceptual paper will be carried out in a more comprehensive manner by elaborating the research problems posed above, into several research questions posed in empirical research between variables. Contributions to this study include the development of a theoretical model, in which this study focuses more on the internal relationships between variables. Meanwhile, operationally specific benefits for practitioners that can be realized in this research are being able to contribute to service provider practitioners in order to optimize Organizational Learning towards Service Delivery Orientation and the quality of digital marketing in improving service performance.

6. Conclusion

This article proposes the concept of digital marketing quality which can be used as an intervening variable between customer-oriented organizational learning and service performance and is expected to contribute to the world of marketing as well as to fill the gaps found in several studies on the factors that result in less than optimal service performance because it has not been implemented. digital marketing quality.

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THE APPLICATION OF RELIABILITY-CENTERED MAINTENANCE METHOD TO DETERMINE MAINTENANCE STRATEGY IN UTILITY PRODUCTION FACILITIES

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ABSTRACT

The objective of this study to determine maintenance strategy through the application of Reliability-Centered Maintenance (RCM) method to rotating equipment in utility production facilities. The maintenance policy for rotating equipment that implemented in utility production facilities from 2019-2022, still focused on regular inspection activities from the routine task list and generally applied to all types of rotating equipment which are categorized in light service, heavy service, and overhaul maintenance. The majority component replacement programs for rotating equipment were also carried out on a corrective-reactive basis. This maintenance policy has the potential effect of a long-term inefficiencies due to the high costs of many unnecessary routine maintenance activities and the impact of corrective-reactive actions that cannot extend the service life of equipment components. This study was conducted by identifying rotating equipment based on criticality rating, failure mode and strive to maximize proactive maintenance (preventive and predictive) according to 7 (seven) processes of the RCM method, as follows: 1) identify the functions of the equipment and performance standards associated with those function in its operation context, 2) identify how the equipment can fail to fulfill its functions, 3) identify the failure mode with events that have a major probability, 4) describe the effect if the failure mode occurs by including all the information needed in assessing the consequences of the failure, 5) describes how those failures affected, 6) identify actions to predict or prevent such equipment failure, and 7) identify if no appropriate proactive action is found. By implementing the RCM method to rotating equipment, it is expected that it will be a consideration for the company in developing the right maintenance strategy, especially in determining the maintenance interval according to criticality rating of the equipment functions to maintain reliability, availability, equipment economic life, and the effectiveness of plant maintenance as well as minimize financial losses due to potential disruptions or downtime.

Keywords: Criticality Rating, Failure Mode, Maintenance Strategy, Reliability-Centered Maintenance.

1. INTRODUCTION

Moubray (1997) defined maintenance as “to ensure that physical assets continue to do according to functions what their users want them to do”. The evolution of maintenance can be divided into three generation as highlighted in figure 1. This evolution is demonstrated through the

industrial needs in each generation regarding the concepts about the maintenance types and how these maintenance have been classified (Trojan, 2017).

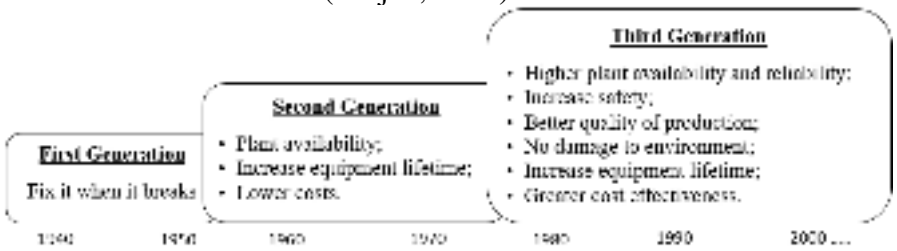

Figure 1. Evolution of Maintenance

The role of maintenance is very important for the continuity of plant operations, especially in minimizing the occurrence of downtime which can obstruct the company's business processes. In order to maximize the operational performance of the plant, a maintenance program is required. For some equipment, maintenance actions must be carried out immediately and for other types of maintenance can be deferred depends on the criticality level of equipment function (Bengtsson et al, 2004). The implementation of information technology is useful in supporting decision making by maintenance management which includes planning activities, selecting policies, scheduling, historical documentation, and predicting facility reliability and maintainability (Lee et al, 2013). The main challenge of facing maintenance management is deciding which maintenance work is beneficial or not to the organization. If the decision is made right, the asset performance will increase and can maintain or reduce maintenance costs. There is no asset management that can eliminate all failures, so it is necessary to plan an asset monitoring system to recognize or overcome problems (Faiz et al, 2009). At the beginning of the plant's operation, maintenance planning was prepared using a traditional approach based on the operation and maintenance manual which generally applies to each type of plant equipment asset that is similar without considering the consequences of failure. At the beginning of the plant's operation, maintenance planning was prepared using a traditional approach based on the operation and maintenance manual which generally applies to each type of plant equipment asset that is similar without considering the consequences of failure. This individual maintenance planning has the potential to bring up new challenges, especially in terms of effectiveness and usefulness as well as scheduling plant maintenance programs where equipment maintenance will occur at the same time. In addition, plant reliability is still a major issue as indicated by the high number of emergency plant maintenance work orders for corrective-reactive work which also has an impact on high maintenance costs, downtime and decreased customer confidence so this needs to be followed-up with a new approach to the maintenance strategy framework by integrating operational patterns and maintenance evaluations that aim to bring better benefits to the company's business processes, especially for plant reliability.

Reliability is the most important thing that supports plant operational processes in utility production facilities of supply energy to the Fertilizer and Agrochemical Industries which require continuous availability of electricity and steam to run machines and other production equipment that must be operated non-stop for twenty four hours. If the supply of electricity or steam is interrupted, it will result in production machinery and equipment stopping operations. In fact, to restart the machine and equipment requires a lot of cost, so the company will suffer a loss or lose the opportunity to produce products and money. Improved service quality can be seen from reliability and availability which are efforts made to keep production machines and equipment operating as expected. This study was conducted by identifying the criticality rating of rotating equipment in utility production facilities, identifying and analyzing rotating equipment in utility

production facilities according to the RCM process, and formulating recommendations for maintenance strategies based on the RCM method from a managerial perspective. RCM will highlight a maintenance program that focuses on preventing failures from occurring. By implementing the RCM method to rotating equipment, it is expected that it will be a consideration for the company in developing the right maintenance strategy, especially in determining the maintenance interval according to criticality rating of the equipment functions to maintain reliability, availability, equipment economic life, and the effectiveness of plant maintenance as well as minimize financial losses due to potential disruptions or downtime. The research data is taken from secondary data sample equipment from the company's monthly maintenance reports for the last four years from 2019-2022. The research is limited to the application of the RCM method in determining maintenance strategies for utility production facilities in rotating equipment at the system level i.e., the Gas Turbine Generator unit that supplies electricity, Heat Recovery Steam Generator units and Package Boiler units that supply steam and Balance of Plant units which include Instrument Air Plant Air, Cooling Tower, Water Treatment Plant, Waste Water Treatment Plant, Condensate Polisher Unit and Fire Water System as supporting the main equipment units.

2. LITERATURE REVIEW

RCM is a process used to determine what must be done to ensure that any physical asset continues to do whatever its users want to do in its operating context (Moubray, 1997). There are seven basic questions of the RCM process in the system or equipment, as follows:

1. What are the functions and associated performance standards of the assets in its present operating context
2. How the equipment can fail to fulfill its functions?
3. What causes each functional failure?
4. What happen when its failure occurs?
5. How those failures affected?
6. What can be done to predict or prevent each failure?
7. What should be done if a suitable proactive task cannot be found?

Several previous studies have attempted to apply RCM in determining maintenance strategies. The study of "The Present Status of Maintenance Strategies and the Impact of Maintenance on Reliability" aims to review the most frequently used maintenance strategies in electric utilities. Effective maintenance policies can reduce the frequency of undesired service interruptions. Maintenance greatly affects the reliability of components and systems, so it is necessary to balance between increasing reliability and maintenance costs through more effective operating policies. Equipment maintenance routines consist mostly of predetermined activities that are performed periodically through scheduled maintenance. However, such maintenance policies may be quite inefficient and become too expensive in the long-term and may not extend components lifetime of the equipment or system. Endrenyi et al (2001) formulated a hypothesis "the results of a limited survey conducted that many utilities have not implemented practices other than scheduled maintenance nor empirical predictive maintenance based on periodic inspections carried out as needed".

Another study attempted to measure the criticality rating based on an adapted RCM approach for selecting maintenance activities of medical equipment in order to support improving operations, reducing risks and costs, and improving services. The study was conducted by examining the relationship between current planned preventive maintenance practices and equipment failure rates over their lifetime, although strict preventive maintenance programs were

implemented in the studied hospitals, some critical equipment exhibited increased failure rates. Shamayleh et al (2020) formulated the hypothesis from "conducted case studies that high-severity failures can be managed through actions aimed to reducing the likelihood of failure and/or changing the consequences of these failures". Reliance on preventive maintenance activities for all equipment as recommended by the original equipment manufacturer (OEM) is becoming inefficient and should be supplemented with a more proactive RCM approach. In addition, this study also examines the results of RCM implementation which is more focused on reducing risk even at the expense of increasing costs. This is evident from the many actions recommending increased health checks and monitoring of functional parameters to trigger maintenance events. These additional actions can increase costs in the short term, but if done properly it will reduce the total cost of asset management in the long term.

Another study by Ramere et al (2021) seeks to carry out a dynamically integrated maintenance process to improve maintenance policies and overall performance through condition-based maintenance that is optimized for the operational life cycle of automotive industrial equipment by predicting the condition of each component and assembly line using Failure Mode and Effect Analysis (FMEA) assists in formulating maintenance schedules and strategies to eliminate unplanned downtime. Study conducted by Prasetyo et al (2020) attempted to measure the impact of implementing RCM to minimize downtime and optimize equipment reliability by implementing RCM through Mean time to Repair (MTTR), Mean time Between Failure (MTBF) and failure frequency. The researcher defines the best equipment reliability indicators as having high MTBF, low MTTR, and low failure frequency.

Another study by Souza et al (2008) evaluated the impact of applying the RCM methodology to power generation systems. RCM guarantees significant improvements in the performance of the maintenance function, as well as increased equipment reliability and availability. A case study was carried out on the combined bearing oil circulation system (guide and support) of a hydraulic Kaplan turbine used by comparing the FMEA (Failure Modes and Effects Analysis) and FTA (Fault Tree Analysis) methods to support failure studies in hydroelectric power plants. The FMEA analysis shows that the important components of the system are the motor pump command and control circuit and the filter. This result stems from the relatively high severity of failures in this component. The FTA analysis considers the essential components of the lubrication and cooling systems in the combined bearings, heat exchangers, and motor pump command circuits. Although the exchanger does not exhibit a failure that is considered severe, it is a frequent occurrence. It is seen that the FTA analysis does not consider the severity of the failure, but only the occurrence.

Azid et al (2019) conducted a study that aimed to conceptually analyze and survey the relationship between TPM and RCM through four conceptual elements which include creating a knowledge base from several types of literature related to TPM and RCM. The goal of TPM is to achieve zero breakdown, zero defects and zero accidents, whereas RCM is to maintain function. TPM is mostly applicable in large manufacturing industries, while RCM can be applied in small or medium size plant. From the literature review of previous research, it can be summarized similar constraints where there is still a lot of maintenance at various facilities carried out based on periodic inspections. In addition, the inability of time-based preventive maintenance to prevent failures related to the failure rate of equipment during its lifetime is also an obstacle faced. The application of the RCM method in various facilities helps improve the performance of the maintenance function, especially in maintaining the function of the system or equipment and has a positive impact on operating performance, cost-effectiveness of maintenance and extending the

life of the equipment. RCM can be used to determine appropriate actions to predict and prevent failures by identifying failure lists and selecting the most appropriate actions.

3. METHODS

The study used both quantitative and qualitative approaches to answer the predetermined problem formulations. The following is a further description of data processing method so that the results of the study objectives are obtained.

3.1 Determine Equipment Criticality Rating

The equipment criticality rating is evaluated from the effect of system failure on impact to safety (K), impact to environment (L), impact to production (P), impact to operating costs (BO), impact to repair costs (BP), and the impact of hidden failures (KT) based on calculations between rating and weighting elements in three categories i.e., high, medium or low. The assessment of element ratings 1 to 5 is based on the criteria of each system or equipment by calculating the aggregate value of the consequence or impact of the failure of the asset in table 1. The assessment of the criticality level of the equipment is divided into 3 (three) categories, as follows:

1. Low category with a value of Equipment Criticality < 17.
2. Medium category with a value of 17 ≤ Equipment Criticality Level ≤ 30.
3. High category with a value of Equipment Criticality > 30.

The equipment criticality rating is calculated using Formula = ∑(Element Rating x Weighting).

3.2 Implementation of RCM Process

Two RCM worksheet are used to implement RCM process i.e., RCM Information Worksheet and RCM Decision Worksheet.

a. Identification of Equipment Functions and Performance Standards
   The initial step of the RCM process is carried out by defining the function of each asset in its operational context and also the expected performance standards that are analyzed to meet the standard performance parameters in system functions. If the standard performance parameters are not met, a malfunction occurs.
b. Identification of Functional Failures
   Events that can stop the performance of an equipment from reaching the desired performance standard are caused by a functional failure, so it is necessary to apply various appropriate failure handling techniques by identifying what failures can occur, especially in the category of critical rotating equipment that can cause the system to partially fails or totally fails to fulfill its function.
c. Identification of Failure Modes
   Furthermore, the identification of failure modes is carried out where the events that have a large enough possibility to cause each failure condition can be identified. In identifying the failure mode, what needs to be analyzed is the symptom, not the root cause. The cause of this failure is described so that an appropriate maintenance strategy can be determined and not waiting for a failure to occurred before. These data are taken from the historical data of the equipment, failures that are being avoided, and failures that could be true in the current state and can occur as a result of deterioration/damage due to normal use or human/design errors.
d. Description of Effects If Failure Mode Occurs
   A failure effect description describes what happens when a failure mode occurs by including information on what evidence a failure has occurred, how the failure threatens safety or the environment, how it affects production or operations, what physical damage the failure causes, and what should be done to correct the failure.

The RCM process is carried out by classifying the consequences of failure as follows:

a. Hidden Failure Consequences (T) where a preventive activity must reduce the risk of multiple failures to an acceptable level.
b. Consequences of Safety (K) where a preventive activity must reduce the risk of failure itself to a tolerable level.
c. Environmental Consequences (L) where a preventive activity must reduce the risk of failure itself to a tolerable level.
d. Operational Consequences (O) where in a period of time the costs of carrying out preventive activities are lower than the costs of operational consequences plus the costs of repairing failures that you want to avoid.
e. Non-operational consequences (N) where in a period of time the cost of carrying out preventive activities is lower than the cost of repairing if allowed to fail.

Proactive activities are selected on the decision worksheet if it is feasible and technically possible to prevent failure with an explanation, as follows:

a. T1/K1/O1/N1 marks suitable on-condition activities to anticipate failure modes before consequences occur.
b. T2/K2/O2/N2 marks suitable periodic repair activities to prevent failures.
c. T3/K3/O3/N3 marks suitable periodic replacement activities to prevent failures.

And for T4, T5, and K4 it is another final action where T4 is chosen if the failure-finding activity is technically feasible and worth doing, T5 is selected if multiple failures can threaten safety and the environment, and K4 is selected if the combination of activities is technically feasible and worth doing.

4. RESULTS

4.1 The Result of Equipment Criticality Rating

The study data includes data on rotating equipment at the system level from a total of 250 (two hundred fifty) rotating equipment on 9 (nine) systems in utility production facilities. Determination of the criticality rating of each rotating equipment is based on the following 6 (six) elements in table 1:

Table 1. Equipment Criticality Rating Matrix

Element Ratings	Impact to Safety (K)	Impact to Environment (L)	Impact to Production (P)	Impact to Operating Costs (BO)	Impact to Repair Costs (BP)	Impact of Hidden Failures (KT)
1	Medical treatment without hospitalization	Not causes environment Exceed the Threshold	Production potentially cut-rate up to 10%	Operating costs up to 0.1%	< IDR 50,000,000	Multiple failure with further secondary (other) damage
2	Medical treatment with hospitalization	Causing environment exceed the threshold in Plant area	Causing Plant cut-rate to minimum	Operating costs from 0.11% to 1%	From IDR 50,000,000 to IDR 200,000,000	Multiple failure with Operating costs increase
3	Permanent disability	Causing environment exceed the threshold in office area	Causing one/several system shutdown (partial)	Operating costs from 1.1% to 5%	From IDR 200,000,001 to IDR 500,000,000	Multiple failure with total shutdown > 3 days

4	Single fatality	Causing environment exceed the threshold in community settlements and outpatient treatment	Causing total Plant shutdown <= 3 days	Operating costs from 5.1% to 10%	From IDR 500,000,001 to IDR 1,000,000,000	Multiple failure with environmental pollution exceed the Threshold
5	Multiple fatality	Causing environment exceed the threshold in community settlements and outpatient treatment serious violations / Plant closures	Causing total Plant shutdown > 3 days	Operating costs are more than 10%	> IDR 1,000,000,000	Multiple failure with fatality consequences

Based on the results of identifying the equipment criticality rating that has been carried out, there are 20 rotating equipment of the high category and 20 rotating equipment of the medium category from 7 systems in table 2. The rotating equipment have a critical impact on each system in the event of a functional failure.

Table 2. Equipment Criticality Rating

No	Description		Element Rating						Weighting						Result	Category
									K	L	P	BO	BP	KT		
	System	Equipment	K	L	P	BO	BP	KT	15	10	5	3	1	0,5		
1	Fire System	Fire Diesel Pump	5	1			2	5	75	10	0	0	2	2,5	89,5	High
2	Fire System	Fire Diesel Engine	5	1			2	5	75	10	0	0	2	2,5	89,5	High
3	GTG	Ratchet Motor		2	5		3	3	0	20	25	0	3	1,5	49,5	High
4	GTG	Ratchet Pump		2	5		3	3	0	20	25	0	3	1,5	49,5	High
5	GTG	Hydraulic Oil Main Pump		2	5		3	3	0	20	25	0	3	1,5	49,5	High
6	GTG	Emerg. Pump Motor		2	3		2	1	0	20	15	0	2	0,5	37,5	High
7	GTG	Emerg. Pump		2	3		2	1	0	20	15	0	2	0,5	37,5	High
8	GTG	Oil Vapour Separator Blower Motor		2	3		2	1	0	20	15	0	2	0,5	37,5	High
9	GTG	Oil Vapour Separator Blower Pump		2	3		2	1	0	20	15	0	2	0,5	37,5	High
10	GTG	Generator			5		5	3	0	0	25	0	5	1,5	31,5	High
11	IAPA	Air Comp. A			3	4	3	2	0	0	15	12	3	1	31	High
12	IAPA	Air Comp. B			3	4	3	2	0	0	15	12	3	1	31	High
13	IAPA	Air Comp. C			3	4	3	2	0	0	15	12	3	1	31	High
14	HRSG	BFW HRSG Pump A			5		4	3	0	0	25	0	4	1,5	30,5	High
15	HRSG	BFW HRSG Pump A Motor			5		4	3	0	0	25	0	4	1,5	30,5	High
16	Boiler	BFW PB Pump A			5		4	3	0	0	25	0	4	1,5	30,5	High
17	Boiler	BFW PB Pump A Motor			5		4	3	0	0	25	0	4	1,5	30,5	High

18	Boiler	FD Fan			5		4	3	0	0	25	0	4	1,5	30,5	High
19	Boiler	FD Fan Motor			5		4	3	0	0	25	0	4	1,5	30,5	High
20	GTG	GT Starting Motor			5		4	3	0	0	25	0	4	1,5	30,5	High

Furthermore, the data is used as a basis for determining the maintenance strategy in accordance with the 7 (seven) processes of the RCM method.

4.2 The Result of Implementing RCM Process

4.2.1 RCM Information Worksheet

RCM information worksheets are used to document system / equipment functions, functional failures where the equipment loses function, failure mode, and failure effects which inform what happens when its failure occurs in table 3.

Table 3. RCM Information Worksheet

No	System	Function	No	Functional Failure	No	Failure Mode	Failure Effect
1	GTG	To generate electricity, gas turbines heat a mixture of air and fuel gas to very high temperatures so that they turn the turbines. The rotating turbine drives a generator that converts mechanical energy into electricity which is integrated into the electrical network used for processes in the Fertilizer and Agrochemical Industry with a capacity of 22 MW.	A	The GT Starting Motor (J01-88CR-1) cannot rotate the gas turbine shaft at all/becomes the prime mover when the GTG starts up to 3000 rpm.	1	Electronic card module error/damage.	The Switchgear Panel cannot supply electricity to turn on the Vacuum Circuit Breaker to the GT Starting Motor so that the motor cannot function to rotate the turbine shaft. Downtime for repairs > 3 days.
					2	Motor bearings are damaged due to lubrication failure.	Imperfect lubrication causes bearing failure and motor overheating. Downtime for repairs > 3 days.
					3	Power cable is broken/damaged .	The Switchgear Panel cannot supply electricity to the GT Starting Motor so that the motor cannot function to rotate the turbine shaft. Downtime for repairs > 3 days.
					4	Motor Short Circuit.	short circuit disturbance due to electric current exceeding the capacity of the motor causing damage to the insulation and motor coils. Downtime for repairs > 3 days.
					5	The starting clutch cannot be coupled with the motor.	The clutch cannot connect the starting motor output shaft to the accessories gear main shaft so that the turbine cannot rotate. Downtime for repairs > 3 days.
			2	Generator (J01-G) cannot produce electricity at a voltage of 11 kV, 50 Hz.	1	Overheating in the stator or rotor winding	Failure to function of the generator protection system can cause damage to the generator stator or rotor. Downtime for repairs > 3 days.

4.2.1 RCM Decision Worksheet

The RCM decision worksheet is used to integrate the consequences and actions of each failure mode described on the RCM information worksheet which includes how the failure affects, what actions can be taken to prevent each failure if no appropriate proactive action is found.

Table 4. RCM Decision Worksheet

No	Information Reference			Consequence Evaluation				T1 K1 O1 N1	T2 K2 O2 N2	T3 K3 O3 N3	Default Action			Proposed Task	Initial Interval	Can be done by
	F	KF	MK	T	K	L	O				T4	T5	K4			
1	1	A	1	Y	N	N	Y	Y	-	-	-	-	-	Schedule on-condition activities on cranking motors and checks/tests on switchgear (rack-out position). Provision of electronic card module spare parts.	18 Months	Operator
2	1	A	2	Y	N	N	Y	Y	-	-	-	-	-	Perform vibration measurements on the motor bearings. If vibration indications are found (> 4 mm/s), then investigate the possibility of bearing damage.	18 Months	Technician (Rotating)
3	1	A	3	N	-	-	-	N	N	N	Y	-	-	Schedule finding failure activities on the power cable by testing the insulation resistance test and polarity index. If significant degradation rate of insulation resistance is found, carry out further investigation and plan for replacement.	18 Months	Technician (Electrical)
4	1	A	4	N	-	-	-	N	N	N	Y	-	-	Schedule finding failure activities on the motor by testing the insulation resistance test and polarity index. If it is found that the rate of decrease in the insulation resistance of the winding is significant, carry out investigation and repair.	18 Months	Technician (Electrical)
5	1	A	5	Y	N	N	Y	Y	-	-	-	-	-	Schedule on-condition activities on the Starting clutch and check whether the position is coupled or not actually in the field or from the CCR.	18 Months	Technician (Rotating)
6	1	B	1	N	-	-	-	N	N	N	Y	-	-	Schedule finding-failure activities on the Generator (testing the insulation resistance test and polarity index) and checking / testing / calibrating the Generator Protection Relay. If a breakdown is found, then carry out further investigation and plan repairs/rewinding.	18 Months	Technician (Electrical)

6. CONCLUSIONS

The results of determining the equipment critical rating based on the effect of system failure on safety, environment, production, operating costs, repair costs, and the impact of hidden failures that have been carried out where out of 7 systems in utility production facilities there are 20 rotating equipment with category of high level and 20 rotating equipment with category of medium level. The application of the RCM method provides useful results in formulating maintenance strategies, especially in determining maintenance activities in the form of scheduled on-condition task, scheduled restoration task, scheduled discard task, finding-failure, multiple failures, and combinations of tasks and in determining maintenance intervals according to the critical level equipment functions so as to maintain reliability, availability, economic life of equipment, and effectiveness of plant maintenance and minimize financial losses due to potential disruptions or downtime. The results of the application of the RCM method are 5 rotating equipment whose maintenance strategy has changed from previously run-to-failure to failure-finding, i.e. GT Starting Motor, Generator, Ratchet Motor, Ratchet Pump and there are also 4

rotating equipment whose maintenance strategy has changed from previously run-to-failure to on-condition monitoring, i.e. Emergency Pump, Emergency Pump Motor, Main Lube Oil Pump, Stand By Pump where the equipment has a critical impact on the Gas Turbine Generator system in the event of a functional failure.

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ANALYSIS OF THE PPP SCHEME'S IMPLEMENTATION IN THE TIGA DIHAJI DAM PROJECT

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ABSTRACT

The government's program in water infrastructure in Ogan regency, South Sumatera is 120 m3 per capita per year by 2024, while Indonesia only provides 53 m3 of water per person annually as of 2019. Due to limited fund, the government needs financial support from private investment in dam building to accomplish this goal, however, currentPPP scheme does not sound effective. Therefore, other schemes, such as Viability Gap Funding (VGF) and Availability payment (AP) were proposed to obtain the best scheme from financial side. This study was started by feasibility analysis using cash flow analysis, which was then continue to scheme selection. The outcomes demonstrated that, based on the economic feasibility analysis of the Tiga Dihaji Dam, which had a negative NPV value (IDR -1,151,864,276,247, -), government support of at least 54.66% VGF or at least P 9.12% of the construction costs paid throughout the entire operating period was required to attract investors. The study showed that the PPP program with AP provided a stronger framework for implementing the building of the Tiga Dihaji Dam.

Keywords: PPP, Dam, Viability Gap Fund, Availability Payment.

1. INTRODUCTION

Despite being a tropical nation with considerable rainfall, Indonesia nonetheless struggles with a water issue because of the country's low population to water storage capacity ratio. In 2019, Indonesia only has a water reservoir of 53 m3/capita/year, significantly behind compared to Thailand, which has a water reservoir of 1,200 m3/capita/year. A country should have a water reservoir of 1,900 m3/capita/year.

The current government's PPP project offer, was not entirely successful to cope this problem. One of dam construction project which apply PPP scheme is the Tiga Dihaji Dam in South Sumatra. However, the project investment is unfavorable as it can only generate 4x10 Megawatts of electricity, while the minimum amount of electricity that is deemed profitable by investors is 100 MW.

According to earlier research conducted by the Infrastructure Center for Indonesia Development Studies Team at the STAN State Finance Polytechnic in 2017 on the subject of "Analysis of Critical Success Factors Success of Government Support in the Preparation of PPP Projects," there were two projects that initially encountered difficulties using the PPP scheme but were ultimately implemented successfully with more government support. The Umbulan SPAM Project, the first PPP Project with Viability Gap Fund facilities, and the Palapa Ring Project, the first PPP Project with Availability Payment facilities, are the two projects in question.

In order to raise project viability and to attract investor, the other schemes are proposed. Based on the aforementioned description, a research will be conducted on the Tiga Dihaji Dam to find the best PPP plan while considering the opinions of private investors.

The objective of this study is to propose alternative PPP schemes, to analyze the cash flow of those offered alternatives that might be used for the construction of the Tiga Dihaji dam, and to select the best scheme. .

2. LITERATURE REVIEW

Public Private Partnership (PPP)

According to the Ministry of Finance, a public-private partnership (PPP) is an agreement between a government and a business entity to work together to provide infrastructure and/or services in the public interest that partially or entirely utilize the resources of the business entity while taking into account risk sharing between the parties. The PPP system is implemented through a partnership agreement (contract) between the Business Entity and the Government, acting as the Cooperation Project Responsible Agency (GCA). The Business Entities may be State-Owned Enterprises, Regional-Owned Enterprises, Limited Liability Companies, Cooperatives, or Private Business Entities. This indicates that while the infrastructure project will benefit the economy and is economically feasible, the private sector is not interested in investing because the project's income (service rates) will not meet its expected rate of return in the form of a return on equity and loans (debt principal and interest).

The government's role in ensuring the success of PPP projects is becoming more and more crucial. This includes offering resources and assistance in order to pique the interest of the business sector and encourage investment. Project Development Facility, Viability Gap Fund, and Infrastructure Guarantee facilities have all been made available for PPP projects thus far by the Indonesian government. In addition, there is another choice in terms of the payment system, namely the Availability Payment system.

The Impact of Government Assistance Two projects in the PPP Project Preparation experienced trouble at first implementing the PPP concept, but they were finally implemented effectively with extra backing from the government. The Umbulan SPAM Project, the first PPP Project with Viability Gap Fund facilities, and the Palapa Ring Project, the first PPP Project with Availability Payment facilities, are the two projects in question.

Government support for PPP projects that already have economic feasibility but lack financial feasibility is known as feasibility support, also known as viability gap fund (VGF). This support takes the form of a cash contribution for a portion of the construction expenses. If there are no other options to make the Cooperation Project financially viable, feasibility support may be offered. Priority PPP Projects are eligible for feasibility support if they meet the following requirements: a) Has achieved economic viability but not financial viability. b) Utilizing the user-pay model. c) Cost not less than IDR 100 billion in overall investment. d) A business entity selected through an open, competitive bidding process executes the project. e) Establish a plan for managing and/or transferring assets from the Business Entity to the GCA at the conclusion of the period of cooperation. f) Developed a thorough pre-feasibility study: g) Take advantage of risk sharing. h) Come to the conclusion that the project is practically, legally, ecologically, and socially feasible. I) By offering Feasibility Support, show that the Cooperation Project becomes economically viable. j) The parties involved in the PPP project have pledged their support.

Service Availability Payment (AP) is a regular payment made to the Implementing Business Entity by the Minister or Head of Institution in exchange for the provision of infrastructure services that meet the standards for quality and/or criteria outlined in the PPP Agreement. The AP scheme is typically used in situations where there is no revenue from service users or no end users who can be charged with tariffs, such as when the government is providing infrastructure used to provide public services or when potential income is insufficient to cover investments in business entities or projects that are not financially viable. Priority PPP Projects may be eligible for Service Availability Payments if they meet the following requirements: a) Infrastructure initiatives in the economy and society that are very advantageous to the community's service customers. b) Return on investment does not come from fees paid by customers. c) If a PPP project generates revenue from user fees for the provision of services, the GCA is unable to determine how much revenue will be used to reimburse the implementing business entity for the provision of the services. d) Taking into mind the fundamentals of fair business competition, election stages for business entities are fair, open, and transparent.

According to the PPP Book 2021 published by Ministry of National Development Planning, 22 projects have been successfully implemented under the PPP program as of June 2021, and they are as follows:

Table 1. List of PPP Projects

No.	Nama	Sector	PJPK	Investor	Pengembalian Investasi	IRR	NPV (USD)	Masa Konsesi	Dukungan Pemerintah
1	Jalan Tol Ujung-Semarang	Jalan - ol	BPJT	PT. Jasamarga Semarang-Ungaran	Tariff Penguna an	23,70%	230 M	40 Tahun	
2	Jalan Tol Bawen-Yogyakarta	Jalan - ol	BPJT	PT. Jasamarga Bawen-Yogyakarta	Tariff Penguna an	13,61%	98 M	38 Tahun	
3	Jalan Tol Jakarta-Cikampek II Elevated	Jalan - ol	BPJT	PT. Jasamarga Jalan Layang Cikampek	Tariff Penguna an	12,92%	104 M	40 Tahun	
4	Jalan Tol Bekasi - Cawang - Kp. Melayu	Jalan - ol	BPJT	PT. Trans Jawa Tollroad Pandaan Malang	Tariff Penguna an	15,87%	380 M	40 Tahun	
5	Jalan Tol Pandaan-Malang	Jalan - ol	BPJT	PT. Jasa Marga Pandaan Malang	Tariff Penguna an	12,33%	12,7 M	40 Tahun	
6	Jalan Tol Kanci - Pejagan dan Pejagan - Brebes	Jalan - ol	BPJT	PT. Waskita Bumi Wira	Tariff Penguna an	14,36%	387 M	40 Tahun	
7	Jalan Tol Pekanbaru - Dumai	Jalan - ol	BPJT	PT. Citra Jasa Tol Dumai	Tariff Penguna an	15,11%	-7,9 M	40 Tahun	
8	Jalan Tol Semarang - Demak	Jalan - ol	BPJT	PT. Trans Jawa Tollroad Semarang Demak	Tariff Penguna an	13,96%	161,1 M	40 Tahun	
9	Jalan Tol Serpong-Balaraja	Jalan - ol	BPJT	PT. Trans Marga Jawa Tollroad	Tariff Penguna an	15,85%	230 M	40 Tahun	
10	Jalan Tol Jakarta-Cikampek II Selatan	Jalan - ol	BPJT	PT. Jasamarga Jalan Layang Cikampek	Tariff Penguna an	11,17%	42,9 M	38 Tahun	
11	Jalan Tol Semarang Demak	Jalan - ol	BPJT	PT. PP Semarang Demak	Tariff Penguna an	11,96%	71,84 M	38 Tahun	
12	Jalan Tol Probolinggo-Banyuwangi	Jalan - ol	BPJT	PT. Jasamarga Probolinggo Banyuwangi	Tariff Penguna an	11,17%	246,23 M	35 Tahun	
13	Pengembangan Jalan Lintas Timur Sumatera	Jalan Baru	Dinas Bina Marga	PT. Jalintim Nusantara	Availability Payment	9,89%	97,39 M	18 Tahun	Availability Payment
14	SPAM Bendungan Lematang	Air Minum	KPBU	PT. Benpam Citra Lematang	Tariff Penguna an	100%	25,7 M	25 Tahun	Viability Gap Fund
15	SPAM Umbulan	Air Minum	Pemprov Jatim	PT. Jatim Tirta Umbulan	Tariff Penguna an	12,05%	94,2 M	25 Tahun	Viability Gap Fund
16	SPAM Semesta Bandung	Air Minum	KPBU	PT. Air Bandung Lestari	Tariff Penguna an	9,62%	26,38 M	27 Tahun	Viability Gap Fund
17	SPAM Batam	Air Minum	Pemprov Jatim	PT. Jatim Tirta Lestari	Tariff Penguna an	10,62%	6,8 M	25 Tahun	Viability Gap Fund
18	Pembangunan Rumah Sakit Pendidikan Universitas Airlangga	Infrastruktur dan Transportasi	PKBU - Kemenkes	PT. Rumah Pendidikan Indonesia	Availability Payment	10,88%	8,1 M	15 Tahun	Availability Payment
19	Pembangunan Rumah Sakit Pendidikan Universitas Diponegoro	Infrastruktur dan Transportasi	PKBU - Kemenkes	Konsorsium Nusantara Sehat	Availability Payment	12,62%	13,9 M	15 Tahun	Availability Payment
20	Pembangunan Rumah Sakit Pendidikan Universitas Padjadjaran	Infrastruktur dan Transportasi	PKBU - Kemenkes	PT. Rumah Pendidikan Padjadjaran	Availability Payment	14,62%	22,8 M	15 Tahun	Availability Payment
21	Pembangunan Rumah Sakit Pendidikan Universitas Brawijaya	Infrastruktur dan Transportasi	Kemenkes	PT. Rumah Sakit Pendidikan Brawijaya	Availability Payment	9,62%	11,38 M	15 Tahun	Availability Payment
22	Pembangkit Listrik Tenaga Uap Jawa 1 Tanjung Jati B	Ketenagalistrikan	PT PLN (Persero)	PT. Jawa Power	Tariff Penguna an	11,12%	836,7 M	25 Tahun	

Source: PPP Book of Ministry of National Development Planning, 2021

Dam

In addition to retaining and storing water, dams are structures made of rock, concrete, stone, or landfill that can also be used to contain and accommodate mining waste (tailings) or to accommodate mud to create a reservoir (Government Regulation No. 37 of 2010 concerning Dams). A dam can be seen from many angles, each of which yields a different type, claims Soedibyo (2003). The types of dams can then be divided based on factors such as size, use, water flow, construction, and purpose of building.

According to their size, there are two different types of dams: huge dams and small dams. A large dam, as defined by ICOLD, is one that is more than 15 meters tall when measured from the base of the foundation to the top of the dam. Minor dams, weirs, and bending are the names for familiar or small dams, respectively. Dams can be classified as single- or multipurpose depending on their intended use. Dams having a single purpose (single purpose dams) are those constructed for a single purpose exclusively, such as generating electricity, irrigation, flood control, inland fisheries, or any other reason. PLTA and irrigation, flood control and hydropower, drinking water and industrial water, hydropower, tourist, and irrigation are a few of the multiple uses that multipurpose dams (multipurpose dams) are intended to serve. Depending on their use, dams include: 1) Storage dams are dams constructed to create reservoirs for the purpose of storing excess water for future use. 2) Diversion dams are structures constructed to raise the water level so that it can flow into canals or aqueducts. 3) Detention dams are dams constructed to impede the flow of water in an area in order to avert significant flooding. 4) Urugan dams are one type of dam based on how it was built (fill dams, embankment dams and concrete dams). 5) The following types of dams are primary cofferdams, dikes, cofferdams, dams main (main dam), side dam (high level dam, saddle dam), which is a dam built on the edge of a reservoir far from the main dam and designed to stop water from escaping the reservoir so that reservoir water does not flow into the nearby area, and 6) embankment (dyke, levee).

Making the best possible plans will help ensure that the project is completed on schedule and with good quality, acceptable costs, and appropriate benefits. This is done to ensure that everyone involved is aware of their roles and responsibilities. A project's stages can be broken down into the following stages: survey, investigation, design, land acquisition, construction, operation, and maintenance (SIDLACOM). When referring to project investment costs, the whole sum of money spent to complete a project—from idea to feasibility study to planning to implementation to operation and maintenance—involves a variety of expenditures. To make the analysis of calculating all expenses easier, these costs are divided into a number of components in the economic feasibility analysis (Robert J., 1995). These expenses are divided into two categories: annual costs and the cost of capital.

Financial Feasibility Analysis

Several techniques known as investment criteria have been established to get a thorough measurement to use as a foundation for evaluating the investment of a project. Break-even analysis, internal rate of return, and net present value are factors that are frequently utilized and advised for use in project appraisal.

3. METHOD

This study is anticipated to provide a clearer picture of how the PPP strategy for dam construction is being implemented. Secondary data was needed for this study's supporting information, includes1) The Sumatra VIII River Basin Center provided technical data for the Tiga Dihaji Dam; 2) initial cost; 3) statistics on hydropower investment costs based on studies in the literature; 4) Information regarding the major cost of producing energy as per Minister of Energy and Mineral Resources Decree No. 169.K/HK.02/MEM.M/2021; 5) Information regarding the basic cost of surface water as stated in Minister of Public Works Ministry No. 12/KPTS/M/2019; 6) South Oku BPS provides information on production and agricultural goods; 7) Ministry of National Development Planning provides information on the financial viability of projects that have adopted the PPP scheme; and 8) Questionnaire for the Application of Alternative PPP Schemes.

The study was started by analysing revenue and cost, which was generated from benefit of the dam project. The benefit is listed as follows:

Table 2. Benefit of Tiga Dihaji Dam

No	Aspect	Tangible Benefits	Intangible Benefits
1	Hydrology	The value of raw water supply benefits (Tariff of raw water)	Flood prevention
2	Hydroelectric power	The value of providing power as a benefit (Electricity Tariff)	-
3	Agriculture	-	Water for irrigation to boost agricultural outputs
4	Fishery	-	Using flooded areas to boost fishery product production
5	Tourist	-	Local communities' favorite vacation spots

Source: BBWS Sumatra VIII, 2019

The value of income for the supply of raw water and the value of income for the supply of electricity are calculated based on above table. The Net Present Value (NPV) and Internal Rate of Return (IRR) numbers are computed in order to determine the Tiga Dihaji dam's financial viability. The first stage in conducting an analysis to determine the target IRR value based on historical data from prior PPP projects is the calculation of the VGF and AP values. Calculating the necessary VGF value and AP value is done using the goal IRR value.

4. RESULT

Dam Project PPP

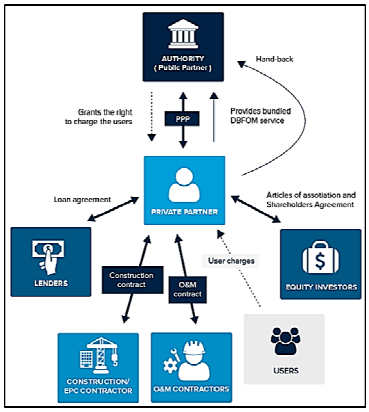


Figure 1. PPP General Schematic (kpbu.kemenkeu.go.id, 2022)

Public private partnership is described as a partnership in which Business Entities will construct and operate dams as a source of capital investment. The government grants permission to business companies to earn money, which is generated by project benefits throughout the mutually agreed concession period as a return/return on investment money.

Analysis of Tiga Dihaji Dam's costs

The South Ogan Komering Ulu (OKU) Regency, South Sumatra Province, is home to the Tiga Dihaji Dam. Three of the 19 sub-districts of OKU Selatan Regency, namely Tiga Dihaji District, Sendang Aji District, and Muara Dua District, will benefit from satisfying their raw water needs. The Tiga Dihaji Dam building cost is broken down into three different categories in this study: the Dam Development Cost, the Hydropower Development Cost, and the Operational-Maintenance Cost. According to the aforementioned information, it will cost IDR 3,827,029,521,000 to build the Tiga Dihaji Dam that were utilized in the calculation. The implementation term will be 5 years, with the following proportions:

Table 3. Implementation Schedule for the Tiga Dihaji Dam Project

Tahun	Jadwal Pelaksanaan	
	Kumulatif	per tahun
2018	0,26%	0,26%
2019	17,39%	17,13%
2020	59,84%	42,45%
2021	88,47%	28,63%
2022	100%	11,53%

Source: S-Curve of Tiga Dihaji Dam Development Project, 2018

The cost of building the hydropower plant is determined using the empirical technique in accordance with the planning data for the Tiga Dihaji Dam hydropower project, which will produce 4x10 MW of power (Source: RETScreen Engineering & Cases Textbook)

Is well-known:

Number of Turbines (*n*) = 4
Grid-connected factor to aacount for the use of induction generators (*G*) = 1
Factor to account for use of lower-cost motors as generators (Cg) = 1
Total Capacity in MW (*MW*) = 40
Gross Head in m (*Hg*) = 127,25
Transmission line difficulty of terrain factor (*D*) = 1
Length of transmission line in km (*lt*) = 25
Transmission line voltage in kV (*V*) = 500
Factor to reflect cost of wood pole vs. steel tower construction (*P*) = 1

So as:

Energy equipment (Generator and Control) $= 0{,}82\, n^{0{,}96} G\, C_g \left(\frac{MW}{H_g^{\,0{,}28}}\right)^{0{,}9} \text{x} 10^6$

$= 0{,}82 \text{ x } 4^{0{,}96} \text{ x } 1 \text{ x } 1 \text{ x } \left(\frac{40}{127^{0{,}28}}\right)^{0{,}9} \text{x} 10^6$

= CAD$ 25.308.807

Instalation of energy = 0,15 x Energy equipment
= 0,15 x 25.308.807
= CAD$ 3.796.321

Transmission Line $= 0{,}0011\, D\, P\, l_t^{\,0{,}95}\, V \text{x} 10^6$
$= 0{,}0011 \text{ x } 1 \text{ x } 1 \text{ x } 25^{0{,}95} \text{ x } 500 \text{ x } 10^6$
= CAD$ 11.705.924

Substation and transformer $= 0{,}0025\, n^{0{,}95} + 0{,}002\, (n+1) \text{ x } \left[\frac{MW}{0{,}95}\right]^{0{,}9} \text{x } v^{0{,}3} \text{ x} 10^6$

$= 0{,}0025\, 4^{0{,}95} + 0{,}002\, (4+1) \text{ x } \left[\frac{40}{0{,}95}\right]^{0{,}9} \text{ x } 500^{0{,}3} \text{ x} 10^6$

= CAD$ 6.451.950

Instalation of substation and transformer = 0,15 x Substation and transformer
= 0,1,5 x 6.451.950
= CAD$ 967.793

Total Biaya Pembangunan PLTA sebesar = CAD$ 48.230.795
= IDR 545.007.982.338,-

The conclusion is that the median yearly cost of maintenance and upkeep of a dam is 0.21%, with a range of 0.14% to 0.35% of the overall dam construction cost. This is based on Petheram & McMahon's (2019) article entitled Dam, dam cost, and damable cost overruns. The following estimates were used to determine the operational and maintenance expenses in this study, which were set at 0.21% of the overall construction expenditures:

Is well-known:

Construction Cost = IDR 3,827,029,521,000
Hydroelectric power Development Cost = IDR 545,007,982,338
Total Development Cost = IDR 4,372,037,503,338

So as:

Operational and Maintenance Costs = 0,21% x 4.372.037.503.338
= IDR 6.120.852.505,- per year

The assumption was derived from historical info, that is 1.32%, the predicted operational and maintenance expenses will be calculated taking the trend of inflation into account (Source: https://www.bi.go.id/id/statistik/indikator/data-inflasi, 2022)

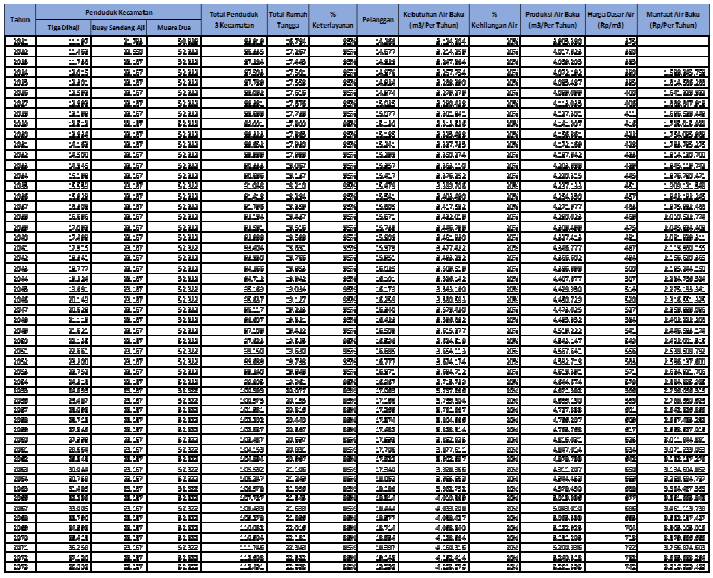
Analysis of Revenues for Building the Tiga Dihaji Dam

Analysis of the revenue from the dam, derived from the determination of the advantages of the Tiga Dihaji Dam's construction, which include the advantages of delivering raw water and the advantages of generating electricity over a 50-year concession period. With the premise that the minimal inflation that has happened over the past ten years is 1.32%, the income projection will account for the trend in inflation (Source: https://www.bi.go.id/id/statistik/indikator/data-inflasi, 2022).

Analysis of Raw Water Supply Revenue

Based on information on population growth and water consumption of 120 liters per person per day, a raw water demand prediction will be generated in order to determine income over the concession period (Directorate General Cipta Karya Planning Criteria, 1996). The following formula was used to determine the anticipated revenue from the provision of raw water throughout the concession period:

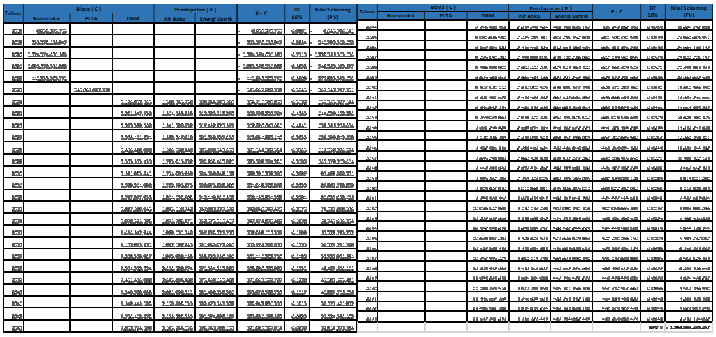
Table 4. Projected Raw Water Needs Calculation



Source: Calculation Results, 2022

Analysis of Electrical Energy Production's Income

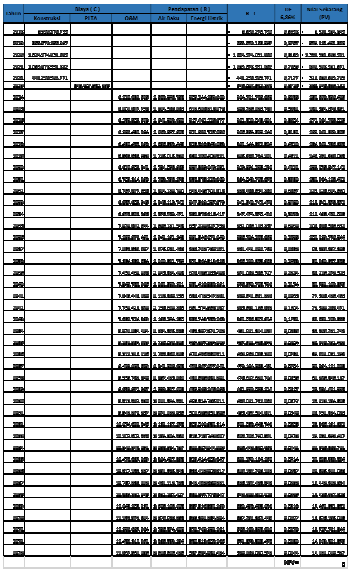
Table 5. NPV Calculation



Source: Calculation Results, 2022

Using the "trial and error" method, the IRR value is the interest rate when NPV = 0. The following precise calculations result in an IRR value of 6.86%:

Table 6. IRR Calculation



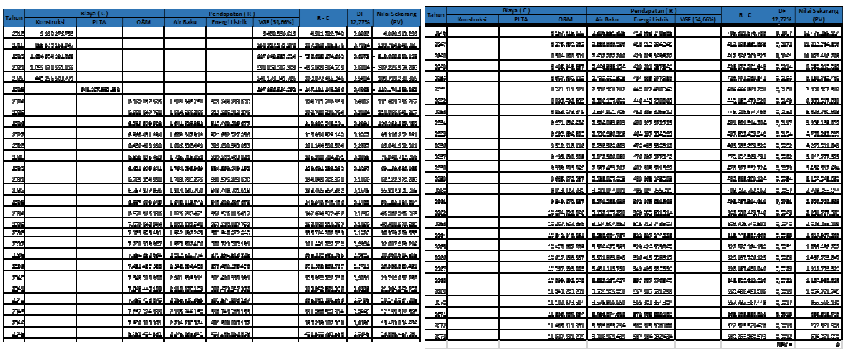
Source: Calculation Results, 2022

According to the analysis of 22 projects carried out under the PPP plan, the average IRR is 12.77%, the minimum IRR is 9.07%, and the maximum IRR is 16%. The optimal IRR for completing the construction of the Tiga Dihaji Dam is found to be 12.77 percent. Therefore, based on the facts presented above, which show that the NPV value is IDR 1,151,864,276,247,- and the IRR value is 6.86%, it can be inferred that the building of the Tiga Dihaji Dam will be challenging to carry out via a PPP scheme without any assistance from the government.

A Different PPP Scheme

Under Viability gap funding (VGF) scheme

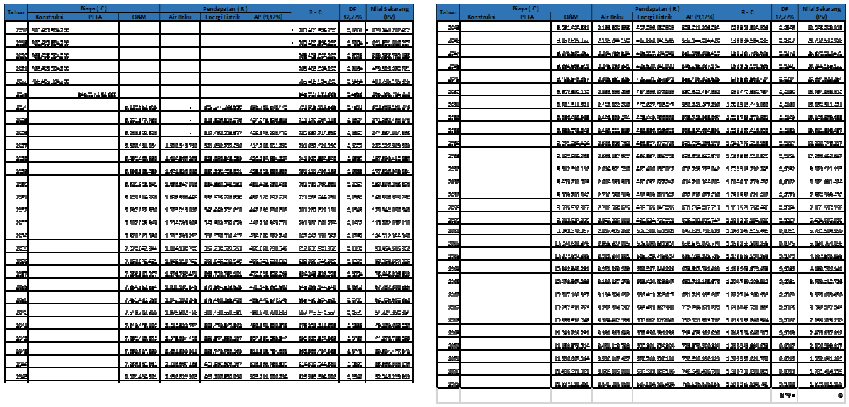
Table 7. VGF Calculation



Source: Calculation Results, 2022

under Availability payment (AP) scheme

Table 8. AP Calculation



Source: Calculation Results, 2022

Sensitivity Analysis

In order to estimate the change of parameter of VGF and AP scheme, the sensitivity analysis was conducted for oncession duration and the inflation rate factors. First, assuming the IRR is set at 12.77%, a "trial and error" method is used to calculate the concession period that has been cut by 20%. The 40-year concession period, the increase in operating-maintenance costs, and the increase in annual income of 1.32% (inflation rate) are some of the factors taken into account in the calculation to arrive at the required minimum AP value of 9.27% of the construction costs paid annually during the concession period. Second, if the IRR is set at 12.77%, a "trial and error" method is used to compute the required AP value in order to determine the value of inflation using the median value of 3.75%. The 40-year concession period, the increase in operating and maintenance costs, and the increase in annual income of 1.32% (inflation rate) are some of the variables taken into account in the calculation to arrive at the required minimum AP value of 5.84% of the construction costs paid annually during the concession period. Third, a "trial and error" method is used to calculate the required AP value if the IRR is set at 12.77% in order to determine that the concession is lowered by 20% and the inflation rate is 3.75%. The 40-year concession period, the increase in operating-maintenance costs, and the increase in annual income of 1.32% (inflation rate) are some of the factors taken into account in the calculation to arrive at the required minimum AP value of 6.11% of the construction costs paid annually during the concession period.

Pros and Cons analysis

Tables 10 and 11 provide an analysis of the benefits and drawbacks of adopting the two PPP schemes from the government and corporate entities point of view in terms of the amount of initial investment necessary, the risk of revenue, and the danger of fraud throughout the concession period:

Table 9. The benefits and drawbacks of business entities

Uraian	VGF	AP
initial investment cost	The initial investment required by a business entity is relatively small because it is the total development cost minus the VGF value paid by the government. **Advantage**	The initial investment value required by business entities is relatively large because it is the total development cost. **Disadvantage**
Income Risk during the concession period	Revenue realization is determined by the production of raw water and electricity which can be smaller or larger than the projected revenue plan, so that business entities have the risk of income uncertainty. Disadvantage	Revenue realization is the value of AP payments, so that business entities have income certainty. **Advantage**

Source: Analysis Results, 2022

Table 10. Governmental advantages and downsides

Uraian	VGF	AP
initial investment cost	The government requires a relatively large initial investment cost which is the value of VGF payments during the construction of the dam. **Disadvantage**	The government requires a relatively small initial investment cost which is the value of AP payments starting during the operational period of the dam. **Advantage**
Risk of fraud during the concession period	Business entities have the potential to commit fraud during the operational and maintenance period which results in raw water supply and energy generation not according to plan, especially if they have passed the BEP (break even point) from a financial perspective. **Disadvantage**	The Business Entity will optimally carry out operations and maintenance during the concession period because it is a condition for AP payments. **Advantage**

Source: Analysis Results, 2022

The PPP Scheme with AP support offers higher benefits than the PPP Scheme with VGF support, according to the analyses in Tables 10 and 11.

6. CONCLUSION

The following conclusions can be drawn from the study's findings: (1) It will be difficult to find investors for the construction of the Tiga Dihaji Dam under a PPP scheme because the calculation results show a negative NPV value (IDR 1,151,864,276,247). In order to find investors, the project needs support from the government in the form of VGF of 54.66% of the total construction costs paid during the construction period or AP of 9.12% of the total development costs paid per year during the concession. (2) According to the results of the sensitivity analysis, it is determined that while the reduction of the concession period from 50 to 40 years does not have a significant impact, changes in the inflation rate used to calculate projected costs and projected income from 1.32% to 3.75% have a significant impact, with the additional NPV value obtained from the calculation results being 57.01% of the initial NPV value. (3) Implementing the PPP Scheme with VGF support with a maximum VGF value limit of 50% of development expenditures, with the result that only conditions 2 (VGF 43.03%) and 3 (VGF 44.20%) in the sensitivity analysis match the criteria. (4) According to the analysis of benefits and drawbacks, the PPP scheme with AP backing has greater benefits, including low startup costs, reduced risk of fraud during the operational phase, and assurance of investors' returns.

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CUSTOMER BEHAVIOR TOWARDS BRAND BUILDING PROCESS IN *ART FASHION* RETAIL

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ABSTRACT

Brands in a specialty retailer can support creation, stimulation, and contribute to enhancing a company's image. The brand identification process is implemented with the aim of creating an atmosphere and information to increase sales. Brand strength is based on the customer's experience of learning, feeling, seeing, and hearing a brand. The method is carried out qualitatively by directly observing customers during their activities to be processed into brand-building classification stages for the type of area and composition of space in the observation of activity routes. The study results show the order trend and the most dominant route passed by customers when visiting art fashion retail and then linking it to the retail brand identification process. The results of field observations in this study revealed that the behavior towards the brand-building classification stages was in accordance with the activities and types of visits made by research respondents. It was also found that the area groups with the busiest routes and types of customers behavior along with the types of brand delivery stages can be used and maximized in the arrangement of supporting elements in art fashion retail.

Keywords: art fashion retail, brand building, customer behavior, direct observation.

1. INTRODUCTION

Fashion is one of the most influential Creative Economy sub-sectors in economic growth in Indonesia with a value of 54.54% in 2019 and is the second largest contributor to national income in Indonesia, (Badan Ekonomi Kreatif, 2019). Art fashion is a type of fashion flow that has become a modern phenomenon since the early 2000s. A fashion work is said to be art fashion when part or all the manufacturing process is done manually by hand (handmade), (Barnard, 2011). In Indonesia, one form of art fashion can be found in the diversity of Wastra Nusantara. Indonesian wastra is a traditional Indonesian cloth that contains symbols and special meanings according to the traditional dimension (dimensional) of the local area concerning color and length and width as well as philosophical and cultural dimensions, (Pratiwi, 2020).

Brands that are built to represent visual identities in art fashion marketing are crucial for consumer acceptance in seeing and deciding behavior when in the sales area. Even though its development is relatively simple as an effort to create different signs and uniqueness for competition, the progress of capitalism has made the difference in the world market wider so that visual identities have developed a lot. Good entrepreneurs know the value that design can have on brand marketing efforts, (Airey, 2019).

This qualitative research used direct observation techniques on 3 respondents with different levels of loyalty and was conducted at retail stores with the specialty retail category in Sarinah, Jakarta. The display center and gallery for Indonesian traditional literature at Sarinah is located on the 1st floor with the concept of sharing areas with various Indonesian traditional literature brands ranging from small to medium scale. With the concept of sharing areas, sellers, hereinafter referred to as tenants, have the challenge of competing with other tenants to attract the attention of customers to approach certain tenant areas. The retail environment as a support for the creation, stimulation, and contribution to the improvement of the company's brand image, is implemented to create a pleasant atmosphere to increase sales. Brand strength is based on customer experiences from activities when learning, feeling, seeing, and hearing a brand, (Keller, 2008). The results of this study are to determine customer behavior towards the achievement of brand development in art fashion retail based on the grouping stages of brand development classification and to know the stages carried out by respondents to be able to provide a scale of brand development achievement in art fashion retail.

2. LITERATURE REVIEW

Visual identity design must be responsive and scalable. Technology is constantly evolving and so designs. In designing a visual identity, it is important to make the core brand longevity in use and effect. But at the same time, a brand's visual identity must be able to adapt to changing needs and deliver a consistent brand experience, (Skaggs, 2018). A field study conducted by Mia Borch Münster on respondents at a fashion retailer in 2018 stated that aesthetic preferences in a store environment have a certain positive effect on the evaluation of products displayed in that store environment, (Münster, 2018). The basic role of the atmosphere in the retail environment is to create favorable conditions such as acceptance and appreciation from customers to gain recognition and increase sales. In a study of how the retail store environment has a relationship with the development of a brand, it was found that environmental elements of visual identity influence customers' understanding of the brand through elements in the retail environment, (Tudor Nistorescu, 2018). The retail environment can support the creation, stimulation, and contribute to enhancing the company's brand image. The elements of the atmosphere are implemented to create a pleasant atmosphere to increase sales. Brand strength is based on customer experiences from activities when learning, feeling, seeing, and hearing a brand, (Keller, 2008).

Brand identity creates a relationship between consumers and companies through various systems that are formed when the brand identity is built and presented to consumers, (Fournier, 1998). Brand building can be achieved through four stages, namely identifying the brand by knowing the brand and then associating it with the product, the brand significance by realizing all brand meanings by associating tangible and intangible elements with certain elements, reacting to the brand by eliciting the desired response from customers according to goals, and connect brands by translating brands into intense, active, and loyal reactions, (Keller, 2008). With attention to the brand-building process in disseminating the value of a brand for the marketing process, the benefits that will arise and be created from having a strong brand according to an academic research review from Hoeffler and Keller (2003) are an increase in perceptions related to the performance of products sold, building better and greater customer loyalty, minimizing vulnerability to competition and crises, the emergence of larger margins than before, an increase in the effectiveness of brand communication, as well as opportunities for brand expansion, (Hoeffler & Keller , 2003).

Consumers in fashion retail are loyal consumers. Customer loyalty is one of the important keys to the success of a retail business. In addition, retaining old customers costs much less than acquiring new customers, (Myron Gable, 2008). This type of selection of customer representation describes a behavioral transition in achieving customer loyalty through customer experience, (Kimura, 2022). The technique of observing respondents is done using direct observation techniques as an important technique in research related to social sciences. This method must be carried out systematically, focusing on research questions, (Ciesielska, Boström, & Öhlander , 2017).

3. METHODS

Research respondents are customers and customers of art fashion retail outlets across the archipelago in Indonesia according to preferences, consumption styles for batik textile products, and loyalty positions of interest in products in the transition of customer segments through loyalty programs. Data collection techniques are the stages that are passed in conducting research data collection. There are two types of data collection techniques, namely data collection through secondary data sources and primary data collection. The source search stage begins with searching for journals and books using keywords on online search engines, reading, and taking notes, then managing them as research materials and resources. The method of extracting primary data is carried out using field observations through data collection techniques by direct observation, and careful observation at research study locations with systematic recording to obtain data and symptoms of research objects. In this study, field observations were conducted with in-depth interview respondents when the respondents carried out visiting activities at the research site. The type of data obtained from this collection technique is in the form of visiting routes and activities carried out while in the retail environment. In addition, field observation activities will be a source as a provision to deepen the process of analyzing brand-building classification and knowing customer behavior based on the grouping of stages carried out by respondents to obtain results and conclusions that are following the research objectives.

4. RESULTS

In knowing customer behavior towards the achievements of art fashion retail brand development, a grouping of the brand development classification stages was carried out based on observational studies of activity routes and knowing the stages carried out by Respondents so that there is a scale of brand development achievements in art fashion retail.

4.1 Observational Environmental Study Results

One of the popular art fashion retail areas in Indonesia is Sarinah. Sarinah is located on Jl. M. H. Thamrin No.11 Jakarta, Sarinah is in the central area of the business district. The location of Sarinah building is at the crossroads of the main road surrounded by office buildings, government buildings, and other shopping buildings. Access to Sarinah can be reached on foot, by motorized vehicles, and by public transportation such as the MRT and Transjakarta.

Figure 1. The location of the Sarinah building in relation to the surrounding environmental conditions

Until now, Sarinah has become a modern shopping center that houses people's businesses, especially in the retail and lifestyle sector. The display center and gallery for Indonesian literature at Sarinah is located on the 1st floor with the concept of sharing areas of various brands of Indonesian traditional literature ranging from micro to medium scales such as Keris Batik, Riana Kusuma Batik, Personal Batik, Doka Tawa Tana Weaving, Ulos Rao, and Rumah Betawi Kebaya. With the concept of sharing areas, sellers, hereinafter referred to as tenants, have the challenge of competing with other tenants to attract the attention of customers to approach certain tenant areas. To distinguish and define tenant areas, Sarinah uses graphical visual aids in the form of signed and graphical elements of instructions installed near certain tenant retail areas.

Figure 2. The atmosphere of the Wastra Nusantara retail area on the 1st floor of Sarinah

Display settings and product layout in the Sarinah retail area are the results of collaboration between Sarinah management and tenants who will then continue the process of service and maintenance assistance by special employees who are responsible for controlling 2 to 3 brands in

the same area. Research observations were carried out on the 1st floor or ground level, especially the archipelago textile retail in the heritage area. The following is a picture of the floor plan and division of areas in the ground level Sarinah retail environment, especially the Nusantara textile retail.

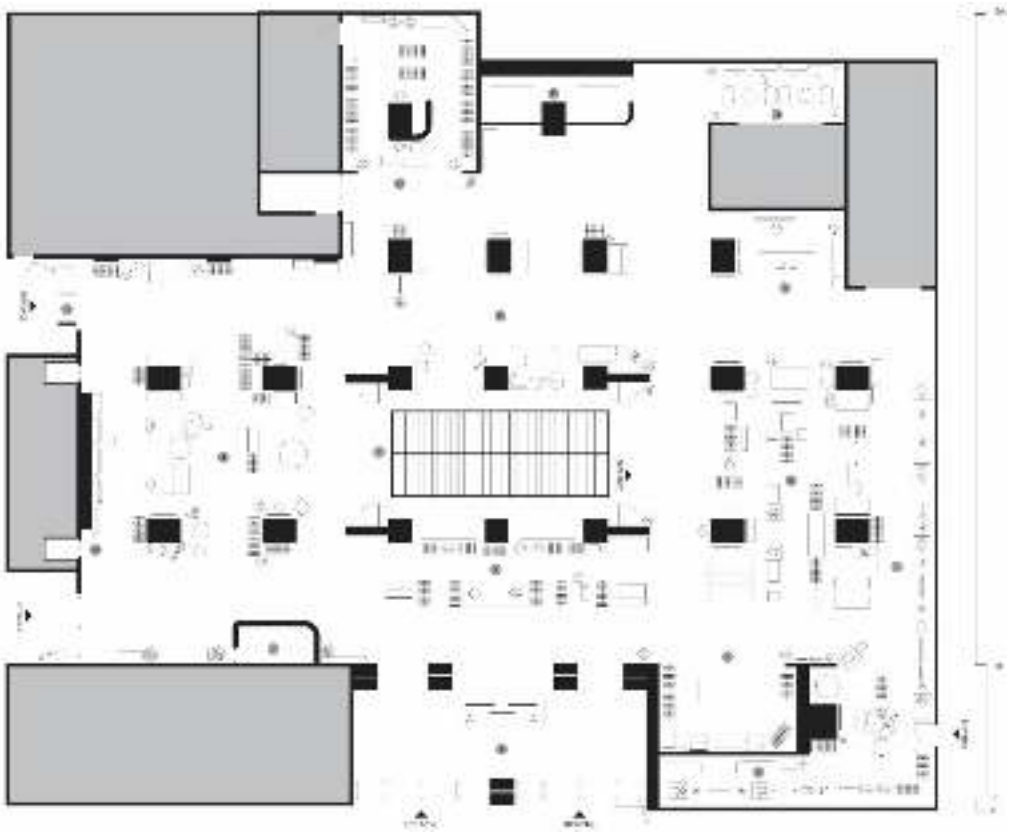

Figure 3. Layout plan and distribution of the Sarinah retail area on the 1st floor

In this study, the division of areas in the Sarinah retail environment was carried out based on function and horizontal layering which was applied on the 1st floor of the Indonesian archipelago retail area. The details and description of the symbol notation for the numbering of area divisions can be seen in the following table.

Table 1. Details and description of the numbering symbol for the division of the Sarinah retail area

Notation	Area Name	Area Type	Composition of visual elements and spatial settings
1	*Foyer*	Access in/out of retail	Display of various information media, and security barriers
2	Display gallery	Shopping and show area	Items with displays, decorative elements, supporting furnishings, and servers
3	Information Desk	Service areas	Service area with employees
4	Display gallery	Shopping and show area	Items with displays, decorative elements, supporting furnishings, and servers

Notation	Area Name	Area Type	Composition of visual elements and spatial settings
5	Escalator	Access in/out of retail	Elevator goes up and down connecting floors
6	Display gallery	Area belanja dan pamer	Items with displays, decorative elements, supporting furnishings, and servers
7	Special display galleries	Private shopping and show area	Items with displays, decorative elements, supporting furnishings, and servers
8	Display window	Area pamer	Items with displays, decorative elements, and supporting furnishings
9	Shared display area	Area pamer dan akses *tenant*	Items with displays, decorative elements, and supporting furnishings
10	Display gallery	Area belanja dan pamer	Items with displays, decorative elements, supporting furnishings, and servers
11	Shared display area	Area pamer dan akses *tenant*	Items with displays, decorative elements, and supporting furnishings
12	Special display galleries	Area belanja dan pamer privat	Items with displays, decorative elements, supporting furnishings, and servers
13	Cashier	Area pelayanan	Service area with employees
14	V.I.P Room	Area pelayanan khusus	Special employees, decor elements, supporting furnishings and discussion areas
15	Special checkpoint	Akses masuk/keluar lingkungan ritel	Security guards and barriers
16	Lift	Akses masuk/keluar lingkungan ritel	Elevator goes up and down connecting floors

From the data and analysis of the type and composition of the area that has been carried out from each point, it can be found that Sarinah has 4 types of area categories, namely:

1. Entrance and exit access, as an entry area and a point for making transfer decisions
2. Shopping area, as an area for discussion and product purchasing process
3. Service area, as an information service and the end point of the visit
4. Display area, as an element to attract the attention of people passing through the retail area.

4.2 Customer Activity Study of Retail Brand Identification

The retail environment as a support for the creation, stimulation, and contribution to the improvement of the company's brand image, is implemented to create a pleasant atmosphere to increase sales. Brand strength is based on the customer's experience of learning, feeling, seeing, and hearing a brand. The following are the steps that must be carried out by research respondents to be able to provide a scale of brand-building achievements:

1. Brand identification stage
   Respondents must know the brand and then associate it with the products sold in the retail area of the research study.
2. Brand significance stage
   Respondents should be aware of all the notions of a brand and relate tangible and intangible elements to specific elements in the retail area of the research study.
3. The reaction stage to the brand

Respondents must express their wishes through a response according to a specific purpose in the research study retail area.

4. Brand connection stage
   Respondents must be able to translate a brand into an intense, active, and loyal reaction in the retail area of the research study.

Following the results of the analysis of the type of area and composition of space in the research in the previous stage as well as observations of the activities of the research respondents in the research retail area, the following is the analysis and results of the stages that must be carried out by the research respondents to achieve brand building at the research site.

Table 2. Analysis of the stages of brand building classification based on the observed behavior

Area Type	Customer behavior	Classification stage			
		1	2	3	4
Access in and out of the area	Stop for a moment to look at the entrance and photograph the retail scene	■			
Shopping area	Approach the product display and then touch the product, select the product, and see the price of the product		■		
Service areas	Ask questions about products and ensure the right way to buy			■	
Show area and private area	View from afar, photograph products, and read information on the area				■

Analysis of the stages that must be carried out by research respondents to achieve brand building at the research location shows the results of grouping the stages of brand building classification on the type of area that occurs based on the behavior that occurs in that area. The results of the stages of brand-building classification based on activity in efforts to achieve brand development at the research site are as follows:

1. Respondents can identify brands by carrying out activities to detect initial appearances that stimulate Respondents to carry out certain behaviors in the retail environment in the entry and exit access areas.
2. Respondents can signify the brand by realizing the meaning of the brand and then linking products/furniture and emotions that result in certain behavioral decisions towards elements in the shopping area and leisure area of the retail environment.
3. Respondents reacted to the brand by expressing their desires through the behavior of inquiring deeper into the product and asking for certain services in the service area and production area of the retail environment.
4. Respondents feel a brand connection through intense reactions in the show area and private area.

4.3 Activity Route Observation

Observation of activities in the art fashion retail area on the 1st floor of the Sarinah heritage area was carried out with 3 respondents. Route notation is described using arrow lines from entering to leaving the area where one respondent and another are distinguished by color based on the direction and area of his visit. The yellow line notation is the route taken by respondent 1, the green line is the route followed by respondent 2, and the red line is for the route traveled by respondent 3. The following is the route of the respondent's activities in the art fashion retail area on the 1st floor, the Sarinah heritage area.

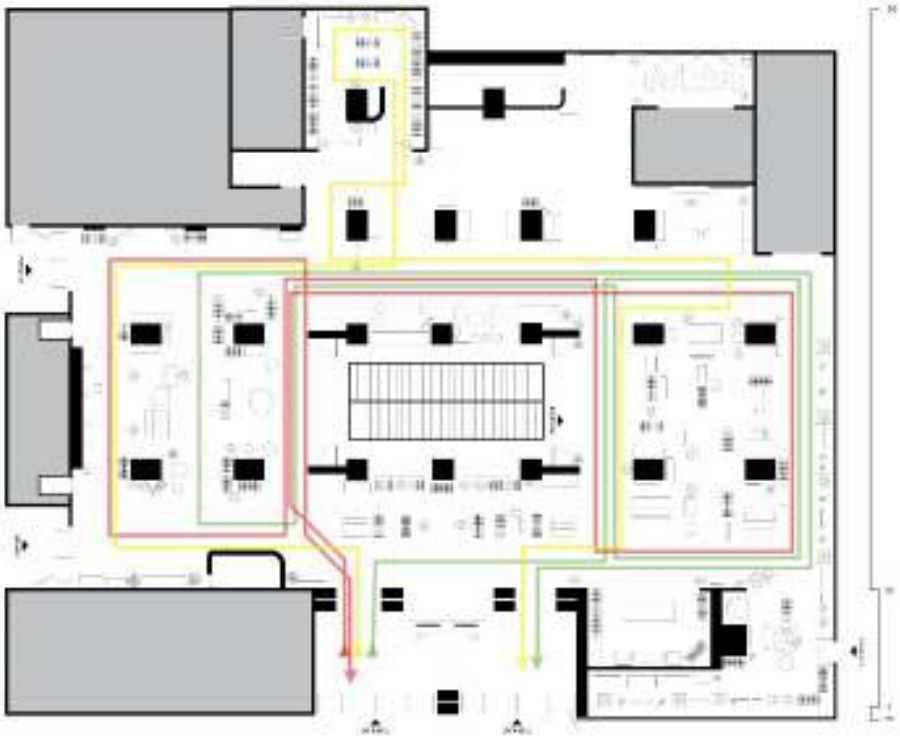

Figure 4. Activity route in the art fashion retail area on the 1st floor of Sarinah

Research respondents carried out activities of entering the retail area to leaving the area during shop opening hours during a visit to plan to purchase wastra products at the research study site while carrying out the retail brand identification process. The routes created from the activities of respondents in the art fashion retail area are then analyzed based on area grouping, route repetition, and classification stages as shown in the following table.

Table 3. Classification behavior analysis based on observation of activity routes

Area Group	Route repetition	Classification stage			
		Identification	Signification	Reaction	Connection
Access in/out of the area	1-2 times	■			
Shopping area	4-6 times		■		
Service areas	1-3 times			■	
Show area and private area	1-2 times				■

Based on the analysis in the table above, the most frequent areas with repeated visits and route repetition occur in shopping areas with stages of significance. Furthermore, a mapping of the results of observations of research respondents was carried out based on the behavior that occurred in the area through the flow of the respondents' activities as follows.

Figure 5. The flow of respondents' activities in the Sarinah art fashion retail area

From the previous mapping and studies, the results of field observations in this study revealed that the behavior towards the stages of brand-building classification corresponds to the activities and types of visits made by research respondents. In addition, it was also found that the area groups with the busiest routes and the important types of customers behavior in these areas along with the types of brand delivery stages can be maximized in the arrangement of supporting elements in art fashion retail.

6. CONCLUSIONS

The results of observing customers behavior in previous activities were processed into an analysis of the classification stages of brand building based on the activities of customers to the type of area and composition of space in the research and observation of activity routes. At this stage, we will get the order trend and the most dominant route passed by customers when visiting art fashion retail and then link it to the application of the EGD elements in the following description of the results of the behavior mapping of the brand development classification stages obtained:

1. Customers identified the brand by carrying out the activity of detecting the initial display which stimulated them to perform the behavior of stopping for a moment to look and take a deeper look at the elements and settings that existed in the retail environment in the entry and exit access areas.
2. Customers signify the brand by being aware of the meaning and purpose of the brand and then linking products/furniture with emotions to consider purchasing decisions in the shopping area of the retail environment.
3. Customers reacted to the brand by expressing their wishes by inquiring more deeply about the product and asking for services from employees in the retail environment service area.
4. Customers feel a brand connection through intense reactions in the private area by finding out deeper product information, storing product memories through photos, and showing a desire to share information about the brand with others.

In the end, area allocation and sectional groupings in retail have an impact on determining the type of customers behavior. The stages of brand delivery through the classification stages starting from the brand identification stage can be carried out by providing stimulation to customers through brand elements in the entry and exit areas of the retail environment. Stages of significance by providing an understanding of the purpose of the brand through setting the brand in the shopping area of the retail environment. The reaction stage by creating a brand can encourage customers to express their wishes regarding products in the service area of the retail environment. The connection stage as the final stage can be carried out by building intense reactions in the private area to bring up the desire to spread information about the brand.

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SUPPLY CHAIN PERFORMANCE MEASUREMENT IN CONSTRUCTION COMPANY USING THE SCOR MODEL

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ABSTRACT

Supply chain management at PT Waskita Karya is responsible for controlling the quality and quantity of materials and services to be used by the noble Project from planning, procurement, management and digitalization of business processes to increase economies of scale so that Project efficiency is achieved in accordance with company targets and quality standards for Projects -projects in the Business Unit. This study aims to measure supply chain performance in one of the company's divisions, namely the SCM Division, which has a procurement portion of 60% due to the implementation of a centralized procurement system since August 2021. Procurement centralization is expected to increase the potential for cost efficiency in the procurement of goods and services. Identification and mapping of business processes will be carried out based on the SCOR model followed by measurement of the centralized procurement performance of the SCM Division which will be focused on measuring the performance of SCOR Levels 1 and 2. The performance measurement of the SCM Division will be compared with historical data during the centralization of procurement, namely 2021 to 2022 and compared to corporate targets for the SCM Division. From the business mapping of the SCM Division as the procurement center for the Project, three level-1 performance metrics and five level-2 metrics were found. Reliability performance shows that the SCM Division fulfills 100% procurement requests from projects since procurement centralization began. Responsiveness performance is obtained by a trend of increasingly long cycle times. Agility performance has an increasing trend, as well as cost performance. Asset management performance shows that the company has experienced a decrease in efficiency in managing costs but is not in a state of loss. From the results of performance measurements during the start of procurement centralization in the company, the strategic target was not achieved so it needs to be studied more deeply to find improvements or changes to procurement authority if necessary.

Keywords: Construction, Supply Chain, SCOR, Performance Measurement, Procurement

1. INTRODUCTION

In recent years, the application of supply chain management (SCM) theory to the construction industry has been seriously investigated as an efficient and effective management strategy to improve performance in the construction industry (Shen, and Y.Wang, 2005). Construction companies need to manage and integrate internal and external stakeholders in order to achieve sustainable business processes so as to increase productivity, quality, efficiency, innovation, and survival in the market. To find out whether the ongoing business processes are appropriate and efficient, performance measurement is needed. This study discusses the supply chain process in the construction company PT Waskita Karya (Persero) Tbk.

In a few years, Waskita managed to grow from a contractor to become one of the largest toll road investors in Indonesia with a total concession ownership of 843 km as of September 2022. Along with these developments, in 2015 to 2018 Waskita managed to record a significant positive performance in which Waskita's revenue grew more than tripled, from IDR 14.153 trillion to IDR 48.789 trillion. This increase occurred thanks to Waskita's role in working on National Toll Road projects, especially on the islands of Java and Sumatra to improve connectivity infrastructure in Indonesia. Rapid business development has consequences for increasing business risks that must be faced by Waskita. Some of the projects undertaken by Waskita are internal business development projects with a turnkey scheme that require quite a large amount of funds because the entire process from start to finish, from design, construction, procurement, to operation of the project is carried out and funded by Waskita. The financial burden that must be borne by Waskita is getting bigger so it affects the Company's liquidity. Delays in several tenders for government infrastructure projects have resulted in a decrease in the Company's productivity, resulting in losses being recorded.

Fig. 1 Waskita Business Income

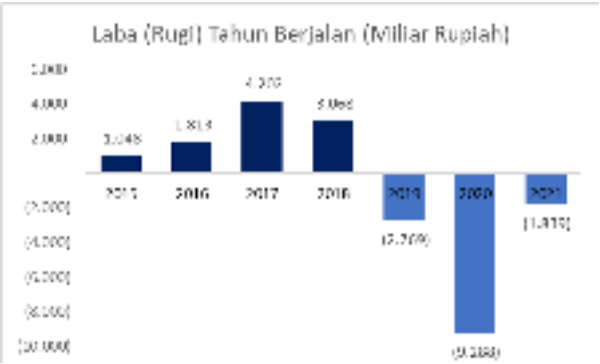

Fig. 2 Waskita Net Profit (Loss)

Unstable financial conditions can affect Waskita's business continuity. This can cause the Company difficulties in meeting financial obligations and maintaining the quality of work. These conditions can also reduce customer trust in the Company, which in turn can reduce the Company's revenue and profits. Therefore, Waskita is trying to restore its financial stability by restructuring. Restructurisation of Waskita's finances was carried out through the "8 Health Streams" program Waskita Finance" with the purpose of accelerating the restructuring process with more process control goods through the distribution of more specific health streams. Healing *stream* Waskita's finances consist from:

a. Core segment divestment toll,
b. Guarantee government on bonds and loans,
c. Restructurisation debt to Waskita's holding company,
d. Restructuring of the Waskita subsidiary,
e. Completion of project road toll special,
f. Participation,
g. Transformation of Business, and
h. Application governance and management guidelines risk.

Waskita is committed to implementing good governance and strives to identify and mitigate business risks that arise in business management. The implementation of governance and risk management guidelines refers to the decision of the Waskita Directors, which explains the 10 procedures that must be applied, one of which is the ‘centralization of procurement’ carried out in the SCM division. The implementation of centralized procurement of goods and services has two

main targets. The first is the target of achieving contracts implemented by the SCM Division of 60% of Waskita's total procurement. The second target is to achieve a cost efficiency of 2% of the planned procurement budget. after 1 year of ongoing procurement centralization, the two targets were not achieved, namely the total procurement carried out by the SCM Division was 57.47% with a cost efficiency of 1.83%. During the start of procurement centralization, the company had never conducted an assessment/evaluation of its supply chain processes. In this study, SCM division performance will be measured using the SCOR method. The benefits and advantages of the SCOR model in this study are that SCOR has the ability to integrate business processes and best practice analysis with company supply chain mapping. In addition, the SCOR model continues to evolve and continuously develop metrics within it flexibly according to the needs of each supply chain. Unstable financial conditions can affect Waskita's business continuity. This can cause the Company difficulties in meeting financial obligations and maintaining the quality of work. These conditions can also reduce customer trust in the Company, which in turn can reduce the Company's revenue and profits. Therefore, Waskita is trying to restore its financial stability by restructuring.

2. LITERATURE REVIEW

2.1 Supply Chain Performance Measurement

Supply Chain Performance Measurement According to Ruky (2001) performance measurement is to compare the results actually obtained with those planned, in other words, the targets that have been targeted must be examined to what extent the achievements have been carried out to achieve the goals.

Performance measurements and metrics have an important role to play in setting goals, evaluating performance and determining actions for future programs (Gunasekaran, 2004). To improve company performance, it is necessary to implement a supply chain management strategy. Information sharing, long term relationship, cooperation and process integration are part of the factors that affect the performance of supply chain management. Companies need to pay attention to information sharing as a basis for implementing supply chain management. the long term relationships that can provide a competitive advantage to companies. Performance measurement using SCOR is able to measure the company from upstream to downstream. This is what makes SCOR superior to other methods that tend to measure company internals only.

2.2 SCOR

The Supply Chain Operations Reference (SCOR) is a model for measuring performance, SCOR is a supply chain reference model based on process. This model integrates three main elements in management, namely business process reengineering, benchmarking, and process measurement into a cross-functional framework in the supply chain. SCOR is also considered a standard that describes processes, performance metrics, implementation and use of supply chain technologies. This requires a comprehensive methodology to improve supply chain performance operations.

The Supply Chain Operations Reference (SCOR) is a product of APICS following the merger between the Supply Chain Council and APICS in 2014. The SCOR model was established in 1996 and is regularly updated to adapt to changes in supply chain business practices. SCOR remains a powerful tool for evaluating and comparing supply chain activities and performance.

SCOR captures the consensus view of supply chain management. It provides a unique framework that links business processes, metrics, best practices, and technologies into an integrated structure to support communication among supply chain partners and to enhance the effectiveness of supply chain management and related supply chain improvement activities.

The APICS member base represents a wide range of industries, including manufacturers, distributors and retailers. The extensive APICS network also consists of technology suppliers and implementers, academia, and government organizations participating in APICS activities and the development and maintenance of the SCOR model

APICS is interested in providing the widest possible deployment of SCOR due to its broad use of models enabling communication using common definitions and metrics, resulting in better customer-supplier relationships, software systems that better support members through the use of common metrics and terms, and the ability to quickly adopt common practice.

The SCOR model has been developed to describe the business activities associated with all phases of satisfying customer demand. The model itself contains several tabbed sections and is organized around the six main management processes Plan, Source, Make, Deliver, Return, and Enable. By describing supply chains using these process building blocks, models can be used to describe very simple or very complex supply chains using a common set of definitions. As a result, different industries can be linked to describe the depth and breadth of almost any supply chain.

This model has successfully described and provided a basis for supply chain improvement for global projects as well as site-specific projects.
SCOR has been developed in terms of determining work indicators for supply chain management and structured implementation by looking at the customer and internal aspects of the company. Based on several facts in the field, it is very appropriate if SCOR is used as a reference for determining work indicators in measuring construction supply chain performance.
SCOR divides the supply chain into five processes, namely plan, source, moke deliver, return, and enable. These five processes function as follows :
1. Plan, is the core and guideline for supply chain management. The goal of the plan process is to determine needs and agree on effective actions to achieve supply chain objectives.
2. Source, is the process of ordering, sending, receiving, and transferring customer orders which can be in the form of raw materials or finished goods/services. The procurement or sourcing process includes activities that link an organization with its suppliers/subcontractors.
3. Make, the process of adding added value to products through mixing, separating, forming, processing, or other technical processes.
4. Deliver, this process carries out order management from goods/service providers to users/customers.
5. Return, is the process of returning/rejecting/transferring the goods/services back to the goods/services provider to handle product deficiencies/damages/defects to be repaired.
6. enable
is a process that enables suppliers and customers to carry out supply chain activities both internally and externally

As for the five SCOR dimensions for performance indicators that will be combined in a company as a strategy to choose which one is efficient to run the supply chain include:

1. Reliability
2. Responsiveness
3. Agility
4. Costs
5. Assets

2.3 Application SCOR Model at Company

Fig 3. Supply Chain at Waskita

3. METHODS

This research is a type of qualitative research that uses a combination of Supply Chain Operating Reference (SCOR) and in-depth interview. The initial stage in this research is to identify the supply chain process of centralization of procurement which is currently run by SCM Divisions at company. The data collection process begins with mapping the existing business processes in the SCM Division. Business process mapping will be carried out by means of in-depth interviews with stakeholders in the company. the interview results will be compared with the existing processes in the SCOR Processes so that the business process flow is in accordance with the SCOR. Furthermore, quantitative data collection was carried out using company data starting from September 1, 2021 to September 30, 2022. The data collected was in the form of operational production data, sales and company financial data.

Determine parts of existing business processes and then proceed to create supply chain performance indicators that are in accordance with SCOR performance. At this research stage, the divisions of the SCOR Level-1 and Level-2 hierarchies will be determined. If necessary, the determination of parts will be carried out until the process is at Level-3.

Next is the analysis stage. This stage looks at which processes affect the performance of the SCM Division's supply chain and it is hoped that the results of this research can find the root causes of existing problems. At this stage, data visualization will be used to clarify problems and is expected to present solutions that can be applied to improve the supply chain performance of the SCM Division. The results of this research are expected to become a basic foundation for the SCM

Division in carrying out process improvements as well as a reference for measuring supply chain performance for projects in Business Units.

4. RESULTS

Performance measurement outcomes shown in this table below:

Atribut Kinerja	Level-1	Level-2	2021	2022
Reliability	RL 1.1 - Perfect Order Fulfillment	RL2.1 %of *Orders Delivered in Full*	97,78%	91,47%
		RL2.2 *Delivery Performance to Customer Commit Date*	64,32%	54,23%
Responsiveness	RS. 1.1 - Order Fulfillment Cycle Time	RS2.1 *Source Cycle Time*	24 hari	27 hari
Agility	AG. 1.3 – Overall Value at Risk	AG. 2.9 – Supplier's Risk Rating	13,86%	31,96%
		AG. 2.11 – Value at Risk (Source)	9,09%	11,22%
Cost	CO.1.1 - *Total Supply Chain Management Cost*		2,390 T	5,646 T
	CO.1.2 – *Costs of Goods Sold*		2,346 T	5,554 T
Asset Management Efficiency	AM.1.3 - *Return on Working Capital*		1,83%	1,63%

5. CONCLUSIONS

Based on the results of the research and discussion in the previous chapter, several conclusions can be drawn.

1. The SCOR model is a good and effective reference for measuring the performance of a company's supply chain, including construction companies, especially in the SCM Division by conducting research using diagnostic methods for measuring supply chain performance to help companies make real improvements to their supply chain processes.
2. Based on the results of supply chain performance measurement analysis using SCOR, the SCM DIVISION has not yet achieved the company's strategic goals with two targets that cannot be achieved, namely the portion of procurement by the SCM Division which has not reached 60% and the recording of procurement efficiency has not reached 2%. These two problems can be answered by looking at the Responsiveness attribute. Both metrics, namely fulfillment time and procurement time, have decreased due to internal and external problems, namely:

a. Constraints during PR creation

b. Budget constraints exceeded
c. There are procurements that need material approval, for example, such as the procurement of asphalt, expansion joints, and guardrail. So that the procurement time is long because it is waiting for the results of laboratory testing to get approval from the project quality control.
d. Material/service specifications change due to adjustment of existing conditions or requests from project providers.
e. Workplace readiness.
f. Vendors who are able to participate in tenders are still some who have not become selected partners, so it takes longer time to process them to become selected partners while the procurement process continues.
3. According to the problem in point 2 above, procurement data is obtained with which the procurement authority in the SCM Division should be held by the project itself in order to achieve the right lead time of 14 days so that the procurement target in SCM is not achieved.

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UNDERSTANDING THE FACTORS THAT INFLUENCE THE PURCHASE INTENTION ON BATTERY ELECTRIC VEHICLE (BEV)

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ABSTRACT

The interest of the citizens of the Republic of Indonesia in purchasing battery electric cars is above the ASEAN average. Sales of battery-based electric cars (BEV) in Indonesia from 2020 to 2022 will reach 876 units. Despite recording sales growth, the scope of this BEV is still very low when compared to oil-fueled cars. The percentage of BEVs sold was not even more than 0.5% in each of those years. The purpose of this study was to analyze the effect of functionality, cost, technology, emotions, and environmental awareness on BEV purchase intention. Based on these data, This type of research design is explanatory with a quantitative approach and obtained a total of 250 respondents aged 24-60 years who have known or used BEV and used purposive sampling. This study aims to influence functionality, cost, technology, emotions, and environmental awareness on BEV purchase intentions using The Structural Equation Model (SEM) and Partial Least Square (PLS) methods. The results of this study indicate that the variables functionality, technology, environmental awareness, and emotions have a positive value and have a significant effect on purchase intention with a T statistic greater than 1.96. Meanwhile, the cost variable has a positive value but does not have a significant effect on purchase intention with a statistical T value of 1.746.

Keywords: Purchase Intention, Battery Electrical Vehicle (BEV), SEM-PLS, Technology.

1. INTRODUCTION

In the current era, the emergence of battery electric vehicles (BEV) cannot be avoided. battery electric vehicles (BEV) have been intensively introduced in several countries, but the adoption rate of electric vehicles is still very low. In the global market, ownership of BEV variant electric cars in the 10 years from 2010 to 2019 has a significant trend annually, the following is a table of BEV electric car use in the world.

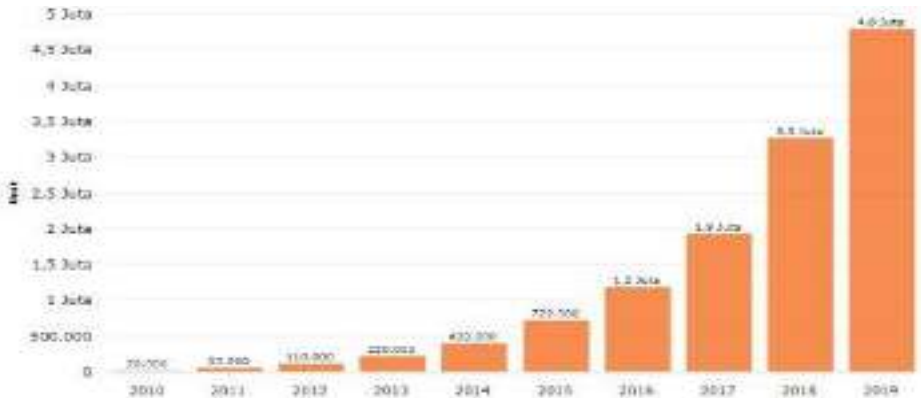

Figure.1Trends in World Electric Car Ownership (Source: *International Energy Agency*, 2020)

Based on data from the Association of Indonesian Automotive Industries (Gaikindo), in 2019 Indonesia sold BEVs increased to 687 units. Despite recording sales growth, the coverage of electric cars is still very low when compared to oil-powered cars. The percentage of electric cars sold was not even more than 0.5% in each of these years (Pahlevi, 2022)

The Indonesian government has issued Government Regulation No. 55/2019 to accelerate the development of the electric vehicle business ecosystem. This ecosystem will include charging station infrastructure, nickel raw material providers, battery manufacturers, component makers, and electric car (BEV) assemblers/producers. The government again raised fuel prices as of September 3, 2022 to reduce the burden of energy subsidies (Sari, 2022). The issuance of Presidential Decree No. 55 of 2019 triggered motor vehicle manufacturers in Indonesia to launch their electrification products and of the several types of existing electrification technology.

The Ministry of Transportation continues to carry out massive campaigns for the use of electric vehicles for the public. This is done in order to find out more targeted markets for electric car sellers. Therefore, this research was conducted to determine the interest in buying an electric car in terms of functionality, cost, technology, emotions and environmental awareness.

This research is expected to provide managerial implications for the automotive industry to find out what values the potential community wants to get both in terms of benefits and risks that hinder the intention to purchase electric cars. In addition, this study aims to support the government in implementing electric cars and to help analyze people's interest in buying electric cars. By knowing this value, the automotive industry can develop the right marketing strategy for potential people who are willing to buy battery electric vehicle (BEV)

2. LITERATURE REVIEW

This research was conducted to determine the factors that influence the decision of the purchase intention of electric car consumers. Okada et al (2019) in their research on electric vehicles in Japan concluded that environmental awareness has a direct effect on the purchase intention of non-electric vehicle users. An increase in environmental awareness will lead to an increase in purchase intention. Regarding the demographics of the respondents, age significantly influences environmental mental awareness and evaluation of electric vehicles. Gender is also significant, and the data shows that men have higher evaluations of electric vehicles but lower environmental awareness. Household income has no significant effect on environmental awareness. Conversely, driving time data can shed light on environmental awareness. Nopers et al. (2014) in Okada et al (2019) insist that environmental attributes are important, and people are motivated to adopt sustainable innovations, such as electric vehicles, because of their environmental benefits. Zhang et

al (2020) also showed that tourists' environmental awareness has a significant and positive effect on the intention to buy pure electric vehicles. Likewise, Yuniaristanto et al (2022) show that a person's level of environmental awareness has a significant influence on the intention to buy a battery electric vehicle in Indonesia.

Febransyah's research (2021) states that the intention to buy an electric car is influenced by several criteria, namely emotion, functionality, car identity and cost of ownership. There are two main factors that determine the success of a new product, namely motivational factors and obstacles. Customers will be motivated by product benefits and price. The more benefits offered at an affordable price, the greater the chance of success of the product. New product success can occur if the product offers ease of use and high availability in the market. To motivate potential buyers in the automotive market, manufacturers offer various product advantages such as technology and attractive car appearance at affordable prices, both in terms of purchase costs and maintenance costs.

2.1 Consumer behavior

According to Shiffman, et al (in Tjiptono, 2014), consumer behavior is behavior that consumers pay attention to in finding, buying, using, evaluating and ignoring product services or ideas that are expected to satisfy consumers to be able to satisfy their needs by consuming the products or services offered.

2.2 Functionality

Functionality variables are factors that describe the uses and benefits one gets when using a product according to Ziefle et al (2014). The variable functionality indicators in this study refer to Febransyah (2021), which includes performance, convenience, security, seating apacity, baggage capacity

2.3 Costs

The costs associated with electric cars according to She et al., (2017) in Yuniaristanto et al (2022) are:

1. High purchase price

The purchase price is the original price of the electric car without purchase subsidies. Sier zchula (2014) said that a high battery capacity causes a high purchase price for electric cars.

2. Lack of understanding of fuel costs

Charging costs are the cost of electricity to start an electric car compared to gasoline. Electric vehicles have the advantage of lower fuel costs (Browne et al., 2012; Sang & Bekhet, 2015).

3. High cost of battery charge

Battery charge is the replacement of the battery when the old battery's life has run out. In Kim et al., (2018) the cost of batteries is a financial barrier to adopting electric vehicles

4. Main rental fee

The main rental fee is an obligation that must be paid to property owners who have lent assets for an interest (Timomor, 2022).

5. Maintenance costs

Maintenance costs are routine maintenance costs for electric vehicles, excluding repairs due to accidents that affect the adoption of electric vehicles. Uncertainty about maintenance, service and facilities for repair is an important factor that hinders the adoption of electric vehicles (Egbue & Long, 2012; Sovacool & Hirsh, 2009).

2.4 Technology

The ability to travel is the farthest distance traveled after the electric car battery is fully charged (Guerra, 2019; She et al., 2017). Power is the maximum speed of an electric vehicle. In (Egbue & Long, 2012; Guerra, 2019), they found that top speed and charging time were barriers to widespread adoption of electric vehicles. Charging time is the total time to fully charge an electric vehicle. The feeling of safety when driving an electric vehicle related to sound (dB) is a factor that influences consumer perceptions of electric vehicles (Sang & Bekhet, 2015; She et al., 2017). In (Graham-Rowe et al., 2012; Habich-Sobiegalla et al., 2018), battery life is considered to be decreasing.

2.5 Emotion

Emotions are one of the most important factors influencing the intention to buy pro-environmental products such as electric cars (Oliver & Rosen, 2010; Febransyah, 2021). According to Febransyah (2021), the emotional variable has two indicator sub-criteria, namely personal and social. The emotional criteria provide an explanation that electric car users want profit or value from the vehicles they use. These benefits have personal and social dimensions (Pimenta & Piato, 2016). The personal benefits of using an electric car are felt by the driver himself, such as pleasure, pride and negative shame (Schiutema et al, 2013). Social benefits are obtained if electric vehicle users can express and show their identities to others (Cui et al, 2022).

2.6 SEM (Structural Equation Modelling)

The research model that will be used in this study is a hierarchical structure model, and to test the proposed hypothesis the SEM (Structural Equation Modeling) analysis technique is used through the partial least squares procedure. The rationale for the proposed use of SEM is that SEM is a set of statistical techniques that allows a relatively "complex" set of relationships to be tested simultaneously. Modeling through SEM also allows researchers to answer research questions about regression and dimensions (ie, what are the dimensions of the measurement concept) (Ferdinand, 2014). Analyzing the research model with SEM can determine the dimensions of a construct as well as measure the level of influence or relationship between the factors of the identified dimensions.

The advantage of SEM in management research lies in its ability to identify the dimensions of concepts or factors that are very commonly used in management, and its ability to measure the impact of theoretical relationships (Ferdinand, 2000: 5). In addition, AMOS (Arbuckle, 1997) was used in this study because of its ability to: 1. Estimate the unknown coefficients of the structural equation lr 2. Include a model with latent variables 3. Include errors of measurement (errors) of the dependent and independent variables 4. Measuring the direct and indirect effects of the dependent and independent variables 5. Contains reciprocal, simultaneous and interdependent causal relationships.

3. METHODS

3.1 Survey Design

Research design is a research design that is used as a guide in carrying out the research process. The research design aims to provide a clear and structured guide to researchers in conducting their research. This research is explanatory with a quantitative approach. In this sampling technique the authors use a purposive sampling method (purposive sampling). Purposive sampling is a sampling technique with certain considerations. Where the criteria for this research sample are between 24 to 60 years of age and have an interest in buying a BEV

3.2 Survey Process

The data collection technique used in this study is to use a questionnaire. And if it is not possible to meet in person, the researcher will provide a questionnaire/questionnaire which is distributed via the Google form link made by the researcher. A total of 250 people responded to the survey from January 2 to January 9 2023. The process of distributing the questionnaire used a Google form which was distributed on various social media with the help of colleagues and family. The filtering system for distributing the questionnaire was provided at the outset with options that could only be selected according to the limitations. Although the survey method allows for a quick collection of 250 respondents, the sample is not representative of the population as a whole. Specifically, it includes more male, younger respondents.

4. RESULTS

4.1 Data Sample

Table 1. Responden Data

Characteristic	Classification	Responden	Percentage (%)
Gender	Man	164	65,6
	Woman	86	34,4
	Total	**250**	**100,0**
Age	24 – 30 Tahun	135	54,0
	30 – 40 Tahun	37	14,8
	> 40 Tahun	78	31,2
	Total	**250**	**100,0**
Job	Student	23	9,2
	Enterpreneur	30	12,0
	Employee	101	40,4
	Housewife	9	3,6
	PNS/POLRI/TNI	48	19,2
	Lainnya	39	15,6
	Total	**250**	**100,0**
Last Education	JHS	1	0,4
	SHS	20	8,0
	Diploma	12	4,8
	Bachelor Degree	157	62,8
	Master Degree	46	18,4
	Others	14	5,6
	Total	**250**	**100,0**
Have or still own car	Yes	154	61,6
	No	96	38,4
	Total	**250**	**100,0**
Know BEV	Yes	**235**	**94,0**
	No	**15**	**6,0**
	Total	**250**	**100,0**
Have Experience used BEV	Yes	31	12,4
	No	219	87,6
	Total	**250**	**100,0**
Factor to consider purchase BEV	Price	**116**	**46,4**
	Technology	**67**	**26,8**
	Environmentally Friendly	**67**	**26,8**
	Total	**250**	**100,0**

Based on the results of distributing questionnaires to 250 users who wish to use electric cars (BEV), the majority of respondents were male (65.6%), and the rest were female (34.4%). In terms of age, it shows that the majority of users who want to use an electric car (BEV) are aged 24-30 years (54.0%), > 40 years (31.2 %) and the remaining users who want to use electric cars aged 30-40 years (14.8%). From the jobs they have, the majority of users who want to use electric cars have private employee jobs as many as 101 people (40.4%), PNS/POLRI/TNI jobs as many as 48 people (19.2%)), other jobs are 39 people (15.6%), self-employed jobs are 30 people (12.0%), student/student jobs as many as 23 people (9.2%) and housewife jobs as many as 9 people (3.6%). Based on recent education, the majority of users who wish to use an electric car (BEV) have a Bachelor's degree as many as 157 people (62.8%), Master's degree as many as 46 people (18.4%) , high school education are 20 people (8.0%), other education are 14 people (5.6%), users who want 12 people (4.8%) use an electric car (BEV) with a recent diploma and the remaining users who wish to use an electric car (BEV) with a junior high school education are 1 person (0.4%).

Based on whether or not the respondents owned a car, the majority of respondents stated that they had owned a car as many as 154 people (61.36%) while the remaining users who did not own a car were as many as 96 people (38.4%). Regarding respondents who know electric cars (BEV), the majority of users who want to use electric cars (BEV) already know about electric cars, namely as many as 235 people (94.0%), who do not know about electric cars (BEV), namely as many as 15 people (6.0%). Based on whether or not the respondents used an electric car, the majority of users who wanted to use an electric car (BEV) gave an answer of never as many as 219 people (87.6), while the rest were users who had used an electric car (BEV) with an answer of 31. people (12.4%). Based on the consideration factor for buying an electric car, the majority of users who want to use an electric car give consideration to the price factor as many as 116 people (46.4%) while the rest are balanced between users who want to use an electric car giving consideration to the price factor as many as 67 people (26.8 %) and users who wish to use an electric car give consideration to the Environmentally Friendly factor as many as 67 people (26.8%).

4.2 Model

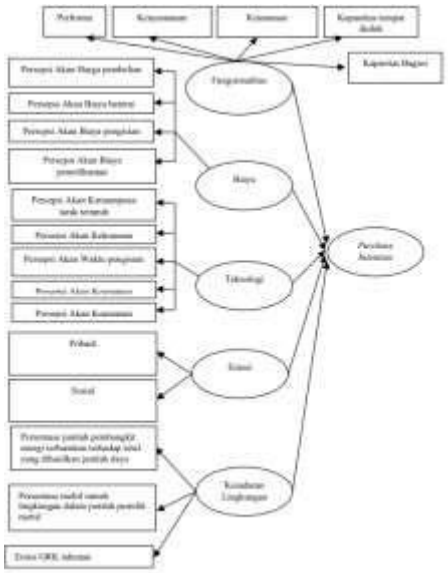

Figure 2. Research Model

4.3 Result and Discussion

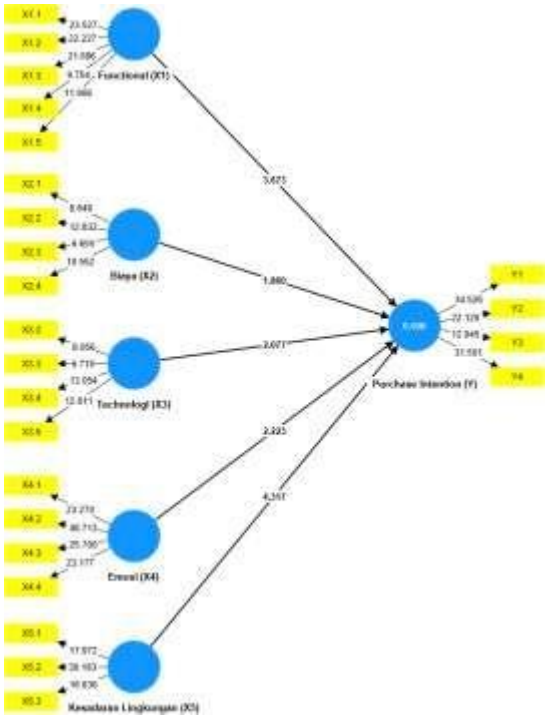

Figure 3. Boostrapping PLS

Functionality (X1) has a significant influence on Purchase Intention (Y) because the statistical T value is 3.673, which means greater than 1.96. Cost (X2) has no significant effect on Purchase Intention (Y) because the T statistic value is 1.860 which means it is smaller than 1.96. Technology (X3) has a significant influence on Purchase Intention (Y) because the T statistic value is 2.077, which is greater than 1.96. Emotions (X4) have a significant influence on Purchase Intention (Y) because the statistical T value is 2.223 which is greater than 1.96. Environmental Awareness (X5) has a significant influence on Purchase Intention (Y) because the statistical T value is 4.317 which means greater than 1.96.

6. CONCLUSIONS

Based on the analysis that has been done, several conclusions can be drawn as follows:

1. The results of the influence of functionality, cost, technology and emotions on the purchase intention of electric cars (BEV) have a significant influence but the initial hypothesis is rejected for the cost. The following is a description of each variable:

a. Functionality has a significant positive effect on the Purchase Intention of electric cars. These results indicate that the first hypothesis "Functionality has a significant effect on Purchase Intention", can be declared accepted and proven true.
b. Price has a positive significant effect on the Purchase Intention of electric cars. These results indicate that the second hypothesis "Price has a significant effect on Purchase Intention", can be declared rejected and not proven true.
c. Technology has a significant positive effect on the Purchase Intention of electric cars. These results indicate that the third hypothesis "Technology has a significant effect on Purchase Intention", can be declared accepted and proven to be true.

d. Emotions have a significant positive effect on the Purchase Intention of electric cars. These results indicate that the fourth hypothesis "Emotion has a significant effect on Purchase Intention", can be declared accepted and proven to be true.

2. Environmental Awareness has a significant positive effect on the Purchase Intention of electric cars. These results indicate that the fifth hypothesis "Environmental Awareness has a significant effect on Purchase Intention", can be declared accepted and proven true.

Managerial Implications of this research are:

1. The results of the survey and data processing of environmental awareness have a significant and acceptable positive effect. The most prominent indicator is reducing exhaust emissions in Indonesia. However, the indicator that has the lowest value is using renewable energy. Therefore, this can be a concentration for distributor companies to socialize more about renewable energy. Because this will be interconnected and many people will not know about the development of renewable energy from electric cars (BEV).
2. The results of the research variable costs have a significant positive effect but cannot be accepted hypothetically. Many people only understand the purchase price of an electric car (BEV). However, regarding incentives from the government, much has not been conveyed. Therefore electric car distributor companies (BEV) can synergize more with the government to provide an understanding to the public that in terms of costs there are incentives from the government for electric cars (BEV).

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IMPROVING CUSTOMER EXPERIENCE IN THE FINANCIAL INDUSTRY IN FACING INDUSTRY 4.0 THROUGH THE DEVELOPMENT OF INDONESIAN CHATBOT APPLICATIONS

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ABSTRACT

Digital channel chatbot services for Wuzz products at CEODE Bank are not yet available.The purpose of this research is to develop Indonesian-language chatbots that can handle formal and non-formal language styles in order to get a better customer experience about Wuzz products. This chatbot uses a corpus-based methodology that combines machine learning and NLP techniques; for corpus generation, customer handling conversation data is used. The Success Rate answering queries and user satisfaction with communicating with the chatbot are the desired outcomes. Five volunteers participated in the chatbot testing, each of whom received 30 question topics—10 formal and 20 non-formal. Out of a total of 150 questions, 107 answers were labeled “Appropriate & Relevant" giving a success rate of 72.0%. For formal language style giving 68.0% and 75.0% non-formal style, respectively, the questions were effectively answered. The success percentage was 77.3% (116 questions) with Statisfactory responses, 22.7% with unsatisfactory answers. According to all analysis, there is potential to strengthen the statement that the use of chatbots can enhance the customer experience due to the very strong correlation between customer satisfaction and the relevance of chatbot accuracy in answering questions, which is very strong at 0.883 and significant at the 0.01 level.

Keywords: Contact Center, Customer Experience, Chatbot, Corpus, Natural Language Processing and Machine Learning, Customer Satisfaction.

1. INTRODUCTION

In Indonesia, almost 64 percent of the people are connected to the internet network, based on research conducted by social media platforms Hootsuite and We Are Social in the 2020 global digital report (Kemp, (2020)). The young population is a potential for the Indonesian people to further develop in the world of digital technology because the majority of users are young people or often called the millennial generation. This became a pull factor for CEODE bank by launching its first digital service in March 2015, named WUZZ. On the other hand, it acts as a push factor

when core revenue from the main business begins to correct due to the tight competition in the banking business (Bank CEODE (2016)), (Bank CEODE (2017)).

On the other hand, referring to a survey conducted by Deloitte in the article Accelerating digital transformation in banking October 2018 Deloitte (2018). Reveals a fact called the digital-emotional connection where the results of cluster analysis confirm a positive relationship between digital use and emotional involvement in three different consumer segments, namely traditionalists, online-embracers, and digital adventurers. Traditionalists comprise 28% of the sample, online embracers are 43%, and digital adventurers are 28% of the sample. Millennials have the highest share of adventurers compared to other segments. the group exclusively uses mobile and online channels for their banking activities. digital adventurers indicated the highest levels of satisfaction for their preferred bank and also generally expressed deeper emotions (would most likely recommend).

Banks can position chatbots as a tool so consumers can stay connected directly to bank representatives on mobile applications. This is a good starting point where this segment expects more real-time problem solving in digital banking channels so that it can improve customer experiences better (Deloitte (2018)), where customer experiences are experiences that customers gain through a long process of interaction. with the company both functionally and emotionally in various channels provided by the company (Klaus & Maklan (2013)). In addition, it shows that understanding the process of creating customer experience in the retail business is important which is formed from many independent touch points or contact points during the transactional journey (Srivastava & Kaul, 2016).

2. LITERATURE REVIEW

In principle, chatbots are a combination of Natural Language Processing (NLP) and Machine Learning, both of which are part of Artificial Intelligence, where computer programs are designed to simulate fairly intelligent conversations between computers and humans, both in voice and text. (Pelk, 2017). There are several types of chatbots, namely rule-based chatbots and corpus-based chatbots. Corpus is a collection of machine-readable text obtained naturally or designed with communicative settings. Corpus is the knowledge base of a chatbot.

2.1. Rule-based chatbots

This chatbot does not have any machine intelligence or learning algorithms, it only checks the text for certain keywords, then assigns values to those keywords, and then turns the input into output. This chatbot works by having a series of regular expression substitutions that each match some part of the input line and change it.

2.2. Corpus-based chatbots

The development of this algorithm cannot be separated from the development of a corpus-based chatbot, which is the development of a manual way to imitate human conversation as naturally as possible. This system is the development of a data-driven model dialogue system that requires intensive data through data training in an end-to-end process (Serban, et al., 2015). This mechanism is also corroborated by (Hancock, et al., (2019)). However, after this chatbot is implemented, next is the saved chatbot conversation data which can be used to train data or find the ideal conversation setting. Most corpus-based chatbots generate responses to user input according to the dialog context. Related to that most systems are one response loop or short conversation. This type of chatbot utilizes natural language processing and machine learning methods. This study will not test the chatbot's ability to produce the right response, but will only

provide the most relevant answer to the question (Krantz & Lindblom, (2017)). In its implementation it is also important to understand the principles of corpus design (Svetla Koeva, 2012).

2.3. Natural Language Processing (NLP)

There are many versions in the creation of the NLP flow process, but in general they contain the stages of data input, pre-processing, corpus creation, and the classification process, as illustrated in Figure 1. (Monica, 2020) is an example of the stages of NLP work that are commonly used, besides According to Poole & Mackworth (2010), there are 3 (three) main aspects of the theory of understanding natural language, namely syntax, semantics and pragmatics.

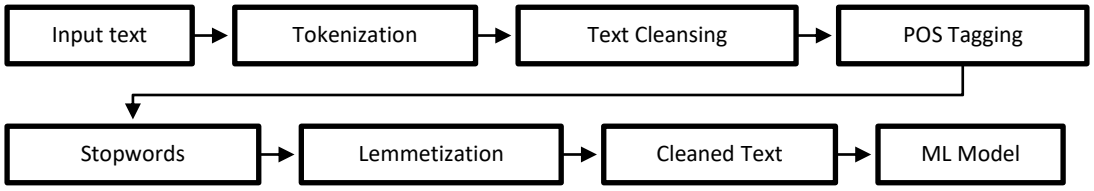

Figure 1. NLP Flow process (Monica, (2020)).

According to (Pustejovsky & Stubbs, 2013) the NLP method has been successfully used to implement Question Answering Systems, Document classification, Machine Translation, which can also be used in implementing chatbots. In this study only a few processes were used from all stages of work in NLP as shown in Figure 1, namely: tokenization, text cleansing, stopwords, stemming and normalization. The thing that needs to be considered at this stage is the stemming part to restore basic Indonesian words because must follow the correct Indonesian language rules regarding affixes (Adriani, M. et al., (2007)). Likewise for word normalization, it is the process of returning two or more words that have the same meaning according to Indonesian grammar. This process is appropriate in dealing with slang words, foreign languages or regional languages that are commonly used in everyday conversations, this is done to increase the accuracy value in the classification process. (Richard Sproat, 2001).

2.4. Feature Extraction

One of the most important things to know about corpus before we apply machine learning algorithms is the basic statistical profile of the words it contains. How can we automatically identify the words from the text that most determine the topic of a text or how can we know the general topic of a text. One simple method is to count the number of meaningful words that appear the most. The process of calculating how many words appear in a text is also called the frequency distribution, the simplest way is based on the frequency of each word that appears in a sentence or document or also called a "bag of words" (Waykole & Thakare, 2018). this is just general information about what types of topics can be observed (Bird, et al., (2009)).

2.5. Machine Learning dan Classification

The goal of Machine Learning is to uncover hidden patterns, unknown correlations between variables, and find useful information from a set of data. In addition, through combining with data analysis, machine learning can be used to perform predictive analysis (Bhatia & Yu-Wei, (2017)). One of the methods in machine learning is logistic regression which is a

discriminative classifier, where the discriminative model only tries to differentiate classes, if one feature separates classes well, then the model is fulfilled (Jurafsky & Martin, (2020)).

Classification is the task of identifying labels for one entity from a set of data, where the data is extracted to obtain basic information on the data which is then a pair of features (features set) and labels processed into machine learning algorithms to be used as a model, then in the prediction process, the same feature extractor is used to convert the input to be predicted into a feature set. This feature set is then fed into the model, which produces predictable labels as illustrated in Figure 2. (Bird, et al., (2009)).

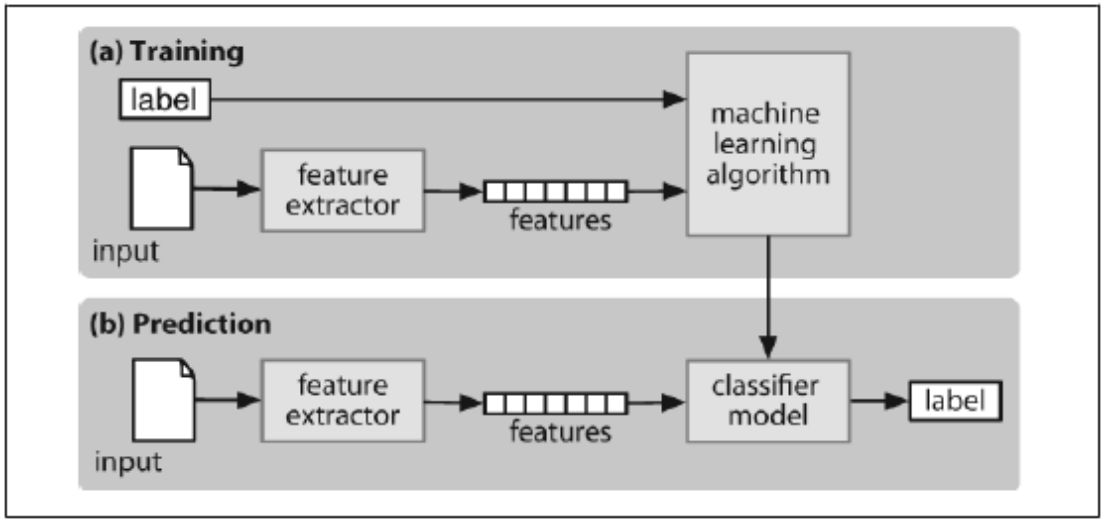

Figure 2. Classification diagram on supervised classification. (Bird, et al., (2009)).

3. METHODS

In this study, to gain customer experience related to chatbot usage satisfaction, an Indonesian-language chatbot application was first developed which is able to handle formal and non-formal sentences and create a corpus management system application, using PHP, Python and SQL Server tools, while the research methodology flow was developed as in Figure 3. At the data collecting phase, the data retrieval process is carried out, which is the process of retrieving data stored in the database. In this study the data used as a corpus (knowledge base) is data for the period Jan'16 – Apr'16 stored in the contact center system, with a total number of customer inquiries of 7,109 observations, the data is the conclusion of the conversation between the customer and the contact center officer which will later be used as a topic of questions, Discussions are held with the Contact Center team regarding the characteristics of the Customer's asking style when submitting a complaint to the Call Center and how the Contact Center team responds to the Customer, also studying Frequently Asked Question (FAQ) data, Observations are also made to review directly conversations that are usually carried out by the Contact Center team in serving customers in order to get a business sense from this business dialogue..

Furthermore, at the system design stage, an outline of the system design is carried out, namely, the Frontend Section includes the design of the chatbot application and the corpus management application; The Middle Service section includes the NLP flow process design used, machine learning design to obtain model classification accuracy values, direct answer responses, machine learning answer responses; The Backend section includes the corpus design as a knowledge base,

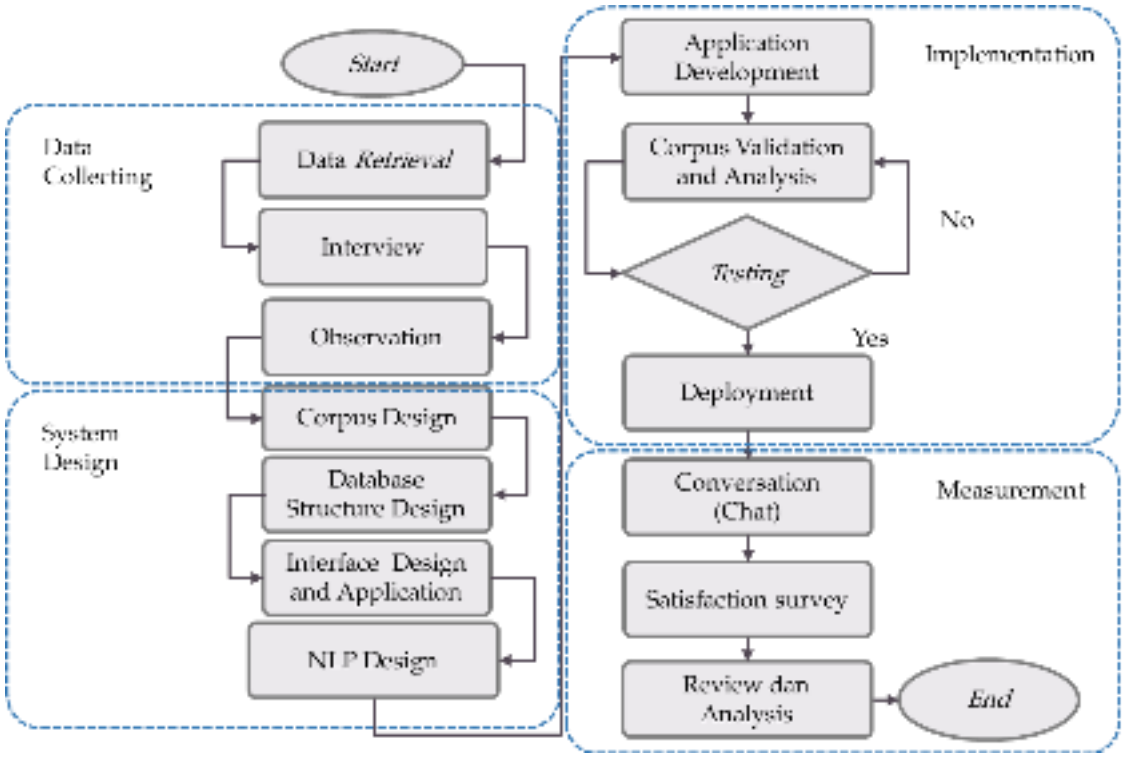

Figure 3. Research Methodology Flow.

where the corpus design includes a corpus of questions and corpus of answers with a corpus text format that will be processed by Natural Language Processing, namely:

Label@Text_Corpus_Question/Answer

Apart from that, a normalized word corpus, stopwords corpus, and watchwords corpus were also designed, and a database table was designed to accommodate customer conversations and a database table to accommodate corpus questions, answers, normalized words, stopwords and watchwords.

Next, in the Implementation stage, the application deployment includes the frontend, corpus testing and the accuracy value of the classification model (middle service) and backend, the overall implementation scheme is as shown in Figure 4, in this scheme input sentences from the chatbot application will be responded to in the middle service section, whether the response is a direct answer or a machine learning response, where in this study the classification model's accuracy value was 71.1%.

Whereas in the Measurement stage a chatbot conversation test was carried out by five volunteers who acted as customers, they were given 30 topic questions consisting of 10 formal question topics and 20 non-formal question topics about Wuzz products, where at the end of the conversation the chatbot will carry out satisfaction survey by asking about satisfaction in using this chatbot.

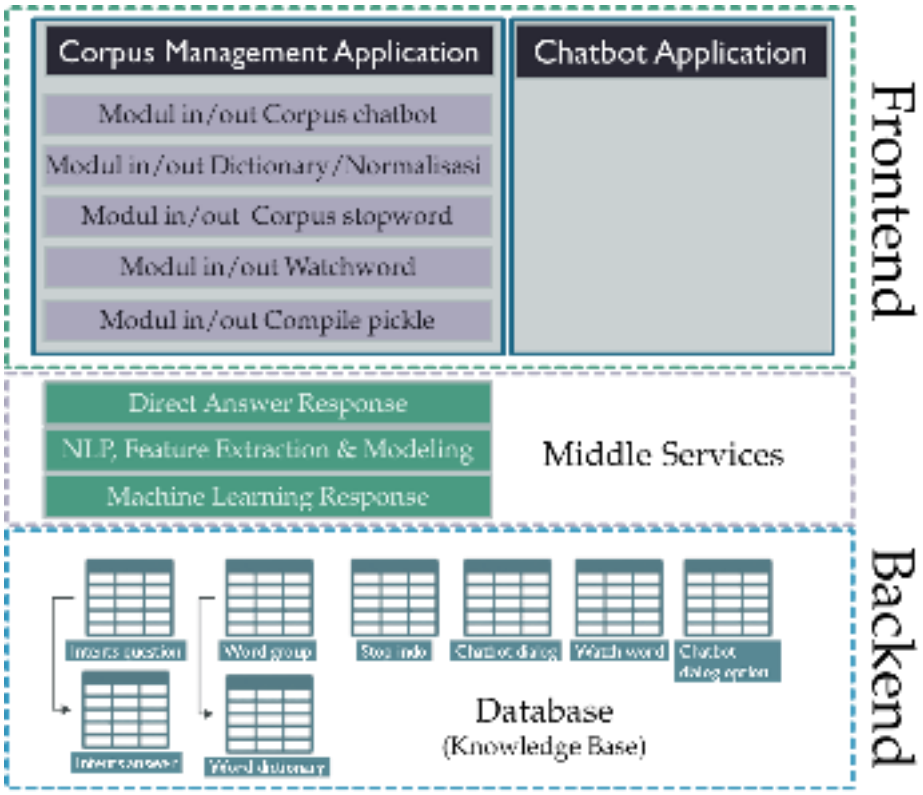

Figure 4. Chatbot System implementation scheme.

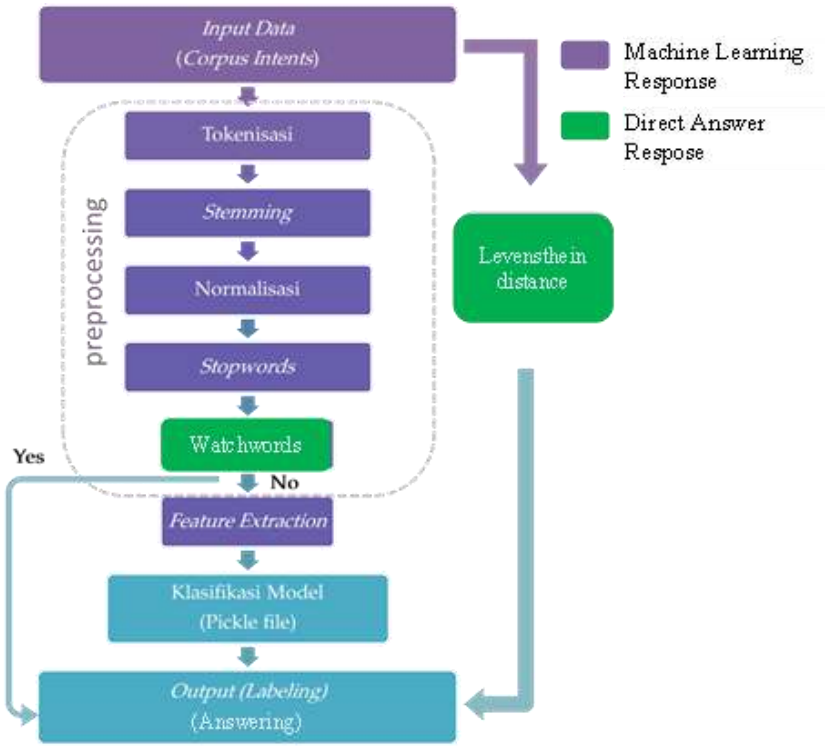

Figure 5. Chatbot Natural Language Processing scheme.

In this study the Natural Language Processing (NLP) scheme that was developed included processes of tokenization, stemming, normalization, stopwords as shown in Figure 5, and the Indonesian language stemming module that was used was the Sastrawi python library (sastrawi, 2017). In this scheme, if the Levensthein distance value between the input sentence and the corpus intent (knowledge base) is 0, it indicates that the two are similar, then a direct answer is given (direct answer response), if not, then the NLP process is carried out, then after the NLP process is fulfilled, before going to the feature extraction and classification stage, the question sentences are checked, if there is a blacklisted word, a direct answer response will be given, otherwise it will go directly to the feature extraction and classification process. This is done because according to (Haldar & Mukhopadhyay, (2011)) In the method of searching for words or sentences, there are several problems that need to be addressed, for example the more words, the more search time and complexity it will increase, in short sentences it is likely that it will not get enough according to context, and also very long sentences will increase search costs.

4. RESULTS

At this stage the volunteers were given 30 questions topic consisting of 10 formal questions and 20 non-formal questions about wuzz products. In formal questions, customers ask according to the grammar and non-formal questions are the opposite. Each question asked recorded the level of satisfaction.

4.1. Relevance status accuracy of answering customer questions

Table 1. Tabulation of answer accuracy based on Appropriate and relevance of answering questions.

Relevancy Status	Number of Question	*Success Rate* (%)
Appropriate & Relevant	107	72,0%
Inappropriate & Relevant	15	9,3%
Inappropriate & Irrelevant	28	18,7%
Total	**150**	**100%**

In Table 1, it can be seen that the ability of the chatbot to answer all questions correctly is 107 questions or 72.0% where this figure is close to the accuracy value of the model which is 71.1%, but there are still 15 questions or 9.3% which are not correct in answer but still fit the context of the answer, where this can be a consideration for customers in receiving chatbot answers.

4.2. Accuracy in answering customer questions regarding language style

Tabel 2. Accuracy in answering questions on language style.

Status	Number of Question	*Success Rate* (%)
Formal	**50**	**100%**
Appropriate & Relevant	34	68,0%
Inappropriate & Relevant	5	10,0%
Inappropriate & Irrelevant	11	22,0%
Non-Formal	**100**	**100%**
Appropriate & Relevant	75	75,0%

Inappropriate & Relevant	8	8,0%
Inappropriate & Irrelevant	17	17,0%
Total	**150**	100%

In more detail, when viewed from the side of formal and non-formal language styles, it shows that the chatbot has the same accuracy in answering both of these language styles, as shown in Table 2, namely for formal language style as many as 34 questions or 68% of the total 50 questions and for non-formal language style as many as 75 questions or 75% of the total 100 questions, while the success rate is lower in formal language style more due to inadequate corpus design for formal language style, because formal language style tends to be longer, this makes the word weight spread and results in a lower accuracy value, compared to non-formal sentences which are shorter and effective even though there are non-standard words but can be overcome by stop words and normalization.

4.3. Status of customer satisfaction with chatbot services

Furthermore, the level of customer satisfaction in chatbot services can be seen in Table 3, where the table shows a satisfaction level of 77.3% or as many as 116 questions can be served by the chatbot out of a total of 150 questions.

Tabel 3. Status of customer satisfaction with the chatbot services.

Satisfaction Status	Number of Question	Success Rate (%)
Satisfied	116	77,3%
Not satisfied	34	22,7%
Total	**150**	**100%**

Furthermore, when viewed from the relevance of answering and the level of satisfaction, it shows a strong relationship as shown in Table 4. Where as many as 109 answers were appropriate and relevant or 94% of all statuses were satisfied. Furthermore, there were 28 questions or 82.4% of the answers that were inappropriate and irrelevant from all Dissatisfied statuses.

Tabel 4. Status of satisfaction with the relevance of answers to the questions.

Satisfaction Status	Number of Question	Success Rate (%)
Satisfied	**116**	**100,0%**
Appropriate & Relevant	109	94,0%
Inappropriate & Relevant	7	6,0%
Not satisfied	**34**	**100,0%**
Inappropriate & Relevant	6	17,6%
Inappropriate & Irrelevant	28	82,4%
Total	**150**	**100,0%**

On the other hand, there are interesting things, namely for Satisfied status, there are 7 questions or about 6% with answers that are not appropriate but relevant, while for Dissatisfied status there are 6 questions or around 17.6% with answers that are not appropriate but relevant,

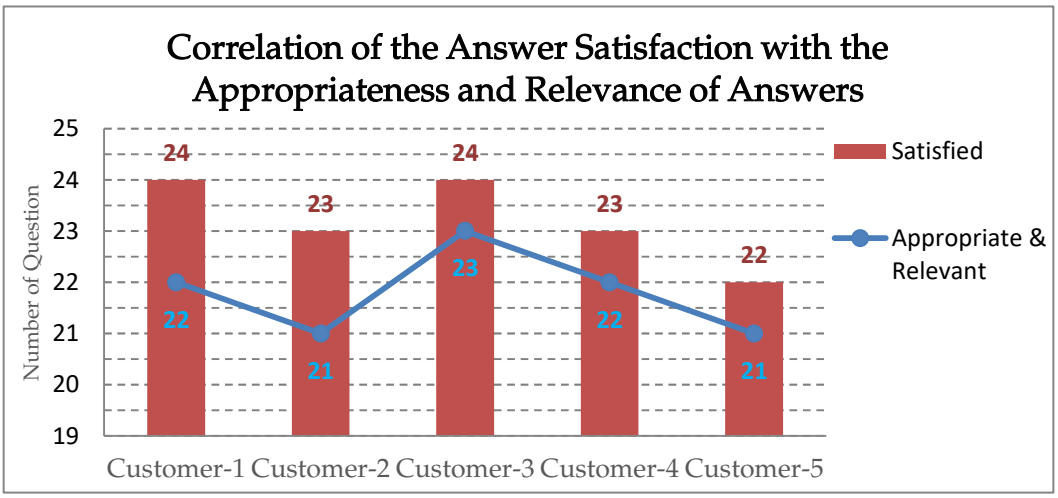

Figure 6. Graph of relationship between the chatbot service answer satisfaction and the appropirate and relevance of answers.

this is caused by the degree of acceptance from the customer in receiving answers that are ambiguous, but there are answers needed by the customer, in this case it affects our ability to design a corpus of chatbot answers, so that as much as possible it can meet the asker's expectations. Furthermore, if we look at the relationship between customer satisfaction on the appropirate and relevance of chatbot answers, as shown in Figure 6.

Correlations

		Satisfied	Appropriate & Relevant
Satisfied	Pearson Correlation	1	.883**
	Sig. (2-tailed)		.000
	N	150	150
Appropriate & Relevant	Pearson Correlation	.883**	1
	Sig. (2-tailed)	.000	
	N	150	150

**. Correlation is significant at the 0.01 level (2-tailed).

Figure 7. Correlation analysis of satisfaction variables and the accuracy of the relevance of answers.

The graph shows a unidirectional trend between the customer satisfaction with the appropirate and relevance of chatbot answers, while the magnitude of the correlation is very significant and unidirectional as shown in Figure 7, where the correlation value is between the variables of customer satisfaction with chatbot services in answering questions and the appropirate and relevance of chatbot answers. very strong is 0.883 and significant at the 0.01 level. Referring to the results of this analysis and discussion, it can be concluded that there is potential to strengthen that the use of chatbots can improve customer experience.

6. CONCLUSIONS

In order to get the potential to increase customer experience in using chatbots related to information needs about Wuzz products, it is first necessary to develop Indonesian-language chatbots that are able to serve formal and non-formal language styles in order to gain customer experience through measurement. Intent corpus data is actual data on conversations between CEODE Bank contact center officers and customers about handling wuzz products. Chatbot application based on PHP and Python, creating a classification model using Natural Language Processing (NLP) and Machine Learning Logistic Regression methods. The scope of NLP is data cleansing, tokenization, stemming, normalization, stopwords. The chatbot answer responses are divided into two, namely Direct Answer Responses (watchword and levenshtein distance) and Machine Learning based Answer Responses. By weighting words using the frequency distribution of the number of words, the accuracy value of the classification model is 71.1%.

The test was carried out on five volunteers who were given 30 questions consisting of 10 formal questions and 20 non-formal questions about wuzz products and their level of satisfaction was measured. For formal questions, customers ask according to Indonesian language rules and non-formal questions. Out of a total of 150 questions, 107 questions were successfully answered with Appropriate & Relevant status or a success rate of 72.0%. Inappropriate & Relevant Status as many as 15 questions or 9.3% and Inappropriate & Irrelevant as many as 28 questions or 18.7%. In addition, formal and non-formal language style has a high Appropriate & Relevant Status, for formal language style it has a success rate of 68.0% or as many as 34 questions, while non-formal language style has a success rate of 75.0% or as much as 75 questions, while the lower success rate in formal language style is more due to inadequate corpus design for formal language style, because formal language style tends to be longer, this makes the word weight spread and results in a low accuracy value , compared to non-formal sentences which are shorter and more effective even though there are non-standard words but can be overcome by stop words and normalization.

Judging from the status of customer satisfaction with experience in using chatbots, there were 116 questions with answers with a Satisfied status or a success rate of 77.3%, and a Dissatisfied status of 34 questions or a success rate of 22.7%. The magnitude of the correlation between customer satisfaction and the relevance of chatbot accuracy in answering questions is very strong at 0.883 and is significant at the 0.01 level. From all calculations and analysis, results can be seen that confirm that the use of chatbots has the potential to improve customer experience.

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IMPLEMENTATION STRATEGY TARGET OFF BLOCK TIME (TOBT) ON DOMESTIC FLIGHTS: A CASE STUDY OF SOEKARNO HATTA INTERNATIONAL AIRPORT

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ABSTRACT

Accuracy in measuring Target Off-Block Time (TOBT) as one of the stages of implementing Airport Collaborative Decision Making (A-CDM) will be able to produce measurable effectiveness and efficiency and be able to orchestrate airport operational activities, especially at Soekarno-Hatta International Airport as Indonesia's largest and busiest airport.

The airport, which has 3 passenger terminals with a total capacity of 43 million passengers per year, a cargo terminal with a capacity of 600,000 tons per year and the support of 3 runways, is part of the Multinodal Air Traffic Flow Management (ATFM) concept. so that the continuity of information governance (Information Sharing) is expected to be able to run optimally through technological support so as to create a very good level of flight timing (punctuality).

Through the use of the IFE and EFE Matrix, SWOT Matrix, SPACE Matrix, Kano Model, and QSPM Strategy it is known that the IFE result is 3.089 which indicates that the internal factor of Soekarno-Hatta International Airport is quite strong. The EFE result is 2,294 which means sufficient success to attract external opportunities and avoid threats that will arise so that this positions Soekarno-Hatta International Airport in quadrant 1 of the Space matrix. So that it is hoped that the company can create more advantages through existing opportunities through the main strategic alternatives, namely Backward Forward Horizontal Integration resulting from the QSPM matrix with an achievement value of 5,490 followed by an alternative strategy of Market Development of 5,583 and Market Penetration of 4,171.

Keywords: Airport Collaborative Decision Making, Target Off-Block Time, SWOT Matrix, SPACE Matrix, Kano Model, and QSPM Strategy

1 INTRODUCTION

Airport operational activities absolutely require the involvement of several operational stakeholders in it. Synergy between airport operators, airlines, ground handling, Air Traffic Controllers, government authorities (Immigration, Customs, Quarantine) is important to run and maintain an operational order while upholding the security and safety aspects of aviation. Challenges or conditions that are often encountered in flight operations such as flight delays, re-scheduling to flight cancellations are conditions that often occur and require coordination and collaboration between stakeholders at the airport.

In the navigation arrangement or Air Traffic Flow Management (ATFM) countries in Asia including Indonesia are in the Multinodal ATFM concept, in each of the multi-modal providers of navigation services or Air Traffic Provider member countries operate ATFM independently. This is motivated by the policies of each country. This condition absolutely requires the support of Information Sharing governance which is interconnected both technically in the delivery of information (technology) and operational regulations. In line with this, technological developments will make it easier to convey information between stakeholders, so a new operational order is needed that prioritizes a combination of operational and technological aspects, which in this case has been implemented at several European airports through the implementation of A-CDM (Airport Collaborative Decision). Making). The A-CDM concept provides decision support as measured in the determination of TOBT (Target Off Block Time), where TOBT is the main indicator of the 16 indicators in the A-CDM milestone approach and plays an important role for all airport stakeholders in departure management. For airport operators, TOBT will provide a target time in the departure process line and at the same time will measure operational resource planning, assessing airspace congestion that is needed by the local ATC to arrange the departure sequence to the estimated flight departure time (Badrinath et al., 2020)

Soekarno-Hatta International Airport in Tangerang is currently focusing on implementing A-CDM. As one of the busiest airports in terms of aircraft movements in the Asia Pacific (APAC) Region, ICAO recommends Soekarno-Hatta International Airport to immediately implement A-CDM, whereas until now there has been no airport in Indonesia that has fully implemented the A-CDM concept and implemented TOBT in daily operational activities.

Research conducted by (Sumiarsih et al., 2018) discusses how to analyze a comprehensive strategy with a system component approach for water transmission systems. This study uses the Klambu-Kudu Water Transmission System in Semarang, Central Java, Indonesia as a case study. Strategy analysis of the Klambu-Kudu Water Transmission System uses Strength, Weakness, Opportunity, and Threats (SWOT) modifications with a Likert scale

and the Quantitative Strategic Planning Matrix (QSPM) method. The result is a strategic priority that is dominated by opportunity factors to overcome weaknesses

Research conducted by (Surya et al., 2020) aims to measure the level of customer satisfaction from the results of the attributes of the actual performance gap with customer expectations so that it will be known how much the level of service satisfaction has been provided to customers and provide solutions for improvement. Service Quality and the Kano method are the methods used in this study. The results obtained in this study are in Kano for the Must-be category on the attribute "Adequate parking area" with a gap score of -1.84. In the One dimensional category on the attribute "Patience and composure of employees in serving customers" with a gap score of -0.44. For the Attractive category on the attribute "Employees are willing to help consumers if needed" with a gap score of -0.44.

The research conducted by (Huet et al., 2016) aims to collect evidence from 17 CDM airports, namely the local benefits enjoyed by CDM airports can be collected and communicated in airport-specific A-CDM fact sheets and results from the EUROCONTROL A-CDM network study before can be perfected. The results showed that A-CDM has facilitated the reduction of ATFM delays by an average of 3 minutes per regulation in restrictions where 30% or more flights originate from CDM airports. This benefit increases as the proportion of flights originating from CDM airports via this sector increases

The purpose of this study is to analyze and plan the strengths and opportunities of implementing Target Off-Block Time (TOBT) on domestic flights: as well as formulating recommendations for Implementation Strategy of Target Off-Block Time (TOBT) on domestic flights.

2 LITERATURE REVIEW

a Target Off-Block Time (TOBT)

Target Off-Block Time (TOBT) is the time the airline or handling agent estimates the aircraft will be ready, all doors are closed, the boarding bridge pushes back the vehicle available, and is ready to start or push back as soon as it receives clearance from air traffic control (Verkerk, 2018). The airline issues the TOBT and is ultimately responsible for its accuracy. The turn-round controller controls and monitors the turn-round process and updates the TOBT up to 15 minutes before the Estimated Off-Block Time (EOBT), requiring approval from the airline manager if the EOBT deviation is more than 15 minutes (Stuttgart Airport, 2020)

TOBT decision making is characterized by an evolutionary approach in a dynamic environment. Coordination of actions is mandatory and depending on the response required for one loop process or unforeseen situation, a long sequence of subsequent processes, coordination or improvement decision making may be required. The response can include actions such as exchanging data or sharing information to jointly making contingency plans

through various interactions between the actors or operators involved. Therefore, not only is close monitoring of this critical path required, but predictions for each turn-round process are required, as the accuracy of TOBT is highly dependent on the precise prediction of all sequential sub-processes.

b Strategic Management

In carrying out strategic planning there are several stages that must exist and must be carried out first. These stages will form the design of strategies that can be implemented, to obtain or design the best strategy. These stages are as follows (Malik et al., 2013) :

a) Stage 1
At stage 1 is the stage where the data is needed that influences the selection of strategies.

b) Stage 2
The second stage is the stage of matching or analysis of the results based on the factors that have been inputted from stage 1 with several matrices that can be used to carry out matching or analysis of input factors.

c) Stage 3
Stage 3 is the stage of selecting the best strategy from several alternative strategies formed based on stage 2 using the Quantitative Strategic Planning Matrix (QSPM).

c Kano Model

The Kano model was developed in 1984 based on Herzberg's 1968 motivation-hygienic theory and the law of diminishing marginal utility (Tan & Waheed, 2011). The role of quality can be classified into five categories, according to the level of acceptance and satisfaction based on the dimensions of the Kano model:

a) Attractive quality (A)
Able to give satisfaction when fully achieved, but not cause dissatisfaction if not fulfilled;

b) One-dimensional quality attribute (O)
Being able to produce satisfaction when it is fulfilled, and dissatisfaction when it is not fulfilled;

c) Must-have quality attribute (M)
If it is not fulfilled it will cause customer dissatisfaction; however, if it reaches a certain level the customer is no longer satisfied;

d) Indifferent quality attribute (I)
Does not significantly affect customer satisfaction, regardless of whether it is fulfilled;

e) Inverted quality attribute (R)
Cause dissatisfaction and if not fulfilled can satisfy the customer.

3 METHODS

Research is based on a framework that describes a specific approach. Quantitative and qualitative research is based on the positivism paradigm which is based on assumptions about empirical objects (Sugiyono, 2016). Determination of respondents using judgment sampling that the information obtained from the sample is accurate. Because those involved in the performance measurement strategy on domestic flights include several elements, the qualifications of this respondent are:

a. Part of the management of Airport Operators Soekarno-Hatta Intl Airport;
b. Passengers or users of airport services;
c. Parties directly involved in flight operations (Airlines, Airport Authority, Ground Handling).

Researchers used interview questions aimed directly at stakeholders and stakeholders and documentation in the form of an overview and work process of the performance measurement strategy through the EFE Matrix, IFE Matrix, SWOT Matrix, SPACE Matrix approaches on domestic flights.

In this study, the sample size to be examined was obtained using the Charan and Biswas formula in 2013 in determining the quality of the research sample selected from the total population of domestic airplane passengers at Soekarno-Hatta International Airport which touched 92,831 passengers per day and used a sampling error rate of 5% with a sample population of 70% based on previous research results, a minimum of 323 passenger samples was obtained. Based on the results of the questionnaires that have been distributed, a total sample of 493 data is obtained.

4 RESULTS

a Questionnaire Evaluation with the Kano Model

To determine Kano's needs, the following provisions are used:

a. If (one dimensional + attractive + must-be) > (indifferent + reverse + questionable) then the grade is obtained from the maximum of (one dimensional, attractive, must-be).

b. If (one dimensional + attractive + must-be) < (indifferent + reverse + questionable) then the grade is obtained from the maximum of (indifferent, reverse, questionable).

Table 1 shows the evaluation table which contains the recapitulation of survey results using the Kano Model for each service attribute.

Table 1. Evaluation of the Passenger Questionnaire According to the Kano Model

	A	M	O	I	R	Q	A + M + O	I + R + Q
Accessibility to the airport	73	103	0	243	55	19	176	243 (317)
Signs to indicate the place and direction in the terminal	56	49	0	340	48	0	105	340 (388)
Airport information service	332	53	0	52	8	48	332 (385)	108
Clarity of departure information on the information screen	10	250	0	30	100	103	250 (385)	133
Clarity of flight calls through loudspeakers	50	60	0	275	45	63	110	275 (383)
Security check queue waiting time	43	30	0	350	15	55	73	350 (420)
Security check procedures	54	54	0	70	275	30	108	275 (413)
Politeness and dexterity of security officers	85	49	0	331	28	0	134	331 (359)
Check-in waiting time	73	70	0	55	250	45	143	250 (438)
Check-in service speed	60	66	0	260	58	49	126	260 (367)
Politeness and dexterity of check-in staff	45	350	0	50	0	48	350 (395)	98
Trolley Availability	265	55	0	128	45	0	265 (320)	173
Availability of ATMs, Banks, Money Changers	45	290	0	130	9	19	290 (335)	158
Cool temperature in the terminal area (AC < 25 degrees Celsius)	65	66	0	6	356	0	131	356 (362)
Availability of seats in the waiting area	150	260	0	3	63	27	260 (410)	93
Internet service/free wifi	268	42	0	65	63	60	268 (310)	183
Airport terminal scene	350	75	0	25	23	20	350 (425)	68
Airport terminal cleanliness	12	6	0	375	0	100	18	375 (475)
Overall satisfied with the service and facilities at the airport	24	443	0	23	0	3	443 (467)	26

Table 2 shows the evaluation table which contains the recapitulation of survey results using the Kano Model for each service attribute

Table 2. Evaluation of the Pilot Questionnaire According to the Kano Model

	A	M	O	I	R	Q	A + M + O	I + R + Q
Ground Time Duration	2	7	0	79	7	0	9	79 (86)
Pushback Time Duration	4	3	0	82	2	4	7	82 (88)
Tower Permit Duration Until Pushback	4	7	0	76	6	2	11	76 (84)
Communication Media to communicate with ATC	3	3	0	61	16	12	6	61 (89)
Use of mobile application to communicate with ATC	3	17	0	59	15	1	20	59 (75)

b Soekarno Hatta International Airport Business Strategy Analysis

Table 3 Results of the Soekarno-Hatta International Airport IFE Matrix

No.	Company internal factors	Score	Rating	Total Score
	Strength			**2,546**
S1	CGK is the largest domestic flight hub and origin in Indonesia	0,085	4	0,34
S2	Supported by Airport Operational Hours (OH) 24 hours a day	0,087	4	0,348
S3	Has 44 domestic flight routes	0,083	4	0,332
S4	International standard airport terminal capacity and airside operations	0,084	4	0,336
S5	It has 3 runways	0,084	4	0,336
S6	Has an Airport Operation Control Center and a modern operational system based on ACDM	0,086	4	0,344
S7	CGK's location is close to the Indonesian business center	0,084	3	0,252
S8	Easy accessibility to the airport	0,086	3	0,258
	Weakness			**0,543**
W1	There is still often a buildup of passengers at busy times	0,054	1	0,054
W2	Inefficient use of flight slots	0,045	2	0,09
W3	The airport is not the final destination for passengers	0,045	1	0,045
W4	Weak coordination between stakeholders	0,045	2	0,09
W5	Large internal company organization	0,041	2	0,082
W6	AOCC and ACDM operations have not been maximized	0,044	2	0,088
W7	Traffic jams often occur for vehicle access to the airport	0,047	2	0,094
TOTAL		**1,000**		**3,089**

From the IFE Matrix table above, it is known that the total weight rating of Soekarno-Hatta International Airport is 3,089 indicates that the company has a fairly strong internal position

Table 4 Results of the Soekarno-Hatta International Airport EFE Matrix

No.	Company external factors	Score	Rating	Total Score
	Opportunity			**1,34**
O1	Clarity of departure information on the information screen	0.029	4	0.116

O2	Airport information service	0.090	4	0.36
O3	Politeness and dexterity of check-in staff	0.031	4	0.124
O4	Trolley Availability	0.030	3	0.09
O5	Availability of ATMs, Banks, Money Changers	0.045	3	0.135
O6	Availability of seats in the waiting area	0.028	3	0.084
O7	Internet service/free wifi	0.026	4	0.104
O8	Airport terminal scene	0.029	3	0.087
O9	Ground Time Duration	0.031	4	0.124
O10	Pushback Time Duration	0.029	4	0.116
	Threat			**0,954**
T1	Accessibility to the airport	0.029	2	0.058
T2	Signs to indicate the place and direction in the terminal	0.045	2	0.090
T3	Clarity of flight calls through loudspeakers	0.059	1	0.059
T4	Security check queue waiting time	0.055	2	0.110
T5	Security check procedures	0.029	2	0.058
T6	Politeness and dexterity of security officers	0.046	1	0.046
T7	Check-in waiting time	0.029	2	0.058
T8	Check-in service speed	0.029	2	0.058
T9	Cool temperature in the terminal area (AC < 25 degrees Celsius)	0.074	1	0.074
T10	Airport terminal cleanliness	0.065	1	0.065
T11	Tower Permit Duration Until Pushback	0.045	2	0.090
T12	Communication Media to communicate with ATC	0.061	2	0.122
T13	Use of mobile application to communicate with ATC	0.066	1	0.066
TOTAL		**1,000**		**2,294**

From the EFE Matrix table above, it is known that the total weight rating of Soekarno-Hatta International Airport is 1.66, indicates that the company is quite successful and able to take advantage of external opportunities and avoid threats facing the company.

c Quantitative Strategic Planning Matrix (QSPM)

Table 5 Quantitative Strategic Planning Matrix (QSPM)

Quantitative Strategic Planning Matrix	Total Score
Market Development	5,383
Market Penetration	4,171
Backward and Forward Horizontal Integration	5,490

From the results of the QSPM Matrix above it is known that the Market Development Strategy has a total attractiveness value of 5.383, the Market Penetration Strategy has a total attractiveness value of 4.171, and the Backward Forward Horizontal Integration Strategy has a total attractiveness value of 5.490.

5 CONCLUSION

To obtain a recommendation strategy for Implementation of Target Off-Block Time (TOBT) on domestic flights.

a. From the IFE Matrix table above, it is known that the total weight rating of Soekarno-Hatta International Airport is 3,089 indicates that the company has a fairly strong internal position.

b. From the EFE Matrix table above, it is known that the total weight rating of Soekarno-Hatta International Airport is 2,294 indicates that the company is quite successful, able to take advantage of external opportunities and avoid threats facing the company.

c. In quadrant I (S and O) the strategy that can be carried out by the company is to use the company's strengths to create more advantages in the opportunities that exist.

d. The Backward Forward Horizontal Integration Strategy has a higher total attractiveness value than the Market Penetration Strategy and Market Development Strategy and can subsequently be applied as the main strategy for the Implementation of Target Off Block Time (TOBT) on Domestic Flights at Soekarno-Hatta International Airport.

Based on the research results implications for PT Angkasa Pura II as the operator of Soekarno-Hatta International Airport are as follows:

a. It is necessary to increase coordination between operational stakeholders, in this case strengthening communication and information through technology support and good operational governance that prioritizes transparency of operational processes. This can be done by elements in charge of operational and/or service functions and their harmonization with functions in charge of technology.

b. It is necessary to optimize and effectively manage flight slots so that impacts that may arise in a series of flights such as frequent accumulation of passengers can be avoided, in this case it is the main responsibility of the operational function.

c. Precise and accurate flight information as well as the duration of the aircraft's ground time are the dominant factors for increasing the accuracy of achieving the Target Off-Block Time (TOBT), this can be done through the use of mobile applications.

d. The process of mobilizing passengers, flight crew and airport operational officers both going to and leaving the airport is also a major concern to minimize the potential for flight delays and other related elements.

e. Collaboration between domestic airports, both as destination airports and airports of origin for flights affiliated with Soekarno-Hatta International Airport expected not be

separated from the main concern, resulting from the collaboration aspect is more to increase flight frequency to mitigate potential operational disruptions may arise during operational activities.

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HOUSING DEVELOPMENT PLANNING AROUND PERTAMINA TUBAN USING SWOT ANALYSIS AND FUZZY AHP

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ABSTRACT

There are still lots of vacant lands in Tuban City that can be developed for residential areas. Housing development planning can begin with determining the location of housing development land. Very often it happens that the developer determines the wrong location, due to several conditions in the field. Even though the location selection is the beginning of a housing developer project. In ensuring the selection of a location for the development of a housing development, it is necessary to carry out an analysis of Strengths, Weaknesses, Opportunities and Threats or often abbreviated as a SWOT analysis. SWOT analysis is used to find out what criteria can be prioritized in selecting a housing development location. Furthermore, Fuzzy AHP analysis was carried out to determine which best location could be developed from various available alternative locations.

Based on the results of the SWOT analysis, it is known that there are 16 criteria that can be prioritized including location accessibility, basic physical condition of the soil, daily necessities, and availability of electricity and internet networks. Then, from the results of the Fuzzy AHP, the Zarkali location was chosen because it had 12 appropriate criteria out of the 16 existing priority criteria.

Keywords: *Land Development, SWOT, Fuzzy-AHP*

1. INTRODUCTION

Tuban city projected to become one of the industrial areas in East Java. Until now there are 6 large industries in the City of Tuban on a national scale, that is: PT Semen Gresik, PT Inti Kalsium Indonesia, PT TPPT, PT Inti Calcium, PT Gasuma, PT Holcim and PT Pertamina. Recently PT Pertamina developed a new oil refinery in Tuban.

The new Tuban oil refinery is Joint Venture (JV) between PT Pertamina and an oil and gas company from Russia, Rosneft with a composition of 55% (Pertamina) and 45% (Rosneft) with an investment value of US$15 billion. The refinery is expected to be the largest in Southeast Asia with a maximum capacity of 300 thousand barrels per day. The project is estimated to require 2 to 20,000 workers during construction and 2,500 workers during the operational phase.

Industrialization increases urbanization related to employment opportunities and urbanization causes an increase in population (Hadijah, 2020). The total population recorded in 2020 was 1,198,012 people with a population density of 651 people/km2. The total population in Tuban increased 0.67% from the previous year (BPS Tuban 2021). The total workforce recorded in 2020 was 943,431 people with a working population of 645,156. The number of labor force working in Tuban City increased by 3.43% from the previous year (BPS Tuban 2021).

As the population grows, the need for clothing, food and boards also grows (Haviz 2021). One of them is housing. When the population grows, the demand for housing will also grow (Hummel, 2020). when the need for housing increases, land conversion will occur, conversion from agricultural land to industry or residential area.

In Tuban City there are still lots of vacant lands that can be developed for residential areas. As a developer, housing development planning can begin with determining the location of residential land development (Amanullah 2017). Very often the developer determines the wrong location, due to several conditions in the field. Even though the location selection is the beginning of a housing developer project. So if from the start developer make a mistake in determining the location, then in the end the results are not as planned.

In this study we used a SWOT analysis to find out what criteria could be prioritized for land selection (Sahani 2021). the analysis is carried out by the developer in order to ensure that good or bad things have been identified before to minimizing losses both financially and non-financially (Toker 2012).

The criteria that have been selected based on the SWOT analysis are still subjective from the team carrying out the FGD. Then proceed with Fuzzy AHP analysis to eliminate subjectivity from respondents, it is hoped that using Fuzzy AHP so that developers, users and contractors who choose the priority criteria and alternatives location can be consistent and unbiased.

2. LITERATURE REVIEW

2.1 Land development

Land use change is a transformation in the allocation of land resources from one use to another. Changes in land use or commonly referred to as land conversion generally occur on agricultural land. The conversion of agricultural land that is currently happening is considered to be getting bigger, if this is allowed to continue, production from agriculture in the long term will decrease and become a food deficit (Sagita, 2014).

2.2 Residential land development

Settlements are part of a residential neighborhood consisting of more than one housing complex that has infrastructure, facilities, public utilities, and supports other functional activities in urban areas or rural areas. Adisasmita, (2010) argued that a settlement is a plot of land designated for settlement development. Certain areas dominated by residential neighborhoods with the main function as a place to live equipped with regional facilities, infrastructure and workplaces that provide services and work opportunities to support livelihoods.

2.3 SWOT Analysis

SWOT analysis is a strategic planning method used to evaluate strengths, weaknesses, opportunities and threats in a project or a business speculation. These four factors form the acronym SWOT (strengths, weaknesses, opportunities and threats). This process involves setting specific goals from business or project speculation and identifying internal and external factors that support and do not achieve these goals (Mariantha, 2018). SWOT analysis is usually a recommendation to maintain strengths and increase the advantages of existing opportunities, while reducing strengths and avoiding threats. If used correctly, SWOT analysis will help us to see the sides that have been forgotten or not seen so far.

2.4 Fuzzy AHP

According to the results of the literature review conducted by Yücenur (2019), fuzzy numbers are used to prioritize RPN values with the Analytic Hierarchy Process (AHP) step

(Özfirat, 2014). In recent years Fuzzy AHP (F-AHP) is a very useful methodology for important applications in multi-criteria decision-making problems under fuzzy operate (Wang et al. 2011), due to human thinking and preferences are inherently imprecise, vague character hence it can be modeled with fuzzy theory easily. In one method, the decision maker's judgment is treated by pairwise comparison and finding the priority vector (Yu, 2002 and Bisso, 2014). Fuzzy comparison matrix is used to evaluate altenative location. The F-AHP method is divided into 2 types, namely extent analysis and geometric mean. Extent analysis is an analytical method that does not represent the relative importance of the criteria in which the method compares the convex fuzzy with k convex fuzzy to calculate the relative importance level (Wang et al. 2008). Meanwhile Geometric mean is a method applied to calculate the priority of criteria using the geometric calculation G1 = (li, mi, ui) (Kuzairi et al. 2017). Where l represents lower, m represents middle, and u represents upper. In the AHP method, the comparison between the criteria uses a scale of 1-9. While the F-AHP must transform the TFN (Triangular Fuzzy Number) as shown on Table 2 to the AHP scale (Ansori, 2012 and Adnyana et al. 2016).

Table 1. Linguistic scale for the relative importance

Linguistic Scales	Symbols	Triangular fuzzy numbers	
		Number	Conjugate
Equally Important	E1	1, 1, 1	1, 1, 1
Weakly more important	WI	2/3, 1, 3/2	2/3, 1, 3/2
Strongly more important	SI	3/2, 2, 5/2	2/5, ½, 2/3
Very Strongly more important	VSI	5,2, 3, 7/2	2/7, 1/3, 2/5
Absolutely important	AI	7/2, 4, 9/2	2/9, ¼, 2/7

3. METHODS

To ensure research effectiveness in selecting housing development, this study is based on the identification of prioritized criteria using SWOT analysis. then for location selection will use Fuzzy AHP analysis.

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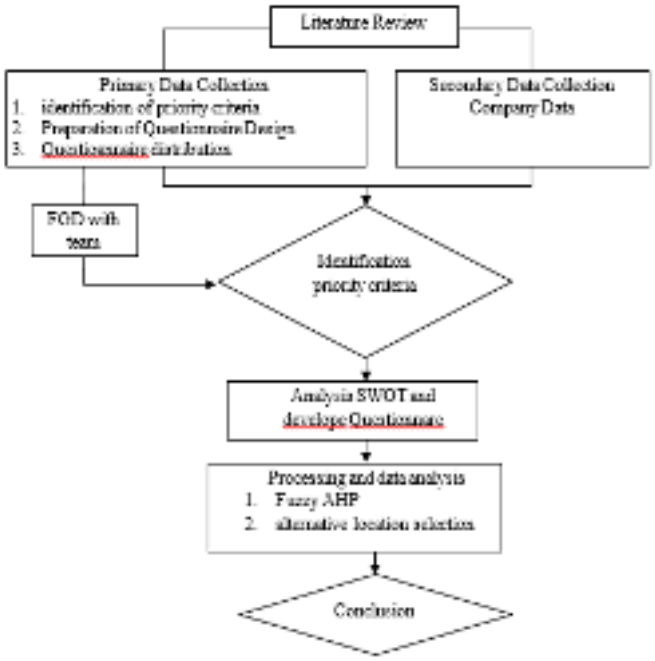

Figure 1. The flow process of research methodology used for this paper

3.1. Begin selection of criteria

In this methodology, the planning management will start with identifying problems according to existing problems in the field by coordinating with decision makers (Decision Makers) to get sponsorship.

3.2. The stages of selection of criteria and SWOT analysis

The team that will be involved has received approval from the decision maker. The team will conduct a Focus Group Discussion (FGD) to brainstorm according to the findings in the field. The team involved is the same person in determining priority criteria and conducting a SWOT analysis. Swot analysis is used to find out which criteria are included in the internal or external factors of each alternative development land.

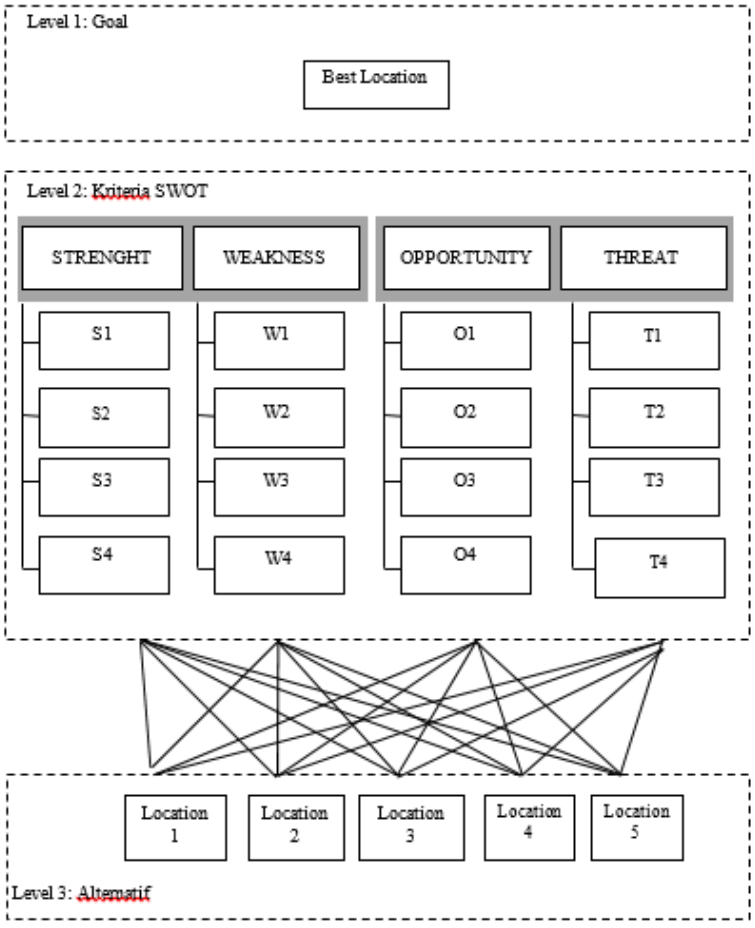

Figure 2: SWOT Analysis

3.3 Fuzzy AHP Analysis

The next stage is to develop a questionnaire from the criteria that have been selected. Questionnaires were given to the respondents. The results of the questionnaire are still in the form of numeric numbers that are converted to TFN numbers (Table.1). From these results, matrix comparisons and weight vector normalization are carried out. From these results we will determine which sequence of criteria will be a priority in land selection. And finally the land selection is carried out from the results of these calculations.

Determine the object, namely X = {x1, x2, …..xn} and the goal is U = {u1, u2,… um }. Due to the method of Cheng's (1996) extent analysis of each object to show each goal (gi), then each object, namely the m extend analysis, is written as Eq. (2)

$M1_{gi}, M2_{gi}, \ldots\ldots, Mm_{gi}$, i= 1,2,…, n, (2)

While the triangular fuzzy value is $M_{g_i}^j (j=1, 2, \ldots, m)$. (3)

From the description above, the next steps are:

a. Fuzzy synthetic extent

`

$$S_i = \sum_{j=1}^{m} M_{gi}^j \otimes \left[\sum_{i=1}^{n} \sum_{j=1}^{m} M_{gi}^j\right]^{-1} \quad (4)$$

After that cal$\sum_{j=1}^{m} M_{gi}^j$ for additional fuzzy operations on m extent analysis,

$$\sum_{j=1}^{m} M_{gi}^j = \left(\sum_{j=1}^{m} l_j, \sum_{j=1}^{m} m_j, \sum_{j=1}^{m} u_j\right) \quad (5)$$

Inverse Vector Calculation, $\left[\sum_{i=1}^{n} \sum_{j=1}^{m} M_{gi}^j\right]^{-1} = \left(\frac{1}{\sum_{i=1}^{n} u_i}, \frac{1}{\sum_{i=1}^{n} m_i}, \frac{1}{\sum_{i=1}^{n} l_i}\right)$ (6)

b. Determination of the degree of probability

is $M_2 = (l_2, m_2, u_2) \geq M_1 = (l_1, m_1, u_1)$ (7)

$$V(M_2 \geq M_1) = \sup_{y \geq x} \min\left(\mu_{M_1}(x), \mu_{M_2}(y)\right)$$

or similar with Eq. (8) (8)

$$V(M_2 \geq M_1) = hgt(M_1 \cap M_2) = \mu_{M_2}(d) = \begin{cases} 1 & \text{if } m_2 \geq m_1 \\ 0 & \text{if } l_1 \geq u_2 \\ \dfrac{l_1 - u_2}{(m_2 - u_2) - (m_1 - l_1)} & \text{otherwise} \end{cases}$$

Where, d= ordinate of the highest point of intersection D between $\mu M1$ and $\mu M2$, to V ($M1 \geq M2$) and V ($M2 \geq M1$)

c. The degree of probability for a convex fuzzy number is more than k convex fuzzy numbers

$M1$ (I = 1,2,…,k) is V (M ≥ $M1$, $M2$, …..Mk) = V [(M ≥ $M1$) and (M ≥ $M2$) and…..(M ≥ Mk)] = minV ((M ≥ Mi), (i=1,2,…k) (9)

assumption that

$$d'(A_i) = \min V(S_i \geq S_k) \quad (10)$$

Which k = 1,2,…n ; k ≠ i. then weight vector is

$$W' = (d'(A_1), d'(A_2), \ldots, d'(A_n))^T \quad (11)$$

where, Ai (i=1,2,….n), n is elements.

d. Normalization of the value of the weight vector

$$W = (d(A_1), d(A_2), \ldots, d(A_n))^T \quad (12)$$

W is nonfuzzy number

4. RESULTS

4.1 Identification of criteria

In the study, the SWOT technique was used, and how in the planning department to select priority criteria. The problem is defined and how this problem affects the workflow is also found out. identified criteria as shown in Table 2.

Table 2. Identification Criteria

SWOT	Factor	Criteria	Meaning
S1	Internal	Location Accessibility	Ease of access to housing development land locations.
S2		Basic Physical Conditions of land	The contour of the land of the land to be developed.
S3		Legal	The developed land must have a housing development permit
S4		Availability landfill	In the development location there is a landfill processing
W1		Electric network	In a development location within reach of the electricity network
W2		Water sources	In a development location within reach of the PDAM
W3		Housing price	The price of the house must be in accordance with the facilities obtained.
W4		Housing material	Building materials or engineering designs that affect the structure of the building.
O1	External	Daily needs facility	The needs in question are the basic needs of society.
O2		Education facility	How close is the location of the development to the existing elementary school and Junior high school.
O3		Tourist facilities	How close is the development location to the tourist site
O4		Sport facilities	How close is the development site to sports facilities
T1		Environmental Safety	Development site safety conditions
T2		Potential flooding	Does the land have the potential for flooding if developed,
T3		Network Conditions	Telephone and internet network conditions at the land development site
T4		Environmental conditions	How acidity level, noise level, and wind load affect the strength of the building.

4.2 Developing fuzzy pairwise comparison matrixes

In the fuzzy prioritization method, the AHP method is carried out first. In fuzzy AHP, questionnaires can be used to compare preferences according to other people's priority criteria to understand the importance of each criterion. The 16 identified criteria (as shown in Table 2) are weighted for each component. The results of the pairwise comparison matrices are shown in Figures 2 . It shows a fuzzy scoring matrix for each priority criterion.

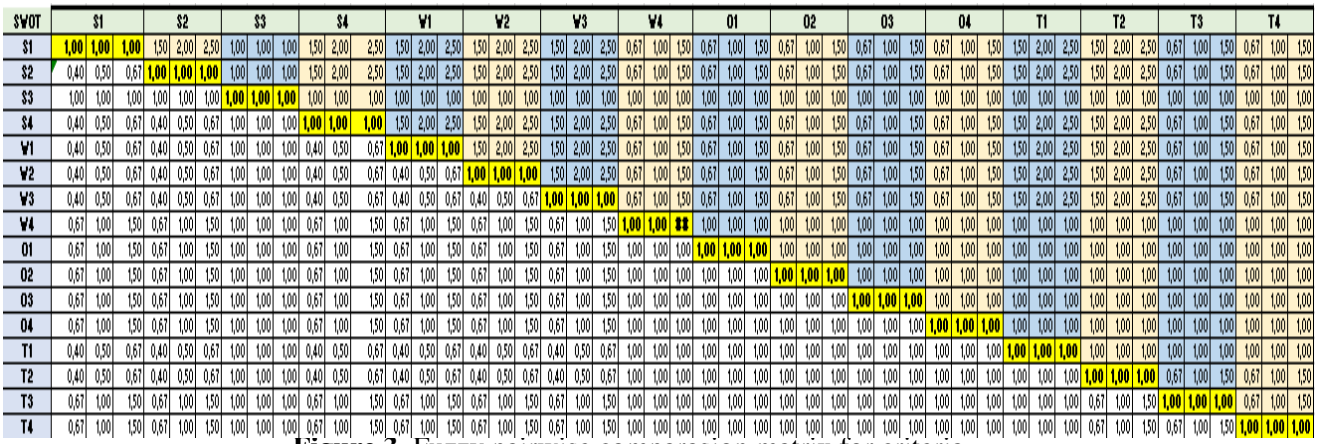

Figure 3. Fuzzy pairwise comparasion matrix for criteria

4.3. Calculating the importance coefficient with the fuzzy prioritization method

After operating the AHP fuzzy steps, we calculate the value weight vectors and normalize the weight vectors to determine the priority of each criterion. The results are as in Table 3.

Table 3. importance coefficient with the fuzzy prioritization method

SWOT	Mi	Ni
S1	0,09	0,0850
S2	0,08	0,0781
S3	0,06	0,0594
S4	0,08	0,0718
W1	0,07	0,0661
W2	0,06	0,0608
W3	0,06	0,0559
W4	0,06	0,0610
O1	0,06	0,0610
O2	0,06	0,0610
O3	0,06	0,0610
O4	0,06	0,0610
T1	0,05	0,0469
T2	0,05	0,0474
T3	0,07	0,0618
T4	0,07	0,0618
Total Mi	1,06	
Total		1,0000

4.4 selection of alternative locations

After knowing the weight of the criteria, then proceed to choose alternative locations based on existing alternatives. The results are as in table 4.

Table 4. Result of Fuzzy AHP and selection of alternative locations

Criteria	SWOT	Final Score	Alternative				
			Sekardadi	Galbang	Pasar Pengkok	Zarkali	Kopeng
Location Accessibility	S1	0,0850	Yes	No	No	Yes	Yes
Basic Physical Conditions of land	S2	0,0781	Yes	No	Yes	Yes	No
Availability landfill	S4	0,0718	No	No	No	Yes	Yes
Electric network	W1	0,0661	Yes	Yes	Yes	Yes	Yes
Network Conditions	T3	0,0618	No	Yes	Yes	No	No
Environmental conditions	T4	0,0618	No	No	No	No	No
Housing material	W4	0,0610	Yes	Yes	Yes	Yes	Yes
Daily needs facility	O1	0,0610	Yes	Yes	No	Yes	No
Education facility	O2	0,0610	No	Yes	No	Yes	Yes
Tourist facilities	O3	0,0610	No	No	Yes	Yes	No
Sport facilities	O4	0,0610	No	Yes	Yes	Yes	Yes
Water sources	W2	0,0608	Yes	No	No	Yes	Yes
Legal	S3	0,0594	Yes	Yes	No	Yes	Yes
Housing Price	W3	0,0559	Yes	Yes	Yes	Yes	Yes
Environmental Safety	T2	0,0474	No	No	Yes	No	No
Potential flooding	T1	0,0469	No	Yes	No	No	No
		Total	**8**	**9**	**8**	**12**	**9**

5. CONCLUSIONS

In this paper, we apply a SWOT analysis using the fuzzy priority method for a property developer company. Priority criteria are determined in a Focus Group Discussion by the planning team. From the results of the FGDs, there were 16 priority criteria. The results of determining alternatives from the criteria that have been prepared are obtained by carrying out matrix

comparisons using fuzzy AHP. So that the highest final score was obtained from the criteria that had been prepared, namely location accessibility with the highest score of 0.0850. This shows that in the modern and developing era like today, potential consumers are more considering access to mobility from facilities and infrastructure in carrying out their daily activities, both office centers, schools, hospitals and shopping centers. The alternative location selected from the five alternative locations is the Zarkali area with 12 criteria including 16 criteria with a total value of 0.726.

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INFORMATION SYSTEM STRATEGIC PLANNING: A CASE STUDY PUSAT INVESTASI PEMERINTAH

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ABSTRACT

Information systems and information technology (IS/IT) have a significant role in the development process of an organization. The use of IS/IT affects business activities in various areas, especially in terms of time and cost efficiency. Utilization of IS/IT has been carried out by Badan Layanan Umum Pusat Investasi Pemerintah (BLU-PIP), in terms of management services and ultra-micro financing program. In practice, BLU-PIP discover that the use of IS/IT that is not optimal, the need for IS/IT to support business processes has not been fulfilled, the system was not integrated, and information management is poorly maintained. Therefore, the purpose of this research is to formulate an information system strategic plan for BLU-PIP as a guideline to improve the management and development IS/IT in the future. This research uses the information system strategic planning method by Ward & Peppard (2016) approach as guidance. Thus, this research uses Mission Model Canvas, Value Chain, Business Process, Critical Success Factor, and the McFarlan Strategic Grid as its analytical methods. The final results of this research are the formulation of IS strategy, IT strategy, IS/IT management strategy, and IS/IT roadmap for 5 (five) years period, that aligns with BLU-PIP business objectives.

Keywords: Information System, Information Technology, Strategic Planning, Ultra Micro Financing, Ward & Peppard, BLU-PIP

1. INTRODUCTION

According to Minister of Finance Regulation (2020) number PMK/193.05/2020, Ultra Micro Financing Program is carried out by the Badan Layanan Umum Pusat Investasi Pemerintah (BLU-PIP). BLU-PIP distributes Ultra Micro Financing based funds allocation that has been stated in the business and budget plan that will be distributed through Non-Bank Financial Institutions/LKBB.

The administration and reporting of BLU-PIP performance is inseparable from the utilization of information systems and information technology (IS/IT). Information systems and information technology have significant role in the development process of an area. As stated in Mgunda (2019), the need for time and cost efficiency affects various area to implement information technology in organizational business activities. Hence, the role of information systems and

information technology able to provide better value for BLU-PIP in terms of business opportunity enhancement. In addition, the application of information systems and information technology at BLU-PIP has an impact on productivity levels, ease of access and better service.

In practice, BLU-PIP discover that the use of IS/IT is not optimal. The need for IS/IT to support business processes has not been fulfilled, the system is not integrated, and information management is poorly maintained. Besides that, there are also duplication of task, lack of IS/IT supervision so that the development of information and technology systems is not align with business objectives which results in inadequate service availability, information management is poorly maintained so that the availability and validity of information cannot be fulfilled. Some of these problems affect the quality of service for Ultra Micro's financing program beneficiaries.

According to Ward & Peppard (2016), these problems occurred because there is no information system strategic planning. The information system strategic planning is needed to aligned the use of IS/IT with business objective and ensure existing information systems and information technology are conformable to the organizational needs. In line with Cassidy (2005), the benefits of information system strategic planning and other mature information technology are more efficient management of IS/IT investments, better communication between businesses and information system organizations, identification of business opportunities through the application of technology hence it provide an increase in added value for the organization, flow and process planning information that becomes more directed and the IS resources that can be allocated effectively and efficiently.

This research aims to design an information system strategic plan that can be used as a long-term IT plan in supporting the BLU-PIP business processes and all its units within the BLU-PIP environment. Hence, this information system strategic plan will later be use as a guideline for BLU-PIP in developing, managing and utilizing IS/IT, determining IT investment priorities and managing and developing human resources in the IT area.

2. LITERATURE REVIEW

2.1 Information Technology (IT)

Van Grembergen, De Haes & Guldentops (2004) explained that Information Technology (IT) provides very important role in the business environment. Information Technology is also described as not only having the potential to support existing business strategies, but also indulge with being able to form new strategies. The existence of IT is not only a factor of success to survive against competition, but also an opportunity to make an organization achieve its competitive advantage. In addition, Mohapatra & Singh (2012) also revealed that IT has developed into an important part of organizational/company resources.

Based on the explanation above, the authors interpret information technology as all hardware, software, and telecommunication networks that can complement the existence of information systems to be utilized by organizations in gaining competitive advantage

2.2 Information Systems (IS)

As stated in Ward & Peppard (2016), information systems are defined as a condition in which people and organizations are able to increase the utilization of technology, so that they can carry out collecting, processing, storing, using and disseminating information activities. Furthermore, Ranier (2014) also defined an information system as an activity carried out to collect, manage, store, analyze, document, and disseminate information for certain needs. Picoli and Pigni (2017) added that there are four fundamental elements or components that must work together in an information system, namely first, information technology which has been explained previously in the previous section; The second component is people/humans which refers to the individuals or

groups who are directly involved in the information system such as end users, managers, or professionals; The third component is the process which is defined as a series of steps required to complete a business activity; And the fourth component is the structure which refers to organizational design (hierarchy) and relationships or communication mechanisms within an organization.

Based on the explanation above, the authors conclude the information system as a series of processes by utilizing technology to collect, manage, store and distribute information needed by the organization.

2.3 Information System Strategic Planning

Cassidy (2005) explained that one of the key factors to success in implementing the IS function to assist an organization for achieving its goals is to make strategic plans. Furthermore, Ward & Peppard (2016) explained the definition of information system strategic planning, that can be interpreted as an activity that aims to study and analyze opportunities and existing resources to gain competitive advantage by utilizing IS/IT.

The business strategy basically determines where an organization's business is going, then the IS strategy determines what applications and information are needed to support the implementation of the business strategy. On the other hand, IT strategy determines how and what is needed by the business strategy and IS strategy that can be fulfilled by using existing technology. Vice versa, the existence of IS/IT in an organization can also be influenced by business strategy or even form a new business strategy.

Based on the explanation above, the authors define information systems strategic planning as an activity to plan the use of IS/IT effectively, efficiently and in line with business processes in order to generate competitive advantage for an organization.

2.4 Ward and Peppard Methods

The Ward & Peppard methodology is the PSSI methodology proposed by John Ward and Joe Peppard in their book. According to Azizi & Sitokdana (2020), this methodology uses an approach from the conditions of IS/IT investments that has been made, nevertheless it does not provide the benefits for achieving organizational goals. The Ward & Peppard methodology also supports a mix of formal and informal techniques. Formal techniques are used when necessary to explore all business elements in a structured way. However, informal techniques are also included to capture innovative ideas that arise in the business, both during the initial strategy process and afterwards.

3. METHODS

This study uses the Ward & Peppard method as previously described. In addition, this research guide is based on previous research, namely Christianti and Harisno, and Ramlan and Hasibuan.

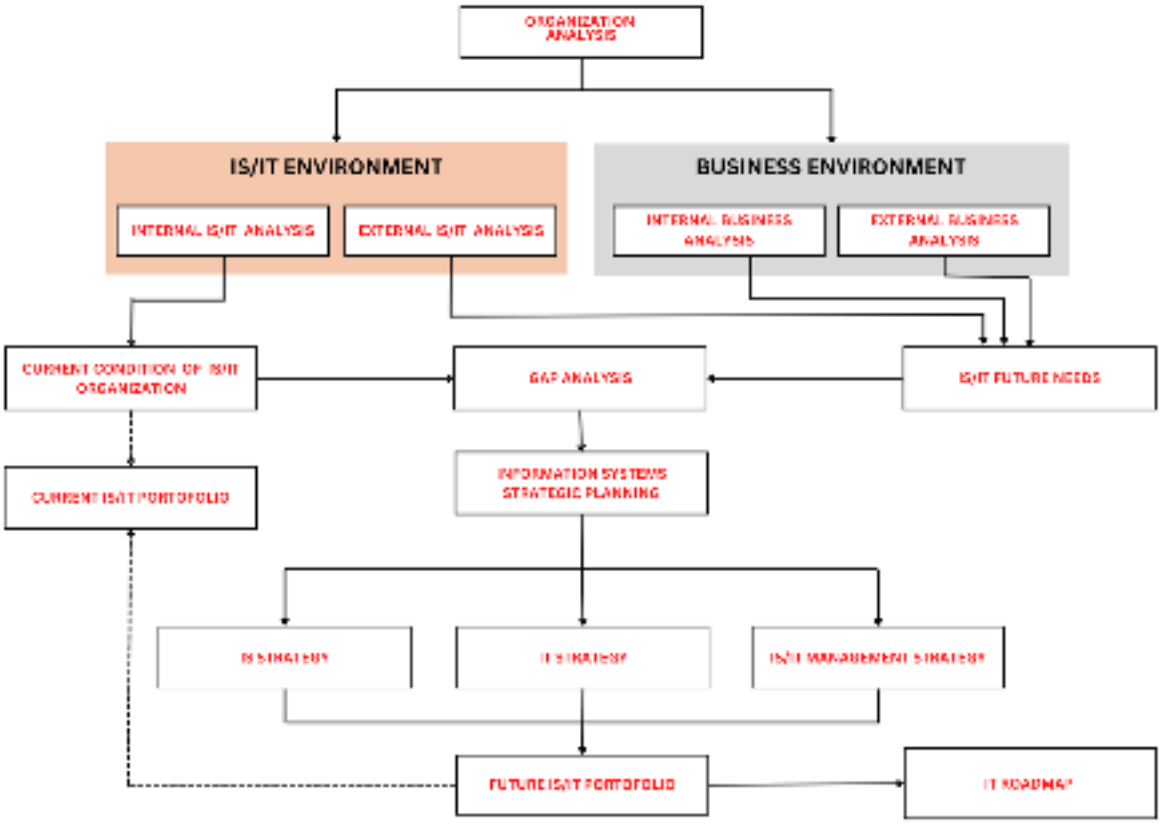

Figure 1. Theoretical Framework

The steps for compiling this research can be seen in Figure 1, starting with analyzing organizational conditions, namely an analysis of the IS/IT environment and an analysis of the business environment. Then carry out an analysis of future IS/IT needs, by developing an information system strategic plan to produce an IS/IT development road map.

Data collection was carried out through Focus Group Discussions (FGD), interviews, questionnaires from individuals and organizations, and observation of an object. In addition, data collection is also obtained indirectly in the form of documents that are related with the information needed regarding business conditions and IS/IT both the internal and external environment of the organization.

Furthermore, before concluding its result, this research also conducts data validation process. From the results of data processing that has been done, a data validation process is carried out to the informants involved. This validation process aims to ensure that the conclusions of the research data are in accordance with what has been conveyed and intended by the sources.

4. RESULTS

Thus, this research uses Mission Model Canvas, Value Chain, Business Process, Critical Success Factor, and the McFarlan Strategic Grid as its analytical methods. Following are the results of the analysis of this study.

4.1 Mission Model Canvas Analysis

Mission Model Canvas (MMC) is a visualization framework for making observations about an organization's business model and for knowing about business parts and business processes. In addition, this tool is the result of an adaptation of the Business Model Canvas (BMC), where BMC

itself focuses more on bringing a mission to non-profit organizations. MMC is used specifically to find out what benefits can be provided by the organization, therefore its not suitable for-profit purpose.

Figure 2. Mission Model Canvas BLU-PIP

4.2 Value Chain Analysis

The purpose of value chain analysis is to understand the series of main activities and supporting activities that carries out an organization's business processes. Value chain analysis in this study refers to the concept of value chain analysis by Michael Porter (1985), but adapted to the place of the case study, namely in government organizations.

Main activities

Acquisition of Channel Partners: acquire potential partners and build partnerships with local governments, institutions or other parties in terms of delivering fund for Ultra Micro Program.
Potential and Risk Analysis: identifying potential and risks from fund distribution partners and debtors through analysis of financing proposals submitted by fund distribution partners (LKBB)
Disbursement of Financing Funds: activity of delivering Ultra Micro financing funds to debtors through LKBB
Education and Assistance: the function of providing educational assistance that aims to provide knowledge for UMi financing beneficiaries.
Reconciliation and Reporting: activities of matching and adjusting reports on the benefits of UMi financing, reports on the performance of UMi financing distribution, reports on the results of cooperation and reports on financing funds.

Supporting Activities

Finance: preparation of work plans and budgets, preparation of business plans and budgets, and management of budgets and finances
Employee Affair: management of human resources within BLU-PIP
Information Technology: management and development of information systems and information technology. This management activity is carried out on software, hardware, network infrastructure inside and outside

General Affair: management of general and domestic affairs, harmonization of internal organizational functions, as well as management of public relations communications and provision of information services.
Procurement: realization and verification of procurement requests in the form of goods and services from each division according to their respective needs to support work.

4.3 Critical Success Factor Analysis

The CSF analysis aims to map IS needs with organizational goals, by analyzing the critical success factors for the organizational mission contained in the BLU-PIP Business Strategy Plan 2020-2024. CSF analysis in this study is used to answer problems related to the use of IS/IT and determine the need for information systems in accordance with organizational goals.

4.4 McFarlan Strategic Grid

The IS application quadrants were determined based on McFarlan Strategic Grid's question indicators on IS development strategy recommendations. Following are the results of McFarlan Strategic Grid analysis for future IS applications.

Table 1. McFarlan Strategic Grid

Strategic	**High Potential**
- *Smart Dashboard* - Pendampingan UMi App - SEMANKA: UMi Disbursement - e-Debt	- e-Cashier
- SIKP-UMi: Disbursement - SIKP-UMi: Funding Management - SIKP-UMi: Monitoring and Evaluation - SIKP-UMi: Fiduciary - Disbursement App - e-Fund - e-Proposal - e-Collect **Key Operational**	- Nadine - HRIS - Finance - STEP - Salam PIP - Website - RUMi - SIMAP - SIPP - e-Track **Support**

Based on the future IS application portfolio, there are 5 (five) applications in the key operational category, 4 (four) applications in the strategic category and 11 (eleven) applications in the support category and 1 (one) application in the high potential category.

4.5 IS Application Architecture Design

The recommended information system architecture design is divided into two, namely UMi financing management services and UMi financing services. This information system architectural design is obtained from the results of an analysis of recommendations on the IS development strategy.

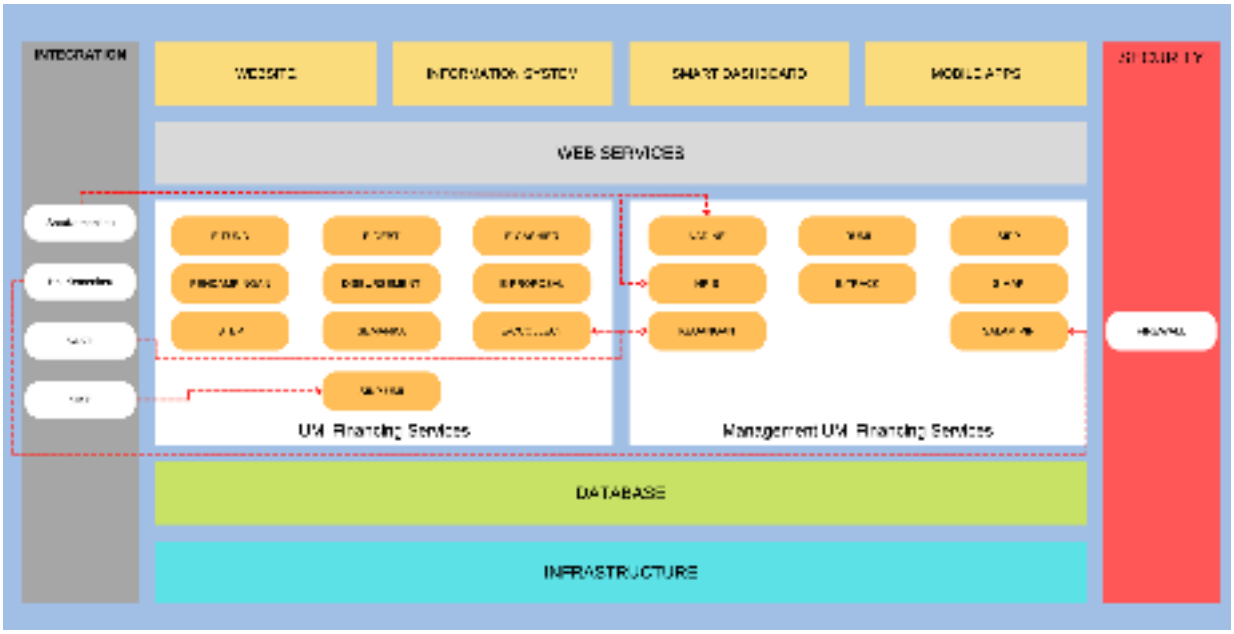

Figure 3. IS Application Architecture Design

UMi Financing Management Services: all application support services for UMi financing management at BLU-PIP.
UMi Financing Services: all service applications related to UMi financing for Ultra Micro financing candidates/beneficiaries.
All information systems included in the components of the two services were built by integrating all UMi management and financing service applications.

4.6 Network Topology

Monitoring the availability of service access requires a system to manage server performance so that it can mitigate unknown server downtime. Server infrastructure development will be carried out separately in the placement of services according to their respective functions, so that server performance can be optimal.

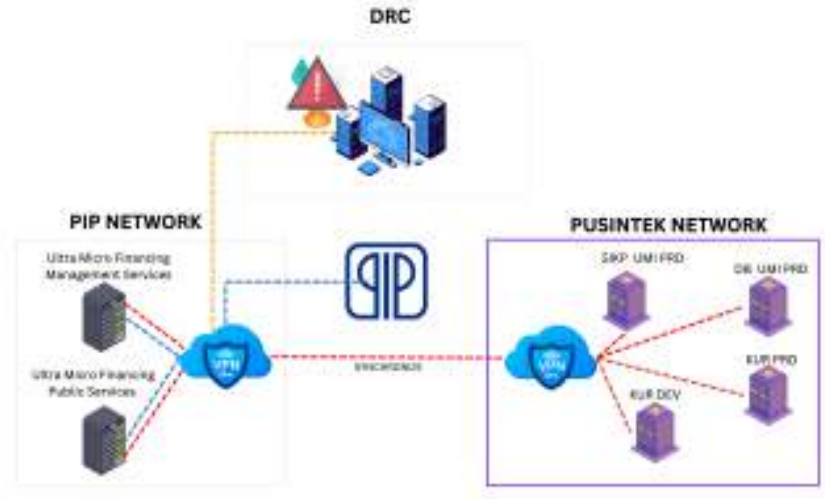

Figure 4. Network Topology

Development of a discover recovery center (DRC) which is recommended to use cloud computing technology. Meanwhile, to address data and information security risk, there are several steps that can be taken, such as using a VPN, SSH private key, antivirus, firewall and SSL. The application of VPN and SSH private keys is carried out to limit access to data and information services available at BLU-PIP. Meanwhile, the installation of antivirus, firewall and SSL is useful for identifying and maintaining data and information security in the BLU-PIP IT network.

4.7 IS, IT Development Strategy and IS/IT Management

Referring to the Decree of the Minister of Finance No. 241/KMK.01 of 2021 concerning the Information and Communication Technology Strategy of the Ministry of Finance for 2021-2024 and Decree of the Chief Information Officer of the Ministry of Finance No. Kep-02/SA.8 of 2021 concerning Implementation of the Ministry of Finance's Information and Communication Technology Strategy for 2021-2024, the authors compiled strategic recommendations.

IS Development Strategies: Implementation of financing distribution mechanisms through digitization, increasing the availability of secure and reliable access to information, implementing applications with collaborative principles, and improving services through user-oriented applications

IT Development Strategies: strengthening IT infrastructure by paying attention to data and information security, as well as improving network quality to accelerate organizational performance

IS/IT Management Development Strategies: Implementation of IS/IT policies and regulations, strengthening IT organization and governance, and improving IT audit management

4.8 Roadmap IT

The IS/IT development roadmap is prepared for a period of 5 (five) years in accordance with the results of the IS/IT recommendations and the IS/IT development strategy obtained in the previous stage. This roadmap has also been mapped to the McFarlan Strategic Grid.

First Year: Initiation of integrated digital service development, the initial stage focuses on information systems development toward to integrated digital services through development of data foundations, applications, infrastructure and build strategic partnerships with prospective/channelling partners. Apart from that, the policies also formulated to support the achievement of integrated digital service development

Second Year: Establish Digitalized UMi Services, this stage focuses on how organizations change its processes that were previously done manually into digital standardization.

Third Year: Strengthening Digitalized UMi Services, continuing the standardized digitization process that has been established in the second year.

Fourth Year: UMi Ecosystem Optimization through governance strengthening, this stage focuses on IT governance strengthening

Fifth Year : Monitoring and evaluating UMi Ecosystem Program, this stage focuses on IT audit activity for evaluation purpose. Moreover, there will be also initiation end-to-end integration for UMi debtors in several priority digital services that will be provided.

5. CONCLUSIONS

Based on the results of the previous discussion, this study resulted in an IS development strategy, an IT development strategy and an IS/IT management strategy. This information system strategic plan recommends 20 (twenty) IS applications needed by BLU-PIP to support business activities. The application consists of 5 (five) applications in the key operational category, 4 (four)

applications in the strategic category and 11 (eleven) applications in the support category and 1 (one) application in the high potential category. In addition, server categorization is carried out according to its function and it is necessary to build a DRC to ensure the continuity and availability of IS/IT services at BLU-PIP. For the IS/IT management area, it is necessary to implement IS/IT policies and regulations guided by the Ministry of Finance's ICT Implementation Strategy. Then, organizational strengthening and IT governance are useful for supporting IS/IT management with adjusted HR capabilities.

The implementation of the information system strategic plan that has been prepared requires the support and involvement of all stakeholders at BLU-PIP, starting from the Head of Division, Director, President Director to the Supervisory Board. Apart from that, cooperation and involvement of employees is also very much needed to create a digital culture, especially in accelerating Ultra Micro financing

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INCREASING THE EFFECTIVENESS OF CNC TURNING MACHINES USING THE OVERALL EQUIPMENT METHOD EFFECTIVENESS (OEE) AND FAULT TREE ANALYSIS (FTA)

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ABSTRACT

The development of the manufacturing industry is increasing every year, of course this makes competition in the manufacturing industry increasingly stringent. This research was conducted at PT. Tjokro Bersaudara Gresik, focused on CNC Turning machines with the type CNC Lathe Machine XTRA 420, namely machines used to produce various types of automotive parts and based on data collected regarding the effectiveness of the machine, it shows that the machine has not fully worked effectively. This is indicated by the presence of downtime data, engine speed reduction data, and product data that does not meet specifications. To find out how good the effectiveness of a machine is, it can measure the OEE value of the machine. Then use FTA (Fault Trees Analysis) in carrying out a quality control approach that is used to track defects in the top-down approach by analyzing system errors from a collection of interacting objects. It can be concluded that the effectiveness rate (OEE) of CNC Turning machines in the January-August 2022 period is between 54.16% to 59.91% with an average of 57.55% (still below the ideal OEE value of 85%) with a percentage six big losses of 42.45%. The recommendations given are repairing the basic causes of each of the six big losses, providing training to operators, and developing a maintenance program.

Keywords: Overall Equipment Effectiveness (OEE), Fault Tree Analysis (FTA), Defect Product

1. INTRODUCTION

The development of the manufacturing industry is increasing every year, of course this makes competition in the manufacturing industry increasingly stringent. Every company must make efforts to improve from several factors, for example increasing the effectiveness of the equipment used as best as possible (Singh, Shah, et al., 2013). The machine used must be in good condition in order to work optimally. To maintain the condition of the machine so that there is no damage or disturbances that cause the production process to stop, good maintenance is needed so that the results can increase the effectiveness of the machine and damage to the machine can be avoided (Azizi, 2015).

Overall Equipment Effectiveness (OEE) is a product of operating activities with six big losses in machines or equipment (Villarinho et al., 2017). The six factors in the six big losses can be grouped into three main components in OEE to be used. In measuring

machine/equipment performance, namely, downtime losses, speed losses and defect losses. OEE is a comprehensive measure that identifies the level of machine/equipment productivity from theoretical performance. This measurement is very important to find out which areas need to be increased in productivity or efficiency of machines or equipment and can also show bottleneck areas in the production line. OEE is also a measurement tool for evaluating and improving the right way to guarantee increased productivity in the use of machines or equipment (Ngadiman et al., 2013).

To find out how good the effectiveness of a machine is, it can measure the OEE value of the machine. OEE measurement is carried out by taking into account three important things, namely the availability rate, performance rate, and quality rate. These three types of factors are generally translated into several types of losses, namely breakdown losses, set up and adjustment, idle and minor stoppage, reduce speed, process defects, and reduce yield. The use of OEE has the main objective to maximize the effectiveness of the equipment. The assessment related to machine OEE following global standards is 90% for the value of the availability rate, 95% for the performance rate, and 99% for the quality rate or 85% for the OEE value of an equipment (Singh, Shah, et al., 2013). The shape of the attachment components produced by CNC Turning machines varies quite a bit both in shape and size, so this has the potential to raise problems related to the machine's availability factor. Quite a variety of attachment components produced by CNC Turning machines if not addressed properly has the potential to cause long setup times and reduced availability of time for production.

This research was conducted at PT. Tjokro Bersaudara Gresik. Many innovations and improvements have been made to the company so as to provide efficient, reliable and high-quality services to customers. This research will focus on CNC Turning machines with the type CNC Lathe Machine XTRA 420, which are machines used to produce various types of automotive parts, such as pistons, gears, etc. Automotive parts are a product that is produced and ordered more than any other product, and based on the data collected regarding the effectiveness of the CNC Turning machine, it shows that this machine has not fully worked effectively. This is indicated by the presence of downtime data, engine speed reduction data, and product data that does not meet specifications. The repairs that have been made are in the replacement of bearings, power packs, pump motors, cooling fans. Apart from that, there are examples of products that are very clearly damaged when the production process is finished, namely gears. The condition of the gears, there is wear and tear on the inner circle of the teeth, the teeth become chipped, There is wear and tear on the ends of the teeth.

2. LITERATURE REVIEW

2.1 CNC machining

CNC stands for Computer Numerically Controlled, which is a machine tool that is equipped with a computer-based mechanical and control system capable of reading code instructions N, G, F, T, etc., where these codes will instruct the CNC machine to work according to program workpiece to be created. In general, the workings of CNC machine tools are no different from conventional machine tools. The function of the CNC in this case replaces the operator's work in conventional machine tools. For example the work of setting the tool or adjusting the chisel movement until it is ready to cut, the cutting movement and the movement back to the initial position, and so on. Likewise, setting the cutting conditions (cutting speed, feed speed and depth of cut) as well as other regulatory functions such as changing the tool, changing the power transmission (number of revolutions of the main shaft), and the direction of rotation of the main shaft, clamping, adjusting the coolant and so on.

2.2 Overall Equipment Effectiveness (OEE)

The performance of a machine can be calculated by calculating the value of Overall Equipment Effectiveness (OEE), which is a total measurement of performance related to the

availability of productivity and quality processes (Villarinho et al., 2017). OEE measurement shows how well a company uses its resources including equipment, workers and the ability to satisfy consumers in terms of delivery according to quality specifications according to consumers.

2.3 Fault Tree Analysis (FTA)

FTA (Fault Trees Analysis) is a quality control approach that is used to track defects in a top-down approach by analyzing system errors from a collection of interacting objects. Control is an activity carried out to monitor activities and ensure the actual performance carried out is in accordance with what was planned Statistical tools in quality control are used to achieve efficiency, so that companies can accept or reject the products produced, by accepting or rejecting product, then an overview of product specifications produced in the general population is obtained. If a good product is obtained, then the production process can take place continuously because the product results obtained are also good

3. METHODS

In looking for problems to be studied it is very necessary to make observations of the problem. Preliminary observations or studies carried out aim to find out more details about the information needed to determine research variables. Based on this information, the stages of solving the existing problems are obtained so that the discussion in this study becomes directed. The steps taken include:

a. Orientation to the company by means of surveys and interviews.
b. Determine the theme of the problem to be examined by conducting a literature study to find and explore the theory concerned with the chosen theme.
c. Carry out an initial survey in the field, which in this case was carried out directly by interviewing the company regarding the actual situation and taking data in the field and adjusting it to the theory that has been studied.
d. Searching for data from companies by collecting as much information as possible about engine damage data related to the research theme, namely overall effectiveness equipment (OEE).

To find out how good the effectiveness of a machine is, it can measure the OEE value of the machine. OEE measurement is carried out by taking into account three important things, namely the availability rate, performance rate, and quality rate. These three types of factors are generally translated into several types of losses, namely breakdown losses, set up and adjustment, idle and minor stoppage, reduce speed, process defects, and reduce yield. The data needed in this method are:

a. Machine working time is the total effective time a printing machine operates in producing products.
b. Planned downtime is time allocated to carry out scheduled maintenance activities so that the condition of machines and other production equipment is in good condition.
c. Failure and repair is the time spent without producing output due to machine or equipment damage and the time needed to repair the machine.
d. Setup and adjustment is the time needed to start production.
e. Data on the number of products per day, is data on the number of products that the company can produce every day.
f. Data on the number of reject and rework products, is data on the number of products that are defective during the production process.

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4. RESULTS

4.1 OEE Calculation Results

The following is a recap of data on OEE values for the period January – August 2022 which can be seen in table 5.1.

Table 1. Data for calculating OEE values for the period January – August 2022

Month	Machine working Time (Hours)	Planned downtime (Hours)	failure & repair (Hours)	Setup & adjust (Hours)	processed amount (unit)	reject (unit)	cycle time (Hours)
January	180	5	0,4	2,6	95	8	1
February	180	5	0,4	2,6	104	12	1
March	180	5	1	2,6	91	5	1
April	189	5,25	0,4	2,7	113	8	1
May	162	4,5	0,3	2,3	116	12	1
June	189	5,25	1,3	2,7	102	10	1
July	171	4,75	0,3	2,4	110	12	1
August	180	5	0,4	2,6	119	12	1
Total	1431	39,75	4,6	20,5	850	79	8

The results of calculating the OEE value of the CNC Turning machine in the period January - August 2022 can be seen in table 5.2. The availability value of the CNC Turning machine is between 77.81% to 81.97% with an average of 80.40%, and overall it is still below the ideal availability value (90%). In this case, the CNC Turning machine still experiences breakdowns and long setup and adjustment times, so it is still possible to increase the availability value by analyzing and repairing the breakdown losses and setup and adjustment losses factors of the CNC Turning machine.

The performance efficiency value of the CNC Turning machine is between 75.93% and 81.07% with an average of 78.29%, and overall it is still below the ideal performance efficiency value (95%). In this case, the CNC Turning machine has not worked according to the speed set by the company, so it is still possible to increase the value of performance efficiency by analyzing and improving the idling factor and minor stoppage losses and reduced speed losses of CNC Turning machines.

The rate of quality products for CNC Turning machines is between 90.68% and 91.67% with an average of 91.42%, and overall is still below the ideal rate of quality products (99%). In this case, the CNC Turning machine still produces products outside the company's specifications, so it is still possible to increase the value of the rate of quality products by analyzing and improving the process defect losses and reduced yield losses of the CNC Turning machine.

Tabel 2. OEE values for the period January – August 2022

Month	Availability Ratio (%)	Performance Efficiency (%)	Quality Ratio (%)	OEE (%)
January	79,83	76,94	91,53	56,22
February	79,32	81,07	92,32	59,37
March	80,6	78,32	91,37	57,67
April	81,53	77,15	90,84	57,14
May	80,7	78,16	91,56	57,75
June	77,81	75,97	91,63	54,16
July	80,51	79,61	91,58	58,69
August	81,86	77,33	91,09	57,67

Average	80,4	78,29	91,42	57,55

The OEE value of the machine is between 54.16% to 59.91% with an average of 57.55%, and overall it is still below the ideal OEE value (85%). In this case, the company (PT Tjokro Bersaudara (Gresik) has a large room for improvement to increase the OEE value by increasing the value of availability, performance efficiency, and rate of product quality.

4.2 Six Big Losses Calculation Results

The results of calculating six big losses for CNC Turning machines in the period January – August 2022 can be seen in table 2. The total time lost during the production process of CNC Turning machines in the January – August 2022 period was 188.19 hours (42.45% of the loading time). Setup and adjustment losses have the largest contribution with a percentage of 43.69% (82.22 hours), followed by idling and minor stoppage losses of 31.23% (58.76 hours), process defect losses of 10.56% (19.88 hours), reduced speed losses of 9.88% (18.60 hours), breakdown losses of 2.48% (4.67 hours), and reduced yield losses which have the smallest contribution of 2.16% (4 .06 hours).

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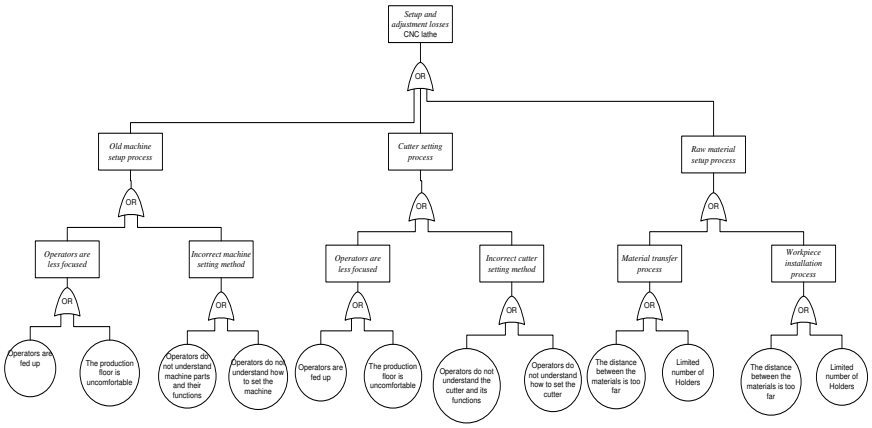
4.3 *Fault Tree Analysis* (FTA)

4.3.1. Setup and Adjustment Losses of CNC Turning Machines

Setup and adjustment losses are losses caused by the length of setup time. There are 3 types of losses that cause setup and adjustment losses of CNC Turning machines, namely the old machine setting process, the old tool setting process, and the old raw material/raw material setup process. The old machine setting process is caused by the operator's lack of focus when setting the machine or because the machine setting method is wrong. The cause of the operator's lack of focus is because the operator is already bored, or because the production floor is uncomfortable. The cause of the wrong machine setting method is because the operator does not understand the parts, machine shape and function, or because the operator does not understand how to set the machine correctly. The long tool setting process is caused by the operator's lack of focus when setting the tool, or because the tool setting method is wrong. The cause of the operator's lack of focus is because the operator is already bored, or because the production floor is uncomfortable. The cause of the wrong tool setting method is because the operator does not understand the tool part and its function, or because the operator does not understand how to set the tool correctly. The process of setting up old raw materials is caused by the process of transferring old raw materials/raw materials, or because of the process of installing raw materials into old raw material buffers. The reason for the long process of moving raw materials is because the distance between the raw materials/raw materials to the raw material supports is far, or because the number of hand pallet trucks is limited. The cause of the process of installing raw materials onto old raw material supports is because the number of manual stackers is limited, or because the operators do not understand how to install raw materials. Fault Tree setup and adjustment losses of the CNC Turning machine can be seen in Figure 1.

4.3.2. Idling and Minor Stoppage Losses for CNC Turning Machines

Idling and minor stoppage losses occur when production is interrupted by a temporary malfunction/damage or when the machine is idle. There are 2 types of losses that cause idling and minor stoppage losses on CNC Turning machines, namely machine settings that don't fit, and tool settings that do not fit. The reason for setting the machine incorrectly is because the position of the machine axle changes horizontally, the position of the machine axle changes vertically, or because the operator does not understand how to set the machine. The reason for the loosening of the tool support nut is due to improper locking of the tool support nut, and



accompanied by high engine vibration. Fault Tree idling and minor stoppage losses for the CNC Turning machine can be seen in Figure 2.

4.3.3 Process Defect Losses CNC Turning Machines

Process defect losses are losses that occur due to defective products during routine production. There are 3 types of losses from process defect losses on CNC Turning machines, namely broken chisels, products not according to size specifications, and machines that break quickly. The factor that causes the chisel to break is due to the setting of the distance between the machine pairs that are not right, or because the raw material/material is not good.

Table 3. Percentage Big Losses of CNC Turning Machines for the January – August 2022 period

NO	*Six Big Losses*	Total Time Losses (Hour)	Percentage of Loading Time (%)	Percentage of Total Time Losses (%)	Percentage of cumulative (%)
1	Setup and Adjustment Losses	82,22	18,55	43,69	43,69
2	Idling and Minor Stoppages Losse	58,76	13,26	31,23	74,91
3	Process Defect Losses	19,88	4,48	10,56	85,48
4	Reduced Speed Losse	18,6	4,2	9,88	95,36
5	Breakdown Losses	4,67	1,05	2,48	97,84
6	Reduced Yield Losses	4,06	0,92	2,16	100,00
Total		188,19	42,45	100,00	

Figure 1. Fault Tree Setup and Adjustment Losses of CNC Lathes

Figure 2. Fault Tree Idling and Minor Stoppage Losses

The reason for setting the machine incorrectly is because the position of the machine axle changes horizontally, the position of the machine axle changes vertically, or because the operator does not understand how to set the machine. The cause of the position of the engine axle changing horizontally is because the engine axle nut is loose, and is accompanied by high engine vibration. The loosened engine nut is caused by improper locking of the axle nut, and is accompanied by a high engine vibration factor.

Meanwhile, the cause of the position of the engine axle changing vertically is because the nut supporting the axle of the engine is loose, or because the rotation of the axle gear is not normal. The loose nut is caused by improper locking of the axle support nut, and is accompanied by high engine vibration. The cause of abnormal axle rotation is because the axle setting nut is loose, or because the bearing is broken. The factor that causes the axle setting nut to loosen is due to improper locking of the axle nut, and accompanied by high engine vibration.

The tool setting does not fit properly because the tool position changes horizontally, vertically, or because the operator does not understand how to properly set the tool. Changes in the position of the tool horizontally, namely a shift of the tool to the left or right, which is caused by a loose tool nut, and is accompanied by high engine vibration. A loose tool nut is caused by improper locking of the tool nut, and is accompanied by high engine vibration. While changes in the position of the tool vertically, namely the increase or decrease in the position of the tool up or down, which is caused by the loose nut supporting the tool, and accompanied by high engine vibration. The reason for the loosening of the tool support nut is due to improper locking of the tool support nut, and accompanied by high engine vibration.

The cause of the machine breaking down quickly is due to blunt chisels, or because the raw materials/materials are not good. Factors that cause blunt chisels are due to the old age of the tool components, or due to high cutting friction. The cause of high cutting friction is because the tool is rarely oiled, or because the chip layer sticks to the tool. Fault Tree process defect losses for the CNC Turning machine can be seen in Figure 3.

4.3.4 Reduced Speed Losses CNC Turning Machines

Reduced speed losses are losses caused by a decrease in equipment speed. There are 4 types of losses that cause reduced speed losses for CNC Turning machines, namely friction between machines with high raw materials, reduced engine rotation speed, abnormal bearing rotation, and high friction between gears.

Friction between machines with high raw materials is caused by the distance between the machines being too close, or because the surface of the machine is dirty. The factor that causes the distance between machines to be too close is because the operator does not understand the allowance for the distance between machines, or because the operator does not understand how to set the machine. The cause of a dirty engine is because the machine is rarely cleaned.

The factor that causes the rotational speed of the motorbike engine to decrease is because the motorbike engine has been used for a long time, or because the condition of the motorbike engine is not well maintained. Abnormal bearing rotation is caused . Fault Tree reduced speed losses of the CNC Turning machine can be seen in Figure 4.

4.3.5 Breakdown of CNC Turning Machine Losses

Breakdown Losses are losses caused by part (component) failure which cannot work anymore and needs to be repaired or replaced. There are 2 types of losses that cause breakdown losses on CNC Turning machines, namely damaged machine surfaces and blunt chisels.

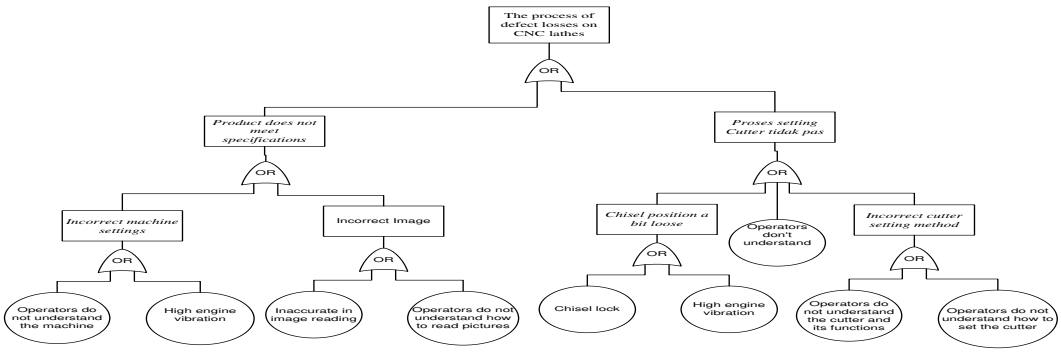


Figure 3. Fault Tree Process Defect Losses

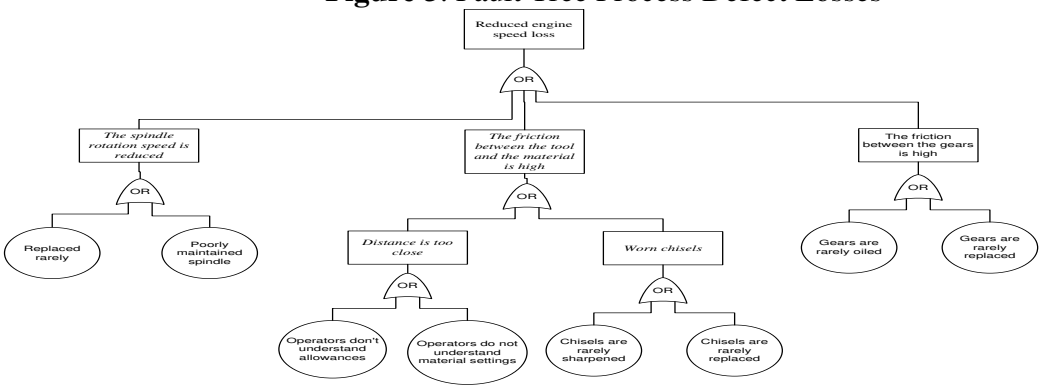


Figure 4. Fault Tree Reduced Speed Losses

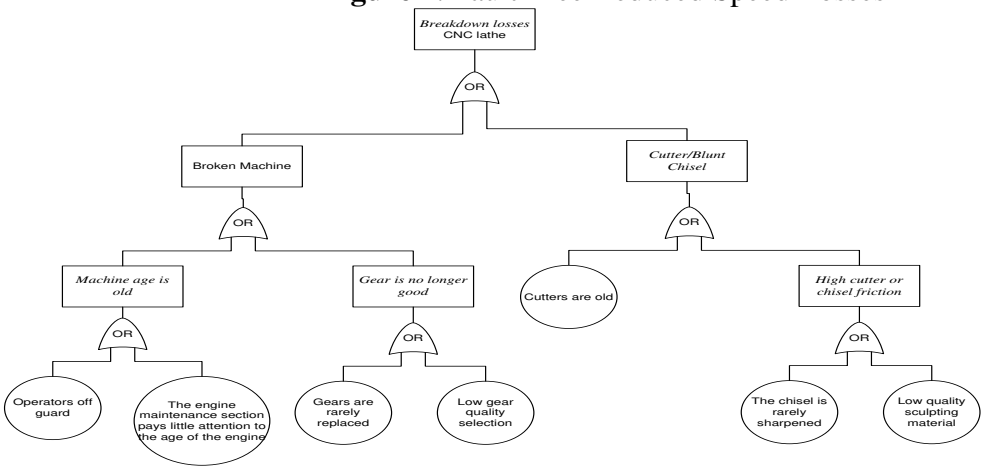


Figure 5. Fault Tree Breakdown Losses

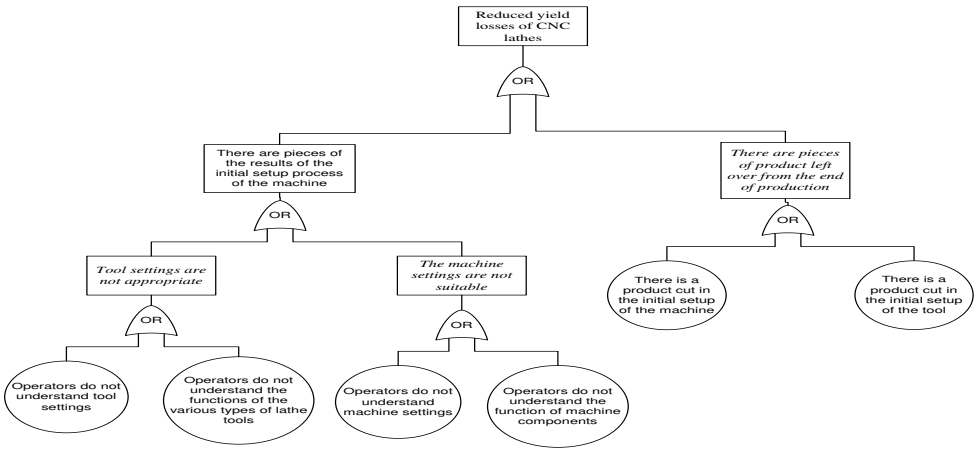


Figure 6. Fault Tree Reduced Yield Losses

Blunt chisels are caused by the age of the tool components for a long time, or because of high cutting friction.

5. CONCLUSIONS

Based on the analysis and discussion that has been carried out, it can be concluded that the effectiveness level (OEE) of CNC Turning machines in the January-August 2022 period is between 54.16% to 59.91% with an average of 57.55% (still below ideal OEE value of 85%) with a percentage of six big losses of 42.45%. Factors causing the six big losses of CNC Turning machines, including factors that cause setup and adjustment losses, factors causing breakdown losses, factors causing reduced yield losses.

Recommendations for improvements given to increase the level of effectiveness of the CNC Turning machine, namely eliminating the six big losses of the CNC Turning machine through the improvements given to the basic causes of each of the six big losses, developing a maintenance program to maintain and maintain the machine in its best condition, and increasing the ability machine operation and maintenance by conducting training to all machine operators.

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DWIPA II+ : Ontology-based Mobile Intelligent Recommender System for Tourist Itineraries in the Borobudur Temple Area

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ABSTRACT

Planning an itinerary for tourists is a challenging task, specifically for those with little or no experience in visiting tourist destinations. Today's increasing amount of information on the Internet with regard to tourist destinations makes this task even more difficult. Efforts have been made to organize information and knowledge, especially in the field of tourism; for example, by managing tourism knowledge into an ontology as developed by Dwipa Ontology. Furthermore, the advance of mobile technology has inevitably become part of everyday life, especially for tourists when looking for destinations or even sharing travel experiences through social media platforms. Thus, there are still opportunities to utilize the knowledge base (ontology) as a source of knowledge for recommendation systems supported by mobile application technology. This paper discusses the design of an intelligent mobile application named Dwipa II+ that can provide recommendations regarding travel by utilizing a knowledge base (ontology). This application was developed using the Rapid Application Development (RAD) method by implementing microservices concept and offers various features for users. Dwipa II+ has been tested using the black-box testing technique, and the results show that the application can provide itinerary recommendations for specific tourist destinations in the Borobudur Temple area, Central Java.

Keywords: Intelligent Recommender System, Ontology, Dwipa II+, Rapid Application Development, Tourism.

1. INTRODUCTION

As stated in the Indonesian law, tourism is a variety of activities that are supported by various facilities and services provided by the community, businessmen, government and local government. In Indonesia, there are 10 priority tourist spots declared by the ministry of tourism in 2015. In response to the development of the tourism sector of Indonesia, one alternative solution has been developed in order to promote tourism via the Internet/ digital platform known as E-Tourism (Seppianta, 2013). However, this technology had not received special attention from various parties engaged in tourism. The major obstacles in implementing E-Tourism in Indonesia was to provide contextual information (knowledge) for tourists when they plan to visit tourism destinations in Indonesia (Augie & Andeka, 2006).

To address the deficiencies of e-Tourism's knowledge in Indonesia, Kuntarto and Gunawan in their research in 2012, built a DWIPA Ontology which is an ontology (knowledge-base) consisting of contextual information of various tourism domains and storing information regarding to accommodations, attractions and cultural events in Bali which is one of the main tourist

destination in Indonesia (Kuntarto & Gunawan, 2012). The DWIPA Ontology has transformed through a population and enrichment process in order to expand its classes and instances. The recent ontology named: DWIPA III Ontology (Kuntarto et al., 2017) was also developed by adopting the ontology learning methodology consisting of ontology enrichment and population process with the final result of having 15 Subclasses and 199 Instances. The new concepts/ classes have been added to the initial ontology named: accommodation, events, activities, amenities, weather and provinces with additional populations of tourist instances including Lake Toba in North Sumatra, Borobudur Temple in Yogyakarta, Tanjung Kelayang in Bangka Belitung, Seribu Islands in DKI Jakarta, Tanjung Lesung in Banten, Mandalika in West Nusa Tenggara , Bromo Tengger Semeru in East Java, Wakatobi in Southeast Sulawesi, Morotai Island in North Maluku and Labuan Bajo in East Nusa Tenggara.

Today's increasing amount of information on the Internet with regard to tourist destinations makes this task even more difficult. Efforts have been made to organize information and knowledge, especially in the field of tourism; for example, by managing tourism knowledge into an ontology as developed by Dwipa Ontology (Kuntarto et al., 2017). Furthermore, the advance of mobile technology has inevitably become part of everyday life, especially for tourists when looking for destinations or even sharing travel experiences through social media platforms. Thus, there are still opportunities to utilize the knowledge base (ontology) as a source of knowledge for recommendation systems supported by mobile application technology. This paper discusses the design of an intelligent mobile application named Dwipa II+ that can provide recommendations regarding travel by utilizing a knowledge base (ontology).

2. LITERATURE REVIEW

In 2017, Lee et al succeeded in building an ontology-based travel recommendation system. The main problem that this research tries to solve is trying to minimize the gap between the ease of travel information provided by most search engines on the Internet and the low feedback provided by these machines which is obtained from the keywords entered by users to obtain information. The system is designed by implementing semantic web technology and ontology as a travel knowledge base using the Resources Description Framework (RDF) format which summarizes location, lodging, attractions, departure and tourist transportation variables with the SPARQL query language and Fuseki server operated with the ASP.NET platform. The result is a tourism recommendation system that allows users to obtain information effectively and enjoy fun tours according to user needs (Lee et al., 2017).

In 2018, Khallouki et al have succeeded in building an ontology-based recommendation system in the tourism domain. In addition, ontology is used as a system knowledge base to provide context awareness for tourists. This is made possible by implementing Internet of Things (IoT) based technology with semantic web technology. This research resulted in a recommendation architecture system design that uses Ontology Web Languages (OWL) to provide context for tourists. The recommendation system algorithm developed uses several variables such as health facilities, attractions, transportation, location and geographic items that are queried using SPARQL (Khallouki et al., 2018).

Table 1. Related Works on Recommender System for Tourism

Year	Authors	Supported by Ontology	Semantic Web Query-based	Platform
2017	Lee et al	RDF	SPARQL	Web-Based (ASP.NET)
2018	Khallouki et al	OWL	SPARQL	IoT
2021	Castellanos et al	Triplestore	Triplestore Query	Web-Based (Java)
2022	Nan et al	None	None	Web (Data Mining)

The recommendation system has become a suitable application to assist travelers in their travel planning. However, the system still has limitations, such as in terms of providing inaccurate judgments regarding user profiles (age) and context, predictability of their suggestions, and lack of a standardized representation of managed knowledge. In 2021, Castellanos et al proposed a textured user-centered recommender system architecture, which supports the PULL (tourists actively retrieve the information they need) and PUSH (visitors are presented with information according to preferences) approaches, and assisted by ontology-based deployment activation algorithms to context-aware recommendations, focusing on predictable decreases in output and coincidental increases, based on aging-like approaches. This system is named RECESO which implements the PULL and PUSH techniques so that the system can increase the serendipity value. As a result, the recommended items have relevance, update value, as well as items that are liked and in accordance with the interests of tourists who use the system. To demonstrate its suitability and performance, the first prototype Java-based architecture has been developed with Fuseki Server and Apache Jena connected to the triplestore and simulating various scenarios, various user profiles, preferences and context parameters. The results show that the proposed ontology-based deployment activation and aging system provides recommendations that are relevant and vary according to user preferences (Castellanos et al., 2021).

In 2022 Nan et al have conducted research which resulted in a recommendation system that provides travel information for individuals and groups. The resulting system successfully combines data mining and recommendation system algorithms used to analyze data so that it can provide recommendations to tourists regarding affordable travel packages, location, distance, and time personally. The recommendation system algorithm used is collaborative filtering. To ensure seamless data analysis, current, available, and forecast data are analyzed together using a variety of different representations. In a multi data representation, missing/overhead causes context files to be identified. Based on identification, mining is carried out; redundant data overflow was filtered out using update knowledge at successive recommendation intervals. From data validation, it can be seen that the proposed process achieves 8.26% high accuracy, 7.41% high data handling rate, 10.47% less mining time, and 12.35% less overhead (Nan et al., 2022).

3. METHODS

Based on the literature study that has been conducted, there is still an opportunity to build a recommendation system based on a mobile application using ontology (OWL) as a knowledge base about tourism which is named Dwipa II+. The Rapid Application Development (RAD) method is used as the main method in designing and building applications. This method was chosen because it has several advantages, namely that it can be used by developers to create a fully operational system without adjusting features, speed or performance characteristics in a very short time. There are three phases which adapted from the RAD method in order to development an

ontology-based intelligence recommender system named Dwipa II+, namely 1) Requirements Planning Stage, 2) User Design Stage, and 3) Construction Phase (Mohd Isa et al., 2021).

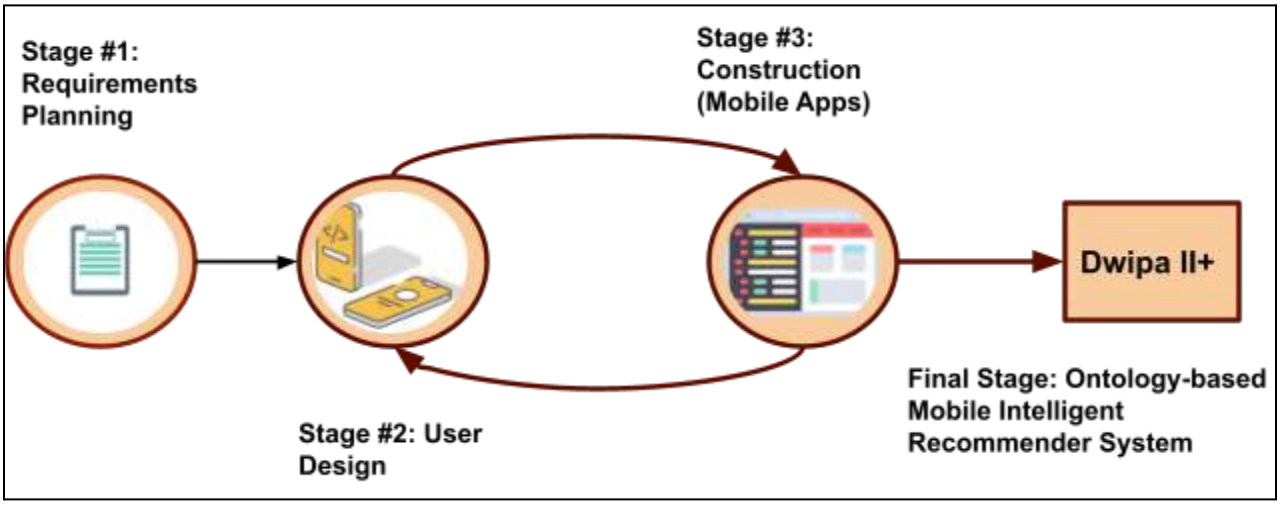

Figure 1. Dwipa II+ development stages based on the RAD Methodology

4. RESULTS

According to Rapid Application Development method, Dwipa II+ is developed through several stages: 1) requirements planning which produces a list of system requirements from both functional and non-functional aspects; 2) user design which articulates the list of requirements into system design including: use case diagrams, activity diagrams, system architecture, and system interface design; 3) construction of an ontology-based intelligent recommendation system using the IONIC framework. The detail of each stage is explained in the following subsections.

4.1 Requirements Planning of Dwipa II+

At the planning stage all the requirements for the Dwipa II+ recommendation system are formulated into a list of functional and non-functional requirements. Functional Requirements consist of several main functions that are interconnected and support one to another. Generally, the list of functional requirements is formulated into three categories: 1) the main feature of the recommender system 2) Travel planner feature and 3) General features.

First, the application must be able to provide recommendations to users in the form of locations, destinations and points-of-interest (POI) according to user preferences which are queried from the travel knowledge base named Dwipa Ontology. This ontology contains approximately 3000 instances and 6 classes consisting of accommodation, attractions, activities, amenities, provinces and weather reports which are focused on the tourist area of Borobudur Temple and its surroundings (Kuntarto et al., 2017). Second, the application can provide travel planning features: pre-departure to a tourist destination, while at a tourist destination (on-site) and post-visiting a tourist destination as well as viewing the user's travel history. Third, the application must be able to provide general features such as: new users registration, login/logout, user profiles and settings, create and view posts, as well as to give comments and likes on posts shared by other users. In addition to functional requirements, the non-functional requirements also play an important key feature on the application that supports functional requirements such as security and usability.

4.2 User Design of Dwipa II+

The second and third stages: user design and construction, are iterative stages. At the user design stage, use case diagrams and activity diagrams are produced which illustrate how the Dwipa II+ application works and what features can be used by users. In addition, the list of requirements is translated into the Dwipa II+ system architecture to provide guidance for the developers.

4.2.1 Use Case Diagram of Dwipa II+

Figure 2 shows Dwipa II+ application use case diagram. Based on the use case, users can register through the application before using the functions provided by the Dwipa II+ application. After the user has finished registering, the user will get the credentials used to access the application through the login feature. There are six use cases provided by the application including: comment, like, upload image, create plan, view history trip and view trip plan. Generally, the six use cases can be classified into two categories: 1) the main use case and 2) the auxiliaries use case. The main use case is to compile travel itineraries recommended by the Dwipa II+ core engine as well as to look at the history of the tours the users have made previously. Another use case provided by Dwipa II+ named auxiliaries use case where the users can also post pictures complete with its captions and share them via the application's home page (story). Only registered users are able to give comments and likes on the story of other users.

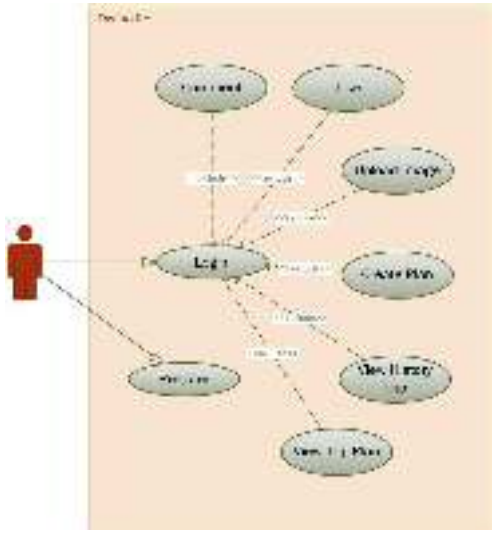

Figure 2. Dwipa II+ Use Case Diagram

4.2.2 Activity Diagram of Dwipa II+

Figure 3 shows the activity diagram of the Dwipa II+ mobile application. The activity diagram depicts the activities of a tourist as a user in using the Dwipa II+ mobile application that is directly connected to the Dwipa II+ server via Dwipa II+ gateway or Application Programming Interface (API). As explained in the use case diagram, only registered users can use the features provided by the application. After the user logs in, Dwipa Gateway will validate the credentials entered by the user. If the validation process is successful then the next process will be handled by Dwipa Server to carry out the user authentication process. This is done to ensure security, which is an important component of non-functional requirements. After the authentication process is

successful, the user can arrange travel plans. The plans that have been prepared are then validated by the Dwipa Gateway and forwarded to the Dwipa Server for the proposed travel itinerary to be executed. Users can then choose the desired tourist destinations in one travel trip per day. Dwipa Gateway will then check into the OWL whether the destination specified by the user is available in the knowledge base or not. Currently, tourist sites are limited to the Borobudur Temple area located in Central Java Province. If the destination is found by the smart system, then the tour can be copied and the user can enter several Points-Of-Interest (POI) that are expected to be visited in one day. After that, the intelligent recommendation system will calculate and sort the POI based on the initial and final route distances set by the user. If the user agrees to the recommendations given by the application, a list of travel trips will appear in the trip plan menu. Conversely, users can edit POIs if there are recommendations that are not in accordance with user preferences.

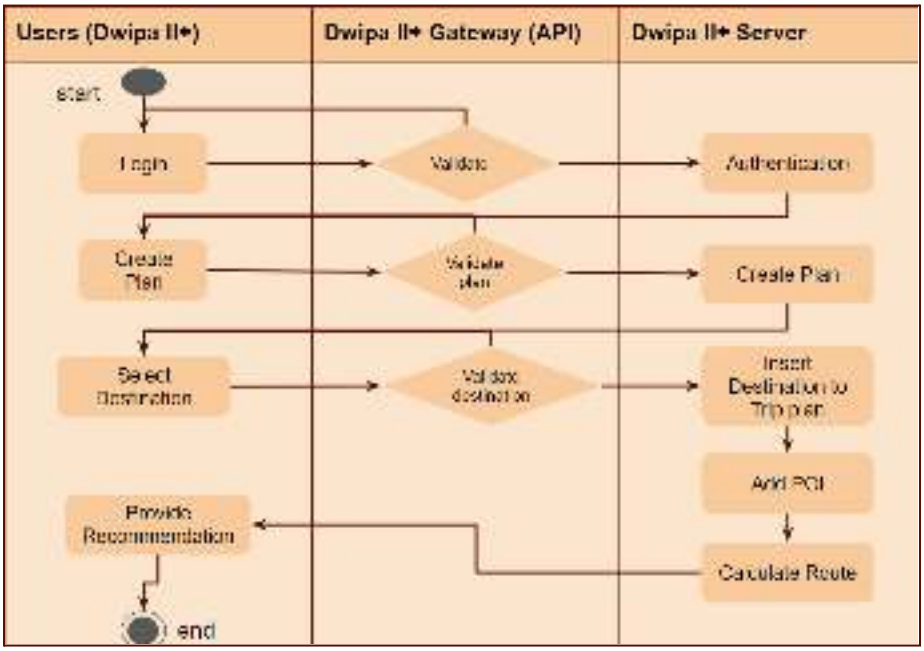

Figure 3. Dwipa II+ Activity Diagram

4.2.3 Architecture System of Dwipa II+

The Dwipa II+ architecture system uses a 3-tier architectural model as shown in Figure 4. The first layer of the architectural block is the data layer. The data layer functions to ensure the availability of data and knowledge. The document database technology, namely MongoDB, was chosen to store user-generated data such as posts, comments, likes and images. While the knowledge base is stored in Ontology Web Languages (OWL) format as described in sub-section 4.1. The second layer is the back-end layer. This layer serves as a link between the interface and the data layer. To limit access to the database layer, a gateway/ API is used: Dwipa API while providing convenience for data interoperability to function. Dwipa API with programming language NodeJS minimum version 12.13.1 (LTS). Meanwhile application queries to the knowledge base (OWL) use a GraphQL-based gateway through the graphql-to-sparql module version 3.0.1 in order to convey SPARQL 1.1 to Dwipa API. These two intermediary applications are run using the microservices concept so that they can isolate errors when a service failure occurs and provide convenience options from a scalability perspective. GraphQL service can be

accessed by users only via Dwipa API. This is intended to keep the knowledge base secure from external direct access. The third layer is the front-end layer which is accessed directly by users through the mobile application platform (Android).

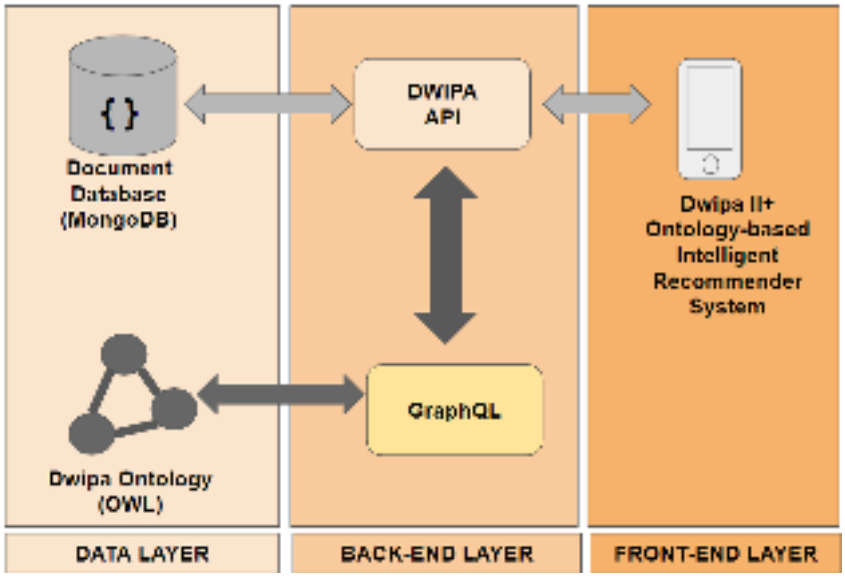

Figure 4. Dwipa II+ Architecture System

4.2.4 System Interface Design of Dwipa II+

Figure 5 shows the interface design of the Dwipa II+ mobile application. The Dwipa II+ mobile application consists of several pages, including the Splash Screen, Welcome page, Login, Registration, Forget Password, Home, Activity (Create Plan, Trip List, Ongoing Trip, Maps), Recommended, Settings (Profile and History), and Terms of Service. The wireframe design is based on the main function of the Dwipa II+ application which can be categorized into 3 sections: 1) Registration and Login; 2) home screen and supporting features such as (settings and profile); 3) The main features consist of the Activity menu (making plans, lists of tourist itineraries, on-going tourist trips and this information is displayed in a map-based visualization). In addition, there are other features of the recommendation system which are displayed in a map format and a list of recommendations that can be sorted according to the distance to the destination location based on the user's position.

Figure 5. Dwipa II+ System Interface Design

4.3 Construction of Dwipa II+

Dwipa II+ is developed by using a hybrid framework. It is a very useful framework to make it easy for developers to translate system architecture into a line of code and compile the code into a mobile application that runs on Android or iPhone platform. Figure 6 shows the results of the program code developed using the IONIC framework based on the wireframe that was generated at the application interface design stage and was successfully released using the Android platform. In general, Dwipa II+ provides four main menus: 1) Home which contains a list of posts in the form of images complete with captions; 2) Activity: provides features for making travel plans (pre-travel, during travel and post-travel); 3) The recommendations menu provides travel recommendations that are processed using the Dwipa Ontology core knowledge engine and 4) the settings menu which contains application settings and user profile columns.

Figure 6. The final Interface of Dwipa II+

At the final stage, the functional and non-functional features of the intelligence recommender system are tested according to the list of requirements as a released product (alpha version). The testing results of Dwipa II+ mobile application is summarized in Table 2.

Table 2. Dwipa II+ Test Results

No.	Objective	Description	Expected Result	Actual Results		Issues
				Success	Failed	
1	Splash screen	Splash screen with Dwipa logo	Display splash screen when application is open	✓		-
2	Welcome Page	Welcome page displays Dwipa features	Display Dwipa features	✓		-
3	Login	Input email and password to the login page	Display home page	✓		-
4	Registration	Input field on registration form	User manages to register new account	✓		-

No.	Objective	Description	Expected Result	Actual Results		Issues
				Success	Failed	
5	Home	Home page containing photos feed and caption from various destinations	Display photos feed and captions	✓		-
6	Create Plan	Create trip plan	Display trip list based on user input (name, destination, interest, and date)	✓		-
7	Trip list	Trip list home page contains list of trips created by the user	Display a list of trips	✓		-
8	Maps Trip Plan	Display maps containing POI based on user input	Display POI nearby Candi Borobudur Temple such as Toko Albasia Seganan, Sami Jaya Rental Mobil, Olive Chicken Borobudur, Berlian Homestore, Nasi Goreng Pak Parno and ATM BNI	✓		-
9	Ongoing Trip	Ongoing trip	Display ongoing trips	✓		-

5. CONCLUSIONS

Dwipa II+ application has been developed and tested to help tourists overcome difficulties in selecting and obtaining information or recommendations about tourist trips to destinations in Indonesia. Additionally, another problem faced by tourists is sorting preferences when traveling. The last problem frequently encountered by tourists is the information about planned, executed, and completed journeys is often scattered and unorganized. This intelligence system is intended to address travel-related problems frequently faced by tourists by providing recommendations nearby at the Borobudur Temple Area of 1) tourist destinations, 2) user preferences, 3) tourist amenities: Automated Teller Machines; activities: shopping for batik, souvenirs/ gifts, and car rentals. Additionally, the system provides features to help tourists make decisions during pre-travel: previewing recommended trips, during travel: taking pictures/photos and adding descriptions to tourist photos, and after the trip: storing all travel activities in historical activities for sharing with other tourists.

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Model Business Integration Model and BSC Framework in Construction Industry

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ABSTRACT

PT XYZ is a company founded in 2014 which is engaged in the mechanical and electrical sector as an infrastructure system provider as well as a Data Center and Smart City contractor. Based on company data, a decrease in company revenue was found. One effort to evaluate the company is to measure the company's performance. In this study tested and described the business model using the Business Model Canvas (BMC) company PT. XYZ. Implementation of performance measurement is used to find out how much effort the company is doing, to find out the company's performance using the Balanced Scorecard (BSC), so that it can be used as a direction for the company's strategy. This study used an exploratory approach with interviews with the Directors and questionnaires with employees of PT. XYZ. The results obtained from the research were to produce 13 (thirteen) strategic objectives, through these strategic objectives, 13 Key Performance Indicators were produced consisting of 3 KPIs from a financial perspective, 2 KPIs from a customer perspective, 5 KPIs from an internal business process perspective, and 3 KPIs from a customer perspective. learning and growth

Keywords: Balanced Scorecard, Business Model Canvas, Performance Measure

1. INTRODUCTION

The business climate in Indonesiain the current era of globalization growing. This development also occurred in the contractor sector. East Java Province has the most construction companies during the 2020-2021 period. Companies need to innovate, stay ahead, and be in a competitive position to survive and gain market share in the industry. Every company that wants to excel in the industry, it is important to have a unique value-added in order to gain profits and dominate the industry.

PT. XYZ is a company engaged in the field of integration solutions. The focus of the company's work is on mechanical and electrical projects, construction. Some of the superior products include the integration of network infrastructure functions, data centers and applications. This industry is popularly known as engineering, procurement and construction (EPC) in the fields of Data Center and Smart City, HVAC Services, Electrical Systems, Access Control & Security, Raised Floor Systems, Server Cabinet Rack Systems, and Cable Tray Systems. PT. BBI experienced several problems in managing the company including: the company's financial health problems caused by declining profits and long-term investment errors. For that PT. XYZ needs to describe its

business model and carry out performance measurements to determine the effectiveness and efficiency of its organization, both programs, business processes and available resources.

One method that can be used in performance measurement is the balanced scorecard (BSC). BSC is a management tool that can help companies identify their vision and strategy and turn them into action. the design of performance measurement through the integration of BMC and BSC is expected to be able to assess company performance holistically so that it can be used by management as a guide in achieving strategic performance management.

2. LITERATURE REVIEW

2.1 Corporate Strategy

Strategy is the art and knowledge of formulating, implementing, and evaluating decisions in an organization.

2.1.1 Business Model Canvas BMC)

The business model is a hypothesis of how a company has long-term income, what are its products, who buys its products, the technology used, how to invest, how to get income, and how to finance it.Based on a book entitled "Business Canvas Generation", there is a canvas model approach, namely "nine building blocks" consisting of value prepositions, customer segments, customer relationships, channels, key resources, key activities, key partnerships, cost structures, and revenue streams (Osterwalder et al., 2010). These nine blocks cover four main areas of business namely customers, supply, infrastructure and financial feasibility (Osterwalder et al., 2010).

2.2 Performance Management

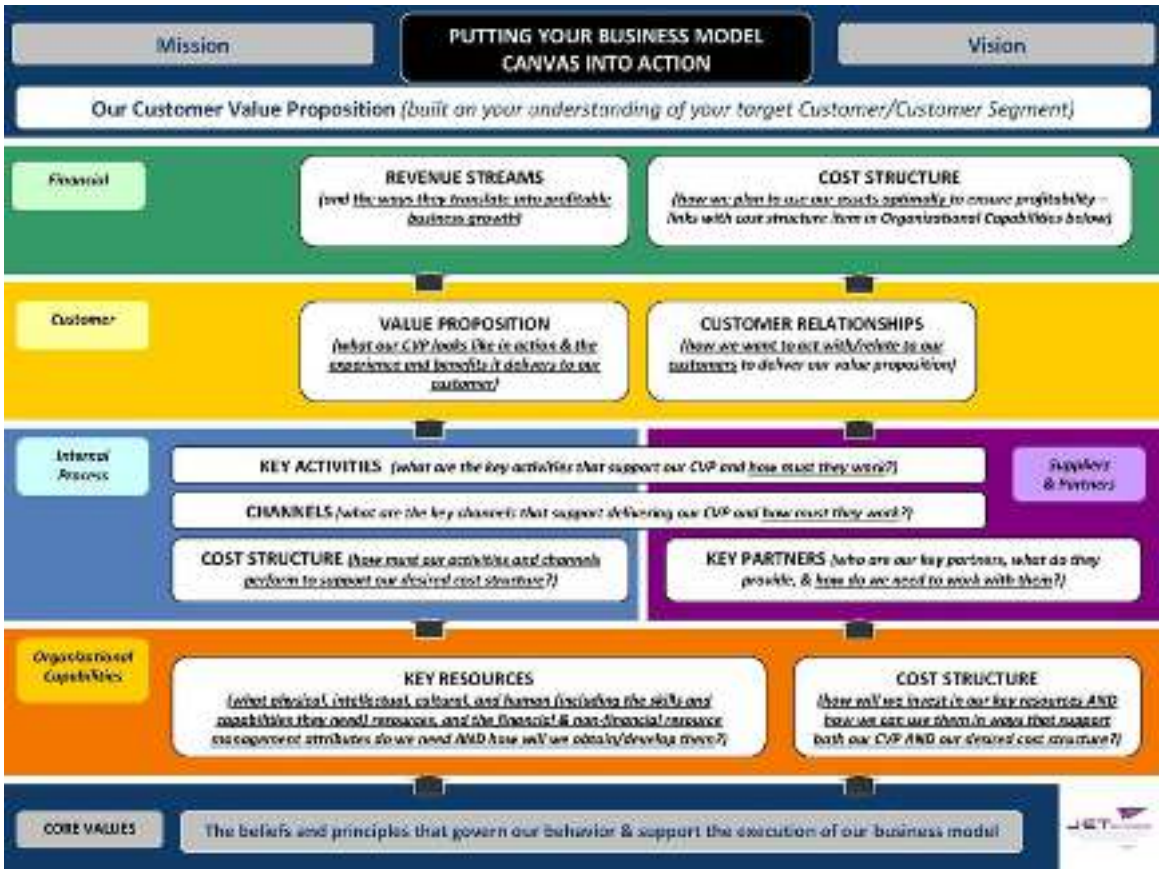
Performance (work achievement) is a result of work achieved by a person in carrying out the responsibilities assigned to him based on skill, experience and sincerity as well as time.

2.2.1 Balanced Scorecard (BSC)

Strategic management system In the form of a new framework that integrates various measures derived from a company's strategy(Hansen & Maryanne, 2009). customer perspectives, internal business processes, and learning and growth derived from the process of translating corporate strategies that are carried out in a structured manner to achieve company goals (Kaplan, 2009). Balanced Scorecard Describes a Management system that integrates vision, strategy, and the four perspectives in a balanced manner.

2.3 Integration of Business Model Canvas and Balanced Scorecard

To integrate BMC and BSC in this study, the concept proposed by Richardson (2014) was developed which shows pictures and directions in translating BMC to BSC as shown in Figure 1. Richardson (2014), provides an understanding so that BMC can be measured and followed up on its business model.



Figures1. nine building blocks from the business model canvas translated to a strategy map

2.4 Structural Equation Modeling (SEM) Method

SEM is a multivariate statistical technique which is a combination of factor analysis and regression (correlation) analysis, which aims to examine the relationships between variables in a model, both between indicators and constructs, or relationships between constructs (Santoso & Bina Nusantara Desman Hidayat, 2019). Based on the data collected in this study, it will be analyzed using quantitative methods, namely the structural model using the Partial Least Square (PLS) Program. According to Ghozali (2006) PLS is an alternative approach that shifts from a covariance-based SEM approach to a variant-based one, covariance-based SEM generally tests causality/theory, while PLS is more of a predictive model.

3. METHODS

1. Identification Phase

researchers make observations and analyze the existing conditions of the company. researchers identify problems related to the development of the required business model with the aim of knowing the condition and performance of PT. XYZ.

2. Data Collection Phase

Data collection was carried out by direct interviews with expert judgment to obtain the existing business model of PT. XYZ based on BMC and questionnaires distributed via google form, respondents to the questionnaire are active employees at PT. XYZ.

3. Data Processing Phase.

The results of the questionnaire are used as the basis for designing the BMC. Translate BMC to BSC based on literature study. At this stage, the company's objective strategy is designed

according to the problems faced by the company. In addition, this stage also designs KPIs and targets from each Objective Strategy. Then, validation of each Objective Strategy was carried out using SEM-PLS. Validation is carried out to determine the linkages and relationships between the Objective Strategies.

4. Analysis Phase.

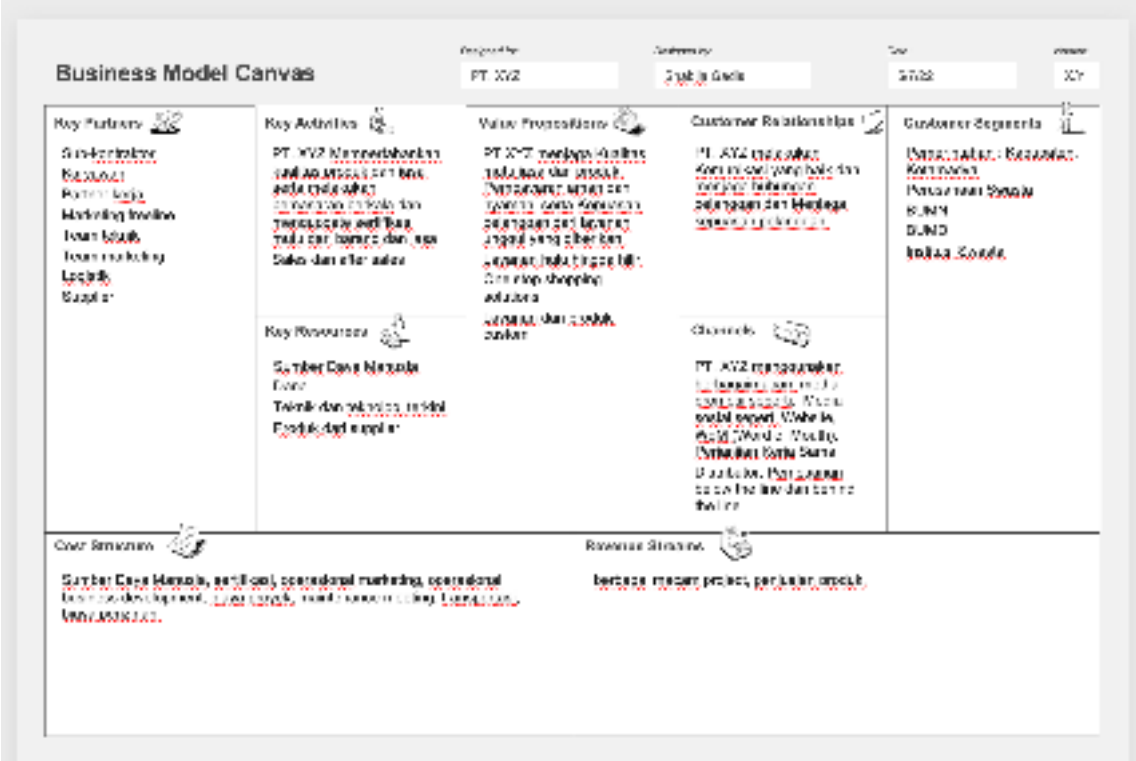
After collecting data and conducting descriptive analysis, the results of data analysis are used to formulate the BSC, this formulation is carried out by knowing the linkages and relationships between the Objective Strategy and the BSC weighting

4. RESULTS

4.1 Existing Conditions of the Company

Based on financial data for 2017-2021 T. XYZ has financial problems, namely an increase and decrease in net profit and an increase in company liabilitiesThis resulted in untimely payments by employers to PT. XYZ, so that PT XYZ's trade receivables were not paid on time to stakeholders. On the customer aspect, PT. XYZ has customers from private companies to government agencies. In terms of production, the problems encountered were production planning that was not carried out properly, one of the causes was the availability of capital needed for production activities in the purchase of raw materials. Because of this, the purchase of raw materials experienced delays and the implementation of production experienced a setback in time.

4.2 Company Business Model Canvas



Figures2. BMC PT. XYZ

Figure 2 is a description of BMC PT. XYZ which has nine blocks.

4.2.1 Value Propositions

Value Propositions are products and services produced by PT. XYZ for customers, namely design and contractor services specializing in quality and reliable command centers, smart cities, and data centers. In addition, PT. XYZ also has capabilities in creating IT infrastructure, data integration services, applications, and assistance in change management. The services provided are carried out by experts in their respective fields, which guarantee customer satisfaction.

4.2.2 Customer Segments

PT. XYZ is a company, government, institution, agency or institution, especially those that apply and require modern technology.

4.2.3 Customer Relations

Customer relationships or relationships with customers is the strategy of PT. XYZ is in a good relationship with its customers. The activities carried out by the company include active interactions with customers through their channels, always active to support positive social issues, active in the community and society, has an active customer loyalty system, and maintains good communication with existing customers to may use the company's services in the future

4.2.4 Channels

Through channels, the company serves consultations, orders, cooperation, and offers to customers. Channels from PT. XYZ includes online media, namely websites and social media, while offline channels include Word of Mouth (WoM), distributors, print media.

4.2.5 Revenue Streams

Revenue Streams or income generated by PT. XYZ is obtained from project work and product sales produced by the company. Services include interior design, civil contractor services, architecture, construction, furniture, hardware, software, and systems.

4.2.6 Key Resources

Key resources or main resources owned by PT. XYZ is currently Human Resources, the latest technology and innovation, high-quality material products, as well as adequate machinery and equipment. The human resources of the company are experts in their fields, ranging from architects, designers, civil engineers, drafters, 3d artists, cost estimators, admin, finance, to PA.

4.2.7 Key Partners

Key Partners from PT. XYZ includes work partners such as sub-contractors, logistics partners, material suppliers for smart city work, command centers and data centers, electrical material suppliers, equipment and machine suppliers for work.

4.2.8 Key Activities

Key activities or key activities carried out by PT. XYZ to achieve business goals starts from marketing activities or marketing of products and services provided by the company. The main activity carried out by the company is the company's operations ranging from architectural and interior design, contractor and civil services, to administrative and financial operations

4.2.9 Cost Structure

Cost structures or expenses from PT. XYZ in carrying out business processes includes human resources who play a role in company organizations, operational marketing activities for business marketing, project work costs, technology investments to support project work, overhead costs from companies including maintenance and transportation, licensing costs, infrastructure digital, to certification.

4.3 Draft BSC

The objective strategy design at BMC was obtained through an analysis of the company's condition as many as 13 objective strategies that have been weighted against each BSC perspective. The weighting is done as a reference for the company to divide the focus on the company's operational costs in each perspective. Weighting is done through:

Table 1. Percentage of Strategic Objectives in XYZ

Perspectives	Theme	Business Model Canvas	Presentations	Strategy Objectives
Financial	FinancialHealtier	Revenue Streams	23%	IncreasingRevenue
		Cost Structure		Reducing Debt Burden
				Reducing operating expenses
customers	Customer Satisfaction	Value Prepositions	15%	Increasing Customer Satisfaction
	Customer Royalties	Customer Relationship & Customer Segments		Increasing Loyalty of the costumer
Internal Business Processes	Increase Productivity	Key Activities	38%	maintain quality
				Increase the production of each of the company's products and services
	Quantity Partnership	Channels		Market development
		Key Partners		Increase the number of strategic partners
	Operational Excellence	Cost Structures		Increase the operational effectiveness of the project
Learning & Growth	Professional and Effectiveness Organization	Key Resources	23%	technology training and certification
				Increase HR productivity
	Business and Technology Concept	Cost Structure		Increase technology investment for enterprise innovation

6. CONCLUSIONS

PT XYZ is a company engaged in the field of integration solutions that has a value proposition of producing smart city and data center products by providing professional services. In carrying out its business, conveying the company's value proposition to customers. PT. XYZ cooperates with various parties, including the private sector, government agencies, material suppliers, and sub-contractors, this is done to support the company's productivity. Process business at PT. XYZ is translated into a Business model Canvas with 9 perspectives to see in more detail the business processes that occur in each unit in the organization, and then transformed into a Balanced Scorecard model. In its transformation into the Balanced Scorecard model, 13 Strategy Objectives were found in 4 perspective areas. In this study it can be confirmed that PT. XYZ can run its business by increasing productivity, increasing the number of partnerships, and increasing project operational effectiveness.

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The Role of Multinomial Naive Bayes Algorithm on Media Monitoring System to Classify Online News Concerning Ciletuh Geopark

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ABSTRACT

Ciletuh Geopark which is located in West Java, Indonesia has been recognized and conserved by the International Network of UNESCO Global Geopark (UGG) since 2018. Unfortunately, the widespread problem of poor waste management issues around the area has attracted international attention, especially in the online media. The main issue was the revocation of geopark recognition from UGG International Network has become a main concern by the Indonesian local authorities. In the different areas, the convergence between information technology (IT) especially in the area of artificial intelligence/ machine learning and communication science, has disrupted the traditional way of reading, monitoring and archiving news. This new paradigm is known as Media Monitoring System (MMS). This study focuses on developing one of the core MMS modules in order to classify issues that circulate on the online media regarding Ciletuh Geopark. The Multinomial Naive Bayes algorithm is successfully applied on the MMS to classify over 200 sets of online data/ articles regarding the main issue of Geopark. The algorithm shows a 90% highly accurate rate of classifying online media into two classes: hard news and soft news. The final result can be used by the local authorities as a reference to respond to the news that circulates on the Internet regarding the main issues at the Geopark.

Keywords: Media Monitoring System, Multinomial Naive Bayes, Machine Learning, Hard News, Soft News, Ciletuh Geopark

1. INTRODUCTION

In 2018, Ciletuh Geopark was recognized and conserved by the International Network of UNESCO Global Geopark (UGG). Unfortunately, the lack of waste management issues surrounding the area has drawn international attention especially in the online media. The major issue was the revocation of geopark recognition from UGG International Network has become a main concern by the Indonesian Authorities (Jalaludin, 2021). Currently, the news in the online media related to the Ciletuh earth park has uploaded negative and positive news. Negative news, for example, regarding waste management and the tourist area of the earth park in Ciletuh as published on the detik.com portal on May 17 2019 (Alamsyah, 2019). This news will affect the cognitive aspects of tourists and stakeholders, especially UNESCO regarding the condition of the earth park and the ability of tourism management in Indonesia to maintain and care for the earth's garden. In addition to news with negative content, positive news articles were also found related to iconic places in the Ciletuh Geopark which were published on the cnnindonesia.com portal at the end of 2018.

Media monitoring on the other hand was invented for organization as a tool to monitor, analyze and detect the news, article or advertisement in the mass media. Technology is deemed necessary by practitioners of public relations (PR) to analyze and detect the contents of a news story, articles or advertisements in mass media, tracking news placement in releases, identifying mentions in other media about an organization, managing brand and reputation regarding related companies or organizations, monitoring competition and public opinion or public opinion developing in online media (Comcowich, 2010). Advances in information and communication technology bring opportunities for artificial intelligence and machine learning to become central in accelerating the implementation of a new paradigm known as the Media Monitoring System (MMS). Research on the implementation of artificial intelligence techniques, especially machine learning, such as text classification or news on online media, has been carried out using several different methods, such as research conducted by Wongso et al. The research conducted was to classify news articles in one of the online media in Indonesia using several Naive Bayes methods with a high accuracy rate of over 90% (Wongso et al., 2017).

Based on the issues presented, media monitoring can be implemented in order to monitor public opinion regarding the Ciletuh Geopark area. This article discusses the role of artificial intelligence/machine learning technology in supporting and classifying news in online media, especially related to problems in Ciletuh Geopark through the Media Monitoring System (MMS).

2. LITERATURE REVIEW

Rini Wongso et al in 2017 succeeded in implementing an algorithm that can classify news articles in Indonesian automatically. The news categories are economic, health, sports, politics, and technology news. The dataset used comes from one of the online media in Indonesia, namely CNN Indonesia, which was obtained using the crawling method on the www.cnnindonesia.com site. In this study, TF-IDF and Singular Value Decomposition (SVD) are used as feature selection and the Naive Bayes Classifier algorithm: Multinomial Naive Bayes (MNB), Multivariate Naive Bayes, Bernoulli Naive Bayes (BNB) and Gaussian Naive Bayes, and Support Vector Machine (SVM) are used for the classification process. Evaluation results based on precision and recall calculations show that the combination of TF-IDF and Multinomial Naive Bayes obtained the best results among other methods with a value of 98.4%. In terms of the time required to process the data, MNB and BNB are shown superior results even though it deals with a very large amount of data extracted (Wongso et al., 2017).

In 2018, Sembodo et al also conducted research on the automatic classification of an Indonesian-language tweet based on 11 news categories. The findings were facilitated by social media (Twitter users) in order to consume information that is spread based on the desired category. There are quite a number of algorithms used to create an automatic classification system in this study, including ZeroR, Support Vector Machine (SVM), Random Forest, Multinomial Na ̈ive Bayes, and Sequential Minimal Optimization (SMO) with the aim of comparing the performance results of each algorithm. the. The total amount of data used is 4230 tweet data from a cumulative total of 11 news categories that have been labeled manually. The results obtained based on the 10-fold cross validation method show that MNB is the algorithm with the best performance with an accuracy of 77.47% (Sembodo et al., 2018).

Research conducted by I M Rabbimov and S S Kobilov in 2020 examined the use of Machine Learning algorithms to perform multiclass text classification of Uzbekistan news articles. The machine learning algorithms used include Linear SVC, Radial Basis Function Support Vector Machine (RBF SVM), Decision Tree Classifier (DTC), Random Forest (RF), Linear Logistics, and Multinomial Naive Bayes (MNB). TF-IDF and n-grams are used for the feature extraction process,

then a 5-fold cross-validation technique is used in this study to determine the hyperparameters of each machine learning algorithm used. The data used in this study were obtained from one of the news media in Uzbekistan, namely "Daryo " by selecting 10 news categories used, namely world, science, culture, local, show-business, sport, technologies, auto, photo, and movie. To maintain the stability of the number of articles in each category, this research collects news article data from each category with a maximum number of 2000 articles. The best results in this study were the 86.68% accuracy value obtained by the SVM algorithm with Radial Basis Function (RBF) using TF IDF with 4 n-gram level characters as feature extraction and using tuning parameters gamma = 1, C = 1. This study concludes that the use of n-grams at the character level has a better effect than n-grams at the word level (Rabbimov & Kobilov, 2020).

In 2022, Karyukin et al have successfully developed and implemented an information system called OMSystem to analyze user opinions on news portals, blogs and social networks in Kazakhstan. The system uses sentiment dictionaries of Russian and Kazakh languages and a machine learning algorithm to determine the sentiment of social media texts. The entire structure and function of the system is also presented. The experimental section is devoted to building machine learning models for sentiment analysis on Russian and Kazakh datasets. Then the performance of the model is evaluated with the metrics of accuracy, precision, recall and F1 score. The model with the highest score is selected to be implemented in the OMS System. Then the OMSystem social analytics module is used to thoroughly analyze the healthcare, political and social aspects of the most relevant topics related to vaccination against coronavirus disease. The analysis allows us to discover the public social atmosphere in the cities of Almaty and Nur-Sultan and other major regional cities in Kazakhstan. In the results obtained, people's moods and attitudes towards Government policies and actions are studied by social network indicators such as the level of topic discussion activity in society, the level of interest in topics in society, and the level of people's mood. The indicators calculated by the OMSystem allow careful identification of factors that are worrying the public (negative attitudes towards government regulations, vaccination policies, confidence in vaccinations, etc.) and assessment of the social atmosphere (Karyukin et al., 2022).

3. METHODS

As explained in the previous section, Media Monitoring System (MMS) plays an important role for Public Relations for monitoring public opinion or developing public opinion, analyzing and detecting the content of a news, article or advertisement in the mass media, tracking the placement of news in releases, identifying mentions in other media about the organization. These included the organization’s brand and reputation on the public domain specifically on social media (Comcowich, 2010). In general, the architecture of the media monitoring system (MMS) that presented in this article consists of three main compartments as presented by Mathias Bank in 2013. The three main compartments consist of Data Backend, Backend Analysis, and Frontend Analysis. In the first compartment, Data Backend has a function as a data center or source that will be used for the purposes of analysis and information visualization. Then the Analysis Backend compartment has a function to process and analyze data based on Key Performance Indicators which can be interpreted as facts or facts from the ICT side that have been agreed upon by the media monitoring manager which is processed through various artificial intelligence techniques. The third compartment is Analysis Frontend which has a function as a visualization of information that has been processed and analyzed in the Analysis Backend compartment (Bank, 2013). This article focuses on the second compartment: to produce the Analysis Backend by implementing

Multinomial Naive Bayes Algorithm to classify the news about Geopark Ciletuh into two classes: soft and hard news.

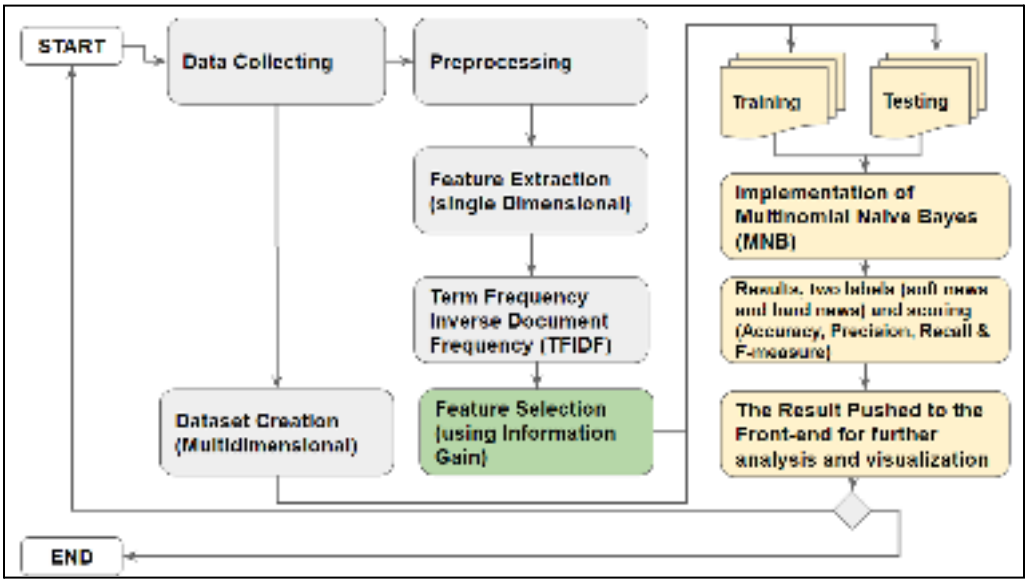

Figure 1. The flowchart of implementing Multinomial Naive Bayes Algorithm to classify news of Geopark Ciletuh

The data is crawled from various data sources: news portals or online media in Indonesia such as CNN Indonesia, liputan6, Tribun, Tempo.co, Okezone, and Radar Sukabumi, with a publication time span ranging from 2016-2020 with a total of 200 articles. The next stage is data preprocessing which includes tokenization, case folding, stopwords removal, and stemming to convert article data into a single dimension. The next process is feature extraction which aims to determine words through feature recognition that describe the characteristics of the data or object. This stage uses the bag-of-words (BoW) technique. The process is continued by giving a weight to a term, so that the dataset containing the term will have its own weight using the Term Frequency-Inverse Document Frequency (TF-IDF) technique. The stage is continued with the process of selecting relevant or informative features using the Information Gain (IG) technique by calculating the entropy value of each feature or data attribute.

The data that has been collected is then grouped subjectively into two classes, namely the hard news class and the soft news class. The dataset is divided into two groups: 70% for training and 30% for testing. For experiment purposes, each group is then divided into several numbers of composition between data training and testing: 1) 90:10; 2) 80:20 3) 70:30 4) 60:40 and 5) 50:50. The training data used to form a Multinomial Naive Bayes (MNB) classification model for detecting news categories (soft news and hard news). Whereas, the data testing used to test the classification model in order to determine the performance level of the model using three parameters: accuracy, precision, recall and F-measure. Reinemann et al argue that the more politically relevant a news item is, the more the reporting is thematically, focusing on the social consequences of an event, journalistic style or impersonal and unemotional news delivery, the more it can be considered as a category of hard news. Meanwhile, the more politically irrelevant news content, the more episodically reported, focusing on the individual consequences of an event, personal and emotional in nature, the more it can be considered that the news is included in the soft news category (Reinemann et al., 2011).

The Naive Bayes multinomial algorithm model is formed by adapting the model form provided by the scikit-learn library executed by python 3.7 with the additional libraries such as numpy, NLTK, and stemming. Multinomial Naıve Bayes to make predictions or classifications based on Bayes' theorem, namely predicting future opportunities based on past experiences. This algorithm calculates the number of classes or labels using the conditional probability and prior probability for each class, then calculates the Maximum a Posteriori (MAP) value by adding up the results of the conditional and prior probability calculations for each class. The best class is determined based on the highest MAP value. The Laplacian Estimator or Additive Smoothing method is also applied to handle if there is a probability value equal to zero. The final stage, the final results are pushed to the front-end compartment for further analysis.

4. RESULTS

Testing was conducted in order to ensure the performance of the classification model formed by using the Multinomial Naive Bayes algorithm. The testing uses four parameters: accuracy, precision, recall and f-measure for measuring the quality of the classification model. The datasets used in the experiment are Single Dimensional and Multidimensional (uses Reinemann's parameter to distinguish between soft and hard news). In the Single dimensional dataset, testings are conducted using extracted features determined by its IG's values: 1) value: 0,01 represents 25 relevant features; 2) 0,05 represents 16 relevant features and 3) without any features. Whereas in the multidimensional dataset the test was conducted without implementing any extracted features.

Table 1. MNB Model Test Results of Training compare to Testing Data

Methods	**Data Dimension**	**Learning Mode**	**(%) Composition of Dataset**	**Recall**	**Precision**	**F-Measure**	**Accuracy (%)**
MNB	Single dimension	Model Creation	90:10	0.75	0.86	0.80	81.67
			80:20	0.74	0.88	0.80	82.50
			70:30	0.71	0.90	0.80	**83.57**
			60:40	0.67	0.89	0.76	82.50
			50:50	0.58	0.86	0.69	78.00
MNB + IG (0.05)	Single dimension	Model Creation	90:10	0.69	0.82	0.75	77.78
			80:20	0.66	0.85	0.74	78.12
			70:30	0.63	0.85	0.73	**78.57**
			60:40	0.57	0.85	0.68	77.50
			50:50	0.51	0.85	0.64	75.00
MNB + IG (0.01)	Single dimension	Model Creation	90:10	0.75	0.86	0.80	81.67
			80:20	0.74	0.88	0.80	82.50
			70:30	0.71	0.90	0.80	**83.57**
			60:40	0.67	0.89	0.76	82.50
			50:50	0.58	0.86	0.69	78.00
MNB	Multi	Model	90:10	0.76	0.87	0.81	82.22

Methods	**Data Dimension**	**Learning Mode**	**(%) Composition of Dataset**	**Recall**	**Precision**	**F-Measure**	**Accuracy (%)**
	dimension	Creation	80:20	0.33	0.87	0.48	65.00
			70:30	0.80	0.86	0.83	83.57
			60:40	0.02	0.50	0.03	51.67
			50:50	0.76	0.90	0.83	**84.00**
MNB	Single dimension	Model Testing	90:10	0.67	0.89	0.76	75.00
			80:20	0.75	0.86	0.80	**77.50**
			70:30	0.70	0.90	0.79	76.67
			60:40	0.57	0.88	0.69	68.75
			50:50	0.60	0.89	0.72	73.00
MNB + IG (0.05)	Single dimension	Model Testing	90:10	0.58	0.88	0.70	70.00
			80:20	0.67	0.84	0.74	**72.50**
			70:30	0.65	0.86	0.74	71.67
			60:40	0.55	0.87	0.67	67.50
			50:50	0.54	0.84	0.66	68.00
MNB + IG (0.01)	Single dimension	Model Testing	90:10	0.67	0.89	0.76	75.00
			80:20	0.75	0.86	0.80	**77.50**
			70:30	0.70	0.90	0.79	76.67
			60:40	0.57	0.88	0.69	68.75
			50:50	0.60	0.89	0.72	73.00
MNB	Multi dimension	Model Testing	**90:10**	0.80	1.00	0.89	**90.00**
			80:20	0.27	0.86	0.41	57.50
			70:30	0.77	0.88	0.82	83.33
			60:40	0.02	1.00	0.05	48.75
			50:50	0.76	0.90	0.83	84.00

Table 1 shows that the average accuracy obtained at the composition of the training data compared to the testing at a ratio of 70:30 was 81.90% specifically for the single dimensional data. For the multi-dimensional data, the accuracy value is achieved at a ratio of 50:50 which is 84.00%. This indicates that the role of adding extracted features using information gain (IG) has no significant impact. In contrast, the native MNB implementation (without extracted features) obtains a higher accuracy value. After the classification model is built and tested, then the model is tested using testing data with varying compositions to validate the quality of the model. For single-dimensional data, the best accuracy is achieved at the ratio of 80:20 with an average accuracy value of 75.83%. In contrast, multi-dimensional data achieved the highest accuracy at the ratio of 90:10 with an accuracy value of 90%.

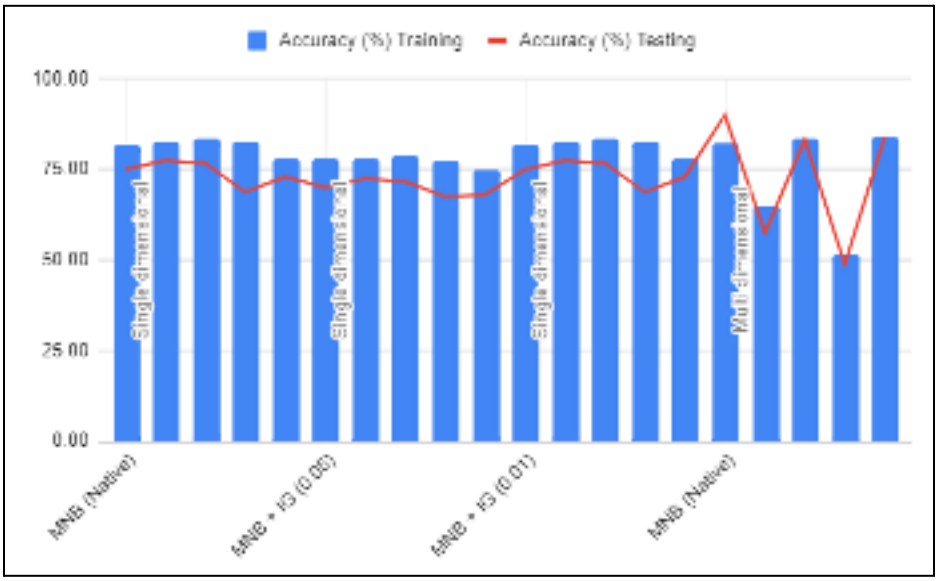

Figure 2. The result of Multinomial Naive Bayes Algorithm performed to classify soft and hard news data.

Figure 2 illustrates that the accuracy value of model testing shows a decrease compared to the accuracy value during training which averages 6.07%, especially for one-dimensional datasets for all MNB methods including with additional IG features. In contrast, for multidimensional datasets there is an increase in test accuracy compared to the average training of 6% for native MNB. This indicates that the role of forming datasets is very important. This is achieved by implementing the parameters as mentioned by Reinemann et al, namely by giving a score in the form of political relevance features (hard news: 1; soft news: 0), focus dimension and style dimension to raw data subjectively through PR expertise and a weighting scheme. On the other hand, the implementation of features using information gain (IG) parameters at scores of 0.05 and 0.01 in the Multinomial Naive Bayes algorithm has a less significant impact on increasing the accuracy of soft and hard news classifications.

In the final stage, the final results of classified data are pushed to the front-end compartment for further analysis using Google Cloud Platform: LookerStudio. The Geopark Ciletuh Media Monitoring System Dashboard can be accessed online by PR practitioners and local authorities of Geopark Ciletuh and is designed so that users can operate menus easily. MMS consists of several interface parts which are top-menu labeled A; score-card room label B; dataset recapitulation in label C datatable format; percentage composition of soft and hard news classification and composition of digital media used label D; distribution of news titles and digital media in a heatmap format labeled E. The top menu consists of several menu options to select parameters to be displayed in sections B, C, D and E namely date, digital media name, news article author name, feature selection: with choices of None, IG 0.01 and IG 0.05 and the classifier model: MNB. In section B, information is displayed in a score card format consisting of several items: total data, number of documents/articles and the accuracy of the classification model selected on menu A. In section C, information is presented in tabulation/datatable format consisting of several columns: date , article title, digital media, article author, editor, classification: Actual and prediction, and number of records. In section D, information is presented in a pie chart format to present the composition of the classification results (%) of soft news and hard news

based on choices through menu A as well as the composition (%) of articles originating from digital media. In section E, information regarding the distribution of articles and digital media is presented in a heatmap format.

Figure 3. The interface of Geopark Ciletuh Media Monitoring System.

5. CONCLUSIONS

The Ciletuh Geopark Media Monitoring System has been successfully developed. One of the crucial features of this system is to monitor digital media regarding public opinion, which was recently reported on the poor management of waste around the area which resulted in the revocation of the geopark from the UGG International Network. This feature is powered by artificial intelligence/machine learning: Bayes' naive multinomial algorithm as the core engine to help PR practitioners work on news classification: soft news and hard news. The Multinomial Naive Bayes Algorithm was successfully applied to MMS to classify more than 200 online article data on major Geopark issues using native MNB feature techniques, IG 0.05 and IG 0.01 for single and multidimensional datasets. The algorithm shows an accuracy rate of up to 90% in classifying online media into two classes: hard news and soft news using native MNB techniques with multidimensional datasets. The final results of classified data are pushed to the front-end compartment for further analysis using Google Cloud Platform: LookerStudio. The Media Monitoring System Dashboard can be accessed online by PR practitioners and local authorities for monitoring public opinion on the Ciletuh Geopark.

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ANALYSIS OF THE LEVEL OF COMMUNITY PARTICIPATION IN REALIZING ECOTOURISM IN THE COASTAL AREA, BULAK DISTRICT, SURABAYA CITY

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ABSTRACT

The Surabaya City Government is planning the Coastal Area of Bulak District, Surabaya City, as a center for marine tourism with ecotourism. However, the lack of community participation has caused various development programs that the Surabaya City government has provided to demonstrate that they are still not achieving ecotourism principles, especially in fisherman villages as destination support zones. To find out the causes of the problem of the lack of community participation in development programs, this study aims to analyze the level of community participation in ecotourism development in the coastal area of Bulak District, Surabaya City. The paradigm used in this study is intersubjective with a qualitative research strategy. Data collection techniques include observation, in-depth interviews, literature studies, and agency studies. The analysis technique skoring analysis and content analysis. The results showed that Bulak District has ecotourism potential in the form of nature tourism, wildlife tourism, cultural tourism, and conservation learning. The full tourism potential is spread across three fisherman villages, namely Cumpat Fishermen's Village, Kejawan Lor Fishermen's Village, and Sukolilo Baru Fishermen's Village, which each community group runs. Based on the results of the axial coding analysis between ecotourism potential and the level of community participation, it was found that community groups in the Cumpat Fisherman Village had a level of participation in the range of manipulation to a delegation of power, the level of participation of community groups in the Kejawan Lor Fisherman Village was in the range of manipulation to informing, while the level of group participation the people in Kampung Nelayan Sukolilo Baru are in the range of manipulation to inform.

Keywords: Ecotourism, Level of Community Participation, Fisherman Villages, Coastal Conservation.

1. INTRODUCTION

Comprehensive management of the environment and local community participation are the keys to successful implementation of sustainable ecotourism (Black and Cobbinah, 2016). Authentic culture owned by local communities in managing resources can create unique local

economic values and can give meaning to tourists' experiences (Das and Chatterjee, 2015; Black and Cobbinah, 2017). Such an application can make ecotourism a means of improving conservation and environmental preservation as well as the economic, social, and cultural welfare of local communities in the long term (Honey 2008).

Involving community participation in ecotourism is often used by developing countries as one of their development efforts and the key to ecotourism success (Masud et al., 2017). The results of research by Tseng et al., (2019) on ecotourism in Thailand show that community participation factors have a major influence on tourism management. Pornpasit and Rurkkhum (2017) show that good community participation in managing ecotourism in Satun Province, Thailand, is able to create a unified ecotourism destination. Meanwhile, on the other hand, Wondirad (2017) found that ecotourism in southern Ethiopia experienced degradation of natural and cultural resources due to the exclusion of the community.

The Surabaya City Government, through the Surabaya City Spatial Plan (RTRW) for 2014–2034 and the Tambak Wedi Detailed Spatial Plan (RDTR), directs coastal development in Bulak District with the concept of ecotourism integrated with fisherman village activities as a tourism support zone to form a tourism center. marine tourism in Surabaya (Khomenie and Umilia, 2013; Ananda and Koswara, 2018). For this reason, the Surabaya City government has made efforts by establishing the identity of a colorful fisherman village, increasing social capital through training, building a Bulak Fish Center (SIB) as a center for selling marine products, and crowning the fisherman village as a superior village during the Prepcom III UN Habitat 2016 visit. (Deviana, 2017; Ananda and Koswara, 2018).

Even though a series of developments have been attempted, fisherman villages are still considered less attractive as tourism support zones (Deviana, 2017). The slums of the fisherman villages and the identity of the colorful villages that have been formed have not been able to give the impression of a tourist attraction for visitors (Khomenie and Umilia, 2013; Deviana, 2017). On the other hand, development efforts have not had a significant livelihood impact on fishing communities, where the low levels of social capital, natural capital, physical capital, and financial capital mean that fisherman village communities are still unable to achieve sustainable livelihoods (Gai, Artiyani, and Soewarni 2020) .

According to Rahmawati and Naibaho (2018), the conditions in the fisherman village occurred due to the lack of community participation in development programs held by the Surabaya city government. The absence of a special institution that manages collaboration between the community and the government, the absence of further program reviews by the Surabaya city government, and the involvement of the community that only participates in socialization cause the fisherman village development program as a tourism support zone in the coastal area of Surabaya City to feel that it has not had a significant impact. significant (Rahmawati and Naibaho, 2018; Ananda and Koswara, 2018). Therefore, this study aims to analyze the level of community participation in ecotourism development in the coastal area of Bulak District, Surabaya City, so that problems with participation activities can be identified and recommendations for efforts to increase participation can be made.

2. LITERATURE REVIEW

Ecotourism Development

Ecotourism is defined as a practical effort to enhance, preserve, and maintain natural systems with the help of tourism (Riaz, 2022). Some factors that need to be developed in ecotourism include:

1. Attractions: consisting of nature tourism (Fossgard and Fredman, 2019), adventure tourism (Akbar, 2017; Hunt and Harbor, 2019), wildlife tourism (Higginbottom, 2004 in Fennel,

2014), cultural tourism (Fennel, 2014; Mousavi et al., 2016), and conservation learning (Fennel, 2014; Zeppel, 2018)

2. Accessibility: integrated between modes of transportation, vehicle circulation, pedestrian circulation, and parking lots (Pookhao, 2013; Fennel, 2014; Rosiyanti and Susilowati, 2017; Sinurat and Marpaung, 2019).
3. Amenities: the provision of accommodation, retail, souvenir shops, and restaurants (Pranata, 2018; Kurniansah and Khali, 2019; Pahleviannur et al., 2020), which are managed from an environmental perspective through the use of alternative energy and sustainable waste management (Nelson, 2010; Fennel , 2014; Mallick et al., 2020).
4. Supporting Facilities: provision of information centers, health services, prayer facilities, and utilities (clean water networks, drainage systems, waste systems, and toilets) (Pranata, 2018; Istiqomah, 2020), with management that minimizes impacts through the utilization of renewable energy and sustainable waste management (Fennel, 2014; Trombadore, 2018; Maslovskaia et al., 2020).
5. Tourism Promotion: digital marketing that promotes ecotourism substance through creating content on various channels/platforms (Bustam et al., 2012; Kaur, 2017).

Participation in Ecotourism

There are three local community groups that need to be involved in ecotourism: bonded residents (local communities living in ecotourism areas), resource users (groups that use resources consumptively), and environmentalists (environmental observers and educators) (Garrod, 2003 in Fennel, 2014). Fennell (2014) added that each group must have both hard and soft skills in carrying out ecotourism.In order for community participation to be successful, the elements must be met (Ca´rdenas et al. 2015). In Arsntein's (1969) level of participation theory, there are at least elements of participation, including participation activities, involvement in managing participation activities, synergy, communication, decision making, and power to manage activities. The characteristics of each element of participation determine the level of community participation, which is classified as follows (Arnsetin, 1969):

1. Citizen Power Levelsa.
    a. Citizen Control: Community groups organize activities well and are independent in management and decision-making.
    b. Delegated Power: Community groups coordinate activities well with partners, but still dominate activity capital and decision making.
    c. Partnership: Community groups organize activities well with partners, but they only have a portion of capital, so they need to bargain for decision-making with participating partners.
2. Tokenism levelsa.
    a. Placement: Management and decision-making of activities are fully managed by partners, but group opinion is considered to be realized.
    b. Consulting: Management and decision-making of activities are fully managed by partners, who are only able to express opinions but not realize them.
    c. Informing: Management and decision-making of activities are fully managed by partners, who are capable of giving opinions but not being heard by partners.
3. Level of non-participation.
    a. Therapy: Involved in planning and implementing a partner's activities but unable to express opinions.
    b. b. Manipulation: powerless to realize participation activities.

3. METHODS

This study uses a descriptive qualitative research paradigm that places reality on the subjectivity in which the researcher interacts with those being studied (Groat and Wang, 2013). The research strategy used is phenomenology, where the research results are in accordance with natural settings and focus on the interpretation and meaning of the empirical reality experienced by respondents by conducting holistic exploration (Groot and Wang, 2013). Data collection techniques using in-depth interviews through purposive and snowballing sampling. The analysis technique used is scoring analysis and grounded theory content analysis with three stages of coding: open coding (the process of extracting the code from the text of phenomena), axial coding (exploring causal codes and interactions between phenomena), and selective coding (presenting information on the results of the coding) (Cresswell, 2007; Bachtiar and Kusuma, 2019).

4. RESULTS

The results of observation and analysis of open coding found that the coastal area of Bulak District, Surabaya City, has three fisherman villages that have the potential to become community-based ecotourism destinations. Among them are the Cumpat Fishermen's Village (Kedung Cowek Village), the Kejawan Lor Fishermen's Village (Kenjeran Village), and the Sukolilo Bari Fishermen's Village (Sukolilo Baru Village). In general, these three destinations have the same potential for ecotourism, including in the form of boat tourism activities, fishing, and the potential for marine life (in the form of fish, shellfish, squid, shrimp, and sea cucumbers). However, the results of the analysis found that there are characteristics of ecotourism potential in each destination. The Cumpat Fishermen Village has a shoreline that is usually used by tourists to play with sand and beach waves, and watch the sunrise. Kampung Nelayan Kejawan Lor has a characteristic attraction in the form of smoked fish culinary offerings that are sold along Jl. Kenjeran. Meanwhile, the Sukolilo Baru Nelayan Village has a characteristic attraction in the form of processed fish crackers that are sold along Jl. New Sukolilo. The distribution of potential ecotourism attractions in the three fisherman villages in the coastal area of Bulak District can be seen in **Figure 1.**

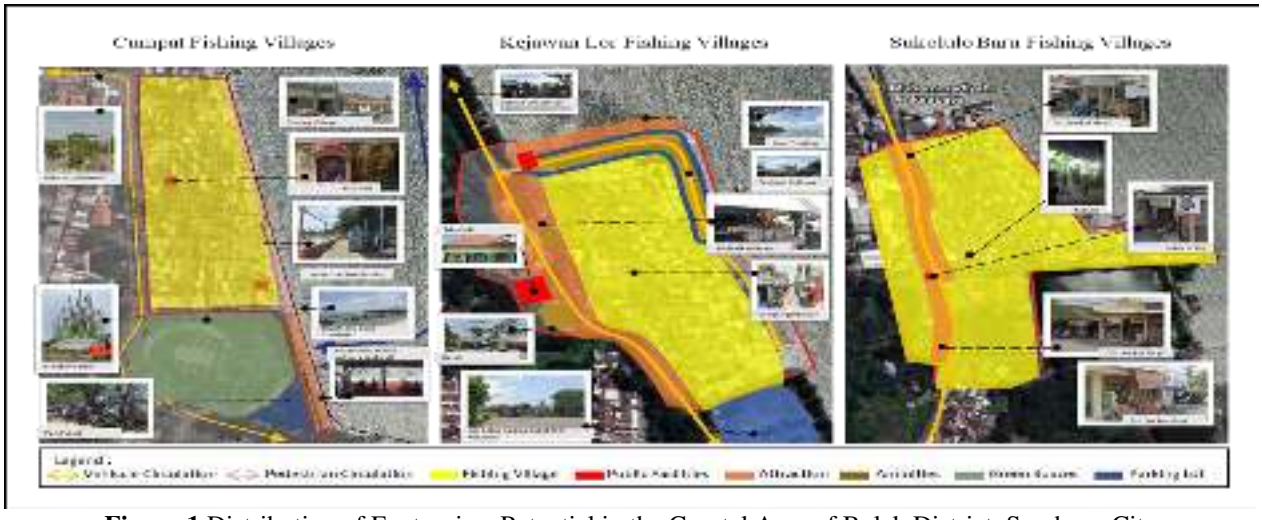

Figure 1 Distribution of Ecotourism Potential in the Coastal Area of Bulak District, Surabaya City
Source: Analysis Results, 2023

The scoring results with a range of 1 to 3 by stakeholders regarding the ecotourism development factor found that on the attraction factor, Kejawan Lor Fisherman's Village had the highest score (1.14) because of the attractions of boat tourism, fishing, and smoked fish culinary.

Meanwhile, Cumpat Nelayan Village, with a score of 1.13, has beach landscape attractions as well as boat and fishing tours. As well as the Sukolilo Baru Nelayan Village with the lowest score (1.07) because there are only culinary attractions processed by fish crackers.

In terms of accessibility, it was found that the Cumpat Fisherman's Village had the highest score (1.85), excelling in the provision of parking spaces by SIB and Suroboyo Park, the existence of shelters behind the SIB parking lots, and pedestrian circulation around the beach. Meanwhile, the scores for the Kejawan Lor Fisherman's Village (1.50) and the Sukolilo Baru Fisherman's Village (1.43) are only available for vehicle circulation.

In terms of aminity, it was found that the scores of the Fisherman's Village of Sukolilo Baru (1.65) and the Fisherman's Village of Kejawan Lor (1.64) were the highest because they provided various kinds of processed smoked fish and fish crackers using some local resources. While the amenity score of Kampung Nelayan Cumpat (1.35) is the lowest because most of it only serves non-marine and non-local culinary delights.

From the perspective of supporting facilities, all fisherman villages tend to have the same score (1.80) because all supporting facilities and infrastructure are available even though there is no use of renewable energy. However, each village has its own method of waste management, such as Cumpat Fisherman's Village, which processes shell waste into paving, Kejawan Lor Fisherman's Village, which processes fish waste into catfish feed and coconut shells are sold as charcoal, and Sukolilo Baru Fisherman's Village, which implements waste bank management.

In terms of promotion, it was found that the score of Fishermen's Village of Sukolilo Baru was the highest (1.09) because the majority of fish cracker traders had used social media for promotions, while the score of Kejawan Lor Fisherman's Village (0.75) was lower because only a portion of smoked fish traders promote on social media, and the Cumpat Fisherman's Village score is the lowest (0.32) because there are very few MSME traders promoting their wares on social media. More details regarding the ecotourism potential score in the coastal area of Bulak District, Surabaya City, can be seen in **Figure 2.**

Figure 2 Diagram of the Ecotourism Potential Score in the Coastal Area of Bulak District, Surabaya City
Source: Analysis Results, 2023

The results of scoring by stakeholders regarding community participation factors found that the score related to community factors involved was highest in Cumpat Fishermen Village (1.35) because it involved dependent residents (tourist groups), resource users (SMEs and fishermen groups), and groups of lovers of the environment (youth groups) who are quite active in participating. Then the score of the Kejawan Lor Fishermen's Village (1.28) is slightly lower because even though it has involved bonded residents (the youth group), resource users (the smoked fish group, MSMEs, and fishermen), and environmentalists (the Punggawa group), only a portion actively participates. Whereas. The score for Kampung Nelayan Sukolilo Baru is the lowest because, even though it has involved dependent residents (the MSME group), resource

users (fishermen's group), and environmentalists (the Aisiyah group), most of them are not very active in participating.

In terms of community skills, it was found that Cumpat Fisherman Village had the highest score (1.62) because one of its communities, namely the MSME group, already had entrepreneurial technical skills (production, finance, and marketing) from the results of official training and had been able to become a speaker for MSME groups in another region. The next highest score is the Kejawan Lor Fishermen's Village (1.49) because there are two groups that have entrepreneurial technical skills from the results of the training, even though they are only participants, namely the smoked fish group and the MSME group. Meanwhile, the lowest score was Kampung Nelayan Sukolilo Baru because only the MSME group had technical entrepreneurial skills from the training results as participants. The group that was not mentioned had self-taught skills in their field.

As for the level of community participation, it was found that the Cumpat Fisherman's Village had the highest score (2.32). This was because the community involved had a range of participation levels, from manipulation to delegation of power. The Kejawan Lor Fishermen's Village and Sukolilo Baru have the same score (1.86), because the communities involved are only in the range of manipulation to inform. A detailed discussion of the level of participation for each community in each fisherman village can be found in table 2. Information on the score of community participation in ecotourism in the coastal area of Bulak District, Surabaya City, can be seen in **Figure 3.**

Figure 3 Diagram of Community Participation Score in Ecotourism in the Coastal Area of Bulak District, Surabaya City

Source: Analysis Results, 2023

Based on the results of the analysis in **Table 2**, it was found that the level of community participation in Cumpat Fisherman Village, if sorted from the highest level of participation, the first is the tourism group with the level of participation in the form of "delegation of power," which indicates that the participation activities have been well coordinated and have equal partners, but tourism groups tend to be dominant in managing activities/capital and making activity decisions. The MSME group has a level of participation in the form of "partnership" which indicates that participation activities have been well coordinated but partners tend to be less involved in managing activities/capital and decision making. The Karangtaruna group has a level of participation in the form of "placement/placement" which indicates that participation activities have been well coordinated and are able to coordinate in two directions with partners but have no power at all in managing activities/capital and decision-making. Meanwhile, the fishermen's group is at the "manipulation" level, where the group only focuses on carrying out the work of catching fish and there are no participation activities at all that are oriented towards the provision of ecotourism activities.

Table 1 Findings on Community Participation on Ecotourism in Bulak Distric of Surabaya Coastal Area based on Arnstein's Ladder of Participation

No	Community	Ecotourism Activities	Partners	Finding	Participation Level
Cumpat Fisherman's Village					
1	Tourism Group	Tourism (boats, fishing, religious festivals), production of paving from shells.	Ship owners, Universities (Unnair, ITS, UHT), Government	Structured organization and regular coordination with clear job desks (admin, logistics, finance). Synergize with partners regarding funding sponsors. dominating capital and activity management. Decisions are made by the chairman with the input of the members.	Delegated Power
2	MSME Group	Seafood products, bazaar events, training, digital marketing.	Trade agency, University (UPN), PT. Pelindo, HIPMI.	Structured organization and regular coordination with a clear job desk (production, marketing). Synergize with partners regarding training (active participants, presenters) and funding. Part of the management and capital activities by partners, so the decision is with partners.	Partnership
3	Youth Group	Tourism event fundraising, boat race festival committee,.	Head of neighborhood, Tourism Group.	Served as a fundraiser and partner helper. Synergize with partners as executors, but can still have opinions. Do not have the power to manage and make decisions. Not managing activities. Just fishing and being a participant in a boat race	Placation
4	Fishermen Group	Fishing, participant in boat races.	-	Structured organization and regular coordination with clear job desks (admin, logistics, finance). Synergize with partners regarding funding sponsors. dominating capital and activity management. Decisions are made by the chairman with the input of the members.	Manipulation
Kejawan Lor Fisherman's Village					
1	Smoked Fish Group	Smoked fish production with zero waste, training, digital marketing.	Bank BRI, ITS.	The organization is structured and routinely coordinates, but the job desk is not clear. Synergize with partners regarding training (active participants) and funding. Partial management and capital activities by partners as well as funding and training decisions follow partners.	Informing
2	MSME Group	Production of shell souvenirs, digital marketing.	University, Government.	Unstructured jobdesk. Synergize with partners regarding training (passive participants) and funding. Partial management and capital activities by partners as well as funding and training decisions follow partners.	Therapy
3	Karang Taruna Group	Boat rental, float boat festival.	-	There is no structured organization or synergy. Just rent a boat and hold a simple boat race.	Manipulation
4	Fishermen Group	Fishing, boat race festvial participants.	-	Not managing activities. Just fishing and being a participant in a boat race.	Manipulation
5	Pungawa Group	Environmentalist	-	There is no structured organization or synergy. Only carry out environmental cleaning activities.	Manipulation
Sukolilo Baru Fisherman's Village					
1	MSME Group	Sea fish cracker production, bazaar event, digital marketing.	Government	The organization is structured and routinely coordinates, but the job desk is not clear. Synergize with partners regarding training (active participants) and funding. Partial management and capital activities by partners as well as funding and training decisions follow partners.	Informing
2	Fishermen Group	Fishing, participant in boat races.	-	Not managing activities. Just fishing and being a participant in a boat race.	Manipulation
3	Aisha's group	Waste bank management.	-	There is no structured organization or synergy. Only carry out environmental cleaning activities.	Manipulation

Source: Analysis Results, 2023

If the level of community participation in the Kejawan Lor Fishermen's Village is sorted from the highest to the lowest, the first group is the smoked fish group, which has a level of participation in the form of "informing" which indicates that participation activities have been well coordinated, but coordination with partners (entrepreneurial training providers) only goes one way, even though they are able to argue and have no power at all in managing activities / capital and making decisions from activities held by partners. The MSME group has a level of participation in the form of "therapy" where there has not been good coordination but where there have been partnerships with entrepreneurial training providers as passive participants who do not think and have no power at all in managing activities/capital and making decisions from activities held by partners. The last one is the youth group, fishermen group, and punggawa group, all three of which are at the level of "manipulation" participation, which indicates that each group only focuses on carrying out work and coordination activities are not going well (no structure, opinion, or division of roles) in carrying out ecotourism activities.

As for the level of community participation in Sukolilo Fisherman's Village, if sorted from the best level of participation, the first is the MSME group, which has a level of participation in the form of "informing" which indicates that participation activities have been well coordinated but coordination with partners (entrepreneurial training providers) only goes one way even though they are able to argue and have no power at all in managing activities / capital and making decisions from activities held by partners. Meanwhile, the fishermen and aisiyah groups both have a level of participation in the form of "manipulation" which indicates that each group only focuses on carrying out work and coordination activities are not going well (no structure, opinion, or division of roles) in carrying out ecotourism activities.

6. CONCLUSIONS

The results of the analysis found that the coastal area of Bulak District has three fisherman villages that have the potential to become ecotourism villages but have not been well developed, namely the fisherman villages of Cumpat (with potential for beach tourism), Kejawan Lor (with potential for culinary smoked fish), and Sukolilo Baru (with potential for culinary tourism of fish crackers). Cumpat Fisherman Village has four community groups involved in ecotourism activities: tourism groups, MSME groups, youth groups, and fishermen groups. The Sukolilo Baru Nelayan Village has five community groups, namely the smoked fish group, the MSME group, the Karangtaruna group, the fisherman group, and the punggawa group. Meanwhile, the Sukolilo Baru Nelayan Village has three groups involved, namely the MSME group, the fishermen group, and the Aisiyah group. Community groups with the highest level of participation were found in the Cumpat Fisherman's Village, namely at the level of delegation of power. Whereas in the Kejawan Lor Fishermen's Village and Sukolilo Baru Fishermen's Village, it was found that the highest level of participation by community groups was only at the informing level. The majority of community groups involved have a low level of participation; therefore, for further research, it is necessary to identify efforts to increase participation that can support ecotourism activities, such as providing training or establishing collaboration schemes between stakeholders.

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SUPPLY CHAIN RISK MANAGEMENT IN A HOT MIX ASPHALT INDUSTRY

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ABSTRACT

This research was conducted at an industry in East Java that produces hot mix asphalt and provides road construction services. There are several problems with this company that indicate the need for a comprehensive analysis of supply chain risk. Supply chain disruptions can affect the fulfillment of customer needs and ultimately reduce company profits. Therefore, good supply chain management is needed. One of the steps that can support this is to carry out risk management for supply chain flow. This study aims to determine the risks that can occur in the supply chain of the hot mix asphalt industry based on the Supply Chain Operation Reference (SCOR). This study uses the House of Risk (HOR) model. Based on the results of risk identification, there are 38 possible risk events that can occur, which can originate from 78 risk agents. Based on HOR Phase 2, 19 risk preventive actions were obtained. Based on these results the management can determine priority for effective risk prevention. The priority action with the highest ranking that can be taken is to design a training model that can improve the human resources competency according to the work area.

Keywords: house of risk, risk management, supply chain, Supply Chain Operation Reference.

1. INTRODUCTION

Risk management is important in a company or industry, including the construction industry. Compared with many other industries, the construction industry is subject to more risks due to the unique features of construction activities, such as being long-period projects including complicated processes, abominable environment, financial intensity, and dynamic organization structures (Taylan *et al*., 2014). Poor supply chain management may account for some delays and cost overruns related to the construction industry (Ahmed, 2017). Therefore, good management is needed in supply chain risk.

Tummala *et al.* (2011) conceptualize that supply chain risk is an event that negatively affects supply chain operations and desired performance measures such as service level, responsiveness and cost. Some of these risks can rarely occur but when they do occur they cause severe damage and are difficult to repair. This is certainly not expected to happen in the company. Therefore, good management is needed in supply chain risk. Albertin (2017) states that the supply chain risk management's objective is to assure the flow of the planned operations and to protect the company against supply chain disruptions.

This research was conducted at an industry in East Java that produces hot mix asphalt and provides road construction services. Asphalt hot mix is a mixture of fine aggregate with coarse aggregate and filler with asphalt binder under high-temperature conditions with a measured composition of various stones and fillers. The company's production system uses the just-in-time manufacturing model. JIT is a system whether company starts manufacturing/purchasing once the

customer orders the good effectively making zero inventories (Kootanaee et al., 2013). The company uses this strategy to increase efficiency and reduce waste by receiving goods when needed so it can reduce inventory costs and adjust the characteristics of the company's products.

One of the problems that indicates the need for further analysis related to supply chain risk in the company is the delay in the procurement of raw materials and supporting goods such as machine and vehicle spare parts. The existence of delays in raw material procurement will affect on production delays which in turn affects the timeliness of project work in the project field. Meanwhile, delays in procuring vehicle spare parts can affect the lack of vehicles as that used as transportation modes to distribute hot mix asphalt from the production plant to the project site. By conducting a risk analysis that focuses on the supply chain, it is hoped that the company will be able to identify supply chain risks so that it can determine priorities and risk mitigation strategies.

This research uses the House of Risk (HOR) method. This method was chosen because it is in accordance with the purpose of this study, which is to carry out a risk assessment from a risk source that is a priority to determine risk mitigation measures.

2. LITERATURE REVIEW

2.1 Hot Mix Asphalt

Hot mix Asphalt is a type of asphalt that is commonly used for highways, residential roads, or can also be used at airports. Hot mix asphalt is a type of asphalt made from a mixture of various materials, namely fine aggregate (stone ash), filler, and coarse aggregate (split stone or screening stone). All of these ingredients are mixed and given a heat binder with high heat. Aggregate or rock is generally defined as the hard part of the earth's crust which is the main component of the road pavement layer, which is 90% - 95% aggregate based on its total weight or 75% -85% aggregate based on its total volume (Layuk, 2014).

2.2 Supply Chain Risk Management

Risks and uncertainties are inherent in every supply chain (Hallikas et al, 2016). Risk can occur at any level and is inherent due to the information asymmetry that exists when operating across business units and company boundaries (Tse *et al*, 2016). In a networked environment, the ability to develop and maintain relationships with suppliers is a critical success factor and also a challenging task for company management. Because of this, companies are vulnerable to various supply chain disruptions and risks (Hallikas *et al*, 2016). Industry and infrastructure differences make it more difficult for companies to manage supply disruption risks effectively (Tse *et al*, 2016).

According to Blos *et al*. (2009) supply chain management is a methodology that can capture both operational and financial aspects in decision making and is effective in reducing loss and damage. According to Moeinzadeh *et al*. (2009) supply chain risk management can be viewed as a strategic management activity in a company considering that it can affect the company's operational, market and financial performance. The essence of supply chain risk management is to make decisions that optimally align organizational processes and decisions to take advantage of opportunities while simultaneously minimizing risks.

2.3 Risk Management Using the House of Risk Model

House of Risk model (HoR) is a modification of the FMEA (Failure Modes and Effect Analysis) and the House of Quality (HOQ) model to prioritize which risk sources are selected first to take the most effective actions in order to reduce potential risks from risk sources. House of Risk is a model based on the need for risk management that focuses on preventive actions to

determine which risk causes are prioritized which will then be given risk mitigation or mitigation measures (Pujawan & Geraldin, 2009).

There are 2 phases of the House of Risk, namely HOR 1 and HOR 2. HOR1 is used to determine which risk agent will be prioritized for preventive action. HOR2 is used to prioritize actions that are considered effective but with a reasonable financial commitment and resources.

2.4 Supply Chain Operations Reference (SCOR)

The Supply Chain Operations Reference (SCOR) model describes the business activities associated with all phases of meeting customer demands. The model is organized around six main management processes of Plan, Source, Make, Deliver, Return and Enable. Using this process of building blocks, the SCOR model can be used to describe very simple or very complex supply chains using a common set of definitions across different industries. Today organizations and companies around the world use this model as the basis for global supply chains and site-specific supply chains for improvement projects.

SCOR covers all customer interactions (quote to cash), all physical material transactions (procurement of payments, including equipment, supplies, parts, mass products, software, etc.) and all market interactions (manufacturing, from understanding aggregate demand to fulfilling every order). This model is designed and maintained to support supply chains of varying complexity across a variety of industries. This model focuses on three levels of processes and does not attempt to define how a particular organization should conduct its business or adapt its systems or information flows.

3. METHODS

The research method is divided into seven stages. The research phase begins with a literature study and field observations to get an overview of the processes running in the company. The identification stage of supply chain processes, risk agents, and risk events is carried out through focus group discussions. Determination of the severity of the risk event and occurrence of the risk agent is carried out using a questionnaire with due regard to historical data according to predetermined criteria. Identification of the correlation between risk agents and risk events is determined through focus group discussions. Severity, occurrence, and correlation values are then used to calculate Aggregate Risk Potentials (ARP). The results of the ARP rating are then processed for the preparation of phase 2 of HOR.

Then in HOR phase 2 was carried out to prepare preventive actions against risk agents. Next is to determine the relationship between each preventive measure and each risk agent. The next step is assessing the difficulty level in implementing risk prevention measures. The assessment was obtained based on a focus group discussion with management-level company officials. The next step is to assess the level of difficulty in implementing preventive actions. The assessment was obtained based on a focus group discussion with the management level. After evaluating the difficulty of performing action, the effectiveness-to-difficulty ratio is calculated until a priority rating is found.

The research flow can be seen in Figure 1.

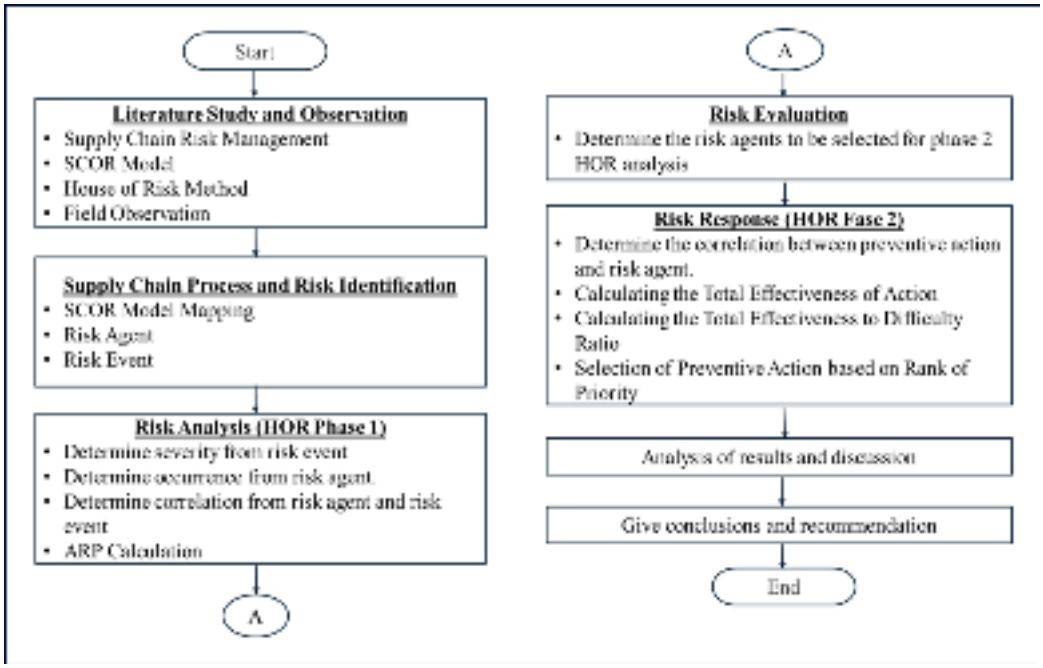

Figure 1. Research flow

4. RESULTS

Supply chain activity mapping is carried out based on the SCOR model. Identification of risk events is carried out through focus group discussions with top management. There are 38 risk events from 16 sub-processes in the company. There are 78 risk agents related to 38 risk events. The severity level of the risk event and the occurrence level of the risk agent is determined based on a questionnaire and historical data. Furthermore, the correlation level is determined before carrying out the HOR 1 calculation. The correlation level of risk agents with risk events can be seen in Table 1.

Table 1. Results Identification of risk agent correlation with risk events

Risk Event	Code	Sev	Risk Agent	Code	Occ	Corr
Incorrect project information and data being worked on	E1	3	The work contract is less detailed and clear	A1	1	9
Project deal failed	E2	5	Incompatibility of legal documents	A2	1	9
Miscalculation of cost or price offered	E3	5	Miscalculation by human resources (human error)	A3	4	9
			Misinformation obtained by marketing	A4	1	3
			Incorrect price information offered by suppliers	A5	2	1
Material price fluctuations	E4	3	National economic conditions	A6	1	3
			Scarcity of materials	A7	5	9
			Increase in currency exchange rates	A8	2	1
Project area mapping error	E5	4	Miscalculation by human resources (human error)	A3	4	9
Making the master timeline for project implementation is not	E6	4	Miscalculation by human resources (human error)	A3	4	1

Risk Event	Code	Sev	Risk Agent	Code	Occ	Corr
correct			The work contract is less detailed and clear	A1	1	1
			Request for changes to the work schedule from internal or external	A9	3	9
			Misinformation obtained by internal or external marketing	A4	1	3
There are project delays	E7	2	Request for changes to the work schedule from internal or external	A9	3	9
			Inadequate resources	A10	3	3
Production scheduling error	E8	4	Miscalculation by human resources (human error)	A3	4	9
			PPIC received data error	A11	4	3
Sudden changes in production schedule	E9	4	Requests for changes to work schedules from internal or external	A9	3	3
			Requests for changes to work schedules from internal or external	A12	4	9
			Requests for changes to work schedules from internal or external	A13	2	1
			Maintenance of production machines outside the schedule	A14	5	1
Excess or shortage of raw material stock	E10	3	Miscalculation by human resources (human error)	A3	4	1
			Production data is not updated	A15	1	3
			There are frequent changes to the production schedule	A16	4	9
Excess or shortage of supporting material stocks	E11	3	The method of procuring buffer stock for fast-moving and slow-moving supporting materials is not appropriate	A17	5	19
			Data recording error	A18	1	1
Material inventory data with material conditions in the warehouse do not match	E12	3	Data recording error	A18	1	1
			Recording of supporting material data is done manually	A19	5	9
			Data recording information system is not good	A20	4	3
Production order change data is not updated	E13	2	There is no special form for changing production orders	A21	5	3
			Changes in production orders are communicated via mobile phone	A22	3	9
			Not periodically checking e-mail	A23	3	1
Lost company internal data	E14	5	No regular data backups	A24	2	9
			There is data that is recorded manually	A25	4	3
			The insufficient data storage application	A26	1	1
The number of vehicles ready for use is less	E15	2	Limited vehicle assets	A27	3	1
			The high demand for transportation that is carried out simultaneously	A78	3	9
			Several vehicles for delivery to the project site are also used to collect raw materials	A28	1	1
			Miscalculation by human resources	A3	4	1

Risk Event	Code	Sev	Risk Agent	Code	Occ	Corr
			(human error)			
Many vehicles are in the maintenance process	E16	1	The vehicle maintenance schedule is carried out simultaneously	A29	3	3
			The technical age of the vehicle is quite old	A30	5	9
			There is a problem with material delivery from the supplier	A76	1	1
Unrecorded Purchase Requisition (PR)	E17	1	There is an error in the information received by purchasing	A31	1	9
Material procurement errors	E18	4	Material specification information on the PR is not clear	A32	2	9
			Miscalculation by human resources (human error)	A3	4	3
Delay in delivery of materials	E19	2	Difficulty finding suppliers	A33	4	9
			The bureaucracy for the approval of ordering several long materials	A34	2	3
			There is a problem paying the bill	A35	4	1
			There is a shortage of materials from suppliers	A36	3	1
			There is a problem with material delivery from the supplier	A76	1	1
The material sent did not pass the quality test	E20	3	The quality of the goods sent by the supplier does not meet the standards	A37	2	9
			The material sent does not meet specifications	A38	2	1
Supplier selection error	E21	4	The duration of the procurement request is too short	A39	4	1
			Lack of manpower for supplier handling	A40	1	9
			Supplier selection does not follow the set criteria	A41	1	1
			Material specification information on the PR is not clear	A32	2	3
Delay in evaluating documents for payment	E22	1	There is a work overload	A42	2	9
			Delay in the information received from the warehouse and QC	A43	1	1
Payment funds are not available	E23	2	Poor financial management	A44	1	9
Decrease in supplier performance	E24	4	Handling cooperation with suppliers is not good	A45	3	9
			There is no follow-up on suppliers with low evaluation results	A46	5	1
			Some suppliers are companies in one group	A47	2	1
Production delays	E25	5	Raw materials are not available on time	A48	3	9
			There is damage to the production machine	A49	3	3
			The production machine maintenance schedule is carried out simultaneously	A50	3	1
			Shortage of production workers	A51	2	1
The raw material in the warehouse is damaged	E26	4	The raw material in the warehouse is damaged	A52	5	9
			Stock is not immediately used	A53	2	1

Risk Event	Code	Sev	Risk Agent	Code	Occ	Corr
Production not according to order	E27	3	Miscalculation by human resources (human error)	A3	4	9
Accidents in the production area	E28	5	Workers do not use PPE according to the provisions	A54	2	9
			Lack of reprimand from the supervisor	A55	2	3
			Damage to engine components	A56	3	1
			Work not done according to SOP	A57	1	1
Production quality is not up to specification	E29	5	There is an error in the information obtained by the production department	A58	2	9
			The quality of the goods sent by the supplier does not meet the standards	A37	2	1
			Inadequate manpower	A59	2	1
Project delays	E30	4	Rainy weather conditions	A60	3	3
			There is damage to production equipment	A61	2	9
			Workers do not do work according to SOP	A62	1	1
			Delay in delivery of hot mix asphalt	A63	3	1
			Miscalculation by human resources (human error)	A3	4	1
			There is misinformation received by project implementers	A64	1	1
			Less manpower required	A77	2	3
Accidents at the project site	E31	5	Workers do not use PPE according to the provisions	A54	2	9
			Lack of reprimand from supervisor	A55	2	3
			Damage to engine components	A56	3	1
			Work not done according to SOP	A57	1	1
Traffic accident	E32	5	The project was carried out at a time when traffic conditions were not yet calm	A65	1	1
			Project work bookmarks are not installed properly	A66	1	1
			Road users do not pay attention to project implementation warnings	A67	1	9
The material sent to the project site is damaged	E33	4	Material handling errors during delivery	A68	1	9
Delay in delivery of asphalt to the project site	E34	3	The project location is too far from the plant	A69	3	9
			Rainy weather conditions	A60	3	3
Complaints about non-compliance from customers	E35	4	The quality of the workmanship is not up to standard	A70	1	9
The customer is late making payments	E36	4	Customer financial management is not good	A71	2	9
			Error sending bills to customers	A72	1	1
The process of returning raw materials to suppliers takes too long	E37	1	The documents for material rejection are too long	A73	3	9
			Waiting for the testing process by QC	A74	2	1
Customer dissatisfaction	E38	3	Customer complaints are not immediately followed up	A75	1	9

The results of the calculation of the Aggregate Risk Potential (ARP) and the risk agent rating can be seen in Table 2. Based on the Pareto diagram, there are 2 priority risk agents for preventive action, namely A3 and A9. However, according to the results of discussions with the company's management, the top 10 risk agent rankings need further analysis to find out the best preventive measures that can be taken and in order to look for opportunities to improve company performance.

Table 2. Risk Agent Ranking Based on ARP Result

Rank	Risk Agent Code	ARP	Rank	Risk Agent Code	ARP	Rank	Risk Agent Code	ARP
1	A3	676	27	A30	45	53	A59	10
2	A9	198	28	A49	45	54	A6	9
3	A52	180	29	A67	45	55	A15	9
4	A54	180	30	A20	36	56	A29	9
5	A12	144	31	A40	36	57	A31	9
6	A7	135	32	A68	36	58	A13	8
7	A17	135	33	A70	36	59	A35	8
8	A19	135	34	A1	31	60	A47	8
9	A48	135	35	A21	30	61	A53	8
10	A16	108	36	A56	30	62	A8	6
11	A45	108	37	A4	27	63	A18	6
12	A32	96	38	A73	27	64	A23	6
13	A24	90	39	A75	27	65	A27	6
14	A58	90	40	A77	24	66	A36	6
15	A69	81	41	A14	20	67	A38	6
16	A33	72	42	A46	20	68	A26	5
17	A61	72	43	A10	18	69	A65	5
18	A71	72	44	A42	18	70	A66	5
19	A37	64	45	A44	18	71	A41	4
20	A60	63	46	A39	16	72	A62	4
21	A25	60	47	A50	15	73	A64	4
22	A55	60	48	A34	12	74	A72	4
23	A22	54	49	A63	12	75	A76	3
24	A78	54	50	A5	10	76	A28	2
25	A11	48	51	A51	10	77	A74	2
26	A2	45	52	A57	10	78	A43	1

In HOR phase 2, preventive actions against risk agents are prepared based on the results of HOR phase 1 and the relationship between each preventive action and each risk agent is determined. After assessing the level of correlation between preventive actions and risk agents, the total effectiveness of action results can be obtained. The next step is assessing the difficulty level in implementing preventive action.

Table 3. House of Risk Phase 2 Result

No.	Risk Agent	Code	Preventive Action	Code	Corr	Tek	Dk
1	Miscalculation by human resources (human error)	A3	Re-socialize business processes, manuals and work instructions that apply in the company	PA1	3	2028	1
			Designing a training model that can improve HR/workforce competencies according to the work area.	PA2	9	6264	2
			Build an information system (automation) that can increase effectiveness and efficiency and help reduce human error in work	PA3	3	2361	5
2	Request for changes to the work schedule from internal or external Request for changes to the work schedule from internal or external	A9	Set a time standard for reconfirming the project work schedule to the customer.	PA4	3	702	1
			Make periodic reminders of the project work schedule to the relevant departments.	PA5	9	1782	1
			Build an information system (automation) that can increase effectiveness and efficiency and help reduce human error in work	PA3	1	2361	5
3	The raw material in the warehouse is damaged	A52	Evaluate the layout and storage warehouse facilities	PA6	9	1620	1
4	Workers do not use PPE according to the provisions Workers do not use PPE according to the provisions	A54	Develop policies for reprimanding workers who do not use PPE according to the provisions	PA7	3	540	1
			Design periodic socialization of the importance of the use and function of PPE	PA8	9	1620	1
			Designing a training model that can improve HR/workforce competencies according to the work area.	PA2	1	6264	2
5	Requests for changes to work schedules from internal or external	A12	Reviewing the maintenance management system that has been running to look for improvement opportunities	PA9	9	1296	1
			Make an evaluation of the performance of production machines	PA10	3	432	1
6	Scarcity of materials	A7	Perform supplier management analysis	PA11	9	1350	2
			Perform material management analysis	PA12	3	945	1
7	The method of procuring buffer stock for fast-moving and slow-moving supporting materials is not appropriate	A17	Make an evaluation of the method of procuring supporting materials	PA13	9	1215	1
			Perform material management analysis	PA12	3	945	1
8	Recording of supporting material data is done manually	A19	Back up data recording to computer periodically	PA14	9	1215	1
			Updating SOP so that daily data can	PA15	3	405	1

No.	Risk Agent	Code	Preventive Action	Code	Corr	Tek	Dk
			be updated to the computer				
			Build an information system (automation) that can increase effectiveness and efficiency and help reduce human error in work	PA3	1	2361	5
9	Raw materials are not available on time	A48	Evaluate the lead time required for ordering and processing raw material orders	PA16	3	405	1
			Evaluate the supplier's ability to send supplies to the company	PA17	9	1215	2
			Perform supplier management analysis	PA11	1	1350	2
			Perform material management analysis	PA12	1	945	1
10	There are frequent changes to the production schedule	A16	Create a production schedule display that is easily accessible to all departments	PA18	3	324	1
			Make agreements with departments regarding the maximum duration of production schedule changes	PA19	9	972	1

The rank of priority of Preventive Actions can be determined based on the results of calculating the effectiveness-to-difficulty ratio in Table 2 by sorting the values of the effectiveness-to-difficulty ratio from the largest to the smallest.

6. CONCLUSIONS

Based on the results of risk identification, there are 38 possible risk events that can occur, which can originate from 78 risk agents. Based on the identification of preventive actions that can be taken and followed by determining the priority of preventive actions using the House of Risk (HOR) Phase 2 model, 19 preventive actions are obtained. The priority action with the highest ranking that can be taken is to design a training model that can increase the competency of the workforce according to the work area. Based on the identification, the existence of human error affects several potential risk events so it is necessary to design training that is suitable for the needs of each department in the company. The other preventive action can be applied according to the results of the calculation of preventive actions priority except for preventive actions PA3 at 15th ranking. Application of preventive action to build an information system (automation) that can increase effectiveness and efficiency and help reduce human error in work (PA3) requires design and deeper design because based on the difficulty of performing action it also requires budgeting or investment costs that are quite large for the company.

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INVESTMENT ANALYSIS OF DEVELOPMENT OF EXTRACTION ASPHALT FACTORY AT BUTON

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ABSTRACT

Development in Indonesia is currently very rapid, one of which is marked by the increasing development of physical infrastructure in the form of road and bridge construction. Asphalt is one of the most needed materials in any infrastructure development work. Based on Pertamina Publish 2022 data, the average need for oil asphalt per year in Indonesia is around 1.3 million metric tons. Fifty percent or around 600 thousand metric tons are produced by Pertamina while the rest are still imported from abroad. Seeing this opportunity, Wika Bitumen has a desire to become a pioneer in producing oil asphalt from Buton asphalt in Indonesia and plans to build an asphalt extraction plant in Buton. The asphalt plant development project is currently still at an interesting evaluation stage to review its investment feasibility. The initial stage of the research was to collect data on investment costs, production operational costs and plans for benefits or income from product sales. Next, the cash flow planning is calculated to obtain the financial feasibility review parameters which include Net Present Value (NPV), Internal Rate of Return (IRR) and Payback Period (PP). The results of the research showed that the NVP value was Rp. 54.425 billion > 0, the IRR value was 17.07% > MARR 14.52% and PP in year 9, meaning that it is financially feasible.

Keywords: *input* and *output* factors, investment, financial feasibility.

1. INTRODUCTION

The development in Indonesia is currently very rapid, both development in the economic, political, social and other fields. The main focus of Indonesia's development is in the economic sector, making progress in this sector more prominent than other fields. The rapid development in the economic sector is indicated by the increasing development of physical infrastructure, including the construction of road networks and bridges.

One of the most needed materials in road construction projects is asphalt. Based on Pertamina Publish 2022 data as shown in Figure 1, the average need for oil asphalt in Indonesia is around 1.3 million metric tons/year. Fifty percent or around 600 thousand metric tons is produced by Pertamina while the rest is from competitors who are still imported from abroad.

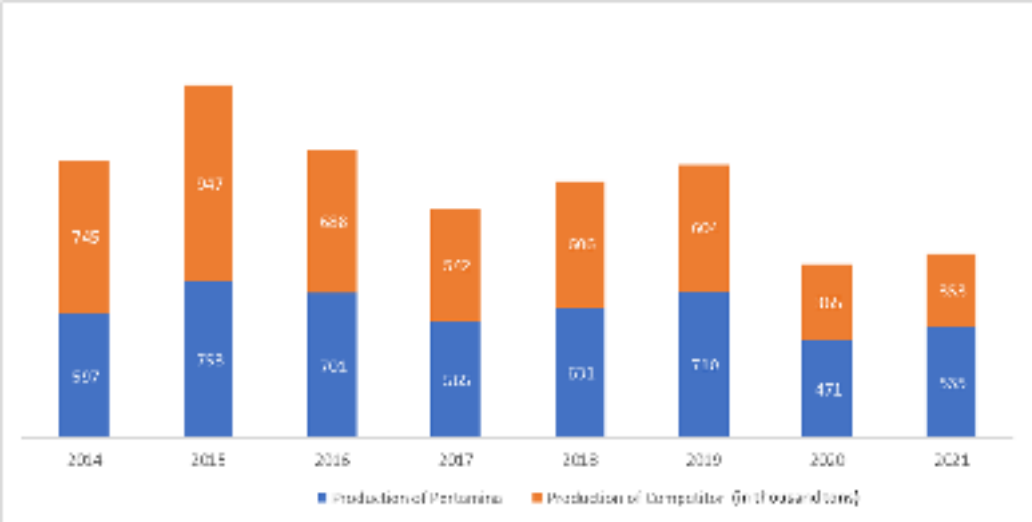

Figure 1. Indonesia Asphalt Needs 2014-2021 (Pertamina, 2022)

Seeing this opportunity, a large market (± 1.3 million metric tons/year) and limited supply (± 50% from Pertamina and the rest is imported), PT XYZ, which is engaged in natural asphalt mining in Buton, has a desire to become the first company in Indonesia as a producer of oil asphalt from Buton asphalt material. For this reason, the company plans to establish an asphalt extraction plant in Buton.

This research is very interesting to be used as a research object related to its feasibility both from a technical and financial point of view because: a. the cost required for investment in this asphalt plant is very high, b. the construction of this asphalt plant is the first in Indonesia and the world because currently there is not a single Butonese asphalt plant in Indonesia and in the world.

This study aims to analyze the financial feasibility of building an asphalt extraction plant in Buton using the investment feasibility criteria, namely Net Present Value (NPV), Internal rate of Return (IRR), and Payback Period (PP).

2. LITERATURE REVIEW

Bodie, et al (2011) has explained that investment is a current commitment to money or other resources with the hope of getting benefits in the future. Basically, everyone has various choices in determining the amount of funds or resources they have to consume at this time or invest for future benefits.

Gitman et al (2006) also explained that the definition of Investment Cost are two terms: (1) Cost (Cost) is all the sacrifices needed in order to achieve goals as measured by the value of money. (2) Expenditure is an amount of money issued or paid in order to obtain the expected result.

Suswarsono (2000) has explained that financial analysis is an analysis that compares costs and benefits to determine whether a business will be profitable over the life of the business. In the analysis of the financial feasibility of the investment, what is considered is the result that must be received by the investor or anyone with an interest in the development of the project. The components of benefits and costs that are taken into account are those that have a direct financial

effect on the interests of investors. Thus, all the cost components will be taken into account, while the direct benefit components are taken into account.

DeGarmo (1997) explained that MARR is the desired minimum rate of return in an investment so that it is attractive, often also referred to as the hurdle rate, which is the limit value of the financial feasibility of a project.

Fabozzi (2000) explained that Net Present Value (NPV) is the difference between the present value of cash inflows and the present value of cash outflows. Ross, et. (2010) explained that the term company cash flow (cash flow of the firm) or free cash flow is often used to the amount of cash owned by the company that can be freely distributed to creditors and shareholders because the cash is not used as working capital or investment in fixed assets. While Keown et.al (2002) explained that the NPV of an investment proposal is equal to the present value of free cash flows minus the initial investment outlay.

Suratman (2002) explained that determining whether a proposed investment project is appropriate or not, it needs to compare the time between the return of the amount of funds for investment and the economic life of the project. Thus Umar (2005) also explained that Payback Period is a period required to cover investment expenditure (initial cash investment) using cash flow.

3. METHODOLOGY

The stages of this research are shown in Figure 2. It begins with identifying the problem, determining the scope and objectives, followed by a literature study related to investment and then the data collection stage.

In this study the data collection techniques were used two reference data sources, namely primary and secondary data. Primary data is a source of research data obtained directly from the original source. The primary data obtained in this study came from field surveys and interviews with PT Wika Bitumen Company Leaders and with its R & D Manager as well as other related Managers. Secondary data is data collected from pre-existing data. Secondary data in this study included articles, books, journals, online media related to factory construction, inflation data, and asphalt selling price data, planning data from the engineering department, financial realization data from the finance department, and so on. The object of this research is the construction of an asphalt extraction plant in Buton.

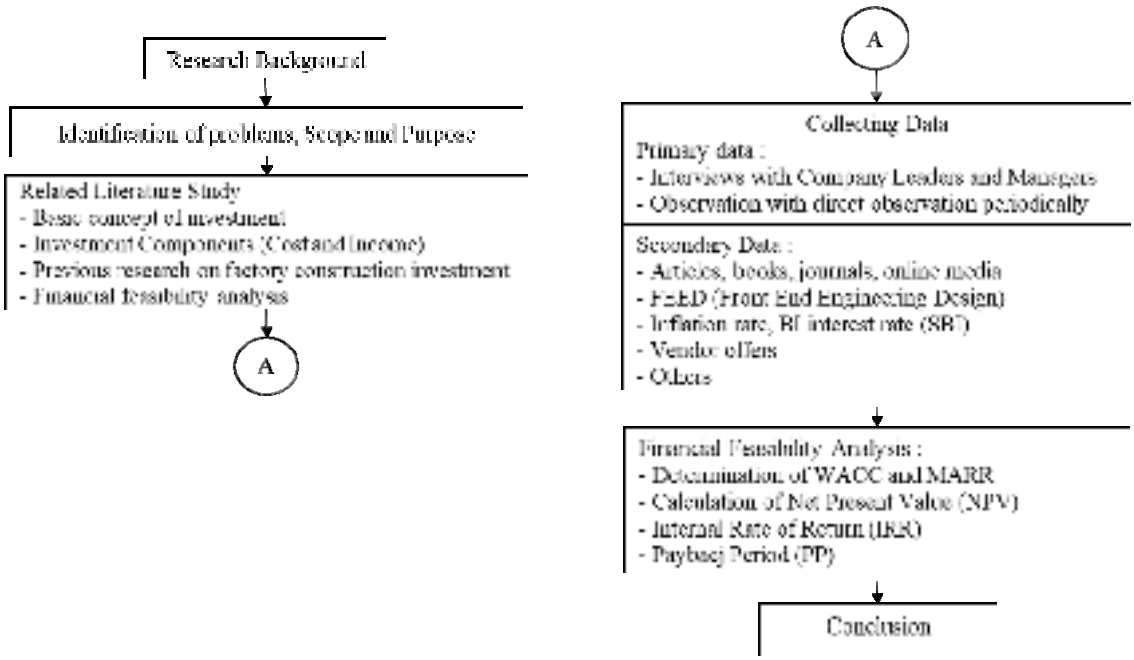

Figure 2. Research Flow Chart

The next stage is to carry out an investment analysis which consists of determining the investment cost of building the factory, determining operational and maintenance costs, determining projected production volume and factory revenue, and then carrying out a financial analysis, namely:

3.1 Net Present Value (NPV)

The Net Present Value of a project provides a measure of the net worth of an investment proposal in terms of its present value for money. NPV is expressed by the following formula:

$$NPV = \sum_{t=1}^{n} \frac{FCFt}{(1+k)^t} - I_o$$

FCFt: Annual free cash flow in the period t; k: Discount rate, as the rate of return (Cost of capital); I_o: Initial cash disbursements; n : project age.

The assessment criteria for NPV are as follows: (1) If NPV > 0, then the asphalt plant investment is feasible. (2) If the NPV < 0, then the investment is not feasible. (3) If NPV = 0, then the investment provides neither profit nor loss.

3.2 Internal Rate of Return (IRR)

Internal Rate of Return (IRR) is an indicator of the level of efficiency of investment. The IRR is used to determine whether an investment is feasible or not, in this case the return on investment made must be higher than the minimum acceptable rate of return or the minimum attractive rate of return (MARR). To analyze MARR using the Weighted Average Cost of Capital (WACC) method and the Capital Asset Pricing Model (CAPM). WACC is the expected rate of return on invested funds. WACC also represents the risk/opportunity that investors are risking in investing their money. IRR is expressed by the following formula:

$$I_o = \sum_{t=1}^{n} \frac{FCFt}{(1+IRR)^t}$$

FCFt : Annual free cash flow in the period t; I_o : initial investment; n : investment age; IRR : Internal Rate of Return.

3.3 Payback Period (PP)

Calculation methods for getting the payback period: Payback Period without interest and Discounted Payback Period. The payback period assessment criteria is that if the payback period can be achieved within the economic life of the asset. For investment in the construction of an asphalt plant, the economic life of the asset is maximum of 16 (sixteen) years (according to the Tax Law for types of mining business other than oil and gas).

The three criteria (NPV, IRR and PP) are obtained from cash flow calculations. According to the Statement of Financial Accounting Standards (PSAK) No. 2, cash flow is the inflow and outflow of cash or cash equivalents.

4. RESULTS

The construction of the asphalt plant is planned for 45 months and expected to produce by the end of the 4th year. The asphalt extraction plant to be built is planned to have a production capacity of 200,000 tons/year which will produce a gradual increase in production volume every year until the target volume is achieved. The main business run by this industry is the sale of asphalt extraction from asbuton materials on Buton Island. Several other provisions used to perform this financial feasibility analysis calculation:

1. The economic life of the asset is set at 14 years.
2. Investment costs used are based on 2022 price calculations.
3. The selling price of asphalt is based on the selling price of oil asphalt several years earlier which is processed using the minitab application in determining the prognosis for the next year.
4. Operational costs experienced an increase in inflation of 6.3% according to the results of calculations with the minitab application based on inflation values in previous years.
5. The planned funding for the construction of the factory is obtained from a bank loan of 70% and 30% of own capital with a credit interest of 10.70%.

The cost components are divided into two, namely investment costs and operational costs. Investment costs are the cost components needed to meet the initial funding needs of production activities which include the construction of buildings and production equipment. The total investment cost required for the construction of the asphalt extraction plant in Buton is IDR 2,940,277,998,142.00 (two trillion nine hundred forty billion two hundred seventy seven million nine hundred ninety eight thousand one hundred and forty two rupiah) already taking into account construction costs, initial design, supervision during implementation and other supporting costs related to investment, with details as shown in Table 1.

Table 1. Investment Cost of Asphalt Extraction Plant Construction

Description	Amount (Thousand IDR)
Construction Cost	
Preparation (PMC + Tender + Contract + etc)	96,770
Engineering (FEED + Detail Design)	53,693
Procurement	1,930,485
Construction + Pre-Comm + Commisioning	538,589
Overhead	60,786
Others	
Research and Development (R & D)	189,955
Exploration Cost	70,000
Total	**2,940,278**

Operational costs are the costs incurred in the production process. Operational costs in the asphalt extraction industry include production costs, maintenance costs and office overhead costs. Production and maintenance costs for operations include raw material costs, labor wages, tools and factory overhead, while office overhead costs include employee salary costs, office operations, vehicles, marketing and depreciation. The amount of operational costs as shown in table 2 and table 3.

Table 2. Operational and Maintenance Costs During Operational Period (million IDR)

No	Description	Year													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Raw material	-	-	-	83,825	178,225	252,646	335,784	357,004	379,593	403,611	429,149	456,303	485,175	515,874
2	Wages	-	-	-	13,729	26,428	29,071	31,978	35,176	38,694	42,563	46,819	51,501	56,651	62,316
3	Supporting material	-	-	-	47,506	101,024	143,222	190,355	202,400	215,206	228,823	243,302	258,696	275,065	292,469
4	Overhead Expenses	-	-	-	17,881	38,025	53,907	71,648	76,181	81,002	86,127	91,576	97,371	103,532	110,083

Table 3. Overhead Costs During Operational Period (million IDR)

No	Description	Year													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Employee salary	-	-	-	7,829	8,612	9,473	10,420	13,971	15,368	16,905	18,596	20,455	22,501	24,751
2	Office Operations	-	-	-	12,136	12,904	13,721	14,589	15,512	16,494	17,537	18,647	19,827	21,081	22,415
3	Vehicle costs	-	-	-	5,483	5,830	6,199	6,591	7,008	7,452	7,923	8,425	8,958	9,525	10,127
4	Marketing	-	-	-	5,621	11,545	15,742	20,052	20,475	20,835	21,196	21,556	21,916	22,277	22,637
5	Depreciation and Amortization	-	2,497	9,544	48,787	254,744	215,750	184,200	181,125	181,125	130,977	130,977	130,977	130,977	130,977

This investment cost requires sources of financing so that the development of this industry can be carried out. To build this asphalt plant, sharing of funds is required between own capital and loans from the Bank, namely 30%: 70% (according to the terms and conditions of the company). Therefore, the amount of sharing funds for sources of financing from main capital is Rp. 882,083,399,442.00 and from credit is Rp. 2,058,194,598,700.00.

The operating income generated is from the sale of bitumen extraction. Projected annual income can be seen in table 4.

Table 4. Annual Income Plan

Description	Year													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Production Volume (Ton)	-	-	-	42,000	84,000	112,000	140,000	140,000	140,000	140,000	140,000	140,000	140,000	140,000
Selling Unit Price/Ton	-	-	-	8,245,323	8,401,449	8,557,575	8,713,701	8,869,826	9,025,952	9,182,078	9,338,204	9,494,330	9,650,456	9,806,582
Amount (thousand IDR)	-	-	-	346,303,562	705,721,697	958,448,361	1,219,918,075	1,241,775,698	1,263,633,321	1,285,490,944	1,307,348,567	1,329,206,190	1,351,063,813	1,372,921,436

Financial Feasibility Analysis

Cost and income data as described above are then processed to calculate cash inflows and cash outflows as shown in table 5 to get a value that is a criterion of feasibility of an investment (NPV, IRR and PP). Based on the results of calculating the financial feasibility of building an asphalt plant in Buton, the following results are obtained:

1) Net Present Value (NPV): is the present value of the net profit (additional net benefit) that will be obtained in the future. In other words, NPV is the difference between the present value of the flow of benefits minus the present value of the flow of costs. The existence of the planned asphalt plant is estimated to be able to produce a net profit value (NPV) after 14 years of IDR

54,425,132,175.00. This gives an interpretation that during the life of the project, an accumulated net profit will be obtained in the future with a present value of the NPV. In other words, that during the life of the project, an accumulated net profit will be obtained in the future where this value is greater than 0 (NPV> 0). Therefore, it can be said that the asphalt manufacturing industry in Buton is feasible to run.

2) Internal Rate of Return (IRR): Based on calculations, this project can produce an IRR of 17.07%. This figure is greater than the discount rate (14.52%). Therefore, it can be said that the asphalt plant in Buton is feasible to run.

3) Payback period (PP): used to calculate the payback period of investment capital used to finance this investment. In other words, the payback period is a period of time that shows how long the capital invested in the business can be returned. Based on the calculation results, the asphalt industry has a payback period of 9 years. This payback period is faster than the technical life of the project (14 years). Therefore, it can be said that the asphalt plant in Buton is feasible to run.

Based on the several investment criteria mentioned above, the asphalt plant construction project is feasible to carry out.

Table 5. NPV and IRR Calculations (million IDR)

No	Year	Cash in Flow											Cash Out Flow				Net Cash Flow	Discount Factor (WACC)	Present Value
		Income	COGS	Overhead Cost	Operating profit	Interest expense	Profit before tax	Tax	Profit after tax	Depreciation and Amortization	Interest	Cash in	Investment cost	Loan Returns	Working capital	Cash Out			
		1	2	3	4=1+2+3	5	6=4+5	7	8=6+7	9	10	11=8+9+10	12	13	14	15=12+13+14	16=11+15	17	18=16x17
1	2023	-	-	-	-	(3,467)	(3,467)	-	(3,467)	-	2,600	(867)	-	-	-	-	(867)	0.975	(845)
2	2024	-	-	(2,497)	(2,497)	(13,781)	(16,278)	-	(16,278)	2,497	10,155	(3,626)	-	(2,256)	-	(2,256)	(5,882)	0.882	(5,191)
3	2025	-	-	(9,544)	(9,544)	(69,230)	(78,774)	-	(78,774)	9,544	51,231	(17,999)	-	(8,622)	-	(8,622)	(26,621)	0.798	(21,256)
4	2026	340,895	(159,886)	(79,856)	101,152	(111,241)	(10,089)	-	(10,089)	48,787	79,894	118,592	-	(44,071)	(107,486)	(151,557)	(32,965)	0.722	(23,816)
5	2027	700,202	(340,313)	(293,636)	66,253	(59,515)	6,738	(1,685)	5,054	254,744	39,299	299,097	(294,028)	(66,503)	(242,588)	(603,119)	(304,022)	0.654	(198,734)
6	2028	954,709	(476,313)	(260,885)	217,511	(8,101)	209,411	(52,353)	157,058	215,750	3,566	376,373	(294,028)	(31,278)	12,857	(312,449)	63,925	0.591	37,809
7	2029	1,216,101	(626,935)	(235,852)	353,314	(3,237)	350,076	(87,519)	262,557	184,200	-	446,757	(294,028)	(2,778)	4,976	(291,829)	154,928	0.535	82,911
8	2030	1,241,776	(669,992)	(238,092)	333,692	(2,940)	330,752	(82,688)	248,064	181,125	-	429,189	(294,028)	-	(3,595)	(297,623)	131,566	0.484	63,706
9	2031	1,263,633	(713,674)	(241,274)	308,685	(2,940)	305,745	(76,436)	229,308	181,125	-	410,434	(294,028)	-	(4,074)	(298,102)	112,331	0.438	49,215
10	2032	1,285,491	(760,250)	(194,538)	330,703	(2,940)	327,763	(81,941)	245,822	130,977	-	376,799	(294,028)	-	45,915	(248,113)	128,686	0.396	51,013
11	2033	1,307,349	(809,914)	(198,200)	299,234	(2,940)	296,294	(74,073)	222,220	130,977	-	353,197	(294,028)	-	(4,408)	(298,436)	54,761	0.359	19,642
12	2034	1,329,206	(862,877)	(202,133)	264,196	(2,940)	261,256	(65,314)	195,942	130,977	-	326,919	(294,028)	-	(4,599)	(298,627)	28,291	0.325	9,182
13	2035	1,351,064	(919,363)	(206,361)	225,341	(2,940)	222,400	(55,600)	166,800	130,977	-	297,777	(294,028)	-	(4,810)	(298,837)	(1,060)	0.294	(311)
14	2036	1,372,921	(979,611)	(210,908)	182,403	(2,940)	179,462	(44,866)	134,597	130,977	-	265,574	(294,028)	-	(5,040)	(299,068)	(33,494)	0.266	(8,899)
																		NPV	54,425
																		IRR	17.07%

Discussion

By obtaining the results of the analysis that the asphalt plant investment is financially feasible to work on, it is hoped that the construction of this asphalt plant can be realized soon. It is also expected to be a trigger to increase revenue from asphalt plant operations, so that many new asphalt plants will emerge to increase asphalt production considering there is still a large demand for asphalt materials in the next few years.

To find out what variables have a significant influence on the feasibility of this investment, it is necessary to carry out a sensitivity analysis (not carried out in this study), however based on the existing literature, the most dominant variables which influencing factory construction are product selling prices and production costs. In terms of the selling price of asphalt, according to the results of interviews with potential investors, it was conveyed that the government is very supportive of the utilization of natural resources in Indonesia, because if the asphalt extraction plant is in production, it will not only reduce asphalt material imports, but it can also increase state revenues and empower human resources. It is hoped that this government's support can guarantee the selling price of asphalt products. While for production costs, there is a need for innovation related to production technology that is more effective and efficient, so that it can reduce production costs and get more benefits from this business.

5. CONCLUSION

Based on the results of the research and analysis and interpretation of the data carried out, it can be concluded that construction of an asphalt extraction plant in Buton with an NPV value of IDR 54.425 billion > 0 and an IRR value of 17.07% > Minimum Attractive Rate of Return (MARR) of 14.52% so that it is financially feasible.

Translated that the factory's income during the economic life of the asset is 14 years, it can return a number of factory investment and operational costs. So, it can be concluded that the construction of an asphalt extraction plant is economically feasible.

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ENTERPRISE ARCHITECTURE PLANNING WITH TOGAF-ADM FRAMEWORK AND ISO 27001:2013 AT INSTITUT TEKNOLOGI TELKOM SURABAYA

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ABSTRACT

ITTelkom Surabaya is an Information and Communication Technology-based higher education institution. The application of information systems/information technology (IS/IT) is very much needed in a business process in an organization as a solution to improve the quality and competitiveness of a business because when an organization gets bigger and the operational level is increasingly complex, the management needs functional requirements, especially business processes, data, technology, and applications will be even greater. The development of IS/IT has helped the efficiency and effectiveness of academic services but does not fully support the business strategy in realizing the institution's vision. There are business processes, job descriptions, key performance indicators, risks, and standards that are not in line with the institution's strategy, and there is no mapping of data ownership and applications with business processes. After analyzing that the results of the enterprise architecture design will not contain logins, so it is necessary to examine the risk to information security. IS/IT strategy planning that is aligned with the institutional business strategy is carried out using an enterprise architecture approach. The IS/IT planning framework used is TOGAF-ADM including business architecture, information architecture, data architecture, and application architecture. In addition to TOGAF-ADM, this research will integrate using ISO 27001:2013 for security management in information systems by conducting a risk assessment. The design of enterprise architecture has produced a blueprint in the form of business architecture, information system architecture, and technology architecture that is integrated and aligned with the business strategy at ITTelkom Surabaya. From the results of the analysis of information security management risk assessment, it shows that there are 3 priority risks that occur in the design of enterprise architecture.

Keywords: Information system/information technology strategic planning, enterprise architecture, TOGAF-ADM, ISO 27001:2013

1. INTRODUCTION

Universities in Indonesia now view the IS/IT system as one of the strategies for improving the quality of education and service to all stakeholders in the organization to become a superior tertiary institution, with an IS/IT strategic plan that is aligned with the organization's business strategy, the higher education institutions have clear guidelines in implementing IS/IT, so that the implementation of IS/IT goes according to the needs of the organization in line with the organization's business strategy, careful planning is needed. Therefore, an IS/IT plan must be prepared to support the business strategy in achieving the vision and mission of the organization (Turban, Volonino, and Wood 2015).

is one of the Higher Education institutions under the auspices of the Telkom Education Foundation (Telkom Foundation). The current condition of ITTelkom Surabaya has indeed helped the efficiency and effectiveness of academic services through the development of IS/IT but has not fully supported the business strategy in realizing the vision of the institution. There are business processes, job descriptions, key performance indicators, risks, and standards that are not aligned with institutional strategy, and there is no mapping of data ownership and applications with business processes. This impacts the rectorate's decision-making, which is inaccurate and inconsistent. Therefore, ITTelkom Surabaya requires an integrated IS/IT strategy aligned with the business strategy. After analyzing that the results of the enterprise architecture design will not have a login on the system, it is necessary to assess the information security risk.

Enterprise Architecture (EA) helps organizations to define business architectures, information systems architectures, and technology architectures that are able to align business strategies with IS/IT strategies (Kurniawan and Suhardi 2013). Enterprise Architecture (EA) in this study uses the TOGAF-ADM Framework. In addition to TOGAF-ADM, this study will integrate with ISO 27001:2103 for security management on the results of the Enterprise Architecture design by conducting a risk assessment.

2. LITERATURE REVIEW

2.1 *Enterprise Architecture*

Enterprise Architecture (EA) is an organizational blueprint that aligns the vision and mission of the organization, as well as business processes (business architecture) with information technology in a data perspective (data architecture), application (application architecture) and technology (technology architecture) (Wahono 2021). Enterprise Architecture is the principles, methods, and models used in the design and realization of enterprise organizational structures, business processes, information systems, and information technology infrastructure (Gorkhali and Xu 2017). Enterprise Architecture is seen as a blueprint for the optimal and targeted placement of resources in the IT environment to support business functions. Blueprint is the output of enterprise architecture that provides an overview of how the appropriate elements (network platforms, applications, application logic) are defined and especially how the relationships between these elements. The alignment of business and information technology is the most important issue in business, therefore enterprise architecture is very important for organizations to support the alignment of business and information technology (Razak et al. 2011). The goal of enterprise architecture is to create an integrated IT environment (standard hardware and software systems) in the enterprise business.

2.2 TOGAF-ADM

The Open Group Architecture Framework (TOGAF) is a form of framework that provides a detailed method of how to build, manage and implement enterprise architecture and information systems called the Architecture Development Method (ADM) (The Open Group 2018). The TOGAF structure is based on 4 interrelated domains, the four domains are business including strategy, governance, organization, key processes, and maximizing benefits for enterprise architecture; application includes systems, methods, and interactions; information system considers logical and physical data structure; while logical infrastructure/Technology considers infrastructure hardware. TOGAF describes in detail what is expected of each phase, steps, inputs, and products. ADM consists of stages such as Figure 1.

Figure 1. ADM Steps

2.3 ISO 27001:2013

ISO/IEC 27001:2013 is an international standard on Information Security Management Systems (ISMS) which is used as a guide on information security management by organizations. ISMS is part of a management system based on a business risk approach to plan (plan), operate and implement (do), review and monitor (check) and improve and maintain or develop (act) for information security organizations (BSN 2013).

2.4 *Risk assessments* ISO 27001:2013

Risk management is key to an organization's governance and protection of its information assets. If an organization does not know the risks it faces, then it will not be able to implement properly and the protection will be less effective. Assessing risks involves identifying assets, threats, and vulnerabilities, and calculating (Humphreys 2008). The following is an explanation of the ISO 27001 risk management process(Mark Darby 2019):

a. Risk Identification, perform risk identification.
b. Risk Analysis, considering the likelihood and impact.
c. Risk Evaluation, conducting analysis, then prioritizing which one is most needed and conducting a review based on the likelihood position.
d. Risk Treatment, handling risks so that they can be carried out properly when carried out internally or controlling risks.
e. Monitoring and reviewing the risk, conducting a review of the risks that have been analyzed to internal/external stakeholders.

3. METHODS

Data collection was carried out through interviews with stakeholders and organizational documents. The process of designing enterprise architecture from the preliminary phase to the TOGAF-ADM architecture change management. A detailed explanation of the stages as follows:

1. Preliminary Phase, this phase is a preparatory and initiation activity to determine the scope of the enterprise architecture and the principles developed.
2. Requirement Management, performs functional identification to realize the concept of solutions to organizational problems.
3. Phase A: Architecture Vision, describes the enterprise architecture that will be made to meet the business goals and strategic objectives of the organization.
4. Phase B: Business Architecture, identify governance and business processes that are currently running in the organization, then develop the existing architecture.
5. Phase C: Information System Architecture, defines the organizational information system architecture including the data architecture and application architecture from the business architecture that has been created.
6. Phase D: Technology Architecture, builds the technology architecture such as software, hardware, and network infrastructure needed to support the deployment of data and information in the organization.
7. Phase E: Opportunity and Solutions, perform gap analysis for all architectures that have been made and create a grand architectural design.
8. Phase F: Migration Planning, carrying out migration planning for the implementation of the architecture to be built.
9. Phase G: Implementation Governance, compiling recommendations for the implementation of implementation governance.
10. Phase H: Architecture Change Management, carries out a management plan for the architecture that has been implemented.

After carrying out the enterprise architecture design process to produce a blueprint then carry out a risk assessment analysis using ISO 27001:2023 clause 6: planning.

4. RESULTS

4.1 *Preliminary Phase*

In this stage, the principles of enterprise architecture design will be developed. This principle is used as a guide in making information technology architecture decisions, and determining the structure of architectural components. The principles used in Table 1.

Table 1. Architecture Principles

Business Principles	**Data Principles**
1. Alignment of Information Technology and business. 2. Continuity business. 3. Development of technology that complies with organizational standards and policies.	1. Data is an asset. 2. Data is shared. 3. Data can be trusted. 4. Data confidentiality.
Application Principles	**Technology Principles**
1. Support user mobility. 2. User-friendliness.	1. Capacity management. 2. Interoperabilitas. 3. Need based change.

4.2 *Requirement Management*

This stage identifies organizational needs according to data requirements at the ADM stage, including business identification using the value chain method, then identifying organizational issues through interviews. The results of the analysis as follows.

a. Aspects of people, the incompatibility of information provided between sections needs re-matching.
b. Aspects of process, business processes are not standardized and not properly monitored, so it is necessary to standardize business processes and monitor all business processes.
c. Aspects of technology, some processes still use a manual system, so the level of efficiency is still lacking, especially work efficiency and coordination between departments.

4.3 *Phase* A: *Architecture Vision*

Ensuring the scope of the enterprise architecture to be built by defining the organization's business processes with value chain analysis. There are 2 activities, namely core activities and supporting activities. Seen in Figure 2.

Figure 2. Value Chain Analysis

4.4 *Phase* B: *Business Architecture*

Describing the organization's business processes based on value chain analysis is done by way of business modeling with BPMN. This stage produces a business process diagram, there are 181 business processes in the organization. Seen in Figure 3. Figure 4 is this stage also identifies organizational governance including risk, KPI, standards and regulations used in the development and mapping of multidimensional-based organizational business processes so that organizational governance is aligned with business strategy.

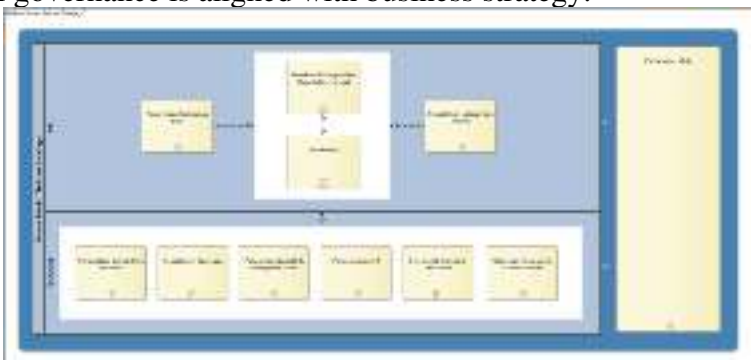

Figure 3. Business Process Diagram

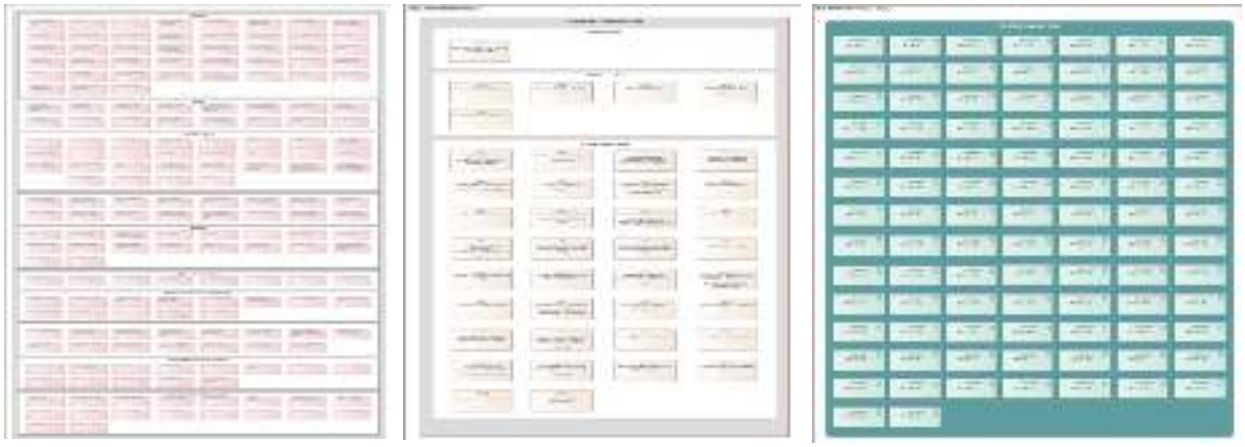

Figure 4. Risk, KPI, Standard & Regulation Diagram

4.5 *Phase* C: *Information System Architecture*

4.5.1 *Data Architecture*

This stage produces a data model diagram, namely the relationship between one entity and another in the form of a class diagram of each business process. The shape of the diagram as in Figure 5.

Figure 5. Data Model Diagram

4.5.2 *Application Architecture*

This stage generates application user and location to show where the application is used by the user. The shape of the diagram as in Figure 6.

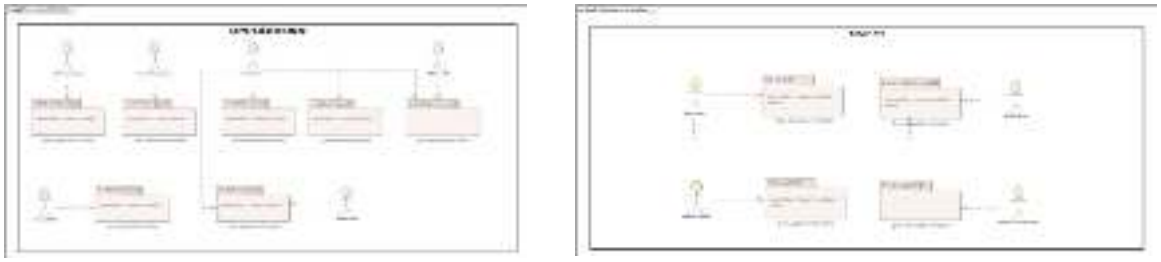

Figure 6. Application user and location

4.6 *Phase* D: *Technology Architecture*

Build the current technology architecture using a network communication diagram that includes communication network technology in organizations. Seen in Figure 7.

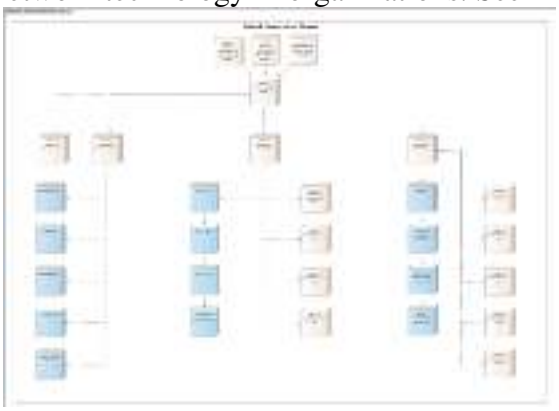

Figure 7. Network Communication Diagram

4.7 *Phase* E: *Opportunity and Solutions*

This stage analyzes the gaps in the business architecture, information system architecture, and technology architecture, and carries out a grand design of enterprise architecture or future architectural plans. Analysis of the results of the gap as follows.

4.7.1 *Business architecture*

Based on interviews with structural officials, there are 7 gaps in the business architecture. The results of the gap analysis are shown in Table 2.

Table 2. Gap Business Architecture

No	Gap	Solution	Target business architecture
1	The process of registering for the scholarship selection for new student admissions is done manually.	Added features to the PMB scholarship registration on the new student admissions system.	Scholarship registration by prospective students can be done automatically, combined into one system with registration, the difference is the path taken.
2	The process of managing student final assignments is done manually.	Make a student final assignment registration application.	Registration for the final assignment from the proposal seminar to the final assignment is done automatically.
3	Tracer study management process is done manually.	Create a Tracy system.	Alumni fill out the questionnaire automatically.
4	The process of applying for employee leave is done manually with different leave forms.	Make leave applications for employees.	Employees apply for leave automatically.
5	The SPPD submission process	Create an SPPD filing	Employees submit SPPD

No	Gap	Solution	Target business architecture
	is done manually.	system for employees.	automatically.
6	The process of applying for loan assets is done manually.	Make an asset loan application.	Employees and students apply for loans automatically.
7	The internal document submission process or document control process is done manually.	Create a document management system.	The unit section files documents automatically.

4.7.2 *Information system data architecture*

Table 3 is the result of gap analysis on data architecture.

Table 3. Gap Data Architecture

No	Service	Gap	Solution
1	New student admissions scholarship registration.	No data available	Preparation of all data for the implementation of scholarship selection for new student admissions, management of final assignments, application for leave, SPPD, borrowing assets, and document control.
2	Final project management.		
3	Tracy		
4	Leave application.		
5	SPPD		
6	Asset lending.		
7	Document control.		

4.7.3 *Information system application architecture*

Table 4 is the result of gap analysis on the application architecture.

Table 4. Gap Application Architecture

No	Information System	Gap	Solution
1	New student admissions scholarship registration	Using the manual method to register for new student acceptance scholarships.	The new student admissions scholarship system is combined with the new student admissions scholarship registration system.
2	Thesis	There are too many google forms so that when students register for their final assignment, errors often occur when registering for their final assignment.	Final assignment information system to make it easier for students to register for final assignments and can monitor the status of their submission.
3	Tracy	Using the manual method to fill in the trace study questionnaire, as well as data management.	Fill out the Tracy Study questionnaire through an information system, which can display updates on graduate developments.
4	Paid leave	Using the manual method to apply for leave, and employees do not know the rest of their leave.	Submitting leave through the information system, which displays the remaining leave of the employee.
5	SPPD	Using the manual method for submitting SPPD, as well as the length of the approval process.	SPPD submission through the information system, where employees can submit SPPD automatically.
6	Asset lending.	Using the manual method for borrowing assets, and having to confirm via chat, and there are missing items.	Asset lending information system.

No	Information System	Gap	Solution
7	Document control.	Using the manual method from document submission to approval.	Document management system.

4.7.4 *Technology architecture*

Table 5 is the result of gap analysis on the application architecture.

Table 5. Gap Technology Architecture

No	Categoty	Gap	Solution
1	Network technology	Bandwidth capacity needs to be increased because it is still lacking to support speed in data processing, as well as increasing number of students and staff and the addition of buildings.	Upgrading bandwidth capacity so that the organization's needs for internet capacity can be met.

4.8 *Phase* F: *Migration Planning*

This stage performs priority analysis of the application system. After carrying out the priority analysis, the architectural roadmap is shown in Figure 8.

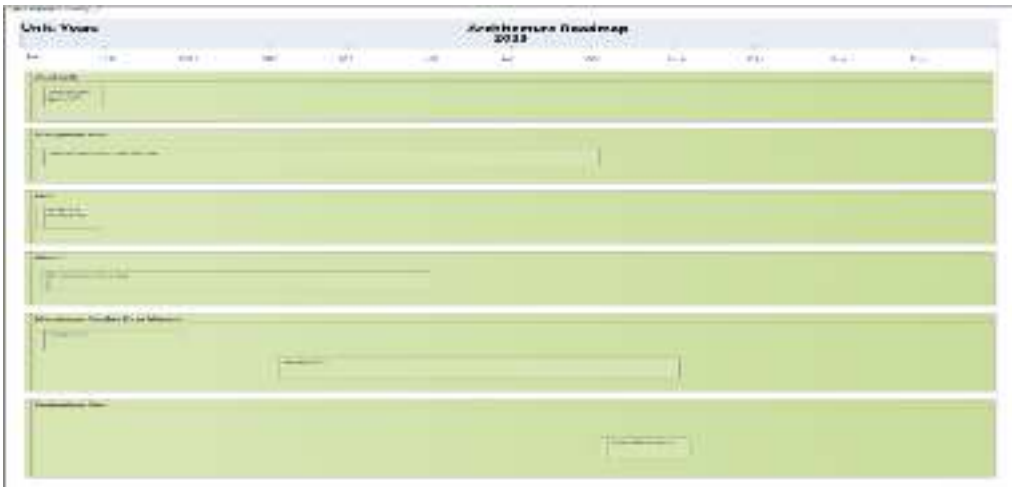

Figure 8. Architecture Roadmap

4.9 *Phase* G: *Implementation Governance*

Compile recommendations for the implementation of implementation governance that has been carried out, the governance carried out includes organizational governance by making or updating standard operating procedures, and socializing these standards. Meanwhile, information technology governance by recommending the platform to be used.

4.10 *Phase* H: *Architecture Change Management*

This stage establishes that the governance of the enterprise architecture framework is successfully executed and ensures the capabilities of the organization's architecture meet these requirements. Where later all the architectures that have been implemented at ITTelkom Surabaya can continue to be used and maintained properly.

4.11 Risk Assessment results for enterprise architecture planning

There are 3 priority risks resulting from the design of enterprise architecture, here are 3 priority risks and countermeasures that need to be carried out, shown in Table 6.

Table 6. Risk Priority Design of Enterprise Architecture

No.	Category	Risk Identification	Level Risk	Treatment Decisions	Control
1	*Software*	There is no login page feature to control access to the depth of the enterprise architecture system.	Critical	Mitigation	Create a login page and only important people are given access to the system
2	*Software*	There is a cyber security attack in the form of hacking on the system.	Very high	Mitigation	Creates restricted access to programs and controlled to avoid accidental changes. Performs backup detection, and recovery to protect the system.
3	*People*	*Human error*	Very high	Mitigation	Conduct training or socialization of the use of the application system to each user.

6. CONCLUSIONS

Based on the discussion that has been explained in this study, the design of enterprise architecture has produced a blueprint in the form of business architecture, information system architecture, and technology architecture that is integrated and aligned with the business strategy at ITTelkom Surabaya. From the results of the risk assessment, there are 3 priority risks that occur in the design of enterprise architecture. The TOGAF-ADM architectural design has many artifacts, but in this study not all of the artifacts were used so it is hoped that further research will be able to describe the artifacts in full.

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ANALYSIS OF PROJECT PERFORMANCE FAILURE FACTORS ON INVESTMENT PROJECT OF RELIABILITY IMPROVEMENT 500 KV SYSTEM AT PT. PLN (PERSERO) UNIT TRANSMISSION OF EASTERN JAVA AND BALI

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ABSTRACT

State Electricity Company or PT PLN (Persero) is a State-Owned Enterprise (BUMN) that provides electricity services and is expected to continue to increase the electrification ratio so that it can meet the needs of new and old customers throughout Indonesia. With high demand growth, PLN is required to increase its production capacity. PLN continues to strive to improve its services by implementing electricity projects as well as initiatives to improve operational effectiveness and efficiency. This study examines the effect of project external environment and construction material supply related problems on project performance failure through ineffective contract management in investment projects to increase the reliability of the 500 kV system at PT PLN (Persero) Unit Transmission of Eastern Java and Bali. This study used a quantitative method with SEM PLS analysis (Structural equation modeling) with the number of respondents obtained by 261 employees. The results of the study show that project external environment has an effect on ineffective contract management, project external environment has an effect on project performance failure, construction material supply related problems has an effect on ineffective contract management, construction material supply related problems has had an effect on project performance failure, and ineffective contract management has an effect on project performance failure**.**

Keywords : *project external environment, construction material supply related problem*, *project performance failure, ineffective contract management***.**

1. INTRODUCTION

State Electricity Company or called PT PLN (Persero) is a State-Owned Enterprise (BUMN) that provides electricity services and is expected to continue to increase the electrification ratio so that it can meet the needs of new and old customers throughout Indonesia. High demand growth, PLN is required to increase its production capacity. PLN continues to strive to improve its services by implementing electricity projects as well as initiatives to improve operational effectiveness and efficiency. In addition, PLN also continues to manage electricity development projects such as power generation, transmission, distribution and other projects to be able to increase capacity and meet community needs.

These various projects are related to investment projects to increase the reliability of the 500 KV system in the Unit Transmission of Eastern Java and Bali. These types of projects include procurement project and installation of transformers, procurement of main transmission materials, tower relocation, tower reinforcement, tower construction, procurement of insulators and insulator string set sets, tower handling, manufacture of DPT for tower security, configuration changes and various other projects. This infrastructure will support services for existing customers and additional customers for the next ten years (Electricity Supply Business Plan 2018-2027), so it is necessary to implement a comprehensive project performance failure management analysis to be able to identify, analyze, evaluate, and respond to the risk of project failure so that project work goes well.

Project performance failure analysis is basically a comprehensive process equipped with the necessary tools, techniques and science to identify, measure and manage project performance failures in a more transparent manner (Alubaid dkk, 2018). According to Andersen & Kristoffer (2017) project performance failure is a logical and systematic process in identifying, analyzing, and evaluating, controlling, monitoring, and communicating project performance related to all activities, functions, or processes with the aim of the company being able to minimize losses and maximize opportunities. In this thesis the author chooses a case study of the process of project performance failure analysis in an investment project to increase the reliability of the 500 kV system at PT PLN (Persero) Unit Transmission of Eastern Java and Bali.

Several problems that often arise in the preparation of project performance failure analysis studies, especially at PT PLN (Persero) Unit Transmission of Eastern Java and Bali, are the subjectivity of contract appraisal which is still very high, delays in project completion targets and so on. Analysis of project performance failures that are not identified in the future has the potential to cause problems due to the unpreparedness of prevention and recovery controls. For example, in the previous project construction, work delays occurred due to unavailability of material supply, external factors, project design problems, contract management issues which impacted project performance failure. The writing of this thesis was carried out by analyzing project performance failure on the 500 kV System Reliability Improvement Investment Project. This project was chosen because it was an ongoing project in 2021 and was one of the project completion priorities by PT PLN (Persero) Unit Transmission of Eastern Java and Bali because it aimed to anticipate the increase in electricity demand for this and the next few years and improved the quality and reliability of electricity distribution to customers.

In the implementation of project performance failure analysis, there is also a weakness, namely that it can only be implemented until the identification stage of project performance failure, so that another method is needed that can continue the process of analyzing project performance failure to the stage of analysis, evaluation, and response to project performance failure. Project performance failure analysis analyzes and evaluates project performance failure factors (Gadisa & Hong, 2020). Research by Alubaid et al (2018) describes problems that often occur during a lifetime construction project that lead to disputes, delays and litigation. Research by Takim & Akintola (2002) that the construction industry is generally considered to be underperforming compared to other industries. Not only that, the UK construction industry has been criticized for not performing at the same level as the rest of the developed world. Soewin & Chinda's research (2018), namely developing a multidimensional performance evaluation framework for construction companies by considering all relevant performance measures. Bajjou & Anas (2018) explain that determining the critical causes affecting project delays in the Moroccan construction industry. These various studies support research related to project implementation at PT PLN (Persero) Unit Transmission of Eastern Java and Bali implemented in analyzing and evaluating project performance failure factors, this implementation is considered effective, but in conducting project performance failure factor analysis it can still be further optimized.

2. LITERATURE

2.1 500 kV System Reliability Improvement Investment Project at PT PLN (Persero) Unit Transmission of Eastern Java and Bali

An investment project is assessed as an activity that lasts for a certain period of time with predetermined resources with the aim of obtaining good quality development results (Alubaid et al, 2018). The main characteristics of a project as follows:

1. There is a specific goal as a result of the final work.
2. Total costs, quality standards as part of the project objectives have been determined.
3. The schedule of activities is clearly detailed from start to finish within a certain time period.
4. The series of activities carried out are not routine and produce products that tend to be unique.

The types of existing construction projects are as follows (Andersen & Kristoffer, 2017):

1. Residential Buildings are simple residential houses designed by architects with construction by contractors. Development in the form of buildings, large developments, traditional construction which is intensive in field work or related to installation
2. Commercial buildings, such as bank buildings, hospitals, office schools and recreation buildings. The general design is coordinated by the architects in collaboration with the structural, mechanical and electrical sectors. Construction is generally coordinated with construction managers according to their area of specialization.
3. Industrial buildings, namely buildings for the process of making goods such as steel factories, paper factories and so on. Matters related to design and construction require high engineering skills not only in the civil field but also in the chemical, electrical and mechanical fields.
4. Heavy engineering construction, namely projects of highways, bridges, dams, railroads and so on with the design and development stages of heavy construction according to the areas controlled. The stages of construction are more machine-oriented with project costs being borne by the government.

2.2 *Project Performance Failure*

Project performance failure is a measure of the likelihood and consequences of not achieving the objectives of a project, while the failure analysis itself is a systematic process for estimating the level of risk that has been identified (Ayalew,et.al., 2016). According to Gadisa & Hong (2020) critical project performance failure can be interpreted as a possible, significant, near term risk that causes a project to fail if not mitigated. It is from the word significant that this risk is called critical. Failure itself according to Mahamid (2018) is defined as the inability of an asset to do something according to the wishes of the user. It is necessary to understand the process of project performance failure, which includes setting context, identifying project performance failures, analyzing project performance failures, evaluating project performance failures, and treating project performance failures.. The project performance failure management process is the systematic application of management policies, procedures and practices of activities to context define, identify, analyze, assess, treat, monitor and communicate. The goal of project performance failure management is to identify and manage significant project performance failures. Project performance failure management involves several key phases, with feedback through the monitoring and review process (Rivera & Jacob, 2016). On most projects, the project performance failure analysis will be complementary to other management processes and procedures.

3. METHOD

This type of research is quantitative with a causality approach. Causality enhancement, namely a research approach to see the influence of one variable with another (Ferdinand, 2014). Quantitative

methods use population research and specific samples with statistical data analysis. This data analysis is intended to answer the problem formulation and test the correctness of the hypothesis (Ferdinand, 2014). This study shows a consequential relationship between exogenous variables and endogenous variables. Research that shows cause and effect is intended to explain the effects of exogenous and endogenous variables. The data were collected through a survey method, namely by distributing research questionnaires. Likert scale used 1-5 (strongly disagree-strongly agree). The number of samples was taken based on the formula of Ferdinand (2014), namely the question item x 5-10 so that (34 x 5 = 170) the respondents were the research sample. Data be analyzed by Smart PLS.

4. ANALYSIS

Outer Loading

Convergent validity is the first stage in testing the outer model. The results of data processing from the convergent validity test can be seen through the loading value. Through the loading value, it can be seen the validity of the data to measure the accuracy of the indicator. The measurement results that have been declared valid can be used to carry out further analysis in this study. The indicator is considered valid if the loading value is> 0.70. However, according to Ghozali (2014), if the loading value shows the numbers 0.50 - 0.60 then the indicator is still acceptable. The results of the loading value of each indicator with its construct in this study are shown in the following table:

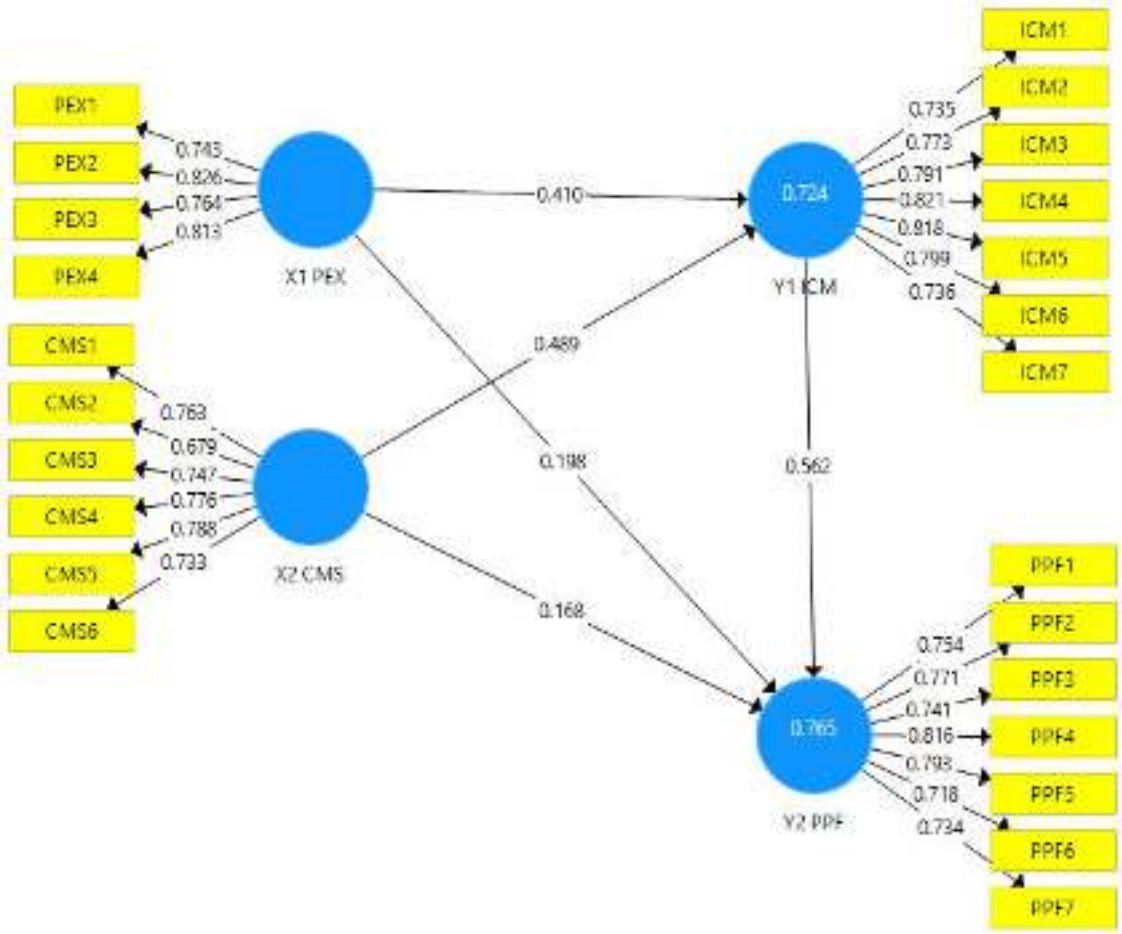

Figure 1. Picture of Outer Model

Table 1 ***Outer Loading***

	X1 Project External Influence	X2 Construction Material Supply	Y1 Ineffective Contract Management	Y2 Performance Project Failure
CMS1		0.763		
CMS2		0.679		
CMS3		0.747		
CMS4		0.776		
CMS5		0.788		
CMS6		0.733		
ICM1			0.735	
ICM2			0.773	
ICM3			0.791	
ICM4			0.821	
ICM5			0.818	
ICM6			0.799	
ICM7			0.736	
PEX1	0.743			
PEX2	0.826			
PEX3	0.764			
PEX4	0.813			
PPF1				0.754
PPF2				0.771
PPF3				0.741
PPF4				0.816
PPF5				0.793
PPF6				0.718
PPF7				0.734

Table 1 shows that the loading value of each indicator for each variable, namely project external influence (X1), construction material supply (X2), ineffective contract management (Y1) and performance project failure (Y2), has an outer loading factor value greater than 0.50. Thus the indicator can be declared valid as a measure of its latent variable, which means that the indicators used are in accordance with the research topic. A construct indicator is said to meet convergent validity if it has a loading value of> 0.70 whereas if the loading value is> 0.50 or> 0.6, it is stated that it can be tolerated (Ghozali, 2014), this is used to measure latent variables.

Discriminant Validity

The second stage of testing the outer model is discriminant validity. This test is also used to see the accuracy of the known indicators based on the cross-loading results. Indicators are said to be valid if the cross-loading value of one construct is greater than other constructs (Ghozali, 2014). Valid which is meant

in this test indicates that the indicators used are good. The results of the cross-loading value are shown in the table as follows:

Table 2 Cross *Loading*

	X1 Project External Influence	X2 Construction Material Supply	Y1 Ineffective Contract Management	Y2 Performance Project Failure
CMS1	0.623	**0.763**	0.647	0.620
CMS2	0.557	**0.679**	0.649	0.597
CMS3	0.602	**0.747**	0.520	0.523
CMS4	0.641	**0.776**	0.617	0.550
CMS5	0.624	**0.788**	0.633	0.641
CMS6	0.482	**0.733**	0.559	0.552
ICM1	0.591	0.619	**0.735**	0.614
ICM2	0.550	0.587	**0.773**	0.661
ICM3	0.643	0.642	**0.791**	0.669
ICM4	0.672	0.638	**0.821**	0.681
ICM5	0.681	0.639	**0.818**	0.692
ICM6	0.640	0.582	**0.799**	0.640
ICM7	0.576	0.733	**0.736**	0.719
PEX1	**0.743**	0.579	0.545	0.512
PEX2	**0.826**	0.704	0.650	0.662
PEX3	**0.764**	0.506	0.604	0.631
PEX4	**0.813**	0.683	0.695	0.629
PPF1	0.558	0.632	0.599	**0.754**
PPF2	0.574	0.620	0.621	**0.771**
PPF3	0.633	0.647	0.669	**0.741**
PPF4	0.653	0.628	0.794	**0.816**
PPF5	0.660	0.652	0.767	**0.793**
PPF6	0.505	0.424	0.480	**0.718**
PPF7	0.522	0.506	0.548	**0.734**

Table 2 shows that the results of the cross-loading value of each indicator when compared to other topics have a greater value, so that it can be stated that the items are valid. Therefore, there is no need for items to be removed or discarded. Valid indicates that the measuring instruments used in this study are appropriate. Therefore, this data can be used for further testing.

Average Variance Extraced

The final method that can be used to assess the discriminant validity test is to look at the Average Variance Extraced (√) value. Each construct can be considered valid if the AVE value is> 0.50, otherwise if the AVE value is <0.50 it is considered invalid (Ghozali, 2014). The results of the Average Variance Extraced (AVE) value are shown in the table below :

Table 3 *Average Variance Extraced* (AVE)

	Average Variance Extracted (AVE)
X1 PEX	0.620
X2 CMS	0.560
Y1 ICM	0.612
Y2 PPF	0.580

The results of the Average Variance Extraced (AVE) in Table 3 of each variable, namely project external influence (X1), construction material supply (X2), ineffective contract management (Y1) and performance project failure (Y2) are used to see the correlation of each construct. The AVE results of the three variables have a number of more than 0.50 so that through these results it is known that all variables can be declared valid, which means that they are appropriate, namely the respondent's answer can pass the truth test.

Composite Reliability and Croanbach Alpha

The final stage of the outer model test is composite reliability and croanbach alpha which are used to measure the reliability of a construct. Reliability measurement is used to see the consistency of the constructs used. If the value of composite reliability and croanbach alpha shows a number> 0.70, then the construct is reliable, on the contrary, if the number shows a result <0.70 then the construct is not reliable (Ghozali, 2014). The composite reliability and Croanbach alpha values are shown in the following table

Table 4

	Cronbach's Alpha	Composite Reliability
X1 PEX	0.795	0.867
X2 CMS	0.843	0.884
Y1 ICM	0.894	0.917
Y2 PPF	0.880	0.906

Composite Reliability* and *Croanbach Alpha

Table 4 shows all values of composite reliability and Cronbach's alpha> 0.70, this indicates that all variables can be declared reliable so that the measuring instrument used can be trusted because of its consistency. Reliability means that research respondents understand and are able to provide answers correctly. Meanwhile, consistency is meant in this case when the answers from the respondent are appropriate and still correct. The indicators used in this study are reliable and their accuracy is trusted so that the answers of respondents are considered to contain truth and reliable accuracy.

Evaluation of *Goodness Of Inner Model*

Goodness of Inner Model is used to determine the ability of endogenous variables to explain the diversity of exogenous variables. The results of the Goodness of Inner Model shown through the R-Squares can be shown in the table below:

:

Table 5 *R Square*

	R Square	R Square Adjusted
Y1 ICM	0.724	0.722

Y2 PPF	0.765	0.762

Based on the results of R Square, the ineffective contract management (Y1) is 0.724 or 72.4%, where project external influence (X1) and construction material supply (X2) can affect the ineffective contract management (Y1) by 72.4%. The remaining 21.6% is the contribution of other variables that are not discussed. The R-squares for performance project failure (Y2) is 0.765 or 76.5%. This shows that the diversity of project external influence (X1), construction material supply (X2) and ineffective contract management (Y1) variables can affect performance project failure (Y2) by 76.5%. The remaining 23.5% is contributed by other variables which are not discussed.

Meanwhile, the predictive relevance of Q Square can be measured in the following ways:

Q = 1- (1-R2 relationship equity) x (1-R2 customer engagement)

= 1- (1-0.724) x (1-0.765)

= 1- (0.216 x 0.235)

= 1-0.05076

= 0.9424

The value of Q Square> 0 indicates that the model has predictive relevance otherwise if Q Square <0 indicates that the model lacks predictive relevance. The Q Square value in this study is 0.9424 or> 0 so that it can be said that the model has predivtive relevance or indicates that the structural model is proven to be good or relevant.

Hiypothesis Test

This hypothesis testing is used to determine the causality developed in the model, namely the effect of exogenous variables on endogenous variables. The significance test can be found through the t-statistic greater than the critical value (t-table 1.96) in the table below:

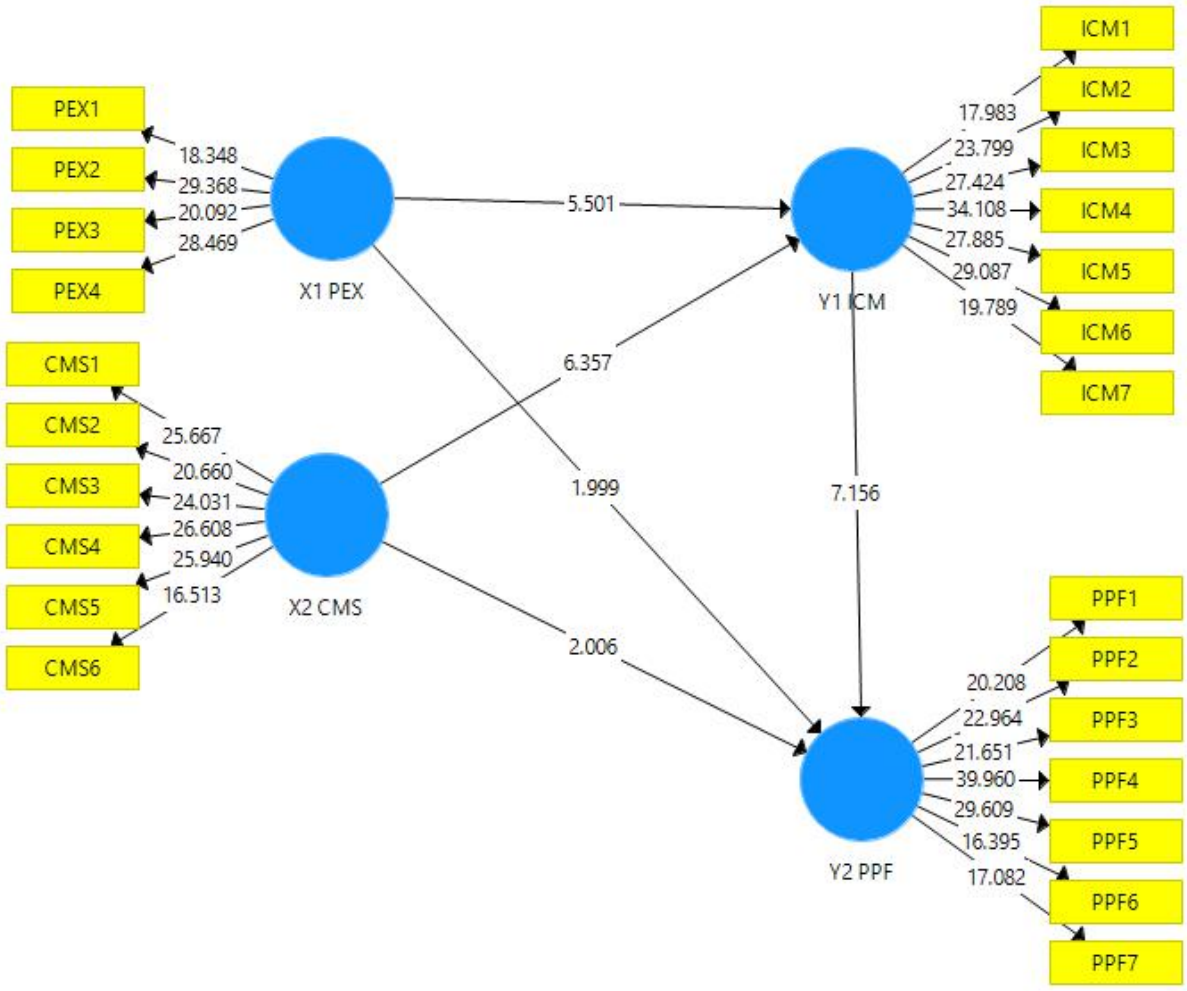

Figure 2 Picture of *Bootsrapping*

Table 6 Path Coefficient

	Original Sample (O)	T Statistics (|O/STDEV|)	P Values
X1 PEX -> Y1 ICM	0.410	5.501	0.000
X2 CMS -> Y1 ICM	0.489	6.357	0.000
X1 PEX -> Y2 PPF	0.198	1.999	0.046
X2 CMS -> Y2 PPF	0.168	2.006	0.045
Y1 ICM -> Y2 PPF	0.562	7.156	0.000

Based on the table, it can be explained that the influence of exogenous variables on endogenous variables is in each of the following hypotheses:

1. Project external influence has a significant positive effect on ineffective contract management with a T-statistic value> 1.96, which is 5,501 and a p value of 0,000 <0.05. The first hypothesis in this study is accepted.
2. Construction material supply has a significant positive effect on ineffective contract management with a T-statistic value> 1.96, which is 6,357 and a p value of 0.001 <0.05. The second hypothesis in this study is accepted.

3. Project external influence has a significant positive effect on performance project failure with a T-statistic value> 1.96, which is 1,999 and a p value of 0.046 <0.05. The third hypothesis in this study is accepted.
4. Construction material supply has a significant positive effect on performance project failure with a T-statistic value> 1.96, which is 2,006 and a p value of 0.045 <0.05. The fourth hypothesis in this study is accepted.
5. Ineffective contract management has a significant positive effect on performance project failure with a T-statistic value> 1.96, which is 7,156 and a p value of 0.000 <0.05. The fifth hypothesis in this study is accepted.

5. CONCLUSION

Based on the research results, it can be concluded that project external influence has a significant positive effect on ineffective contract management, construction material supply has a significant positive effect on ineffective contract management, project external influence has a significant positive effect on performance project failure, construction material supply has a significant positive effect on performance project failure and ineffective contract management has a significant positive effect on performance project failure at PT PLN (Persero) Unit Transmission of Eastern Java and Bali.

- ***Effect of Project External Influence to Ineffective Contract Management***

Ineffective contract management can also be defined as the ineffectiveness of an agreement signed by the contractor, architect and owner after the initial contract was made and then modified several scopes of work to adjust to costs and time (Gadisa & Hong, 2020). This analysis provides output in the form of a diagram that provides a good description of a problem, so it is very useful for analyzing the influence of project performance failure factors in carrying out project work with the risk of project performance failure on various projects being carried out.

- ***Effect of Construction Material Supply to Ineffective Contract Management***

Construction material supply related problems or better known as construction material supply problems related to supply chain management is a process of good mutual relations between providers and customers with optimal results and low costs in order to gain profits. Improper project design procurement process associated with the process of change in a job tends to be experienced in every construction project because almost all construction projects always change, both large-scale and small-scale changes are associated with inappropriate project design procurement processes (Gadisa & Hong, 2020).

- ***Effect of Project External Influence* to *Performance Project Failure***

Research by Alubaid et al (2018) describes problems that often occur during a lifetime of construction projects that lead to disputes, delays and litigation. Research by Takim & Akintola (2002) that the construction industry is generally considered to be underperforming compared to other industries. Not only that, the UK construction industry has been criticized for not performing at the same level as the rest of the developed world. Soewin & Chinda's research (2018), namely developing a multidimensional performance evaluation framework for construction companies by considering all relevant performance measures.

- ***Effect of Construction Material Supply to Performance Project Failure***

Bajjou & Anas (2018) explains that determining the critical causes affecting project delays in the Moroccan construction industry. These various studies support research related to project implementation at PT PLN (Persero) Unit Transmission of Eastern Java and Bali implemented in analyzing and evaluating project performance failure factors, this implementation is considered effective, but in conducting project performance failure factor analysis it can still be further optimized.

- ***Effect of Ineffective Contract Management to Performance Project Failure***

Ineffective contract management can also be defined as the ineffectiveness of an agreement signed by the contractor, architect and owner after the initial contract was made and then modified several scopes of work to adjust to costs and time (Gadisa & Hong, 2020). This analysis provides output in the form of a

diagram that provides a good description of a problem, so it is very useful for analyzing the influence of project performance failure factors in carrying out project work with the risk of project performance failure on various projects being carried out.

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A Systematic Literature Review Malware Detection

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1. INTRODUCTION

The development of the industrial revolution 4.0 began in 2016 through the use of sensors, actuators, controllers, clouds, and smartphones that are part of the industrial automation ecosystem [1]. While the data is in progress, yahoo can play an important role in solving a problem, reducing the amount of data volume during the accumulation and data collection. The effectiveness of devices and networks poses a complex challenge of information security is vulnerable to malware attacks.

The data phase triggers security loopholes to attack with new malware variants thereby increasing the amount of malware that needs to be analyzed. The spread of malware starts from corrupting files on the device. Security loopholes work in three phases.

First, the device's network traffic is a harmless profile. Any alerts associated with potential anomalies locally to detect anomalies in the network and identify stages using solutions that are localized in space and time. proposed work in terms of its ability to spread spatially and temporally. Second, Any warnings related to potential anomalies are processed locally to detect anomalies on the network and identify attack stages using solutions that tend to be localized in time and space. proposed work in terms of its ability to be spatially and temporally dispersed.

Through the characteristics can be identified the type of malware attack. Several solutions are proposed in the literature to defend the device against malware threats. most of these solutions use the concept of changing algorithms for detection. In the infrastructure model, the mobile operator automatically monitors the network for abnormalities, in addition, to the scarcity of resources of each node limit the spread of malware. In considering the general behavioral characterization of proximity malware. Characterization, in terms of system calls and program flow, has been propose as effective alternative to the earlier pattern detection for malware detection. The main purpose of this literature review is to find out the collection of information from the algorithm used for the classification process. The algorithm is formed from two analyze is Static code analysis and dynamic behavior analysis. A statistical-based detection is an anti-malware approach that identifies malware by examining software patterns against a database of known malware signatures. This scheme is based on the premise that malware instances can be defined through patterns. The disadvantage of the statistical analysis method is that because the byte signature pattern is from a known malware, the pattern is also generally recognized.

One of the important lessons learned from the increase in malware attacks is that the computing power used is less than a smartphone or computer as a result many new malware

programs are created as duplicates of existing programs from executable code changes. This program was created to prevent and improve anti-malware tools and malware detection modules.

The focus of our literature study is on evolving malware programs with three main characteristics. They are: (a) rare in type (b) made with customized packaging (c) highly intelligent. This type of malware program has not been discussed in most of the related studies in malware behavior modeling and detection. Therefore, this paper focuses on (a) disassembling and executing malware (b) extracting the necessary features (c) developing possible mutations to train classifiers capable of accurately detecting such malware.

There is a need to gather more information from an IT point of view so that computer science is interested in new research that can detect malware. In addition, this paper also tries to explore the use of various algorithms.

Therefore, we structured the following research questions:

(RQ1) : Analysis with Algorithm machine learning ?
(RQ 2) :The current most effective algorithm for detecting malware?
(RQ3) : How to develop a new algorithm?

2. LITERATURE REVIEW

To answer this question, we conducted a literature review using the Systematic Literature Review (SLR) methodology. The SLR methodology will be presented in part II. The results of the SLR will then be explained in part III and discussion in part IV. In the last section, we will conclude and propose gaps for future research. and management of social assistance. Today there is a need to gather more information from an IT point of view so that computer science researchers are interested in malware detection algorithms.

3. METHODS

We adopt SLR, It contains seven phases, (1) question definition malware detection, (2) selection of work team, (3) research strategy, (4) search, eligibility, and coding, (5) quality assessment, (6) synthesis of results,and (7) study presentation. Those phases can be grouped into three steps of [18] i.e., (1) review planning, (2) review conducting, and (3) results reporting.

1. Review Planning

Question Definition

This paper is intended to explore Malware Detection. Therefore, this paper can deliver basic knowledge for future research. The research questions of this paper are:

(RQ1) : Analysis with Algorithm for machine learning?
(RQ 2) :The current most effective algorithm for detecting malware?
(RQ3) : How to develop a new algorithm?

2. Selection of Work Team

The working team consists of two people as mentioned on the first page as the authors of this paper. The author is a student and promoter of this research.

3. Research Strategy

Considering the research questions, our search terms are 'algorithms', 'malware detection', and 'Information Security'. The selected query that is applied to the research database site or research indexing site is.

Sources for searching this paper are the Social Science Research Network, Scopus, ScienceDirect, and IEEE Xplore, Semantic Scholar. The search results are then exported to a spreadsheet format to simplify the inclusion and exclusion process.

Inclusion and Exclusion Criteria include:

Inclusion 1 (I1), scientific publications in the form of journals or proceedings/conference papers,
Listing 2 (I2), the publication time span listed is between 2011 – 2022,

- Exception 1 (E1), the first exception being the publication that we were unable to obtain the full text version.
- Exception 2 (E2), publications are not written in English.
- Exception3 (E3), the publication does not contain 'algorithms', 'malware detection', 'Internet Of Things' 'Information Security' in its abstract, keywords and/or main content.
- Exception 4 (E4), publications are not journals or proceedings/conferences. Publishers sometimes misclassify

From the exclusion process, the remaining publications are then read in full text. Their publications, for example posters but are marked as articles. Thus, this exception acts as a final filters.

4. RESULTS

From the exclusion process there were 52 publications left which were then read. The following two phases will present the information.

Result System

The results of reading the full text will be presented first as a summary. We divided the summary into a list of research questions. The list of exception recapitulation in table 2.

TABLE 2 .
EXCEPTION RECAPITULATION

Exception	Description	Publication
	Pre-Exception	153
E1	Full text version not available	10
	Pasca-E1	143
E2	Publications are not written in English	5
	Pasca-E2	138
E3	Required terms (Malware, “Malware Alert”, and/or “Malware Detection ”) Are not found in the abstract, keywords or main content	30
	Pasca-E3	108
E4	Publications are not journals or proceedings/ conference papers	56
	Pasca-E4	52

- **RQ1**

Algorithm Definition. On the other hand, we found publications that explained the analysis in terms of algorithms but found more technical aspects of the performance of malware detection tools.

- **RQ2**

Malware detection capability of the algorithm.We present a collection of information read about detection of malware classifications.

- **RQ3**

We found no publications mentioning how to build a step-by-step algorithm. More to the results of the classification of malware than the algorithm used.

5. DISCUSSION

In this section, we will outline what we presented in section III. We present the discussion in the form of research question points as in section III.

RQ1

After compiling definitions from the publications reviewed, we found that the use of the word "algorithm" was unique. reviews of publications that use the term algorithm as a term known to the public as a "problem solving method or step. Algorithms can simplify big things into programming so that they are easily executed into computer understanding output.

RQ2

When performing a search for the word malware detector. The use of these two words namely detection and malware will lead to the implementation or experimentation of using devices to catch malware.In research with both detection, dynamic real-time and static malware detection using additional tools.

RQ3

The use of algorithms is very important in detecting malware and selecting malware based on the type, size, file being attacked, attack method of the attacker and the device being attacked. Thus, the development of devices, especially in the application of IoT, must be accompanied by supporting support to be accurate in detecting anomalies.

6. CONCLUSION

Malware is one of the threats in a network system because it will damage the data in file storage. The attacker will definitely have the advantage in many cases. This would be a criminal act. The challenges that researchers will face are the growing variety of malware. So it takes the ability to anticipate attacks and prepare to strengthen network security, devices, and systems in the automation of malware analysis.

In the automation of malware analysis the use of algorithms is very influential. The algorithms used in detecting and selecting malware must be reliable in terms of both time and resources. Automation of malware analysis as an output of algorithm development so that it is hoped that the new algorithm will minimize the increased risk of security holes that are the target of malware

embedding. So it's necessary to apply machine learning algorithms that have an effective and efficient approach.

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THE EFFECT OF INSTAGRAM MARKETING ON CONSUMER PURCHASE DECISION THROUGH BRAND AWARENESS, BRAND TRUST AND BRAND LOYALTY AT TENTWO COFFEE SURABAYA

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ABSTRACT

The culinary business is one sector that influences the growth of the tourism industry. One of which is coffee shop, referring to national coffee consumption data from the Ministry of Agriculture, which has increased by 8.22 percent every year, but in the growth chart, it tends to decrease. Tentwo Coffee which was chosen as the research object also implemented its marketing strategy through the use of Instagram Marketing. However, a problem arose, namely Tentwo Coffee could not convert and analyze the impact of Instagram Marketing on purchasing decisions from Tentwo Coffee customers via brand awareness, brand trust, and brand loyalty. Instagram marketing is important because according to data from the Surabaya city government, the number of businesses grows every year which means competitors from Tentwo coffee. Therefore Tentwo coffee must deliver value proposition and differentiation compared to other competitors through content. Based on the S-O-R framework, this study aims to examine how Instagram marketing activities influence purchase decisions through brand awareness, brand trust, and brand loyalty for Tentwo Coffee. This research is a research model conclusive descriptive – multiple cross-sectional with a quantitative approach. To achieve the research objectives, the processing techniques and data analysis in this study used descriptive analysis and PLS-SEM with 157 samples. The results show that Instagram Marketing has a positive and significant relationship with brand trust, brand loyalty, and brand awareness. Next brand awareness and brand trust are positively and significantly related to purchase decisions. But Instagram Marketing and Brand Trust are positively and not significantly related to purchase decisions. There are managerial implications for Tentwo coffee as a future marketing strategy through social media, especially on Instagram, which serves to increase value brand awareness, brand trust, and brand loyalty which will impact the purchase decision.

Keywords: Instagram Marketing, Purchase Decision, Brand Awareness, Brand Trust, Brand Loyalty, Coffee Shop

1. INTRODUCTION

Active social media users in Indonesia in 2022 will reach 204.7 million people and Indonesia will experience an increase in social media users by 12.6% from 170 million to around 191.4 million people (Riyanto, 2022). Instagram Marketing refers to interaction and

communication between consumers and brands. Instagram Marketing can strengthen and meet different individual needs, as well as enhance the appearance of consumer-brand relationships (Ibrahim, 2020). Marketing using social media must be creative and attractive so as to form brand awareness (Upadana & Pramudana, 2020). Among other tourism sectors, the culinary business is a sector that is quite large in using internet technology as a marketing strategy. One of the culinary business sectors that uses internet technology activation, namely Instagram Marketing, is coffee shops. Currently, drinking coffee has become a lifestyle for some people in Indonesia, especially the millennial and gen Z generations. This can be seen in the many coffee shops that have sprung up all over Indonesia. It is estimated that from 2016-2021, the growth rate of coffee consumption will increase by 8.22% per year. However, behind the increase in the number of coffee consumption in Indonesia, there is an aspect that is no less important, namely the decrease in the growth in the amount of coffee consumption, which means that this is a challenge for coffee shops in Indonesia to maximize all of the strategies to survive, one of which is by Promotional media use Instagram Marketing to convey messages about value proposition and differentiation from other competitors.

Tentwo coffee is a case study in this research because this coffee shop carries local coffee raw materials and is intended for Indonesian people, this shop also carries the concept of kindness which offers this value through three aspects, namely hospitality, music playlists, and the ambience that is given to customers. Tentwo coffee is not yet optimal in using Instagram marketing, because in terms of the number of followers it is very far away compared to competitors. Likewise, the value of the engagement rate obtained by Tentwo Coffee is not that significant. At the same time, the number of followers from Tentwo Coffee is quite small when compared to its competitors. Based on the background explained, the use of Instagram Marketing in marketing activities is essential and related to purchase decisions and the formation of brand awareness, brand trust, and brand loyalty, but Tentwo coffee has not been able to convert from using Instagram Marketing to sales or purchase decisions and Tentwo coffee has not optimally use Instagram marketing because it has not been able to increase in terms of followers and engagement rates achieved when compared to competitors.

2. LITERATURE REVIEW

2.1 Tentwo Coffee

Tentwo coffee which was chosen by the researcher as the object of the case study has been established since 2020 in December to be precise. Tentwo coffee carries the concept of coffee & kindness which has the energy of hospitality and kindness, this value is given to customers through three aspects, namely through hospitality services, namely how the barista or team from Tentwo coffee provides friendly and educative service regarding products or brand matters. Next is the music playlist from Tentwo coffee to support a comfortable and friendly atmosphere for customers who spend time at Tentwo coffee

2.2 Brand Awareness

Brand awareness in this study is the ability of consumers to remember a brand or advertisement through spontaneous circumstances or after being stimulated by keywords (Fajri, 2021).

2.3 Brand Trust

Brand trust is consumer belief that a product has certain attributes, a belief that is obtained through repeated display, learning, and experience (Arief, Suyadi, & Sunarti, 2017).

2.4 Brand Loyalty

According to (Kanuk, Schiffman, & Lazar, 2009), brand loyalty is also a consumer preference to consistently buy certain products with certain service categories from the same brand.

2.5 Instagram Marketing

According to (Nummila, 2015), the successful use of Instagram marketing is about being active, posting great content, following interesting people, leaving comments and asking questions for these people, and gaining followers and influence in brand image.

2.6 Purchase Decision

Purchase Decision is a combination of consumer interest and the possibility of buying a product according to (Kim & Ko, 2012).

3. METHODS

This research is conclusively descriptive with a quantitative approach to determine what factors influence purchasing decisions at Tentwo Coffee through Instagram Marketing. Collecting research data using multiple cross-sectional designs, a design that takes more than one population sample where information is collected only once for each intended respondent (Malhotra, 2010). This research uses a probability sampling technique with a simple random sampling method. The sample in this study was 157 respondents with the criteria as having visited or consumed products from Tentwo coffee. Data collection uses an online survey with Google Forms.

4. RESULTS

From the demographic aspect, private employees who make up the majority of customers from Tentwo coffee Surabaya and followed in second place are students, with an age range of 22-26 years and monthly income of around IDR 3,000,000 to IDR 6,000,000.

Table 1. Demographic Analysis

Responden Demographic	Total	Percentage (%)
Age		
Woman	79	55,6
Man	63	44,4
Total	142	100
Domicile		
Bandung	1	0,7
Denpasar	1	0,7
Gresik	2	1,4
Jakarta	5	3,5
Jombang	1	0,7
Ponorogo	1	0,7
Purwokerto	1	0,7
Sidoarjo	15	10,6
Surabaya	110	77,5
Tangerang	4	2,8
Yogyakarta	1	0,7
Total	142	100
Age		
17 – 21 Years	16	11,3
22 – 26 Years	111	78,2
27 – 31 Years	8	5,6
32 – 36 Years	2	1,4
> 36 Years	5	3,5
Total	142	100

Job		
Student	40	28,2
Entrepreneur	21	14,8
Government Employee	3	2,1
Private Sector Employee	66	46,5
Other	12	8,5
Total	142	100
Income/Month		
< Rp 1.000.000	10	7,0
Rp 1.000.001 – Rp 3.000.000	30	21,1
Rp 3.000.001 – Rp 6.000.000	56	39,4
Rp 6.000.001 – Rp 9.000.000	29	20,4
> Rp 9.000.000	17	12,0
Total	142	100

Furthermore, in the aspect of consumer behavior characteristics of Tentwo coffee Surabaya, it is dominated by consumers who know Tentwo coffee Surabaya through the platform Instagram, with the majority of consumers spending costs in the price range of IDR 100,000 – IDR 200,000 and in one transaction, the majority of consumers buy 2 types of products. The next products that are often purchased from consumers are the main course and handcrafted bottles from Tentwo coffee. On the other hand, Tentwo coffee has already activated usage key opinion leaders on Tiktok, apparently not enough impactful to impress potential Tentwo coffee customers.

Table 2. Usage Analysis

Respondent Usage	Total	Percentage (%)
Last Time Visited and Consumed Tentwo Coffee Products		
< 1 month		
1 – 3 month	48	33,8
> 3 month	46	32,4
	48	33,8
Total	142	100
Average Spending per Month		
< Rp 1.000.000	26	18,3
Rp 1.000.001 – Rp 3.000.000	74	52,1
Rp 3.000.001 – Rp 6.000.000	35	24,6
Rp 6.000.001 – Rp 9.000.000	3	2,1
> Rp 9.000.000	4	2,8
Total	142	100
The average cost that is willing to be spent to buy Tentwo Coffee products		
< Rp 100.000	50	35,2
Rp 100.001 – Rp 200.000	78	54,9
Rp 200.001 – Rp 350.000	8	5,6
Rp 350.001 – Rp 500.000	4	2,8
> Rp 500.000	2	1,4
Total	142	100
Number of Products Purchased in Every Transaction		
1		
2	23	16,2
3	83	58,5
4	21	14,8
5	12	8,5
>5	1	0,7

Respondent Usage	Total	Percentage (%)
	2	1,4
Total	142	100
Where Can Tentwo Coffee Product Information Be Obtained?		
Instagram		
Tiktok	75	52.8
Friend/family recommendation	0	0.0
Whatsapp	63	44.4
Others	0	0.0
	4	2.8
Total	142	100

Descriptive analysis is done by counting the mean, median, mode, and standard *deviation* of 5 latent variables and 28 indicator variables used in the PLS-SEM analysis method. Descriptive analysis aims to see the tendency of respondents' answers and opinions on questions related to each variable posed by researchers in the questionnaire. From the data processing that has been done, there are three variables that have the highest average value, including Instagram Marketing with a value of 4.29, this means that the majority of respondents answered that they agreed if the Instagram content presented by Tentwo Coffee was interesting. Brand Trust with a value of 4.39, which means that the majority of respondents answered that they agreed if they had high enough expectations for Tentwo Coffee products, and purchase decision with a value of 4.09 which means that the majority of customers agree to repurchase Tentwo Coffee products.

Table 3. Validity and Reliability Test

	Mean	Median	Mode	Std. Deviation
IM – *Instagram Marketing*				
IM1	4,41	4,00	5	0,632
IM2	4,44	5,00	5	0,647
IM3	4,39	5,00	5	0,693
IM4	3,89	4,00	4	0,905
IM5	4,36	4,50	5	0,747
IM6	4,47	5,00	5	0,660
IM7	4,17	4,00	5	0,867
IM8	4,18	4,00	5	0,804
	4,29			
BT – *Brand Trust*				
BT1	4,49	5,00	5	0,639
BT2	4,54	5,00	5	0,626
BT3	4,19	4,00	4	0,798
BT4	4,35	4,00	5	0,717
	4,39			
BL – *Brand Loyalty*				
BL1	3,01	3,00	3	1,136
BL2	3,86	4,00	4	0,864
BL3	3,45	3,00	3	0,979
BL4	4,12	4,00	4	0,812
	3,61			
PD – *Purchase Decision*				
PD1	4,34	4,50	5	0,762
PD2	4,18	4,00	5	0,896

	Mean	Median	Mode	Std. Deviation
PD3	4,07	4,00	5	1,036
PD4	3,77	4,00	4	1,048
	4,09			
BA – *Brand Awareness*				
BA1	4,42	5,00	5	0,737
BA2	4,07	4,00	5	0,864
BA3	3,88	4,00	4	0,926
BA4	3,45	3,00	3	1,095
BA5	3,90	4,00	4	0,894
BA6	3,99	4,00	5	0,942
BA7	4,01	4,00	4	0,871
BA8	3,87	4,00	5	0,988
	3,95			

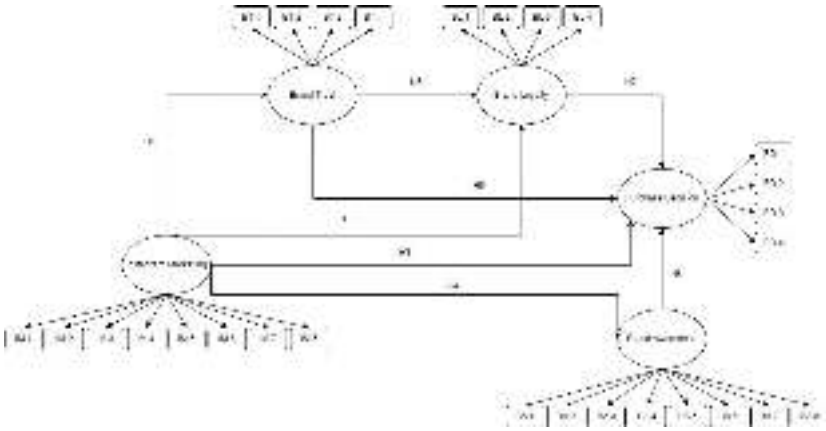

Figure 1. Research Model

Based on the results of hypothesis testing, six hypotheses are accepted and have a significant relationship because they have valuet-statistics > 1.65 and valuep-values ≤ 0.05, the six hypotheses include: (H1) Instagram marketing to brand trust; (H2) Instagram marketing to brand loyalty, (H4) Instagram marketing to brand awareness, (H5) Brand trust to brand loyalty, (H7) Brand loyalty to purchase decision and (H8) Brand awareness to purchase decision. These results indicate that the influence of these latent variables has a high degree of truth for the diversity of the data obtained. Meanwhile, the other two hypotheses (H3 and H6) were rejected and showed no significant relationship. The absence of significance is supported by value path coefficients that do not meet the minimum threshold.

Table 4. Hypothesis Testing

Hypothesis	Effect	*Path Coefficient*	*t-statistics*	*p-values*	Remarks	Hypothesis
H1	*Instagram Marketing → Brand Trust*	0.726	14.728	0	Significant	Approved
H2	*Instagram Marketing → Brand Loyalty*	0.34	3.086	0.002	Significant	Approved
H3	*Instagram Marketing → Purchase Decision*	0.11	1.453	0.147	Not Significant	Rejected
H4	*Instagram Marketing → Brand Awareness*	0.726	19.017	0	Significant	Approved
H5	*Brand Trust → Brand Loyalty*	0.331	3.009	0.003	Significant	Approved
H6	*Brand Trust → Purchase Decision*	0.069	0.705	0.481	Not Significant	Rejected

H7	*Brand Loyalty → Purchase Decision*	0.501	6.728	0	Significant	Approved
H8	*Brand Awareness → Purchase Decision*	0.258	2.445	0.015	Significant	Approved

Hypothesis 1 shows that Instagram Marketing has a significant positive effect on Brand Trust. These results support the hypothesis put forward in the study. This finding is also in accordance with previous research conducted (Ibrahim, 2021). According to (Ibrahim, 2021) the impact of Instagram Marketing on brand *Trust* signifies that IM includes an impact on BT through aspects of expectations, expectations, reliability, and honesty of Tentwo coffee. The use of Instagram Marketing has a positive and significant effect on value creation trust for consumers according to research findings from (Zulfikar & Mikhriani, 2017)

Hypothesis 2 shows that Instagram Marketing significantly positively affects Brand Loyalty. According to (Ibrahim, 2021) the impact of Instagram Marketing on brand loyalty has a positive and significant effect by offering potential relationships to build effective brands. Instagram Marketing influences brand loyalty through the effective use of tools in Instagram features, developing customer relationships, and stimulating engagement and interaction, which influences return intentions.

Hypothesis 3 shows that Instagram Marketing has no positive and significant relationship to purchase decisions, Based on research conducted by (Upadana & Pramudana, 2020) which shows that Instagram marketing has a positive effect on purchasing decisions, the better the level of Instagram marketing, the better the level of consumer purchasing decisions. However, this will not necessarily have a positive impact on Tentwo Coffee, which uses Instagram Marketing as a promotional medium. Based on the 4P marketing mix theory put forward by (Borden, 1964), which consists of product, price, promotion and place, which means that business processes do not only depend on one aspect, namely as in this hypothesis, Instagram Marketing.

Hypothesis 4 shows that Instagram Marketing has a significant positive effect on brand awareness, This is in line with research conducted by (Fajri, 2021) which means that the higher the use of Instagram Marketing as a marketing tool, the better the level of consumer memory of the brand.

Hypothesis 5 shows that brand trust has a significant positive effect on brand loyalty, According to (Ibrahim, 2021) through his research, brand trust leads to brand loyalty or commitment because trust produces high-value exchange relationships. In line with research conducted by (Murtiningsih, 2016) the results show that brand trust has a positive effect on brand loyalty.

Hypothesis 6 shows that brand trust has no positive and significant relationship to purchase decisions, This is contrary to research conducted by (Ibrahim, 2021) which states that BT has a positive impact on PD. It is presumed that potential customers from Tentwo Coffee only believe in the products and brands from Tentwo Coffee, but do not extend to purchase decision activities. This happened because it was suspected that there was a trigger from competitors in the Jl. Jawa Surabaya, which makes Tentwo coffee potential customers choose other brands to visit with price competition and also the concept offered in terms of product and ambience.

Hypothesis 7 shows that brand loyalty has a significant positive effect on purchase decision,

Through research conducted by (Ibrahim, 2021) that Instagram Marketing influences brand loyalty through the use of effective tools, developing customer relationships, and stimulating engagement and interaction, which influence purchasing decisions by consumers.

Hypothesis 8 shows that brand awareness has a significant positive effect on purchase decision, The results of this study can be concluded that building consumer brand awareness is

very influential in the purchasing decision making process. This means that the better the brand awareness, the higher the purchase decision for a brand (Fajri, 2021).

6. CONCLUSIONS

The characteristics of respondents or consumers from Tentwo coffee Surabaya who use Instagram as a social media used to search for information can be seen from the demographic aspect and usage behavior. From the demographic aspect, private employees who make up the majority of customers from Tentwo coffee Surabaya and followed in second place are students, with an age range of 22-26 years and monthly income of around IDR 3,000,000 to IDR 6,000,000. Furthermore, in the aspect of consumer behavior characteristics of Tentwo coffee Surabaya, it is dominated by consumers who know Tentwo coffee Surabaya through the Instagram platform, with the majority of these consumers spending in the price range of IDR 100,000 – IDR 200,000 and in one transaction, the majority of these consumers buy 2 types of products. Meanwhile, Instagram Marketing does not have a positive and significant relationship to the purchase decision because it refers to the 4P marketing mix concept, which includes product, price, promotion and place, which means that when a purchase decision is made, potential consumers will consider these four aspects, so that Instagram Marketing is not just one the only tool to create sales. Broadly speaking, the use of Instagram marketing influences purchase decisions indirectly, but through the stages that must be passed first, namely creating content creation that has the potential to create value for brand trust, brand loyalty and brand awareness.

Based on the results of the PLS-SEM analysis, it was found that Instagram Marketing had a positive and significant relationship to brand trust, brand loyalty and brand awareness. These are related to one another because the perceived usefulness of using Instagram Marketing through content creation, promo activation and event activation that has been created by Tentwo Coffee can generate values regarding awareness, trust and loyalty to Tentwo coffee consumers. In addition, brand trust is also not positively and significantly related to purchase decision. This could happen because it was suspected that there was a trigger from competitors in the Jl. Jawa Surabaya, which makes Tentwo coffee potential customers choose other brands to visit with price competition and also the concept offered in terms of product and ambience.

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DEVELOPMENT OF SMART LIVING STRATEGY TO DEAL WITH THE COVID-19 PANDEMIC (CASE STUDY: MAKASSAR CITY)

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ABSTRACT

The COVID-19 pandemic has affected many cities around the world, including Makassar. Several measures to control the spread of the virus are carried out by the City of Makassar, one of which is physical distancing. Related measures significantly affect the transport and mobility of the city. Meanwhile, the smart living planning and framework on the Makassar City smart city master plan was developed before the existence of COVID-19, therefore it does not describe the current conditions. Moreover, so the purpose of this study is to analyze current conditions and develop recommendations for smart living strategies to deal with the COVID-19 pandemic in Makassar City using qualitative methods with case studies. The data collection techniques used are documentation and Focus Group Discussion (FGD) with respondents consisting of the Head of the Service, Secretary of the Service, and/or Expert Staff at the Communication and Informatics Service, Social Service, and the Makassar City Regional Development Planning Agency. The results achieved in this study are to find out the current condition of the city of Makassar after the COVID-19 pandemic still needs to face various challenges in the aspects of health, urban planning and mobility (smart living). On the health front, the pandemic is stressing health systems and triggering changes in how cities understand and deal with public health. In the urban planning aspect, the pandemic has accelerated changes in lifestyle and work culture that have affected urban planning and spatial planning. In terms of urban mobility, the pandemic is causing changes in the way people move and travel, including a decrease in the demand for public transportation and an increase in the use of private modes of transportation such as self-driving

Keywords: Smart Living, Mobility, Healthy**,** Makassar**,** COVID-19.

1. INTRODUCTION

The COVID-19 pandemic that occurred in March 2020 has affected the lives of millions of citizens around the world, including Indonesia. COVID-19 has had a major impact on many sectors, especially the economy and has a sustainable influence on people's lifestyles and mobility. In almost all countries, governments restrict mobility in public places to reduce the transmission of the virus. However, community activities, such as going to school, to the office or to the market cannot be stopped, even if mobility is restricted. Thus changing people's habits to adapt to doing all activities remotely using technology In the field of urban planning, technology has been integrated in the (Yeganeh, 2021) (Rachmawati, et al., 2021) (Gebre & Gebremedhin, 2019) (Rachmat & Mangkoesoebroto, 2022)masterplan document to establish smart city planning. Smart cities are a trend of urban development today that has been adapted from various countries because it has proven to significantly reduce the impact of COVID-19 on various sectors. (Ameen & Mourshed, 2017)

Smart living is one of the important elements of smart cities that are closely related to the formulation of transportation mobility and smart infrastructure. So that (Kemenkominfo, 2017)the best practices of some smart living are important inputs for resilience and developing mobility strategies and city infrastructure in the future. This research case study was conducted in Makassar City as the largest metropolitan city in Eastern Indonesia. Makassar City is faced with one of the most strategic regional issues listed in the Makassar City Regional Medium-Term Development Plan (RPJMD) for 2021-2026 "Limited Availability of Urban Infrastructure". This is due to several causes. So that smart (Makassar, RPJMD Tahun 2021-2026, 2021)living best practices are needed for Makassar City to be resilient to current conditions and can support one of the missions of Makassar City in 2021-2026, namely "Restoration of inclusive urban spaces towards a world-class comfortable city that is 'sombere and smart city' for all". Makassar City has developed a smart city masterplan known as "Sombere and Smart City". However, the (Madani & Nasrulhaq, 2017)masterplan was developed before the COVID-19 pandemic. So that the existing framework and methodology need to be re-analyzed to deal with the COVID-19 pandemic, especially in the aspects of transportation, infrastructure and health. (Afdhal, et al., 2022)

This study aims to develop smart living strategy recommendations which begin with an analysis of the latest conditions in the aspects of smart living in Makassar City which then formulates strategy recommendations as a resilience effort to respond to the ongoing COVID-19 crisis, especially in Makassar City This research was conducted through primary and secondary data mining with several data collection techniques such as Focus Group Discussion (FGD) and surveys with open-ended questionnaires. Data collection was carried out with smart city expert speakers and regional apparatus organizations (OPD) related to smart city implementation, such as the Statistics and Persandian Informatics Communication Service, the Regional Development Planning Agency and the Makassar City Transportation Agency. Meanwhile, secondary data is obtained from the application of data management techniques in the form of documentation.

2. LITERATURE REVIEW

Yang (2021) defines smart city is the concept of using information technology that focuses on integrating information to provide solutions to city problems and being able to create a better city. (Yang & Chong, 2021)

The Ministry of Communication and Informatics (2017) launched the 'Movement Towards 100 Smart Cities" which is an initiative aimed at the implementation of 100 smart cities in Indonesia by 2045. This goal will be translated into six pillars, including smart governance, smart branding, smart economy, smart living, smart society and smart environment. Smart living is one of the important elements of smart cities that are closely related to the formulation of transportation

mobility and smart infrastructure. The goal of smart (Kemenkominfo, 2017)living in a smart city is to create a liveable, comfortable, and efficient living environment. Smart living development initiatives can be carried out on several indicators as follows.

a) Harmonization of Regional Spatial Planning (Harmony)
   The main objective of this indicator based on the book is to create a comfortable and harmonious living environment between residential environments (residential), business activity center (commercial) environment supported by recreational facilities for families (recreational). (Kemenkominfo, 2017)
b) Realizing Health Standards
   Realizing access to the availability of healthy food and beverages (food), access to health services (healthcare), and access to sports facilities and infrastructure (sports).
c) Ensuring the Availability of Transportation Facilities (Mobility)
   Realizing a transportation ecosystem that guarantees easy mobility for individuals, the public, and to meet the logistics needs of an area.

3. METHOD

3.1 Literature Review

At this stage, a literature study was carried out from previous research related to the development of smart living recommendations in the city of Makassar. Researchers collect these data which are then analyzed to produce recommendations for smart living strategies to deal with the impact of the COVID-19 pandemic in accordance with the research to be developed.

3.2 Preparation of a Research Plan

The preparation of the research plan is carried out as a terrain orientation process and the stages of developing research instruments, including the schedule of activities for the research, research time, resource persons, and so on. This process aims to make the research process systematic and can achieve smooth research goals.

3.3 Data Collection

Data collection aims to confirm the thing analyzed or unit of analysis. Data collection on qualitative methods according to consists of 4 (four) types, namely (1) observation or observation; (2) interviews; (3) documentation; (4) (Murdiyanto, 2020)Focus Group Discussion. Based on this theory, data mining in this study was carried out through documentation techniques and Focus Group Discussions.

a) Documentation
   Documentation is carried out by observing documents in the form of softcopy or hardcopy, photos, audio, video and other supporting documents.
b) Focus Group Discussion
   The FGD technique was carried out to collect validation segaligus data by preparing research discussion guides for interviews and semi-structured surveys. FGD is conducted offline in Makassar City. The process starts from design or planning, continues with discussion and analysis, and ends with reporting. The FGD was conducted with smart city experts and regional apparatus organizations (OPD) related to smart city implementation, including the

Statistics and Persandian Informatics Communication Service (Kominfo), the Regional Development Planning Agency (Bappeda) of Makassar City, and the Makassar City Transportation Agency.

3.4 Analysis

The data that has been collected is then analyzed as a process of answering the formulation of problems that have been found before. This analysis process consists of several stages, namely first injecting smart living indicators and COVID-19 parameters referring to previous research then analyzing the smart living strategy that has been developed by the Makassar City government in the 201 Makassar City Smart City Masterplan Book. As well as analyzing the latest vision and mission of Makassar City contained in the Regional Medium-Term Development Plan (RPJMD) for 2021-2026. The third analyzes the current state by using a SWOT analysis tool. Fourth, develop smart living strategy recommendations that describe current conditions for resilience to COVID-19.

3.5 Research Validation

Validation of this research was carried out to determine the results of the analysis developed in accordance with the conditions and facts that occurred in Makassar City as well as the recommendations for the smart living framework provided can be applied to the development of smart cities, especially in the aspects of smart living that are in accordance with current conditions after the COVID-19 pandemic. The validators of the results of this study are the head of the office, the secretary of the service, and expert staff from the Statistics and Persandian Informatics Communication Service, the Regional Development Planning Agency and the Makassar City Transportation Agency. Related speakers were chosen because they have an important role in the development of smart cities in Makassar City.

4. RESULT

4.1 Current State Analysis

Analysis of the current condition of smart living in Makassar City involves evaluating and monitoring the city's situation related to strengths, weaknesses, opportunities and threats (SWOT) related to smart living. By analyzing the latest conditions, it is hoped that it can get an overview of the real situation and assist in planning a smart living development strategy that suits the needs of Makassar City. More details can be seen in Table 1

Table 1. SWOT Analysis

Strength	Weakness
Harmony **SH.1** Almost all areas of Makassar City can be reached by fiber optic networks so that internet access is smooth in Makassar City (ADB, 2021) **SH.2** Makassar City has developed a smart city masterplan known as "Sombere and Smart City" (Makassar D. , 2017) **SH.3** Makassar City Government develops Aparong (Lorong Apartment) for Low Producing Communities (MBR) (Makassar D. , 2017)	**Harmony** **WH.1** Limitations of human resources in the control and utilization of open space (ADB, 2021) **WH.2** Decreased capability of waste treatment facilities (Makassar, RPJMD Tahun 2021-2026, 2021) **WH.3** Smart city guidelines and masterplans that were developed before the COVID-19 pandemic (Makassar D. , 2017)

Healthy **SE.1** The development of smart technology to support health services (Megahed & Kader, 2022) **SE.2** Increased public investment in crowd warning systems and temperature checks in buildings (Megahed & Kader, 2022) **Mobility** **SM.1** There is a Regional Regulation No. 4/2015 concerning the Makassar City Spatial Plan 2015-2034 which includes the regulation of rail transportation systems, integrated land water transportation, anatmoda transportation, and integrated systems for pedestrians, bicycles, and persons with disabilities (Makassar P. , JDIHN, 2022) **SM.2** Has a wide range of public transportation, such as pete-pete (microbus), PASIKOLA (Petepete Cerdas Anak Sekolah), BRT (Bus Rapid Transit), online-based transportation (GOJEK, GRAB, MAXIM), Taxy and conventional ojek (ADB, 2021) **SM.3** Against several programs of the Makassar City Transportation Agency to support mobility, including: Pete-pete smart, PASIKOLA, E-NASSAMI, MODTRAP GOES TO SCHOOL (PAIR, 2021)	**WH.4** The socialization process of the Bus Friends program has not fully run optimally. Where there are still many people who don't know about the Teman Bus program (Makassar, RPJMD Tahun 2021-2026, 2021) **Healthy** **WE.1** Lack of human resources with the skills needed in the implementation of home care programs (Putra, 2017) **WE.2** There are only 246 puskesmas, polikinik and pustu (1: 4,115.25 of the total population in 2020). As well as 50 hospitals in Makassar City (1: 28,477.54 of the total population in 2020) (Makassar, RPJMD Tahun 2021-2026, 2021) **WE.3** Low level of drinking water availability (Makassar, RPJMD Tahun 2021-2026, 2021) **WE.4** Based on data from the COVID-19 task force for COVID-19 positive patients in Makassar city until October 2022, there are a total of 64,329 confirmed patients (Makassar P. , Info Penanggulangan COVID-19 Kota Makassar, 2022) **Mobility** **WM.1** Limited availability of urban infrastructure (Makassar, RPJMD Tahun 2021-2026, 2021) **WM.2** Still low number of good quality roads (Makassar, RPJMD Tahun 2021-2026, 2021) **WM.3** Unavailability of an effective mass transportation system (Makassar, RPJMD Tahun 2021-2026, 2021) **WM.4** Makassar City GRDP decreased by -1.27% in 2020 due to the pandemic (Makassar, RPJMD Tahun 2021-2026, 2021) **WM.5** There are a total of 15.58 km of roads in damaged condition and 0.08 km in severely damaged condition in 2021 (Makassar, RPJMD Tahun 2021-2026, 2021) **WM.6** There is congestion due to growth and population density that is not in line with the growth of the transportation system and its network (ADB, 2021) **WM.7** Bus Friends Program Is Not Running Optimally (Asharie, 2022) **WM.8** absence of integration of the development of the two infrastructures in the master plan of Makassar city or the master plan of South Sulawesi province (PAIR, 2021)
Opportunity	**Threat**
Harmony **OH.1** Makassar City has a strategic position as a service and development center in South Sulawesi (Sulsel P. , 2022)	**Harmony** **TH.1** The rapid development of science and technology so as to change people's needs for space utilization and mobility (Kompas, 2022)

OH.2 Preparing the largest budget in the 2021 General Procurement Plan (RUP), which is IDR 543 billion for infrastructure project activities in 2022 (BPK, 2022) **Healthy** **OE.1** Secured funding from USAID (United States Agency for International Development) for the "Building Healthy Cities (BHC)" project. (IOM, 2021) **OE.2** The "Building Healthy Cities (BHC)" project in Makassar City to strengthen multisectoral data integration by developing an application to collect and integrate various health data for HIV, Tuberculosis, Malaria, Homecare visits, maternal and child health, Immunization, and nutrition data in one software platform (IOM, 2021) **Mobility** **OM.1** Re-operation of BRT in collaboration with Deutsche Gesellschaft Internationale Zusammenarbeit (GIZ) (ADB, 2021) **OM.2** There is a construction of a National railway line connecting Makassar and Parepare (ADB, 2021) **OM.3** There is a National project, namely Makassar New Port (MNP) as the main port hub for the distribution of goods to eastern (ADB, 2021) **OM.4** MNP development brings export utilization from ASEAN Economic Community (ADB, 2021) **OM.5** real-time traffic management and monitoring (Megahed & Kader, 2022) **OM.6** Expansion of ICT infrastructure (Megahed & Kader, 2022) **OM.7** To be the center of development of the Mamminasata Metropolitan Area which covers the entire Makassar City area of the National Strategic Area (KSN) in PP 26 of 2008 concerning the National RTRW (DPMPTSP, 2022)	**TH.2 the** accommodation and eating/drinking business sector experienced the largest decrease in income by 92.47%. Other positions followed by other service sectors, transportation and warehousing (Kompas, 2022) **TH.3** Population growth is getting higher, causing the need for land use and housing to increase (BPS, Sektor Usaha Paling Terdampak COVID-19, 2021) **Healthy** **TE.1** The rise of fake news (hoaxes) related to the coronavirus (Katherina, 2015) **Mobility** **TM.1** in 2018 there were already 70% of Makassar residents owning motorcycles (ADB, 2021) **TM.2** Inadequate road conditions for constructing BRT-only lines (ADB, 2021) **TM.3** Transition to work and study from home (Megahed & Kader, 2022)

4.2 Strategy Formulation

The strategies that have been recommended are based on the results of the SWOT analysis which consists of opportunity and strength strategies, weakness and opportunity strategies, threat and strength strategies, and weakness and threat strategies. The COVID-19 pandemic changed the world, including the city of Makassar in various ways and affected the routine of people's daily lives. The spread of the virus has caused the government to take unprecedented steps. One of the most impactful domains is smart living. In the aspect of urban planning (harmony), Makassar City is faced with various challenges, one of which is increasing population growth, so that people's

needs for land and housing also increase. The increase in population in Makassar City has caused many changes in the structure of the city, including infrastructure improvements, the construction of new areas, and an increase in the number of public facilities. The government has taken several steps to address the problems caused by population growth in Makassar City, such as developing Aparong (Lorong Apartments) for Low Income Communities (MBR). However, there is still much to be done to ensure that the impact is felt by everyone in society. Some strategies that can be done are to prepare and provide smart city infrastructure by implementing several program solutions and smart technology, including: the development of Aparong which is increasingly being intensified, the implementation of the Urban Control and Command Center, Improving the quality of human resources to support smart city readiness.

In terms of health (healthy), Makassar City is one of the cities in Indonesia that has been greatly affected by the COVID-19 pandemic. Its sizable resident population and high level of mobility make the city vulnerable to the spread of the virus. The city of Makassar has implemented several measures to control the spread of the virus, one of which is the application of technology by developing the Makassar Recovery application (smaRt Emergency protocol againts Covid-19 and sERvice) and "Home Care" with the concept of Telemedicine. However, there is still much to be done to address this pandemic problem. The government must continue to improve quality health services by accelerating the transition to digitalization. The application of program solutions and smart technologies that can be used is to provide 5G networks in Makassar City to improve technological and operational efficiency, the application of big data, AI, and IoT to facilitate the integration of health data and the application of other intelligent technologies.

In the aspect of mobility, there are several public transportations provided by Makassar City, including Pete-pete, Pasikola, and E-Nassami. Each of these public transportations has been given a digital service in the form of a smart city card that can be used multifunctionally for transactions. However, the pandemic has dropped sharply in the number of public transportation uses, due to the widespread policies of physical distancing, work from home (teleworking) and e-learning. Thus causing the number of public transport passengers to drop sharply during this pandemic. This threatens a significant decline in demand and revenue. Moreover, Makassar City currently has the opportunity to build the Makassar New Port (MNP) toll road and the National railway line connecting Makassar and Parepare (Makassar Livable City Plan: Situation Assessment Report). So that there are several strategies that can be implemented in Makassar, including the construction of more sustainable roads, the development of rail-based urban mass transportation planning, and the development of transportation networks to support accessibility for all residents and businesses. More details can be seen in Table 2

Table 2. Recommended Smart Living Strategy in Makassar City

Opportunity and Strenght	Weakness dan Opportunity
S.5 Preparation of integrated and collaborative ported system management (WM.3, WM.7, OM.5, TM.2, SH.4, SM.5) **S.6** Application of blockchain technology (SE.6, SH.4, OM.5, OM.6) **S.7** Using smart technology for forecasting and prediction (SE.1, SE.4, SE.5, SE.6, OE.2, OE.4) **S.8** Application of Big Data in the health sector in Makassar City (SE.6, SM.4, OE.2, SH.4)	**S.1** Sustainable road construction (WM.1, WM.2, WM.5, WM.6, OM.3, OM.5) **S.3** Transportation network development supports accessibility for all residents and businesses (WM.2, WM.3, OM.4) **S.4** Development of rail-based urban mass transportation planning (WM.3, OM.2) **S.5** Preparation of integrated and collaborative ported system management (WM.3, WM.7, OM.5, TM.2, SH.4, SM.5)

S.11 Support transparent communication (SE.1, OE.1, OE.3) **S.12** Improvement of quality health services (SE.2, SE.6, SE.7, TE.4) **S.14** provides alternatives that intend to continue basic functionality (SE.3, TM.4, OM.3, OM.8) **S.16** Accelerating the transition towards digitization in smart living aspects (OE.3, SE.7, SE.6, SE.8)	**S.10** Prepare and provide smart city infrastructure (SH.2, SH.3, TH.1, TH.3, OH.2, WH.1, WH.3)
Threats and Strenght	**Weakness and Threats**
S.9 Realizing a comfortable and harmonious living environment between the residential environment, the business activity center environment (commercial) supported by recreational facilities for the family (recreational). (SH. 5, TH. 4) **S.10** prepare and provide smart city infrastructure (SH.2, SH.3, TH.1, TH.3, OH.2, WH.1, WH.3) **S.13** Application of mobile Global Positioning System (GPS) to track and monitor COVID-19 cases (SE.1,SE.6,TE.5) **S.14** provides alternatives that intend to continue basic functionality (SE.3, TM.4, OM.3, OM.8) **S.15** supports 'overstrechted' sectors (TE.5, SE.6) **S.17** Realizing a comfortable and harmonious living environment between residential and business activity centers (commercial) supported by recreational facilities for families (recreational). (SH.4, SH.5, TH., TH.4)	**S.2** Reducing the number of modes of transportation on Main Roads (TM.1,TM.2, WM.6, WM.3) **S.18** offers lessons for operational optimization (WH.5, WH.4, TH.1)

4.3 Research Validation

The validation assessment itself uses the content validity technique with the approach proposed by namely (Aiken, 2016)Aiken's Coefficient V with a scale of 5 (five) and the number of raters as many as 7 (seven) to ascertain whether the contents of the questionnaire or questionnaire reflect the research objectives. This validity technique measures each item by calculating the validity coefficient based on the assessment results of as many as 'n' smart living experts. The following for the summary results of the validation of experts is described in Table 3 as follows.

Table 3. Expert Judgment Results on Validity

Items	Expert	A	B	C	D	E	F	ΣS	V	Information
Item 1	r	6	5	4	6	6	2	23	**0.639**	**High Validity**
	S	**5**	**4**	**3**	**5**	**5**	**1**			
Item 2	r	6	6	7	6	6	5	30	**0.833**	**Very High Validity**
	S	**5**	**5**	**6**	**5**	**5**	**4**			
Item 3	r	6	6	6	6	5	4	25	**0.694**	**High Validity**
	S	**5**	**5**	**5**	**5**	**4**	**1**			
Item 4	r	5	6	6	5	3	5	24	**0.667**	**High Validity**
	S	**4**	**5**	**5**	**4**	**2**	**4**			
Item 5	r	7	5	6	6	5	7	30	**0.833**	**Very High Validity**
	S	**6**	**4**	**5**	**5**	**4**	**6**			

Items	Expert	A	B	C	D	E	F	ΣS	V	Information
Item 6	r	6	6	5	6	7	5	29	**0.806**	**Very High Validity**
	S	**5**	**5**	**4**	**5**	**6**	**4**			

Note:
S : R and Lo Subtraction Result (S = r – Lo)
ΣS : The total S value of each component (Sa + Sb + .. + Sf)
V : $\Sigma S/[n(C-1)$
N : Number of appraisers (6 people)
C : Highest number in assessment (7)
Lo : Lowest number in assessment (1)

The results of measurements that have been made in Table 4.21 obtained coefficients of 0.636 (item 1), 0.833 (item 2), 0.694 (item 3), 0.667 (item 4), 0.833 (item 5) and 0.806 (item 6). Then each of the coefficient values is clarified according to the criteria, as follows:

- $0.80 < V \leq 1.00$: Very high
- $0.60 < V \leq 0.80$: High
- $0.40 < V \leq 0.60$: Enough
- $0.20 < V \leq 0.40$: Low
- $0.00 < V \leq 0.20$: Very low

As for the validity result in table 4.21 of the Aiken' V coefficient, it can be concluded that item 2 and item 5 have "very high" validity while item 1, item 3, and item 4 are classified as having "high" validity. Thus the questions given can be said to be valid.

5. CONCLUSIONS

The current condition of Makassar City is still recovering from the impact of the COVID-19 pandemic. Although the Government has implemented various actions and strategies to reduce the impact of the pandemic, there are still many sectors that need to be improved. In the aspect of smart living, several strengths are found that are categorized in supporting harmonious and integrated urban planning (harmony), quality health services (healthy), and adequate transportation services (mobility). Some examples of the strengths possessed by the City of Makassar are the Development of Aparong (Lorong Apartments) by the Makassar City Government for low-income people. In addition,this innovation was developed in an environmentally friendly manner and overcame the slums in the alleys. This is a strength owned by the City of Makassar that can be improved to realize smart living. In terms of weaknesses, Makassar City is currently facing strategic issues listed in the RP JMD Makassar City, namely the low number of good quality roads in Makassar City, guidelines and smart city masterplans that have been developed before the COVID-19 pandemic. In the aspect of opportunities that Makassar City has in the aspect of harmony, Makassar City as a development center in South Sulawesi is certainly very profitable because it can invite investors to invest in Makassar City. For example, Makassar City has received funding from USAID (United States Agency for International Development) for the "Building Healthy Cities (BHC)" project. The "Building Healthy Cities (BHC)" project in Makassar City is to strengthen multisectoral data integration by developing integrated applications to support various health services in Makassar City. In the aspect of threats, there is a rapid development of science and technology so that it can change people's needs for the use of space and mobility. The application of intelligent technology in all aspects can be a solution to the development that continues to advance. However, it also needs to be controlled because there are other risks and challenges that

are also accepted, one of which is the current rampant hoax news, especially related to the COVID-19 pandemic. This can hinder efforts to solve the problem of the COVID-19 pandemic.

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COST-BENEFIT ANALYSIS FOR TANGIBLE, QUASI-INTANGIBLE, AND INTANGIBLE FACTORS IN PENSION PAYMENT DIGITALIZATION PROJECTS IN INDONESIA'S SOCIAL INSURANCE COMPANY

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ABSTRACT

The role of Information Technology (IT) is important for businesses because it can improve their performance, so a lot of companies allocate their capital expenditures to IT projects in large numbers. However, the amount of IT capital expenditure was not accompanied by a good evaluation because the benefits provided by IT Projects are more intangible or non-quantitative, which makes the project hard to be evaluated by management. This became a challenge for a social insurance company in Indonesia that implements the Pension Payment Digitalization project, an IT project that focuses on digitizing services for pensioners with a large investment value, but the benefits tend to be intangible for the pensioners and the company. Therefore, in this study, an analysis of the costs and benefits of the Digitalization of Pension Payments project will be carried out using the Information Economics method to analyze the cost and benefit aspects and determine the feasibility of the project. This study uses quantitative methods in analyzing tangible and quasi-tangible benefits and uses qualitative methods in analyzing intangible benefits. This method also produces a value that will be calculated together with tangible and quasi-intangible benefits on the Information Economics Scorecard to produce a final value that determines the feasibility of the Pension Payment Digitization project. The results obtained from this study are that the Pension Payment Digitalization project can provide various benefits both tangible, quasi-intangible and intangible. Based on the IE Scorecard, this project is included in the "Very Eligible" category.

Keywords: information technology project, cost-benefit, information economics, digitalization

1. INTRODUCTION

In the current business era, the rapid development of Information Technology (IT) makes it easier for employees, customers, suppliers, and business partners to interact with each other by carrying out their respective business functions (Asosheh, Nalchigar, & Jamporazmey, 2010). IT has become a crucial tool for companies to compete because it is key to a company's competitive advantage (Chen, Zhang, & Lai, 2009). With these considerations, IT spending in a company increases dramatically and becomes part of the capital budget in many organizations. In Indonesia, IT spending in 2017 reached IDR 399 trillion, increasing from the previous year which amounted to IDR 320 trillion (Aristamy, 2018). The amount of IT investment became a challenge to management because it is difficult to calculate the costs incurred compared to the benefits received by the company. The results of a study from the Kellog School of Management show that of an average of USD 230 million in IT spending in respondent companies, 51% of respondents stated

that their organizations do not have a process for evaluating IT investments against business strategy (Dekleva, 2005).

Evaluating the investment in an IT project is a challenge. Investments in IT projects have special characteristics like high risks, and substantial costs and the benefits are mostly intangible (Aristamy, 2018). Benefits that are intangible or non-quantitative are a problem in preparing investment proposals, but these benefits need to be translated so that they have monetary value (Dekleva, 2005). If the costs incurred and the benefits obtained by an investment in an IT project cannot be identified properly, an IT Productivity Paradox issue will arise. The IT Productivity Paradox, according to Pribadi (2015) is an investment in IT that the results are not worth the large costs incurred (Azhario, 2016). The existence of problems in the imbalance between costs and benefits is what makes the need for the need to evaluate an investment in an IT project.

The case study taken in this research is the Pension Payment Digitization project at a Social Insurance Company in Indonesia. The Pension Payment Digitization Project is an innovation that can improve services to pension recipients and increase the efficiency of the pension payment business process. This project changes the authentication scheme that pensioners must carry out when receiving pension funds every month. This authentication system aims to allow the company to pay pensions to pensioners who are entitled to receive them. Initially, they had to come to the branch office of a payment partner that had collaborated with the company so that the officers there carried out manual authentication before the pension money was paid. This project digitizes the authentication process, so they can perform biometric authentication using their smartphones anywhere and anytime without having to come physically anymore. This digitalization has an impact on the convenience of pensioners in authenticating, the accuracy of pension payments, and the efficiency of the pension payment process which cannot be quantified or intangible. However, these intangible benefits cannot be analyzed comprehensively so it can't be compared with the relatively large project costs. This makes the Pension Payment Digitization project look expensive and when compared to the tangible benefits obtained by the company, the breakeven point of this investment can be achieved in a long time.

Therefore, the purpose of this study is to carry out a quantitative and qualitative feasibility analysis of the project by considering the costs and benefits of investing in the post-implementation Pension Payment Digitalization project based on the tangible, quasi-tangible, and intangible benefits respectively. The benefit analysis uses the Information Economics method that can analyze tangible, quasi-tangible, and intangible benefits and can determine the feasibility level for IT project investment.

The Information Economic (IE) method combines financial and non-financial approaches so that it will provide better and more accurate results (Rembang, 2012). The IE method can describe tangible benefits that are easy to quantify in terms of costs, quasi-intangible benefits that affect profits indirectly but are difficult to quantify, and intangible benefits that are difficult to quantify so it becomes a limitation of several cost-benefit methods. In addition, this method provides an overview and analysis of information technology investments based on the company's business potential and the process of making information technology investment decisions based on the company's business strategy (Aristamy, 2018). The output of this method contains the results of assessments for tangible, quasi-tangible, and intangible benefits that are adjusted to the corporate value (Corporate Value) of the company's current conditions to get the value of Information Economics (Azhario, 2016).

2. LITERATURE REVIEW

Several studies have been conducted to identify the costs and benefits of an IT project. Altinkemer and Wang evaluated the costs and benefits of authentication projects using several factors, namely Implementation Cost, Privacy Sensitive Customers, Convenient Sensitive Customers, and Market Share (Altinkemer & Wang, 2011). However, the paper does not describe the impact from the user side. Griffith-Charles and Sutherland conducted a cost-benefit evaluation of the 3D Cadaster system in Trinidad Tobago by considering variables that can be quantified financially and cannot be quantified financially (intangible) and from an economic, social, and environmental perspective (Griffith-Charles & Sutherland, 2013). This research is limited to the implementation of 3D Cadaster and is felt to be too broad in scope, so it does not go into detail. Asosheh, Nalchigar, and Jamporazmey try to evaluate an IT project in a selection that uses the BSC approach in determining the evaluation variables and DEA in its ranking (Asosheh, Nalchigar, & Jamporazmey, 2010). Bala Nayar and Kumar analyzed the implementation of cloud computing to illustrate how the cost-benefits of using cloud computing are compared to on-premises technology (Bala Nayar & Kumar, 2018). Weerakkody, Irani, Lee, Osman, and Hindi collect various kinds of Costs, Opportunities, Benefits, and Risks in e-government implementation (Weerakkody, Irani, Lee, Osman, & Hindi, 2013). The resulting output is a reference to various costs, opportunities, benefits, and risks that must be considered when implementing e-government as a system. Azhario conducted a cost-benefit analysis on a computer-based training project using the Information Economics method because it was felt to be able to answer the tangible and intangible values of IT investment (Azhario, 2016). However, the authors do not dig deeper into the benefits in the financial aspect and have not paid attention to the risks that may occur.

From the several studies above, it was found that each study had a different approach to implementing cost-benefit analysis on investments in IT projects, especially in terms of the variables used in the analysis process. The variables used in the research are adjusted to the characteristics of their IT project investment. Each approach has similarities regarding the use of variables that can calculate intangible values as one of the concerns related to IT investment which tends to have hidden benefits. One of the methods that can be used for evaluating tangible and intangible values in Information Economics because this method is comprehensive and can answer several factors and unit characteristics as well as various issues and challenges faced in evaluating IT investment projects (Parker, 1988).

3. METHODS

There are two types of approaches used in this study, namely qualitative in the form of financial data and existing data in the process of pension payments and quantitative related to project and company conditions obtained from observations and interviews with several experts involved in the Pension Payment Digitization project. At the stage of data collection and processing, the initial step taken was to collect quantitative data. The data collected is quantitative data related to the Pension Payment Digitization project utilizing document review. Some of the data collected include:

1) Project financial data includes initial project capital costs, project operational costs for five years, and all costs resulting from the implementation of information technology projects
2) Project operational data includes data on the number of pensioners for five years, and the number of partners who assist the company in the authentication process.

The next stage is the collection of qualitative data. This data was obtained using the observation method, survey method, and interview method with expert respondents who were

experienced in the Pension Payment Digitization project. The process of observation, surveys, and interviews carried out in this study aims to obtain project-related data which include:
1) Company strategy and long-term goals
2) Analysis of organizational conditions at the Company
3) Project-related data associated with the company's current condition
4) Comparison of processes before and after the project is implemented
5) The benefits provided by the implementation of information technology projects

The data that has been collected will be analyzed so that the costs and benefits obtained can be classified into tangible, quasi-intangible, and intangible. To help analyze the benefits derived from information technology projects, Ranti's Generic IS/IT Business Value approach is used (Azhario, 2016). After analyzing the costs and benefits, the next step is the classification of costs and benefits. The grouping is done based on the criteria in the Information Economics method.

Once identified, the next stage is performing data processing based on the categorization of benefits and costs. For the tangible category, an analysis of project financial data is carried out based on project documents using the financial performance method like Return on Investment (ROI) method which is validated by Net Present Value (NPV) and Payback Period (PP). For the quasi-intangible and intangible categories, data processing from interviews and surveys was carried out to produce scores for each criterion. Quasi-intangible benefits are also calculated using ROI, NPV, and PP but with the addition of quantified benefits. For intangible benefits, scores are calculated based on the results of interviews with experts. In addition, to determine the weighted value on the Information Economics Scorecard, current organizational conditions are used as the basis for determining where a company's corporate value is in the quadrant.

At this stage, a tangible, quasi-intangible and intangible list of benefits and costs related to the project is available along with a weighted value based on corporate conditions. With these data, evaluation and analysis can be carried out regarding the benefits and costs of information technology projects. The next stage is to analyze the benefits and costs using the Information Economics Scorecard method. All scores on ROI calculations from tangible in quasi-intangible benefits and scores from interviews for intangible benefits are calculated according to the Information Economics Scorecard. After obtaining the results of the Information Economics Scorecard, the score will be compared with the eligibility table so that at this stage we can find out whether the selected information technology project, namely Pension Payment Digitization, is eligible or not.

4. RESULTS

Analysis of potential benefits in projects, especially in information technology investments in organizations, can be reviewed through an approach to the 13 categories designed in Ranti's Generic IS/IT Business Value (Azhario, 2016). From these potential benefits, a grouping of tangible, quasi-intangible, and intangible benefits is carried out.

From the list of benefits previously obtained, the benefits included in the tangible benefits are the cost efficiency of the data reconciliation process with paying partners and the income from paying partners for managing the data of pensioners that are their customers and insurance participants. Financial performance methods like ROI, NPV, and PP are used to measure these benefits. This measurement is obtained by calculating the value of capital expenditure and compared with cash flow from operational expenditure and tangible benefits that are deducted. From the calculation of tangible benefits, an ROI score of 46.42% was obtained. This value is validated using another method, namely the Net Present Value (NPV) with a value of IDR

129,977,402,797 and the Payback Period with a value of 2.15. This indicates that from a tangible analysis, the project can be said to be eligible because it produces a positive ROI value.

Table 1 Tangible Benefit

Method	Note	Benefit
Traditional ROI (validated using NPV and PP)	Data related to financial costs and revenues on information technology projects	- Income from project implementation (fee-based income from paying partners) - Reducing costs for the data reconciliation process

Based on the Information Economics framework, benefits that are quasi-tangible are categorized into value acceleration, value linking, value restructuring, and value innovation. The pension payment digitization project provides benefits in value restructuring, where there is a potential increase of 40% because the work of the team managing pension payments can be optimized so that they can be transferred to other jobs. This benefit has a savings impact of IDR 744,000,000 per year. With these two quasi-tangible benefits, there is an increase in ROI to 46.6950% which is validated by an NPV value of IDR 132,287,230,119 and a PP of 2.14.

Table 2 Quasi-tangible benefit

Method	Notes	Category	Benefit
Enhanced ROI (validated using NPV and PP)	Benefit data that has a financial impact indirectly	Value restructuring	The effectiveness of the work of the finance team

For intangible benefits, the Information Economic framework performs calculations using scoring for aspects that are divided into two domains, the business domain, and the technology domain. Scores for this benefit were obtained by interviewing experts who represent company management, experts who are responsible for information technology, experts who understand business processes and technical information technology projects, and experts who interact with users, so they understand project implementation from their side.

Table 3 Intangible Benefit

Domain	Aspect	Average
Business	Strategic Match	4
	Competitive Advantage	4
	Management Information Support	4.666666667
	Competitive Response	5
	Organizational Risk	0.333333333
Technology	Strategic IS Architecture	4
	Definitional Uncertainty	2.333333333
	Technical Uncertainty: Needed Skill	3.333333333
	Technical Uncertainty: Hardware Dependencies	4.333333333
	Technical Uncertainty: Software Dependencies	4
	Technical Uncertainty: Software	4.333333333
	Technical Uncertainty: Software Implementation Dependencies	4
	Infrastructure Risk	0

After these benefits are calculated, the next step is deciding the company's position that affects the calculation in Information Economic Scorecard. Based on the interview from experts, this company has a mature business because of many government regulations that regulate the company and a lot of awards received by the company for its business process. Furthermore, business processes in this company are fully supported by IT because IT is involved in every aspect of business as shown in the company's IT Masterplan. With the matured business and great IT support, based on the Corporate Value matrix, this social insurance company is in Quadrant B "Strategic". This matrix affects Information Scorecard on its Weighted Value.

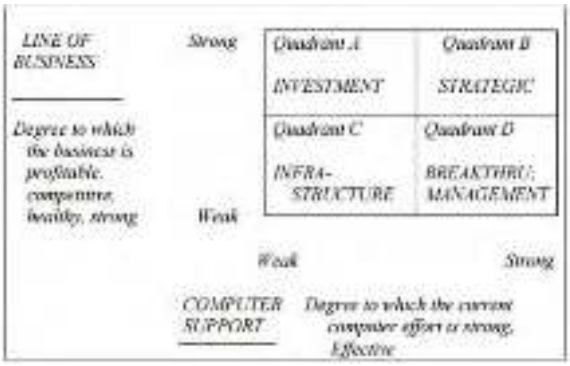

Figure 1 Corporate Value Matrix

An information economic scorecard is calculated based on the calculated score from tangible, quasi-intangible, and intangible benefits with corporate value as its weighted value. From Table 4, the total score of the Pension Payment Digitization project is 66.3. To determine whether the project is eligible or not based on the score that has been calculated, we must determine the maximum score and minimum score to calculate the range of its eligibility. The maximum score is obtained from the benefits multiplied by the maximum value (5) and the risk multiplied by the minimum value (0) which produces a value of 70. The minimum score is obtained from the benefits multiplied by the minimum value (0) and the risk multiplied by the maximum value (5) which results in a value of 10. These two values are then equally divided into 5 ranges of values so that they are following Table 5.

Table 4 IE Scorecard

Evaluator	**Business Doman**						**Technology Domain**			
(factor)	**ROI**	**SM**	**CA**	**MI**	**CR**	**OR**	**SA**	**DU**	**TU**	**IR**
	+	+	+	+	-	-	-	-	-	-
Business Domain	1	4	4	4.67	5	0.33				
Technology Domain							4	2.33	4	0
Weighted Value	2	4	6	2	4	-1	1	-2	-1	1
Score	2	16	24	9.33	20	-0.33	4	-4.67	-4	0
Total Score	**66.3**									

Table 5 IE Score Criteria

Scale	Min	Max
Very Not Eligible	10	22
Not Eligible	22	34
Enough	34	46
Eligible	46	58
Very Eligible	58	70

Based on the analysis before, after analyzing its tangible, quasi-tangible, and intangible benefits, the Pension Payment Digitization project yields a value of 66.3 using the Information Economics method so it can be said that this project is "Very Eligible"

6. CONCLUSIONS

Making rational decisions based on economic factors related to information technology becomes both important and more difficult (Hubbard, 2010). Return on Investment (ROI) only cannot be implemented in information technology prioritization because it does not assure that a good ROI value indicates that technology initiatives are aligned with the company's business strategy and the benefits of investing in information technology are often not visible and have no impact on company profits (Dekleva, 2005). In this study, a project eligibility calculation was carried out as evaluation material after the implementation of the Pension Payment Digitization project which has been implemented since 2018. This research uses the Information Economics method which considers tangible, quasi-intangible, and intangible factors in determining feasibility Even though from a tangible point of view the enhanced ROI calculation yields a score of 46.6950% so it can be said to be eligible, in the IE Scorecard the weight is only 2, not as big as other weights in the intangible aspect. After the calculations were made, the IE Scorecard from the final stages of Information Economics was 66.3, indicating that this project was "Very Eligible". That is, when viewed from the financial and non-financial aspects, the post-implementation Pension Service Digitization project can be said to be very eligible and provide commensurate benefits when compared to the costs to the company.

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MAINTENANCE SCHEDULING OPTIMIZATION IN COSMETICS MANUFACTURER USING POWER LAW PROCESS METHOD

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ABSTRACT

Research object is a manufacturing company in cosmetics field that located in Industrial Area in Surabaya. Although the company is still newly established, but the production capacity is high. Machines breakdown are one of disruption issue that must be avoided because it can lead to production output decreased and affect company sales income. Cosmetics product manufacturing process consists of several different steps which are weighing, mixing, filling and packing. Based on the historical data and issue, critical machine in PT XYZ is mixing machine because if there are problems in this process, it will cause company losses in time and also cost. Beside that, abnormality in mixing process will lead to product contamination that will generate quality issues. In this research, modelling will be done to obtain predicted time of machine failure. After time prediction of machine failure is obtained, the data will be used as the basic of *maintenance* scheduling of each machine. Model that will used in this research is Power Law Process. The used of Power Law Process is because the researched machines are repairable and most likely the rate of machine failure increases as time goes by. The results of this research the optimum *maintenance* schedule or optimum time of machine component changed is when the component reach 3777 *hours meter* operational time or when it reach their sixth failure, depends on what occurred first. Estimation cost of failure is Rp 4.416 per *hours meter* or Rp 14.269.212 per mean time to replacement. The comparison of existing maintenance cost compared with the optimum cost is reduced by 10,8%.

Keywords: *MTTF, Power Law Process, MTBF, Non Homogenous Poisson Process*.

1. INTRODUCTION

A cosmetic manufacturer company in East Java is the research observation object was founded in 2018. Even though this company has not been operating for a long time, their production volume is quite high. This is because consumer demand for beauty products is increased, and public awareness are also growing rapidly. The company's significant growth is supported by the many product innovations developed and good customer services. The overall production process is carried out through four stages, which are weighing, mixing, filling, and packing. The process that used machine is mixing, filling, and packing. Critical process in Cosmetic manufacturing is product mixing process is because number of mixing machines

operated at the company is fewer than the filling machines. If an abnormality occurs in the components of the mixing machine, the potential for contamination is higher and has a more severe effect because the capacity of the mixing machine is larger than that of the filling machine. Therefore, in this research, mixing machine will be the object of research. The mixing machine at the observed company consists of several different machines with different capacities. Machines with a capacity of 350L and 750L will be the object of observation because these machines are the machines with the largest capacities in the observed companies.

One aspect in manufacturing operations is maintenance. Maintenance can contribute to the effectiveness of the operating system, increasing system reliability and availability (Swanson, 2001). Maintenance system implemented by the company today is preventive maintenance and corrective maintenance. Based on Angius et al (2016), preventive maintenance (PM) is a scheduled machine machines repairment to check and also replace machine parts or components if needed before engine failure occurs. Maintenance schedule must be determined based on data because it is important and have a lot of impact on the production process (Assauri, 2008). Preventive maintenance scheduling at PT XYZ is currently made only based on the estimated average duration of machine failure and there is still no detailed study about analysis and calculations regarding the determination of preventive maintenance schedules and the optimal time for replacing machine components. In addition, in the existing conditions, the determination of maintenance scheduling has not considered minimizing costs due to machine failure. Therefore, in this research it will be analyzed and determined the optimal component replacement schedule for the company in order to avoid machine breakdowns and reduce costs as a result of the machine breakdown.

The vacuum machine consists of a homogenizer shaft, a gear pinion shaft, an oil pot motor, a water pot motor, a homogenizer motor, and a scrapper motor. Replacement of these components in the existing conditions is carried out during the machine overhaul at 10,000 hours meter intervals. In the existing conditions, during preventive maintenance only repairment and components checking are done. While replace components are only done every 10,000 hours and there is no standard procedure that consists of time interval of machine components replacement. Repair process in machine components can reduce the reliability of components and the failure rate will increase. Repairment process of component in preventive maintenance are no longer efficient and economical for the company because components that are repaired too often will be damaged more often. However, if the component is replaced too often it will also cause an increase in costs. Therefore, it is necessary to determine the optimal replacement interval for engine components in order to reduce repair costs and component replacement costs.

Power Law Process method is used in this study because the observed machine is a repairable system and the probability of its damage rate increases over time. Repairable according to the type of repair of machine components, namely repairs to components by welding certain parts. The damage rate increases over time, meaning that as the machine's service life increases, the possibility of the system failing to operate will be greater and the increase in damage will not be constant. In the Power Law Process model, the reliability of the system after being repaired will return to how it was before the system was damaged (as bad as old).

2. LITERATURE REVIEW

A. Stochastic Process

Stochastic process is a process of $\{N,t \geq 0\}$ which has a realization in the form of a counting process and N is a random variable of the number of failure at time intervals (0,t). The

purpose of tochastic process is to determine the relationship of a series of events that are uncertain (Hoyland & Rausand, 1994). Stochastic process research on machine component replacement were developed and generate a Renewal Process and Minimal Repair theories. Renewal Process is when a component experienced failure and after being repaired it can return to the condition similar to when it is a new component (as good as new). There are two types of renewable processes, namely repairable and non-repairable. Repairable system is a condition when a component experience failure it can be repaired without replacing the entire system. Whereas in non-repairable systems these components cannot be repaired and must be replaced with new components. Furthermore, minimal repair is a condition when a system failure occurs and being repaired, the system will function again and the effective age of the system is the same as it is in the last failure. The assumption of minimal repair is that repair time is considered minimum and to obtain a flexible model of system failure, only a small proportion of system elements will be replaced in the repair process. Minimal repair in a system result is a system condition that is the same as before the system experienced failure.

B. Power Law Process (PLP)

The Power Law Process is a model used to analyze the reliability of a repairable system and is used to process data following the Non-Homogenous Poisson Process (NHPP) (Baker, 1996). NHPP is a Poisson process with a non-constant decay rate. In this model, it is assumed that repair systems that fail are returned to their initial state before the failure occurred. The PLP model is used for the failure process with the assumption of minimal repair. The minimal repair type is repair of one component in a system that makes the system operational again and the reliability of the system returns to almost the same as before it failed. This is because a system usually consists of several components, after the failed component is repaired, the system has also been repaired. But other components that continue to operate with various ages cause the system to not return to its new state even though it has gone through repairs. The reliability function with the Weibull distribution has the following equation (Rigdon & Basu, 2000).

$$S(t) = \exp\left[-\left(\frac{t}{\theta}\right)^{\beta}\right], \text{t} > 0 \qquad (2.1)$$

Furthermore, t is a random variable with a cumulative distribution function as follows

$$F(t) = 1 - S(t) = 1 - \exp\left[-\left(\frac{t}{\theta}\right)^{\beta}\right], \text{t} > 0 \qquad (2.2)$$

From the previous equation, the probability density function, damage rate, and Mean Time to Failure (MTTF) are obtained as follows

$$f(t) = F'(t) = \frac{\beta}{\theta}\left(\frac{t}{\theta}\right)^{\beta-1} exp\left[-\left(\frac{t}{\theta}\right)^{\beta}\right] \qquad (2.3)$$

$$w(t) = \frac{f(t)}{S(t)} = \frac{\frac{\beta}{\theta}\left(\frac{t}{\theta}\right)^{\beta-1} exp\left[-\left(\frac{t}{\theta}\right)^{\beta}\right]}{\exp\left[-\left(\frac{t}{\theta}\right)^{\beta}\right]} = \frac{\beta}{\theta}\left(\frac{t}{\theta}\right)^{\beta-1} \qquad (2.4)$$

$$MTTF = \theta\tau\left(1 + \frac{1}{\beta}\right) \qquad (2.5)$$

β is the shape parameter and θ is the scale parameter. Parameter β indicates that the system performance will reduced as the time goes. If $\beta > 1$ then the intensity function w(t) increases, while $\beta < 1$ then w(t) will decrease and if $\beta = 1$ shows a decrease in the Power Law

Process it becomes simpler, namely a Homogeneous Poisson Process with an intensity function of $1/\theta$.

C. Time Truncated Case

The time truncated case is the condition of the observation data when the observations stop in a predetermined time t and the amount of damage or Nk is a random variable. Nk is the number of damages in the time interval (0, Tk) and the damage time T1 < T2 < … < Tk is a fixed variable whose distribution is Nk statistical order of uniform distribution in intervals (0, Tk) (Leung & Cheng, 2000, p. 773).

D. Trend Testing

Data analysis with statistical tests was carried out to find out whether the rate of failure has increased. The method used is the Cramer-von Mises test to test for damage following the Homogeneous Poisson Process or the Non-homogeneous Poisson process. The hypothesis used is as follow.

H_o : The failure rate does not experience a trend or follow the Homogeneous Poisson Process

H_1 :The failure rate experiences a trend or follows the Non-Homogenous Poisson Process.

Hereby is the statistical test formula using the Cramer-von Mises test

$$C_R^2 = \frac{1}{12N} + \sum_{i=1}^{N}(\hat{R}_i - \frac{2i-1}{2N})^2 \quad (2.6)$$

Where, $\hat{R}_i = \left(\frac{T_i}{t}\right)^{\bar{\beta}}$ (2.7) and $\bar{\beta} = \frac{N-1}{N}\hat{\beta}$ (2.8)

The decision is taken by comparing the C_R^2 statistical value with critical value at fault tolerance in 0.05 and H_0 rejected when calculated value of $C_R^2 < C_R^2$ table.

E. Parameter Value Estimation

The failure rate value which is T1 < T2 < … < TN < tf indicates if the observation of the system failure end after the T-th time and the N-th damage is a random variable that has the possibility of no failure after the T-th time. The density function of (N, T1, … TN) is as follows (Rigdon & Basu, 2000).

$$f\ (n, t_1, \ldots t_n = \begin{cases} f_{N(n)}\ f\ (t_1, \ldots., t_n\ |n), n\ \geq 1 \\ f_N\ (0), \qquad\qquad n = 0 \end{cases} \quad (2.9)$$

Nt is a random variable that follows poisson distribution with mean $\left(\frac{t}{\theta}\right)^{\beta}$ and generate equation as follows.

$$f_N\ (n) = \frac{\left[\left(\frac{t_f}{\theta}\right)^{\beta}\right]^n \exp\left[-\left(\frac{t_f}{\theta}\right)^{\beta}\right]}{n!}, n = 0,1, \ldots \quad (2.10)$$

Density function when n = 0 are as follows.

$$f_N\ (0) = \exp(-\frac{t}{\theta})^{\beta} \quad (2.11)$$

The previous equation can be derived from β and θ with the results of parameter estimation using maximum likelihood estimation as follows.

$$\widehat{\theta} = \frac{t}{N^{\frac{1}{\hat{\beta}}}} \quad (2.12) \quad \text{and} \quad \hat{\beta} = \frac{N}{\sum_{i=1}^{N} \ln(\frac{t}{T_i})} \quad (2.13)$$

F. Replacement Model

Sudden replacement of components will have greater costs, especially if the machine is damaged during the production process, the costs borne by the company will be higher. Planned replacement of components will cost less because it can reduce lost machine operating time and reduce the adverse impact caused to other components on the machine. Therefore, to reduce the possibility of sudden system failure, it is necessary to schedule planned component replacement at certain time intervals. Determining the time of component replacement or machine repair aims to reduce costs per unit time. The replacement model is the regular replacement of machines or components on the T-th period or on the N-fault after installation, whichever occurs first. The machine only undergoes minimal repairs between periodic replacements when breakdowns occur, so the level of engine damage is not compromised. The assumptions on the time used for repair and replacement of machines are very minimal or can be ignored. The optimal turnover policy based on minimizing long-term costs is as follows (Nakagawa and Kowada, 1983).

$$\Pr(Y_n > T) + \int_0^T td\ \Pr\ (Y_n \leq t) = \int_0^T \Pr(Y_n > t)\ dt$$

$$= \sum_{j=0}^{n-1} \int_0^T \frac{[W(t)]^j}{j!}\ e^{-W(t)} dt \quad (2.)$$

j = 0, 1, 2 … , (n-1)

Furthermore, the component replacement cost function based on the Nth damage and the Tth damage time is expressed by the following equation.

$$C(T;n) = \frac{C_f\left[n - \sum_{j=0}^{n-1}(n-j)\frac{[W(T)]^j}{j!}e^{-W(T)}\right] + C_p}{\sum_{j=0}^{n-1}\frac{[W(t)]^j}{j!}e^{-W(t)}dt} \quad (2.$$

$T > 0, n = 1,2, \ldots$ and j = 0,1,2, … , (n-1).

Then, W(T) shows the cumulative hazard or mean cumulative intensity. The optimal replacement policy for each machine is determined by minimizing the C(T;n) equation with respect to the values of T and n. The damage rate function against time for Power Law Process is expressed by the following equation.

$$W(t) = \int_0^t w(t)dt = \left(\frac{t}{\theta}\right)^{\beta} \quad (2.$$

3. METHODS

A. Data Source

Data source of this research is secondary data obtained from maintenance department of one of cosmetics manufacturer in East Java. Data used is time between failure of each machine which is the time interval of machine operation time when experiencing breakdown and when the machine experiencing the next breakdown. Based on time between failure data, machine operation time when experiencing failure will be calculated (tNk,1 and tNk,2). There are two different machines that will be observed in this research which are 350L vacuum machine and 750L vacuum machine. Data obtained is from January - October 2022. Then, the data will be used for evaluation in optimizing component replacement time based on machine reliability.

B. Research Variable

Variable use in this research are as follows.

Table 1. Research Variable

Variable	Unit	Description
Failure time	*Hours*	Machine operating age when experienced failure
Time between failure	*Hours*	Time interval between each failure

The data used consists of vacuum engine data with a capacity of 350L and 750L. Each machine has different failure or breakdown time. The machine breakdown data structure used in this research can be seen in table 2.

Table 2. Data structure of time between failure

Kerusakan ke-*i*	Waktu antar Kerusakan Mesin *Vacuum* (k)	
	350L	750L
1	$t_{1,1}$ - 0	$t_{2,1}$ - 0
2	$t_{2,1}$ - $t_{1,1}$	$t_{2,2}$ - $t_{2,1}$
-	-	-
N_k	$t_{Nk,1}$ - $t_{Nk-1,1}$	$t_{Nk,2}$ - $t_{Nk-1,2}$

C. Research Analysis Flow

The research analysis flow used in determining the optimization time to replace components of the machine is as follows.

1. Data Collection of failure time and time between failure (MTBF) of the observation machine. The machine that became the object of observation are 350L vacuum and the 750L vacuum.
2. Determine the time-truncated data of research which is 4500 hours from January-September 2022.
3. Analysis of the data characteristics and data visualization is carried out on the machine failure data that has been obtained previously.
4. Testing the trend in machine life time using the Cramer von Mises Test to find out whether the machine life follows the Non Homogenous Poisson Process (NHPP) and has a trend
5. Determine the parameter estimation $\hat{\beta}$ and $\hat{\theta}$ for each machine system
6. Calculate reliability indicator value which are reliability estimation, ROCOF and mean time to failure (MTTF).
7. Determine the time to replace components and schedule maintenance with a minimum cost
8. Develop conclusions from the results of the analysis

4. RESULTS

Observed object in this research is vacuum machine which is a repairable system. It is called repairable system because when failure happened, repair process can be done to the machine and components replacement is not required. After being repaired, the machine will have the same reliability as before they were experienced failure (as bad as old). The lifetime data used for research uses a time truncated case, with T set for 4500 days.

A. Characteristics of machine components lifetime data

The objects of observation of this research is two mixing machines with the largest capacities at PT XYZ, which are 350L and 750L capacity. The mixing machines both manufactured by the same machine manufacturing company. Apart from that, parameters such as temperature and how the machine operates also have something in common. The differentiation parameters on the two machines are the engine capacity and the frequency of use of the machine.

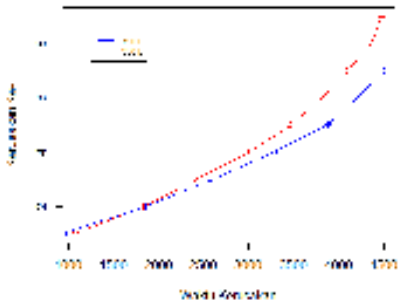

Figure 1. Machine Failure Time

Figure 1 shows the failure time during time truncated data on both machines. Based on the graph, it can be seen that the 350L experienced failure more often than the 750L. It is because the frequency of use of the 350L engine tends to be more stable compared to the 750L from start to finish. Research data is taken so that damage occurs more frequently in 350L engines. This is supported by graph of time interval between machine failure which can be seen in the following figure.

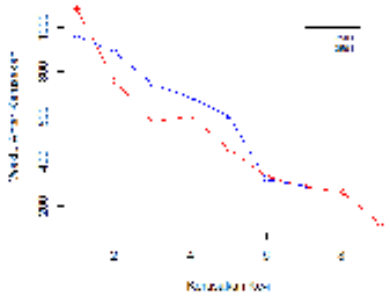

Figure 2. Machine Time between Failure

Figure 2 shows that from the middle to the end of the process, time between failures of the 350L is much faster than that of the 750L. This is because starting from mid of the year, there are many products that has lower order quantity. Therefore, it is enough to be processed using a machine with a small capacity, which are 350L,

B. Trend Testing on Machine Lifetime Data

Trend testing is carried out to test whether the failure time on the two systems follows the Power Law Process. The null hypothesis used in testing the data is the failure time is not formed from the power law process. The results of the calculation of test statistics can be seen in table 3 below.

Table 3. Trend Testing 350L and 750L

Machine	*Critical Value*	C_R^2	Decision
350L	0,908	0,606	Reject H_0
750L	0,978	0,362	Reject H_0

The table above shows the value of C_R^2 in 350L is 0.606 and 750L is 0.362. The critical value is obtained based on the Cramer von Mises table. The value of the test statistic, the value of the test statistic on both engines is smaller than the critical value so that the decision taken is to reject H0 and the service life of the 350L engine is formed from the power law process. The conclusion is that the two machines follow the Non Homogenous Poisson Process model and the Power Law Process model can be used for cases of failure of 350L and 750L machine.

C. Parameter Estimation and Graph of ROCOF (Rate of Occurrence of Failure)

Trend similarity test on both machines shows that the two systems failure rate has the same trend pattern. Therefore, the combined parameter estimates will be calculated for the two systems. Both systems that have the same failure rate trend can have identical optimum component replacement policies. Table 4 below shows the results of parameter estimation calculations for the service life data of the combined components of the two systems.

Table 4. Parameter Estimation

Parameter	Estimation Value
$\hat{\theta}$	1947,11
$\hat{\beta}$	2,883

Based on the calculation of parameter estimates for identical systems, the value of $\hat{\beta}$ is greater than 1, it indicates that both systems have an increasing failure rate and are in a wear out condition and the reliability of the machine decreases as time goes. Furthermore, the estimation results of the combined parameters $\hat{\beta}$ and $\hat{\theta}$ will be used in the calculation of reliability indicators and determine the optimal component replacement model by minimizing costs for both systems. Then, the reliability indicators that were calculated which is the Rate of Occurrence of Failure (ROCOF). Calculation of reliability indicators aims to show the reliability of both systems.

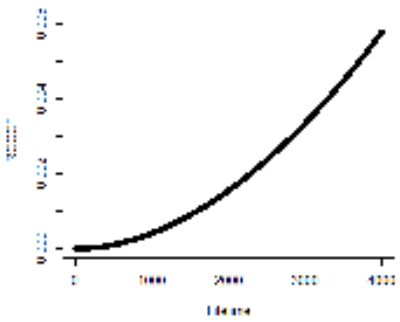

Figure 3. Rate of Occurrence of Failure (ROCOF)

Based on the graph above it can be seen that the rate of system failure is directly proportional to the increase in machine operational lifetime. This shows that with increasing of operational age, the system will experience failure more often. At the age of 1000 hours of use the system ROCOF value is 0.0005, which means that at the age of 1000 hours the machine failure rate is 0.0005 per hour meter. The estimated amount of damage is as much as 0.5 failure or 0 to 1 failure when the system life is 1000 hours meter.

D. Replacement Model

Replacement model aims to determine the right time for preventive maintenance to be carried out by minimizing the costs generated due to machine damage. The cost considered is the average component repair cost (C_f) and component replacement cost (C_p). Those two cost values are used in data processing using the expected cost of failure per hour meter. Following is the equation for costs due to failure.

$$C(T;n) = \frac{800.000\left[n - \sum_{j=0}^{n-1}(n-j)\,\frac{[W(T)]^j}{j!}\,e^{-W(T)}\right] + 10.000.000}{\sum_{j=0}^{n-1}\frac{[W(t)]^j}{j!}\,e^{-W(t)}dt}$$

From the equation, T is the operation time of the component, n is the number of damages, and W(T) is the cumulative hazard value with the combined β and θ parameter values of the two machines. T values range from 1 to 4500 according to predetermined time truncated data. Then the value of n starts from 1 to 10. The value of some of these parameters will be substituted with the value of the average repair cost and machine replacement cost. The optimum replacement time for engine components is obtained based on the values of T and n which obtained minimum C(T;n). The value of the optimum cost estimate C(T;n) for both machines increase in time and per number of failure can be seen in the following table.

Table 5. Cost Estimation of Component Replacement

	Kerusakan Ke-									
Usia (T)	1	2	3	4	5	6	7	8	9	10
Min	6221	4963	4522	4314	4205	4146	4115	4098	4090	4086

Determine time of component replacement is not only based on the minimum costs resulting from damage but is determined when the value of the difference in costs between damages converges. It is because if the component experienced failure too often it will reduce the performance of the machine and will increase the possibility of failure in the production process. Costs are categorized as convergent when the n^{th} cost differences are Rp. 100 compared to the failure costs n+1. The difference in costs of Rp. 100 is considered the difference in convergent costs or is so small that it does not affect the costs due to machine repairs. The following is a table of the difference in costs between failure.

Table 6. Cot Difference between Failure

Kerusakan Ke-								
1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10
1257.742	441.171	208.540	108.735	58.454	31.375	16.502	8.402	4.106

From table above it can be seen that the difference in cost is less than Rp 100 between the 5th and 6th failure. It can be concluded that on the 6th damage, the costs due to damage are included in the convergent category. The minimum cost on the 6th breakdown is when 3777 hours meter. Thus, the optimum time for engine repair is when the engine reaches the age of 3777 hours meter or when the engine has experienced the 6th breakdown. Based on the MTTR table, the MTTR value at 3777 hours meter machine life is 3441. Therefore, the cost due to damage is IDR 4147 per hour meter or equal to Rp 14.269.212 per one cycle of the average component replacement age. The MTTR value is less than the machine's optimal replacement age policy value. This indicates that there is a possibility that the component will be replaced due to damage 6 times before reaching the service life of 3777 hours meter.

Based on data obtained from PT XYZ, so far these engine components have a replacement age if they have reached 10000 hours meters and after the 30th breakdown. So that the average total cost due to damage in one component life cycle of 10,000 hours meter is Rp 46.200.000. Meanwhile, by using the optimum policy, the estimated total cost due to damage is Rp 41.468.213 per 10000 hours meter. This means that the optimum preventive maintenance policy or component replacement can reduce costs by 10.2% for 10000 hours meter usage. This cost reduction has not been added to the company's reduced losses due to the number of machine breakdowns that have been subject to restrictions on the optimal time component replacement policy.

5. CONCLUSIONS

The optimal preventive maintenance strategy based on data processing using the power law process method is carried out when the machine reaches a service life of 3441 hours meters or when the machine suffers the 6th breakdown depending on whichever occurs first. The minimum cost from the determined preventive maintenance time strategy is Rp 4,146 per hour meter. The total cost due to damage with the optimum component replacement time policy is IDR 14,269,212 per one cycle of the average component replacement age. This optimization replacement time policy will reduce costs due to damage by 10.1% when compared to the total cost with the company's existing policy.

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THE ANALYSIS OF MAKE OR BUY DECISION OIL & GAS COMPANY IN MAINTENANCE DREDGING ACTIVITIES WITH NPV & MCDA APPROACH (MULTI CRITERIA DECISION ANALYSIS)

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ABSTRACT

This study discusses the decision to make or buy XYZ Company activities after being appointed as port manager at XYZ Company (Persero) ports throughout Indonesia in terms of dredging. In managing a new business activity, such as dredging, XYZ Company faced several challenges to fulfill the implementation of dredging maintenance activities. In fulfilling it, XYZ Company faces two choices: investing in a new dredger vessel (make) or chartering a vessel from a dredging company (buy). In making this choice, XYZ Company analyzes, using a financial feasibility study and the Net Present Value (NPV) and Internal Rate of Return (IRR) calculation approaches, which scenario has the most optimal business investment value. Apart from the financial feasibility, there are other main factors (market, asset, experience, and expertise) that are also needed to be considered for drawing up a strategy, where these factors are the result of expert judgment questioning. The results of the economic analysis show that the NPV value for the dredger vessel investment is positive, which is 14.897 > 0, and the IRR value is 16.49% > 9,75% (hurdle rate), so that the investment is feasible. Apart from that, the results of the questioners are weighted, with the result that the largest value is to charter a vessel from a dredging company (buy). With the results of a positive economic analysis (make) and other factors concluding that it is necessary to charter a vessel from a dredging company (buy), it is hoped that XYZ Company will make a strategy for carrying out maintenance dredging activities at the port of XYZ Company (Persero), namely by making a short-term strategy by chartering ships from a dredging company (buy) and a long-term planning strategy of investing in new dredges (make) so that its role as port manager is fulfilled.

Keywords: Maintenance Dredging, Make or Buy Decision, NPV, MCDA.

1. INTRODUCTION

Ports are places where ships can moor, anchor, embark or disembark passengers, load or unload goods, and are equipped for the safety of shipping and port-supporting activities, as well as the movement of intra- and inter-modal transport (Bichou, 2009).

XYZ Company (Persero) currently has around 107 ports, as shown in Figure 1, so good management of water facilities or assets is needed to maintain port reliability. XYZ Company, as a port operator, is expected to be able to carry out its role, one of which is maintenance dredging.

Figure 1. Location of Ports

To meet the needs for maintenance dredging work shown in Table 1 , XYZ Company can carry out various business steps, including implementing it yourself by investing in new dredgers (make) or appointing a dredging Company to carry out the dredging work (buy). The Company's decision to carry out an activity on its own or buy it from another Company is called the "make or buy decision." "make" means the Company carries out the activity itself, while "buy" means relying on the supply Company to provide those inputs, which are usually bound by a contract (Besanko et al., 2012).

Table 1. Project in 2023 – 2025

No.	Years		
	2023	2024	2025
1	[illegible]	[illegible]	[illegible]
2	[illegible]	[illegible]	[illegible]
3	[illegible]	[illegible]	[illegible]
4	[illegible]		
5	[illegible]		

If the dredging work is chartered form dredging companies (buy), it will have an impact on the Company's dependence (weak bargaining position) with third parties and will also erode the Company's profits. Meanwhile, conducting joint operations can help absorb all captive market activities, but the profits that will be obtained will be shared on a percentage basis. Therefore, XYZ Company is expected to be able to decide to analyze whether investing in a dredger will enable the Company to fulfill its role rather than renting one. (Sillanpaa, 2016).

Based on these conditions, the researchers used a scenario planning approach to identify XYZ Company scenarios that they would make or buy in carrying out maintenance dredging activities in the future. This research also conducts a financial feasibility study to analyze each scenario and a Multiple Criteria Decision Analysis (MCDA) to determine other factors that influence the make or buy decision that must be made.

2. LITERATURE REVIEW

To maintain navigational waterways in ports, dredging is a crucial port operation needed to remove sediments transported naturally by waves, rivers, coastal currents, and tides and accumulated in channels/berths the depths of which should be maintained to allow safe access for

ships called maintenance dredging. However, maintenance dredging is often undertaken regularly either continuously or periodically (Khorram et al., 2016). Maintenance dredging concerns the removal of siltation from the bottom of navigation channels and ports to maintain the designed depth.

To identify the typical of equipment (dredger vessel), this study arranged the type and size of equipment suitable for general work processing for XYZ Company (Persero) after analyzing the historical data, literature and interviews with experts. The typical of Clamshell dredger move by using anchors, spud carriage systems or by a tug for significant distances and are typically used in both capital and maintenance projects. They are typically used in areas where hydraulic dredges cannot work (particularly around docks and piers or within other restricted areas), or where the disposal area is too far from the dredging site (Lisi et al ., 2016).

Meanwhile, based on the results of the Company's internal analysis that was carried out previously using the SWOT method which included an analysis of the Company's external and internal environments, it is known that XYZ Company needs to penetrate to be able to invest in dredgers to fulfill their role as port operators at XYZ Company (Persero).

What is a good investment decision? From a financial management perspective, a good investment decision is a decision that raises the current market value of the firm's equity, thereby creating value for the firm's owners. The capital investment decision, also called the capital budgeting decision or capital expenditure decision. The process is initiate when the firm identifies business opportunities that can be translated into potentially valuable investment proposal. After the proposal's financial parameters have been estimated, an investment criterion should be applied to decide whether the proposal will be accepted or rejected. This paper examines the net present value (NPV) rule in detail and the profitability index briefly (Hui, 2015).

Decision makers should not focus on a single criterion when deciding because they must make choices while taking multiple criteria into account (Jeong et al., 2016). Therefore, it requires various input data to get another set of data based on research and studies that have been carried out.

a. Market
   Dredging requires a large amount of money, which makes the port owner consider whether to maintain the depth of the area around the port or not to do dredging immediately (Jeong et al., 2016).
b. Assets
   The main issues when the dredger operates are human resources, equipment on the dredger and procedures in dredging activities (Khorram et al., 2016).
c. Experience
   In carrying out maintenance dredging, there are things that need to be considered by all stakeholders, including the objectives and scope of dredging, the technical characteristics of the dredger, related laws, the data monitoring environment, work progress, etc. (Cutroneo et al., 2014).
d. Expertise
   One of the success factors in maintenance dredging is expertise in dredging in dredging area, selected dredger, turbidity standards, solid concentration of dredger capacity, solid concentration in dredging area, dredged materials, capacity of disposal site, total amount of dredged materials, target number of dredged materials in each dredging area, dredger efficiency (Jeong et al., 2016).

After the financial feasibility study is finished and the results are known, the next step is to identify the factors that influence scenario selection and conduct weightings toward levels of

importance for each factor (total sum of 100), based on the decision of a panel of three experts applying to Table 2.

Table 2. Model For Criteria

		Make			Buy		
Criterion	**Criteria Weight**	**Level**	**Criterion Score**	**Total Score**	**Level**	**Criterion Score**	**Total Score**
Market	0.60	Small (20)			Small (20)		
		Average (50)			Average (50)		
		High (100)			High (100)		
Asset	0.20	Smalll (20)			Smalll (20)		
		Average (50)			Average (50)		
		High (100)			High (100)		
Expetise	0.10	Poor (20)			Poor (20)		
		Average (50)			Average (50)		
		Excellent (100)			Excellent (100)		
Experince	0.10	Poor (20)			Poor (20)		
		Fair (50)			Fair (50)		
		Excellent (100)			Excellent (100)		
	Total			**0**	**Total**		**0**

3. METHODS

To make this research manageable, a framework of analysis is being made and can be seen in the Figure 2.

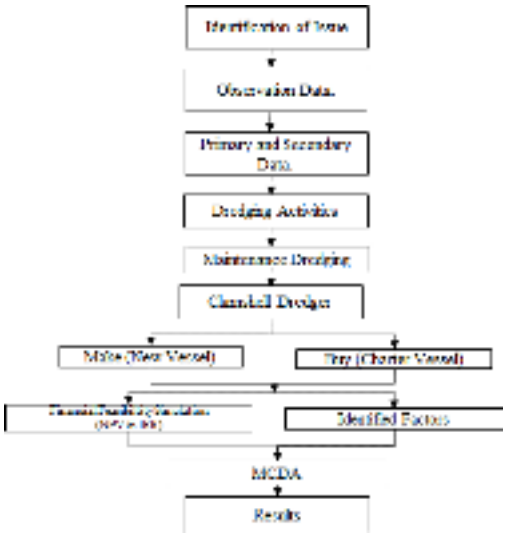


Figure 2. Framework Analysis

Researcher conducts preliminary study about issue that XYZ Company current conditions and analyze the problems that emerge and to determine the factors that lead to these problems. To collect and gather relevant information researcher conduct from primary and secondary data. After having enough information and holistic knowledge then determines the scenario. The first analysis will use financial feasibility study to determine which scenario has the most optimal result (has the highest NPV among the scenarios). Because decision making cannot rely only to one factor, then another approach is being made by using the Multiple Criteria Decision Analysis (MCDA) that can analyse multiple factors. Processing data in this research to analyze whether to make or buy used two methods, namely quantitative and qualitative.

3.1 QUANTITATIVE ANALYSIS

The quantitative analysis method uses the NPV, IRR and hurdle rate analysis approaches. To determine whether an investment is profitable or not, its economic aspects must be studied or evaluated at the time of investment proposal. One way is to do a cash flow analysis to calculate the

economic indicators of investment. The analysis flow for purchasing investment value is illustrated in Figure 3.

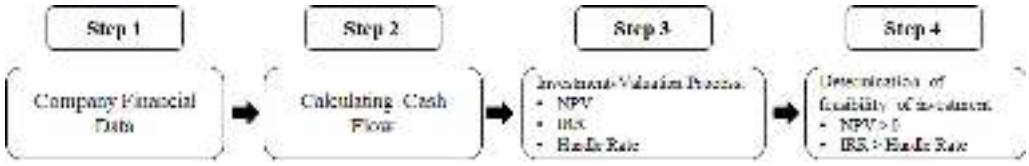


Figure 3. Flow Process Quantitative Analysis

NPV is one of the methods used to assess the success or failure of an investment. These criteria will later be used to make investment decisions (Marchioni et al., 2018). NPV is the difference between expenditure and income that has been discounted by using the social opportunity cost of capital as a discount factor or is an estimated cash flow in the future that is discounted at this time.

IRR is the internal rate of return, which is a reference for calculating the efficiency of an investment. IRR is measured by calculating the interest rate at which the present value of future cash flows equals the required capital investment. The advantage is that the timing of cash flows in all future years is considered, and therefore, each cash flow is assigned the same weight using the time value of money. IRR gives each Company a snapshot of which capital projects will provide the greatest potential cash flow. It can also be used for budgeting purposes, such as to provide a quick overview of the potential value or savings of buying new equipment over repairing old equipment (Zhang, 2022).

The hurdle rate represents the opportunity cost of capital, namely the minimum return that can be offered by other investment projects that have the same risk profile as the project being evaluated. The higher the risk, the higher the hurdle rate set, and vice versa.

3.1 QUALITATIVE ANALYSIS

The qualitative analysis method used is MCDA. The analysis process is carried out by determining the best scenario for decision-making on maintenance dredging work by weighing the determining factors of each alternative scenario. An assessment needs to be done in order to determine which factors are more important and relevant to the targets that have been set. The more important these factors are, the higher the rating will be. The results are obtained through mapping. An illustration of the flow analysis for determining value in certain scenarios is described in Figure 4.

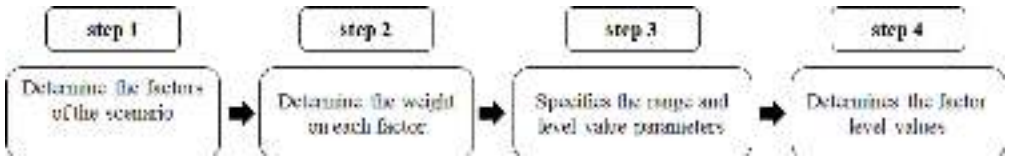


Figure 4 Flow Process Qualitative Analysis

The multi-criteria decision analysis technique, or MCDA (Multi-Criteria Decision Analysis), is an approach that can sort out which decision is better or in accordance with the existing conditions. Using the MCDA technique, the authors try to develop a process for selecting criteria related to maintenance dredging at XYZ Company matches.

4. RESULTS

In the deterministic economic method, parameters that significantly influence the NPV and IRR components are determined with fixed values. These parameters are the cost of building the ship, the technical specifications of the ship, and the ship operating costs (salary for the dredger crew, costs for mobilization and demobilization of the dredger, maintenance costs, costs for stores and spare parts, ship insurance, overhead costs) appears in Table 3.

Table 3. Proposal Cost

Details	Summary		Details	Summary	
Exchange Rate USD - IDR			Economic Life	20 years	
• 1 USD	Rp.	15.500	Commercial Days		
Interest Rate & Tenure			• Non-Docking	330 days	
• Interest Rate	10% p.a		• Docking	310 days	
• Tenure Loan	7 Years		Depreciation	Straight Line Method	
Capital Structure			Salvage Value	Nil	
• Debt	80%		Insurance for 1st year (Hull & Machinery)	Rp.	1,214,228,988
• Equity	20%		Repair and maintenance	Rp.	1,488,815,775
• Hurdle Rate	9.75%		Stores & Spare Parts	Rp.	4,460,125,925
Capex / Dredger Price	Rp.	50,005,988,341	Overtime Expenses	Rp.	149,211,600
Charter Rate per day	Rp.	60,000,000	Subsistence	Rp.	198,948,800
Grab Capacity		9 & 11 m3			

From that data, direct financial processing is carried out to determine the feasibility of the investment made in accordance with the objectives until the results are obtained, which become an assessment of the feasibility of the investment shown in the result of Table 4.

Table 4. Result Financial Feasibility Study

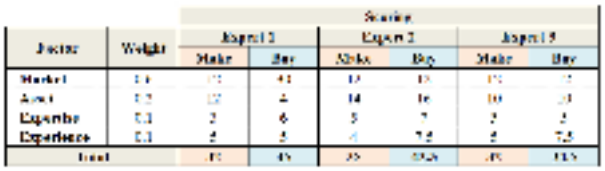
Net Present Value	14.89
IRR	16.49%
Hurdle Rate	9.75%
Profitability Index	1.84
Discounted Payback Period	10.00

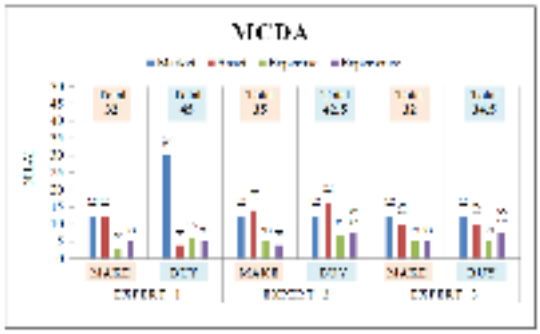
From the results above:

1. The NPV value > 0, with a value of 14.89, is a positive number. With this simulation, it is certain that the revenue is greater than the value invested.
2. The hurdle rate is the minimum rate of return on an investment or project required by the Company after calculating the risk, which is based on the Company's provisions, which is 9.75%. While the IRR obtained above is the hurdle rate, with a magnitude of 16.49%, the rate of return is higher than the level of risk faced.

Apart from the results of the investment calculation calculations, the results of the expert judgment questionnaire are as follows shown in Table 5.

Table 5. Expert Judgment Questionnaire





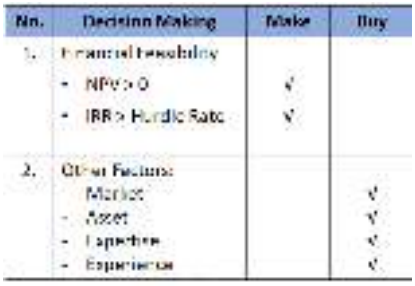
The results of the make vs buy mapping using the MCDA method and considering other main factors, it was decided to choose a chartered a vessel from dredging companies (buy) scenario.

6. CONCLUSIONS

Calculating the most optimal financial feasibility value for each make-or-buy scenario from the results of economic calculations and the calculation of the Company's cash flow, the results obtained indicate that the XYZ Company clamshell type dredger procurement plan is feasible to implement.

Comparing the analyses of the financial feasibility study and the MCDA provides different results to be taken as in Table 6. This can be seen even though the economic results are positive; when the results are weighted for maintenance dredging activities, XYZ Company continues to partner with dredging company (buy) to fulfil their duties in port management. Therefore, a short-term strategy that can be carried out by XYZ Company to achieve the goal charter a dredger (buy), and a long-term strategy that can be implemented is to build a clamshell type dredger (make).

Table 6. Result Financial Feasibility And MCDA



The construction dredgers will be placed in two locations, Jakarta and Surabaya, with one unit each. The dredger at the Jakarta location will accommodate dredging activities for the western area (Sumatra Island, the western part of Java, the central part of Java, and Kalimantan). The dredger at the Surabaya location will accommodate dredging activities for the eastern area (the eastern part of Java Island, Sulawesi, Bali, and Nusa Tenggara) applying Figure 5.

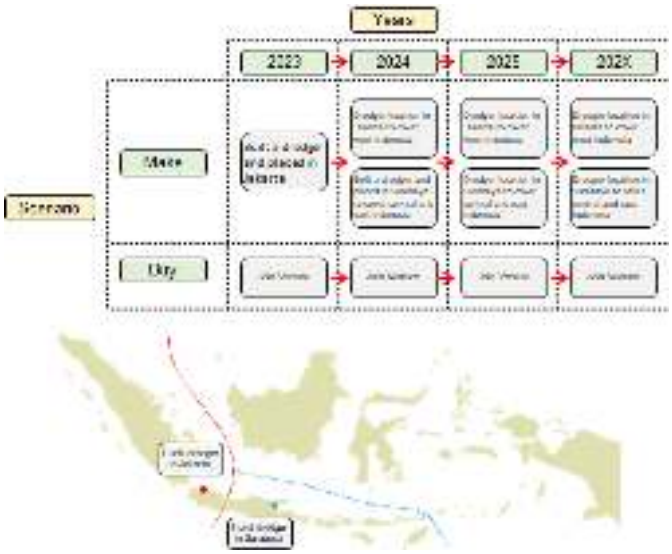


Figure 5. Alternative Strategy

The researcher hopes that in future research it will be possible to calculate the patterns of second-hand investment (make) and joint operations (buy) in managing maintenance dredging.

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DIGITAL TRANSFORMATION IN PUBLIC ADMINISTRATION: A BIBLIOMETRIC MAPPING

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ABSTRACT

Digital transformation in public administration (DTPA) has become essential in light of the pervasive e-government trend. The incorporation of digital technologies into governance sparks digital transformation. To keep up with the digital era, organizations frequently need to make considerable adjustments in reaction to the effect of digital technology. This essay's objective is to summarize the last 10 years of scientific research in the area of public administration's digital transformation. The Scopus database is used as the source for the data collection. 387 publications published between 2013 and 2022 were used to gather the data. VOSviewer was applied to perform a bibliometric study. The findings demonstrate that technology is now widely employed and that publications on the digitization of public administration have increased significantly. The data shows that the Russian Federation region produces the most notable publications and citations, followed by Italy and Germany. The bibliometric analysis's findings revealed six research clusters: public administration and digital transformation, e-government, digitalization, education, Covid-19, and digitization.

Keywords: digital transformation; public administration; e-government; digital government; digitalization; bibliometric.

1. INTRODUCTION

The adoption of digital technologies to deliver government services has become a global trend in public administration coined as e-government. In the same way, New Public Management (NPM) reforms in the public sector. Globalization is creating an offer of interactive initiatives and demands in national public administrations, which are putting public bureaucracies worldwide under pressure to change and innovate how their bureaucracies relate to citizens. E-government inherits the administrative reform policies inspired by NPM reforms implemented over the past twenty years to provide public services digitally (Dwivedi et al., 2011). The e-government implementation can improve government services to its stakeholders with ease of use, ease of access, inclusiveness, and security guarantees (Rowley, 2011). E-government promises more efficient public administration and more effective service delivery (Dunleavy et al., 2006). As part of the government affected by e-government implementation, public administration must make

changes and reengineer its business processes to adapt to the new strategy and culture of digital government.

Implementing digital technology in e-government triggers digital transformation. The impact of new technologies on organizations often requires radical changes, such as breaking away from the status quo and standard operating procedures by experimenting with new technologies to run public administration with a new paradigm and transformation process. (Tangi et al., 2020). The development of digital technology increasingly supports the ongoing public administration reform. It can increase the efficiency and productivity of government institutions and enable citizens to transact with the government anytime, anywhere, it can also deepen the democratic process, empower citizens to participate in policy formulation (Katsonis & Botros, 2015). An important aspect of using digital technologies in public administration is the changing expectations of citizens and businesses about their interactions with government (Mergel et al., 2019). Digital government is often seen as an enabler or even a driving force for the transformation of public administration, with the goal of creating public value. Such transformations are complex, requiring lengthy processes of change; often, digitization of public services is seen as the primary means of achieving this goal (Lindgren & Veenstra, 2018). This new expectation is a big challenge for the government, because it requires transformation from the government itself (OECD, 2019; Tangi et al., 2020).

According to (Bloomberg, 2018; Verhoef et al., 2021), there are three stages of digital transformation: digitization, digitalization, and digital transformation. Digitization transforms information and services from paper-based inputs and outputs to paperless or electronic inputs. The second stage involves digitalizing processes and methods of operation, converting manual tasks into electronic and automated ones for individual steps and the entire process. The last stage is digital transformation, or digitalizing business models and producing new forms of public value.

Digital transformation in public administration is a growing research domain. Many literature reviews have been published in the recent years. (Datta et al., 2020) conducted a field study of digital transformation in Italy and found that digital transformation creates government accountability and two-way transparency between government and society, on the one hand the government can see more information about taxpayers, while on the other hand the public can access data and public reports provided by the government. Besides that, digital transformation of public administrations is a way of trying to fasten the service delivery, and make the services cheaper and better, and save time. E-government improves efficiency and increases user-friendliness and accessibility. It also helps promote ethical practices and reduce the risks of corruption in the public sector (Galushi & Malatji, 2022). To find out more about the research and see a complete picture of digital transformation in public administration, we will use bibliometrics to examine how the topics develop and digital transformation creates new research fields in public administration.

3. METHOD

There are four stages in analyzing the papers. According to the presented multistage process (see Figure 1). First, we browse the Scopus database using a Boolean operator lookup operation, which includes: (TITLE-ABS-KEY (digitization OR digitalization OR "digital transformation") AND TITLE-ABS-KEY ("public administration")). The title, abstract, and keywords are all included in the search. Second, we limit year from 2013 to 2022 and solely concentrate on article and conference paper.

Third, after selecting the resulting articles from the search and extracting the data, a bibliometric analysis is performed. Bibliometrics is a cross-disciplinary science that uses mathematical and statistical techniques to quantitatively analyze all types of knowledge bearers (Merigó et al., 2016). It is a method that is frequently used to determine how a certain subject is developing. The most obvious benefit of bibliometrics is that it enables researchers to analyze a particular field of study by examining citations, co-citations, geographic distribution, and word frequency, and then come to extremely helpful conclusions. So far, the application of bibliometrics has been widely used in hotspot research, co-authorship analysis, co-citation analysis, and mapping the growth of study topic areas (Merigó & Yang, 2017).

In this bibliometric study, we use VOSviewer to map the network and keyword density exposed from the articles. In the last stage, to understand more deeply what things are researched, we conducted a content analysis of the articles with the highest number of citations and articles from authors who wrote many topics.

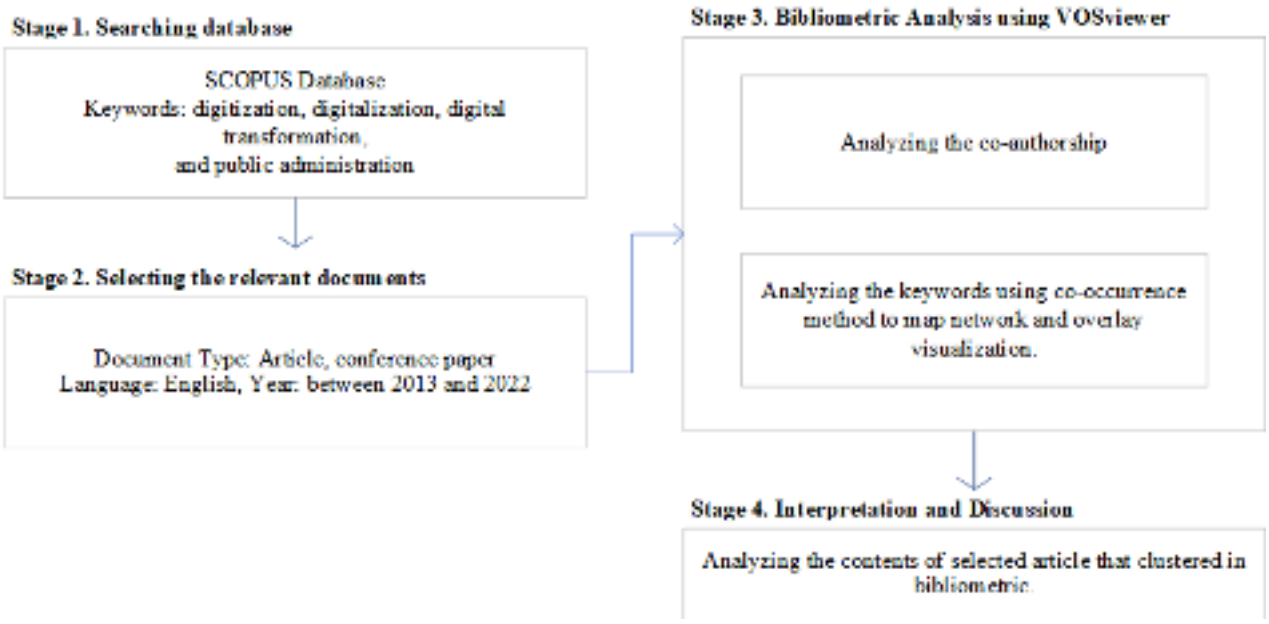

Figure 1. Multistage Process in Analyzing the Papers

4. RESULTS AND DISCUSSION

Annual Trends of DTPA-Related Publications

The publication search results on Scopus, as shown in Figure 2, yielded 387 scientific papers published from 2013 to 2022, involving 1178 authors from 68 countries, where the number of documents and affiliated countries grew exponentially.

In the first half of the decade (2013–2017), the literature appears scarce, with between 1 and 11 papers each year. These years may be referred to as the initial stage in research on DTPA. The next half of the decade (2018–2022) witnessed increased attention toward the topic, as demonstrated by the slight increase in the number of publications. This stage can be designated the initial growth stage. The subsequent five years are featured by a rapid increase in research interest

in the topic of DTPA. This stage can be named the exponential growth stage since it observes the most significant growth rate during the study period.

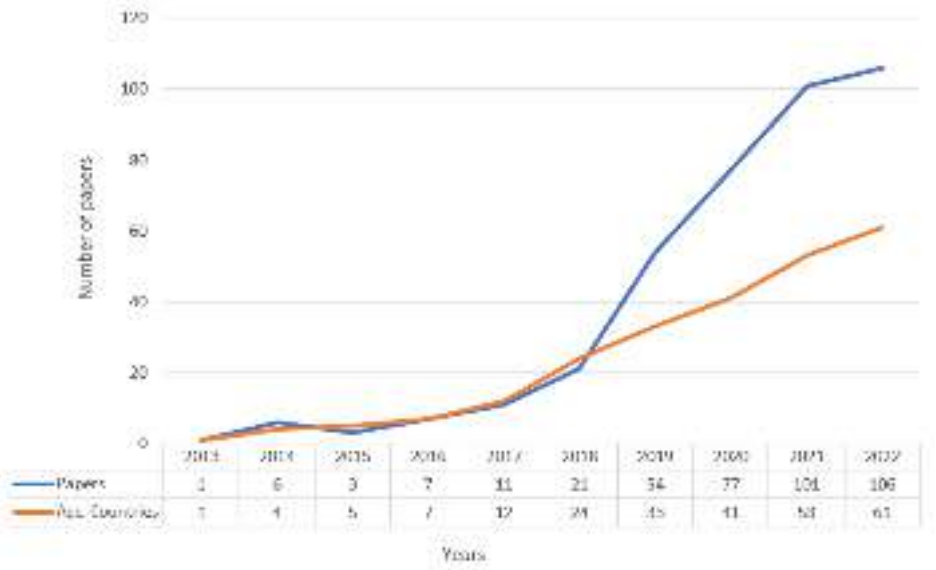

Figure 2. The development of publications on DTPA and the accumulation of the number of affiliated countries

Countries of DTPA-Related Publication

Figure 3 shows the distribution of publications according to countries. As can be seen, the highest number of publications (92) originated in the Russian Federation, followed by the Italy (48), Germany (32), Ukraine (30), and Spain (21). Summarizing, research on DTPA has been carried out worldwide, even though there is a high concentration of scholarly output in developed countries.

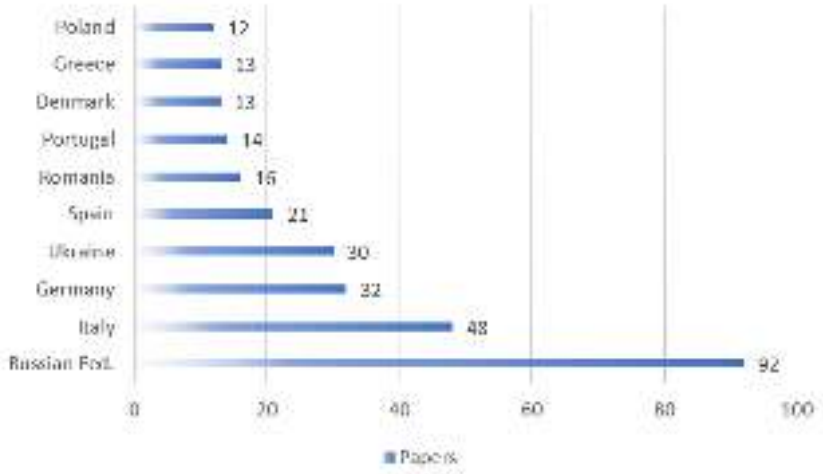

Figure 3. Ten countries with most publication on DTPA

Journals of DTPA-Related Publication

Publications by Journals Table 1 shows the top 10 relevant journals publishing articles on DTPA. ACM International Conference Proceeding Series tops the list with 43 articles. Following closely, Sustainability published 14 articles, Advances in Intelligent System and Computing 9 articles, Government Information Quarterly 9 articles and Lecture Notes in Networks and Systems 9 articles. The scope of these journals draws upon several research areas and topics, including computer science, sustainability, and social science. As a result, articles published in these journals mirror the diversity, richness, and multidisciplinary nature of DTPA research.

Table 1. Top 10 relevant journals on DTPA

Journals	Field of Studies	Papers
ACM International Conference Proceeding Series	Computer Science	43
Sustainability	Social Science, Computer Science	14
Advances in Intelligent System and Computing	Computer Science, Engineering	9
Government Information Quarterly	Social Science	9
Lecture Notes in Networks and Systems	Computer Science	9
Lecture Notes in Computer Science	Computer Science	8
E3S Web of Conferences	Environmental Science	7
Communications in Computer and Information Science	Computer Science	6
Smart Innovation Systems and Technologies	Computer Science, Decision Science	6
CEUR Workshop Proceedings	Computer Science	5

The Co-Authorship Analysis

File clusters are created based on the affiliation of the authors' countries of origin based on the results of the bibliometric co-authorship analysis, as shown in Figure 4. Italy, Spain, Portugal, United States, Austria, and South Africa make up Cluster 1, which is denoted by red circles, and they are connected to one another by publishing research articles. The two nations with the greatest publications in this cluster—Italy and Spain—were represented by nodes with higher node diameters than the rest. This cluster produced 94 articles.

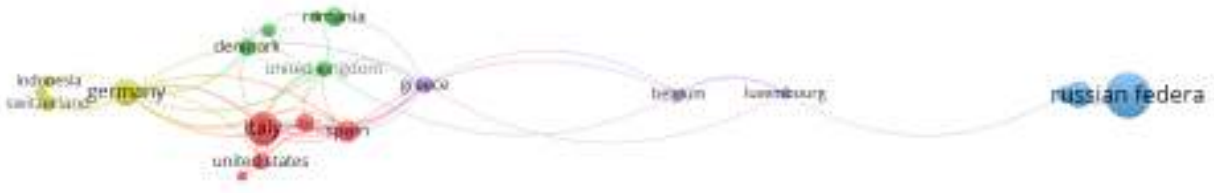

Figure 4. Visualization of Co-Authorship by Country

Denmark, the United Kingdom, Romania, Sweden, and Finland are the five nations that makeup Cluster 2 in this network. There are 47 papers in this cluster, with scholars from the Romania, Denmark and the United Kingdom made the most significant contributions. Furthermore, cluster 3 contains four countries in the network: Russian Federation, Ukraine, Poland, and Kazakhstan. This cluster produced 136 articles, with Russian Federation having the most publications with 92 articles. Meanwhile, Cluster 4 produced 51 articles, which researchers from Germany, Czech, Switzerland, and Indonesia wrote. In this cluster, nodes Germany and Switzerland are the countries with the most publications, which can be seen from their nodes being more significant than other countries in the cluster. Cluster 5 only consisted of three countries, namely Greece, Belgium, and Luxembourg, and this cluster produced 19 articles.

The Co-occurrence Analysis and Distribution of Subject Area

The next step in our study was to analyze the keywords using co-occurrence method to map network and overlay visualization. The Calculations using VOSviewer resulted in 2307 unique keywords, then analyzed using the co-occurrence method with a minimum keyword occurrence setting of 5, resulting in 77 keywords that met the threshold. Figure 5 shows a network map of term co-occurrence, where a circle represents each term, and the circle's diameter and label size represent that term's frequency. Color represents conceptual grouping, while proximity to other terms indicates the relationship between the terms. The visualization results show that public administration (the largest circle) is the most discussed area of research, followed by digital transformation, digitalization and e-government.

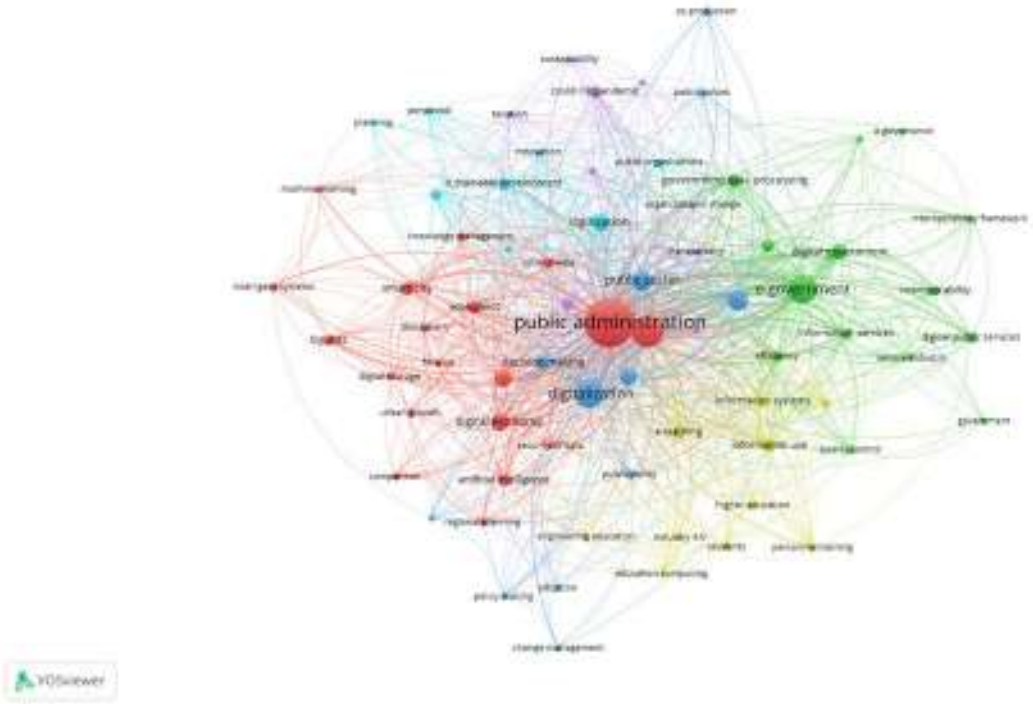

Figure 5. A network map of 77 keywords with a minimum occurrence frequency of five

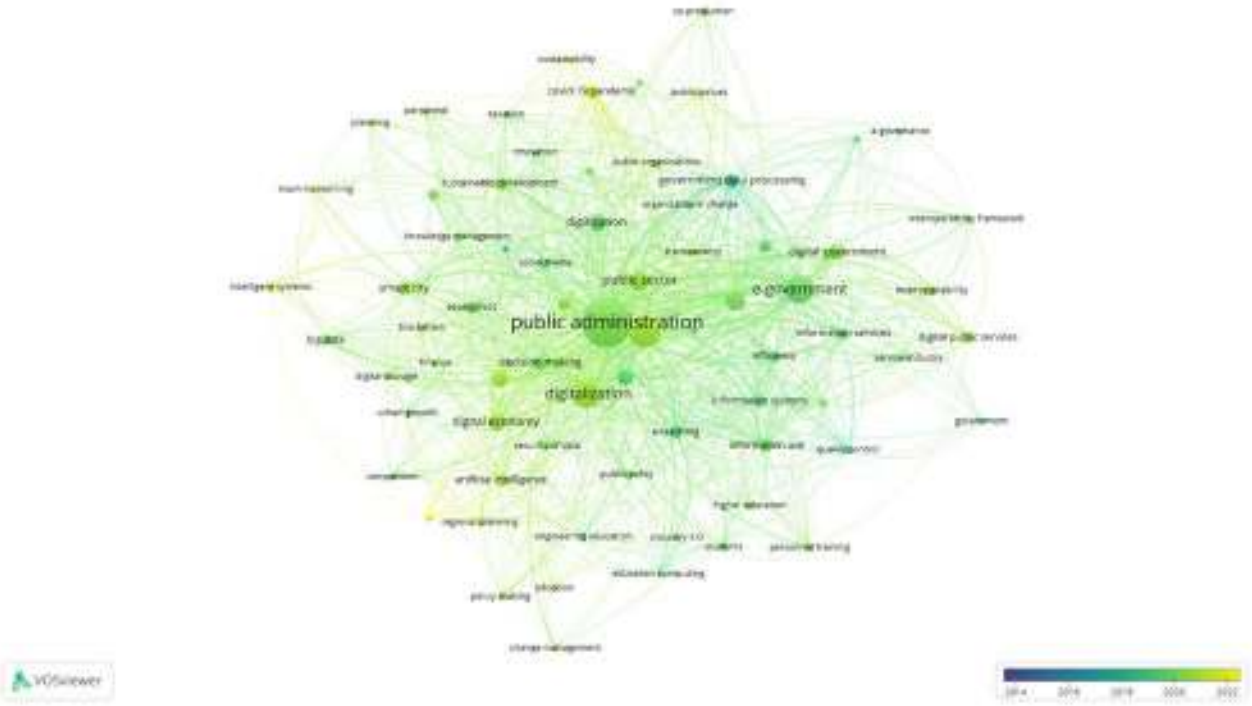

Figure 6. An overlay map of 77 keywords with a minimum occurrence frequency of five

Figure 6 is an overlay visualization of Figure 5 which shows the progress of the study over time, which is indicated by a color gradation from blue to yellow. Blue indicates earlier research, while yellow indicates recent research. Since almost all of the nodes in the visualization appear to be light green and yellow, it may be inferred that the research themes and sub-topics in the study of DTPA are still being explored. The results of the network visualization shown in Figure 5 identify six clusters that represent the research group. This condition indicates that many developing research topics are related to DTPA.

Cluster #1, shown in the image on the center and colored red, can be referred to as public administration and digital transformation cluster, this cluster represents the research topic that we are currently conducting, which groups other research sub-focuses that are generally related to the use of digital technology in public administration such as digital technology, intelligent systems, artificial intelligence, big data, machine learning, blockchain, knowledge management, digital economy, regional planning, smart cities, economics, finance , and urban growth. Brunetti et all's paper is one of the widely cited articles regarding these topics highlights that digital transformation is a pervasive challenge of regional innovative system that requires a multifaceted set of strategic actions falling into three main pillars such as “culture and skill”, “infrastructure and technologies”, and “ecosystem” (Brunetti et al., 2020). Mainwhile Noordt in his paper shows strongly that the use of AI in government is not just dependent on obtaining high-quality data; rather, it is supported by some environmental, organizational, and other elements that are tightly connected with one another (van Noordt & Misuraca, 2022). In addition, digital technology also introduces big data which, according to Maciejewski's article, has changed the game for public administration in the domains where it is applied. When used properly, public administration achieves astoundingly effective, efficient, and client-satisfying outcomes (Maciejewski, 2017).

Zeki-Suac et al. draw attention to the significant energy use in public buildings. In their article, they present an energy efficiency model that, as a key component of the smart city idea, combines Big Data platforms with machine learning to create an intelligent system for controlling the energy efficiency of the public sector (Zekić-Sušac et al., 2021). Other articles in this cluster also discuss blockchain. The introduction of this technology has given the government new opportunities, one of which is the use of blockchain-based smart contracts that are based on Distributed Ledger Technologies (DLTs), that could be implemented in the governance of public procurement (Sánchez, 2019).

Cluster #2, shown on the right and colored green, can be called e-government cluster. In line with the topic of this article, the keywords e-government and digital government occupy the largest number of discussions among articles, generally the sub-topics discussed in this cluster are regarding government services, such as digital public services, e-governance, e-services, efficiency, interoperability, government data processing, information services, and the service industry. These topics also seem to underline that the goal of digital transformation is to improve public services. As found in Gasova and Stofkova's research, e-government provides access to various services provided to the public and ensures that all public services are available online, which provides benefits for citizens such as time and cost savings, and 24/7 service availability (Gasova & Stofkova, 2017). Meanwhile, according to research by Scholta and Lindgren, digital transformation transforms reactive delivery into proactive delivery that ensures that all recipients are treated equally, necessitates no interaction with the recipient, and is only applicable to mandatory services with unambiguous eligibility assessment criteria (Scholta & Lindgren, 2019).

Cluster #3 is digitalization, colored blue. This cluster focuses on digitalization, ICT, public services, public sector, public policy, public values, and decision making. In their paper, Lindgren and Veenstra noted that, with the goal of generating public value, digital government is frequently viewed as a driver of the transformation of public administration. They also noted that, in order to maintain the digitalization of public services, a variety of change and redesign processes must be used, not only on the processes involved organizations but also on regulatory and institutional aspects (Lindgren & Van Veenstra, 2018). Meanwhile, in their paper, Dobrolyubova et al. show that while there is a statistically significant positive correlation between government digitalization and public administration performance, it is stronger for government effectiveness, controlling corruption, and doing business and Discussing digital transformation, it is undeniable that the pandemic has accelerated the use of digital technology as well as re-engineering and improving business processes in the field of public administration weaker for e-participation, voice and accountability, and efficiency of public spending (Dobrolyubova et al., 2019).

Cluster #4, shown in the left image and colored yellow, this cluster can be called the education cluster, including keywords such e-learning, education computing, engineering education, personnel training, open data and industry 4.0. There is a critical need for trained personnel to handle the digital transformation of public administration. There is a rising demand for e-governance courses and education programs. One of the essential factors in closing the gap is the e-government curriculum (Sarantis et al., 2019). In this work, Schenk and Dolata describe the organization and instructional strategies used in a public administration course offered to students at a German university. Overall, the article shows how public administration universities can support digital transformation by working with local governments and equipping students to lead and manage it in the public sector (Schenk & Dolata, 2020).

Cluster #5, seen at the top and colored purple, is the Covid-19 cluster, a cluster that emerged as a result of the pandemic between 2020 and 2022. Discussing digital transformation, it is undeniable that the pandemic has accelerated the use of digital technology as well as re-

engineering and improving business processes in the field of public administration (Gabryelczyk, 2020). In another paper in this cluster, it is stated that the pandemic has effectively disrupted earlier operational models and sparked widespread and potentially long-lasting changes, including telework and digital adoption (Raghavan et al., 2021).

Cluster #6, shown on the top, colored tosca, can be referred to as digitization cluster. This cluster groups terms related to analog to digital converter, information management, innovation, and sustainable development. Eric and Robert argue that digitization requires citizens to have a new type of competency that combines financial and digital skills. Citizens who do not have these skills tend to be at a disadvantage when using these services. They identify five crucial phases in the citizens' digital self-service process: interest, access, comprehension, reflection, and support. These phases can be conceived as barriers that prevent citizens from further engagement in the self-service process (Breit & Salomon, 2015). Therefore, to digitize public administration, appropriate steps are needed so that all levels of citizens can benefit from it.

6. CONCLUSIONS

The modernization of public administration through digital technology is one of the most popular subjects right now. An analysis of the Scopus database from 2013 to 2022 revealed 387 papers with 1178 authors from 68 countries. The number of publications on this topic has increased exponentially. Russian Federation is currently in first place for the corresponding authorship. It has 92 papers in its account, which is a remarkable effort and has led to many favorable outcomes. At the same time, Italy and Spain collaborated most in research and produced 94 papers. The study finds that ACM International Conference Proceeding Series and Sustainability are two major journals with maximum influence. Based on the bibliometric mapping, there are six research clusters: public administration and digital transformation, e-government, digitalization, education, Covid-19, and digitization. A wide range of sub-focuses is covered, including e-government, digital government, smart city, digital economy, digital society, public sector, public services, public values, and education. ICT and digital technology, such as blockchain, big data, and artificial intelligence, are also covered. These findings indicate that technology is now widely adopted, and publications on the digitalization of public administration have become a widespread concern of researchers, which are new topics that require further research. To discover more about how a particular country uses digital technology in public administration and its stages and developments, we advise further study based on country affiliation.

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EVALUATION OF EXTRUDER MACHINE MAINTENANCE IN ORDER TO IMPROVE THE EFFECTIVENESS OF MAINTENANCE TIME USING MARKOV CHAIN METHOD

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ABSTRACT

PT. WTR is a company engaged in the manufacture of Polyvinyl Chloride (PVC) pipe products. In the production process there is a machine that is always used, namely the Extruder Machine. The machine is very important in producing PVC pipes, so we need a method to avoid frequent damage. The method used is Markov Chain which can be used to streamline maintenance time in a company, especially for companies that often have damage to their production machines. The results obtained maintenance time in the company amounted to 227 hours with maintenance planning carried out 251 days (8 months 3 days) while the alternative effective maintenance time is 183 hours in 4 years with preventive maintenance planning carried out every 203 days (6 months 17 days) contained in the maintenance of proposal III using the Markov chain method.

Keywords: Maintenance, Extruder Machine, Markov Chain.

1. INTRODUCTION

Competition in the manufacturing industry in Indonesia is getting tighter, and the development of increasingly sophisticated technology makes every company want to achieve success. The success of an industry in achieving its production goals is highly dependent on the smooth production process. The smoothness of the production process is influenced by several factors including labor, energy, smoothness of materials and machine readiness. Continuous use of the machine will affect the decline in quality and performance of the machine and if there is damage, it will cause losses. Damage to the machine will hinder the production process resulting in decreased company productivity. In addition, damage to the machine will also incur repair costs that are not cheap. To support the machine in a ready-to-use or good state, it is necessary to hold regular and well-planned maintenance activities. Well-conditioned machinery and equipment will be able to increase the efficiency and productivity of the original production system. However, given the limited capabilities of existing machinery and equipment and the high losses incurred as a result of the hampered production process, the maintenance of machinery and equipment is an influential factor in achieving large profits.

PT WTR is a company engaged in manufacturing. The products produced are Polyvinyl Chloride (PVC) pipes which are divided into two types of production, namely, AW type pipes and D type pipes. Wibowo (1974) explains that a pipe is a round sleeve (hollow cylinder) used to drain liquid or gas fluids. Pipes are usually equated with the term tube, pipes are usually made of

various materials according to their needs, such as iron, copper, brass, plastic, pvc, aluminum, and stainless. To produce these products requires machinery and equipment in good condition and will launch the production process. In a production process at PT WTR, maintenance problems are often ignored, resulting in irregular maintenance activities. For this reason, it is necessary to maintain and inspect the machine regularly to prevent damage to the machine. One of the machines that is always used in the production process at PT. WTR is the Extruder Machine.

Extruder Machine is a machine that functions to press (push) pipe material that has been heated. The main components of the Extruder Machine consist of main motor, gear box, coupling, pressure box, barrel, vacuum barrel, screw and dies. The production process at PT WTR depends on the readiness of the Extruder Machine. So that Extruder Machine maintenance needs to be carried out regularly, because the Extruder Machine is a machine that is often used at PT. WTR in the production process. The maintenance affects downtime and preventive maintenance. Machine maintenance for damaged machines can be said to be corrective maintenance, while machine maintenance to prevent damage is said to be preventive maintenance. To avoid frequent damage to the Extruder Machine, the best maintenance system is needed, in order to minimize machine maintenance based on downtime. This research aims to get effective maintenance time on the extruder machine to avoid damage so that the production process can still run smoothly and implement effective preventive maintenance planning with the Markov Chain method.

2. LITERATURE REVIEW

Research on Markov chain from Pricopie, et all. (2020) discusses proactive maintenance strategies used to improve equipment reliability. The purpose of the study was to find the most profitable optimal time. The machines observed in the study were actuators used in the sugar industry. The results of the study in the form of simulations are in accordance with the method of calculating the optimal update time and with the proposed parameterization, for this particular case (taken from the practice of sugar juice flow control).

Research from Liu (2018) conducted research on Markov chain with the aim of building a model based on the different conditions of each algorithm can significantly increase production efficiency and reduce costs.

Research from Agrawal (2019) conducted research on Markov chains with the aim of analyzing sustainable production systems with Markov Chains. The machines observed in the study were Tunnel Boring Machines. The results obtained from research using the Markov chain method are more effective maintenance time.

Research from Syakhroni (2021) conducted research on Markov chain with the aim of planning maintenance time to reduce downtime so as to minimize maintenance costs. The machines observed in the study were Wheel Loaders Machine, Batching Plant Machine, Truck Mixer Machine with four states of the machine. The results obtained from the study using the Markov chain method are more cost-effective maintenance on the observed machines compared to the maintenance costs of the company.

While research from Pratama (2022) conducted research on Markov chain with the aim of formulating policies that should be taken to reduce machine maintenance costs. The machines observed in the study were Roller Machines, welding machines, and cutting machines with four states of the machine. The results obtained from the study using the Markov chain method resulted in savings in maintenance costs on the observed machines compared to the initial maintenance costs.

3. METHODS

In this study, what the researcher did was to streamline preventive maintenance planning and plan alternative maintenance times on the Extruder Machine using the Markov Chain method. Ariyani (2010) suggested Markov Chain is a method that studies variable events in the present, which is based on past events to predict the same events in future variables. Markov Chain only requires some previous period data to know the estimated future maintenance. The calculations in the Markov Chain method are easy and simple and can improve the results for the next period (not just for the next period). Markov Chain has practical advantages in calculation because it is formulated in a transition probability matrix, where the current state is independent of the past. So the current process does not depend on the length of the process that occurred in the past, but the calculation is based on the current state.

The stage taken is the determination of the most critical machine. Machines that in the last four years have experienced maintenance time above average (Extruder Machine). Referring to the maintenance policy obtained from the type of decision taken to carry out maintenance. Determination of the status and condition of machine damage in the last 4 years which data is taken every month. Determination of the probability of machine status transition calculated from the number of states of each machine in each month. Creating an initial transition matrix which will be considered as proposed maintenance from the company. Determination of the probability of machine damage status in each month, the matrix that has been made will then be written in the form of equations, and by using linear equations, the probability of each status will be obtained. Maintenance scheduling planning, from the probability of each status that has been obtained, then determine the estimated maintenance costs obtained from the three proposals. Furthermore, the estimated maintenance cost of the proposal will be divided by the most effective company cost estimate and then multiplied by the corrective maintenance time. The result is an effective planning time for maintenance on the Extruder Machine.

Pudji (2012) suggested that a Markov chain process to fulfill the steady state equation is described in the following formula.

$\pi_i > 0$

$\pi_j = \sum_{i=0}^{M} \pi_j \, P_{ij}^{(n)}$ for j and n = 0, 1, 2, . . . M

$$\sum_{i=0}^{M} \pi_j = 1$$

Description:

π_j = probability values

P_{ij} = transition probability

i = 1,2,3,4,5,6 (initial status)

j = 1,2,3,4,5,6 (end status)

Or it can be shown in matrix form as follows,

$$\begin{bmatrix} \pi_0 \\ \pi_1 \\ \cdot \\ \cdot \\ \pi_M \end{bmatrix} = [\pi_0 \quad \pi_1 \quad \cdot \quad \cdot \quad \pi_M] \begin{bmatrix} P_{00} & P_{01} & \cdots & P_{0M} \\ P_{10} & P_{11} & \cdots & P_{1M} \\ \cdots & \cdots & \cdots & \cdots \\ P_{M1} & P_{M1} & \cdots & P_{MM} \end{bmatrix}$$

The decision in the Markov Chain is as follows the machine in the process of operation undergoes several possible state transitions, which change from one state to another and experience an increase of one state above. If, it is said that in a short interval of time there are six possible states, then to change the status conditions experienced, several actions are taken according to the status conditions. For example, if the repair of a new machine is carried out after the machine is severely damaged (status 6), then for status 1, status 2, status 3, status 4 and status 5 no maintenance is carried out. But if the policy is changed where maintenance is carried out when the machine is in status 6 so that it returns to status 1. This type of decision is adopted from previous research by Hartono (2002), but there are several decision assumptions that differentiate from the research. The decision taken in determining machine maintenance is shown in table 1.

Table 1. Markov Chain Decision Types

No	Action Taken	Status
1	No maintenance performed	1
2	Performed preventive maintenance (up one status above)	2,3,4,5
3	Corrective maintenance performed (system returns to status 1)	6

From the types of decisions above, to carry out maintenance there is a maintenance policy. Wisdom is a decision rule or statement that explains the decision for each situation that may occur. This maintenance policy adopts from previous research by Hartono (2002), but there are assumptions that distinguish the maintenance policy from the research. The table of policies performed in machine maintenance is shown in table 2.

Table 2. Maintenance Policy

Wisdom	Description	$d_1(P)$	$d_2(P)$	$d_3(P)$	$d_4(P)$	$d_5(P)$	$d_6(P)$
P_0	Corrective maintenance at state 6 and preventive maintenance at state 5	1	1	1	1	2	3
P_1	Corrective maintenance at state 6 and preventive maintenance at state 5 and state 4	1	1	1	2	2	3
P_2	Corrective maintenance at state 6 and preventive maintenance at states 3, 4 and 5	1	1	2	2	2	3
P_3	Corrective maintenance at state 6, preventive maintenance at states 2, 3, 4 and 5	1	2	2	2	2	3

Policy P_0 is the maintenance performed by the company, which is also the initial transition matrix. For P_1, P_2 and P_3 are proposals obtained from changes in the initial matrix according to the actions taken. If the machine is in a condition of mild disruption and moderate disruption, then the machine will not transition to a good condition, in other words, machines that are in a condition of mild disruption and moderate disruption will remain in that condition or transition to a condition of mild damage, moderate damage and severe damage. If the machine is in the severe fault condition or the machine is almost unusable until the next inspection interval, or if the machine will be severely damaged during the inspection interval, it will be repaired at the next inspection interval.

4. RESULTS

Based on the data collected in this study are data on the number of machines, machine status transition data, maintenance time data and maintenance costs. The machine used as the object of research is Extruder Machine, obtained a result that the wisdom of the conditions in the company's maintenance costs amounted to Rp 6,016,726,804, the time required to perform maintenance for 4 years is 227 hours and for preventive maintenance planning in 4 years is 251 days (8 months 3 days). As for the proposed maintenance using the Markov Chains method, Proposal 1 maintenance costs Rp 4,129,873,840, the time required to perform maintenance for 4 years is 190 hours and for preventive maintenance planning in 4 years is 210 days (6 months 24 days), Proposal 2 maintenance costs Rp 4,073,234. 924, the time required to perform maintenance for 4 years is 188 hours and for preventive maintenance planning in 4 years is 208 days (6 months 22 days) and Proposal 3 the maintenance cost is Rp 3,982,735,896, the time required to perform maintenance for 4 years is 184 hours and for preventive maintenance planning in 4 years is 203 days (6 months 17 days).

Table 3. Maintenance Planning in 4 Years

Policies	Maintenance Costs	Time required to perform maintenance for 4 years	Preventive Maintenance Planning in 4 years
Conditions in the company	Rp 6.016.726.804	227 jam/4 tahun	251 hari
Maintenance proposal 1	Rp 4.129.873.840	190 jam/4 tahun	210 hari
Maintenance proposal 2	Rp 4.073.234.924	188 jam/4 tahun	208 hari
Maintenance proposal 3	Rp 3.982.735.896	184 jam/4 tahun	203 hari

6. CONCLUSIONS

The result obtained maintenance time in the company amounted to 227 hours with preventive maintenance planning carried out 251 days (8 months 3 days) while the alternative maintenance time is 184 hours in 4 years with preventive maintenance planning carried out every 203 days (6 months 17 days) contained in the maintenance of proposal III using the Markov chain method. These results are alternative maintenance times and preventive maintenance planning

using the Markov chain method which is more effective than the maintenance carried out by the company. This proves that the Markov chain method can be applied to increase the effectiveness of maintenance time and plan machine maintenance.

Future research is expected to apply assumptions that are not limited only to machine status transition data and can apply the use of random probability from Markov chain. Determination of machine condition status and policy can be added by using the appropriate status or policy.

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DETERMINATION OF OPTIMUM POINT OF PRODUCTION PROCESS OPERATIONAL PARAMETERS IN NPK GRANULATION PLANT PT XYZ

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ABSTRACT

NPK fertilizer is a type of compound fertilizer that contains three macro nutrients, namely Nitrogen (N), Phosphorus (P), and Kalium (K). NPK fertilizer itself is produced in a granulation NPK fertilizer factory using the granulation method or a mixing process. The study related to data optimization carried out in this study aims to determine the optimum point of the parameter in order to produce the best variable value. The stages of data optimization carried out in this research are descriptive data analysis, specification of regression values, parameter estimation, model feasibility test, residual analysis, and changing the existing value with Z score. This study concludes that in order to optimize the parameters of the production process at the NPK Granulation fertilizer plant, it is possible to regulate the use of 25,305 tons of steam. The next parameter is the use of electricity where the optimum value obtained is 4429.387 kWH. Then the last parameter is plant downtime where the optimum value obtained is 0.105 hours/day. The total fertilizer production achieved at the NPK Granulation Fertilizer factory using optimum operational parameters was 530.978 Tons.

Keywords: Optimum point, steam usage, electricity usage, downtime plant, production costs, z-score

1. INTRODUCTION

NPK fertilizer is a type of compound fertilizer which contains three macronutrients, namely Nitrogen (N), Phosphorus (P) and Potassium (K). In addition to macronutrients, some NPK fertilizer producers also add other micronutrients such as chloride, boron, iron, manganese, calcium, magnesium, sulfur, copper, zinc, and so on in order to make a fertilizer formulation that is adapted to the commodity designation. The form of NPK fertilizer products circulating in the market is quite varied. Solid NPK fertilizer can be in the form of tablets, pellets, briquettes, granules, and powder. There are also NPK fertilizers in liquid form with different levels of solubility respectively. Each type and brand of NPK fertilizer has a different composition and some have additional elements that function as mineral additions to plantation commodities. From the facts and data from some of these problems, an optimization step is needed from the use of factory utilities which are the parameters of the NPK granulation factory production process so that they can match the predetermined HPP values.

In the production process at the granulation NPK fertilizer factory, there are various process parameters that have been set in quantity and quality so that the product produced is in accordance

with market standards and needs. In its continuity, several parameters that support factory operations often experience data fluctuations such as steam usage, electricity usage, and downtime plant.

The objectives of this research are as follows:

1. Determine the optimum steam usage value in the production process at a granulation NPK fertilizer factory.
2. Knowing the value of optimum electricity use in the production process at granulated NPK fertilizer factories.
3. Knowing the optimum plant downtime value in the production process at a granulation NPK fertilizer factory.
4. Determining the optimum operational parameter point for the granulation NPK fertilizer plant in producing the product by comparing the value of the use of steam, electricity, and plant downtime.

2. LITERATURE REVIEW

NPK fertilizer can be produced by 4 different methods which are chemically produced such as Nitrophosphate Process, Sulfuric Acid (Mixed Acid) Process, Dry mix NPK, and by using granulation steam. sd, all raw materials in solid form (powder) are mixed and granulated using water, steam and heat as media.iterature review describes the literature relevant to your study. Use mostly references from international journals. When citing references, using the names of the authors and the year of publication is preferable. Here is an example. Smith (2005) suggested that the referencing style is one of the writing aspects that most students ignore when preparing a paper.

The regression method is a statistical method to investigate and model the relationship between the response variable Y and the predictor variable X. In general, the relationship between Y and X can be written as follows:

$$Y_i = m(X_i) + \varepsilon_i$$

where m(x) is a regression function that is unknown and needs to be estimated, and ε_i is a random variable that describes the variation of Y (Hardle, 1990). Draper & Smith (1998) defined the relationship between response variables and explanatory variables in a linear regression model.

To find out whether the regression model really shows a significant and representative relationship, a regression test will be carried out:

a. Heteroscedasticity Examination

Heteroscedasticity examination aims to see whether in the regression model there is an inequality of variance from the residuals of one observation to another. If the variance from the residual of one observation to another observation remains, then it is called homoscedasticity, and if it is different it is called heteroscedasticity. In other words, a good regression model is a model with a variance of homoscedastic residuals. To determine heretoscedasticity, a scatterplot graph can be used. The dots formed must spread randomly, spread both below and above the number 0 on the Y axis and not have a regular pattern. If these conditions are met then there is no heteroscedasticity so that the regression model is feasible to use. (Sunjoyo, 2013)

b. Simultaneous Regression Coefficient Test (Test F)

The hypothesis put forward in this test is that all the independent variables used in the simultaneous regression equation model have no effect on the dependent variable if the significance value is greater than 0.05. So the guideline used is that if the significant value is less than 0.05, the conclusion that can be drawn is to reject the null hypothesis (H0), which means the coefficient is statistically significant (Ghozali, 2012).

The F test is a test of the regression relationship simultaneously which aims to determine whether all the independent variables together have a significant influence on the dependent variable.rrespondingly, the references should be listed based on alphabetical order of the first author's last name. See examples at the end of these guidelines.

Optimization is derived from the word "optimal" which means the best, highest, most profitable, making the best, making the highest, optimizing processes, ways, optimizing actions (making the best, highest, and so on). Thus, optimization is an action, process, or methodology to make something (as a design, system, or decision) more/fully perfect, functional, or more effective.

In determining the optimization of the model, it is necessary to make managerial decisions in several stages. The ultimate goal in making this decision is to minimize the effort required or to maximize the desired benefits. The effort required or the benefits desired in practice can be expressed as a function of the variable. It can be seen from Figure 2.4, that if the point x is related to the minimum value of the function f(x), the same point is also related to the maximum value of the negative function, -f(x). Without losing its generality, optimization can be interpreted as minimizing, because the maximum of a function can be obtained through the minimum of the negatives of the same function.

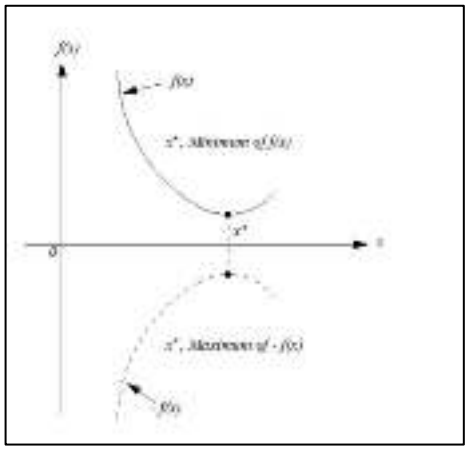

Figure 1. X Point Position

3. METHODS

Data collection techniques are methods used to obtain data and information that support the research being carried out. In carrying out this research, the authors collected data through secondary data sourced from the NPK fertilizer production process at an NPK fertilizer factory operated by PT XYZ. Secondary data was obtained from the production division and the operation control plan for the NPK fertilizer factory unit. The production process data used as secondary data starts from factory operations from January 1, 2021 to December 31, 2021.

The predictor variables used in this study were Steam Usage (Tons), Electricity Usage (kWh), and Plant Downtime (Hour). Meanwhile, the response variable (Y) in this study consisted of total NPK Fertilizer Production (Tons) and Production Cost (Rp/Ton).

The optimization of the data carried out in this study aims to determine the optimum parameter point in order to produce the best variable value. Optimization itself is a process of maximizing or minimizing the desired objective function by fulfilling the applicable rules or limitations (Ashok, 1999).

Model Feasibility test (F test) is used to assess the feasibility of the regression model that has been formed. Testing is done by comparing the value of F table with F count. In determining

the value of the F table, the significance level used is 5% with degrees of freedom (df) numerator = k-1, and denominator df = n-k, where n is the number of respondents and k is the number of variables.

The test criteria used, namely

a. if Fcount > Ftable, then H0 is rejected and Ha is accepted

b. if Fcount < Ftable, then H0 is accepted and Ha is rejected

After that, Independent Residual Assumption Examination is conducted to test the freedom between residuals can be done by using the Durbin-Watson test with the following hypothesis (Draper & Smith, 1998) with the following hypothesis:

H0: Residual data is independent

H: Residual data is not dependent

The independent residual test can also be seen visually, namely the ACF plot, if nothing comes out of the line then it can be said to be independent residual. Examination of the Residual Normality Assumptions is used to test whether the residual values resulting from the regression are normally distributed or not. A good regression model is one that has normally distributed residual values. Examination of the assumption of normality residuals can be done by looking at the distribution of data on diagonal sources on the Normal Probability Plot graph and histogram which compares the observed data with a distribution close to the normal distribution.

The data from each variable will be searched for its range. From each of these ranges, it will be converted into a z-score and then used as a range for plotting on the regression graph that will be formed. iefly explain what you do and how. This section should focus on methodology only. Do not write problem description, research objectives and conclusions in this section. Presenting flow chart is not compulsory in this section although many people did it to show the sequence of activities in their research process.

4. RESULTS

This section presents the results of your study. Present only the most important aspects of your study. Use tables and figures to support your message. However, the space to put tables and figures should be less than the space used to write the narratives. Use subsections 4.1, 4.2 etc as necessary.

Table 1. Descriptive Statistics of Predictor Variabel

Variable	Mean	StDev	Minimum	Maximum
Penggunaan Steam (Ton)	25,294	3,977	15,227	31,642
Penggunaan Listrik (kWh)	4428,6	504,3	3373,0	5414,7
Downtime Plant (Hour)	0,10472	0,031	0,05017	0,17848

Table 2. Descriptive Statistics of Response Variable

Variable	Mean	StDev	Minimum	Maximum
Total Produksi Pupuk NPK (Ton)	530,48	53,12	427,35	616,12
Harga Pokok Produksi (Rp/Ton)	4682645	123094	4338593	4885856

In the last discussion of descriptive statistics, a scatter plot graph of all the predictor and response variables that have been linked is displayed. The purpose of presenting this scatter plot is to see the overall distribution of data from predictor variables and responses.

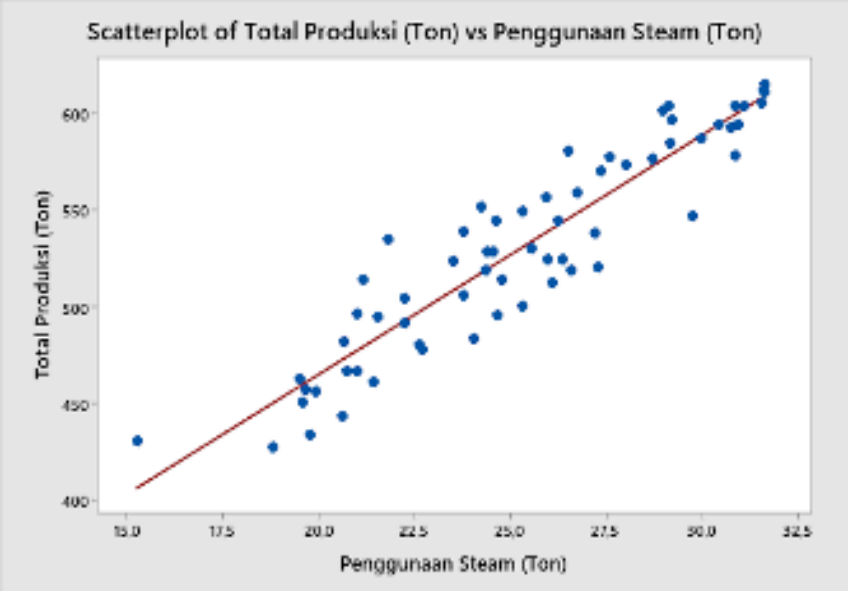

Figure 2. Scatterplot of Total Production vs Steam Usage

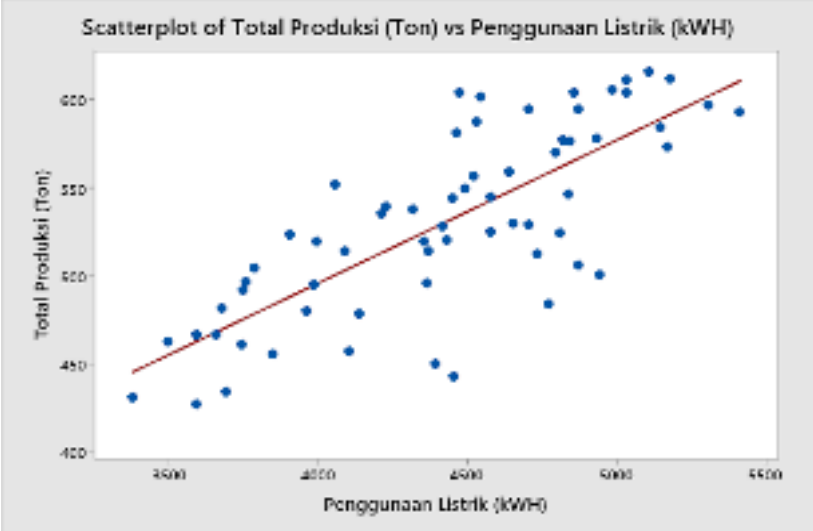

Figure 3. Scatterplot of Total Production vs Electricity Usage

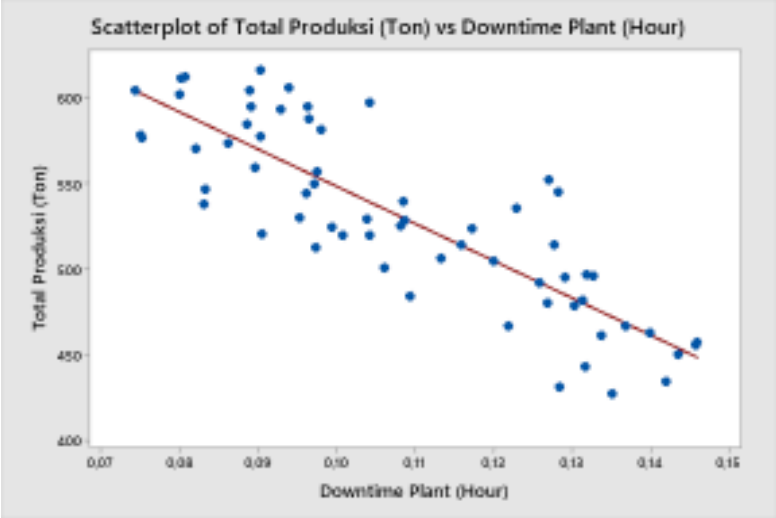

Figure 4. Scatterplot of Total Production vs Downtime Plant

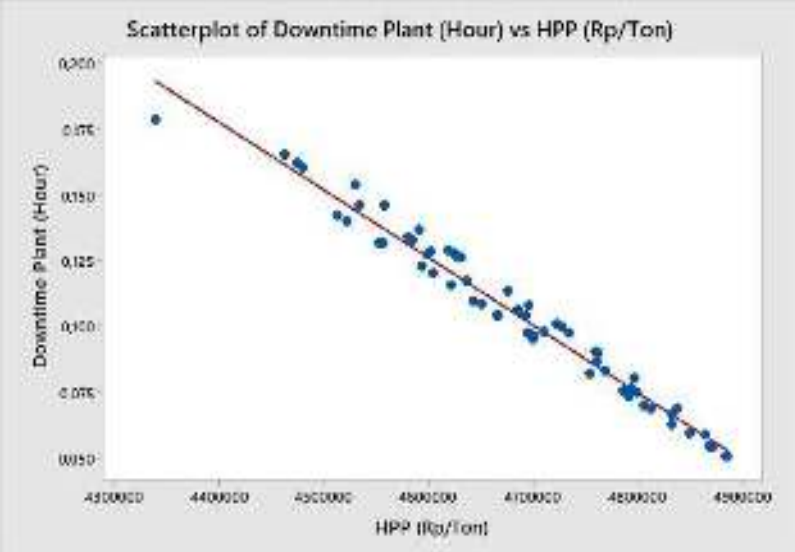

Figure 5. Scatterplot of Production Cost vs Downtime Plant

After that, we do the Regression Model Specification, which is the process of finding an equation model that best meets the goodness of fits criteria, which is tested according to the classical assumptions testing procedure.

Table 3. Regression Model Specification

No	Y	X	S	R-sq	R-sq(adj)	R-sq(pred)
1	Total Production (Ton)	Steam Usage (Ton)	19,8074	86,32%	86,10%	85,50%
2	Total Production (Ton)	Electricity Usage (kWH)	34,1769	79,27%	78,61%	77,18%

3	Total Production (Ton)	Downtime Plant (Hour)	28,4092	81,86%	81,40%	80,19%
4	Production Cost (Rp/Ton)	Downtime Plant (Hour)	49444,2	82,30%	82,01%	81,13%

After that, we do Parameter Estimation In solving this problem, the OLS (Ordinary Least Square) method is used for each variable relationship. The summary of the parameter estimation results is shown in Tables below.

Table 4. Parameter Estimation

No	Y	X	b_0	b_1	S^2	S
1	Total Production (Ton)	Steam Usage (Ton)	217,0	12,409	392	19,8074
2	Total Production (Ton)	Electricity Usage (kWH)	171,7	0,08110	1168	34,1769
3	Total Production (Ton)	Downtime Plant (Hour)	765,0	-2168	807	28,4092
4	Production Cost (Rp/Ton)	Downtime Plant (Hour)	5235781	-5092778	2444727619	49444,2

In order to find the optimum point, we must determines in advance what are the constraints in this problem. The specified constraints are important operational parameters in the production process at the NPK Granulation Fertilizer Factory such as the use of Steam, Electricity, and Downtime Plants.

1. **y = - 9,993 + 0,01882 x2**

   Pada studi kasus ini, besaran Penggunaan Listrik dalam proses produksi pabrik adalah maksimal sebesar 5414,7 kWh.

2. **y = 9,993 – 0,01882 x3**

   Constraint ini menandakan target Downtime minimum yang harus dicapai oleh pabrik pupuk NPK Granulasi yaitu sebesar 0,05 Hour/Day.

3. **y = 217,0 + 12,409 x1**

   Pada studi kasus ini, penggunaan Steam dalam proses produksi pabrik adalah minimal sebesar 15,227 Ton.

For constraints (1) and (2) the optimum point can be determined in the following way:

9,993 – 0,01882y = - 9,993 + 0,01882y

19,986 = 0,03764y

$y = \frac{19,986}{0,03764}$

$y = 530,978$

So, the Optimum Point achieved when y = 530,978

Therefore,

- Electicity Usage = 549 + 7,308 (530,978) = 4429,387 kWh. Coordinates: (4429,387 ; 530,978)
- Downtime Plant = 0,3963 – 0,000549 (530,978) = 0,105 Hour/Day. Coordinates: (0,105 ; 530,978)
- Steam Usage = -11,63 + 0,06956 (530,978) = 25,305 Ton. Coordinates: (25,305 ; 530,978)

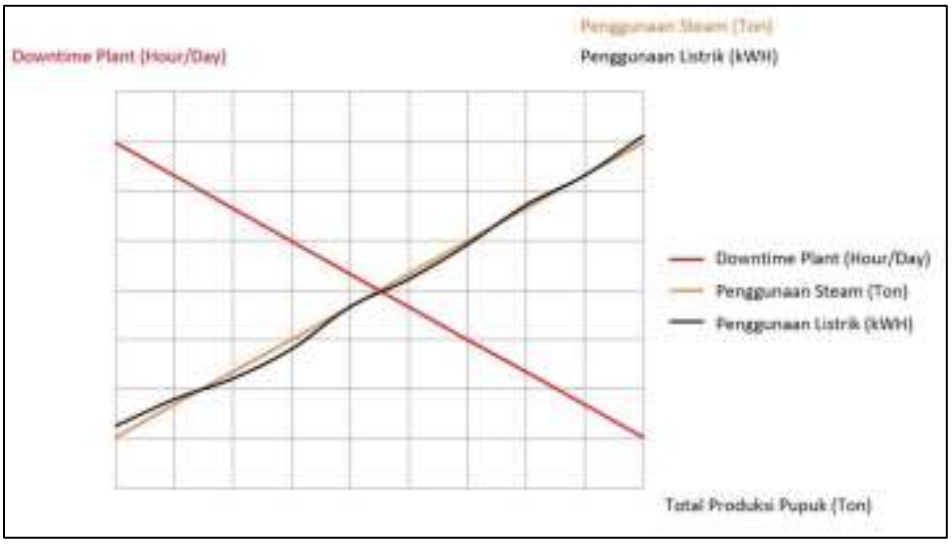

Figure 4. Final Optimum Point Graph

6. CONCLUSIONS

From the results of the analysis and discussion, it can be concluded several things as follows:

1. The optimum Steam usage value used is 25.305 tons.
2. The optimum electricity usage value used is 4429.387 kWh.
3. The optimum Downtime Plant value achieved in the operational production process is 0.105 Hour/Day.
4. The optimum operating point for the Granulation NPK Fertilizer Plant in carrying out the production process can be achieved by using the operational parameters of Steam with a value of 25.305 Tons, the use of Electricity with a value of 4429.387 kWh, and a Downtime Plant of 0.105 hours/day with Total Fertilizer Production reaching 530,978 tons.

As for suggestions for the of further research related to this research topic are:

1. The company's management can use the optimum operational parameters of the NPK Granulation fertilizer plant which can produce a total fertilizer production of 530.978 Tons

using the operational parameters of steam production with an average usage of 25.305 Tons, electricity usage of 4429.387 kWH, and plant downtime of 0.105 Hours/Day.

2. In determining the regression model, it is necessary to observe the trend of raw material prices for NPK fertilizer production in the future so that the impact on changing the optimum point can be seen.
3. This research can be supplemented with other supporting parameters related to product quality standards such as natural gas, hard water, and recycled products for further research materials.

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IT GOVERNANCE IN SCADA TECHNOLOGY TO IMPROVE COMPANY PERFORMANCE USING COBIT 2019

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ABSTRACT

PLN Main Unit for Maluku and North Maluku Region is also a driving force in the electricity sector in Maluku Province and North Maluku Province with a total area of 852,735 km2 in the form of an archipelago that has SCADA technology to help its electricity reliability.

SCADA (Supervisory Control and Data Acquisition) is software to control and monitor the status of network breaker equipment, both high and medium voltage systems. Seeing the complexity of the risks faced by the company, the need for good governance practices also increases.

This research aims to obtain a measure of the current and expected capabilities of Information Technology processes and develop recommendations to align them with business strategies. This research method uses the COBIT 2019 framework and Capability maturity model integration (CMMI). After conducting gap analysis 10 sub domains / processes consisting of EDM02, EDM04, APO04, APO06, APO07, APO10, BAI04, BAI05, MEA01, DSS02. In the sub domains and processes of EDM02, APO04, and DSS02 with a gap value of 2 and EDM04, APO06, APO07, APO10 and MEA01 with a gap value of 3 indicating that the management of Information Technology in the identified information technology domains and processes is stated to be very poor / very not optimal to meet the company's business targets and it can also be stated that it does not yet have or implement the process of implementing IT Governance.

Keywords: : SCADA, IT Governance, Capability Level, COBIT 2019

1. INTRODUCTION

Electricity is a facility that plays an important role in national development because it is an infrastructure needed to support production in various sectors (Arifin & Hermawan, 2021). Electricity also acts as the driving force of a business activity.

The working area of PT. PLN (Persero) UIW MMU (Maluku and North Maluku Regional Main Unit) is in the form of islands with a total area of 852,735 km^2, consisting of a land area of 87,463 km^2 (10.26%) and an ocean area of 765,272 km^2 (89.74%). Saat ini operasional pelayanan penyediaan tenaga listrik ke pelanggan, PT. PLN (Persero) UIW MMU consists of 7 (seven) UP3 with 35 (thirty-five) ULP in it, as well as 1 (one) UPK that manages the generation system. In semester 1 of 2021, Maluku and North Maluku Provinces served 601,768 customers.

Figure 1.1: Map of the Main Unit PLN Working Areas for the Maluku and North Maluku Regions

PT. PLN (Persero) UIW MMU itself has applied information technology, starting with PLN Mobile, AMS, AMIO, AMOR, and many others. For technology in the field of distribution itself, PT. PLN (Persero) UIW MMU starting in 2015 plans to apply SCADA technology, which is the technology used to carry out automation. Automation plays an important role in industrial systems. To speed up industrial processes, almost all industries operate remotely through the Supervisory Control and Data Acquisition (SCADA) system (Upadhyaya & Sampallia, 2019).

Figure 1.2: Map of SCADA at PT. PLN (Persero) UIW MMU

The SCADA system at PT. PLN (Persero) UIW MMU has only applied 12 systems and 424 separate equipment points throughout the work area of PT. PLN (Persero) UIW MMU, as shown in Figure 1.2: Map of SCADA at PT. PLN (Persero) UIW MMU. The equipment currently integrated with SCADA is LBS Motorized, LBS Three Ways, Recloser, PMCB, and Cubikel. The main functions of the SCADA system can be grouped into three parts, namely telemetering, telesignaling, and remote control (Tuwongkesong, 2020). SCADA Remote Control Performance, it can be seen that the SCADA performance itself is still below 80% of the applied system, therefore PT. PLN (Persero) UIW MMU itself continues to strive to develop infrastructure in all of its work units by paying attention to aspects of security, innovation, cost aspects, and the stability of the SCADA technology.

COBIT is a framework for enterprise information and technology governance and management, intended for the entire enterprise. Enterprise information and technology refers to all information processing and technology used by the enterprise to achieve its goals, regardless of where it occurs within the enterprise. In other words, enterprise information and technology is not limited to the IT department of an organization but certainly includes it (ISACA, 2018). In the 2019 COBIT framework, there is value creation consisting of risk optimization, benefit realization, and resource optimization because IT (information technology) has an important function in the success of daily operations and the creation of a company's competitive advantage.

COBIT® 2019 is a framework to help ensure effective corporate governance of information and technology and optimize risk levels and resource utilization (ISACA, 2018). The COBIT® 2019 Framework consists of 40 processes grouped into 5 domains, namely EDM (Evaluate, Direct, and Monitor), APO (Align, Plan, and Organize), BAI (Build, Acquire, and Implement), DSS (Deliver, Service, and Support), and MEA (Monitor, Evaluate, and Assess). This method is designed for the process of comparing estimated costs with benefits that are closely related to decision-making to determine whether the decision to be made is valid or not from a business perspective.

The purpose of this study is to discuss the information technology governance audit at PT. PLN (Persero) UIW MMU in order to determine the level of capability in managing existing information technology. Through this research, it is expected that PT. PLN (Persero) UIW MMU will be able to improve company performance by optimizing the potential of SCADA information technology. The framework that is planned to be used in this study as an audit guide is COBIT 2019. The results of the information governance audit process will be in the form of an explanation of the current and expected level of IT management capability. Furthermore, recommendations will be made to IT management as a supporter of achieving company goals in order to improve it even further.

2. LITERATURE REVIEW

(Lunardi et al., 2014), in his research, found that companies that implement IT governance will get increased performance, especially regarding profitability. The positive effects or impacts that are felt, especially regarding the company's financial performance, from the implementation of IT governance will be felt in the next few years and not in the first year when companies are just starting to implement IT governance mechanisms. (Andrianti & Assegaff, 2018). In his research, he also states that the implementation of IT governance is urgently needed to prevent and deal with problems such as damage to IT infrastructure, which can cause loss of important data or information that can affect the company's operational activities, and to fix it certainly requires money and time. which is not small enough to cause losses for the company.

The completion of this research is inseparable from relevant previous research that serves as study material for solving existing problems.

(Dwiwanti, 2020) provided recommendations for the preparation of data and information management for each selected objective. For each selected objective, then set the level to be achieved in the next 5 years. There are many basic things that need to be addressed, such as compliance with the Standard Operating Procedure (SOP) flow and the flow of handling if a problem occurs. Apart from that, matters related to the work functions of certain units are also added, bearing in mind that adding units or fields cannot be done immediately and must adjust to the organizational structure determined by the relevant ministry. This study uses the COBIT 2019

method for measuring capability level using the Capability Maturity Model Integration (CMMI) standard. Eight IT objectives were selected in COBIT 2019 for this research, namely EDM03, EDM05, DSS05, APO11, APO12, APO14, MEA01, and MEA03.

(Kasma, 2019) then conducted additional research on the design of an e-Government security governance system using COBIT 2019 using the Design Research Methodology (DRM) method with Type 5 and COBIT 2019. In 2019, the SPBE security management system is derived from the 28 core COBIT models by combining critical success factors (CSFs) and risks from the entire COBIT core model, resulting in a total of 40 core models. Whereas the research on the thesis selected the object of study APO13, The organization that is the object of research is at maturity level 2, and in the next five years it will reach maturity level 3. The resulting recommendations are: Investment security risk mitigation plans are developed and maintained, as are available solutions for investment components. Development of risk mitigation plan implementation proposals that include information security cases, providing input on risk mitigation plans, training and privacy awareness programs, and integrating information security monitoring with other controls.

(Safitri, 2021) identify the management level of SIPERUMKIM governance. SIPERUMKIM itself is the process of digitizing public service recommendations for housing permits in the city of Salatiga. The measurement of the governance management level aims to help organizations achieve risk optimization, governance, and information technology management. The results of this study are in the form of corporate information technology governance designs and important process recommendations for the Salatiga City Housing and Residential Area Service using the APO12, DSS 02, and DSS 03 domains in COBIT 2019.

(Ishlahuddin, 2020) Subsequent research that discusses the analysis of the maturity level of IT governance in smaller higher education institutions uses COBIT 2019. The measurement of the maturity level of IT governance uses the EDM01, EDM02, EDM04, APO01, APO02, APO04, APO07, and BAI01 domain methods. BAI02.

(Atrinawati, 2019) In connection with previous research, there is other research related to assessing the level of process capability at XYZ University based on COBIT 2019, where the author, in assessing the process capability, uses the domains APO03, APO08, APO09, APO11, APO12, APO13, APO14, BAI03, BAI06, DSS04, and DSS05.

(Nachrowi, 2020) regarding the evaluation of governance of information technology management services using COBIT 2019 and ITIL 4, where the use of these domains uses EMD03, APO10, APO12, BAI02, BAI03, BAI06, BAI07, BAI10, DSS04.

(Yasin, 2020) regarding the design of information security governance recommendations and roadmaps using the COBIT 2019 framework and ISO 27001:2013 at the XYZ Regional Police Directorate of Criminal Investigation, where the domains used include EDM, APO, BAI, MEA, and DSS.

(Intan, 2020) conducted research related to the analysis and design of SOE information technology governance in the process of investment management and information technology risk management. Using the 2019 COBIT Framework at PT. POS Indonesia, the domains used in this study were the APO05 and APO12 domains.

(Oktianatasari, 2017) Apart from research related to COBIT 2019, there are several studies using relevant COBIT 5, such as research related to an IT governance audit at PT. Pelabuhan Indonesia III (Persero), which uses the COBIT 5 framework. The method used is the weighting method on the RACI chart combined with the median method for IT capability values. And from the 37 selected domains, 26 IT domains and processes managed to reach level 1 (performed), and 11 IT domains and processes managed to reach level 2 (managed). The IT management capability

level is expected to reach level 3 in 2018, which means that the company currently has not implemented the defined process or has failed to achieve the goals of the process. In this study, recommendations were compiled that aimed to improve process capability in order to achieve the expected level of capability.

(Nistrina, 2019) regarding information security for hospital information technology using COBIT 5, which uses the quantitative method with a questionnaire analysis of 86 respondents who use or implement the Hospital Information System (HIS) at Soreang Hospital, Bandung. The framework used is COBIT 5. In addition to receiving the results, Soreang Hospital's capability level is at level 1 for the DSS05 domain with L (largely achieved) criteria and level 0 for the APO13 domain with L (largely achieved) criteria. To achieve the target capability level with fully achieved criteria, improvements in information security in HIS are required.

3. METHODS

Research on information technology (IT) governance audits will be carried out in several stages, such as:

a. Literature Study, which consists of a literature review and company document study.
   Literature study is a way of finding references that are relevant to examples of existing problems or cases encountered in research. The references used can come from books, journals, research report articles, and sites on the internet. The output obtained from this method is the collection of references that are relevant to the problem formulation of the research.
b. Making a condition assessment based on interviews with experts
   The process of assessing and collecting data uses a questionnaire for the Senior Manager of Engineering and Transmission. for the implementation of this assessment by collecting data using the online survey method. The online survey was conducted using a tool in the form of a Google form. The questionnaire data created in this online survey includes all factor designs contained in COBIT 2019. Questionnaire data obtained from the Google form is then transferred to the toolkit provided by COBIT 2019.
c. Determination of objectives for COBIT 2019
   After assessing the conditions based on the previous design factors, the next step is to determine objectives in COBIT 2019 using two methods, namely, conducting an assessment based on indicators in the design factors and identifying the needs of stakeholders and the company's business goals. In COBIT 2019, the company is declared a stakeholder. needs and enterprise goals. Stakeholder needs are the needs of every stakeholder in the company.
d. Assessment related to current conditions and expected conditions
   An analysis was conducted to assess the level of capability of the current technology governance process. At this analysis stage, an assessment of each attribute of the capability model for the process to be assessed is carried out. Where processes within each governance and management objective can operate at various levels of capability, ranging from 0 to 5.
e. Do a gap analysis.
   The gap analysis aims to facilitate the improvement of information technology governance through capability-level information regarding which processes have gaps and require improved information from company management.
f. Develop steps for improvement.
   This stage of improvement is needed so that the selected objectives can achieve what is desired. In the improvement steps, it is necessary to meet the level of the current condition until it is fully achieved so that it can go up to the next level.

g. Compilation of information governance recommendations
The preparation of this recommendation is made so that the selected IT process can achieve the target expected by the management of PT. PLN (Persero) UIW MMU. Thus, IT management and investments made in order to realize the intended alignment goals can be in line with the enterprise goals of PT. PLN (Persero) UIW MMU.

4. RESULTS

4.1. Capability Analyzing

In analyzing the level of IT management capability, the data processing method used is a combination of the RACI table and the median method. The RACI table is used as a basis for re-mapping existing positions because there are differences in the names of positions that exist at PT. PLN (Persero) UIW MMU with COBIT 2019. Data originating from roles with a level of responsible and accountable responsibility, denoted by the letters R and A, is the type of data selected from the intended role. This is done based on the consideration that roles with the level of responsibility stated in the letters "R" (responsible) and "A" (accountable") are considered to better understand and master processes related to existing IT domains and processes so that the processed data will be more valid. The results of the assessment process for capabilities can be seen in Table 4.11:

Table 4.1 Capability Assessment Process

PROCESS	CAPABILITY LEVEL		INDICATION OF THE CURRENT RATING
	As Is	To Be	
EDM 02 Ensured benefits delivery	1	3	PLN UIW MMU already has a process that regulates the results of managing the company's IT processes so that they remain aligned with company goals, but it does not yet have good performance.
EDM 04 Ensured resource optimization	0	3	PLN UIW MMU does not yet have a process that regulates resource optimization.
APO04 Managed innovation	1	3	PLN UIW MMU already has a process that regulates the results of managing innovation.
APO06 Managed budget and costs	0	3	PLN UIW MMU does not yet have a process related to cost and financial management.
APO07 Managed human resources	0	3	PLN UIW MMU does not yet have a process related to human resource management.
APO10 Managed vendors	0	3	PLN UIW MMU does not yet have a process related to vendor management.
BAI04 Managed availability and capacity	0	3	PLN UIW MMU does not yet have a process related to the availability and capacity related to SCADA.
BAI05 Managed organizational changes	0	3	PLN UIW MMU does not yet have a process related to organizational change arrangements.
DSS02	1	3	PLN UIW MMU does not yet have a process related

PROCESS	CAPABILITY LEVEL		INDICATION OF THE CURRENT RATING
Managed service requests and incidents			to managing service requests and incidents in SCADA activities.
MEA01 Managed performance and conformance monitoring	0	3	PLN UIW MMU does not yet have a process related to SCADA performance management and related monitoring.

The capability level of a process is determined on the basis of achieving certain process attributes according to ISO/IEC 15504-2:2003. The maturity level of IT governance is level 3 according to the Guidelines for the Preparation of Information Technology Management for Government Business Entities and standard best practices in the global industry. For this reason, PT PLN (Persero) UIW MMU targets to reach level 3 in 2022, which indicates that the process there has been well managed and stable.

4.2. Gap Analysis

It is a process that aims to analyze the gap that occurs between the current level of IT management capability and that expected by PT (Persero) PLN UIW MMU. The gap between the current level of IT management capability and what is expected in 2022 can be seen in Table 4.2 :

Table 4.2 Gap Analysis

Process		Capability Level		Gap
		As Is	To Be	
Evaluate, Direct and Monitor				
EDM 02	*Ensured benefits delivery*	1	3	2
EDM 04	*Ensured resource optimization*	0	3	3
Align, Plan and Organise				
APO04	*Managed innovation*	1	3	2
APO06	*Managed budget and costs*	0	3	3
APO07	*Managed human resources*	0	3	3
APO10	*Managed vendors*	0	3	3
Build, Acquire and Implement				
BAI04	*Managed availability and capacity*	0	3	3
BAI05	*Managed organizational changes*	0	3	3
Deliver, Service and Support				
DSS02	*Managed service requests and incidents*	1	3	2
Monitor, Evaluate and Asses				
MEA01	*Managed performance and conformance monitoring*	0	3	3

5. CONCLUSIONS

Through an IT Governance and Risk Audit using the 2019 COBIT framework and analyzing 10 IT subdomains and processes, a significant gap (gap) was found between the current level of capability and that expected by PT PLN UIW MMU in 2022. In IT subdomains and processes, EDM02, APO04, and DSS02 with a gap value of 2, and EDM04, APO06, APO07, APO10, and MEA01 with a gap value of 3, indicate that IT management in the identified IT domains and processes is stated to be "very poor" or "not optimal" to fulfill the company's business targets, and it can be stated that it also does not have or implement an IT governance implementation process and cannot clearly identify IT risks, so the company is not optimal in achieving the set targets.

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ANALYSIS OF FACTORS AFFECTING CUSTOMER INTEREST IN MAKING PURCHASES ON ONLINE MARKETPLACE WITH UTAUT2 APPROACH

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ABSTRACT

Technological developments have made a shift in customer shopping behaviour from offline to online throughout the world including Indonesia, one of which is marked by the growth of e-commerce throughout the world which is experiencing a significant increase. The e-commerce industry has the potential to be one of the drivers of the domestic economy. One of the impacts of the advancement of e-commerce is the emergence of many online-based marketplaces or so-called e-marketplaces. Seeing the increasingly competitive market service competition, especially during the pandemic, the background for this research is to be able to look for factors - factors that influence consumers in using marketplace services in Indonesia. In this study, the integrated theory of acceptance and use of technology 2 (UTAUT2) is used as a research model with additional variables of trust and structural equation model (SEM) as a method for analyzing. The study used a survey method to collect data which was carried out by distributing online questionnaires based on the variables and indicators of UTAUT2 with the addition of Hedonic Motivation, Habit, Trust variables. There are 31 item questions, with a scale of 1 – 5, processing using SPSS and GSCA software in 216 respondents. The first test and try out with testing using the measurement model. After that, testing with a structural model is carried out. The results of testing these data indicate that in this study the variables of Performance Expectancy, Effort Expectancy, Facilitating Condition, Hedonic Motivation, User Satisfaction, Habit, Trust affect market interest and use.

Keywords: Bukalapak, Marketplace, Structural Equation Modelling, Trust, UTAUT2.

1. INTRODUCTION

The progress of digital technology today is overgrowing. Especially in the post-Covid-19 pandemic era forced us to accelerate the use of digital technology that changes people's habits. According to McKinsey & Company, one of the actual impacts of post-Covid-19 social change changes in consumer behaviour in consuming needed goods and changes in shopping methods. Many people who used to fulfil their needs by leaving the house to go to traditional markets or shopping centres are now shopping online. Online businesses that are used to meet human needs also have many innovations, one of which is the marketplace. A marketplace is a medium where various sellers sell merchandise on one website.

The development of marketplaces in Asia, especially in Indonesia, has been very rapid, especially in the last ten years, one of which is Bukalapak. However, according to The Map of E-

Commerce in Indonesia (2021), Bukalapak is one of the top three marketplaces in Indonesia that experienced the most significant decrease in the number of visitors in 2021, by 26 percent, to be precise. This phenomenon affects purchasing decision users in Bukalapak by reducing the number of web visitors per month. This pain problem makes the Bukalapak topic very interesting for research. Online business does bring the convenience offered in the transaction process, but some factors cause people to be reluctant to use online business. These factors are the problem of personal data security in applications, insecurity about security in payments, fear of fraud from sellers, and others (Tashia, 2017). This factor is undoubtedly an obstacle because there is an aspect of trust from consumers that influences the intention to use marketplace services. The issue of trust here is very influential in terms of Behavioural Intention (Widodo, 2019) because it is no longer a private matter, especially in terms of payment services (Yan & Yang, 2015) and online services (Chen & Corkindale, 2008).

The increase in online business in Indonesia made the authors research the factors influencing customer intentions toward consumer trust. This research was conducted by predicting consumer user behaviour toward information technology with the Unified Theory of Acceptance and Use of Technology 2 (UTAUT2). The UTAUT2 model here will focus on eight factors: Performance Expectancy, Effort Expectancy, Social Influence, Facilitating Conditions, Hedonic Motivation, User Satisfaction, Habit, Trust for exogenous variables, then Behaviour Intention, Purchase Intention, Use Behaviour for endogenous variables. This research is expected to provide an overview of the Bukalapak marketplace regarding how user behaviour can be used for online business strategies in the future so it can increase the number of visitors and improve its services.

2. LITERATURE REVIEW

2.1. Bukalapak Application

Bukalapak is one of the leading digital-based buying and selling companies in Indonesia. By carrying out the online marketplace and mall business model, Bukalapak allows a person, a small shop, or a brand to open and manage an online shop. Bukalapak, in this case, provides an electronic trading platform (marketplace) where users can make buying and selling transactions of goods and use the various features and services available.

2.2. Unified Theory of Acceptance and Use Technology (UTAUT)

The UTAUT theory proposed by Venkatesh et al. (2003) has grown from year to year in line with rapid technological developments. UTAUT itself can be used to examine what factors influence the application of this technology to make it easier to design a technology update so that it can be more accepted by users, as well as explore factors that influence the intention to adopt a technology.

2.3. Generalized Structured Component Analysis (GSCA)

Generalized Structured Component Analysis, commonly referred to as GSCA, is a component base analysis method in SEM (Tanuwijaya and R. Sarno, 2010). GSCA software can handle global optimization problems to determine model parameter estimates.

3. METHODS

At this point, the method used in this thesis will be described, such as Data Collection, Conceptual Model, Hypothesis.

3.1. Data Collection

The collection stage is the work methodology stage, which includes compiling questionnaires to obtain data. Questionnaires were distributed to all Bukalapak application users throughout Indonesia, with age around 17-45 years. The questionnaire questions will be in the form of closed questions. Closed questions contain ratings in the form of intervals using a Likert Scale, with details:

1 = Strongly disagree
2 = Disagree
3 = Neutral
4 = Agree
5 = Strongly agree.

The method used in filling out this questionnaire is in the form of a self-administered survey. After questionnaires data is taken, the next is process of grouping each construct variable clearly.

Table 1. Research Indicator

Variable	Indicator (Code)
Performance Expectancy (PE)	System Benefits (PE1)
	Time Efficiency (PE2)
	Productivity Improvement (PE3)
Effort Expectancy (EE)	Easy Learn System (EE1)
	Easy Advanced (EE2)
Social Influence (SI)	Influence of Important People (SI1)
	Influence of Special people (SI2)
	Ad Influence (SI3)
Hedonic Motivation (HM)	Happy (HM1)
	Enjoy (HM2)
	Entertained (HM3)
User Satisfaction (US)	Sense of Satisfaction with Information Quality (US1)
	Satisfaction with Service (US2)
Trust (TR)	Trust (TR1)
	Reliable (TR2)
	Safety of Use (TR3)
Facilitating Condition (FC)	Facility Availability (FC1)
	Knowledge Ownership (FC2)
	Technology Compatibility (FC3)
	Availability of Assistance (FC4)
	System acceptable (FC5)
Habit (HT)	Habit (HT1)
	Service Addiction (HT2)
	Must (HT3)
Behaviour Intention (BI)	Future Use Intention (BI1)
	Intention to Use (BI2)
Purchase Intention	Purchase Intention (PI1)
	Stay Subscribed (PI2)
Use Behaviour	Intensity (UB1)
	Service Usage (UB2)

	Place of Service Use (UB3)

3.2. Data Collection

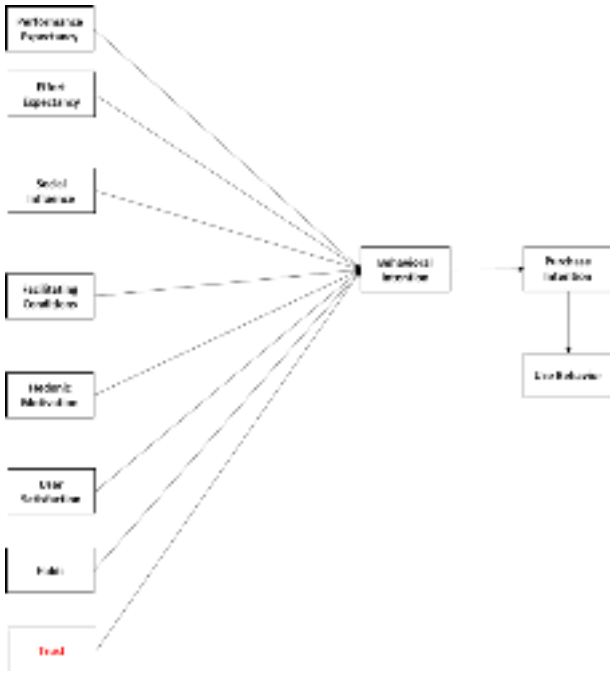

Figure 1. Model Conceptual

The UTAUT 2 model used in this study consists of eight primary constructs: performance expectancy, effort expectancy, social influence, hedonic motivation, habit, trust, facilitating condition, and Hedonic Motivation (Venkatesh et al., 2012). The construct influences Behavioural Intention (behavioural intention), Purchase Intention and user behaviour (use of technology). This study adds the variables of User Satisfaction and trusts in the hope that it can influence user intentions in using the Bukalapak application. Then the Purchase Intention variable is added to test the relationship between interest in using the Bukalapak application and interest in purchasing products through the Bukalapak application

3.3. Hypothesis

In the hypothesis determination stage, several hypotheses are related to UTAUT2 taken from Viswanath Venkatesh (2012). It can be seen in **Table 2** that the research hypothesis is formulated as follows:

Table 2. Research Hypothesis

Code	Indicator (Code)
H1	Performance Expectancy significantly and positively affects Behaviour Intention
H2	Effort Expectancy significantly and positively affects Behaviour Intention
H3	Social Influence significantly and positively affects Behaviour Intention
H4	Facilitating Conditions significantly and positively affect Behaviour Intention
H5	Hedonic Motivation has a significant and positive effect on Behaviour Invention
H6	User satisfaction has a significant and positive effect on Behaviour Invention
H7	Habit significantly and positively affects Behaviour Intention

H8	Trust significantly and positively affects Behaviour Intention
H9	Behaviour Intention significantly and positively affects Purchase Intention.
H10	Purchase Intention has a significant and positive effect on user behaviour.

In this study, a hypothesis test was carried out based on the research method. Then it was processed using SEM-GSCA, which would produce a P-value with some conditions:

- P-value ≤ α value means the hypothesis is accepted. If the hypothesis is accepted, then there is a significant influence that can be said from the independent variables on the dependent variable.
- P-value > α value means the hypothesis is rejected. If the hypothesis is rejected, then no influence can be said to be significant from the independent variables on the dependent variable.

4. RESULTS

4.1. Respondent Characteristics

Respondents in this thesis data collection are 216 Bukalapak application users. The following descriptive data is obtained from the respondent's data on the questionnaire distributed via Google form. Then it will be used for analysis based on characteristics, namely gender, duration of using the Bukalapak application, and income.

Table 3. Respondent Characteristic Data

No	Characteristic		Total	Percentage
1	Gender	Men	72	33.33%
		Female	144	66.67%
2	The Duration of Using the Bukalapak Application per Month	0 - 5 Times	125	57.87%
		> 5 Times	91	42.13%
3	Income	Rp 0 - Rp 5.000.000	89	41.20%
		> Rp 5.000.000	127	58.80%

4.2. Measurement Model Testing

Analysis of the suitability of the measurement model is based on the loading estimate value and the reflective nature of the indicators of all variables. The purpose of the model analysis is to see whether the indicators or question items in the research can measure research variables properly and correctly. The results of this test are divided into three types: convergent validity, discriminant validity, and composite reliability. Convergent Validity Measurement showed that each indicator in variable has a valid convergent validity as shown in **Table 4** :

Table 4. Convergent Validity Measurement

Variable Laten	Indicator	Estimate Loading
Performance Expectancy (PE)	PE1	0.6772
	PE2	0.6715

Variable Laten	Indicator	Estimate Loading
Hedonic Motivation (HM)	HM1	0.8787
	HM2	0.7774

Effort Expectancy (EE)	EE1	0.6836
	EE2	0.6852
Social Influence (SI)	SI1	0.8441
	SI2	0.8461
	SI3	0.8334
	SI4	0.7753
Facilitating Condition (FC)	FC1	0.7589
	FC2	0.7853
	FC3	0.7688
Hedonic Motivation (HM)	HM1	0.8787
	HM2	0.7774
	HM3	0.7854

	HM3	0.7854
User Satisfaction (US)	US1	0.8643
	US2	0.8616
Habit	H1	0.9157
	H2	0.9089
Trust	T1	0.8595
	T2	0.8636
Behaviour Intention	BI1	0.8980
	BI2	0.8969
Purchase Intention	PI1	0.8109
	PI2	0.9149

The results of convergent validity testing are used to measure the correlation between indicators and their latent variables. The indicator is declared valid if the results of the loading estimate test are > 0.5 (Ghozali, 2013). If it turns out that the result is <0.5, then the indicator is declared invalid.

The results of the discriminant validity test were used to evaluate the validity of the reflective indicator based on the AVE (Average Variation Extracted) value. The method compares the square root of the average variable extracted for each latent variable with the correlation between other variables in the model. If the Square Root value of the Average Variable Extracted is greater than the correlation with all other latent variables, then the instrument is said to have good Discriminant Validity (Ghozali, 2013)

Table 5. Discriminant Validity Measurement

	PE	**EE**	**SI**	**FC**	**HM**	**US**	**H**	**T**	**BI**	**PI**	**UB**
PE	**1**	0.57	0.60	0.59	0.77	0.71	0.71	0.64	0.71	0.52	0.64
EE	0.57	**1**	0.46	0.61	0.64	0.61	0.60	0.63	0.60	0.49	0.55
SI	0.60	0.46	**1**	0.61	0.66	0.58	0.68	0.53	0.67	0.50	0.62
FC	0.59	0.61	0.61	**1**	0.71	0.72	0.60	0.70	0.65	0.65	0.64
HM	0.77	0.64	0.66	0.71	**1**	0.77	0.78	0.75	0.78	0.63	0.70
US	0.71	0.61	0.58	0.72	0.77	**1**	0.64	0.65	0.69	0.60	0.59
H	0.71	0.60	0.68	0.60	0.78	0.64	**1**	0.68	0.83	0.58	0.76
T	0.64	0.63	0.53	0.70	0.75	0.65	0.68	**1**	0.70	0.65	0.61
BI	0.71	0.60	0.67	0.65	0.78	0.69	0.83	0.70	**1**	0.61	0.75
PI	0.52	0.49	0.50	0.65	0.63	0.60	0.58	0.65	0.61	**1**	0.56
UB	0.64	0.55	0.62	0.64	0.70	0.59	0.76	0.61	0.75	0.56	**1**

The discriminant validity results show that the AVE root value is more than 0.5. It is known that all variables have a square root value of AVE above the latent variable correlation value, which means that the distribution of data on all variables is good enough. It can be concluded that all variables have met the provisions of discriminant validity.

Table 6. Composite Reliability Measurement

Variable Laten	*Composite Reliability*	Remark
Performance Expectancy (PE)	0.781	Reliable
Effort Expectancy (EE)	0.734	Reliable
Social Influence (SI)	0.812	Reliable
Facilitating Condition (FC)	0.779	Reliable
Hedonic Motivation (HM)	0.745	Reliable
User Satisfaction (US)	0.757	Reliable
Habit (H)	0.790	Reliable
Trust (T)	0.750	Reliable
Behaviour Intention (BI)	0.758	Reliable
Purchase Intention (PI)	0.772	Reliable

Last, composite reliability test are used to measure the consistency of each statement in the variable and determine the reliability of the variable. Composite Reliability can be known through the alpha value (Cronbach's alpha). The composite reliability value for all variables is more significant than 0.70, which means that all indicators for the variables have high reliability.

4.3. Hypothesis Measurement

At this stage, 10 hypothesis tests will be carried out, where each hypothesis is tested based on the structural model using GSCA software. This hypothesis test aims to prove the truth of the hypothesis formulated at the hypothesis formulation stage. There are two kinds of hypothesis testing results; the first is if the p-value <0.05 is significant, whereas if the p-value is > 0.05, it means it is not significant. The following is a summary of the results of hypothesis testing in **Table 7**, along with an analysis of each hypothesis.

Table 7. Hypothesis Measurement

Hypothesis	Structural Model Category	Path Coefficient			Result
		Correlation	Estimate	p-value	
H1	All	PE --> BI	0.219	0.001	H1 Accepted
	Male		0.201	0.005	H1 Accepted
	Female		0.265	0.010	H1 Accepted
	Experiences 0-5 per Month		0.203	0.029	H1 Accepted
	Experiences > 5 per Month		0.173	0.024	H1 Accepted
	Income Rp0 – Rp5.000.000		0.246	0.003	H1 Accepted
	Income > Rp5.000.000		0.153	0.047	H1 Accepted
H2	All	EE --> BI	0.023	0.347	H2 Rejected
	Male		-0.113	0.761	H2 Rejected
	Female		0.093	0.071	H2 Rejected
	Experiences 0-5 per Month		0.085	0.256	H2 Rejected
	Experiences > 5 per Month		0.053	0.206	H2 Rejected
	Income Rp0 – Rp5.000.000		0.160	0.085	H2 Rejected
	Income > Rp5.000.000		-0.010	0.565	H2 Rejected

H3	All	SI --> BI	0.102	0.062	H3 Rejected
	Male		0.142	0.120	H3 Rejected
	Female		0.109	0.111	H3 Rejected
	Experiences 0-5 per Month		-0.042	0.651	H3 Rejected
	Experiences > 5 per Month		0.209	0.010	H3 Accepted
	Income Rp0 – Rp5.000.000		0.103	0.214	H3 Rejected
	Income > Rp5.000.000		0.098	0.082	H3 Rejected
H4	All	FC --> BI	0.124	0.007	H4 Accepted
	Male		0.127	0.020	H4 Accepted
	Female		0.124	0.053	H4 Rejected
	Experiences 0-5 per Month		0.150	0.024	H4 Accepted
	Experiences > 5 per Month		0.119	0.025	H4 Accepted
	Income Rp0 – Rp5.000.000		0.018	0.452	H4 Rejected
	Income > Rp5.000.000		0.244	0.006	H4 Accepted
H5	All	HM --> BI	0.121	0.059	H5 Rejected
	Male		0.184	0.148	H5 Rejected
	Female		0.083	0.216	H5 Rejected
	Experiences 0-5 per Month		0.022	0.425	H5 Rejected
	Experiences > 5 per Month		0.157	0.131	H5 Rejected
	Income Rp0 – Rp5.000.000		0.145	0.236	H5 Rejected
	Income > Rp5.000.000		0.118	0.126	H5 Rejected
H6	All	US --> BI	0.277	0.000	H6 Accepted
	Male		0.538	0.000	H6 Accepted
	Female		0.043	0.294	H6 Rejected
	Experiences 0-5 per Month		0.404	0.005	H6 Accepted
	Experiences > 5 per Month		0.164	0.099	H6 Rejected
	Income Rp0 – Rp5.000.000		0.332	0.008	H6 Accepted
	Income > Rp5.000.000		0.270	0.030	H6 Rejected
H7	All	H --> BI	0.467	0.000	H7 Accepted
	Male		0.300	0.041	H7 Accepted
	Female		0.515	0.000	H7 Accepted
	Experiences 0-5 per Month		0.540	0.000	H7 Accepted
	Experiences > 5 per Month		0.414	0.000	H7 Accepted
	Income Rp0 – Rp5.000.000		0.417	0.005	H7 Accepted
	Income > Rp5.000.000		0.461	0.000	H7 Accepted
H8	All	T --> BI	0.415	0.000	H8 Accepted
	Male		0.333	0.000	H8 Accepted
	Female		0.513	0.000	H8 Accepted
	Experiences 0-5 per Month		0.320	0.003	H8 Accepted
	Experiences > 5 per Month		0.479	0.000	H8 Accepted
	Income Rp0 – Rp5.000.000		0.417	0.000	H8 Accepted
	Income > Rp5.000.000		0.364	0.003	H8 Accepted
H9	All	BI --> PI	0.614	0.000	H9 Accepted
	Male		0.249	0.077	H9 Rejected
	Female		0.711	0.000	H9 Accepted
	Experiences 0-5 per Month		0.578	0.000	H9 Accepted
	Experiences > 5 per Month		0.645	0.000	H9 Accepted
	Income Rp0 – Rp5.000.000		0.538	0.000	H9 Accepted
	Income > Rp5.000.000		0.645	0.000	H9 Accepted

H10	All	PI --> UB	0.558	0.000	H10 Accepted
	Male		0.431	0.002	H10 Accepted
	Female		0.595	0.000	H10 Accepted
	Experiences 0-5 per Month		0.550	0.000	H10 Accepted
	Experiences > 5 per Month		0.575	0.000	H10 Accepted
	Income Rp0 – Rp5.000.000		0.551	0.000	H10 Accepted
	Income > Rp5.000.000		0.593	0.000	H10 Accepted

4.4. Variable Effect Contribution

The R Square value indicates the contribution of the endogenous latent variable, which other influencing latent variables can explain. The meaning of R Square is if the value is close to 1, then the independent variables have a strong influence on the dependent variable. Conversely, the independent variable is declared not to influence the dependent variable if the R2 value is close to 0 (Vinzi et al. l, 2010).

Table 8. R Square Value

R Square of Latent Variable	
Behaviour Intention	0.765
Purchase Intention	0.577
Use Behaviour	0.511

Based on **Table 8**, the R2 value for the endogenous Behaviour Intention variable is 0.765 or 76.5%. This value indicates the variance of changes in the endogenous Behaviour Intention variable which can be powerfully explained by the exogenous variables that influence it, namely the variables Performance Expectancy, Effort Expectancy, Social Influence, Facilitating Conditions, Hedonic Motivation, User Satisfaction, Habit, Trust, increase, then these variables affect Behaviour Intention by 76.5% and the rest is influenced by other variables outside of the research model. Furthermore, the R2 value in the Purchase Intention endogenous variable is 0.577 or 57.7%. R2 value in Purchase Intention shows that the value of the endogenous Purchase Intention variable is moderately influenced by its exogenous variable (Behaviour Intention) of 57.7%, and other variables outside this research model explain the other 51.1%.

5. CONCLUSIONS

After researching the analysis of the model using the Bukalapak application for Bukalapak users, the conclusions are as follows:

- Based on research, the variables influencing Purchase Intention and user interest in using the Bukalapak application will increase based on factors (Performance Expectance, Facilitating Conditions, Habit, User Satisfaction, and Trust. Suppose the user's interest in using the Bukalapak application is booming. In that case, it can increase users' buying interest in the Bukalapak application, influencing buying intentions for buying and selling transactions through the Bukalapak application. Companies need to take advantage of the potential of Bukalapak users, especially the characteristics of the male gender, with a duration of use of more than five times per month and an income of more than IDR 5,000,000 per month.

- The strategy that needs to be done to increase user interest in using Bukalapak services in buying and selling transactions is to focus on matters relating to Performance Expectancy, Facilitating Conditions, User Satisfaction, Habit, and Trust, such as:

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IMPACT ANALYSIS OF THE USE OF YANTEK MOBILE PLN USING TTF PERSPECTIVE AND IS SUCCESS MODEL ON EMPLOYEE PERFORMANCE

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ABSTRACT

PLN's services to customers are now simpler, faster, integrated, easier, and can be monitored and controlled in real-time. The Yantek Mobile application is a tool to support customer complaint management activities that allow the Yantek team to arrive at the location and carry out handling. Several factors that influence the use of information systems in organizations are Information Systems (IS) Success Model and task technology fit (TTF). This study aims to identify the usefulness of TTF and IS Success Model on employee performance using Yantek Mobile PLN. This study uses the Yantek Mobile Application, which is used to facilitate field officers to facilitate task mobility, and data can be directly inputted into the application so that the results can be directly monitored. The Partial Least Square Structural Equation Modeling (PLS-SEM) method was used to test the research hypothesis. This quantitative research uses a survey approach to respondents, who must be from the Yantek division unit (Technical Services) in the Main Distribution Unit of East Java, UP3 Mojokerto. The results of this study show that the most influential factors in improving task technology fit are task characteristics. The most significant factor in increasing usage behavior is system quality, recommendations for PLN to improve services through the use of the PLN mobile application with the concentrate on important factors or determinants ranging from the largest to the slightest effect.

Keywords: Employee Performance, Yantek Mobile PLN, Partial Least Square Structural Equation Modeling (PLS-SEM), Task Technology Fit (TTF), IS Success Model.

1. INTRODUCTION

Electricity is a strategic energy resource and is very important for many people's lives. Domestic electricity consumption has increased every year. In Indonesia, electricity procurement is managed by a State-Owned Enterprise (BUMN) called PLN or the State Electricity Company. PLN is part of the Company's Company under the Ministry of SOEs. Over time, PLN has developed as a provider of electricity, power generation, telecommunications, finance, and maintenance services. (Sihombing, 2019).

The condition of the Covid-19 pandemic that has been going on since 2020 has had an impact on the national economic downturn and has become a challenge for various companies; PLN responds to this by making significant changes in corporate governance and working through transformation programs that have been launched since April 2020 to achieve the vision while adapting to the challenges of changing times. As a result, the transformation by PLN has yielded

results where PLN's net profit increased amid the pandemic and further strengthened the company's resilience in a pandemic situation.

PLN can dismantle slow systems and build faster business systems and processes. This is the digitization of customer service. Systems that were initially manual with many human interventions that resulted in slow results were replaced by automated digital systems that were fast field (Christian, 2022). The culture change in engineering service officers (Yantek) is carried out by implementing a digital system, and a Virtual Command Center (VCC) connected to the Yantek Mobile feature in the PLN Mobile application so that services can be completed quickly. With this integration, direct monitoring of the performance of the General Manager and Manager of the Customer Service Implementation Unit (UP3) to officers in the field through a virtual command center (Santia, 2022).

Engineering services (Yantek) is a unit located in PLN Distribution. The scope of PLN Distribution is the stage of electric power distribution and the final step in delivering electric power. PLN Distribution is spread throughout Indonesia. One of the PLN Distribution units is the East Java Distribution Main Unit, UP3 Mojokerto, where UP3 Mojokerto serves the distribution of electricity to the city of Mojokerto and its surroundings with approximately 180 employees, including the Engineering service unit (Yantek) in it.

Researchers took variables from the Information Systems Success Model, namely system quality and information quality (Tam & Oliveira, 2016), which became the focus for researchers in knowing both aspects so that they became variables that affect the performance of Engineering service officers (Yantek) on the Yantek Mobile application. Urbach & Müller (2012) said that the system quality factor focuses on the usability and performance characteristics of the information system, while information quality, the quality of formation, this factor is a desirable characteristic of the output of the Information System (IS) (Urbach & Müller, 2012). Goodhue & Thompson (1995) regarding user utilization and attitudes about technology causing individual performance impacts. The importance of task technology fits in explaining how technology leads to performance impact.

At the same time, task technology fit (TTF) states that individual performance is a function of the superior conformity of task and technology characteristics and usage, which is reasonable but too imprecise to generalize the entire information technology (IT) (Tam & Oliveira, 2016). In this study, researchers applied the theory of task technology fit (TTF), defined as the degree to which technology assists individuals in performing their portfolio tasks (Goodhue & Thompson, 1995). This research combines elements of the Information Systems Success Model and task technology fit (TTF) in a new way. Previous studies have shown that age and gender play an important role in adoption patterns and use of information technology (IT) but rarely consider them separately in the context of individual performance.

This research is expected to bring new insights regarding the determining factors that affect individual performance in the Yantek Mobile application. This study aims to identify the factors in the Task Technology Fit and Information Systems Success Model on employee performance in the use of Yantek Mobile PLN and how employee performance impacts the use of Yantek Mobile PLN using the perspective of Task Technology Fit and Information Systems Success Model to give rise to recommendations that will be given to PLN Mojokerto Branch (PLN UP3 Mojokerto) in efforts to improve and improve the Performance Impacts of Yantek Mobile PLN.

2. LITERATURE REVIEW

Task Characteristics and Technology Characteristics of Task Technology Fit

A certain level of system usage will help to save time in the performance of job tasks (Venkatesh et al., 2003). Findings from several previous studies on age and gender also mention the role of task and technology characteristics on behavioral intentions to adopt IT applications (Venkatesh et al., 2003; Morris & Venkatesh, 2000). Regarding gender, men and women have different views on IT-based services, as stated. A previous study found that men tend to be more task-oriented than women (Venkatesh et al., 2012). In terms of age, younger consumers tend to seek novelty and innovation more than older consumers (Venkatesh et al., 2012; Morris et al., 2005). Based on these findings and applying the TTF model, researchers propose to study the relationship between task and technology characteristics of TTF. The better the suitability, the more likely the user will positively perceive the quality of service. In the context of mandatory application usage, TTF is the extent to which a technology can assist a user in performing his portfolio of services or tasks. The suitability of m-banking tasks and good technological characteristics will positively impact the TTF level (Zhou et al., 2011). In particular, TTF corresponds to the relationship between the characteristics of the task, user capabilities, and technological functionality. Thus, the hypotheses tested in the study:

H_1: *Task Characteristics Have a Positive and Significant Effect on Yantek Mobile PLN Fit Technology Task*

H_2: *Technology Characteristics Have a Positive and Significant Effect on Yantek Mobile PLN Fit Technology Task*

System Quality and Information Quality of Task Technology Fit

System quality focuses on information systems' usability and performance characteristics (DeLone & McLean, 2003; Urbach & Müller, 2012). In their research, Celik & Ayaz (2022) evaluated the system's quality by examining the ease of use, functionality, and flexibility related to the student information system (SIS). Ease of learning, ease of use, responsiveness, reliability, usability, accessibility, and flexibility are valued by student information system (SIS) users (DeLone & McLean, 2003; Gable et al., 2008). In the information system (IS) literature, system quality is associated with the use of systems (Delone & McLean, 1992; DeLone & McLean, 2003; Mohammadi, 2015) and user satisfaction (DeLone & McLean, 2003; Gurkut & Nat, 2016; Ramírez-Correa et al., 2016). Meanwhile, information quality is a desirable characteristic factor of the output information system (IS) (Urbach & Müller, 2012). An example is information that can be created using an information system (IS), such as updated student certificates or transcripts. In their research, Celik & Ayaz (2022) evaluate the quality of information by checking the accuracy of the information. This factor is desirable for the output information system (IS) (Urbach & Müller, 2012). An example is information that can be created using an information system (IS) output, such as updated student certificates or transcripts. The study evaluates the quality of information by checking the accuracy of the information. So the hypothesis proposed in this study is as follows:

H_3: System Quality Positively and Significantly Affects Task Technology Fit on Yantek Mobile PLN

H_4: Information Quality Positively and Significantly Affects Task Technology Fit on Yantek Mobile PLN

System Quality and Information Quality of User Behavior

As a result of the difficulties that arise in sophisticated information systems, researchers and specialists are determined to prove the functionality and quality of newer systems to exploit future

growth prospects (Wang & Lai, 2014). The overall quality has therefore been examined in a second-order construction role of quality of service, systems, and information (Ho, Kuo, & Lin, 2010; Isaac et al., 2017). Furthermore, system quality is described as the intensity with which users feel that the system is easy to operate, connect, and learn and is pleasant to use (Petter & McLean, 2009). Thus, two hypotheses were tested in the study:

H_5: System Quality Has a Positive and Significant Effect on Yantek Mobile PLN User Behavior

H_6: Information Quality Has a Positive and Significant Effect on Yantek Mobile PLN User Behavior

Task Technology Fit on User Behavior and Performance Impacts

TTF is described as a system intensity that corresponds to interests, corresponds to or corresponds to tasks, and meets requirements (Lin & Wang, 2012). Lu and Yang (2014) describe the concept as the degree to which technology assists users in their courses or work performance. They also refer to disposition as the degree to which a particular system is appropriate or suitable to assist in completing tasks based on work requirements (Lu & Yang, 2014). Behavioral intent is determined as a proxy factor in user acceptance and use of technology (Venkatesh et al., 2003). This research investigates the factors influencing the behavioral intentions of technical service officers (Yantek) when using yantek mobile applications for collaborative purposes. According to Goodhue and Thompson (1995), the Task-Technology-Fit (TTF) model is used as a predictor of performance in the context of technology. The basic principle is typical from the TTF Model that if an information system matches the tasks it supports, that will have a positive impact on user performance testing. The behavioral intent effect significantly affects the actual use of systems (AU) of social media technologies, as shown in various studies (Dumpit & Fernandez, 2017).

Regarding the use of technology in organizations, actual use still needs to be improved to provide a complete description without including TTF in total consideration, i.e., if the technology fits the corresponding task (Goodhue & Thompson, 1995). Several papers have examined the positive effects of TTF on user behavior. Glowalla & Sunyaev (2014) and Lee & Lehto (2013) famously examined the positive effects of TTF on factors regarding information system (IS) effectiveness, including effects on performance and net gain. Their findings are supported by many previous studies that have found a positive relationship between TTF and personal performance (Gatara & Cohen, 2014; D'Ambra et al., 2013; McGill & Klobas, 2009; Larsen, Srebø & Søreb, 2009; David et al., 2011; Norzaidi et al., 2007; and Lee, Lee, & Kim, 2005). This research will investigate the significant effect of TTF on performance. The researcher put forward a hypothesis:

H_7: Task Technology Fit Has a Positive and Significant Effect on Yantek Mobile PLN User Behavior

H_8: Task Technology Fit Has a Positive and Significant Effect on Yantek Mobile PLN's Performance Impacts

User Behavior on Performance Impacts

Zwass (2003), in his research, says that with the use of m-banking, there are applications, solutions, and products available for mobile devices that make it a valuable platform for users who expect connectivity benefits anywhere and anytime. Igbaria & Tan (1997) proposes that the use of systems has a direct positive effect on the performance impacts felt by individuals (i.e., the perceived impact of computer systems on decision-making quality, performance, productivity, and work effectiveness) and is supported by the results of research Tam & Oliveira (2016) mentions that use is a more important factor for older subsamples. Based on this, the use of this Yantek Mobile

application, anytime and anywhere, can positively impact individual performance. The hypotheses to be tested are:

H_9: User Behavior Has a Positive and Significant Effect on Yantek Mobile PLN's Performance Impacts

Task Technology Fit with System Quality and Information Quality to User Behavior

Information quality is the intensity at which users consider information from online learning to be accurate, thorough, timely, organized, and updated (Halonen et al., 2009). In addition, service quality is depicted with reliability, assurance, tangible responsiveness, interactivity, empathy, and functionality (DeLone & Mclean, 2003; Lin, Fofanah, & Liang, 2011; Pituch & Lee, 2006). In their research, Isaac et al. (2019) show that the greater the overall quality of the newer technology, the more likely it is that this will reflect the desires and lifestyles of its users. In this study, researchers will also examine the mediation relationship of Task Technology Fit on the relationship of System Quality and Information Quality to User Behavior. Thus, two hypotheses were tested in the study:

H_{10}: Task Technology Fit mediates the relationship between System Quality and User Behavior of Yantek Mobile PLN.

H_{11}: Task Technology Fit mediates the relationship between Information Quality and User Behavior of Yantek Mobile PLN.

User Behavior with Task Technology Fit to Performance Impacts

In this study, researchers will also examine the relationship of Use Behavior mediation to the relationship of Task Technology Fit to Performance Impacts. The hypotheses to be tested are:

H_{12}: User Behavior mediates the relationship between Task Technology Fit and Yantek Mobile PLN Performance Impacts.

3. METHODS

This research uses quantitative methods, which can be interpreted as research methods based on the philosophy of positivism, used to research on specific populations or samples, data collection using research instruments, and data analysis is quantitative, with the aim of testing predetermined hypotheses (Sugiyono, 2017). The population in this study was 180 employees working at PLN Mojokerto Branch (PLN UP3 Mojokerto). Researchers use Non-Probability Sampling as a sampling technique. The Non-Probability Sampling technique used in this study is purposive sampling which establishes specific considerations or criteria in this study, such as; 1). Karyawa Yantek Division of PT PLN 2). Yantek Division (Engineering Services) employees at the East Java Distribution Main Unit, UP3 Mojokerto. Based on the guidelines put forward by Hair et al. (2011), the technique used to determine the minimum sample size in this study was five times larger than the indicator used to measure each construct with a calculation of 35 x 5 = 175 respondents. In this study, the data sources used were primary data which were research data sources. It will be obtained directly from the respondents' information, which was unearthed by direct observation in the field using a questionnaire according to the variables studied.

In this study, there were three bound variables (endogenous variables), namely task technology fit (TTF), user behavior (UB), and performance impacts (PI). In addition, free variables (exogenous variables) in this study were task characteristics (TAC), technology characteristics (TEC), system quality (SQ), and information quality (IQ). The conceptual framework in this study is as follows:

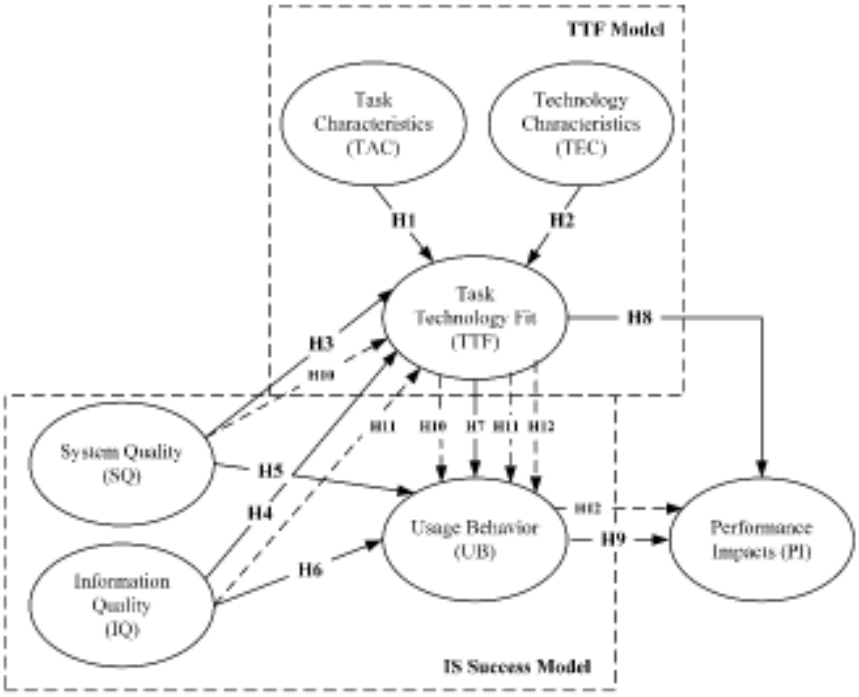

Figure 1. Research Framework

In this study, the author determined four independent variables, namely task characteristics (TAC), technology characteristics (TEC), system quality (SQ), and information quality (IQ), with the mediation variables being task technology fit (TTF), and user behavior (UB) and the dependent variable is performance impacts (PI) and described the operational definition of the variables to be studied as follows:

Table 1. Variable Measurement

Variable	Measuring Indicators
Task Characteristics (X1) Adapted from Guo et al. (2016), Oliveira et al. (2014), Lu and Yang (2014)	I need some information related to my work through Yantek Mobile.
	With regards to work, I need convenient and fast access to Yantek Mobile
	The content contained in Yantek Mobile must be of high quality to support my work
	The content in Yantek Mobile must be aligned with my work needs
Technology Characteristics (X2) Adapted from Guo et al. (2016), Oliveira et al. (2014), Lu and Yang (2014)	The Yantek Mobile platform has a resource acquisition function and provides information sharing features
	The Yantek Mobile platform provides social interaction between users
	The Yantek Mobile platform provides high quality information
	The Yantek Mobile platform can be accessed by all forms of devices (Laptop, Mobile, etc.)
	The Yantek Mobile platform provides a variety of job evaluation functions
System Quality (X3) Adapted from Tam and Oliviera (2016)	Yantek Mobile is very easy to operate
	Yantek Mobile allows me to get my work done easily
	The system owned by Yantek Mobile is very well structured
	Yantek Mobile's interface system is very easy to understand

Variable	Measuring Indicators
	Yantek Mobile provides decent features according to the needs of my work
Information Quality (X4) Adapted from Tam dan Oliviera (2016)	The information provided by Yantek Mobile is useful for my work
	The information provided by Yantek Mobile is easy to understand
	The information provided by Yantek Mobile is interesting
	Information provided by Yantek Mobile reliably
	Complete information provided by Yantek Mobile
	Up-to-date information provided by Yantek Mobile
Task Technology Fit (Y1) Adapted from Lin and Wang (2012), McGill & Klobas (2009)	Yantek Mobile was able to complete all aspects of my work
	Services from Yantek Mobile were able to adjust to my work needs
	Features and functions of Yantek Mobile are able to adjust my work needs
	The quality of Yantek Mobile was able to adjust to my work needs
Usage Behavior (Y2) Adapted from Tam dan Oliviera (2016)	I use Yantek Mobile
	I use Yantek Mobile to complete my work tasks
	I use Yantek Mobile to monitor my work process
	I use Yantek Mobile to interact with consumers
Performance Impacts (Y4) Adapted from PT PLN Yantek (2022)	Yantek Mobile allows me to get work done faster
	Yantek Mobile makes it easy for me to get work done anywhere and anytime
	Yantek Mobile is very beneficial for my work

4. RESULTS

4.1 Descriptive Analysis

The data of this study was obtained from a questionnaire distributed online to the subjects of the study totaling 180 people. The majority of respondents' genders were dominated by the "male" sex as many as 180 respondents with the age of 31 - 40 years as many as 92 respondents, the age of 41-50 respondents as many as 67 respondents, the age of 21 - 30 years as many as 21 respondents had high school / equivalent final education as many as 172 respondents, Bachelor / S1 as many as 6 respondents, and Diploma III (D3) as many as 2 respondents with a long predominance of working for 3 - 10 years as many as 90 respondents, over 10 years as many as 66 respondents, 1 – 3 years as many as 24 respondents.

4.1 Research Data Analysis

In the initial test, where the data was tested to assess the assumption of data normality by looking at the critical value (skewness) and kurtosis value, the test results showed that there was no value number in the Skewness column that was more significant than ±2.00 or a kurtosis value of more than 7. Therefore it can be said that there is no evidence that the distribution of this data is abnormal. Furthermore, evaluate the measurement model to assess the validity and reliability of the model. According to Hair et al. (2016), to assess convergent validity, the outer loading value must be more than 0.70. However, according to Henseler et al. (2016), loading reflective indicators can be considered a good measure for latent variables if it is above 0.50 (loading factor is between 0.50. Based on the test results, it can be seen that all items have a loadings value above 0.7 and a p-value below 0.05. Therefore, the indicators in the model can be said to be valid.

Another method to see convergent validity is to see that the average variance extracted (AVE) value must be greater than 0.5. The test results show that all values have met the test requirements

of loading factor values and average variance extracted (AVE) above 0.50, so they can be said to be valid and can be used to measure each latent variable. Testing discriminant validity, reflective indicators can be seen in the cross-loading between the indicator and its construct; the results of the test of the loading value on each intended construct are more significant than the value of loading with other constructs. Thus, latent constructs predict indicators on their blocks better than indicators in other blocks (Ghozali, 2015). After the indicator is evaluated for validity, the next stage is to evaluate the reliability of each latent construct using Cronbach's alpha and composite reliability values. The reliability test results show that all latent variable values have a Cronbach's alpha value ≥ 0.60 and composite reliability ≥ 0.70.

After the estimated model meets the outer model criteria, the following structural model (inner model) testing is carried out. The multicollinearity assumption was carried out by looking at the inner model VIF and the test results. The multicollinearity assumption found that the value of the correlation between observed variables (VIFs) is not allowed to be more than 10. In assessing the model with PLS continued by looking at R-Square (R2) for each endogenous latent variable. The value of R-Square (R2) or the coefficient of determination of the construct Performance Impacts (Y3) is 0.699, Task Technology Fit (Y1) is 0.756, and Usage Behavior (Y2) is 0.741. The test continued by looking at Predictive relevance (Q2) for structural models in measuring how well the observation value was produced; the test results showed a value greater than zero, so it can be concluded that the model has relevant predictive values.

To test the proposed hypothesis, it can be seen from the value of path coefficients, T-Statistic values through the bootstrapping procedure, and p-value. The results of the recapitulation of direct and indirect influence testing (mediation) to answer the research hypothesis are presented in the following table.

Table 2. Direct Relationship Hypothesis Testing

Direct Hypothesis		Original sample (O)	T statistics (|O/STDEV|)	P values	Decision
H1	Task Characteristics (X1) -> Task Technology Fit (Y1)	0.404	2.598	0.006	Positive and Significant
H2	Technology Characteristics (X2) -> Task Technology Fit (Y1)	0.242	2.898	0.004	Positive and Significant
H3	System Quality (X3) -> Task Technology Fit (Y1)	0.355	5.085	0.000	Positive and Significant
H4	Information Quality (X4) -> Usage Behavior (Y2)	0.340	3.950	0.000	Positive and Significant
H5	System Quality (X3) -> Usage Behavior (Y2)	0.316	4.123	0.000	Positive and Significant
H6	Information Quality (X4) -> Task Technology Fit (Y1)	0.303	3.220	0.001	Positive and Significant

Direct Hypothesis		Original sample (O)	T statistics (|O/STDEV|)	P values	Decision
H7	Task Technology Fit (Y1) -> Usage Behavior (Y2)	0.303	3.441	0.001	Positive and Significant
H8	Task Technology Fit (Y1) -> Performance Impacts (Y3)	0.324	4.266	0.000	Positive and Significant
H9	Usage Behavior (Y2) -> Performance Impacts (Y3)	0.553	7.145	0.000	Positive and Significant

The results of hypothesis testing show that Task Characteristics (X1) were found to have a direct influence on Task Technology Fit (Y1) because they have path coefficients of 0.404 which are close to the value of +1, T-Statistical value of 2,598 (>1.96), and p-value of 0.006 (<0.05), Technology Characteristics (X2) were found to have a direct influence on Task Technology Fit (Y1) because it has a path coefficients value of 0.242 which is close to the value of +1, the value of T-Statistic 2,898 (>1.96), and the value of p-value 0.004 (>0.05), System Quality (X3) was found to have an influence on Task Technology Fit (Y1) because it has a path coefficients value of 0.355 which is close to the value of +1, a T-Statistical value of 5,085 (>1.96), and a p-value of 0.000 (<0.05), Information Quality (X4) was found to have an influence on Task Usage Behavior (Y2) because it has a path coefficients value of 0.340 which is close to the value of +1, a T-Statistic value of 3,950 (>1.96), and a p-value of 0.000 (<0.05), System Quality (X3) was found to influence Task Usage Behavior (Y2) because it has a path coefficients value of 0.316, which is close to the value of +1, a T-Statistic value of 4,123 (>1.96), and a p-value of 0.000 (<0.05), Information Quality (X4) is found to influence Task Technology Fit (Y1) because it has a path coefficients value of 0.303 which is close to the value of +1, a T-Statistical value of 3,220 (>1.96), and a p-value of 0.001 (<0.05), Task Technology Fit (Y1) was found to influence Usage Behavior (Y2) because it has a path coefficients value of 0.303 which is close to the value of +1, the value of T-Statistic 3.441 (>1.96), and a p-value of 0.001 (<0.05), Task Technology Fit (Y1) was found to have an influence on Performance Impacts (Y3) because it has a path coefficients value of 0.324 which is close to the value of +1, a T-Statistic value of 4,266 (>1.96), and a p-value of 0.000 (<0.05), Usage Behavior (Y2) was found to have an influence on Performance Impacts (Y3) because it has a path coefficients value of 0.553 which is close to the value of +1, a T-Statistic value of 7,145 (>1.96), and a value of T-Statistic 7,145 (1.96), and a value of T-Statistic 7,145 (1.96), and a value of T-Statistic 7,145 (1.96), and a value of T-Statistic 7,145 (1.96), and a value of T-Statistic 7,145 (1.96), and a value of T-Statistic of 7,145 (1.96), and a value of P-Value of 0.000 (0.05), Usage Behavior (Y2) was found to have an influence on Performance Impacts (Y3) because it has a path coefficients value of 0.553 which is close to the value of +1, T-Statistic 7,145 (1.96), and a value of T-Statistic of 7,266 (1.96), and a p-value of 0.000 (0.05), Usage Behavior (Y2) was found to have an influence on Performance Impacts (p-value 0.000 (<0.05).

Table 3. Indirect Relationship Hypothesis Testing

Indirect Hypothesis		Original sample (O)	T statistics (|O/STDEV|)	P values	Decision
H10	System Quality (X3) -> Task Technology Fit (Y1) -> Usage Behavior (Y2)	0.108	2.989	0.003	Mediating
H11	Information Quality (X4) -> Task Technology Fit (Y1) -> Usage Behavior (Y2)	0.103	2.529	0.011	Mediating
H12	Task Technology Fit (Y1) -> Usage Behavior (Y2) -> Performance Impacts (Y3)	0.167	3.084	0.002	Mediating

The test results on the indirect influence of System Quality (X3) on Usage Behavior (Y2) through Task Technology Fit (Y1) have a path coefficients value of 0.108, which is close to the value of +1, the value of T-Statistic 2,989 (>1.96), and the p-value of 0.003 (<0.05).

6. CONCLUSIONS

The study results concluded that the factors in the Task Technology Fit and Information Systems Success Model affect employee performance using Yantek Mobile PLN. The impact of employee performance on the use of Yantek Mobile PLN using the perspective of Task Technology Fit and Information Systems Success Model users feel that Yantex Mobile applications will increasingly suit their work when users have a match on the characteristics of the work compared to the quality of the system, the quality of information, as well as the characteristics of the technology and users, will continue to use the Yantek Mobile application when they feel that the quality of the system has improved compared with the quality of information and the suitability of the work. The most influential factor in improving task technology fit is task characteristics, followed by system quality, information quality, and technology characteristics. In its influence on usage behavior, the most influential factor in increasing usage behavior is system quality followed by infromation quality and task technology fit. Managerial implications in this study for system quality factors can be improved by management by improving the system owned by Yantek Mobile so that it can be well structured, easy to operate and for task characteristics factors can be improved by management by providing more information to adjust user needs, multiplying existing content in Yantek Mobile that has alignment with work needs user.

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TIME SERIES IMPLEMENTATION IN THE COVID-19 PANDEMIC SALES OF FIRE AND WATER

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ABSTRACT

The COVID-19 pandemic has forced companies to think actively in developing strategies and forecasting in the face of increasingly fierce business competition. Increased competition and sales uncertainty is also experienced by PT. Indobara Bahana core business is including distributing, engineering, and procurement and contractor company, pumps, rotating equipment, fire detection & fire protection, safety, and Waste water & wastewater treatment solution and services. Reserch purposes to get an overview of the companies sales time series forecasting to determine the proportional target in 2023. From the companies business, two sales of fire and water will be investigated using the ARIMA (Autoregressive Integrated Moving Average) and ANN (Artificial Neural Network) with forecasting methods. This study uses quantitative data from the sales year period 2016 to August 2022 to view and compare the companies sales forecasts.

Research Methodology for predicting sales of fire and water is carried out using two methods, ARIMA method and the ANN method. The first forecasting method uses the ARIMA method for sales of fire and water to get the best ARIMA model (1,0,1). The results of forecasting on data testing obtained MSE sales of fire values of 8.763 and MAPE of 32%, while sales of water obtained MSE values of 106.029 and MAPE of 50%. The second forecast for sales of fire and water using the ANN method is that the best architectural model for both is 12-7-1. The results of forecasting on testing data obtained MSE sales of fire values of 3.950 and MAPE of 19%, while sales of water obtained values of 56.620 and MAPE of 25%. The ANN method was chosen to forecast sales of fire and water by obtaining the smallest accuracy value which indicates the resulting model has better forecasting results. This research is expected to be one of the decision support elements related to sales by the company.

Keywords: Sales, Forecasting, Time Series, ARIMA (Autoregressive Integrated Moving Average), ANN (Artificial Neural Network)

1. INTRODUCTION

The COVID-19 pandemic has caused a slowdown in economic development in the world, including in Indonesia. Data from the Badan Pusat Statistik (BPS) shows that the COVID-19 pandemic has had a significant impact on sectoral performance of the national economy. The COVID-19 pandemic has had a direct impact on various sectors, one of which is the construction sector, which has been significantly affected by 87.94% of the COVID-19 pandemic. The impact

on the field of business has caused the company to experience a decrease in revenue and sales, one of which is PT. Indobara Bahana.

Sales of fire and water decreased from 2018 and decreased significantly in 2021. During the COVID-19 pandemic that occurred throughout the world, it caused imbalance and uncertainty in all matters, especially in sectors that were badly affected. There is a downward trend in sales performance and it will start to rise again in 2021. Therefore, researchers will analyze "Time series implementation COVID-19 pandemic sales of fire and water". This research is expected to provide an evaluation of the company in planning sales performance in 2023 in order to get a good solution regarding the plan to determine sales of fire and water targets in the coming period.

2. LITERATURE REVIEW

In this literature, researchers want to compare the two forecasting methods ARIMA and ANN. The best forecasting results with the smallest error will be used to forecast sales of fire and water. (Chelule et al, 2019) Time Series Analysis of Road Accidents Using Autoregressive Integrated Moving Average (ARIMA) Model. The empirical results obtained obtained the two best ARIMA models used. Suggestions from the authors of the model should not be used for long-term forecasting (preferably a maximum of 9 years). (Fattah et al, 2018) Forecasting of demand using ARIMA model. Sales forecasting for the next 10 months food industry demand data by obtaining the best model. (Garg et al ,2018) Time Series Forecasting of Producer Price Index, using ARIMA. Forecasting the future PPI quarterly in the USA using the ARIMA Model for 2003-2007, ARIMA Model Results with differences for stationarity, Obtaining the best ARIMA model to model future PPI, and obtaining the minimum AIC value. (Shakti et al, 2017) Annual Automobile Sales Prediction Using ARIMA Model. The ARIMA model has better performance than the ARMA model because it is faster at series stationary, both in the training and forecasting phases. (Saravanan et al, 2019) Forecasting Techniques for Sales of Spare Parts. Forecasting by looking at the best Root Mean Square Error (RMSE) and Mean Absolute Deviation (MAD) for spare parts. Models with weekly data using R Studio get the best RMSE and MAD values. (Fauzi et al, 2021) Implementation of Product Sales Forecast Using Artificial Neural Network Method. PT XYZ product forecasting using an Artificial Neural Network was successfully implemented with an average forecasting accuracy of 97%. (Tinna et al, 2021) Prediction of the Repo Rate of India Using Artificial Neural Network. ANN with Regression to Multilayer Perceptron (MLP) is used to predict the repo rate. High test accuracy is obtained with 10% testing data. (Cantón et al,2018) Sales Prediction through Neural Networks for a Small Dataset. Forecasting in chemical companies for the next 3 months. The findings show that ANN provides better performance compared to the simple moving average concerning error. (Gamlath, 2020) Artificial Neural Network Approach to Predict Milk Yield of Dairy Farm. In this study a two-layer feedforward network is used because it has the potential to represent the input output regardless of the relationship. (Kaygisiz et al, 2017) Forecasting goat milk production in Turkey using Artificial Neural Networks and Box-Jenkins models. Create 10 year forecasts with ARIMA and ANN. It can be seen that the ANN model is more successful and goat milk production will follow an increasing trend in 10 years. This paper further clarifies the conflicting views reported in the literature review regarding the superiority of ANN over ARIMA in forecasting sales of fire and water.

3. METHODS

There are two methods of analysis used for forecasting the achievement sales of fire and water, the first is the autoregressive integrated moving average (ARIMA) method and the second is the artificial neural network (ANN) method.

The first stage of the autoregressive integrated moving average (ARIMA) method is carried out:

1. Describe the pattern of achievement of sales of fire and water from January 2016 to August 2022.
2. Divide the data into 2 parts, namely training and testing data. The training data used (January 2016 - December 2021) is 72 data, while testing (January 2022 - August 2022) is 8 data. In modeling, training data will be used.
3. Make a time series plot to find out the stationarity of the data. If the data is not stationary in the variance then the transformation process is carried out and if it is not stationary in the average then the differencing process is carried out.
4. After the data is stationary in terms of variance and average, enter the analysis stage by making ACF and PACF plots from data that is stationary for the alleged ARIMA model by looking at the graph.
5. Testing the significance of model parameters. Based on the alleged model in stage 3.
6. If the model parameters are significant, then the next step is to carry out a diagnostic checking. To find out whether the residuals meet the white noise assumption, the Ljung-Box test is carried out and the residual assumptions are normally distributed. If the residuals meet the white noise assumption and are normally distributed, then the model is considered valid.
7. Selecting the best model, from several valid models at point 5, he takes the most appropriate model again.
8. Using the ARIMA model to predict sales testing data for sales of fire and water for the next 8 months.
9. Calculate the mean square error (MSE) and mean absolute percentage error (MAPE) from the forecasting results of the ARIMA model testing data.

In the second stage the artificial neural network (ANN) method carried out is:

1. Perform the preprocessing stage by normalizing the data so that the data has a value between 0 to 1 contained.
2. The data distribution is divided into 2 parts, namely training data and data testing. Data training uses data (January 2016 - December 2021) as many as 72 data where the target is 2017, while data testing uses (January 2022 - August 2022) as many as 8 data.
3. Building the ANN architecture, in the training data the first step is to form an architecture with 1 hidden layer and 2 hidden layers, from several architectures made in sales fire and water will be compared and the smallest error will be selected. The smallest error value is obtained by the best model.
4. With the best architecture in step 3, forecasting is done on data testing for the next 8 months.
5. Calculate the mean square error (MSE) and mean absolute percentage error (MAPE) values from the forecasting results.
6. Forecast sales of fire and water for the next 4 months (September 2022 - December 2022) using the best chosen method and the smallest error value.

4. RESULTS

Minitab 16 and Matlab R2013a are used for simulation of ARIMA and ANN, respectively. The experimental results are being obtained is described below:

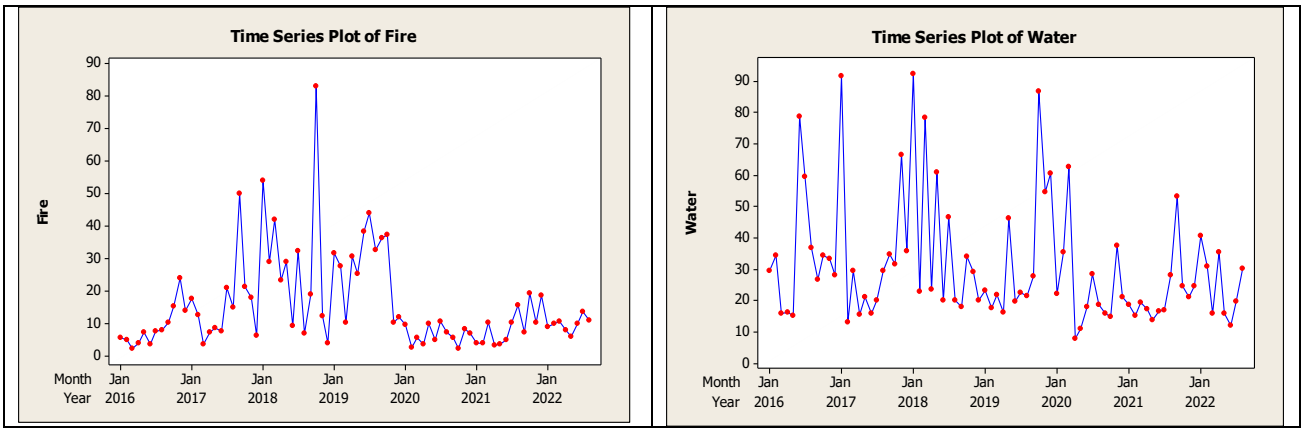

Figure 1. The Time Plot Sales of Fire and Water

Figure 1. The time plot sales of fire and water as a whole in the figure it can be seen that the two variables have high fluctuations and tend to fluctuate and this data also shows that the data is far from the middle or average. In determining this ARIMA model, the data will be divided into 2 parts training and testing data. The training data used (January 2016 - December 2021) is 72 data, while testing (January 2022 - August 2022) is 8 data. In the modeling used in the ARIMA modeling process, training data is used.

4.1. Results of ARIMA Models

4.1.1 Identification of Models

In the early stages of modeling ARIMA is identification to look at the stationarity of the data both in variance and in the mean. In the data plot it can be seen that the data has a distribution far from the center line. Data is declared stationary in variance if the rounded value of the estimated lambda value is equal to one or there is a value of one between the Lower Control Limit and Upper Control Limit of the lambda value. Based on these results, a Box-Cox transformation is carried out for sales of fire with the form $Z_t = \ln Z_t$ and sales of water with $Z_t = \frac{1}{\sqrt{Z_t}}$.

The results of the transformation are then identified for stationarity in the mean. With the unit root using the augmented dickey-fuller (ADF) stationarity test to see the stationarity data in the mean. The results of testing using the ADF test can be seen in the table.

Table 1. ADF Test Results

Data	ADF Test Value	Mackinnon's Critical Value			P-value	Decision
		1%	5%	10%		
Sales Fire	-3.182	-3.527	-2.290	-2.589	0.0252	stationary
Sales Water	-6.693	-3.526	-2.902	-2.589	0.0000	stationary

Table 1. shows that the value of the ADF test sales of fire obtained a p-value of 0.0252 and sales of water obtained a p-value of 0.000. When the p-value < α = 5%, then reject which states the data is stationary. The hypothesis of stationary test of time series data using ADF is:

H_0 : data is not stationary

H_1 : stationary data

The results of p-value sales of fire 0.0252 < α = 5% so concluded reject H_0, then the p-value sales of water is 0.000 < α = 5% so concluded reject H_0, then sales of fire and water data are stationary in the mean.

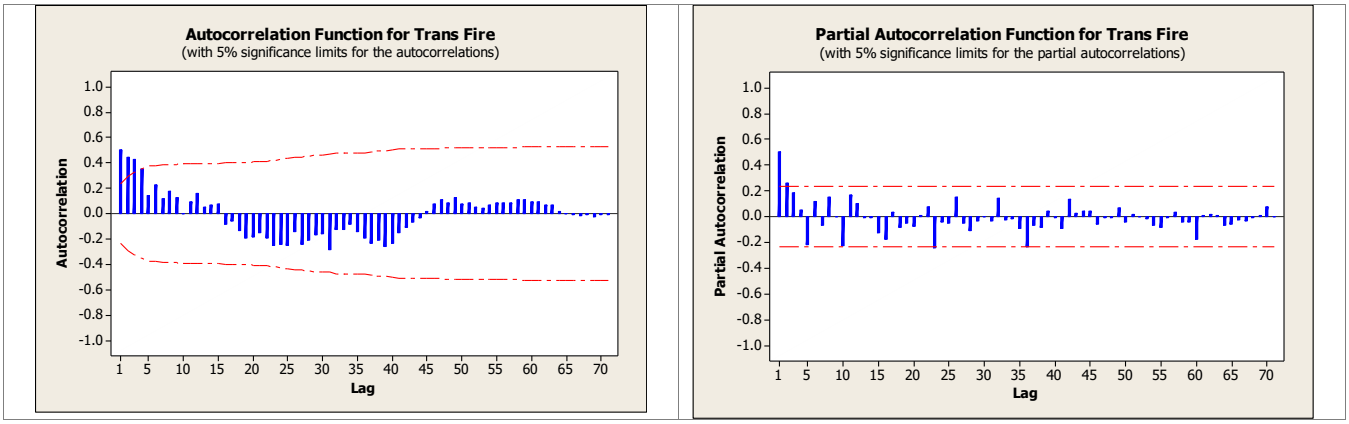

Figure 2. ACF and PACF Sales of Fire Transformation

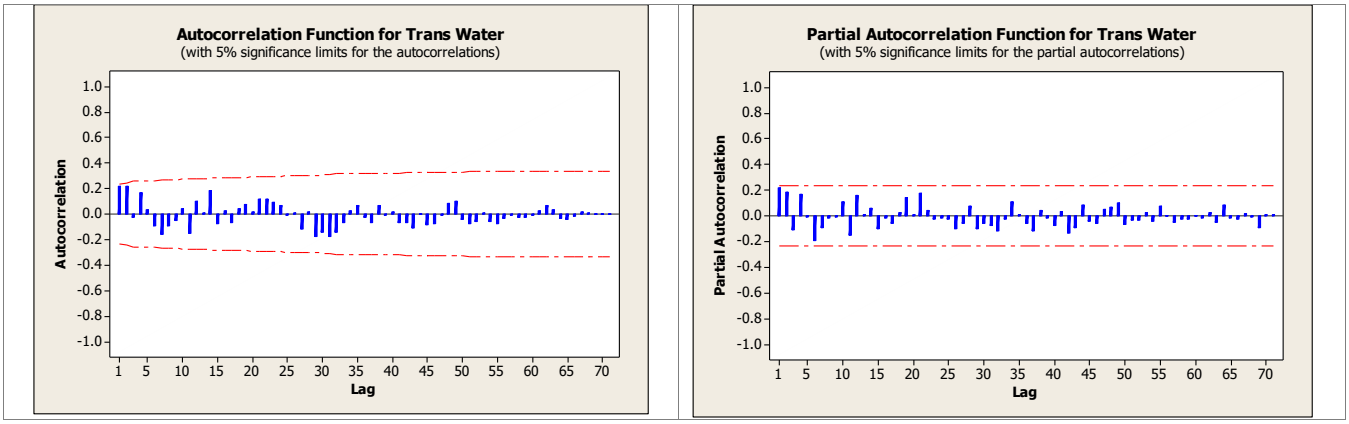

Figure 3. ACF and PACF Sales of Water Transformation

Figure 2. ACF sales of fire plot shows cut off and dies down meaning ARIMA (p, 0, q) and ACF looks like it dies down or cut off after the 3rd lag ARIMA suspected (1, 0, 0) and (0, 0, 3). Figure 3. ACF and PACF plots sales of water show that ACF and PACF have no lag that leaves the tentative ARIMA model (p,0,q) or (0,0,0).

4.1.2 Parameter Estimation

ARIMA model with ARIMA sales of fire variable models (1,0,1), (1,0,0), and (0,0,3). In the ARIMA sales of water variable (1,0,1). Next is to test the significance of these parameters using the p-value.

H_0 : $\theta = 0$ or $\phi = 0$ (not significant parameter)

H_1 : $\theta \neq 0$ or $\phi = 0$ (significant parameter)

With a significant level of 5%. Reject if p-value < α = 5%. The results of the parameter significance test are as follows. The following is the result of the parameter significance test.

Table 2. ARIMA Model Parameters and Model Fit Statistics

Variable	ARIMA Models	Parameter	Estimation	P-value	Decision	MSE Value
Sales Fire	ARIMA(1,0,1)	$\hat{\phi}_1$	0.9998	0	significant	0.544
		$\hat{\theta}_1$	0.6276	0	significant	
	ARIMA(1,0,0)	$\hat{\phi}_1$	0.9545	0	significant	0.7319
	ARIMA(0,0,3)	$\hat{\theta}_1$	-0.9108	0	significant	1.537
		$\hat{\theta}_2$	-0.7509	0	significant	
		$\hat{\theta}_3$	-0.3886	0.001	significant	
Sales Water	ARIMA(1,0,1)	$\hat{\phi}_1$	1.0001	0	significant	0.002616
		$\hat{\theta}_1$	0.9443	0	significant	

Table 2. shows the significant test results in the ARIMA model with a p-value < α = 5%, the conclusion is rejected, meaning that the sales of fire variable in the ARIMA model (1,0,1), (1,0,0), (0,0,3), and sales of water model ARIMA (1,0,1) significant parameters in the model. From a model that is already significant, the next step is to look at diagnostic checking white noise. It is this parameter estimate that will be used in modeling, provided that the residuals meet the assumptions.

4.1.3 Diagnostic Checking

White noise testing is carried out with the initial hypothesis used is residual data that is white noise. When the p-value < α rejects H_0 it indicates that the assumption of white noise has been fulfilled.

Table 3. White Noise Test

Variable	ARIMA Models	White Noise		Decision
		Lag	P-value	
Sales Fire	ARIMA(1,0,1)	12	0.182	white noise
		24	0.541	white noise
		36	0.31	white noise
		48	0.461	white noise
	ARIMA(1,0,0)	12	0	no white noise
		24	0.001	no white noise
		36	0	no white noise
		48	0.001	no white noise
	ARIMA(0,0,3)	12	0	no white noise
		24	0	no white noise
		36	0	no white noise
		48	0	no white noise
Sales Water	ARIMA(1,0,1)	12	0.051	white noise
		24	0.124	white noise
		36	0.081	white noise
		48	0.189	white noise

Table 3. shows the results of the white noise test on sales of fire and water. The white noise test that is generally carried out is by using the Ljung-Box.

H_0 : $\rho_1 = \rho_2 = \ldots = \rho_K = 0$ the assumption of white noise has been fulfilled

H_1 : At least there is one $\rho_k \neq 0$ where $k = 1, 2, \ldots, K$ (the assumption of white noise has been not fulfilled)

The output of the ARIMA sales of fire model variable (1,0,1) and the ARIMA sales of water model variable (1,0,1) in the Ljung-Box test p-value > α = 5%, then accept H_0. It can be concluded that the sales of fire variable with the ARIMA model (1,0,1) and the sales of water variable with the ARIMA model (1,0,1) fulfill the white noise assumption.

The next assumption test is the normal distribution assumption test that is used is the Kolmogorov-Smirnov test with the initial hypothesis that the residual data meets the normal distribution assumption.

H_0 : $F(e_t) = F_0(e_t)$ (residual observations are normally distributed)

H_1 : $F(e_t) \neq F_0(e_t)$ (residual observations are not normally distributed)

The results for sales of fire obtained a p-value of 0,143 and sales of water obtained a p-value of 0,150. accepted H_0 if the p-value > α = 5%, from the p-value obtained it can be concluded that the residual observations are normally distributed. Variable sales of fire model ARIMA (1,0,1) and sales of water model ARIMA (1,0,1) are both normally distributed and included in the selection of the best model.

4.1. Results of ANN Models

Data normalization in the backpropagation neural network algorithm uses the sigmoid binary activation function where this function has a value between 0 to 1. The next process is the distribution of training data and data testing. To get optimal network performance, it is necessary to determine the best network configuration. Building the ANN architecture, in the training data the first step is to form an architecture with 1 hidden layer and 2 hidden layers, from several architectures made in sales of fire and water, we will compare it and choose the smallest error. The smallest error value is obtained by the best model.

Table 4. Neural Network Structure Sales of Fire and Predicting Result

Sales Fire Architecture	Performance	MSE	MAPE
12-1-1	$2.19e^{-2}$	176.040	58%
12-2-1	$5.87e^{-3}$	73.647	36%
12-3-1	$4.19e^{-4}$	40.625	48%
12-4-1	$4.38e^{-5}$	39.299	59%
12-5-1	$6.63e^{-12}$	22.401	32%
12-6-1	$2.63e^{-8}$	23.663	32%
12-7-1	$1.30e^{-14}$	19.503	30%
12-8-1	$4.51e^{-9}$	23.048	43%
12-9-1	$2.46e^{-9}$	26.148	40%
12-10-1	$2.42e^{-11}$	25.284	42%
8-7-1	$1.02e^{-5}$	97.975	53%
9-7-1	$8.88e^{-8}$	77.947	46%
10-7-1	$2.10e^{-9}$	126.362	32%
11-7-1	$4.39e^{-9}$	116.135	56%

12-7-1	$1.30e^{-14}$	19.503	30%
12-3-4-1	$8.62e^{-8}$	60.783	58%
12-5-2-1	$2.65e^{-5}$	104.405	64%
12-6-5-1	$2.65e^{-5}$	80.878	43%
12-7-3-1	$7.58e^{-5}$	90.514	52%

Tabel 4. output results of each model are obtained which are the values of training data. The best model with the smallest MSE and MAPE values. In sales of fire the results of backpropagation learning were obtained on architecture 12-7-1, the performance results were $1.30e^{-14}$, MSE was 19.503, and MAPE was 30%.

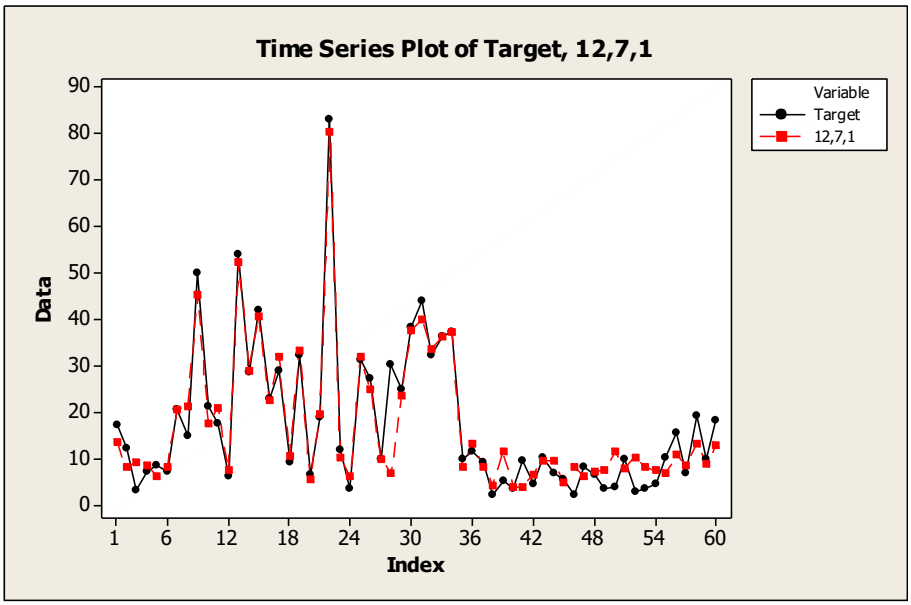

Figure 4. Graph Comparison of Actual Data and Training Sales of Fire

Figure 4. Graph plot results of comparison of actual data and training data. The sales of fire architectural graphic pattern from the predicted results follows the actual data line pattern, which means that this model is good to use. The 12-7-1 sales of fire architecture will then be forecasted against testing data.

Table 5. Neural Network Structure Sales of Water and Predicting Result

Sales Water Architecture	Performance	MSE	MAPE
12-1-1	$2.42e^{-2}$	213.161	33%
12-2-1	$4.59e^{-3}$	96.128	40%
12-3-1	$1.58e^{-2}$	164.749	24%
12-4-1	$6.08e^{-11}$	31.087	18%
12-5-1	$1.74e^{-11}$	86.536	20%
12-6-1	$6.51e^{-12}$	32.405	15%
12-7-1	$1.63e^{-14}$	30.672	11%
12-8-1	$3.52e^{-11}$	31.706	17%
12-9-1	$8.30e^{-13}$	69.150	21%
12-10-1	$1.89e^{-10}$	34.673	22%
8-7-1	$1.50e^{-6}$	98.414	23%

9-7-1	$2.47e^{-9}$	138.551	43%
10-7-1	$5.16e^{-12}$	88.801	34%
11-7-1	$1.86e^{-9}$	143.463	26%
12-7-1	$1.63e^{-14}$	30.672	11%
12-3-4-1	$2.13e^{-5}$	202.523	37%
12-5-2-1	$1.14e^{-9}$	168.919	12%
12-6-5-1	$8.92e^{-10}$	220.359	22%
12-7-3-1	$6.79e^{-10}$	157.335	28%

Tabel 5. output results of each model are obtained which are the values of training data. The best model with the smallest MSE and MAPE values. In sales of water the results of backpropagation learning were obtained on architecture 12-7-1, the performance results were $1.63e^{-14}$, MSE was 30.672, and MAPE was 11%.

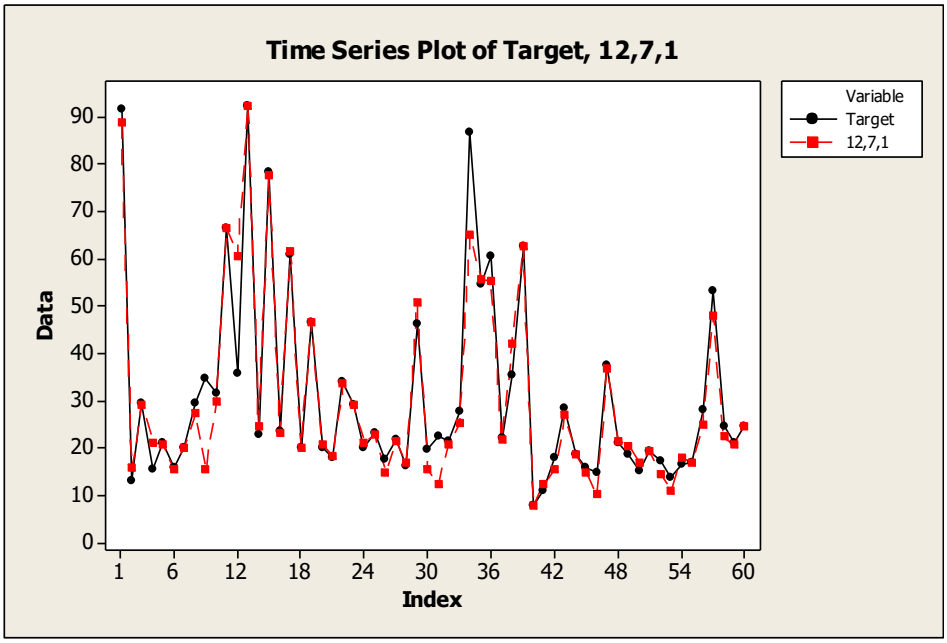

Figure 5. Graph Comparison of Actual Data and Training Sales of Water

Figure 5. Graph plot results of comparison of actual data and training data. The graphical pattern sales of water architects from the prediction results follows the actual data line pattern, which means that this model is good for use. The 12-7-1 sales of water architecture will then be forecasted against testing data.

4.3. Comparison of ARIMA and ANN Forecasting Methods

The ARIMA sales of fire forecasting method that will be compared is the ARIMA model (1,0,1) and the ANN method (12-7-1). In the ARIMA sales of water model (1,0,1) and the ANN method (12-7-1). The smaller the percentage error indicates that the model is valid and selected as the best model for forecasting

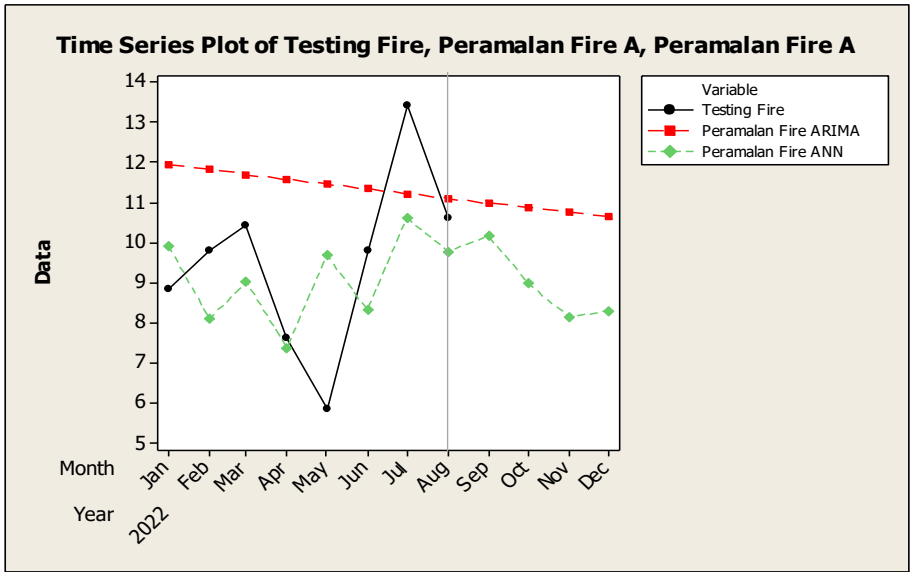

Figure 6. Comparison of Forecasting ARIMA, ANN, and Actual Sales of Fire

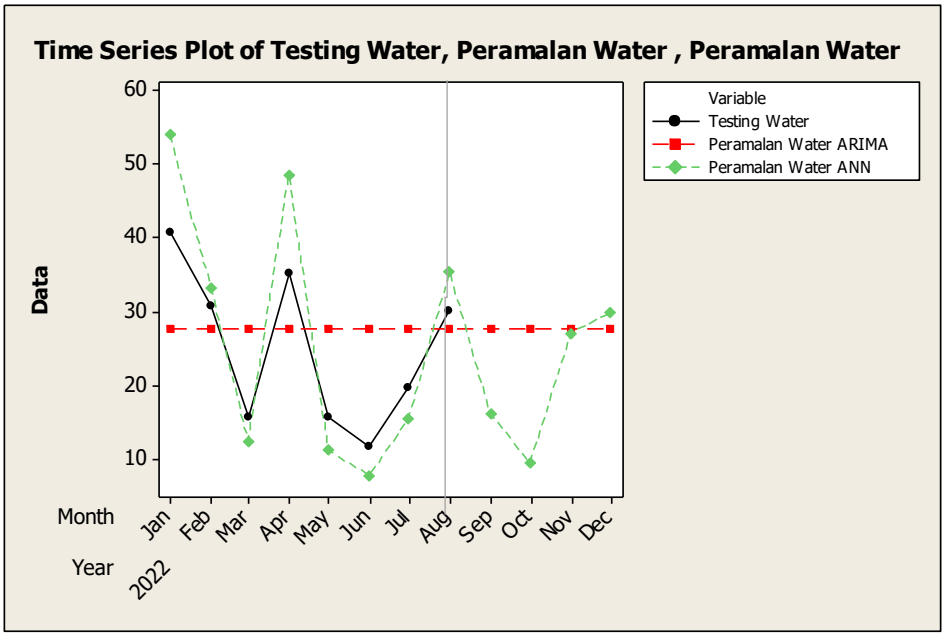

Figure 7. Comparison of Forecasting ARIMA, ANN, and Actual Sales of Water

Figure 6. and Figure 7. shows the results of the forecasting carried out on the training data applied to the testing data period (January 2022 - August 2022) as a validation for the model that has been found. The smaller the percentage error indicates that the model is valid and selected as the best model for forecasting. The green line is the ANN method and the forecasting results show that it follows the pattern of testing data.

Table 6. Testing the Forecasting Results of the ARIMA and ANN Models

Variable	Method	MSE	MAPE
Sales Fire	ARIMA	8.763	32%
	ANN	3.950	19%
Sales Water	ARIMA	106.029	50%
	ANN	56.620	25%

Table 6. the difference in the comparison of forecasting accuracy in the ANN method compared to ARIMA in sales of fire on the MSE and MAPE values can be seen to be almost more than half the smaller accuracy in the ANN method. This also goes straight for sales of water with the result that the accuracy of MSE and MAPE is half less than the ARIMA method. The next step is the best selected method and the smallest error value is the ANN method for forecasting.

Table 7. Forecasting Results of Sales of Fire and Water

Month	Forecasting Sales Fire	Forecasting Sales Fire
September 2022	10.15	16.08
October 2022	8.98	9.54
November 2022	8.14	27.13
December 2022	8.30	29.86

Table 7. The ANN sales of fire forecasting method shows that for the September 2022 period at 10,15 billion, the October 2022 period at 8,98 billion, the November 2022 period at 8,14 billion, and in December 2022 at 8,30 billion. Forecasting for the next 4 months, sales of water for the September 2022 period will be at 16,08 billion, for the October 2022 period at 9,54 billion, for the November 2022 period at 27,13 billion, and in December 2022 at 29,86 billion.

5. CONCLUSIONS

The best ARIMA model for sales of fire and water obtained is the ARIMA model (1,0,1). In forecasting testing data (January 2022 - August 2022) for sales of fire, an MSE value of 8,763 and MAPE of 32% were obtained, while sales of water obtained an MSE value of 106,029 and MAPE of 50%. The best scheme for forecasting sales of fire and water using an ANN is architecture 12 – 7 – 1. The results of the forecasting testing data (January 2022 - August 2022) on sales of fire obtained an MSE value of 3,950 and MAPE of 19%. While sales of water obtained an MSE value of 56,620 and MAPE of 25%.

The difference in the accuracy of forecasting testing data on the ANN and ARIMA methods on sales of fire on the MSE and MAPE values can be seen to be almost more than half the accuracy that is smaller in the ANN method. This also goes straight for sales of water with the result that the accuracy of MSE and MAPE is half less than the ARIMA method. The best selected method used with the smallest error value is the ANN method. Forecasting results using the ANN method with sales of fire forecasting results are September 2022 of 10,15 billion, October 2022 of 8,98 billion, November 2022 of 8,14 billion, and December 2022 of 8,30 billion. Furthermore, the results of forecasting sales water are as follows September 2022 of 16,08 billion, October 2022 of 9,54 billion, November 2022 of 27,13 billion, and December 2022 of 29,86 billion.

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BUSINESS STRATEGY ANALYSIS USING IE MATRIX, SWOT MATRIX AND AHP STUDY CASE: XYZ CAKE SHOP AS MSME BUSINESS

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ABSTRACT

The market was competitive, threatening XYZ cake shop as a business within the scope of MSME to change its business practices, including management and strategy evaluation, operational considerations, market opportunity analysis, and environmental factors of the production process. Strategic plans have been developed systematically to observe, assess and evaluate internal and external factors that impact business organizations. This study also included qualitative and quantitative approaches. The AHP as a multi-criteria decision-making model, generates value to determine the SWOT strategy and proposes a method of assigning weights, which applies a hierarchy structure and pairwise comparison of environmental factors of production operations and business development. The IE matrix in the diagram shows MSME in Growth and Aggressive, having strengths and opportunities to direct the organization's internal potential to take advantage of opportunities and support aggressive growth policies. These are determined by the total score on the IFE and EFE matrix of 2,763 and 3.244, respectively. The SWOT matrix analysis produces twelve alternative strategies with strategic priorities (WO3) to develop new target markets or customers (value = 0.147).

Keywords: Business Strategy, IE Matrix, SWOT Matrix, AHP

1. INTRODUCTION

Culinary was not only a basic need but has become a lifestyle for society. The growth of the culinary business shows an increase from time to time. Table 1. data compiled by Statistics Indonesia (2021) shows that in 2021 the food and beverage industry quarterly assessment give a year-on-year basis grew by 2.54%. That fact is the basis for the optimism of culinary business players that they are on the right track of business line.

However, some challenges should be noted ahead. Business actors must be able to develop strategies as an accelerated business. Market conditions are dynamic, with various variations or types of products manufacturers offer. Building a sustainable culinary business is difficult; it will not survive if it only has the capital to follow trends and depend on viral moments.

Table 1. Rate Data for the Growth of the Food and Beverage Industry in 2021

Period	Growth (%)
Q1	2,45
Q2	2,95
Q3	3,49
Q4	1,23
Year-on-year	2,54

Sources : Statistics Indonesia (2021)

XYZ cake shop is a creative economy business engaged in the culinary industry. Established in 2017 in Madiun, East Java, with an artisan cake business concept that offers various types of premium quality cake products. XYZ cake shop, based on the Regulation of Government of The Republic Indonesia Numb 20 of 2008, about criteria for the MSME scale, XYZ cake shop is categorized as a business organization within the scope of small businesses with a structure of family ownership management, which is the owner acts as a manager in his own business.

The business competition was very high and certainly spurred the enthusiasm of business actors to be able to increase productivity and make improvements to the systems and management. According to Rahayu et al., (2022), businesses can compete and develop means by creating new strategies. A culinary business development plan may be implemented by recognizing a company's internal and external aspects. Sianturi (2020) suggested that SWOT analysis is one of the recommended management tools to determine business strategy, marketing, and the competitiveness of MSME. The basic idea is evaluating opportunities and challenges in business organizations' external and internal environments. SWOT analysis, according to Rangkuti (2016), methodically discovers many aspects of establishing a firm strategy. The analysis is founded on a perspective capable of leveraging strengths (S) and opportunities (O) while concurrently avoiding weaknesses (W) and threats (T). Developing goals, strategies, operational and managerial activities, and business organizational decisions are all part of strategy analysis.

The research focuses on designing entrepreneurial development by strategy formulation for small businesses in the culinary field through qualitative and quantitative analysis of internal and external factors. With an excellent strategy, it is hoped that business organizations can adapt to various changes in the business environment to achieve a competitive advantage.

2. LITERATURE REVIEW

Successful strategists think about how the organization is positioned and what it wants as a business person. Determining a strategy does not rely solely on intuition in choosing alternative courses of action. This activity needs to be analyzed systematically to implement the right programs and policies to support a business's future development within a certain target time. According to David & David (2015) all forms of strategy must be managed and controlled to achieve a business organization's goals. Strategic management is used as a basis for determining the direction of an organization. A business should adopt a proactive rather than a reactive approach in industrial activities. Businesses must strive to influence, anticipate, and initiate.

Some people start their businesses to earn good and stable prosperity. Indonesia has various business activities, one of which is on a micro, small and medium scale, known as MSME. Managing a business behooves creativity, a sense of not giving up easily, taking risks**,** and constantly trying to find advanced conditions directed toward improved performance (Tambunan, 2002). Small business management is a process carried out by people with the authority and responsibility to manage small business resources (human, financial, physical, and information) to effectively and

efficiently achieve business organization goals. Management should be carried out by considering the business's type and scale (Setiawati, 2020).

According to the Regulation of Government of The Republic Indonesia Numb 20 of 2008 about MSME in Indonesia, MSME are productive economic enterprises autonomous and operated by individuals or business entities that are not owned, controlled, or part of a large company. MSME need to be aware of the extent of their business process development. (Dewi & Mahendrawathi, 2019). Today's perspective is that MSME's development is affected by internal and external factors.

The procedure for creating a SWOT analysis includes the creation of the organizational structure and control mechanisms required to carry out the plan. Before creating an organization's objectives and vision, a SWOT analysis can be performed. It highlights the organization's strengths and weaknesses also the presence of business opportunities and threats (Aslan et al., 2012). SWOT analysis demonstrates that organizations that can use their internal strengths to investigate external possibilities and be aware of threats while fixing internal weaknesses are more likely to obtain a competitive edge over competitors.

Figure 1. SWOT Analysis in Supporting Decisions

SWOT analysis is created by observing the organization's internal and external environments to identify the company's strategic goals and management based on a study of the major players in the market. The proper activities to govern the company should consider the strategic vision produced in terms of researching rivals' weaknesses. To determine the organization's strengths and weaknesses, internal evaluation examines every business component, including its technical expertise, staff, infrastructure, and locations. To identify possibilities and risks, the external evaluation investigates anthropological, environmental, political, economic, social, technical, and competitive variables (Aslan et al., 2012). Before moving further with the creation of a business strategy, it is crucial to do a SWOT analysis. SWOT analysis is a technique for conducting strategic analysis and comprehending an organization's current position in its business environment. Its use is critical for organizations performing self-evaluations.

Strengths are necessary inside the internal framework for the company to perform optimally. Strength is an internal factor that assists an organization in meeting its objectives. Resources, know-how, or other benefits that may be achieved through optimizing financial resources, image, market advantages, and strong relationships between customers and suppliers are supporting elements. Weaknesses could be improved in internal circumstances that cause the organization's operations to be subpar. Weaknesses are internal elements that impede the attainment of organizational objectives. Inadequate facilities, a lack of financial resources, managerial abilities, marketing skills, and company image are all impediments. A favorable external environmental component is opportunity. Opportunity External elements that help the organization achieve its objectives. Policy changes, competitive changes, technological changes, and supplier and buyer relationship growth are examples of external variables that might help with target attainment. Threats are external environmental variables that are harmful. Threats are external elements that prohibit a company from attaining its objectives. External factors that might stymie a corporation include new rivals, sluggish market development, enhanced negotiating power of significant suppliers and purchasers, technical advancements, and new legislation (Dess et al., 2020).

The Analytic Hierarchy Process (AHP) is a measurement theory used to generate ratio scales from discrete and continuous pairwise comparisons (Whitaker 2007). The AHP method's hierarchy is defined as a representation of complicated issues. In the multi-level structure, the first level is the aim, followed by the factor level, criteria, and so on, all the way down to the alternative level. AHP, developed by Saaty (1998), explains that AHP is often used to assess actions associated with comparing the importance weights between factors and several alternative choices. AHP uses a basic approach in making or making decisions. A systematic decision structure and a series of calculation procedures can produce priority recommendations or decision weights for each proposed alternative.

3. METHODS

When selecting informants for the research to be conducted, the researcher mines the information and gathers data about the decision-making strategies of the relevant organizations. Information is collected from internal business organizations through documents, in-depth interviews with stakeholders, and direct observation. As a form of data validation with a quantitative approach, the data was supported by a survey. The questionnaire is a list of written statements designed to validate the information from respondent's ratings. This survey or questionnaire evaluates involve of all internal human resources of a business (saturation sampling technique). Combine an external perspective through convenience sampling of respondents selected from customers who visit XYZ cake shop

Figure 2. Flowchart of Research Methodology

3.1 Input IFE (Internal Factor Evaluation) & EFE (External Factor Evaluation)

The internal environment of the firm was examined utilizing the IFE (Internal Factor Evaluation) matrix analysis method. Internal data is gathered to examine issues with the company's internal environment: 1.) various resources, 2.) abilities, and 3.) fundamental competencies. This matrix assesses internal characteristics connected to the company's strengths and shortcomings. To examine a company's external environment, an EFE (External Factor Evaluation) matrix analyzer is employed. External data is gathered to examine concerns: 1.) The external environment encompasses the political, economic, social, and technical environments. 2.) the industrial environment; and 3.) the managerial environment. The following are the steps required to generate an IFE & EFE matrix (David & David, 2015):

1. Determine and evaluate internal (strengths and weaknesses) and external (opportunities and threats) variables influencing the firm.
2. On a scale of 0.0 (not essential) to 1.0 (very important), assign a weight to each factor. The weighting assigned to a particular component indicates its relative relevance to the company's performance in that industry. The total of the weights cannot be greater than 1.0.
3. Enter a rating value. Each factor has a score of 1-4, with the score indicating whether the factor is very weak (score=1), weak (score=2), strong (score=3), or very strong (score=4).
4. To calculate a weighted score, multiply the weighted average of each element (rank) by the appropriate weight. To obtain the final result, add the weighted scores of each variable.

3.2 IE (Internal-External) Matrix

The IE matrix has two primary parameters, according to David and David (2015), the number of IFE weight points on the x-axis and the number of EFE weight points on the y-axis. The overall weighted score acquired from the divisions enables the firm-level development of the IE Matrix. The overall IFE weight score is represented by the x-axis IE matrix, where 1.0-1.99 represents a weak internal position, 2.0-2.99 is deemed moderate, and 3.0-4.0 is considered a strength. Similarly, the y-axis displays the overall weight of EFE, with a weighted score of 1.0-1.99 representing the weakest external position, a score of 2.0 to 2.99 regarded as moderate, and a high score of 3.0-4.0 representing the most vital external position.

3.2 SWOT Matrix for Strategy Business

The SWOT Matrix is a method for integrating strategic organizational elements. In Nourlette and Hati (2017)'s research, the SWOT matrix is a critical matching tool that supports players in constructing four strategies:

1. SO strategy involves maximizing the company's internal strengths to capitalize on opportunities in the external environment. In principle, businesses will pursue a WO, ST, or WT strategy if they want to be in a position to utilize a SO strategy.
2. The WO approach seeks to remedy internal deficiencies by capitalizing on external opportunities. Great possibilities come from time to time, but firms' internal problems prohibit them from capitalizing on them.
3. ST strategy uses a company's strengths to avoid or reduce the effect of external threats. This does not imply that a successful company must always go after external threats directly.
4. The WT strategy is a defensive method that aims to reduce internal vulnerabilities while avoiding external dangers. An organization that faces several external threats and vulnerabilities is in grave danger.

Determining improvement and evaluation of strategies selected through the level of urgency. AHP modelling is one approach to answering problems in decision-making. The assessment of the weight of this strategy is based on management's assessment using a comparison of values between factors.

4. RESULT

The essential objective of SWOT analysis is to assist in the development of a comprehensive understanding of all elements that might impact strategic planning and decision-making, a goal that can be applied to practically all aspects of MSME. Starting with the input stage, which comprises the IFE and EFE matrix analysis stages, the weights acquired may be inserted into the IE matrix diagram to appraise a corporate organization's position. The matching stage will next apply SWOT matrix analysis, followed by the deciding stage utilizing AHP weighting criteria.

In the input stage, all information data in the form of identifying functional factors will be given an assessment of the weights and ratings the author has obtained and summarized into a matrix. The calculation of the IFE matrix is a calculation to determine importance, ratings and scores. Internal factors originating from within the MSME environment are strengths and weaknesses, which are then assessed, weighted, and calculated based on the level of importance. Weight evaluation using a Likert scale (1-5) information collection questionnaire (Sugiyono, 2017). For each internal factor rating, the rating value ranges from 1 to 4. It should be emphasized that strengths must be rated 3 to 4, and weaknesses must be scored 1 or 2. The rating is based on the business, while the weight depends on the industry. Respondents from all XYZ cake business internal human resources assessed these internal variables. The IFE matrix computation yielded the following results:

Table 2. Results of the Internal Factor Assessment Questionnaire

Numb	Indicator	Weight	Rating	Score
S1	The variety of artisan cake products offered is diverse and tempting	0,057	3,667	0,210
S2	References in the product development section are quite broad	0,059	3,667	0,215
S3	Tester helps consumers a lot in selecting products	0,063	3,667	0,233
S4	The price of products is quite competitive compared to competitors	0,063	3,444	0,219
S5	Has been registered (have an Indonesian Business Permit or SIUP) as MSME	0,025	3,444	0,087
S6	Providing product replacement guarantees if the cake product not meet quality requirements	0,060	3,667	0,221
S7	Products have consistent quality (taste and design)	0,067	3,444	0,230
S8	Custom products are satisfying because had been met customer expectations	0,060	3,444	0,208
S9	Selection of premium raw materials	0,057	3,667	0,210
S10	Easy billing via e-payment (go-pay, OVO, bank transfer, QRIS, debit)	0,059	3,667	0,215
S11	Delivery services (house-in) have been satisfied customers	0,060	3,667	0,221
Total Strength		**0,666**		2,268
W1	Don't have BPOM and Halal permits	0,062	1,333	0,083
W2	Services that are inefficient during high season due to limited production	0,033	1,444	0,048
W3	Information on digital platforms needs to be more massive for updated business and products.	0,029	1,333	0,038
W4	Product is easy to copy	0,062	1,333	0,083
W5	Human resources skills in customer service are less attractive	0,062	1,333	0,083
W6	Less of maintaining continuous relationships with customers	0,059	1,333	0,078
W7	Cakeshop is in the process of renovation and arrangement to provide an interior design.	0,062	1,333	0,083
Total Weakness		**0,334**		0,495
Total Internal Factor		**1,000**		2,763

Like the preceding internal matrix procedure, the EFE matrix is a calculation to derive weights, ratings, and scores. What distinguishes external factors is that they originate outside of the MSME environment in the form of opportunities and threats, but the weight calculation is the same as IFE, which is decided based on the level of relevance. It is critical to calculate each element's rating value using a scale ranging from 1 (below average/not required) to 4. This statement was evaluated by 39 respondents, including 9 internal business organization employees and 30 customers picked at random while visiting the XYZ cake store. The EFAS matrix simulation results are shown in the table below.

Table 3. Results of Questionnaire Assessment of External Factors

Numb	Indicator	Weight	Rating	Score
O1	Participation in MSME events or exhibitions to gain new markets	0,098	3,667	0,359
O2	The concept of "artisan cake" still rarely	0,094	3,564	0,334
O3	Increasing accounts on digital platforms as promotional media	0,101	3,667	0,372
O4	Demographical conditions, expand consumer reach.	0,100	3,641	0,365
O5	Building business partners from organizations or agencies	0,096	3,487	0,333
O6	Availability of loan capital for business development	0,099	3,615	0,358
O7	Technology investment to increase production capacity and improve digital services	0,096	3,513	0,338
Total Opportunity		**0,648**		2,459
T1	Fluctuating product prices (especially for custom cake products) due to adjustments to raw materials	0,097	3,487	0,337
T2	The threat of competitors who have a stronger brand image	0,046	2,333	0,107
T3	Difficulties in substituting certain raw materials	0,045	2,103	0,096

Numb	Indicator	Weight	Rating	Score
T4	Impact of fuel price increase	0,044	2,026	0,090
T5	Threat of packaged cake products from factories/manufacturing	0,043	2,256	0,097
T6	Extensive market reference due to following trends	0,040	1,436	0,058
Total Threat		**0,316**		**0,785**
Total External Factor		**1**		**3,244**

After obtaining the total weight of the IFE and EFE inputs, these values become the basis for mapping the position of business units in the IE matrix to make it easier to formulate appropriate alternative strategies. The cumulative IFE weight score of 2.763 on the x-axis of the IE Matrix indicates a modest internal position. With a similar categorization mapping, the overall EFE weight score also on the y-axis becomes 3.224, indicating that external variables significantly affect business organizations.

Total IFE	Total EFE			
		Strong (3,00 - 4,00)	Moderate (2,00 - 2,99)	Weak (1,00 - 1,99)
	Strong (3,00 - 4,00)	I	II (Growth)	III
	Moderate (2,00 - 2,99)	IV	V	VI
	Weak (1,00 - 1,99)	VII	VIII	IX

Figure 3. IE Matrix for XYZ cake shop

The research results describing the IE matrix position are in quadrant II. Growth is an excellent thing for the company. XYZ cake business has strengths and possibilities to direct the organization's internal capacity to capitalize on current prospects. In this situation, the plan must be implemented to promote an aggressive growth program. These divisions may gain through either intensive (market share, market expansion, and product creation) or integrative (backward, forward, and horizontal integration) strategies (David & David, 2015).

SWOT analysis is a significant step that XYZ cake shop should take to keep the firm running. This analysis generates a variety of possible outcomes. SO, ST, WO, and WT are the four basic approaches that might be proposed. From the SWOT matrix analysis results, 12 alternative strategies were obtained, as shown in **Figure 3.**

The decision stage is the reaches in strategy formulation. This decision step is responsible for identifying the optimal alternative plan derived from the SWOT matrix. AHP is intended to determine priorities between strategies obtained from the results of the SWOT matrix analysis by filling out a questionnaire conducted by the owner.

Before assessing and determining priorities, it is necessary to decompose or preparation of the AHP hierarchical structure.

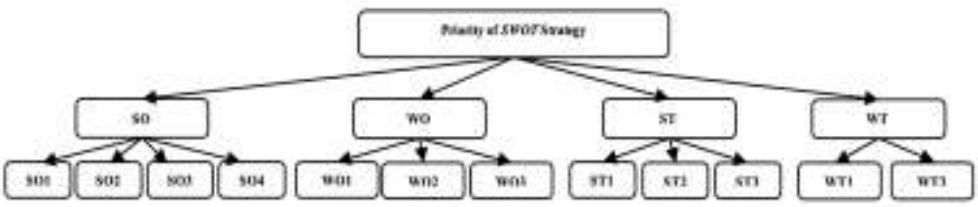

Figure 4. Variable Decompose of SWOT Matrix Strategy

	Strength (Kekuatan)	Weakness (Kelemahan)
	S1 Product variation	W1 Don't have a BPOM (Indonesian National Agency for Drug and Food Control) permit
	S2 Well-reference in Product	W2 Well-reference in Product
	S3 Tester available	W3 Information on digital platforms (IG, Facebook, Whatsapp) is less massive
	S4 Competitive price with similar business competitors	W4 Product is easy to copy
	S5 Registered as MSME (Indonesian Business Permit)	W5 Product knowledge and service manner need to be more comprehensive for all employee.
	S6 Product replacement guarantee or money back	W6 Customer relationship and customer engagement could be more effective.
	S7 Consistent quality (taste and design)	W7 Stores and displays under renovation
	S8 There are custom products	
	S9 Premium raw materials	
	S10 Easy billing via e-payment	
	S11 Delivery service (home-in)	
Opportunity (Peluang)	Strategi SO	Strategi WO
O1 Participated in the IWKM exhibition event	SO1 Various and updated products (S1, S2, S8, O1, O2)	WO1 Human resources management and management improvement (W2, W5, W6, O6)
O2 The concept of artisan cake is still rare	SO2 Prioritizing product quality (S3, S5, S6, S7, S8, S9, O2)	WO2 Strengthening external stakeholder network (W1, W3, W5, W6, O1, O3, O5)
O3 Improve digital promotional media platforms	SO3 Improve customer service (S3, S4, S5, S8, S10, S11, O1, O4, O5)	WO3 Build new target markets or customers (W2, W3, W4, W7, O1, O2, O3 , O4, O6)
O4 Demographic conditions and strategic locations	SO4 Capital investment, digitalization and technology (S10, O5, O6, O7)	
O5 Opportunity to build cooperation with parties		
O6 Availability of capital for business development		
O7 Technology investment and digitization		
Threat (Ancaman)	Strategi ST	Strategi SO
T1 Fluctuating product cause raw material prices	ST 1 Develop a brand image (S1, S5, S9, T2, T5)	WT 1 Developing and delivering product value (W1, W2, W5, W4, T1, T2, T3, T5, T6)
T2 Market competition with more prominent brands	ST 2 Information services and consumer voice (S2, S6, S7, S8, S10, T1, T3, T4)	WT 2 Identify similar competitors to find opportunities to build excellent businesses (W3, W4, W7, T2, T6)
T3 Raw materials are difficult to obtain and substitute	ST3 Increased competitive value/advantage (S2, S3, S4, S6, S8, S11, T6, T5)	
T4 Impact increasing price of fuel		
T5 Competitor packaged bakery products from the manufacturing industry		
T6 References customers about patisserie products getting faster and easy to get the information because of the internet		

Figure 5. SWOT Matrix Strategy for XYZ cake shop

After the decomposition or arrangement of the hierarchy is carried out, a pairwise comparison is carried out between the strategies and provides an assessment with the following criteria:

Strategy X	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Strategy Y

- Number 1 if strategy X has the same level of importance as strategy Y
- Left side, the scale is filled if strategy X has a level of importance above strategy Y, the right side of the scale is filled if strategy Y has a level of importance above strategy X

The assessment results are made a comparison and pair matrix to calculate the priority weight and the level of consistency with the AHP method.

Tabel 4. Assessment Input Results and SWOT Strategy Paired Matrix

	SO1	SO2	SO3	SO4	WO1	WO2	WO3	ST1	ST2	ST3	WT1	WT2
SO1	1	2	2	0,333	0,333	2	0,5	0,5	5	0,5	2	3
SO2	0,5	1	3	4	0,5	3	2	2	3	1	4	8
SO3	0,5	0,333	1	3	0,5	3	0,5	0,5	5	0,5	3	5
SO4	3	0,25	0,333	1	0,333	2	0,25	0,333	6	0,5	2	5
WO1	3	2	2	3	1	4	0,5	0,5	8	2	5	8
WO2	0,5	0,333	0,333	0,5	0,25	1	0,2	0,2	4	0,5	3	2
WO3	2	0,5	2	0,25	2	5	1	2	7	2	5	9
ST1	2	0,5	2	3	2	5	0,5	1	8	3	3	6
ST2	0,2	0,333	0,2	0,167	0,125	0,25	0,143	0,125	1	0,111	0,25	0,333
ST3	2	1	2	2	0,5	2	0,5	0,333	9	1	3	6
WT1	0,5	0,25	0,333	0,5	0,2	0,333	0,2	0,333	4	0,333	1	7
WT2	0,333	0,125	0,2	0,2	0,125	0,5	0,111	0,167	3	0,167	0,143	1

Each pairwise comparison matrix's eigenvector values are calculated. The resultant number is the weight of each factor element, which will be used to decide the element's priority.

Tabel 5. Eigenvectors or SWOT Strategy Criteria Weighting Results

Criteria	Eigenvector/weight
SO1	0,078
SO2	0,141
SO3	0,076
SO4	0,065
WO1	0,144
WO2	0,040
WO3	0,147
ST1	0,142
ST2	0,015
ST3	0,097
WT1	0,038
WT2	0,018

Checking the consistency of the hierarchy, in this step, the consistency ratio is calculated with the consistency index. The consistency ratio is said to be correct if the result is less than equal to 10%.

Tabel 6. Result Value Consistency Ratio AHP SWOT Strategy

Value of Random Index		CI	CR
Orde	**RI**	0,148	0,09995
12	1,48		

The consistency ratio value becomes 0.09 <10%, so the weighting and AHP calculations show the correct and consistent ratio. So, based on the results of processing the AHP data shown in Table 4, the priority sequence of strategic alternatives is obtained.

5. CONCLUSIONS

Conclusions have been formulated address the problem presented in this research based on the results of observation, processing of the data, and analysis:

1. Internal factors that affect the running of XYZ cake shop business include:
   a. The constancy of cake products in terms of both taste and presentation is the company's business organization's strength.
   b. The main weakness is the absence of BPOM and Halal legality permits
2. External factors include:
   a. Opportunities also attractive on digital platforms as promotional and marketing media. Digitalization of marketing helps make it easier for consumers to get product information and media in delivering the value of products to open up new market opportunities
   b. The main threat is product prices which fluctuate according to the availability and prices of cake raw materials.
3. The IE matrix analysis results show that XYZ cake shop position is currently in cell II (Growth and Aggressive). These results were determined based on the IFE and EFE matrix scores of 2.763 and 3.244, respectively.
4. The SWOT matrix analysis produces twelve alternative strategies with strategic priorities (WO3) Building new target markets or customers (weight value = 0.147)

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ANALYSIS OF AMMONIUM SULFATE FACTORY GREEN PRODUCTIVITY MANAGEMENT USING FAILURE MODE AND EFFECT ANALYSIS METHOD (FMEA)

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ABSTRACT

PT. Petrokimia Gresik is a company engaged in the largest and most comprehensive fertilizer producer in Indonesia. In addition, PT. Petrokimia Gresik also produces several other chemical products. One of the many production process activities is the production process of ZA (Ammonium Sulfate) fertilizer. Referring to Government Regulation of the Republic of Indonesia No. 22 of 2021 concerning Implementation of Environmental Protection and Management.

From the Ammonium Sulfate production activities, there are several processes that produce by-products in the form of emission losses into the atmosphere, namely from the scrubbing and drying process of ZA crystal powder, there is a collecting Pit to accommodate Factory I and B3 Warehouse for solid waste, Green Productivity management aspects need to be evaluated the amount of input, output and waste, where from these three aspects it will be seen how much the company's productivity is then given alternative Green Productivity solutions using the Pareto Diagram Method, Cause & Effect Diagram and Failure Mode and Effect Analysis. The impact of this waste problem affects the operating rate of ZA I/III Plants which is only 80% of the factory's initial design.

The results of this research resulted in the selected alternative Making a new X-scrubber at the E-301 A outlet before heading to the condenser and carrying out mechanical cleaning on the condenser with the ability to recycle emissions of 111.84 tons / year, the required investment costs are Rp. 25,100,000, - and succeeded in obtaining cost savings of Rp. 4,941,940,000, - this improvement succeeded in increasing the production rate to 111% with processes that remained environmentally friendly and produced new products from waste to product. The Business Model Canvas has also produced broader and more effective business processes.

Keywords: Ammonium Sulfate, Business Model Canvas, fertilizer, FMEA, Green Productivity, PT. Petrokimia Gresik, ZA.

1. INTRODUCTION

Fertilizer is a strategic commodity in order to support national food security so the supply of fertilizer cannot stop. ZA (Zwavelzure Ammonium) Factory Zwavelzure Ammonium Fertilizer has the chemical formula $(NH4)_2SO_4$ which contains 21% nitrogen and 24% sulfur, ZA I/III Factory produces Fertilizer ZA liquid and solid fertilizer which in the production process produces emissions that are lost to the atmosphere, liquid waste in the Collecting Pit and B3 solid waste (Hazardous and

Toxic Materials) in the TPS warehouse. For these three types of waste, it is necessary to carry out efforts to control environmental pollution in order to generate revenue from side/waste products.

Referring to Government Regulation of the Republic of Indonesia No. 22 of 2021 concerning Implementation of Environmental Protection and Management and Regulation of the Minister of Environment and Forestry of the Republic of Indonesia Number P.17/Menlhk/Setjen/Kum.1/4/2019 concerning Quality Standards for Businesses and/or The activities of the Fertilizer Industry and the Ammonium Nitrate Industry, it is necessary to comply with environmental regulations to produce optimal production. Along with the decreasing reliability of the Ammonium Sulfate factory, it is necessary to carry out Preventive Action in an effort to control emissions, water and solid waste in the company area and ring 1 residents.

The green productivity approach has a concept for testing and evaluating production processes to pay attention to steps to improve or increase productivity which simultaneously realize improvements in productivity and environmental protection, one of which is the utilization of waste. This can be seen from the generation of alternatives based on the order of reduce, reuse and recycle, then reduction is applied by utilizing liquid waste as biogas fuel, so that palm oil liquid waste can provide added value to the company. (Sundari, 2018)

Failure Mode and Effect Analysis (FMEA) is a method in risk management that can be used in various fields such as manufacturing and service industries, profit and non-profit organizations, private, public organizations, or government organizations (Najwa, 2018). compiling FMEA to determine the priority of alternative improvements to be carried out from the Risk Priorty Number (RPN) value. The preparation of FMEA was carried out using online FGDs and the same team as in the fishbone diagram method (Delfian, 2021). The risk management process with the FMEA method begins with risk identification (Rama et al, 2016).

2. LITERATURE REVIEW

Green Productivity is an application, technique and management system to produce environmentally friendly products. Green productivity also mediates from two needs that are in conflict, namely the business need to generate profits and the need to protect the environment (Haryo Santoso, 2015). The concept of green productivity itself is taken from two important things in the development strategy, namely productivity and the environment.

In contrast to Green Manufacturing which is a method for minimizing waste and pollution resulting from the production process or manufacturing process based on a sustainable production system (Sustainable Production System) in producing a product. Green productivity is a strategy to simultaneously increase productivity and environmental performance in socio-economic development (APO, 2003).

Productivity can be used in two senses, namely technically and economically and financially, the definition of technically and economically productivity is the efficiency of production, especially in the use of technology. Meanwhile, the notion of financial productivity is a measurement of the productivity of output and input that has been quantified, in an industrial company (Ningsih, 2019).

$$GP = \frac{Output}{Input}$$
$$(Raw\ Materials + Environment\ Cost + Energy\ Equipment + .. + ..$$

Failure mode is something that can indicate that the item is not working according to its function. Failure can be in the form of not being able to work according to function, decreased item performance, until the resulting performance does not match the required function. Effect is the

result of the failure mode. The consequences that arise can be identified starting from the effects on the item itself to the system and even the end user of the item.

Severity is an effect rating that shows the level of severity of the effect. This rating is based on a predetermined severity level :

Rating	*Severity*	*Criteria*
10	Kegagalan untuk Memenuhi Persyaratan Keselamatan dan atau Regulasi	Katastropik. membahayakan pelanggan tanpa peringatan. Pelanggaran terhadap hukum / atau undang-undang;
9	Gangguan Utama	Membahayakan pelanggan dengan peringatan. Kerugian total. 100% produk mungkin harus dibuang atau pabrik mati / shut down
7	Gangguan yang signifikan	Kritis. Menurunkan loyalitas pelanggan, Berpotensi untuk berhadapi operasi. Sebagian dari produksi mungkin harus dibatalkan.
6		Mengakibatkan keluhan pelanggan (komplain). pengembalian atau perbaikan produk. Pengecualian terhadap biaya produksi (akibat pengerjaan ulang).
5		Produktivitas pelanggan berkurang.
4	Gangguan Moderat	Pelanggan kecewa karena kinerja yang menurun.
3		Pelanggan sedikit terganggu akibat kinerja yang berkurang
2		Pelanggan akan mempertahankan ketidak / pengaruh. Sedikit kelelahan ketidaknyamanan pada proses, operasi atau operator.
1	Tidak Berdampak	Pengaruh tidak signifikan.

(Sumber : Pyzdek & Keller, 2010)

Figure 1. Criteria Severity

Cause is the reason for the appearance of the failure mode. Identification can use why questions to find the root of the problem. In general, it describes the mechanism of an item that can experience failure. Occurrence is the level of possibility of failure mode of an item. The level of possibility can be adjusted as needed to match the operating conditions of each item :

Failure Likelihood	*Criteria, Incidents/ Item*	*Rank*
Sangat tinggi (hampir selalu terjadi)	>= 100 Per 1000 >= 1 dalam 10	10
Tinggi	50 Per 1000 1 dalam 20	9
Tinggi	20 Per 1000 1 dalam 50	8
	10 Per 1000 1 dalam 100	7
	2 Per 1000 1 dalam 500	6
Sedang	0.5 Per 1000 1 dalam 2000	5
	0.1 Per 1000 1 dalam 10000	4
Rendah	0.01 Per 1000 1 dalam 100000	3
	<= 0.001 Per 1000 1 dalam 1000000	2
Sangat rendah	*Failure* Dieliminasi Dengan *Preventive Control*	1

(Sumber : Pyzdek & Keller, 2010)

Figure 2. Occurance Criteria

Controls are methods or methods that already exist to mitigate the risk of failure modes and the effects of items. Detection is a rating regarding the ease of detecting the failure mode or the cause of the failure. RPN is a risk rating for each potential failure mode. RPN is the result of multiplying the severity, occurrence, and detection.

The Business Model Canvas (BMC) is the process by which companies create value and benefit from the value it creates in a sustainable manner. BMC is a tool developed by Osterwalder and Pigneur (2019), this method was developed to help business organizations and novice entrepreneurs to map and carry out a feasibility analysis of their business models.

Figure 3. Business Model Canvas

3. METHODS

Data collection in this study was obtained from monitoring reports of liquid, solid and gas waste. Factory I for 1 year. The report is obtained from the Department of Quality Control and Planning (PPK) and the Department of Process and Energy Control (PPE). The data taken includes:

1. Fertilizer Production Data ZA I/III
2. Factory Raw Material Consumption Data ZA I/III
3. Data on the Use of Factory Auxiliary Materials ZA I/III
4. Factory Hardwater Consumption Data ZA I/III

This stage is carried out by looking for several alternative scenarios of the problem of high sources of pollution loads at PT Petrokimia Gresik's Factory I.

3.1 Root Cause Analysis

In determining this alternative scenario, the first step is to identify using Pareto to find out the dominant factors of the high pollution load in Factory I. Root Cause analysis is carried out based on the results of identifying the most influential factors that have been obtained at the analysis stage using Pareto charts. The tools used in root cause analysis are cause and effect diagrams equipped with a 5 why's tool, namely compiling a table of 5 why's questions.

3.2 Failure Mode and Effect Analysis

After analyzing the causal factors using cause and effect diagrams so that the root causes of the problem can be successfully traced, the next step is to make a failure mode and effect analysis to find out the priority for improvement that can be made by looking at the risk priority number (RPN). In making a risk priority number, what must be done is to determine the Severity, Occurance, and Detection criteria.

3.3 Simulation of Repair Alternatives

Based on the recommended actions and actions taken in the Failure Mode and Effect Analysis, alternatives for improvement and actions to be taken are developed. Alternative improvement simulations are carried out on the basis of journals, research and technology.

The simulation of alternative repairs carried out is also accompanied by a technical evaluation so that it can be used as a decision making for the best alternative repairs and is selected for improvement in overcoming the dominant problems causing the high pollution load of Factory.

3.4 Results Analysis Stage

In the Results Analysis stage, alternative improvements are selected and improvements are made to solve the problem of the high pollution load of Factory I PT Petrokimia Gresik. The results of the selected improvements after the repairs were carried out, then after that a validation was

carried out on the improvements that had been made, with the aim of ensuring that the improvements that had been made had no problems.

The results of the validation of these improvements are continued to decide that these improvements are feasible to implement by conducting an evaluation analysis of investment (CAPEX) and operational costs (OPEX) on the improvements that have been made. This analysis is to compare the profits in the form of net income generated with the costs of repairs or investments incurred.

4. RESULTS

The concept of green productivity uses the calculation of total productivity with the aim of knowing the extent of a company's productivity as seen from its income, along with the accumulated output and input data at ZA I/III factories:

Table 1. Green Productivity Indeks

Bulan	OUTPUT (Rp)	INPUT (Rp)					TOTAL INPUT (Rp)	GP
	Total Produksi	Bahan Baku	Bahan Penolong	Konsumsi Hardwater	Konsumsi Energi	Pengelolaan Lingkungan		
Januari	410.115.000.000	131.357.865.000	24.984.380.000	19.743.600.000	26.354.700.000	27.010.000	202.467.555.000	2,03
Februari	369.103.500.000	130.902.100.200	18.737.980.000	17.512.800.000	28.126.800.000	33.670.000	195.313.350.200	1,89
Maret	410.115.000.000	141.468.404.400	28.450.400.000	17.644.800.000	25.485.300.000	28.120.000	213.077.024.400	1,92
April	396.444.500.000	120.369.211.800	26.619.180.000	16.521.600.000	27.010.800.000	45.140.000	190.565.931.800	2,08
Mei	410.115.000.000	91.142.354.500	25.118.580.000	24.033.600.000	25.488.000.000	24.050.000	165.806.584.500	2,47
Juni	396.444.500.000	112.476.405.300	22.434.580.000	27.519.600.000	23.686.200.000	32.930.000	186.149.715.300	2,13
Juli	410.115.000.000	129.246.511.400	13.786.000.000	24.212.400.000	26.546.400.000	19.980.000	193.811.291.400	2,12
Agustus	410.115.000.000	129.481.020.200	33.098.600.000	17.551.200.000	26.646.300.000	25.530.000	206.802.650.200	1,98
September	273.410.000.000	61.253.611.900	20.582.620.000	12.007.200.000	26.909.100.000	19.980.000	120.772.511.900	2,26
Oktober	410.115.000.000	68.140.822.000	24.474.420.000	15.670.800.000	29.713.500.000	35.150.000	138.034.692.000	2,97
November	396.444.500.000	136.707.467.500	25.289.380.000	21.356.400.000	26.904.600.000	14.060.000	210.271.907.500	1,89
Desember	410.115.000.000	109.314.991.900	14.122.720.000	23.311.200.000	24.095.700.000	27.750.000	170.872.361.900	2,40
Total/Year	4.702.652.000.000	1.361.860.766.100	277.698.840.000	237.085.200.000	316.967.400.000	333.370.000	2.193.945.576.100	2,14

In the process of calculating the concept of green productivity there is a difference with total productivity, the difference is in the addition of the environmental management budget.

PT Petrokimia Gresik in carrying out business processes produces side products / residue from production in the form of waste, there are 3 (three) types of waste produced, namely; solid waste, liquid waste, and air waste.

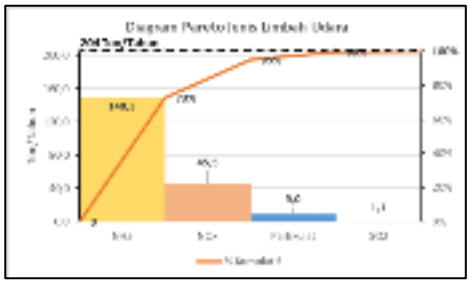
Table 2. waste product resource

Waste	unit	ZA I	ZA III
Solid waste	Ton/Year	179	137
Liquid waste	Ton/Year	128	98
Air waste	Ton/Year	**204**	156

Based on the data on the type of waste at the ZA I/III Factory, it can be seen that the most dominant waste is found at the ZA I Factory of 204 tons/year, then to identify and determine the priority of the problem of high waste problems at the ZA I Factory, a Pareto diagram of air waste sources is used. the following :

Table 3. air waste ZA I

No	Air waste ZA I	average (ton/year)	%	% komulatif
1	NH_3	148,3	72%	72%
2	NO_x	45,5	23%	95%
3	Partikulat	9	5%	99%
4	SO_2	1,1	1%	100%



No	Air waste ZA I	average (ton/year)	%	% komulatif
	Total	204	100%	100%

Based on the Pareto diagram of the types of air waste above, it can be concluded that the main cause of the highest air waste in the ZA I Plant is Ammonia of 148.3 tons/year. Next, the author will do a breakdown of the equipment for the source of Ammonia air waste at the ZA I Factory, which is shown in the following table:

Table 4. air waste NH3 resource

No	Air waste resource NH3 - ZA I	ton/year	%	% komulatif
1	Saturator E-301 A	**113,4**	76%	76%
2	Saturator E-301 B	16,6	11%	88%
3	Dryer D-302 A	9,8	7%	94%
4	Dryer D-302 B	8,5	6%	100%
Total		148,3	100%	

Based on the pareto diagram of the type of Ammonia ZA I air waste above, it can be concluded that the main cause of the highest Ammonia ZA I air waste is Saturator E-301 A of 113.4 tons/year. The next evaluation that will be carried out by the author is the target of reducing the problem of Ammonia air waste in Saturator E-301 A ZA I Factory.

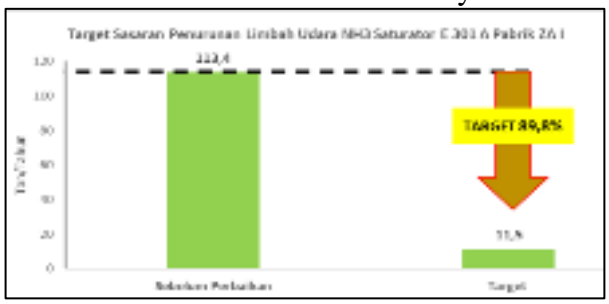


Figure 1. reduction target

$$Sasaran = \frac{Ton\ NH_3\ tertinggi - Ton\ NH_3\ terencah}{Ton\ NH_3\ tertinggi} \ldots\ldots\ldots\ldots\ldots (4.2)$$

$$Sasaran = \frac{18,6 - 1,9}{18,6} x\ 100\% = 89,8\ \%$$

$$Target = Ton\ NH_3 Total - (sasaran\ x\ Ton\ NH_3 Total) \ldots\ldots\ldots (4.3)$$

$$Target = 113,4 - (62,24\% \ x\ 113,4) = 11,5\ Ton/Tahun$$

Graph of the target for reducing ammonia air waste in Saturator E-301 A ZA I Factory can be concluded that the target is 89.8% or equivalent to ammonia air waste of 11.5 tons/year.

This target is the final target which will be the conclusion of the best alternative choice, where the selected alternative is required to reach 11.5 tons/year or lower than the target target.

Table 5. root cause analysis

No	ID	Root cause	RPN	% relatif	% kumulatif
1	A4	The efficiency of the existing condenser is very low	1000	44%	44%
2	A3	The material tube in the condenser is full of scaling	810	36%	**80%**
3	A1	The air around the factory is too hot	336	14%	94%
4	A5	Check Condition of Incidental Saturator	90	4%	98%
5	A2	Using conventional processes.	36	2%	100%
Total			**2.272**	**100%**	

In accordance with the Pareto 80/20 concept, namely 80% of problems are solved with 20% of solutions, then the dominant cause of the 5 root causes of the analysis using FMEA is 80% of the total RPN. From the Pareto above, it can be seen that the causes of the problem of ammonia air waste in Saturator E-301 A ZA I Factory amounted to 113.4 tons/year include:

1. The efficiency of the existing condenser is very low (A4)
2. The material tube in the condenser is full of scaling (A3)

Development of Alternative Improvement Scenario Solutions

In the stage after the discovery of the dominant root cause, it is necessary to carry out alternative improvement scenarios to reduce the problem of ammonia air waste in Saturator E-301 A ZA I Factory of 113.4 tons/year by making several alternative improvement scenarios as follows:

Table 6. alternative improvement scenarios

No	root cause	Alternative Improvement Scenarios
1	The efficiency of the existing condenser is very low	1. Installing the control valve to regulate the receipt of ammonia gas supply from the 105-J compressor. 2. Adding a cooling water valve opening to the ZA I condenser. 3. Install the venturer packed scrubber on the heat exchanger line outlet. 4. Install the wet scrubber at the heat exchanger outlet. 5. Recycle ammonia emissions from the heat exchanger outlet to the E-301 A saturator. 6. Enlarge the size of the condenser in Saturator E-301 A. 7. Installing a new spiral scrubber at the Saturator E-301 A outlet after the line condenser 8. Installing a new Horizontal scrubber at the Saturator E-301 A outlet before heading to the condenser. 9. Make a new X-scrubber at the E-301 A outlet before heading to the condenser and perform mechanical cleaning on the condenser.
2	The material tube in the condenser is full of scaling (A3)	

The improvement scenario above has 2 dominant root causes and 9 alternative solutions to reduce the problem of ammonia air waste in Saturator E-301 A ZA I Factory of 113.4 tons/year. In the process of selecting alternative solutions, there needs to be clarification and agreement from the parties involved, such as; finance department, factory maintenance department, engineering department, production department, and process and quality control department.

From the nine alternatives, the chosen alternative is the last, there are making a new X-scrubber at the E-301 A outlet before heading to the condenser and performing mechanical cleaning on the condenser.

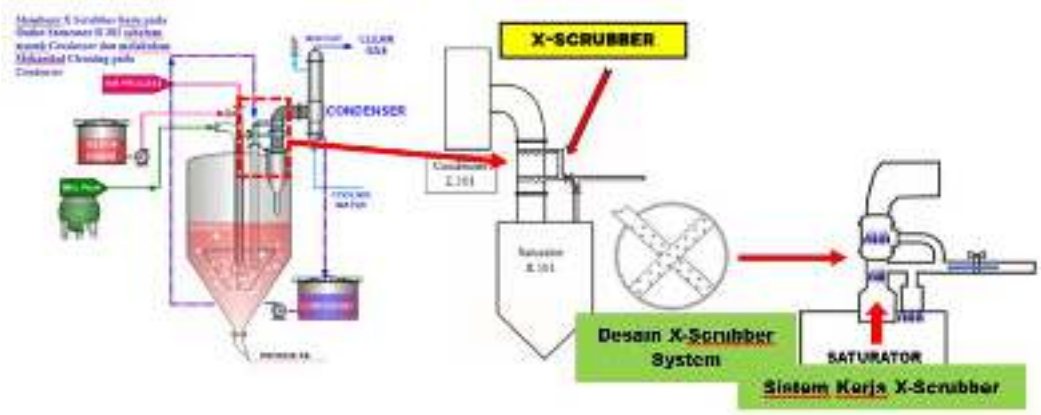


Figure 2. x-scrubber system (best alternatives)

In the picture above is the ZA I production process, by making a new X-scrubber at the E-301 A outlet before heading to the condenser. In the downstream part of the process, the aim of this experiment is that the NH3 exit gas that comes out can be trapped and then recycled to the process. Based on running with the Hysys software, NH3 emissions still pass into the air but the numbers are not too high, the production process remains in balance. this repair work can be done at any time because it does not interfere with the production process of the ZA I factory. Then this alternative repair is analyzed with QDHEMS Quality Aspects (Quality, Delivery, Healthy, Environment, Morale, Safety)

Figure 3. dispersion emission

Based on the picture above, it can be seen that the distribution of air waste pollution generated in scenario 9 is already very low, namely 514 Micrograms. For this reason, scenario 9 needs to be considered, due to the addition of a tie-in in the condenser and does not require a large area. This alternative is the best alternative of the 9 alternatives above.

Scenario Investment Calculation

There are 9 alternative scenarios above, each scenario has different investment costs, this is also an important consideration in selecting the best alternative scenario, the costs incurred to realize the above scenarios can be seen in the following table:

Table 6. investment calculation

No	Item	Unit	Total
A	**Value Savings from reducing NH3 emissions**		
1	NH3 Emission Losses in E-301 A Saturator Before Repair	Ton/Year	113,4
2	NH3 Emission Losses in E-301 A Saturator After Repair	Ton/Year	1,56
3	Difference in NH3 Emission Losses Before and After Repair (1 - 2)	Ton/Year	111,84
4	Price of NH3 Liquid in International trade	Rupiah/Ton	6.000.000
5	NH3 losses savings results in 1 year (3 x 4)	Rupiah	671.040.000
B	**Value Savings from increasing the production rate**		
6	Production Rate Before repair	%	80
7	Production Rate After Repair	%	90
8	Increasing the production rate of ZA fertilizer (7-6)	%	10
9	Production Rate	Ton/Bulan	5.000
10	Number of increase in ZA Fertilizer production (8 x 9)	Ton	500
11	ZA Fertilizer Price	Rupiah/Ton	8.700.000
12	Revenue results from increased production rate (10 x 11)	Rupiah	4.350.000.000
C	**Savings Result from 1 Year Repair (5 + 12)**	Rupiah	5.021.040.000
D	**Value Savings for 2 Years**		
13	Monitoring of Repair Activities	Year	2
14	NH3 losses savings results in 2 validation years. (5 x 13)	Rupiah	**1.342.080.000**
15	The results of increasing ZA fertilizer products in 2 years of validation. (12 x 13)	Rupiah	**8.700.000.000**
E	**Investment Cost**		
16	Cost of Making X-Scrubbers	Rupiah	19.000.000
17	X-Scrubber Installation Fee	Rupiah	3.500.000
18	X-Scrubber Handling Fee	Rupiah	**2.600.000**
19	Total Investment Cost (16 + 17 + 18)	Rupiah	**25.100.000**
F	**X-Scrubber Operational Cost 1 Year**	Rupiah	**54.000.000**
	Total Cost Savings in 1 Year (C - E - F)	**Rupiah**	**4.941.940.000**

Based on alternative scenario 9 data, absorption of waste air NH3 losses into a product of 111.84 tons/year, there is an increase in the production rate of 10% and generates savings in 1 year of IDR 4,941,940,000.-

Table 6. BMC Analysis

8. KEY PARTNERS	7. KEY ACTIVITIES	2. VALUE PROPOSITION	4. CUSTOMER RELATION	1. CUSTOMER SEGMENT
• Fertilizer Distributor • Subsidiary • Farmer • Ministry of Agriculture	• Marketing • Operation • Unit *Recovery*	• Best fertilizer • New product innovation • Competitive price • Development, *Knowledge, Attitude, Skills*	• Cheap air waste management costs • Maintained quality (Research	• Plant cultivation • Farmers • Self-employed • Researcher • Public *"Top Management PT Petrokimia Gresik"*
	6. KEY RESOURCES • Unit *Saturator ZA I* • Dep. research • SDM exlence		**3. CHANNEL** • Distributor • warehouse • *Kios*	
9. COST STRUCTURE • Salary/wages of factory unit operators ZA I • Cost of transporting raw materials • Heavy equipment rental payments • Electricity payments • Tax			**5. REVENUE STREAM** • Utilization of NH3 losses and PCT for internal factories • Retail Product Sales	

6. CONCLUSIONS

Based on the research that has been carried out at PT Petrokimia Gresik's ZA I/III Factory, several conclusions have been obtained, namely:

1. There are 3 sources of types of waste found in ZA I/III factories, namely; solid waste, liquid waste and air waste. From the results of research on waste, the highest was found in airborne waste from Ammonia, namely: 204 tons/year. and sourced from ZA I Factory.
2. Based on the breakdown of the problem, sourced from Saturator E – 301 A of 113.4 tons/year. The strategy used to increase green productivity management is to utilize the lost waste to be substituted into re-products (recycle waste to product) by selecting the best improvement alternative, in this study the best alternative solution was alternative 9.
3. Reducing the load of Ammonia air waste pollutant at the ZA I Saturator E-301 A Factory by creating a new tool in the form of the X-Scrubber System and mechanical cleaning. Based on the process and technical evaluation, with the addition of this tool, the uptake of air waste to the product is the highest, namely 111.84 tons/year, the required investment cost is Rp. 25,100,000.
4. Based on the business model canvas resulted in increased product and more widespread distribution of fertilizer products

Some suggestions that can be given to companies and further research development are:

1. Make continuous improvements to environmental performance in order to have a good impact on the environment and workers so as to gain trust and increase productivity.
2. It is necessary to develop new products again to minimize air waste generated in the future. So as not to overproduct from waste to this product
3. It is necessary to carry out routine monitoring for the addition of the X-Scrubber System because this is a new tool, so it is necessary to have detailed IK (Work Instructions) to produce the durability of this equipment.This research can be supplemented with other

supporting parameters related to product quality standards such as natural gas, hard water, and recycled products for further research materials.

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PRIORITY SELECTION OF WELL INTERVENTION WORK PLAN WITH A COMBINATION OF AHP & TOPSIS METHODS IN THE OIL AND GAS FIELD X, PT. XYZ

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ABSTRAK

In an effort to maintain production in field X, PT. XYZ performs Well Intervention work on existing wells. The Well Intervention work plan is prepared annually by the Exploitation function in the form of suggestions & proposals for Well Intervention work, which are then prioritized and scheduled for the work on the Well Intervention work plan. Current conditions, PT. XYZ does not yet have official guidelines for determining priorities for good Intervention work plans, resulting in priorities being subjective, less measurable and inconsistent. Through this research, it is expected that priority work plans can be carried out in an objective and measurable manner. The decision-making method for determining the weight of important sub-criteria uses the AHP method, while for prioritizing alternatives using the TOPSIS method. The AHP-TOPSIS combination was chosen to minimize the weaknesses of the AHP method in using many alternatives, which would complicate the pair comparison process, therefore the combination with the TOPSIS method was chosen which has a simpler form in compiling alternative priorities. The research results obtained were that the Production Gain criteria had the highest weight (0.362), followed by cost (0.234), Difficulty Level (0.172), Work Duration (0.080), Rig Needs (0.078) and Road Access & Location (0.073). Then the results of the priority well intervention work plan with are divided into several priority levels as follows: 1. Very Priority: Well-08, Well-14, Well-11, Well-13, Well-02, Well-03, 2. More priority : Well-01, Well-07, Well-05, Well-15, Well-09, Well-19, 3. Priority: Well-04, Well-12, Well-17, Well-23, Well-20, Well -06, 4. Less Priority: Well-22, Well-21, Well-18, Well-16, Well-26, Well-27, Well-10, Well-24, and Well-25.

Keywords: Work Plan, Well Intervention, AHP, TOPSIS

1. INTRODUCTION

PT XYZ is a company in the upstream oil and gas sector, PT XYZ has a very wide working area starting from the western end of Indonesia to the eastern end of Indonesia. Field X is one of

the PT XYZ fields, which has a working area in the bekasi regency area to the Karawang regency of West Java, and is one of the oil and gas producing fields. In an effort to maintain its production PT. XYZ performs Well Intervention Work on existing Wells. Well Intervention is non-routine work carried out for the purpose of maintaining / repairing / increasing production by reopening and or adding perforation hoses to existing zones that have existed or are being produced, such as Stimulation, Cementing and Perforation work. The Well Intervention work plan is made annually by the Exploitation function in the form of Well Intervention proposals & candidate, which are then submitted to the Well Intervention function and field to prioritize and schedule work on the Well Intervention work plan. In the process of prioritizing this work plan, there is no standard method owned by the company. So far, prioritization is only based on the greatest production gains. Determining the order of precedence will be difficult if there are wells that have the same production gain. So that prioritization becomes subjective by each decision maker. Through this research, it is hoped that it will be able to provide input for more objective decision making about the priority order of Well Intervention work based on the criteria in the company, so that later a decision can be obtained that can be accounted for and approved by all decision makers. Decision making will be more objective if everything that is the subject of decision consideration has been measured or weighted.

2. LITERATURE RIVIEW

AHP Invented by Thomas L. Saaty in 1980 at the University of Pittsburgh, Pennsylvania, USA, is a popular and widely used method for multi-criteria decision making. Allows the use of qualitative, as well as quantitative criteria in the evaluation. AHP is a decision-making method that involves a number of criteria and alternatives that are selected based on consideration of all related criteria. AHP analysis is carried out by giving the priority value of each variable, then comparing pairs of existing variables and alternatives (Nur et al., 2016).

The TOPSIS method was developed by Hwang & Yoon in 1981, and is a pragmatic method for dealing with real-life Multi-Criteria Decision Making (MCDM) problems. This method helps decision makers compare and rank a set of alternative decisions. In this method, the selection of the best alternative is based on the shortest distance from the positive ideal solution and the farthest from the negative ideal solution (Jozaghi et al., 2018).

The definition of the questionnaire method according to Arikunto (2006: 151) "A questionnaire is a written statement used to obtain information from a respondent in the sense of a report about a person or things he knows". Meanwhile, according to Sugiyono (2008: 199) "Questionnaire or questionnaire is a data collection technique carried out by giving a set of questions or written statements to respondents to be answered".

3. METODE

To achieve research objectives, it is necessary to plan the stages of research and writing activities that will be carried out. The research flow is used as a reference from the beginning of the research starting to the end which will be a systematic guideline. Here is the flowchart used in this study:

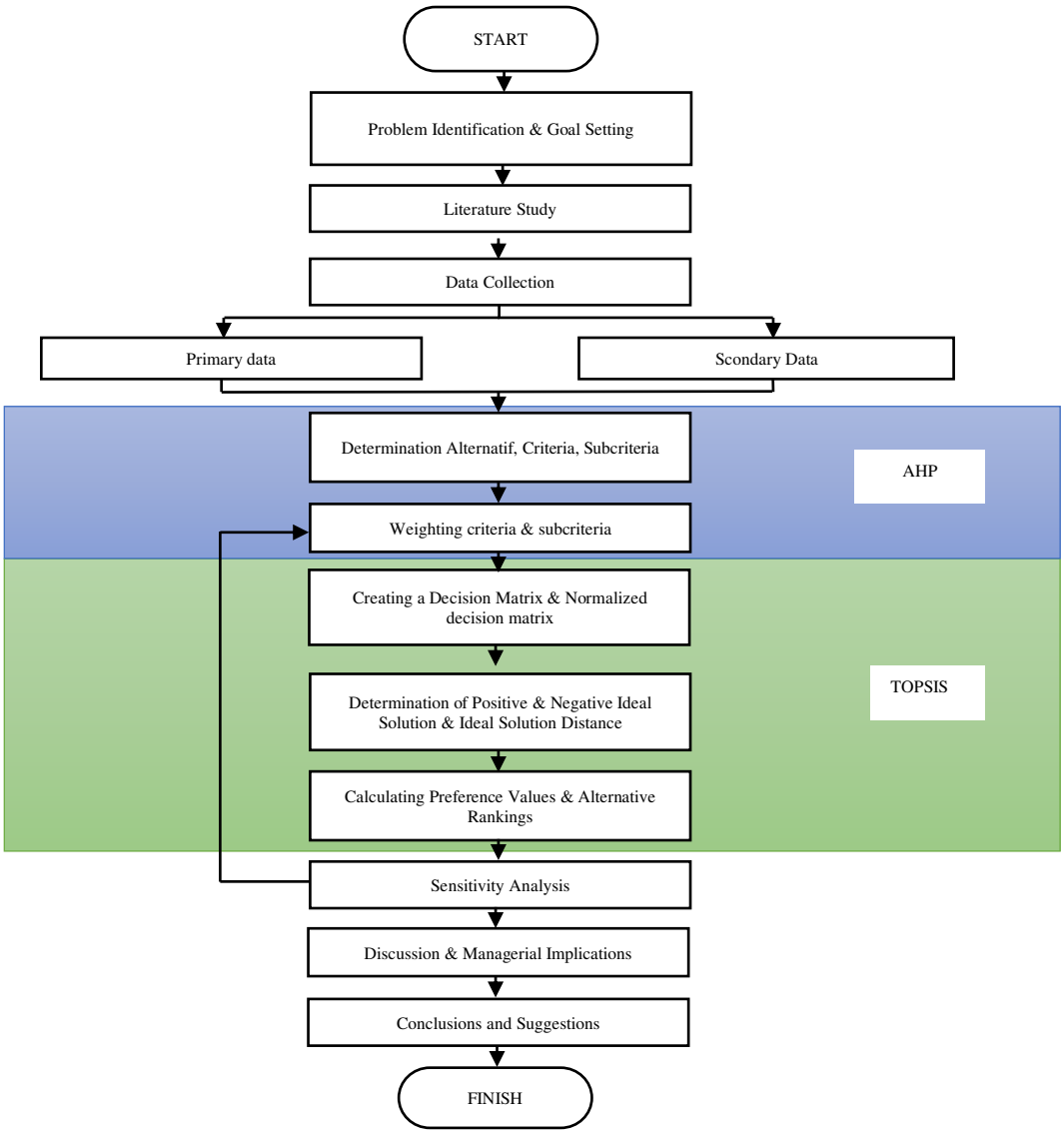

Figure 1. Research Flow Chart

4. RESULTS AND DISCUSSION

Selection of Criteria

Data collection in this study was through a questionnaire aimed at 9 practitioners and decision makers in the field of Well Intervention and Petroleum Engineering, so as to be able to assess the importance of Criteria and Subcriteria in this study. The determination of criteria and subcriteria using an open questionnaire means that respondents can add new criteria or subcriteria that they think are worthy of inclusion in this study. From the results of the questionnaire on 9 respondents, there were no additional criteria or subcriteria. The results of filling out the questionnaire for each criterion are as follows:

Table 1. Criteria Assessment Results

No	Criteria	Total Score	Maximum Score (%)	Skor (%)	Conclusion
1	Production Gain	42	45	93,33	**Totally Agree**
2	Duration of Work	38	45	84,44	**Totally Agree**
3	Cost	40	45	88,89	**Totally Agree**
4	Rig Needs	35	45	77,78	**Agree**
5	Difficulty Level	37	45	82,22	**Totally Agree**
6	Access roads and locations	33	45	73,33	**Agree**

Table 2. Subcriteria Assessment Results

No	Criteria	Total Score	Maximum Score (%)	Skor (%)	Conclusion
C5	Easy (S13)	37	45	82,22	**Totally Agree**
	Intermediate (S14)	37	45	82,22	**Totally Agree**
	Difficult (S15)	37	45	82,22	**Totally Agree**
C6	Minor Repair (S16)	37	45	82,22	**Totally Agree**
	Medium Repair (S17)	37	45	82,22	**Totally Agree**
	Major Repair (S18)	36	45	80,00	**Totally Agree**

Alternative Selection

The alternative that will be used in this study is the Field Well Intervention X work plan in 2023. Where the Well Intervention work plan is in the form of a Well intervention work program in Field X wells, where there are 27 wells to be worked on during 2013. Where this work plan has previously been carried out in-depth studies and analysis related to subsurface by exploitation functions. Here are the alternatives used in this study.

Table 3. Research Alternatives

No	Alternatif	Job	Interval perforation
1	Sumur-01	Reparasi	TAF
2	Sumur-02	Reparasi	TAF
3	Sumur-03	Reparasi	TAF
4	Sumur-04	Stimulasi	Pre-Cibulakan
5	Sumur-05	Reparasi	TAF
6	Sumur-06	Stimulasi	BRF
7	Sumur-07	Reparasi	TAF
8	Sumur-08	Reparasi	TAF

9	Sumur-09	Reparasi	BRF
10	Sumur-10	Reparasi	CBA
11	Sumur-11	Reparasi	TAF
12	Sumur-12	Reparasi	TAF
13	Sumur-13	Reparasi	TAF
14	Sumur-14	Reparasi	CBA
15	Sumur-15	Reparasi	CBA
16	Sumur-16	Reparasi	CBA
17	Sumur-17	Stimulasi	BRF
18	Sumur-18	Stimulasi	BRF
19	Sumur-19	Reparasi	BRF
20	Sumur-20	Stimulasi	BRF
21	Sumur-21	Stimulasi	BRF
22	Sumur-22	Reparasi	BRF
23	Sumur-23	Stimulasi	BRF
24	Sumur-24	Stimulasi	BRF
25	Sumur-25	Reparasi	Cisubuh
26	Sumur-26	Reparasi	Parigi
27	Sumur-27	Reparasi	Cisubuh

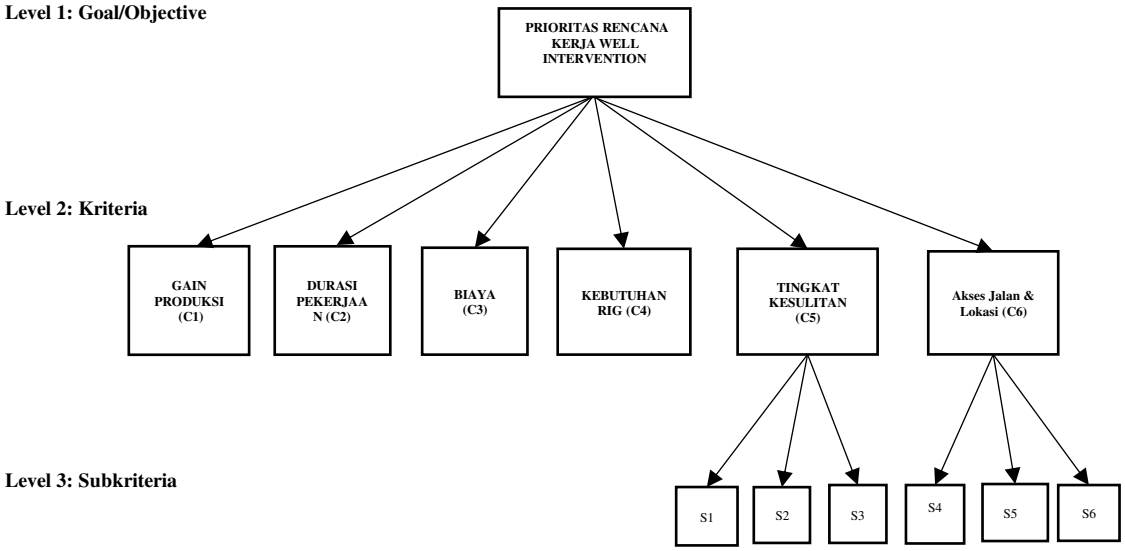

Figure 2. Research Hierarchy

Weighting Criteria & Subcriteria AHP Method

After collecting questionnaire data from several respondents at the managerial level and group discussions in the form of comparative judgments for criteria, subcriteria and alternatives, weighting calculations were carried out using the Analytical Hierarchy Process (AHP) method through the help of Expert Choice software. From this calculation, it is known the weight of values and rankings for the following criteria and subcriteria:

Table 4. Weight Criteria

CRITERIA	LOCAL WEIGHT	GLOBAL WEIGHTS	PERCENTAGE
Production Gain (C1)	0.362	0.362	36.2%
Job duration (C2)	0.080	0.080	8.0%
Cost (C3)	0.234	0.234	23.4%
Rig Needs (C4)	0.078	0.078	7.8%
Difficulty level (C5)	0.172	0.172	17.2%
Access roads and locations (C6)	0.073	0.073	7.3%

Table 1. Weight Subkriteria

SUBCRITERIA	LOCAL WEIGHT	GLOBAL WEIGHTS	PERCENTAGE
Easy (S13)	0.714	0.123	12.3%
Medium (S14)	0.219	0.038	3.8%
Difficult (S15)	0.067	0.012	1.2%
Minor Fixes (S16)	0.741	0.054	5.4%
Medium Repair (S17)	0.203	0.015	1.5%
Major Repair (S18)	0.056	0.004	0.4%

Determination of Alternative selection based on TOPSIS

The TOPSIS method is used to prioritize alternatives Well intervention work plan, starting with compiling a decision matrix prepared based on the assessment of criteria for each alternative, then data processing is carried out in accordance with the rules of the method. The following are the stages of data processing using the TOPSIS method in this study.

1. Decision Matrix, The first stage is to create a decision matrix by conducting an assessment based on the interpretation of secondary data.

Table 6. Decision Matrix

Kriteria/Subkriteria / Alternatif	Gain Produksi (bopd)	Durasi Pekerjaan (hari)	Biaya (miliar rupiah)	Kebutuhan Rig (Horse Power)	Tingkat Kesulitan			Akses Jalan dan Lokasi		
					S1	S2	S3	S4	S5	S6
Sumur-01	29	18	4,34	550	3	3	9	9	3	3
Sumur-02	29	18	4,34	550	3	9	3	3	9	3
Sumur-03	29	18	4,34	550	3	9	3	3	9	3
Sumur-04	16	15	3,01	550	3	9	3	9	3	3
Sumur-05	30	17	5,22	550	9	3	3	9	3	3
Sumur-06	10	7	1,86	550	9	3	3	9	3	3
Sumur-07	26	17	4,14	550	9	3	3	9	3	3
Sumur-08	25	15	2,88	550	3	9	3	3	9	3
Sumur-09	20	14	3,48	550	3	9	3	3	9	3
Sumur-10	5	13	2,75	550	3	9	3	3	9	3
Sumur-11	25	16	3,28	550	3	9	3	3	9	3
Sumur-12	15	17	3,40	550	3	9	3	3	9	3
Sumur-13	25	15	3,47	550	3	9	3	3	9	3
Sumur-14	23	9	2,32	350	9	3	3	3	3	9
Sumur-15	17	9	1,69	350	9	3	3	3	3	9
Sumur-16	5	11	2,16	350	9	3	3	9	3	3

Sumur-17	8	7	1,26	350	9	3	3	9	3	3
Sumur-18	8	7	1,18	350	9	3	3	9	3	3
Sumur-19	15	11	2,28	350	9	3	3	9	3	3
Sumur-20	8	7	1,18	350	9	3	3	9	3	3
Sumur-21	8	7	1,26	350	9	3	3	9	3	3
Sumur-22	5	12	1,92	350	9	3	3	9	3	3
Sumur-23	8	7	1,26	350	9	3	3	9	3	3
Sumur-24	8	7	1,18	350	9	3	3	9	3	3
Sumur-25	5	12	3,37	350	9	3	3	3	3	9
Sumur-26	5	12	3,26	350	9	3	3	3	3	9
Sumur-27	5	12	2,33	350	9	3	3	3	3	9
Jumlah	412	330	73,20	12050	183	135	87	165	129	111
Tipe Subkriteria	**Benefit**	**Cost**	**Cost**	**Cost**	**Cost**	**Cost**	**Cost**	**Cost**	**Cost**	**Cost**

2. The Second Stage is a Normalized Decision Matrix.
3. The Third Stage is the Normalized and Weighted Decision Matrix, After normalization, the decision matrix is then multiplied by the weight of each subcriterion obtained from the calculation results of the AHP method

Table 7. Normalized and weighted Decision Matrices

Kriteria/Subkriteria	**Gain Produksi**	**Durasi Pekerjaan**	**Biaya**	**Kebutuhan Rig**	**Tingkat Kesulitan**			**Akses Jalan dan Lokasi**		
Alternatif					**S1**	**S2**	**S3**	**S4**	**S5**	**S6**
Sumur-01	0,1137	0,0216	0,0664	0,0181	0,0096	0,0038	0,0061	0,0137	0,0016	0,0005
Sumur-02	0,1137	0,0216	0,0664	0,0181	0,0096	0,0115	0,0020	0,0046	0,0047	0,0005
Sumur-03	0,1137	0,0216	0,0664	0,0181	0,0096	0,0115	0,0020	0,0046	0,0047	0,0005
Sumur-04	0,0627	0,0180	0,0461	0,0181	0,0096	0,0115	0,0020	0,0137	0,0016	0,0005
Sumur-05	0,1176	0,0204	0,0799	0,0181	0,0289	0,0038	0,0020	0,0137	0,0016	0,0005
Sumur-06	0,0392	0,0084	0,0284	0,0181	0,0289	0,0038	0,0020	0,0137	0,0016	0,0005
Sumur-07	0,1019	0,0204	0,0633	0,0181	0,0289	0,0038	0,0020	0,0137	0,0016	0,0005
Sumur-08	0,0980	0,0180	0,0441	0,0181	0,0096	0,0115	0,0020	0,0046	0,0047	0,0005
Sumur-09	0,0784	0,0168	0,0532	0,0181	0,0096	0,0115	0,0020	0,0046	0,0047	0,0005
Sumur-10	0,0196	0,0156	0,0421	0,0181	0,0096	0,0115	0,0020	0,0046	0,0047	0,0005
Sumur-11	0,0980	0,0192	0,0502	0,0181	0,0096	0,0115	0,0020	0,0046	0,0047	0,0005
Sumur-12	0,0588	0,0204	0,0520	0,0181	0,0096	0,0115	0,0020	0,0046	0,0047	0,0005
Sumur-13	0,0980	0,0180	0,0531	0,0181	0,0096	0,0115	0,0020	0,0046	0,0047	0,0005
Sumur-14	0,0901	0,0108	0,0355	0,0115	0,0289	0,0038	0,0020	0,0046	0,0016	0,0015
Sumur-15	0,0666	0,0108	0,0259	0,0115	0,0289	0,0038	0,0020	0,0046	0,0016	0,0015
Sumur-16	0,0196	0,0132	0,0331	0,0115	0,0289	0,0038	0,0020	0,0137	0,0016	0,0005
Sumur-17	0,0314	0,0084	0,0180	0,0115	0,0289	0,0038	0,0020	0,0137	0,0016	0,0005
Sumur-18	0,0314	0,0084	0,0348	0,0115	0,0289	0,0038	0,0020	0,0137	0,0016	0,0005
Sumur-19	0,0588	0,0132	0,0180	0,0115	0,0289	0,0038	0,0020	0,0137	0,0016	0,0005
Sumur-20	0,0314	0,0084	0,0193	0,0115	0,0289	0,0038	0,0020	0,0137	0,0016	0,0005
Sumur-21	0,0314	0,0084	0,0293	0,0115	0,0289	0,0038	0,0020	0,0137	0,0016	0,0005
Sumur-22	0,0196	0,0144	0,0193	0,0115	0,0289	0,0038	0,0020	0,0137	0,0016	0,0005
Sumur-23	0,0314	0,0084	0,0180	0,0115	0,0289	0,0038	0,0020	0,0137	0,0016	0,0005
Sumur-24	0,0314	0,0084	0,0516	0,0115	0,0289	0,0038	0,0020	0,0137	0,0016	0,0005
Sumur-25	0,0196	0,0144	0,0499	0,0115	0,0289	0,0038	0,0020	0,0046	0,0016	0,0015
Sumur-26	0,0196	0,0144	0,0356	0,0115	0,0289	0,0038	0,0020	0,0046	0,0016	0,0015
Sumur-27	0,0196	0,0144	0,0356	0,0115	0,0289	0,0038	0,0020	0,0046	0,0016	0,0015
Tipe Subkriteria	**Benefit**	**Cost**	**Cost**	**Cost**	**Cost**	**Cost**	**Cost**	**Cost**	**Cost**	**Cost**

4. The Fourth Stage of Calculating Positive and Negative Ideal Solutions

Table 8. Positive Ideal Solutions

Kriteria	**Gain Produksi**	**Durasi Pekerjaan**	**Biaya**	**Kebutuhan Rig**	**Tingkat Kesulitan**			**Akses Jalan dan Lokasi**		
Subkriteria					**S1**	**S2**	**S3**	**S4**	**S5**	**S6**
Solusi Ideal (A+)	0,1176	0,0084	0,0180	0,0115	0,0096	0,0038	0,0020	0,0046	0,0016	0,0005

Table 9. Negative Ideal Solutions

Kriteria	Gain Produksi	Durasi Pekerjaan	Biaya	Kebutuhan Rig	Tingkat Kesulitan			Akses Jalan dan Lokasi		
Subkriteria					S1	S2	S3	S4	S5	S6
Solusi Ideal (A-)	0,0196	0,0216	0,0799	0,0181	0,0289	0,0115	0,0061	0,0137	0,0047	0,0015

5. Fifth Stage Measures the distance of positive & negative ideal solutions, preference values, and alternative ratings.

Table 10. Positive & Negative Ideal Solution Distances, Preferred Values, and Alternative ratings

Jarak Solusi Ideal Alternatif	Si + (Positif)	Si - (Negatif)	Nilai Preferensi	Peringkat
Sumur-01	0,05170776	0,097303626	0,65299457	7
Sumur-02	0,051396062	0,097468625	0,654746448	5
Sumur-03	0,051396062	0,097468625	0,654746448	6
Sumur-04	0,063816193	0,058422392	0,477937403	13
Sumur-05	0,066816854	0,098420174	0,595630259	9
Sumur-06	0,082149069	0,057411858	0,411374868	18
Sumur-07	0,054190183	0,084467426	0,609179884	8
Sumur-08	0,035584072	0,088930278	0,714217099	1
Sumur-09	0,054357231	0,068277693	0,556755703	11
Sumur-10	0,101680388	0,044030812	0,302178641	25
Sumur-11	0,040545025	0,086625376	0,681175612	3
Sumur-12	0,069729568	0,052801403	0,43092291	14
Sumur-13	0,042611241	0,08570984	0,667932655	4
Sumur-14	0,037902783	0,085262845	0,692261683	2
Sumur-15	0,055094807	0,073838779	0,572688477	10
Sumur-16	0,101504259	0,048890671	0,32508191	22
Sumur-17	0,088819991	0,065294262	0,423674386	15
Sumur-18	0,090390385	0,049702535	0,354782635	21
Sumur-19	0,062721201	0,074549686	0,543084461	12
Sumur-20	0,08882928	0,064079221	0,419069054	17
Sumur-21	0,089534139	0,054727983	0,379364885	20
Sumur-22	0,100459779	0,062015213	0,38169082	19
Sumur-23	0,088819991	0,065294262	0,423674386	16
Sumur-24	0,094945847	0,035216543	0,270558515	26
Sumur-25	0,104982297	0,034098339	0,245169566	27
Sumur-26	0,101571848	0,047123967	0,31691522	23
Sumur-27	0,101571848	0,047123967	0,31691522	24

From the table above, it shows that the alternative priority that ranks first is Well-08. Well-08 is a well with an estimated oil production gain of 25 bopd and gas of 0.15 Mmscfd so that it is included in the well category of medium production gain, this well if done in accordance with the existing work program, then the estimate takes 15 days. After taking into account the various needs of equipment, services, and materials, the estimation of this well if done will cost Rp. 2,884,846,708,-. This well-05 has a deep enough depth of more than 2000 m so that based on best practices and calculations of circuit load and safety factor, it is recommended to use a 550 HP Rig.

Then from the History data, this well has not been maintained for a long time and also the production zone well profile is in the 4-1/2" Liner so that it has a considerable potential for mechanical problems. Furthermore, from the Field Survey, the access road and the location of the well-08 have quite a lot of points that must be repaired because this well has not been carried out for a long time. It can be concluded that Well-08 deserves to be the first priority because it has a considerable value on the high-weight criterion (closest to the positive ideal solution) and has a fairly small value on the low-weight criterion (furthest with a negative ideal solution).

Sensitivity Analysis

To determine the sensitivity of the research results, sensitivity testing will be carried out which is a fundamental concept in the multi-criteria decision making method (MCDM) to measure the stability of the selection of optimal solutions if there is a change in parameters. In this study, changes will be made to the criteria that have the highest weight, namely Production Gain, where the first scenario is by gradually decreasing starting from 5%,10%,15%,20%, and 25% from the initial weight, while the second scenario is by gradually increasing starting from 5%, 10%, 15%, 20%, and 25%. If there is a change in the criteria, then the level below it will also change, in this case the weight of subcriteria and alternative priorities. The following are the results of the sensitivity test in this study.

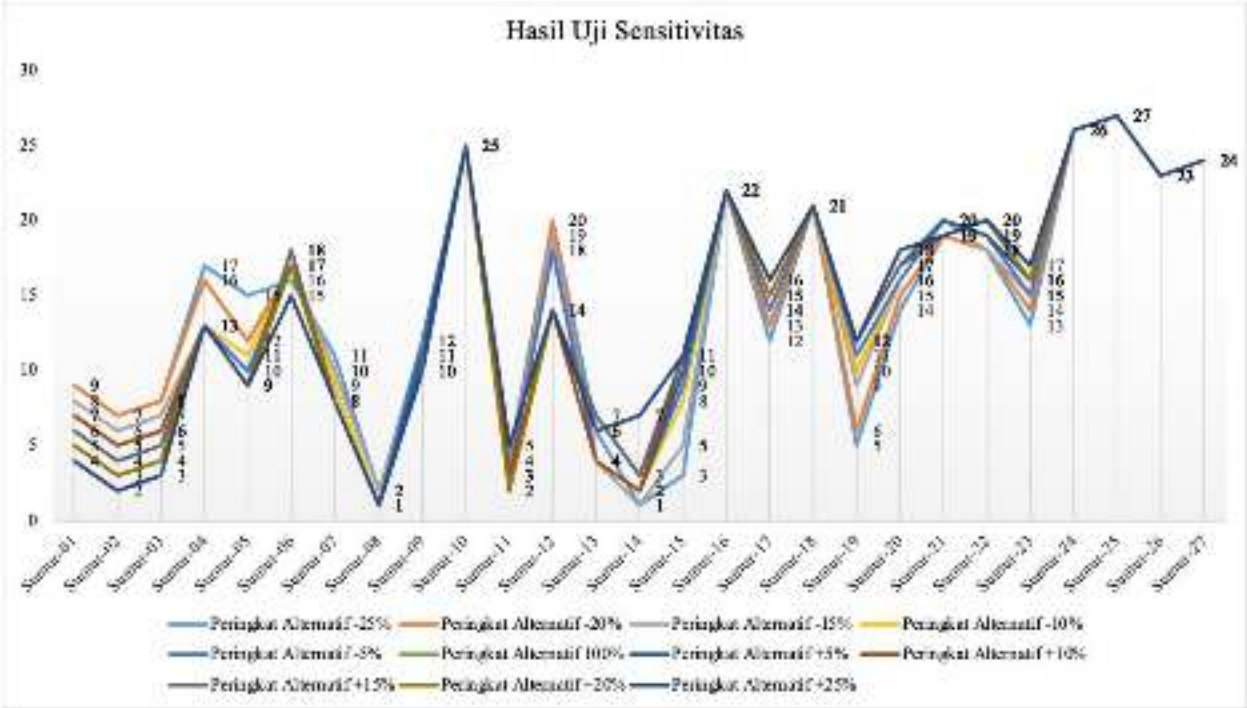

Figure 3. Sensitivity Analisys Chart

Changes occurred in alternative priorities after sensitivity analysis with a weight-loss change scenario of +- 5%-25%, but in general did not have a significant effect on the order of priority. Figure 4.3 shows that the alternative priority of Well-08 remains at the top of the rating on the sensitivity test of -20% to +25%, and begins to change to rank 2 on the sensitivity test of -25%. Meanwhile, the alternative Well 25 remains at the bottom of the rankings, so it can be concluded that the decision-making in this study is quite robust.

5. CONCLUSION

Based on the entire research process that has been carried out, the following conclusions can be drawn:

1. There are 6 criteria in determining the priority of well intervention work plans in the field X. Proportion of the weight of criteria that affect the selection of well intervention work plans is as follows: 1. Production Gain: 0.362, 2. Cost: 0.234, 3. Difficulty level: 0.172, 4. Duration of Work: 0.080, 5. Rig Needs: 0.078, 5. Access Road and and Location: 0.073. So it can be concluded that the Production Gain criterion is the most critical and important criterion compared to the other 5 criteria in the process of prioritizing well intervention work plan.
2. Referring to the results of the study, namely calculations with the AHP- TOPSIS method, Then the results of the priority well intervention work plan with are divided into several priority levels as follows: 1. Very Priority: Well-08, Well-14, Well-11, Well-13, Well-02, Well-03, 2. More priority : Well-01, Well-07, Well-05, Well-15, Well-09, Well-19, 3. Priority: Well-04, Well-12, Well-17, Well-23, Well-20, Well -06, 4. Less Priority: Well-22, Well-21, Well-18, Well-16, Well-26, Well-27, Well-10, Well-24, and Well-25.

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RISK FACTOR ANALYSIS WITH JOB SAFETY AND HOUSE OF RISK ANALYSIS APPROACH (CASE STUDY PT SEGAR AGRO NUSANTARA)

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ABSTRACT

Occupational health and safety is an important factor in all industrial fields. The International Labor Organization (ILO) notes that 2.78 people worldwide die as a result of work accidents and the Indonesian Central Bureau of Statistics (BPS) records that from 2018 to 2020 there has been an increase in work accident cases. PT Seger Agro Nusantra (SAN), which has been established since 2006 in Sumbawa district, PT Segar Agro Nusantara is a company that collects various agricultural commodities, where PT Segar Agro Nusantara has integrated with other companies to supply raw materials such as corn, rice, soybeans and cashews, but the branch in Sumbawa district only processes corn and rice, which requires human labor in this processing. Therefore, researchers conducted an analysis of risk factors using the Job Safety Analysis and House of Risk approaches in order to find out the risk factors that occur and the mitigation measures that will be carried out. In this study the Job safety analysis method obtained 22 work activities and 14 work risks that could occur in the 3 divisions at PT. SAN of work activities and work risks obtained are then entered into the HOR model 1 table to be given an assessment of the correlation between work risks and work activities carried out by workers from HOR 1, the highest ARP value is obtained, namely the activity of unloading corn from trucks with a value ARP 84, and for the 2nd ranking, namely the activity of putting husks into the furnace with an ARP value of 76. Then this ARP value will be entered into HOR model 2 to look for mitigation actions that really need to be done so that the highest value PA8 is obtained as ranking 1, namely carrying tools lighting with an ETDk value of 268 because this lighting tool is widely used in several work activities.

Keywords: Health safety at work, Job safety analysis, House of risk.

1. INTRODUCTION

According to data compiled by the International Labor Organization (ILO), there are 2.78 people worldwide who die due to work accidents and the Indonesian Central Statistics Agency (BPS) noted that from 2018 to 2020 there was an increase in work accident cases where in 2018 there were 109.21 cases, 2019 as many as 114.00 cases and 2020 as many as 177.00 cases. The increase in work accident cases is due to the lack of workers' awareness of the work environment and the company's lack of attention to discipline the implementation of the Occupational Safety and Health Management System (SMK3).

PT Seger Agro Nusantara has been established since 2006 in Sumbawa and is the largest warehouse on the island of Sumbawa. This company has approximately 80 workers. To carry out all these activities, companies really need workers who must deal directly with workplace conditions that are dusty, hot, smoky, and other hazardous components. So that there is a potential for a risk of work accidents. PT SAN as a company that has been engaged in the supply of raw materials for a long time, of course, is aware of government regulation No. 50 of 2012 that SMK3 is a guideline for companies to protect their workers through efforts to prevent work-related accidents and illnesses, but in reality it has not been managed properly due to the lack of awareness and awareness of workers about the risks that will occur as a result of their negligence at work. The results of the initial observations were that there were several activities that were quite risky, namely the process of unloading the corn from the truck to the silo, inserting the rice husks for oven burning, drying, and checking the corn when it was loaded into the truck from the shelter. Therefore, it is important for PT.SAN to mitigate risks that will occur if workers continuously carry out work activities like this.

2. LITERATURE REVIEW

a. Job Safety Analysis

Job safety analysis is a method that helps the principles of occupational safety and health practices that are accepted in certain job operations, in JSA each job requires identification of potential hazards that will occur so that the safest way to do the job itself can be recommended. Some people prefer to extend the analysis to all aspects of work and not just safety. The methodology is based on the idea of being an integral part of every job and not a separate entity.

b. House of Risk

The House of Risk (HOR) method is a model used as a framework that functions to manage supply chain risk pro-actively (Pujawan, 2009). HOR is an integrated model between the FMEA model to measure risk and the HOQ model to prioritize risk agents and determine the most effective actions against the risks that occur (Pujawan, 2009). The HOR model is divided into 2, including House of Risk 1 which functions to determine priority levels for risk agents or causes of risk and House of Risk 2 which functions to determine priority mitigation strategies that are considered effective in decision making.

3. METHODS

The method used in this study began with field studies and literature studies. Furthermore, modeling is carried out by analyzing workers using job safety analysis, the first step is to determine the activities carried out by workers and then sequence them according to the steps taken then identify and analyze the hazards for each work activity carried out. The next step is to determine the House of Risk 1 model and continue with the House of Risk 2 model.

4. RESULTS

Based on the results of data collection, modeling using Job Safety Analysis is obtained by mapping the work in 3 departments namely the Quality Control Department, the Operations Department, and the Mechanical Department. After that, 22 work activities were mapped and 14 risks that could occur.

From the identification above then enter HOR Stage 1 where the process of identifying risks, causes of risk and calculating the value of each Aggregate Risk Potential (ARP) risk.

Table 1. Risk Identification and Risk Impact Assessment Results

Risk Identification and Risk Impact Assessment Results		
Code	Risk	Score
E1	hit by a vehicle	4
E2	truck run over	3
E3	fall accidentally	3
E4	pinched	3
E5	inhale dust	2
E6	slipped	2
E7	back injury	3
E8	arm injury	3
E9	eye irritation	2
E10	collide	2
E11	sparked	3
E12	itching on the skin	2
E13	injured	2
E14	respiratory disorders	3

From the table above it can be seen that 14 incidents of work accidents have occurred, this impact value will be used in the calculation of the Aggregate Risk Potential (ARP) which will be used to determine the agent causing the most influential risk based on the calculation.

Table 2. Respondents' Assessment of Risk Agent Probability

	Respondents' Assessment of Risk Agent Probability	
Code	Risk agen (Penyebab Risiko)	Occurance
A1	The truck goes up to the weighing machine	2
A2	Sampling to check water content	2
A3	The operator unloads the corn from the truck	4
A4	Lifting corn to the drying floor	3
A5	Drying corn on the drying floor	2
A6	Checking the dryness level of corn	3
A7	Loading corn into silos	4
A8	Putting the chaff into the furnace	4
A9	Start a fire	4
A10	Checking and adding rice husks for the combustion process	4
A11	Turn off the heat after all the baking process is complete	4
A12	Periodic checks on all vehicles	3

	Respondents' Assessment of Risk Agent Probability	
A13	Vehicle disassembly	2
A14	Welding for damaged vehicles	3

This probability value will also be used in calculating the Aggregate Risk Potential (ARP), which is to determine the most influential agent/caused risk based on the calculation.

Table 3. Calculation of ARP and Ranking

HOR 1															
Cause of Risk (Ej)															
Risk (Ej)	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	Sevirity
E1	3														4
E2	2	3	3												3
E3		2						3	2						3
E4															3
E5				4	4	4	3	3		2	4	3			2
E6															2
E7												2			3
E8				1	2	2	2						2		3
E9			2								3				2
E10			3					2				2	2		2
E11									4	4				3	3
E12			1												2
E13												3			2
E14															3
Occurance	2	2	4	3	2	3	4	4	4	4	4	3	2	3	
ARP	36	30	84	33	28	42	48	76	72	64	56	66	20	27	
Rank	9	11	1	10	12	8	7	2	3	5	6	4	14	13	

From the table above, it can be seen where the calculation results are

ARP $ARP = O_j \sum S_j R_{ij}$

The highest is A3 with a value of 84, the operator lowering the corn gets rank 1.

Table 4. Agent Risk Calculation Results

Kode	Risk Agen (Penyebab Risiko)	ARP
A3	Lifting corn to the drying floor	84
A8	Putting the chaff into the furnace	76

Kode	Risk Agen (Penyebab Risiko)	ARP
A9	Start a fire	72
A12	Periodic checks on all vehicles	66
A10	Checking and adding rice husks for the combustion process	64
A11	Turn off the heat after all the baking process is complete	56
A7	Loading corn into silos	47
A6	Checking the dryness level of corn	42
A1	The truck goes up to the weighing machine	36
A4	Lifting corn to the drying floor	33
A2	Sampling to check water content	30
A5	Drying corn on the drying floor	28
A14	welding for damaged vehicles	27
A13	vehicle disassembly	20

Table 5. Risk Mitigation Action

Code	Mitigation Action	Score
PA1	check before doing work	4
PA2	using a mask	4
PA3	using safety shoes	4
PA4	adjust the position of the posture while working	3
PA5	use safety glasses	2
PA6	wear safety clothing	3
PA7	use a safety helmet	3
PA8	bring lighting	2
PA9	use earpacks, welding helmets or welding masks	4
PA10	provision of ladders to climb the truck	2
PA11	set the parking brake, put the gear in, and got a wedge	3
PA12	ensure the position of the vehicle is in a safe area and put a distance sign	2
PA13	do not stop at bends, intersections, or narrow roads	2
PA14	worker compliance with recommended PPE	2

Table 6. Tek Calculations and ETDk

Risk Agent	Proaktif Action (PAk)														ARP
	PA1	PA2	PA3	PA4	PA5	PA6	PA7	PA8	PA9	PA10	PA11	PA12	PA13	PA14	
Lifting corn to the drying floor	2		2	3											84
Putting the chaff into the furnace	2					2	2	2						2	76
Start a fire						3	2	2							72
Periodic checks on all vehicles				2			3								66
Checking and adding rice husks for the combustion process		2					2	2						2	64
Turn off the heat after all the baking process is complete		3				2		2						2	56
Loading corn into silos		3	2	3			2			3				1	47
Checking the dryness level of corn															42
The truck goes up to the weighing machine											3	4	2		36
Lifting corn to the drying floor															33
Sampling to check water content			2										2		30
Drying corn on the drying floor				2											28
welding for damaged vehicles					3				3						27
vehicle disassembly		2									3				20
Total effectiveness of action (Tek)	320	477	322	581	81	480	716	536	81	141	168	144	132	439	
Degree of diffuculty preforming action (Dt)	4	4	4	3	2	3	3	2	4	2	3	2	2	2	
effectivenes to diffucilty Ratio (ETDk)	80	119	81	194	41	160	239	268	20	71	56	72	66	220	
Rank	8	6	7	4	13	5	2	1	14	10	12	9	11	3	

Table 7. Risk Agent Calculation Results

Rank	Mitigation Action	Kode	ETDk
1	bring lighting	PA8	268
2	use a safety helmet	PA7	239
3	worker compliance with recommended PPE	PA14	220
4	use safety shoes	PA4	194
5	wear safety clothing	PA6	160
6	check before doing work	PA2	119
7	using safety shoes	PA3	81
8	check before doing work	PA1	80
9	ensure the position of the vehicle is in a safe area and put a distance sign	PA12	72

Rank	Mitigation Action	Kode	ETDk
10	provision of ladders to climb the truck	PA10	71
11	do not stop at bends, intersections, or narrow roads	PA13	66
12	set the parking brake, put the gear in, and got a wedge	PA11	56
13	use safety glasses	PA5	41
14	use earpacks, welding helmets or welding masks	PA9	20

6. CONCLUSIONS

Based on the data processing and analysis that has been done previously, the conclusions that can be drawn in accordance with the research objectives set at the beginning include the following:

1. Knowing the risk factors using the Job safety analysis and House of risk approaches. From the results of this study, 22 work activities have the potential to occur and based on the House of risk approach, work activities are very dangerous and need to be addressed immediately, namely the activity of operators unloading corn from trucks this activity gets the first ranking with the number of ARP 84 while the last order is the activity of dismantling vehicles from the mechanic division with a score of 20.
2. Providing risk mitigation steps and recommendations to PT SAN, where this study conducted risk mitigation with the House of risk model 2 approach and this model 2 approach provides risk mitigation by assessing the correlation between work activities and risks that occur, the results of risk mitigation are obtained PA8 is ranked 1, namely bringing lighting equipment with an ETDk value of 268 because this lighting tool is widely used in several work activities such as starting a fire, adding husks, and turning off the fire after the baking process is complete while those who get the last ranking are using a welding helmet and earpark with a total ETDk value of 20 because this work activity is not done too often.

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MODELING BEHAVIOR OF USE AND ACCEPTANCE OF THE PLN MOBILE APPLICATION USING TECHNOLOGY ACCEPTANCE MODEL 3

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Abstract

In today's digital era, faster and faster service and repair processes are increasingly needed by companies and are in demand by customers. PLN makes innovations to improve the quality of service to customers in the form of the PLN Mobile application which provides PLN core services in real time and can be accessed anywhere. In order to improve the quality of service through the PLN Mobile application, knowledge is needed about the variables that influence consumer behavior and acceptance of PLN Mobile. There are several new technology acceptance models to analyze the variables that affect the users of a technology.
This research aims to find out the usage behavior and acceptance of the PLN Mobile application using the modified Technology Acceptance Model 3 (TAM 3) method. Data collection is done by online and offline survey method of users who have used PLN Mobile application features. The survey contains 46 question items from 17 variables using a likert scale (1-5). The data processing process uses the SEM - PLS (Structural Equation Model - Partial Least Square) analysis method. The results showed that the variables Output Quality (OUT) and Result Demonstration (RES) have a positive and significant effect on Perceived Usefulness (PU). Computer Self Efficacy (CSE) and Computer Anxiety (CANX) have a positive and significant effect on Perceived Ease of Use (PEOU). Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) have a positive and significant effect on Behavioral Intention (B). Behavioral Intention (B) has a positive and significant effect on Use Behavior (USE) on the use of the PLN Mobile application.

Keywords: PLN Mobile, TAM 3, Structural Equation Modeling (SEM), Use Behavior (USE)

INTRODUCTION

Technological developments facilitate people's activities so that it greatly influences everyday life. Every time, from the start of their activities to resting at night, they are always surrounded by technology, as a result, people become dependent on technology due to changing lifestyles (Sasono et al., 2021). Smartphones or smart phones are a technology that is very close to people's lives today, various brands to the operating system that each smartphone has. Likewise, the software provided varies with the aim of facilitating everyday life (Chang et al., 2012). PLN Mobile is a software that can be operated via a smartphone, thus enabling PLN electricity consumers to get PLN services anytime and anywhere. In line with generally a technology whose purpose is to simplify everyday life. Starting from reporting disturbances, complaints, buying electricity tokens to changes in electrical power can be accessed through the software. PLN understands that the PLN Mobile application makes it very easy for residents, but

data from the PLN East Java Distribution Main Unit (UID) shows that users of the PLN Mobile software in the Sutojayan Customer Service Unit (ULP) area have only 59,492 customers out of a holistic total of 90,540 customers or just less more than 65.7% of the total number of customers in the working area of PLN ULP Sutojayan. The high level of complaints from users at the start of the launch of the PLN Mobile application related to the PLN Mobile application features accompanied by a 1 star rating on the PLN Mobile application and a 1 star rating on service reviews, disruptions and complaints were also a concern for PLN Management to fix this problem. TAM itself was developed by Davis et al, based on the TRA model. TAM consists of 2 main constructs, namely perceived usefulness and perceived ease of use. TAM 3 is a development of TAM 1 where TAM 3 examines more deeply the determinants of perceived usefullness and perceived ease of use. In its development, the TAM method is not only used to measure the level of application acceptance but can also be used to measure application user usage behavior. This is mentioned in Al Ghatani's research (2001) which states that the behavior of using a system can be measured by several characteristics, such as the relationship between IT staff (in this case, managers of web-based learning (e-learning) and users), system usability and ease of use. useIn TAM 3, perceived usefulness has several determining factors, namely image (IMG), job relevance (REL), result demonstrable (RES), output quality (OUT), subjective norm (SN), and perceived ease of use (PEOU). TAM 3 also has moderating variables, namely voluntariness (VOL) and experience (EXP) (Venkatesh and Bala, 2008). Based on the description above, this research will analyze the behavior of using the PLN MOBILE application using the Technology Acceptance Model 3 (TAM 3) method to determine the factors that influence the behavior of using and accepting the PLN Mobile application. .

RESEARCH METHODS

In the research design, it describes the model used to determine what variables affect consumers in using the PLN Mobile application, where this modeling uses a conceptual model based on previous research and new findings that are tested empirically. This research uses a quantitative approach which is carried out by conducting a survey.

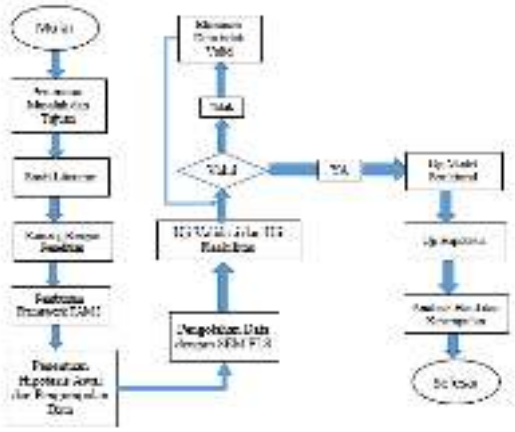

Figure 1. Research Flow

A. Identification of problems

From the description that has been written in the background, the formulation of the problem to be discussed in this study is:

1. What is the behavior of PLN consumers towards the use of the PLN Mobile application using the TAM 3 model modification analysis?
2. What are the results of the TAM 3 (Technology Acceptance Model 3) method that has been modified by researchers?
3. Variables - what variables can influence consumers to use the PLN Mobile application using the TAM 3 model modification.
4. What are the results of implementing the PLN Mobile application for PT PLN consumers?

B. Literature Study

At this stage the researcher searches, studies, and understands literature such as books, scientific journals, news, books and previous research which are used as references to support research implementation.

C. Determination of Population and Sample

In this study, the researchers chose respondents who are domiciled in the work area of PLN ULP Sutojayan, Blitar Regency. Sample selection was carried out by randomly selecting respondents who had previously registered using the features of the PLN Mobile application. The number of users domiciled in the work area of PLN ULP Sutojayan is unknown because it changes in real time. The minimum sample size is calculated using the Lameshow formula because the population size is unknown

$$n = \frac{z^2 p(1-p)}{d^2}$$

Information:
n = Number of samples
z = Standard value = 1.96
p = Maximum estimate = 50% = 0.5
d = alpha (0.10) or sampling error = 10%
Based on the formula and calculations above, it can be obtained that the number of samples in this study is 96.04. Total respondents in this study were 208 respondents.

D. Questionnaire Preparation

The preparation of the questionnaire in the study was carried out by adopting the dimensions of the Technology Acceptance Model 3 (TAM 3) model. TAM 3 variable according to (Venkatesh Bala, 2008).

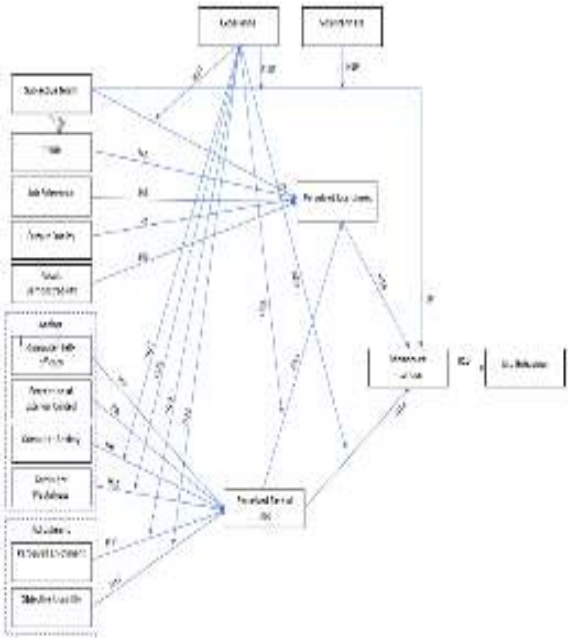

Figure 2. TAM 3 Model

Table 1. TAM 3 Variables and Indicators

Variable		Indicator
Subjective Norm (SN)	SN1	Influence the behavior of others to use the application
	SN2	Using the app because of other people
Experience (EXP)	EXP1	Experience using similar applications
	EXP 2	Experience using different applications
Voluntariness (VOL)	VOL1	Volunteer to use the application without coercion
	VOL2	Volunteer to use the application even though there are other alternatives
Image (IMG)	IMG1	Pride of using the application
	IMG2	Add profile
Job Relevance (REL)	REL1	Essential apps for work
	REL2	Work-related applications
	REL3	Applications related to tasks in work
Output quality (OUT)	OUT1	Application output quality
	OUT2	Application output problem
	OUT3	Application output assessment
Result Demonstrability (RES)	RES1	Ease of notifying results using the application
	RES2	Easily communicate to others the impact of using the app
Computer Self-Efficacy (CSE)	CSE1	Suggestions from other people using the app
	CSE2	Others tell about the app
	CSE3	Instructions for using the application come from other people
	CSE4	Previously used the same or similar application
Perception of External Control (PEC)	PEC1	Control in using the application
	PEC2	Personal resources using the app
	PEC3	The application is suitable and useful
Computer Anxiety (CANX)	CANX1	Dare to use a smartphone
	CANX2	Not nervous about using a smartphone
	CANX3	Convenience of using a smartphone
	CANX4	Smartphones do not create dependence
Computer Playfulness (CPLAY)	CPLAY1	Spontaneity
	CPLAY2	Skills
	CPLAY3	Fun application
Perceived Enjoyment (ENJ)	ENJ1	Discover the fun of using the app
	ENJ2	Convenience of using the application
	ENJ3	Happy to use the app
Objective Usability (OU)	OU1	Time using the app with other people
	OU2	Frequency of using the app with other people
Perceived Usefullness (PU)	PU1	Speed Up Work
	PU2	Effectiveness
	PU3	Simplify Work
Perceived Ease of Use (PEOU)	PEOU1	Easy to learn
	PEOU2	Clear and easy to understand
	PEOU3	Controllable
	PEOU4	Easy to become skilled/proficient
Behavioral Intention (BI)	B1	Intention to use the application
	B2	Use the app at a later date
	B3	Positive attitude
	B4	Trust in referrals
Use Behavioral (USE)	USE1	The average frequency of using the application every day
	USE2	Average time using the app each day

The hypothesis in this study is indicated by:

Table 2. Research Hypothesis

Kode	HIPOTESIS
H1	Subject norms have a positive influence on the perceived usefullness of the PLN MOBILE application.
H2	Image has a positive influence on the perceived usefulness of the PLN MOBILE application.
H3	Job relevance has a positive influence on the perceived usefulness of the PLN MOBILE application.
H4	Output quality has a positive influence on the perceived usefulness of the PLN MOBILE application.
H5	The results of demostrability have a positive influence on the perceived usefulness of the PLN MOBILE application.
H6	Subject norms have a positive influence on the image of PLN MOBILE application users.
H7	Computer self-efficacy has a positive influence on the perceived ease of use of the PLN MOBILE application.
H8	Perception of efficacy has a positive influence on the perceived ease of use of the PLN MOBILE application.
H9	Computer anxiety has a positive effect on the perceived ease of use of the PLN Mobile application
H10	Computer playfulness has a positive influence on the perceived ease of use of the PLN MOBILE application.
H11	Perceived enjoyment has a positive influence on the perceived ease of use of the PLN MOBILE application.
H12	Objective usability has a positive influence on the perceived ease of use of the PLN MOBILE application.
H13	Perceived usefulness has a positive influence on the behavioral intention of the PLN MOBILE application
H14	Perceived ease of use has a positive influence on the behavior intention of the PLN MOBILE application.
H15	Perceived ease of use has a positive influence on the perceived usefullness of the PLN MOBILE application
H16	Behavioral intention has a positive influence on the use behavior of the PLN MOBILE application
H17	Subject norms have a positive influence on the perceived usefulness of the PLN MOBILE application moderated by Experience
H18	Subject norms have a positive influence on the behavior intention of the PLN MOBILE application moderated by Experience
H19	Subject norms have a positive influence on the behavior intention of the PLN MOBILE application moderated by voluntariness
H20	Subject norms have a positive influence on the behavior intention of the PLN MOBILE application.
H21	Computer anxiety has a positive influence on the perceived ease of use of the PLN MOBILE application moderated by Experience
H22	Computer playfulness has a positive influence on the perceived ease of use of the PLN MOBILE application moderated by Experience
H23	Perceived enjoyment has a positive influence on the perceived ease of use of the PLN MOBILE application moderated by Experience
H24	Objective usability has a positive influence on the perceived ease of use of the PLN MOBILE application moderated by Experience
H25	Perceived ease of use has a positive influence on the perceived usefulness of the PLN MOBILE application moderated by Experience
H26	Perceived ease of use has a positive influence on the behavioral intention of the PLN MOBILE application moderated by Experience

E. Data collection

Researchers distributed questionnaires via google forms and offline questionnaires.

F. Data Analysis and Evaluation

1. Measurement Model Testing (Outer Model)

This stage aims to determine the validity and reliability of the variables for each indicator in the construction studied . The indicators in this test can be formative or reflective. Testing this measurement model has certain criteria based on the type of indicator as presented in the table

Table 3. Reflective Indicators

Criteria	Definition
Indikator Loadings	*Indikator Loadings ≥ 0.708*
Construct Reliability	*Internal Consistency Reliability ≥ 0.7*
Convergent Validity	*Average Variance Extracted* (AVE) *≥ 0.5*
Discriminant Validity	HTMT < 0.9

2. Structural Model Testing (Inner Model)

The structural model testing phase (Inner Model) aims to determine the variance of the relationship between exogenous and endogenous variables from the structural model so that how well a concept can be measured. There are several methods used in this method. The methods that can be used can be seen in the following table:

Table 4. Inner Model

Criteria	Definition
Path Coefficients	P values < 0.10
Coefficient Determination (R^2)	R^2 = 0,25 (Weak) R^2 = 0,5 (Moderate) R^2 = 0,75 (Strong)
Effect Size (f^2)	f^2= 0,02 (Weak) f^2 = 0,15 (Moderate) f^2 = 0,35 (Strong)
Cross-Validated Redundancy (Q^2)	$Q^2 > 0$

3. Hypothesis test

After the results of the measurement model (Outer Model) and the structural model (Inner Model) are of good quality, it can be continued to test the 26 hypotheses from TAM 3 in this study. Testing this hypothesis aims to determine whether the independent variables have a significant influence on the dependent variable in the structural model studied. This study uses an alpha (α) value of 10% with the following conditions:

- If the If P-Value ≤ alpha value (α), then the HYPOTHESIS is accepted
- If the If P-Value > alpha value (α), then the HYPOTHESIS is rejected .

4. Managerial Implications

The results of the research will be analyzed and used to obtain suggestions for further development of the PLN Mobile Application service .

5. Conclusion

Conclusions are drawn from the results of the research to answer the questions that have been explained in the introduction.

RESULTS AND DISCUSSION

Evaluation of the Measurement Model (Outer Model)

Evaluation of the Measurement Model (outer model) is carried out with 4 criteria that must be met, namely the Construct Reliability Test (consisting of the composite reliability test and Cronbach Alpha); Convergent Validity (AVE) Test and Outer Loading Test and HTMT Discriminant Validity Test.

- Construct Reliability

Table 5. Construct Reliability

Variable	Cronbach's Alpha	Composite Reliability
B	0,780	0,860
CANX	0,724	0,827
CPLAY	0,817	0,889
CSE	0,814	0,890
ENJ	0,706	0,833
EXP	0,829	0,921
EXP*CANX	1,000	1,000
EXP*CPLAY	1,000	1,000
EXP*PEC	1,000	1,000
EXP*PEOU	1,000	1,000
EXP*PEOU (B)	1,000	1,000
EXP*SN	1,000	1,000
EXP*SN (B)	1,000	1,000
IMG	0,784	0,902
OUT	0,803	0,881
PEC	0,748	0,857
PEOU	0,774	0,856
PU	0,809	0,887
REL	0,846	0,906
RES	0,826	0,919
SN	0,853	0,931
USE	0,786	0,900
VOL	0,752	0,889
VOL*SN	0,929	0,947

From the table above, we get the research variables with values composite reliability ≥ 0.7 and cronbach alpha ≥ 0.7 declared reliable, except for the OU variable whose Cronbach alpha value is below 0.7. This unreliable variable was removed from the research model because it was not reliable

- Convergent Validity and Outer loading Test

An indicator is said to have good reliability when the value is from Outer loading > 0.7. In research on undeveloped fields, Outer loadingvalues can use a scale of 0.5-0.6, said to have sufficient reliability. Average Variance Extracted - AVE is used to determine whether the discriminant validity requirement is met. The minimum value to state that reliability has been achieved is 0.50.

Table 6. Outer Loading & AVE

Variabel	Indikator	Outer Loading	AVE	KET
Output Quality	OUT1	0,876	0,712	Valid
	OUT2	0,780		
	OUT3	0,871		
Perception of External Control	PEC1	0,809	0,669	Valid
	PEC2	0,900		
	PEC3	0,737		
Perceived Ease of Use	PEOU1	0,842	0,601	Valid
	PEOU2	0,74		
	PEOU3	0,622		
	PEOU4	0,872		
Perceived Usefulness	PU1	0,828	0,724	Valid
	PU2	0,913		
	PU3	0,809		
Job Relevance	REL1	0,803	0,763	Valid
	REL2	0,863		
	REL3	0,949		
Result Demonstrability	RES1	0,906	0,850	Valid
	RES2	0,938		Valid
*Moderasi SN *PU*	SN*EX	1,472	1	Valid
*Moderasi SN *B*	SN*EX (B)	1,472	1	Valid
*Moderasi SN*VOL*	VOL1*SN1	1,082	0,819	Valid
	VOL1*SN2	1,077		
	VOL2*SN1	1,16		
	VOL2*SN2	1,155		

Variabel	Indikator	Outer Loading	AVE	KET
Behavior Intention	B 1	0,845	0,611	Valid
	B 2	0,775		
	B 3	0,571		
	B 4	0,895		
Computer Anxiety	CANX1	0,723	0,545	Valid
	CANX2	0,768		
	CANX3	0,665		
	CANX4	0,791		
Computer Playfulnes	CPLAY1	0,871	0,727	Valid
	CPLAY2	0,902		
	CPLAY3	0,871		
Computer Self Efficacy	CSE1	0,881	0,729	Valid
	CSE2	0,859		
	CSE3	0,820		
Perceived Enjoyment	ENJ1	0,790	0,628	Valid
	ENJ2	0,911		
	ENJ3	0,656		
Experience	EXP1	0,937	0,853	Valid
	EXP2	0,91		
Image	IMG1	0,912	0,822	Valid
	IMG2	0,902		Valid
*Moderasi EXP*CANX*	EXP*CANX	1,312	1	Valid
*Moderasi EXP*CPLAY*	CPLAY*EXP	1,457	1	Valid
*Moderasi EXP*PEC*	EXP*PEC	1,403	1	Valid
*Moderasi EXP*PEOU*	EXP*PEOU	1,247	1	Valid
Subjective Norm	SN1	0,938	0,871	Valid
	SN2	0,929		
Use Behavioral	USE1	0,940	0,819	Valid

There are several indicators with values Outer loading < 0.7 but still > 0.5, namely indicators B3, CANX3, ENJ3, OU2, PEOU3. This indicator does not need to be removed because the AVE value is still > 0.5.

- HTMT Discriminant Validity Test

Table 8. HTML

	B	CANX	CPLAY	CSE	ENJ	EXP	EXP*CANX	EXP*CPLA	EXP*PEC	EXP*PEO	EXP*PU	EXP*SN	IMG	OUT	PEC	PEOU	PU	REL	RES	SN	USE	VOL	VOL*SN
B																							
CANX	0,845																						
CPLAY	0,355	0,425																					
CSE	0,843	0,854	0,382																				
ENJ	0,836	0,817	0,532	0,837																			
EXP	0,214	0,189	0,536	0,182	0,137																		
EXP*CANX	0,216	0,247	0,11	0,229	0,206	0,145																	
EXP*CPLA	0,188	0,065	0,376	0,112	0,07	0,294	0,294																
EXP*PEC	0,210	0,275	0,127	0,253	0,276	0,002	0,852	0,308															
EXP*PEO	0,198	0,210	0,459	0,203	0,242	0,257	0,805	0,245	0,793														
EXP*PU	0,190	0,212	0,554	0,209	0,242	0,251	0,806	0,245	0,793	0,883													
EXP*SN	0,091	0,115	0,373	0,105	0,08	0,259	0,305	0,868	0,322	0,259	0,259												
EXP*SN	0,091	0,115	0,373	0,105	0,08	0,259	0,305	0,868	0,322	0,259	0,259	0,753											
IMG	0,355	0,425	0,655	0,357	0,267	0,516	0,998	0,311	0,091	0,135	0,135	0,310	0,310										
OUT	0,742	0,559	0,355	0,692	0,825	0,09	0,304	0,955	0,294	0,221	0,221	0,095	0,095	0,251									
PEC	0,674	0,907	0,439	0,753	0,809	0,121	0,214	0,113	0,906	0,215	0,215	0,132	0,132	0,436	0,895								
PEOU	0,849	0,878	0,306	0,893	0,786	0,252	0,172	0,143	0,195	0,175	0,175	0,134	0,134	0,333	0,573	0,857							
PU	0,734	0,828	0,223	0,732	0,754	0,143	0,102	0,101	0,201	0,210	0,210	0,101	0,101	0,223	0,846	0,848	0,877						
REL	0,394	0,437	0,643	0,423	0,549	0,491	0,152	0,071	0,159	0,171	0,171	0,071	0,071	0,881	0,071	0,455	0,327	0,892					
RES	0,728	0,516	0,651	0,677	0,802	0,259	0,148	0,245	0,168	0,135	0,135	0,245	0,245	0,672	0,611	0,829	0,828	0,793	0,694				
SN	0,348	0,459	0,545	0,334	0,378	0,459	0,115	0,354	0,128	0,147	0,147	0,952	0,952	0,516	0,272	0,453	0,297	0,224	0,322	0,666			
USE	0,795	0,848	0,292	0,890	0,811	0,153	0,104	0,114	0,035	0,270	0,270	0,103	0,103	0,270	0,520	0,788	0,673	0,875	0,330	0,516	0,229		
VOL	0,366	0,267	0,543	0,372	0,286	0,512	0,145	0,305	0,172	0,172	0,172	0,444	0,444	0,572	0,325	0,431	0,228	0,353	0,742	0,666	0,732	0,287	
VOL*SN	0,173	0,194	0,495	0,159	0,148	0,373	0,269	0,769	0,232	0,271	0,271	0,714	0,714	0,495	0,094	0,134	0,259	0,143	0,498	0,344	0,498	0,067	0,501

Discriminant Validity Test are said to be valid if they have a heterotrait-monotrait ratio (HTMT) value of <0.9. Based on the table above, it can be concluded that all variables have an HTMT value <0.9 so that the questionnaire is declared valid.

- Hypothesis testing

Hypothesis test using the accelerated bootstrapping method are biased with a significance value of 0.1. Sorting hypotheses that are accepted or rejected is done by sorting hypotheses with a p value <0.1 for these hypotheses to be accepted. The results of the bootstrapping test in the first iteration are listed in the table below:

Table 9. First iteration P-Values

Hubungan	Org sample	T stats	*P Values*
B -> *USE*	0,666	14,017	0,000
CANX -> PEOU	0,289	4,482	0,000
CPLAY -> PEOU	-0,104	1,978	0,024
CSE -> PEOU	0,566	8,553	0,000
ENJ -> PEOU	0,074	0,948	0,172
EXP -> B	0,018	0,807	0,210
EXP -> PEOU	0,108	1,872	0,031
EXP -> PU	-0,042	1,184	0,118
IMG -> PU	-0,016	0,320	0,374
OUT -> PU	0,465	14,779	0,000
PEC -> PEOU	-0,027	0,319	0,375
PEOU -> B	0,492	8,607	0,000
PEOU -> PU	0,512	10,744	0,000
PU -> B	0,512	8,407	0,000
REL -> PU	-0,025	0,462	0,322
RES -> PU	0,163	4,260	0,000
SN -> B	-0,010	0,308	0,379
SN -> PU	0,004	0,064	0,475
VOL -> B	0,056	1,779	0,038
EXP x PU -> B	-0,007	0,127	0,450
EXP x SN -> PU	0,006	0,215	0,415
VOL x SN -> B	0,033	1,535	0,062
EXP x CANX -> PEOU	0,050	0,871	0,192
EXP x CPLAY -> PEOU	-0,050	1,406	0,080
EXP x ENJ -> PEOU	0,035	0,540	0,294
EXP x PEOU -> B	0,014	0,287	0,387
EXP x PEOU -> PU	-0,021	0,888	0,187

After the first iteration is carried out, the relationship between variables with the highest P values is sought to be removed from the research model. Then the bootstrapping method is iterated again , then the relationship between variables with the highest P Values is searched again to be removed again from the research model and this iteration continues until it is found that all relationships between variables have P Values that meet the significant requirements, namely P Values below < 0.1. When a variable has no significant relationship at all with other variables, then that variable is removed from the research model . After 7 iterations, it was found that there were 12 hypotheses that could be accepted.

Attached is the final bootstrapping iteration table for the final model of the study:

Table 10. P-Values of the last iteration

Hubungan	Org sample	T stats	*P Values*
B -> *USE*	0,666	13,717	0,000
CANX -> PEOU	0,307	6,046	0,000
CPLAY -> PEOU	-0,106	1,988	0,024
CSE -> PEOU	0,585	12,381	0,000
EXP -> PEOU	0,122	2,455	0,007
OUT -> PU	0,477	15,696	0,000
PEOU -> B	0,487	8,515	0,000
PEOU -> PU	0,506	11,288	0,000
PU -> B	0,521	8,753	0,000
REL -> PU	-0,052	1,581	0,057
RES -> PU	0,159	4,181	0,000
EXP x CANX -> PEOU	0,083	2,254	0,012
EXP x CPLAY -> PEOU	-0,045	1,400	0,081

The table above shows that of the 26 hypotheses proposed, there are 12 hypotheses

that have a significant effect, namely H3, H4, H5, H7, H9, H10, H13, H14, H15, H16, H21, and H22. The positive effect is shown in the original sample which has a positive value and a negative influence on the original until it has a negative value. Significant influence is indicated by the p-value that meets the requirements (p-value <0.05). Then the remaining 14 hypotheses do not have a significant effect because they have a p-value > 0.05 or have no relationship with other variables apart from the hypothesis variable itself (SN->IMG).

Final Research Model

The results of the analysis of the respondent's data after going through the process of testing the measurement model (Outer Model), structural model (Inner Model), and hypothesis testing showed that the variables OUT, RES, and PEOU had a direct positive and significant effect on PU variables; the variables CSE and CANX have a positive and significant direct effect on PEOU; PU and PEOU variables have a direct positive and significant effect on B ; variable B has a direct positive and significant effect on USE.

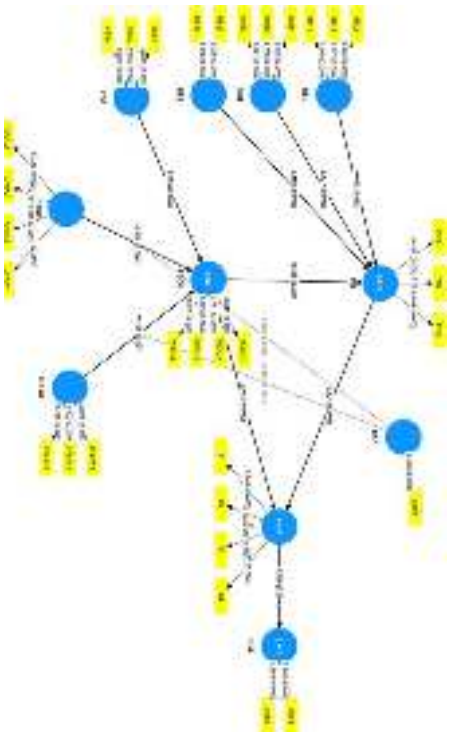

Figure 4. Final Research Model

The structural model formula is obtained as follows:

1. USE = 0.666 B
2. B = 0.521 PU+ 0.487 PEOU
3. PU = 0.477 OUT + 0.159 RES + 0.506 PEOU – 0.052 RES
4. PEOU = 0.585 CSE + 0.307 CANX + 0.122 EXP + 0.083 CANX*EXP
5. PEOU = 0.585 CSE + -0.106 CPLAY + 0.122 EXP - 0.045 CPLAY*EXP

Inner Model

Inner Model Testing is a structural model that is used to predict the causality relationship (cause and effect relationship) between latent variables or variables that cannot be measured directly. The structural model (Inner Model) describes the causality relationship between latent variables that has been built based on the substance of the theory. In the structural model test (Inner Model) using the help of the Bootstrapping procedure in the SMART PLS application . There are 4 types of tests performed on structural model evaluation, namely Coefficient Determination (R^2) , Cross-Validated Redundancy (Q^2), Effect size (f^2) and Path Coefficients (Hair et al., 2019)

- Coefficient Determination Test (R^2)

Table 11. R test ^{2}

Variabel	*R-Square*	Keterangan
PU	0,919	Kuat
PEOU	0,624	Sedang
B	0,870	Kuat
USE	0,553	Sedang

The coefficient of determinant (R^2) shows the size of the combination of exogenous variables that affect the endogenous variable values in the range of 0 - 1. The closer to the value 1 means the stronger the influence between endogenous-exogenous variables, the better the model that appears in the regression. Criteria for R2 value > 0.75

(strong), R2 value > PU 0.50 (medium), and R2 value > 0.25 (weak).

- Cross-Validated Redundancy Test (Q^2)

Table 12. Q^2

Variabel Endogen	Q^2
Perceived Usefulness (PU)	0.615
Perceived Ease of Use (PEOU)	0.343
Behavioral Intention to Use (B)	0.550
Use Behaviour (USE)	0.344

The Q2 test was carried out using the blindfolding method on the SmartPLS application . Cross-Validated Redundancy Test (Q2) used for represents a synthesis of validation and fitting functions with predictions of manifest variables and estimates of construct parameters. The value of Q2 > 0 indicates that the model has predictive relevance, while Q2 <0 indicates that the model lacks predictive relevance (Ghozali and Latan, 2015). Based on table on, results testing obtained all values > 0 which showing that model own strong predictive relevance value

- **f^2 test**

Table 13. Test f^2

Hipotesis	Hubungan Antar Variabel	*f2*	KET
H3	REL->PU	0.024	Efek Lemah
H4	OUT -> PU	1,176	Efek Kuat
H5	RES -> PU	0,095	Efek Kuat
H7	CSE -> PEOU	0,488	Efek Sedang
H9	CANX -> PEOU	0,138	Efek Lemah
H10	CPLAY->PEOU	0.020	Efek Lemah
H13	PU -> B	1.156	Efek Kuat
H14	PEOU -> B	1,010	Efek Kuat
H15	PEOU -> PU	1,297	Efek Kuat
H16	B -> *USE*	0,797	Efek Kuat
H21	EXP*CANX->PEOU	0.025	Efek Lemah
H22	EXP*CPLAY->PEOU	0.020	Efek Lemah

Effect Size testing uses a value of f^2 with the criterion value of $f^2 > 0.35$ (strong), f^2 value > 0.15 (medium), and $f^{2\ value} > 0.02$ (weak).

- Coefficient Path Test

Table 14. Path Coefficient

Hipotesis	Hubungan Antar Variabel	*Path Coefficient*
H3	REL ->PU	-0.052
H4	OUT -> PU	0.474
H5	RES -> PU	0.130
H7	CSE -> PEOU	0.557
H9	CANX -> PEOU	0.287
H10	CPLAY->PEOU	-0.106
H13	PU -> B	0.521
H14	PEOU -> B	0.487
H15	PEOU -> PU	0.510
H16	B -> *USE*	0.666
H21	EXP*CANX->PEOU	0.083
H22	EXP*CPLAY->PEOU	-0.045

Path Coefficient ranging from -1 to +1. A Path Coefficient value that is close to +1 indicates that the relationship between exogenous and endogenous variables has a positive relationship, whereas when it is close to -1 it means that the relationship is negative.

Managerial Implications

Managerial implications that can be applied from the research results are as follows:

1. Output Quality (OUT) variable , PLN Mobile application users are very concerned about the output of the PLN Mobil feature where the smoothness, efficiency, and completeness of application features play an important role. PLN must continue to improve application performance on an ongoing basis, especially in terms of smoothness and completeness of features so that the output of application features is maintained of good quality. Application features must be able to run without bugs, with complete features added so that all PLN services must be able to go through the application, and customers do not need to come to the PLN office to take care of any problems related to PLN. This will increase user interest in using the application and become a new habit for users to use the application
2. From the results of the Result Demonstration (RES) research, users of the PLN Mobile application are very concerned about the ease

of communicating the results, impacts, and advantages of using PLN Mobile . So PLN must develop a strategy, both a marketing strategy and an application development strategy so that the impacts and benefits of using the PLN Mobile application can be socialized more broadly to the public.

3. From the results of research where Job Relevance has a significant negative effect on Perceived Usefulness , it shows that PLN Mobile application users use this application the majority when there are problems related to electricity services (questionnaire results show the 2 most frequently used features are reporting disturbances/complaints and requests for information. So the use PLN Mobile tends to be associated as there are problems that occur in PLN services that could interfere with user work activities.PLN can develop applications to make it more relevant to help its users' work activities regardless of demographics, for example adding an alarm feature for postpaid customers who have not paid for electricity after passing the 20th (Unpaid -> electricity temporarily turned off -> work activity interrupted) and other features that are useful in general.

CONCLUSIONS AND RECOMMENDATIONS

The research that has been done regarding the Modeling of Satisfaction Using the PLN Mobile Application Using Technology Acceptance Model 3, the following conclusions are obtained:

1. Job Relevance, Output Quality (OUT), Result Demonstration (RES), Computer Self Efficacy (CSE), Computer Anxiety (CANX), Computer Playfulness , Perceived Usefulness (PU), Perceived Ease of Use (PEOU), Experience Moderation from Computer Anxiety (CANX) and Computers Playfulness (CPLAY) to Perceived Ease of Use (PEOU) , Behavioral Intention (B) has a significant influence on the Use Behavior (USE) of PLN Mobile application users in the working area of PLN ULP Sutojayan.
2. Experience Moderation Variable (EXP) significant effect in moderating the Computer Anxiety (CANX) and Computer Playfulness (CPLAY) variables of 0.083 and -0.045. The relationship between the Experience variable and the Perceived Ease of Use variable is significantly positive at 0.122.
3. Perceived Usefulness (PU) is significantly influenced by the variables Job Relevance (REL), Output Quality (OUT), Result Demonstration (RES) and Perceived Ease of Use (PEOU) with each of -0.052, 0.477, 0.159, and 0.506 respectively. Perceived Usefulness (PU) of the PLN Mobile application users in the work area of PLN ULP Sutojayan will increase if the Output Quality (OUT), Result Demonstration (RES) and Perceived Ease of Use (PEOU) variables increase and will decrease if the Job Relevance variable increases.
4. Perceived Ease of Use (PEOU) is significantly influenced by Computer Self Efficacy (CSE), Computer Anxiety (CANX), Computer Playfulness (CPLAY) variables and EXP moderation variable on Computer Anxiety (CANX). and Computer Playfulness (CPLAY). There are 2 structural equations that appear, namely PEOU = 0.585 CSE + 0.307 CANX + 0.122 EXP + 0.083 CANX*EXP and PEOU = 0.585 CSE -0.106 CPLAY + 0.122 EXP - 0.045 CPLAY*EXP. Perceived Ease of Use (PEOU) for PLN Mobile application users in the work area of ULP Sutojayan will increase if the Computer Self Efficacy (CSE) variable, Computer Anxiety (CANX), the EXP moderation variable for Computer Anxiety (CANX) increases and will decrease if the Computer variable Playfulness (CPLAY) and EXP moderation towards Computer Playfulness (CPLAY) increased.
5. Behavioral Intention (B) is significantly and positively influenced by the variables Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) with respectively 0.521 and 0.487. Behavioral Intention (B) of PLN Mobile application users in the work area of PLN ULP Sutojayan will increase if Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) increase.
6. Behavioral Use (USE) is positively and significantly influenced by Behavioral Intention (B) of 0.666. Use Behavior (USE) for PLN Mobile application users in the work area of PLN ULP Sutojayan will increase if Behavioral Intention (B) increases.

7. Subjective Norm (SN), Image (IMG), Job Relevance (REL), Perception of External Control (PEC), Computer Playfulness (CPLAY), Perceived Enjoyment (ENJ), Objective Usability (OU), Experience (EXP), and Voluntariness (VOL) has no significant effect on the exit variable. This shows that these variables do not have a significant impact on the use and acceptance of the PLN Mobile application in the work area of ULP Sutojayan.

Suggestion

1. Future research can broaden the scope of research by adding other areas with more samples, so that research results have higher/bigger generalizability.
2. Future research can use other external variables in research, such as trust and price value , so that more in-depth research results can be obtained.
3. PT PLN (Persero) needs to be more aggressive in increasing socialization regarding the ease and benefits of using the PLN Mobile application . Socialization can be held in the form of webinars, competitions, advertisements in various media, as well as mutually beneficial cooperation with the government and the private sector.

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INTER REGIONAL INPUT OUTPUT ANALYSIS FOR THE ECONOMIC RECOVERY STRATEGY OF ACCOMMODATION AND FOOD SERVICE ACTIVITIES SECTOR IN BALI PROVINCE POST PANDEMIC COVID-19

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ABSTRACT

The impact of the Covid-19 Pandemic on economic conditions in Indonesia can be seen from the decline or slowdown in national economic growth as reflected in the Gross Domestic Product (GDP). The Accommodation and Food Service Activities sector was chosen as the object of research because according to data released by the Central Statistics Agency (BPS) this sector was one of the sectors that was most heavily affected during the Covid-19 Pandemic. This research was conducted using the Inter Regional Input Output (IRIO) Model approach to determine priorities for economic sectors that have a significant impact on increasing economic growth to accelerate economic recovery, specifically the Accommodation and Food Services Activites and Province of Bali in general. An approach using the IRIO model will help show the power distribution and degree of sensitivity of the economic sectors in the Province of Bali. Through the simulations that have been carried out, it was found that if the Government wants to encourage an increase in final demand in the Province of Bali, the stimulus assistance can be distributed to 13 sectors that fall into the category of non-leading sectors so that it will provide an increase in final demand for the Province of Bali with an average an increase of 7.599 percent

Keywords: Accomodation and Food Service Activities, Economy growth, Gross Domestic Product, Input Output, Inter Regional Input Output

1. INTRODUCTION

The Covid-19 pandemic has hit almost all countries since the end of 2019. Starting from one country, the Covid-19 pandemic quickly began to spread to all parts of the world. The economic impact of the pandemic hit countries significant. This can be seen from the decline in economic growth, increased unemployment, and increased poverty rates, as well as other impacts. For Indonesia itself, the main impact of the pandemic from an economic and social perspective can be seen from the figures produced by BPS. This condition has affected almost all sectors of economic activity. The Accommodation and Food Service sector is one of the sectors that has been quite badly affected.

Figure 1.1 Q2 2020 GDP Growth Rate (BPS, 2021)

Figure 1.1 shows that the Accommodation and Food Service Sector was the sector that experienced the second largest decline after the Transportation and Warehousing sector, reaching -22.02 percent. This provides an illustration of how big the impact of the pandemic is on the Accommodation and Food Service Sector. Here is an example.

Bali is one area that has quite a lot of tourism destinations. In fact, Bali is well-known to foreign countries as an Indonesian tourism area that offers extraordinary tourist charms, and Bali has the nickname "Island of the Gods". The Covid-19 pandemic hit Bali tourism hard enough to almost paralyze all tourism activities in Bali. Many economies in the archipelago are particularly dependent on foreign tourists for the tourism industry and regional economic growth (Pratt, 2015). The tourism industry's dependence on foreign tourists is the basis for this research to specifically analyze the Province of Bali as a research object to see the impact of the Covid-19 pandemic on the The Accommodation and Food Service Activities Sector. In addition, tourism is considered as a solution for economic recovery or improvement in a region (Pratt, 2011).

According to BPS data, up to the Fourth Quarter, Bali's economy in 2020 recorded negative growth of -9.31 percent. Even though it is still experiencing negative growth, when compared to conditions in the First Quarter and Second Quarter, conditions in the Third Quarter and Fourth Quarter of 2020 have improved. In the fourth quarter, The Accommodation and Food Service Activities sector became one of the three economic sectors which recorded the most significant positive growth, namely up to 3.61 percent when compared to the third quarter. According to BPS data, this is because tourist visits, which are dominated by domestic tourists, have increased, thus encouraging an increase in added value in the The Accommodation and Food Service Activities sector business fields. This increase can be seen in Figure 1.2.

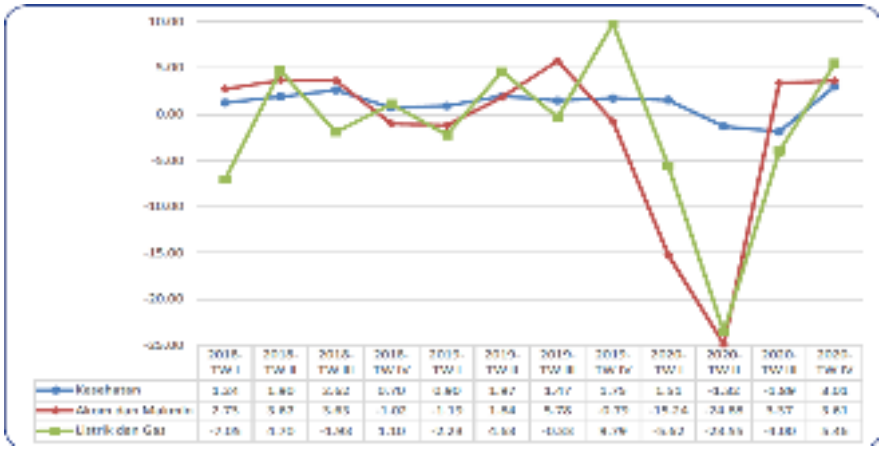

Figure 1.2 Growth Rate (%) of the Three Highest Business Fields in 2018-2020 (q to q) Bali Province (BPS, 2021)

2. LITERATURE REVIEW

The Input Output model is basically a description in the form of a matrix which presents information about transactions of goods and services and the interrelationships between units of economic activity (sectors) in an area for a certain period (BPS, 2021). This matrix can also be used to predict the effect of changes in one sector on other sectors (Doherty et al., 2007). The value along the row in the matrix is an illustration of the output of an economic sector allocated to other sectors to meet intermediate demand and final demand. The input output model is a model originally released by Wassily Leontief around 1930 and is a model based on the principle of general balance. In Indonesia, the input-output model was prepared by BPS by deriving the SUT Table (Supply and Used Table) where this table is a table composed of basic data. The input-output table matrix contains rows which represent output allocations produced by a sector to meet intermediate and final demand, while the column sections represent the input structure used by each sector in the production process, both intermediate and primary inputs. The I/O model is also a model that can be used or used to see and measure the impact of a phenomenon, for example a natural disaster on economic conditions in a region (Yagi et al., 2020). Chinese economists claim that I/O models are very useful in analysis, planning, management, and even economic predictions (Chen et al., 2005).

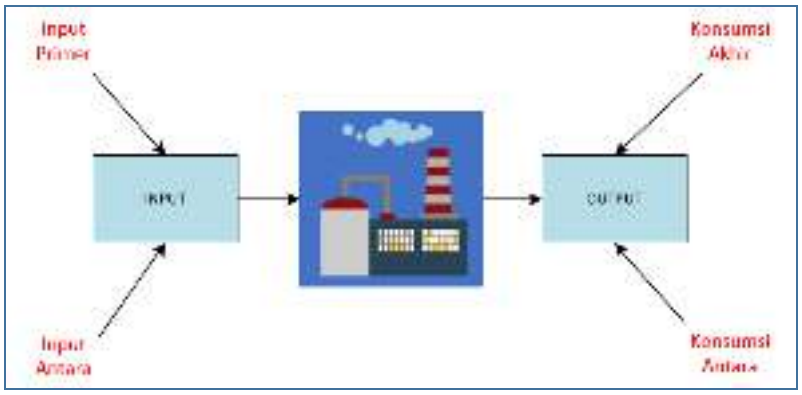

Figure 2.1 Illustration of Input Output Model

The input output table compiled has three basic assumptions namely;

a. Uniformity (homogeneity), namely that each existing sector only produces one type of output with a single input structure.
b. Proportionality, namely the use of inputs in a sector will be directly proportional to the output produced.
c. The additivity of the effects of production activities in various sectors is the sum of the influences exerted by each of these sectors.

Through the three assumptions used, the I/O model will provide the following benefits;

a. As a descriptive analysis, which can be used to see the composition of the supply and use of goods and services, especially in the analysis of import needs and the possibility of substitution.
b. As a multiplier and linkage analysis, which can be used to see which sectors provide the most dominant influence on economic growth and sectors that are sensitive to economic growth both nationally and regionally.
c. As an impact analysis, which can be used to predict the impact of final demand on output, value added imports, tax revenues, and employment in various production sectors.
d. As a predictive tool, that is, it can be used to compile projections and evaluate macroeconomic variables.

Presentation of information in the input output table shows the connectedness of economic activities carried out by each sector. So that the model formed makes it possible to see cross-sectoral relationships (Velázquez, 2006). Here's the equation as follows:

$$\begin{aligned} x_{11}+x_{12}+x_{13}+F_1 &= X_1+M_1 \\ x_{21}+x_{22}+x_{23}+F_2 &= X_2+M_2 \\ x_{31}+x_{32}+x_{33}+F_3 &= X_3+M_3 \end{aligned}$$

……. (2.1)

Equation (2.1) can be written in a more general equation as follows:

$$\sum_{j=1}^{3} x_{ij}+F_i = X_i+M_i \, , untuk \; i = 1,2,3$$

……. (2.2)

or

$$X_i = \sum_{j-1}^{3} x_{ij} + F_i + M_i$$

……. (2.3)

where:

x_{ij} = Sector I provider used by sector j
X_i = Total output (domestic) sector i
F_i = Final demand for sector i
M_i = Imports in sector I

By using the same process flow, input and output allocations in each other sector can be calculated and then combined through the following formula:

$$\begin{aligned} x_{11}+x_{21}+x_{31}+V_1 &= X_1 \\ x_{12}+x_{22}+x_{32}+V_2 &= X_2 \\ x_{13}+x_{23}+x_{33}+V_3 &= X_3 \end{aligned}$$

……. (2.4)

or

$$\sum_{j=1}^{3} x_{ij} + V_j = X_j, untuk\ j = 1, 2, 3$$

……. (2.5)

where:

V_j = sector primary input j

In addition, the assumptions used in the I/O model apply that the amount of input used by a sector must be equal to the amount of its output. This is stated in the following formula:

$$\sum_{i=1}^{n} X_i = \sum_{j=1}^{n} X_j$$

……. (2.6)

Equation (2.6) is an equation that explains the relationship between the figures presented in the input-output table and the GDP figures. Through the two previous equations, namely equations (2.3) and (2.5), we obtain:

$$\sum_{i=1}^{n} X_i = \sum_{i=1}^{n}\sum_{j=1}^{n} x_{ij} + \sum_{i=1}^{n} F_i - \sum_{i=1}^{n} M_i$$

……. (2.7a)

$$\sum_{i=1}^{n} X_i = \sum_{i=1}^{n}\sum_{j=1}^{n} x_{ij} + \sum_{j=1}^{n} V_j$$

……. (2.7b)

Based on equation (2.6), equation (2.7a) can be substituted into equation (2.7b), so it becomes the following:

$$\sum_{i=1}^{n}\sum_{j=1}^{n} x_{ij} + \sum_{i-1}^{n} F_i - \sum_{i=1}^{n} M_i = \sum_{j=1}^{n}\sum_{i=1}^{n} x_{ij} + \sum_{j=1}^{n} V_j$$

bacause $\sum_{i=1}^{n}\sum_{j=1}^{n} x_{ij} = \sum_{j=1}^{n}\sum_{i=1}^{n} x_{ij}$ then the equation is obtained:

$$\sum_{i=1}^{n} F_i - \sum_{i=1}^{n} M_i = \sum_{i=1}^{n} V_j$$

……. (2.8)

Equation (2.8) is the total added value of all existing economic sectors and is the same as GDP. Equation (2.8) only applies to the economy as a whole and not per sector.

3. METHODS

Analysis of the problems as presented in the background of the problem shows that the The Accommodation and Food Service Activities Sector is one of the sectors most significantly affected by the Covid-19 pandemic. The Accommodation and Food Service Activities sector is very closely related to the tourism industry operating in Indonesia. Therefore, the The Accommodation and Food Service Activities Sector is the sector chosen to be the focus of this research. Furthermore, because accommodation and eating and drinking are closely related to the tourism industry as previously explained, to sharpen the analysis, the research focus will also focus on the Province of Bali or the Province of Bali. Bali was chosen because it is a region which

is also a province. Bali is also an archipelago that has many tourist destinations, one might even say that its economy is based on the tourism industry. Making the The Accommodation and Food Service Activities Sector in the Province of Bali the focus of research is expected to provide more accurate research results.

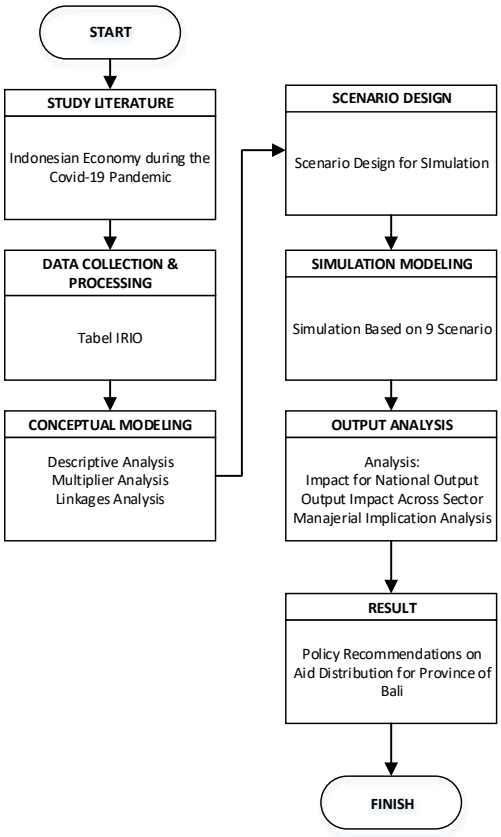

Figure 3.1 Research Methodology

The research scope is in the I/O analysis, the research area coverage is national and in the IRIO Table analysis, the area coverage is regional in the Province of Bali. In the analysis of the IRIO table, it can be seen in detail how the economic structure in the Province of Bali and the sectors that have a direct impact on the economy. The first scenario that will be simulated is to enter the aid component according to the predetermined province. The second and subsequent scenarios will adjust the value of assistance in the Province of Bali. In addition, assistance for the 2021 fiscal year can also be used as a basis for the simulations to be carried out because the PEN program is still ongoing and the absorption report has been published by the Ministry of Finance of the Republic of Indonesia.

4. RESULTS

Through the results of the descriptive analysis that has been carried out on the economic sector in the Province of Bali, it is known that The Accommodation and Food Service Activities Sector is the sector that has the largest contribution to the formation of output, intermediate consumption, and labor.

Through the results of the multiplier analysis that has been carried out, it can be seen that the sector that has the highest multiplier figure in the Province of Bali in output formation is the Electricity and Gas Procurement Sector, then in the formation of gross added value is the Financial Services and Insurance Sector, and finally in the formation of the workforce is the Education Services Sector.

Linkage analysis is an analysis that can provide information about the impact of linkages between economic sectors or production sectors within a province. The impact of linkages is carried out by analyzing the numbers or values that appear in the form of a power distribution index (IDP) and a degree of sensitivity index (IDK) or commonly known as power distribution and degree of sensitivity in the IRIO model. the two indices are usually analyzed using quadrants to assist in the interpretation process.

Table 5.1 Value of the Economic Sector Quadrant of the Province of Bali

Provinsi	Deskripsi	Kode	IDP	IDK	Kuadran
51	Pertanian, Kehutanan, dan Perikanan	A	0.828	0.959	Kuadran 4
51	Pertambangan dan Penggalian	B	0.894	0.668	Kuadran 4
51	Industri Pengolahan	C	1.135	0.868	Kuadran 3
51	Pengadaan Listrik dan Gas	D	2.445	1.667	Kuadran 1
51	Pengadaan Air, Pengelolaan Sampah, Limbah dan Daur Ulang	E	1.001	0.611	Kuadran 3
51	Konstruksi	F	1.172	0.689	Kuadran 3
51	Perdagangan Besar dan Eceran; Reparasi Mobil dan Sepeda Motor	G	0.862	0.982	Kuadran 4
51	Transportasi dan Pergudangan	H	1.145	1.187	Kuadran 1
51	Penyediaan Akomodasi dan Makan Minum	I	1.002	1.273	Kuadran 1
51	Informasi dan Komunikasi	J	0.976	1.030	Kuadran 2
51	Jasa Keuangan dan Asuransi	K	0.760	0.972	Kuadran 4
51	Real Estate	L	0.825	0.775	Kuadran 4
51	Jasa Perusahaan	MN	1.018	0.921	Kuadran 3
51	Administrasi Pemerintahan, Pertahanan dan Jaminan Sosial Wajib	O	1.026	0.611	Kuadran 3
51	Jasa Pendidikan	P	0.866	0.612	Kuadran 4
51	Jasa Kesehatan dan Kegiatan Sosial	Q	1.032	0.599	Kuadran 3
51	Jasa Lainnya	RSTU	0.987	0.687	Kuadran 4

Table 5.1 is a table of IDP and IDK values for each economic sector in the Province of Bali. There are 3 economic sectors that enter quadrant 1, then 1 economic sector that enters quadrant 2, the next 6 sectors enter quadrant 3, and finally 7 sectors enter quadrant 4. If we look closely, the majority of economic sectors in Bali Province still in quadrant 4 which means it is not a leading sector. Even so, The Accommodation and Food Service Activities Sector is one of the sectors that is included in quadrant 1 or is the leading sector in the Province of Bali. This is in line with the previous analysis which makes The Accommodation and Food Service Activities Sector a vital sector for the Province of Bali.

Figure 5.1 Diagram of the IDP and IDK Quadrants of the Economic Sector in the Province of Bali

Figure 5.1 illustrates the distribution of economic sectors in Bali Province into the existing quadrants. All four quadrants are filled with at least one economic sector. This shows that the economic sectors in the Province of Bali are quite diverse and evenly distributed, from leading sectors to non-leading sectors**.**

Simulation result for the impact of national output resulting from the first simulation to the last try is compared to get the highest average increase in final demand for the The Accommodation and Food Service Activities Sector. The results of the third simulation provide the highest average increase for the 34 existing provinces, namely 4.124 percent. The results of the comparison between Simulation 1 and Simulation 2 as well as Simulation 3 and Simulation 4 show that dividing the Government assistance stimulus evenly across the 34 Provinces directly has an impact on increasing final demand higher when compared to providing Government assistance stimulus based on the number of priority tourist destinations owned by a Province or when compared to providing an aid stimulus only for the Province of Bali as in Simulation 5. In addition, Simulation 1 and Simulation 3 also show that the larger the nominal assistance stimulus provided, the higher the final demand will be.

Simulation 5 to Simulation 9 was carried out with a focus on the Province of Bali and using the same budget absorption basis, namely 2021. The simulation results were also compared to obtain the highest average increase in final demand for the Province of Bali. Through the comparisons that have been made it is known that providing stimulus assistance to the The Accommodation and Food Service Activities Sector industry has been proven to be able to drive an increase in final demand. However, if the goal to be achieved is to increase total final demand from the Province of Bali, what can be done is to provide government assistance stimulus to sectors that are in quadrants 3 and 4, namely economic sectors that are not in the category of non-leading sectors or non-leading sectors. This is evident from the results of Simulation 9 which uses a scenario of providing Government assistance stimulus to 13 sectors in the non-superior category and the results can encourage the highest increase in the final demand for the Province of Bali, which is an average of 7.599 percent.

6. CONCLUSIONS

The conclusions that can be obtained from a series of simulations and analyzes that have been carried out are as follows:

1. Through the results of the descriptive analysis that has been carried out, it can be concluded that in terms of economic growth in the Province of Bali, the The Accommodation and Food Service Activities sector has the second largest contribution in

the Province of Bali, namely the transportation and warehousing sector, the next sector which has the largest contribution is the construction sector, followed by the processing industry sector. The results of the analysis show that the The Accommodation and Food Service Activities Sector in Bali Province is a leading sector. Through the results of the multiplier analysis that has been carried out, it can be seen that the sector that has the highest multiplier figure in the Province of Bali in output formation is the electricity and gas procurement sector, then in the formation of gross added value is the financial services and insurance sector, and finally in the formation of the workforce is the education services sector.

2. Based on the simulation carried out, to strengthen economic growth in Bali, special treatment is needed for the Province of Bali by providing direct and full support. If the distribution is carried out as a whole with the same proportion, then economic growth, especially the contribution of The Accommodation and Food Service Activities sector as the leading sector in Bali, will not be significantly affected. The provinces that have been significantly assisted are the provinces of North Maluku, Papua and West Papua, West Sulawesi.
3. Through the simulation results that have been carried out, several things can be seen as follows:
    a. The greater the stimulus assistance provided by the Government to a sector, the more it will encourage an increase in final demand. This can be seen through a comparison made with the same scenario but with a different stimulus value, namely the absorption of the Economic Recovery Program (PEN) aid budget for the tourism sector in 2020 amounting to 2.82 trillion rupiah and in 2021 amounting to 6.49 trillion rupiah. Where the results show that the stimulus using the absorption of the PEN budget in 2021 encourages higher final growth when compared to the stimulus with the absorption of the PEN budget in 2020 which is smaller in value.
    b. The Government's national stimulus assistance for The Accommodation and Food Service Activities Sector will be more optimal if it is distributed evenly across 34 Provinces when compared proportionally based on the number of priority tourist destinations owned by a province. However, if the focus of increasing demand to be achieved is the Province of Bali, then on the other hand the distribution of assistance is carried out proportionally based on the number of priority tourist destinations owned by a province. This result is because the Province of Bali has the most number of priority destinations when compared to other provinces in Indonesia, namely 9 destinations.
    c. The stimulus for assistance for the Province of Bali will be more optimal if it is given or distributed to 13 sectors that are included in quadrants 3 and 4, namely the category of sectors that are not superior and not superior. This will provide a more significant increase compared to if it is only distributed to leading sectors and superior potential, for example the The Accommodation and Food Service Activities Sector. This is evident from the results of simulation 9 using the scenario of providing Government assistance stimulus to 13 sectors with non-superior or non-superior categories of 499.231 billion rupiah per sector, which will be able to encourage an increase in the final demand for the Province of Bali, which is an average of 7.599 percent.

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MAINTENANCE MANAGEMENT ON MAIN ENGINE OF CONTAINER SHIP, WORKING WITH SLOW STEAMING USING RELIABILITY- CENTERED MAINTENANCE

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ABSTRACT

The application of slow steaming is currently being carried out continuously due to changes of regulation of IMO Global Sulfur Cap 0.5%, where the high sulfur fuel (2.5% - 3.5%) was not allowed since January 1st 2020. The low sulfur fuel (max. 0.5%) presently is more expensive in the global market, hence all the shipping companies run their ships more efficiently and make a lot of improvements to their operating patterns and maintenance of the ship's machinery
This research was conducted on container ship with 2 stroke engine as main propulsion with power 19,810 kW where operated in slow steaming with continuously, slow steaming is running engine with low loads, where less than 40% load.
Base on data damaged report which reported since January 2020 to December 2020 shown a significant indication of the slow steaming effect, especially the components in the combustion area.
Slow steaming has several negative effects for the continuation of the maintenance period of several engine components and the proper maintenance methods are needed to reduce the downtime. In this Thesis the proper maintenance method is obtained by using Reliability-Centered Maintenance (RCM). RCM design stages consist of seven step's of analysis such ; system selection and data collection, definition of system boundary, system description and functional block, system function functional failure, failure mode effect and criticality analysis (FMECA), classification of maintenance tasks based on the RCM analysis, and maintenance cost calculations. Finally, the right RCM decision can be obtained to design budget of vessel operational expenses (VOE) and prepare critical spare parts, and expected to reduce vessel offhire due to un-plan maintenance

Keywords : Slow Steaming, Reliability-Centered Maintenance, Failure Mode Effect and Criticality Analysis (FMECA)

1. INTRODUCTION

A new limit on the amount of sulphur in ship fuel oil, known as IMO 2020, went into effect on 1st January 2020. As an IMO member, Indonesia is required to abide with and put this regulation into practice. The excessive sulfur emissions of currently utilized marine fuels are the primary justification for IMO drafting this regulation. Currently, heavy fuel oil a byproduct of crude oil distillation is used as ship fuel. Sulfur is a component of crude oil, and when it burns in an engine, it releases sulfur emissions. The ingredient sulfur oxide (SOx), which can lead to respiratory issues and lung disease, is bad for human health. If sulfur oxides are allowed to enter the atmosphere, they can produce acid rain, which harms aquatic life, crops, and forests, as well as contributes to the acidification of the oceans.

"Recalling further that, at its seventieth session, the Committee adopted, resolution MEPC.280 (70), Effective date of implementation of the fuel oil standard in regulation 14.1.3 of MARPOL Annex VI, confirming "1 January 2020" as the effective date of implementation for ships to comply with global 0.50% m/m sulphur content of fuel oil requirement" *(IMO-MEPC, 2019).*

Anyway, the largest cost factor for operating a ship is fuel, which accounts for about 50% of all operational costs. Additionally, this fuel component is known as DOE (Direct Operating Expenses). Prior to January 1, 2020, the price of HSFO (High Sulfur Fuel Oil) was approximately USD 409/MT. The price per liter for LSFO (Low Sulfur Fuel Oil) in November 2020 is approximately USD.516/MT and then increasing more at the year after, and every ship currently uses this type of fuel. This indicates that there is a 26% difference in price when compared to the HSFO pricing. Whether one likes it or not, efficiency must be improved in order to compete with rivals and continue serving clients with reasonable costs and efficient services. Because slow steaming can greatly reduce fuel usage, it was developed as a remedy to counteract rising bunker prices. This paper will go into further depth on slow steaming and how does it impact the main engine and maintenance patterns with the RCM (Reliability Centered Maintenance) approach to get effective results.

There are some options for complying with IMO 2020 and described by the following Table 1.

Table 1. Options for complying with IMO 2020 *(Marine,S.2016)*

MGO (Low Sulphure Distillate Fuel)	**HFO (Residual Fuel) with 0,1% to 0,5% Sulphur**	**Exhaust Gas Cleaning System (Scrubber)**	**LNG (Liquid Natural Gas)**
(+) Convenient	(+) Convenient	(+) Continue Used HSFO	(+) Reduction emission, NOx and SOx
(+) Low investment cost	(+) Low investment cost	(+) Low operating cost (OPEX)	(+) Low fuel cost
(-) High Operational Expenses	(-) High Operational Expenses	(-) Lack of Installation Capacity	(-) High investment cost
	(-) Fuel stability and properties	(-) High Investment Cost	(-) LNG Availiability & infrastructure
		(-) Loss of cargo load capacity	(-) Handling and safety
			(-) Ship Crew competency as ship Operator

2. LITERATURE REVIEW

2.1. What Is Slow Steaming

The main engine function to produces propulsion against the ship so that the ship can move. It is made up of numerous components or systems. One method being used at the moment to cut down on fuel usage for the main engine is to run with slow steaming mode. While slow steaming refers to the practice of lowering the ship's speed in order to reduce the amount of fuel used by the main engine, and is only considered slow steaming when the load on the main engine is between 10% and 40% of the MCR (Maximum Continuous Rating).

For instance, if a container ship is operated at a service speed of 17 Knots and has an engine with a 100% MCR of 19810 KW (at 108 Rpm), the daily fuel consumption is approximately 61.6 MT. However, the fuel consumption per day is roughly 30 MT when the ship is operated in slow steaming mode, which is limited to a service speed of 13 Knots. This indicates that slow steaming can reduce fuel usage by almost 50% daily. Reducing fuel use also implies reducing air pollution from exhaust gas emissions

The reduction in main engine power will decrease fuel consumption and speed as illustrated in the graphic 2.1 as below. In the other side, reduction in fuel oil consumption corresponds and equivalent reduction of the CO2 gas emissions

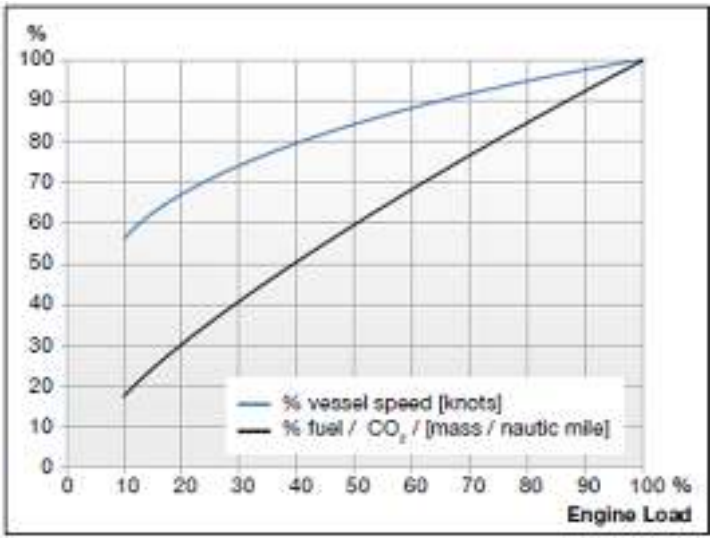

Figure 2.1. Correlations of Ship speed, Engine power and Fuel consumption *(MAN B&W Service letter, Low Load Operation, 2009)*

Ships are designed and built for a certain specified load and speed range, at which the system total efficiency is optimised. Because of the fixed-pitch propeller direct drive by the main engine, the main engine itself is then also laid-out for that optimized operating range. The optimal load range of the two-stroke engine lies between 70-85% (*Wartsila Technical Journal, 2010).*

The fuel efficiency of the engine has become operational parameters for ship management in term of managing their engine as well, this is correlated with service lifetime of each engine part if running with low load which is more less than expected as mentioned at the engine manual book. The critical component such ; piston ring, cylinder liner, cylinder head, piston, plunger and barrel are most important to maintain as well in order to maintain the fuel efficiency

2.2. Effect of Slow Steaming

Slow steaming has definite advantages for fuel saving, but there are also issues and difficulties with this method. To ensure that engine damage is kept to a minimum, extra procedures, checks, and expenses must be made. It is crucial to take these steps in order to avoid unforeseen engine damage that would require extensive repairs and render the ship inoperable (off-hire).

The damaged and irregularities that result from operating the main engine in slow steaming mode are explained in Table 2.1 below, which includes some images obtained from the main engine. The proper maintenance and repair plan must, of course, be in place by the time Ship Management decides to use this slow steaming mode. In the discussion that follows, we'll try to use the RCM approach as a possible alternative that can be used for this treatment.

Table 2.1. Slow steaming effect for engine's component

Part Name	Descriptions	Actual Damage Picture
Exhaust Valve Seat	Poor combustions, there are carbon deposit came from incomplete combustion	
Nozzle Ring Turbo Charger	Fouling, photo taken from the turbo charger nozzle ring	
Cylinder Cover	Reduced of airflow, leads to higher engine exhaust gas temperatures, which damage a number of spare parts in the exhaust gas passageway and cause cracks to appear in the water cooling area within the cylinder cover's inner chamber.	
Piston Ring	Due to the development of a significant amount of soot on the piston ring grove side, poor combustion might also result in stickiness on the piston ring side.	
Cylinder Liner	Cold corrosion, caused by condensation that resulted from jacket cooling at low engine temperatures due to run with low load engine	

3. RCM METHODOLOGY

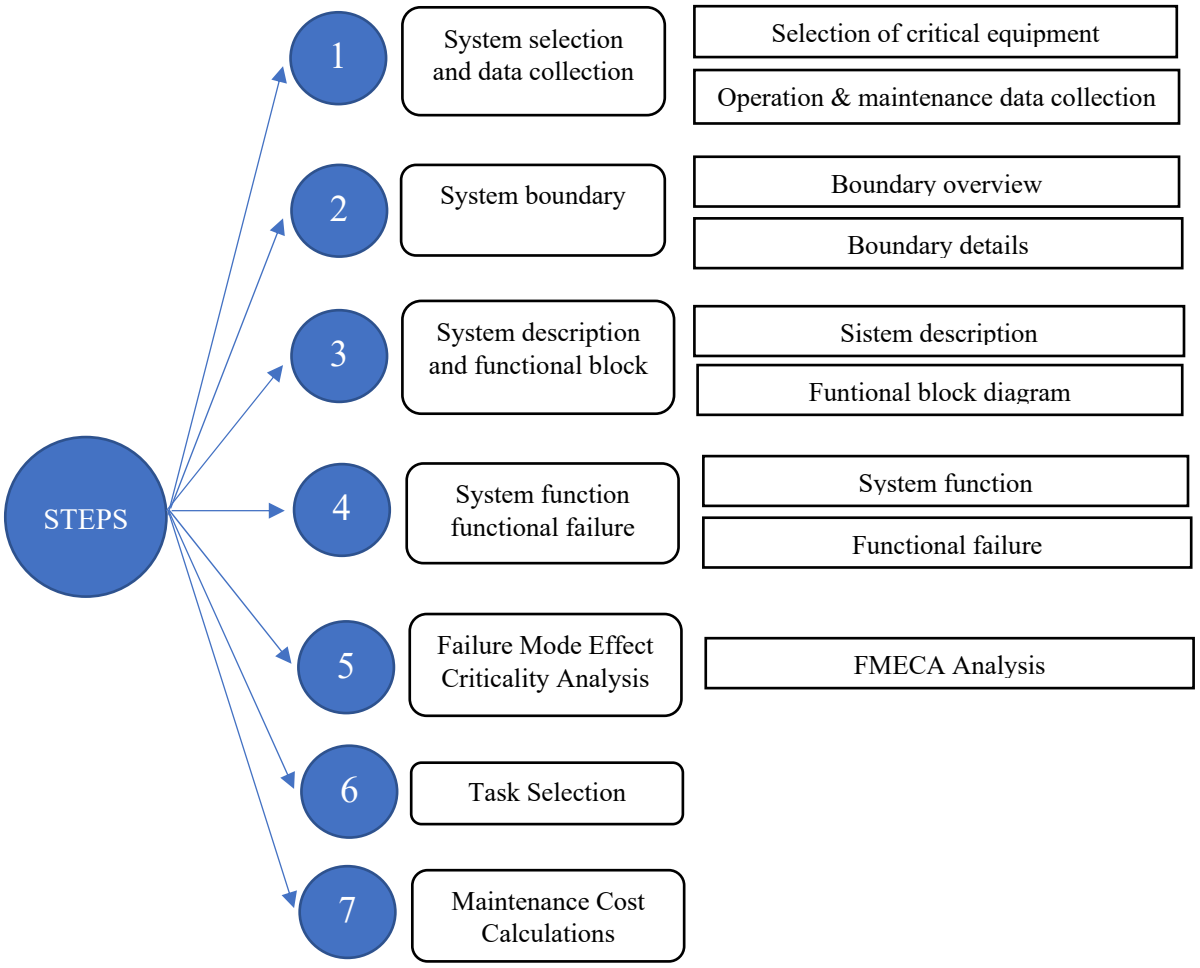

Figure 3.1. Flow Chart of RCM Analysis

Additionally, data analysis was done using the RCM methodology, which can be regarded as an effective tool that offers recommendations for reaching high standards of care. This entails determining important equipment and creating the best maintenance practices based on reliable data. RCM can be utilized for functional failure analysis, which takes cost and human factors into account, as well as for the design of maintenance plans for primary engine components. The RCM Methodology is shown in Figure 4.1 above, and it consists of seven procedures at each level. The research outcomes are following ;

1. Choose the best main engine maintenance strategy for the pattern of ship operations that run in slow steaming mode using the Reliability-Centered Maintenance approach.
2. Comparing the service life of the main engine components when applying slow steaming loads versus normal loads
3. Estimating the main engine maintenance costs based on its slow steaming operation pattern versus normal loads

4. RESULT AND ANALYSIS

4.1. Total number of tasks comparison

The comparison between the number of maintenance tasks now performed by the ship crew (existing tasks) and the number of maintenance tasks performed utilizing the RCM approach is shown in Figure 4.1 below. It is known that there are 138 maintenance tasks with the existing system, compared to 129 tasks with the RCM maintenance approach. As can be seen, the data indicate a 9 point gap. These numbers diverge, which suggests that one component is currently undergoing repeated maintenance. This comparison is also helpful for demonstrating whether RCM leads to a significant reduction in work or the opposite, i.e. an increase in tasks.

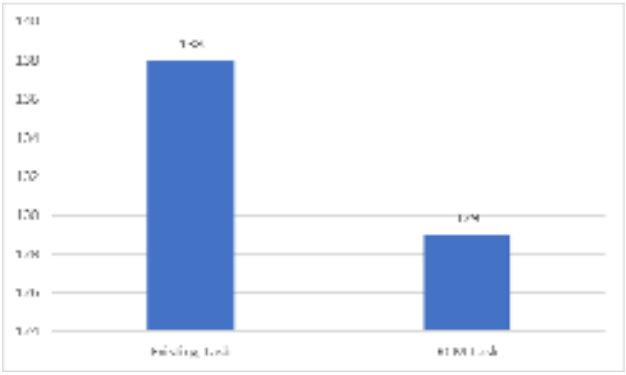

Figure 4.1. Comparison of existing task versus RCM task

4.2. Tasks per component

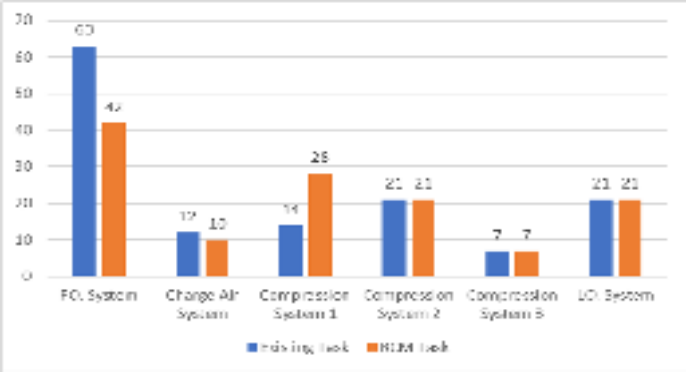

Figure 4.2. Comparison of task per component

A comparison of the quantity of maintenance tasks performed on each sub-system is shown in Figure 4.2. This is also done to determine which subsystem type has had the greatest modifications while accounting for maintenance activity. On FO System, it is well known that the system's activity has significantly decreased. As an illustration, the suction valve and puncture valve can be checked, and this can be done by creating a second plug and play that is ready to use, which will reduce the number of maintenance tasks.

4.3. Maintenance task breakdown comparison

Figure 4.3 shows. The 34 primary engine maintenance procedures are listed below according to the manufacturer's instructions for that particular engine. The crew of the ship does this task on a regular basis. It is evident that the proportion grows as a result of the condition monitoring pattern while the proportion of routine checks decreases.

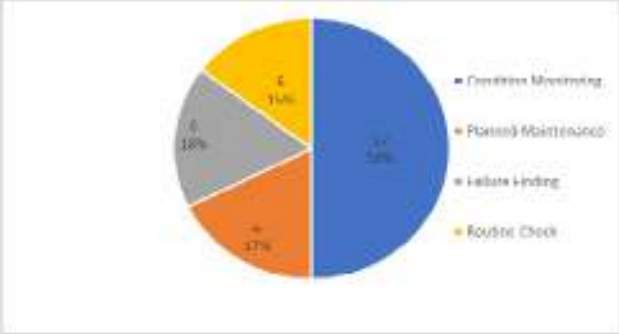

Figure 4.3. Current number of maintenance task (Existing)

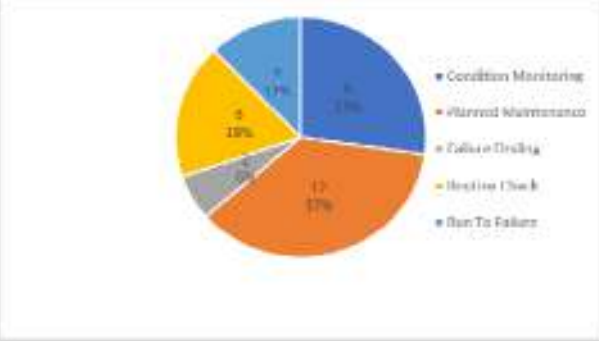

Figure 4.4. Number of maintenance task with RCM

In contrast, Figure 4.4. above illustrates a pattern of RCM-based treatment approaches. The procedure is explained in more depth below;

1. Conditions Monitoring (CM)
   The majority of condition monitoring operations are routine inspection tasks that need the crew of the ship to disassemble them in order to visually assess whether any associated parts or components need to be maintained or repaired. Without taking the system apart, inspection is used to demonstrate specific conditions and functionalities.
   The number of current condition monitoring activities has been greatly decreased from the initial 17 maintenance operations to just 9 activities when compared to the RCM approach in figures 4.3 and 4.4 Condition monitoring operations have fallen by 47% as a percentage.

2. Planned Maintenance (PM)
   Is the disassembly, installation, and execution of inspections that take place during the upkeep and repair of organized equipment. Piston rings, exhaust valve seats and spindles,

injector nozzles, and cylinder heads are examples of parts that can be replaced with new ones once their working hours have been reached. However, parts whose service lifetime is still several years away but whose inspection time has already been met must only be disassembled, cleaned, measured, and reassembled (cylinder liner, fuel pump, turbo charger, charge air cooler).

The RTF technique is only advised if the component can be fixed right away, such as by crew laps on the exhaust valve seat and exhaust valve spindle's contact surfaces. Consequently, this does not ensure that its function may be utilized in. According to the RCM approach's findings, there were 6.8% fewer PM activities overall, falling from 97 to 90.4 in total.

3. Failure Finding (FF)
   Through routine inspection, this operation seeks to uncover hidden equipment damage. According to the RCM approach's results, there are now only 2 FF activities, down from 6 previously, a decrease of 67%.

4. Routine Check (RC)
   This routine check (RC) activity is a straightforward monitoring and observation task performed by each ship's crew to evaluate the state of the machinery and component parts. One illustration is keeping track of the oil pressure and exhaust gas temperature. Every four hours, the reading outcomes from these activities are entered into the Log Book. By comparing the data collected at that time with earlier data that has been noted in the Log Book, the ship's crew can determine whether there has been a change in the status of the equipment.
   The results of the RCM technique indicate a 6% increase in this RC activity, and this increase suggests that the ship's crew must exert more effort to

4.4. Maintenance Labour Breakdown

VOE (Vessel Operating Expenses), often known as ship operational expenditures, are planned for a year. The highest portion, or 36%, is taken up by the expense of crew salaries. If this cost is broken down, it consists of the following: basic pay, BPJS, home allowance, and extra route. You won't find a salary for overtime or overtime work on the list of crew salary components above. Of course, the crew is required to operate successfully and efficiently while doing their duties on the ship.

The rhythm of the ship's crew working hours won't change as a result of engine maintenance approach that uses the RCM , but additional work will inevitably be required if engine damage occurs outside of the maintenance schedule. This additional problem must be addressed right away to prevent disrupting ship operations. Due to this damage, overhaul job can be done whenever it's convenient and outside of the crew's regular working hours. It is hoped that a good engine maintenance routine will prevent any work from going above and beyond what has been scheduled, giving the crew of the ship enough time to rest at sea. Figures 4.5 and 4.6 working hour comparison reveals a significant improvement in time efficiency for PM, CM, and FF operations involving engine repair. However, RC activity did noticeably rise.

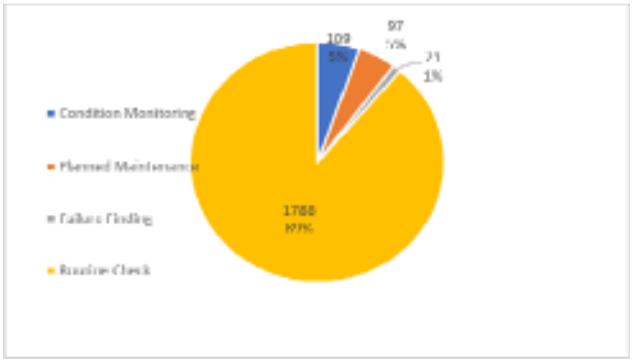

Figure 4.5. Current working hours per maintenance strategy over one year

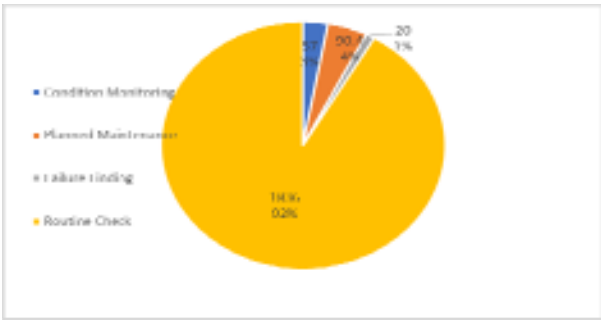

Figure 4.6. RCM working hours per maintenance strategy over one year

4.5. Task Selection and Summary

4.5.1. Using the reliability-centered maintenance strategy, the slow steaming mode maintenance effectiveness

After comparing the quantity of maintenance tasks now performed with the RCM maintenance technique, Figure 4.7 below is obtained. Additionally taken into consideration are the annual amount of maintenance tasks and labor hours needed for each component. It is evident that the RCM approach greatly increases the efficiency of main engine maintenance tasks. This indicates that this approach will probably be employed as a substitute to obtain a higher level of effectiveness.

It is well known that there are much fewer maintenance jobs in the condition monitoring (CM), planned maintenance (PM), and failure finding (FF) areas, but there has been an increase of 2% that is realistic to expect in the regular check section.

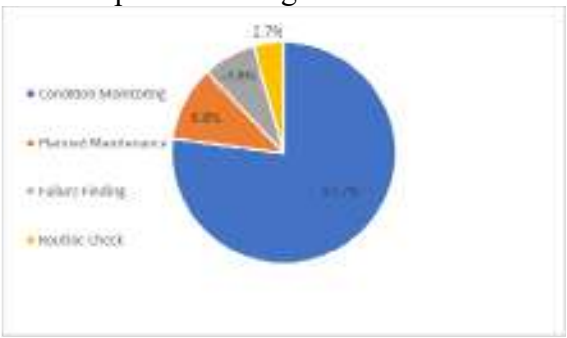

Figure 4.7. Maintenance efficiency with RCM

4.6. Maintenance Cost Calculations

The following summarizes the difference in how much it costs to maintain the main engine in the slow steaming operation pattern compared to the normal operating pattern ;

1. It is presummated that the main engine will work 350 hours in a month.
2. To determine the average number of months and the costs paid, the quantity of service lifespan is divided by the number of working hours of the primary engine components (in 1 month).
3. The maintenance expenses associated with a normal load and a slow steaming load are as follows;

Operation Mode	**Cost (USD)**	**Average Number of Month**	**Cost per Month (USD)**
Normal Load (USD)	179.833	43	4.183
Slow Steaming Load (USD)	179.833	28	6.423

5. CONCLUTIONS

This paper highlights the maintenance of main engine running with slow steaming as continuously using RCM approach. Base on above calculation, the findings show the importance of reliability centred maintenance in terms of significantly reduce the needed of maintenance by the ship crew and also cost effectiveness. The data processing and analysis outcomes allow for the conclusion that ;

1. When performing main engine maintenance in slow steaming mode, the approach known as reliability-centered maintenance achieved a total efficiency of 0.6% for man hours per year.
2. Using the slow steaming mode results in maintenance expenses for the main engine that are 54% more than when using the normal load

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ANALYSIS OF CONSUMER BEHAVIOR ON PURCHASING DECISIONS THROUGH PURCHASE INTENTION WITH MARKETING STRATEGY AS A MODERATING VARIABLE AT BABYSHOP RETAIL

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ABSTRACT

The retail industry is a sector that has major challenges during the pandemic and digitalization, including in terms of consumer behavior due to changes in consumer habits. Retail types can be divided into conventional and modern retail. During this pandemic, conventional retail cannot be avoided from changes in consumer behavior, so it is interesting to study how marketing strategies influence to increase sales by looking at consumer behavior. The Alladin store and its network are sis one form of conventional retail MSMEs with commodities in the form of baby and child needs. The observed phenomenon was that the Alladin Store network was able to survive with an increasing sales trend.This study aims to see the effect of consumer behavior on purchasing decisions through purchase intention with marketing strategy as a moderating variable. The research method uses quantitative with 111 customers as respondents. Data processing uses the SmartPLS 4.0 analysis tool. The result of the research is that marketing strategy is not a moderating variable between consumer behavior and purchasing decisions, while buying interest is proven to be a mediating variable between consumer behavior and purchasing decisions.

***Keywords** : Consumer Behavior, Purchasing Decisions, Purchase Intention, Marketing Strategy*

1. INTRODUCTION

. Seiring berjalannya waktu, persaingan bisnis mengalami perubahan. Situasi dan kondisi ini dapat disebabkan oleh banyak hal, antara lain; ketatnya persaingan ritel *offline online* dan terdapat perubahan strategi bisnis pada perusahaan (Katadata.co.id, 2019). Untuk itu para pelaku bisnis ritel seharusnya lebih memikirkan dengan teliti strategi yang akan dilakukan demi memenangkan persaingan bisnis serta mempertahankan eksistensinya. . Menurut data *Euromonitor* yang dihimpun *United States Department of Agriculture* (USDA), pada 2021 ada 3,57 juta gerai ritel tradisional di Indonesia. Meski jumlahnya mendominasi, ternyata jumlah ritel tradisional ini telah berkurang sekitar 1 juta unit jika dibandingkan empat tahun lalu. Pada 2017 gerai ritel tradisional di Indonesia jumlahnya masih sekitar 4,57 juta gerai. Jika dilihat secara keseluruhan, penjualan ritel Indonesia juga mengalami penurunan dalam beberapa tahun terakhir.

Penurunan penjualan ritel diatas erat kaitannya dengan konsumen ritel, menurut Kotler (2005), keputusan pembelian merupakan suatu tahap dimana konsumen telah memiliki pilihan terhadap barang/jasa dan siap untuk melakukan pembelian atau pertukaran antara uang dan janji

membayar dengan hak kepemilikan atau penggunaan suatu barang atau jasa. Untuk mencapai keputusan pembelian, tentulah para peritel berusaha dan berupaya memuaskan kebutuhan konsumen dengan mencari kesesuaian antara barang-barang yang dimilikinya dengan harga, tempat, promosi yang diinginkan pelanggan dengan menerapkan strategi pemasaran, Banyak faktor yang menjadi pertimbangan peritel dalam pemilihan strategi pemasaran yang objektifnya untuk menarik konsumen, sehingga peritel harus jeli dalam menganalisa faktor-faktor apa saja yang perlu diperhatikan salah satunya adalah faktor perilaku konsumen. Engel, dkk (1994) memberi pengertian bahwa perilaku konsumen didefinisikan sebagai suatu tindakan yang langsung dalam mendapatkan, mengkonsumsi serta menghabiskan produk dan jasa, termasuk proses keputusan. Perilaku konsumen menjadi hal yang mendasari konsumen untuk membuat keputusan pembelian. Adapun hal-hal tersebut adalah proses dan aktivitas ketika seorang konsumen berhubungan dengan pencarian, pemilihan, pembelian, penggunaan serta pengevaluasian produk dan jasa demi memenuhi kebutuhan dan keinginan. Perilaku konsumen lebih dari sekadar cara seseorang membeli produk, namun juga mencakup penggunaan fasilitas, layanan, kegiatan, pengalaman, dan ide-ide konsumen serta menentukan berbagai hal berdasarkan preferensinya (Hoyer, Maclnnis, & Pieters, 2013). Maka, pelaku bisnis sudah harus merancang fasilitas dan layanan yang komprehensif yang dapat diberikan atau ditawarkan kepada konsumen, sehingga bisnis ritel ini akan menarik dan menjadi pilihan utama bagi konsumen. Minat beli *(willingness to buy)* merupakan bagian dari komponen perilaku dalam sikap mengkonsumsi. Suatu produk dapat dikatakan telah dikonsumsi oleh konsumen apabila produk tersebut telah diputuskan untuk dibeli.

Alladin adalah jaringan UMKM Ritel di Kota Bekasi dengan komoditi berupa kebutuhan bayi dan anak-anak seperti susu formula, diapers, sabun, shampoo, minyak telon, dan kebutuhan lainnya. Di tengah era digitalisasi dan masa pandemic, UMKM ini mampu sustain, dengan trend positif dari tahun 2020-2022. Data penjualan jaringan Toko Alladin yang merupakan ritel konvensional berupa toko *offline* pada tiap semesternya mengalami kenaikan penjualan 37% (tiga puluh tujuh persen) selama 3 (tiga) tahun *year on year,* artinya terdapat peningkatan keputusan pembelian konsumen jaringan Toko Alladin meskipun pada tahun 2020 hingga 2022 dihadapkan pada situasi pandemi dimana beberapa studi menunjukkan konsumen mengubah pola pembelian dari pembelian *offline* menjadi pembelian *online* karena terdapat pembatasan tatap muka sehingga terdapat peningkatan adopsi aktivitas online yang menggantikan aktivitas tatap muka (Eurofound, 2020; Nguyen et.al, 2020; Pierce, Perrin, Tyler, McKee, & Watson, 2021; Wijesooriya, Mishra, Brand, & Rubin, 2020).

Keputusan pembelian dapat dilihat dari perilaku konsumen yang sesuai dengan penelitian Aditya Wardhana, Mahir Pradana, and Hasna Shabira (2021) yang menghasilkan bahwa *consumer behavior has a significant effect on purchasing decisions*. Sedangkan sebelum terjadinya keputusan pembelian, konsumen merespon untuk bersedia membayar barang atau jasa yang diminatinya. Hubungan minat beli dan keputusan pembelian telah diteliti oleh Satriawan, Kadek Aria dan Putu Yudi Setiawan (2020) bahwa *purchase intention has a positive and significant effect on purchase decisions.* Maka penelitian ini selanjutnya membahas apakah pada saat pandemi semua aktivitas ritel harus mutlak mengikuti sistem *online* untuk menghasilkan keputusan pembelian dengan faktor yang mempengaruhi yaitu perilaku konsumen dan strategi pemasaran untuk menciptakan minat beli. Hal ini menjadi kebaruan dalam penelitian karena penelitian ini akan menjawab bagaimana pengaruh perilaku konsumen terhadap keputusan pembelian melalui minat beli dengan strategi pemasaran sebagai varibel moderasi pada UMKM Ritel *baby shop* pada masa pandemi.

2. LITERATURE REVIEW

Menurut Kotler (2010), pemasaran adalah sebuah proses sosial dan manajerial dimana individu-individu dan kelompok-kelompok mendapatkan apa yang mereka butuhkan dan inginkan melalui penciptaan, penawaran dan pertukaran produk-produk atau value dengan pihak lainnya. Sebagaimana Berman & Evans (1992, dalam Asep ST Sujana, 2005) mendefinisikan kata ritel dalam kaitannya dengan ritel management sebagai *those business activities involved in the sale of goods and services to consumers for their personal, family, or household use* atau keseluruhan aktivitas bisnis yang menyangkut penjualan barang dan jasa kepada konsumen untuk digunakan oleh mereka sendiri, keluarga, atau rumah tangganya.

Kotler & Keller (2013:137) minat beli adalah perilaku konsumen yang muncul sebagai respon terhadap objek yang menunjukkan keinginan pelanggan untuk melakukan pembelian. Indikator Minat beli dalam penelitian ini adalah Minat transaksional, Minat refrensial, Minat preferensial, Minat eksploratif, (Ferdinand, 2014). Perilaku konsumen dapat diartikan sebagai sebuah studi individu, kelompok dan organisasi, mencakup proses yang digunakan untuk memilih, mengamankan, menggunakan, mengeliminasi produk, layanan, pengalaman dan untuk memenuhi kebutuhan dan dampaknya terhadap konsumen dan masyarakat (Shimp, 2013) dengan indikator indikator perilaku konsumen adalah faktor budaya, sosial, pribadi, psikologi.

Menurut Kotler Strategi pemasaran adalah keseluruhan tindakan-tindakan, agar kelangsungan hidup perusahaan terjaga serta kemajuan dan keunggulan dalam bisnis, maka pembisnis berupaya menerapkan strategi berupa bauran pemasaran dengan harapan untuk menciptakan minat pelanggan. Indikator strategi pemasaran dalam penelitian ini adalah pemilihan pasar, perencanaan produk, penetapan harga, sistem distribusi, komunikasi pemasaran. Buchari Alma (2011:96) berpendapat bahwa keputusan pembelian sebagai suatu keputusan konsumen yang dipengaruhi oleh ekonomi keuangan, teknologi, politik, budaya, produk, harga, lokasi, promosi, physical evidence, people dan process, sehingga membentuk suatu sikap pada konsumen untuk mengolah segala informasi dan mengambil kesimpulan berupa response yang muncul produk apa yang akan dibeli dengan indikator pilihan produk, merek, penyalur, waktu pembelian, dan jumlah pembelian yang sesuai dengan kebutuhan konsumen terhadap suatu barang.

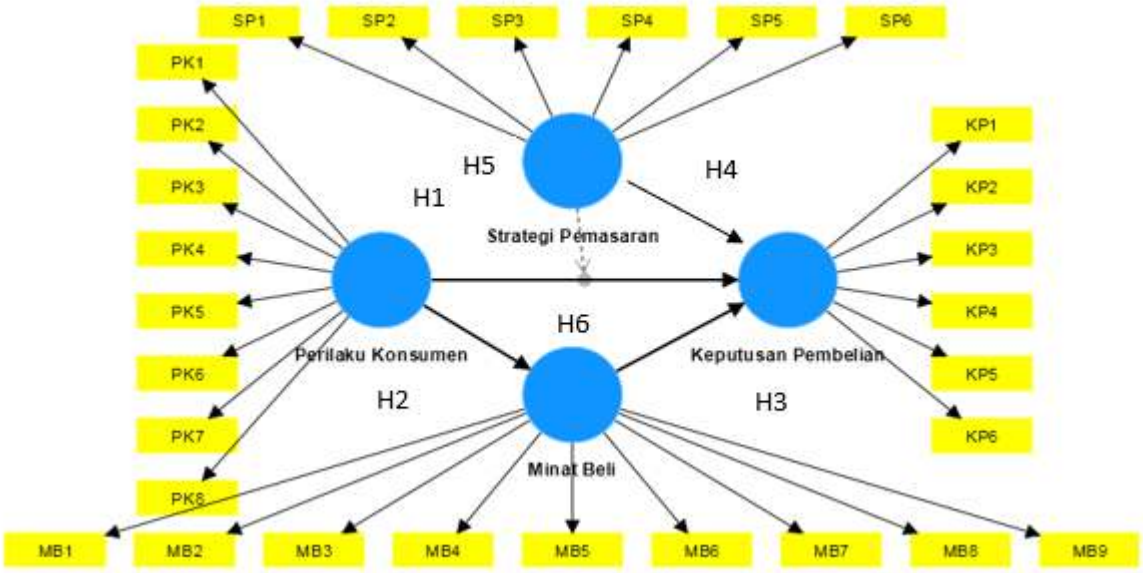
3. METHODS

Metode yang dipilih untuk melakukan penelitian ini yaitu metode penelitian kuantitatif. Penelitian ini bertujuan untuk mendapatkan informasi sedalam mungkin mengenai fenomena perubahan perilaku konsumen yang hubungannya dengan keputusan penjualan melalui analisa strategi pemasaran dan minat beli. Penelitian dilakukan di 3 (tiga) Toko Jaringan Alladin yang berada di wilayah Kota Bekasi. Pengambilan lokasi penelitian memiliki alasan yaitu ingin mengetahui secara general perilaku konsumen, strategi pemasaran, minat beli dan keputusan pembelian pada toko *offline* Alladin.

Teknik pengambilan sampel yang digunakan dalam penelitian ini adalah *purposive sampling*. Menurut Sekaran (2006), purposive sampling adalah pengambilan sampel yang dilakukan tidak secara acak, tetapi sampel dipilih dengan karakteristik tertentu. Karakteristik yang diambil merupakan pelanggan UMKM Ritel Toko Alladin mulai dari bulan Oktober – Desember 2022 dengan jumlah sampel 111 (seratus sebelas) Jumlah sampel ini sudah memenuhi *requirement* minimal yang diperlukan dalam metode analisis *SEM* agar dapat bisa dianggap representatif adalah sebanyak 100 sampel.

Structural Equation Model (SEM) merupakan teknik statistik multivariat yang mengkombinasi antara analisis faktor dan analisis regresi yang bertujuan untuk menguji hubungan antar variabel pada sebuah model, baik antara variabel indikator dengan konstruknya, ataupun antar

variabel konstruk (Hair, 2014). Salah satu jenis metode SEM adalah *Partial Least Square* (PLS), PLS atau yang dikenal dengan *path*-model sendiri merupakan sebuah metode untuk mengkonstruksikan model-model menggunakan variabel laten dengan indikator. PLS merupakan pendekatan yang lebih tepat dalam tujuan prediksi. Dengan variabel laten berupa kombinasi linier dari indikatornya, maka prediksi nilai dari variabel laten dapat dengan mudah diperoleh, sehingga prediksi dari variabel laten yang dipengaruhinya juga dapat mudah dilakukan (Hair, 2014).



Gambar 1. Model Struktural PLS

H1 : Perilaku konsumen berpengaruh secara signifikan terhadap Keputusan Pembelian.
H2 : Perilaku konsumen berpengaruh secara signifikan terhadap Minat Beli.
H3 : Minat Beli berpengaruh secara signifikan terhadap Keputusan Pembelian.
H4 : Strategi Pemasaran berpengaruh secara signifikan terhadap Keputusan Pembelian.
H5 :Moderasi Strategi Pemasaran berpengaruh secara signifikan terhadap hubungan Perilaku konsumen kepada keputusan pembelian.
H6 : Mediasi Minat Beli berpengaruh secara signifikan terhadap hubungan Perilaku Konsumen kepada Keputusan Pembelian

4. RESULTS

Dilakukan 3 kali proses iterasi untuk mendapatkan hasil *outer loading output* indikator semua variabel masing-masing indikator konstruknya dinyatakan menunjukkan validitas karena memiliki nilai >0.7 seperti pada gambar 2. Selanjutnya menunjukkan variabel independen, variabel dependen, variabel mediasi/intervening dan variabel moderating memiliki *Cronbach Alpha* > 0.6 dapat dikatakan memenuhi reliabilitas data sampel atas kuesioner yang telah disebar secara random sampling karena lebih dari atau > 0.6. (Chinn, 1998). Sedangkan kesimpulan reliabilitas komposit dan *Cronbach Alpha* dari penelitian ini didapatkan hasil yang bagus dengan skor lebih besar dari *rule of tumb* > 0.6 dengan demikian model pengukuran semua variabel memiliki reliabilitas yang baik (Sofyani, 2017) yang dapat dilihat pada gambar 3.

Perilaku Konsumen	Minat Beli	Strategi Pemasaran	Keputusan Pembelian
XIPK1= 0.722	Z2MB1= 0.783	Z2SP1= 0.727	YKP1= 0.763
X1PK2= 0.743	Z2MB2= 0.787	Z2SP2= 0.765	YKP2= 0.752
X1PK4= 0.703	Z2MB3= 0.852	Z2SP3= 0.782	YKP3= 0.732
X1PK5 = 0.737	Z2MB4= 0.828	Z2SP4= 0.823	YKP4= 0.727
X1PK6 = 0.825	Z2MB5= 0.785	Z2SP5= 0.747	YKP5= 0.787
X1PK7 = 0.837	Z2MB6= 0.727	Z2SP6 = 0.732	YKP6 = 0.776
X1PK8 = 0.758	Z2MB8= 0.700		
	Z2MB9= 0.707		

Gambar 2. *Outer Loading* Variabel

	Cronbach's alpha	*Composite reliability (rho_a)*	*Composite reliability (rho_c)*	*Average variance extracted (AVE)*
Keputusan Pembelian	0.852	0.864	0.889	0.572
Minat Beli	0.903	0.909	0.922	0.597
Perilaku Konsumen	0.880	0.892	0.906	0.581
Strategi Pemasaran	0.857	0.862	0.893	0.583

Gambar 3. Uji Realibilitas Konstruk SmartPLS

	Original sample (O)	*Sample mean (M)*	*Standard deviation (STDEV)*	*T statistics (|O/STDEV|)*	*P values*
Minat Beli -> Keputusan Pembelian	0.290	0.270	0.105	2.778	0.006
Perilaku Konsumen -> Keputusan Pembelian	0.047	0.056	0.112	0.423	0.673
Perilaku Konsumen -> Minat Beli	0.367	0.397	0.103	3.552	0.001
Strategi Pemasaran -> Keputusan Pembelian	0.388	0.406	0.137	2.826	0.006
Strategi Pemasaran x Perilaku Konsumen -> Keputusan Pembelian	0.054	0.082	0.111	0.487	0.627

Gambar 4. *Path Coefficients*

Selanjutnya dilakukan uji hipotesis yang diistilahkan dalam SmartPLS sebagai *Bootstrapping* dapat dilihat hasilnya pada gambar 4. Suatu hipotesis penelitian ini bahwa terdukungnya melalui *rule of tumb*s adalah Jika koefisien atau arah hubungan variabel (ditunjukkan oleh nilai original sampel)

sejalan dengan yang dihipotesiskan dan Jika nilai t statistik lebih dari 1.64 (*two tiled*) atau 1.96 (*one tiled*) dan *probability value* (p-value) kurang dari 0.05 atau 5 persen.(Sofyani, 2017). Pembahasan masing-masing hipotesis dijelaskan berikut :

Pembuktian Hipotesis (H1) : Hasil T-Statistik 0.423 dan P-*value* 0.673 sehingga disimpulkan perilaku konsumen berpengaruh tidak signifikan (positif) terhadap keputusan pembelian.

Pembuktian Hipotesis (H2) : Hasil pengolahan data dari pengaruh perilaku konsumen terhadap minat beli ditunjukkan dengan T-Statistik yaitu memiliki skor nilai 3.552 dan P-*Value* yaitu 0.001 sehingga menunjukkan perilaku konsumen berpengaruh signifikan (positif) terhadap minat beli.

Pembuktian Hipotesis (H3) : Pengaruh minat beli terhadap keputusan pembelian data dilihat dari nilai T-Statistik yaitu memiliki skor nilai 2.778 dan P-*Value* memiliki skor nilai 0.006 sehingga menunjukkan bahwa minat beli berpengaruh signifikan (positif) terhadap keputusan pembelian.

Pembuktian Hipotesis (H4) : Hasil statistik yang ditunjukkan yaitu T-Statistik menghasilkan skor nilai 2.826 dan P-*Value* nilai skor 0.006 sehingga dapat disimpulkan bahwa strategi pemasaran berpengaruh signifikan (positif) terhadap keputusan pembelian.

Pembuktian Hipotesis (H5) : Melalui perhitungan yang telah dilakukan,dapat dilihat bahwa dengan T-Statistik dihasilkan skor nilai 0.487 dan P-*Value* nilai skor 0.627 sehingga menunjukkan pengaruh yang tidak signifikan (positif).

Pembuktian Hipotesis (H6) : Diketahui bahwa perilaku konsumen berpengaruh signifikan (positif) terhadap keputusan pembelian Melalui Minat Beli dengan nilai T Statistik uji *two tailed* kurang dari skor 1.64 atau dan probability value (P-Value) lebih dari 0.05 atau 5 persen (Sofyani, 2017), ditunjukkan dengan TStatistik skor nilai 2.087 > 1.64 *two tailed* dan P-Value nilai skor 0.039 atau kurang dari 0.05 atau 5 persen menunjukkan pengaruh yang signifikan sehingga dapat dijelaskan bahwa variabel minat beli mampu menjadi perantara variabel perilaku konsumen dan variabel keputusan pembelian yang dapa dilihat pada gambar 5 di bawah ini :

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
Perilaku Konsumen -> Minat Beli -> Keputusan Pembelian	0.106	0.109	0.051	2.087	0.039

Gambar 5. *Specific indirect effects*

Path Coeficient tidaklah cukup untuk membuktikan hipotesis penelitian, tetapi diperlukan uji koefisien determinasi untuk menjelaskan kemampuan hubungan antara variabel independen pada variabel dependen dengan moderasi variabel moderator dan variabel intervening. Gambar 6 menunjukkan pengaruh variabel Keputusan Pembelian dan Minat Beli Y = 39.1 % sedangkan sisanya 60.9% adalah variabel lainnya.

	R-square	R-square adjusted
Keputusan Pembelian	0.414	0.391
Minat Beli	0.134	0.126

Gambar 6. *R Square*

Implikasi Manajerial :

Perilaku konsumen berpengaruh tidak signifikan (positif) terhadap keputusan pembelian bertolak belakang dengan hasil yang diperoleh pada penelitian ini, penelitian yang dilakukan baik sebelum pandemi maupun setelah pandemi dimana sebelum pandemi, menghasilkan pengaruh yang signifikan yaitu penelitian dilakukan oleh Haghshenas, Leila, dkk (2013) yang menghasilkan bahwa perilaku konsumen berpengaruh terhadap keputusan pembelian serta Lautiainen, Tanja (2015) juga menghasilkan bahwa faktor perilaku konsumen yaitu sosial, personal dan psikologi berpengaruh terhadap proses pembuatan keputusan pembelian konsumen. Pembahasan berikutnya pada penelitian ini adalah bahwa untuk menghasilkan keputusan pembelian jika dilakukan analisis dari perilaku konsumen, dikarenakan pengaruhnya tidak signfikan, maka terdapat hal lain yang dapat menghasilkan pengaruh yang signifikan antara perilaku konsumen terhadap keputusan pembelian. Implikasi bagi pelaku UMKM jaringan Toko Alladin adalah perlu mengamati dan mempelajari lebih lanjut apakah yang dapat memberikan pengaruh signifikan tersebut sehingga selanjutnya pelaku UMKM jaringan Toko Alladin memberikan focus dan perhatian untuk meningkatkan pemasukan bagi ritel UMKM melalui penjualan yang dihasilkan dari para pembelian konsumen berdasarkan perilaku konsumen.

Perilaku Konsumen Berpengaruh Signifikan Terhadap Minat Beli sejalan dengan penelitian yang dilakukan oleh Araujo, Clarisse Jane G. (2022) yaitu perilaku konsumen khususnya Generasi Z berpengaruh positif terhadap minat beli. Hasil yang sama juga ditunjukkan oleh Uran, Muhammad Nur, dkk (2021) bahwa perilaku konsumen yang terdiri dari faktor budaya, sosial, individual, dan karakter psikologis berpengaruh positif terhadap minat beli konsumen. Dijelaskan lebih lanjut dalam penelitian ini adalah karena dibuktikan oleh hasil penelitian bahwa perilaku konsumen memberikan pengaruh signifikan kepada minat beli maka analisis perilaku konsumen dapat lebih diperdalam untuk dipelajari, diamati dan diterapkan untuk menghasilkan minat beli sehingga jika terjadi perubahan perilaku konsumen, minat beli tetap terjaga. Implikasi manajerial yang dapat direkomendasikan kepada pelaku UMKM yaitu bahwa pelaku UMKM wajib untuk mengamati perilaku konsumen untuk menghasilkan minat beli, sebagai contoh karena jaringan toko Alladin merupakan toko konvensional *offline*, maka komunikasi, pelayanan, kebutuhan stok, kebersihan toko harus senantiasa dijaga untuk memberikan kenyamanan dalam menghasilkan minat beli. Hal ini dikarenakan perilaku konsumen di jaringan Toko Alladin merupakan konsumen yang senang berkomunikasi, berinteraksi langsung dengan pegawai toko yang ramah dan suasana toko yang bersih serta menyenangkan. Kebutuhan stok juga menjadi hal yang penting dalam memahami perilaku konsumen karena karakter konsumen yang menginginkan barang diperoleh dengan mudah sehingga konsumen memiliki minat beli toko konvensional *offline*.

Minat Beli Berpengaruh Signifikan Terhadap Keputusan Pembelian sesuai dengan penelitian yang dilakukan oleh Komalasari, Farida, dkk (2021) yang menunjukkan bahwa minat beli memiliki pengaruh positif terhadap keputusan pembelian. Dan juga penelitian yang dilakukan oleh Amri, Sirly dan Dorojatun Prihandono (2019) yaitu minat beli berpengaruh signifikan dan positif terhadap keputusan pembelian. Dikarenakan penelitian ini juga terbukti menghasilkan bahwa minat beli berpengaruh signifikan terhadap keputusan pembelian maka jaringan Toko Alladin harus meningkatkan minat beli untuk menghasilkan keputusan pembelian. Minat beli dapat dilakukan diantaranya melakukan berbagai macam hal-hal yang memikat konsumen yaitu memberikan diskon, hadiah, pengantaran gratis, info barang baru atau promo, serta strategi-strategi menarik lainnya yang dapat menghasilkan kekonsistenan konsumen dalam menciptakan minat beli untuk menjadi keputusan pembelian.

Strategi Pemasaran Berpengaruh Signifikan Terhadap Keputusan Pembelian**.** Hasil ini juga diperoleh Saechurroji, dan Cecilia Rita Juliana Martin (2022) bahwa strategi pemasaran yang

digunakan dapat meningkatkan keputusan pembelian atas produk yang ditawarkan dan mempertahankan konsumen membeli produk. Begitu pula penelitian yang dilakukan oleh Atuti, Retno, dkk (2015) bahwa strategi pemasaran berdasarkan *marketing mix* terutama harga merupakan strategi pemasaran terbaik untuk meningkatkan keputusan pembelian. Hal ini juga dihasilkan oleh Masterina, Olivia Dame, dkk (2021) yaitu strategi pemasaran berpengaruh positif signifikan terhadap keputusan pembelian. Dalam hal penelitian ini maka ritel UMKM harus memiliki strategi pemasaran dalam kegiatan operasionalnya, agar pada akhirnya para pelaku UMKM dapat meningkatkan penjualan dari keputusan pembelian para konsumen, sebagai contoh melalui strategi harga yang diterapkan jaringan Toko Alladin selama ini yaitu menetapkan harga di bawah *modern market,* membuat konsumen tidak ragu untuk melakukan aktivitas pembelanjaan di jaringan Toko Alladin. Juga dapat dilihat, meskipun saat ini toko konvensional *offline* menghadapi persaingan tinggi dengan toko *online* terutama dalam segi harga dan produk, namun melalui strategi pemasaran yang tepat, toko Alladin siap bersaing di pasar ritel terutama komoditi kebutuhan bayi dan anak. Oleh karena itu pelaku UMKM harus terus menggali dan menerapkan strategi pemasaran yang sesuai untuk terus mencapai keputusan pembelian di Toko Alladin.

Moderasi Strategi Pemasaran berpengaruh tidak signifikan terhadap hubungan Perilaku konsumen kepada keputusan pembelian. Penelitian yang dilakukan oleh Rajagopal (2008) menunjukkan bahwa perilaku konsumen dipengaruhi untuk melakukan keputusan pembelian melalui daya tarik produk dan promosi yang dilakukan oleh bagian penjualan. Dalam penelitian yang dilakukan di Toko Alladin, strategi pemasaran tidak berhasil membuktikan bahwa strategi pemasaran harus dikuatkan atau dilemahkan untuk memberikan pengaruh antara perilaku konsumen terhadap keputusan pembelian karena bukan merupakan variabel moderasi, sehingga perlu diteliti kembali variabel yang memang berperan sebagai variabel yang dapat memperkuat atau memperlemah pengaruh perilaku konsumen terhadap keputusan pembelian atau bagaimana peran strategi pemasaran terhadap pengaruh antara perilaku konsumen terhadap keputusan pembelian. Namun dengan arah yang positif artinya semakin tinggi strategi pemasaran maka pengaruh perilaku konsumen terhadap keputusan pembelian semakin meningkat. Implikasi kepada pelaku UMKM adalah melakukan strategi pemasaran dalam rangka meningkatkan penjualan atau keputusan pembelian para pelanggannya, karena strategi pemasaran memang aktifitas positif dapat meningkatkan penjualan dari keputusan pembelian para konsumen. Aktivitas strategi pemasaran yang dapat dilakukan oleh Toko Alladin bisa melalui menambah variasi produk yang dijual, meningkatkan komunikasi pemasaran, tetap mempertahankan harga yang ekonomis sehingga perilaku konsumen khususnya pada pasar konvensional akan tetap menarik untuk dibawa sampai menghasilkan keputusan pembelian.

Mediasi Minat Beli berpengaruh secara signifikan pada Pengaruh Perilaku Konsumen terhadap Keputusan Pembelian. Hasil penelitian ini sejalan dengan penelitian yang dilakukan oleh Li, Shimiao Li dan Nor Siah Jaharuddin (2020) yang menghasilkan bahwa niat beli secara signifikan dapat memediasi hubungan antara masing-masing sikap pembelian, kontrol perilaku yang dirasakan, budaya terapi makanan, dan pada akhirnya sampai kepada keputusan pembelian. Minat beli konsumen dapat muncul akibat adanya rangsangan/perilaku yang ditawarkan oleh perusahaan, dan konsumen akan memberikan respon yang merupakan bagian dari sikap mengonsumsi produk pilihan konsumen. Minat beli mampu menjadi variabel yang mempengaruhi hubungan antara perilaku konsumen dengan keputusan pembelian dan menajdi hubungan yang tidak langsung dan tidak diamati dan diukur sehingga dalam hal ini ritel UMKM *offline* harus dapat menganalisa perubahan perilaku konsumen untuk kemudian menjadikan referensi dalam *approach* meningkatkan minat beli, agar dapat meningkatkan keputusan pembelian para konsumen. Implikasi manajerial yang dapat dilakukan dalam hal perilaku konsumen yaitu salah satu contohnya adalah Toko Alladin

memperhatikan jam buka toko yaitu selama kurang lebih 14 (empat belas jam) dalam 1 (satu) hari supaya konsumen yang senang berbelanja di toko fisik, dapat terlayani pada pagi sampai malam hari. Toko Alladin juga memiliki respon yang cepat dalam menangani pelanggan melalui media sosial seperti Instagram dan Whatsapp sehingga konsumen semakin tinggi memiliki minat beli di Toko Alladin dan pada akhirnya tercapai tujuan usaha yaitu penjualan.

5. CONCLUSION

Bahwa Perilaku Konsumen Berpengaruh Tidak Signifikan Terhadap Keputusan Pembelian memberikan pemahaman bahwa perubahan perilaku konsumen para pelanggan Toko Alladin pengaruhnya tidak berarti karena efeknya sangat kecil terhadap penjualan atau keputusan pembelian para konsumen, namun memiliki arah yang positif. Perilaku Konsumen Berpengaruh Signifikan Terhadap Minat Beli dapat diartikan bahwa perubahan perilaku para konsumen Toko Alladin memiliki arti atau bersifat nyata kepada minat beli/keinginan untuk membeli barang di Toko Alladin dengan arah yang positif yang berarti apabila perilaku konsumen meningkat atau terjadi perubahan maka minat beli juga mengalami perubahan atau peningkatan. Minat Beli Berpengaruh Signifikan Terhadap Keputusan Pembelian yaitu bahwa minat beli memiliki pengaruh yang berarti atau nyata terhadap keputusan pembelian dengan arah yang positif. Strategi Pemasaran Berpengaruh Signifikan Terhadap Keputusan Pembelian dimana jika strategi pemasaran mengalami peningkatan maka keputusan pembelian juga akan mengalami peningkatan. Dalam penelitian ini berarti strategi pemasaran yang dilakukan oleh Toko Alladin berdampak langsung terhadap penjualan yang ditandai dengan meningkatnya keputusan pembelian oleh para konsumen. Moderasi Strategi Pemasaran berpengaruh tidak signifikan terhadap hubungan Perilaku konsumen kepada keputusan pembelian dapat diartikan strategi pemasaran berdasarkan analisa perilaku konsumen tidak memiliki kemampuan atau besaran dalam mempengaruhi hubungan antara perilaku konsumen terhadap keputusan pembelian dengan arah yang positif. Dalam penelitian ini analisa yang dilakukan terhadap perubahan perilaku konsumen yang kemudian dijadikan referensi untuk menyusun dan menerapkan strategi pemasaran ternyata tidak mempengaruhi penjualan atau keputusan pembelian para pelanggan Toko Alladin. Mediasi Minat Beli berpengaruh secara signifikan terhadap hubungan Perilaku Konsumen kepada Keputusan Pembelian sehingga dalam hal ini analisa mengenai perubahan perilaku konsumen yang dijadikan referensi oleh Toko Alladin untuk meningkatkan minat beli para pelanggan, hasilnya berdampak terhadap penjualan Toko Alladin dengan indikasi meningkatnya keputusan pembelian para pelanggan Toko Alladin.

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QUALITY CONTROL CIRCLE PROCESS ON ELECTRONIC ENGINEERING DOCUMENT MANAGEMENT IN EPC COMPANY

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ABSTRACT

The COVID-19 pandemic has greatly impacted the document management systems of companies, requiring them to quickly adopt digital solutions for remote access and collaboration. In the context of electronic document management for Interdisciplinary Check and Review in an Engineering, Procurement, and Construction company, the Quality Control Circle process can play a significant role in ensuring the quality of the electronic documents being used in the engineering IDCR process. PT Wijaya Karya, an EPC company in Indonesia, has implemented an electronic document management system named Docudo The implementation of the QCC process has improved the efficiency and effectiveness of the IDCR process and continuously improves the EDMS over time. As the result, the benefits achieved include reduced manhour spending costs by 14.17% for a polypropylene tender study case, documents secure to be viewed from anywhere, and most importantly, no more loss of documents or different revised documents used as references. According to the results of a user satisfaction survey, respondents felt satisfied with a score of 3.54 out of a possible 4.00.

Keywords: Quality, Interdisciplinary, Engineering, Electronic, Document, Efficiency.

1. INTRODUCTION

The COVID-19 pandemic has had a significant impact on many companies and their operations, including their document management systems. With the shift to remote work and social distancing measures, many companies have had to quickly adapt and find new ways to manage and share documents electronically. Amankwah (2021). One of the biggest impacts of the pandemic on document management systems has been the increased need for digital solutions that allow for remote access and collaboration. Many companies have had to implement new technologies, such as cloud-based document management systems, to ensure that all employees can access and work on documents from anywhere. Kutnjak (2021). Tønnessen (2021). Another impact of the pandemic on document management systems has been the need for improved security measures. With more employees working remotely, companies have had to ensure that their documents and data are

protected from cyber threats and unauthorized access. Mourtzis (2022). This has led to an increase in the use of encryption and other security measures to protect sensitive information.

The COVID-19 epidemic has had a considerable impact on how Engineering, Procurement, and Construction (EPC) firms perform multidisciplinary checks and reviews on engineering papers. Due to the necessity for distant work and social separation, the usage of paper copies for Interdisciplinary Document Check and Review (IDCR) has become challenging to adopt. As a result, businesses have attempted to disseminate documents via e-mail and chat programs, but this technique has been unproductive because it makes document tracking and tracing difficult. The current approach of using e-mail and chat applications to distribute documents is not a sustainable solution as it lacks the necessary features to support the IDCR process, which includes checking, review and approval. Ayaz (2020). It's challenging to track changes and revisions to the documents, monitor the progress of the review process, and ensure compliance with regulatory requirements. It also lacks the security features to protect sensitive documents from unauthorized access or data breaches.

To adapt to this new reality, EPC companies should accelerate their digital transformation efforts, particularly in the field of electronic document management systems. These systems provide features such as version control, access controls, and digital signature, which support compliance and regulatory requirements. Artamonov (2018). Furthermore, electronic document management systems can help to improve the transparency and traceability of the IDCR process by providing an audit trail of all comments, approvals, and access to the documents, helping to ensure that the final engineering documents are of high quality. Digital document management systems can also provide collaboration tools such as commenting and approval workflows, real-time updates and notifications for team members, and secure storage and sharing of documents. These tools are essential for effective collaboration among different departments and teams, eliminating the need for physical distribution of hard copies and facilitating the IDCR process. Chang (2022).

PT Wijaya Karya (WIKA), as one of the leading engineering, procurement, and construction (EPC) companies in Indonesia, is constantly looking for ways to improve its operations and increase efficiency. One of the ways they are doing this is through the implementation of an electronic document management system (EDMS) in their Quality Control Circle (QCC) team. The QCC team is responsible for ensuring that all aspects of a project are in compliance with the relevant codes and standards, and that the project is completed on schedule and within budget. Ahmad (2017). To achieve this goal, the QCC team at WIKA is working to create an Interdisciplinary Check and Review concept. IDCR is a process that involves the review of project documents by multiple disciplines to identify and resolve any potential issues before construction begins. This is a critical step in ensuring the overall quality and success of a project.

This paper will provide a detailed examination of how the Quality Control Circle process is utilized in the development of an Electronic Document Management System (EDMS) for the Interdisciplinary Check and Review process in engineering. It will show how the QCC process helps to improve the efficiency and effectiveness of the IDCR process by streamlining document management, automating tasks, and reducing errors. It will also demonstrate how the QCC process ensures that the EDMS meets the specific needs of the IDCR process, and how it helps to continuously improve the EDMS over time.

2. METHODS

Quality Control Circle is a method of continuous improvement used in organizations to improve the quality of products, services, and processes. It is a participatory approach that involves a cross-functional team of employees in identifying, analyzing, and resolving quality problems.

QCCs typically focus on specific processes or areas of the work environment, and use data and statistical analysis to identify and eliminate sources of variation and waste. The goal of QCC is to improve the overall performance and competitiveness of an organization by involving all employees in identifying and solving quality-related problems, thereby promoting a culture of continuous improvement. There are eight steps in setting up a Quality Control Circle. WIKA (2022):

1. Determining the Theme/Title/Dominant Issue: Establish themes or concerns based on the proposed difficulties that have the biggest impact on achieving work unit goals and are the most prevalent. Identifying the specific area or problem that the QCC will focus on. This could be a specific process, product or service, customer complaint, or any other area that the group believes needs improvement.
2. Identify the Cause of the Problem: Collecting and analyzing data related to the problem to identify the root cause of the problem. Describe and collect factors related to the causes of the problem by considering internal and external factors. This is typically done through brainstorming, process mapping, and statistical analysis.
3. Define Solutions: List potential solutions based on the most prevalent root causes. The optimum option will then be determined by taking into account numerous supporting elements and examining the hazards of the chosen solution. It's important that the solutions are realistic and can be implemented within the resources and constraints of the organization.
4. Planning Improvements: Using the 5W + 2H analysis table, create an improvement plan based on the selected solution. Make a record of your improvement strategy. Set up a project monitoring system and plan preventive measures against the hazards of the chosen solution. Creating a detailed plan for implementing the solutions. The plan should include specific actions, timelines, and resource requirements.
5. Implement/Implement the Improvement Plan: Prepare the implementers' competency. Prepare the necessary resources. Improvements are documented as they are implemented. And tracking the adoption of improvements. Putting the plan into action. This is typically done by the QCC members, with support from other employees and management. This step is critical for actually making the improvements and achieving the desired results.
6. Repair Evaluation: The evaluation process compares the defined aim to the actual conditions obtained after improvement. The evaluation relates to features of Quality, Cost, Delivery, Safety and Morale (QCDSM) in addition to the aim. Evaluate the outcomes of each change, including the challenges encountered, and consider the impact of the improvements on the firm or interested parties.
7. Establish Standardization: Create standardization in the form of processes, work instructions, or other new norms to ensure that problems do not reoccur. Validate new standards and familiarize related parties with new standards. This step ensures that the improvements are sustained over time and that they become part of the organization's culture.
8. Determine the Next Theme: Make additional work plans based on the problem's priority. Identifying a new problem or opportunity for improvement. The QCC process is cyclical, and the next theme should be chosen based on the organization's goals and objectives, and feedback from members on the effectiveness of the previous theme. This step allows the QCC to continuously improve and achieve the organization's goals and objectives.

The proposed methodology is a systematic approach aimed at assisting organizations in the implementation of a Document Management System that aligns with the standards outlined in ISO 9001:2008 Quality Management Systems. Hernad (2013). The methodology utilizes a Quality Control Circle approach to ensure that the implementation of the Document Management System is in line with the Quality Management System requirements.

No	Description of Activity	QCC Advisor	QCC Facilitator	QCC Leader	QCC Member
1	Determine the theme/problem to be solved - Top down themes/problems, it can also be from current issues or from the results of an agreement between QCC members and leader - If the theme / problem to be solved is an agreement between the QCC members and leader QCC		1		1
2	Problem analysis base on available data resource				2
3	Solve the problem, review the problem solving methods				3
4	Propose for approval regarding problem solving method		4		
5	Carry out problem solving				5
6	Monitoring the results of problem solving	6		6	
7	Standardize problem-solving method				7
8	Determine the next theme		8		

Figure 1. QCC Process Flow Chart

3. RESULTS

3.1. IDCR Process

The IDCR process for engineering document management involves several key roles and stages, starting with an engineer creating the documents. Jones (2020). These documents are then reviewed by a senior engineer for accuracy and compliance, and approved by a lead engineer. The final step is for the engineering manager to finalize the documents and hand them over to the document control team for distribution, who may use an EDMS to track the document status and ensure the client has access to accurate information. The IDCR process includes document version

control, history tracking, and notifications of updates, ensuring that all parties have access to the most recent and accurate information. Hahm (2014).

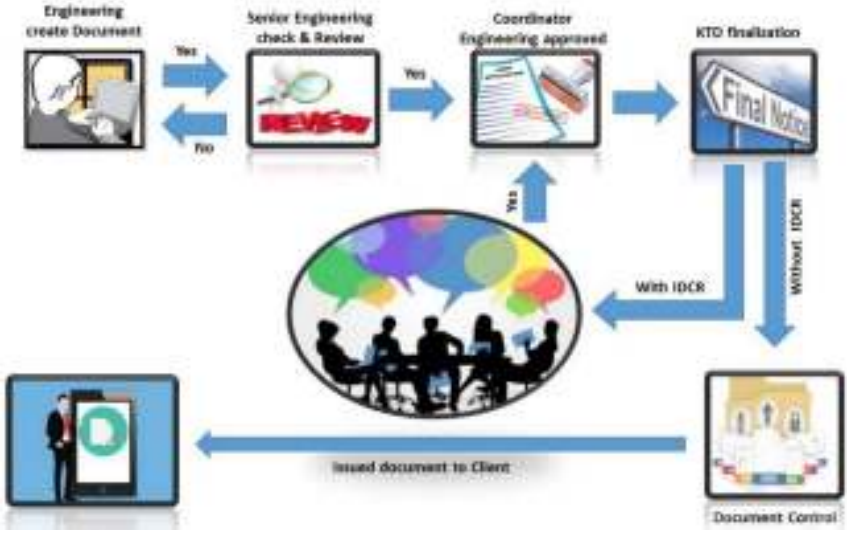

Figure 2. IDCR Process Flow Chart

3.2. Theme Identification

The following issues were discovered as a result of the QCC team's brainstorming:

1. Process of Online Checking and Review Not effective via WhatsApp or email.
2. Document Control does not appropriately monitor the check and review process.
3. The coordinator does not supervise the workload of employees who "work from home."
4. Engineering document storage that is not linked to the internet
5. Manual document archiving is not possible while working from home.

Table 1. QCDSM Analysis

No	Aspect	Before	After
1	Quality	IDCR control form does not work because engineers communicate by whatsapp. Document can archive and access only from office.	IDCR control form will be generate as per comment by system automatically. Document can archive and access in everywhere safely.
2	Cost	Documents shall be printed for distribution to all engineers in order to offline IDCR process. Besides, final document shall be printed to be submitted to client. So that, 1 document will be printed minimum 3 copies each cycle. No budgeting for document application development tools in RKAP.	Printed document is only final and submitted version. So, document will be printed once and will be reduce printing cost 66.6%. Document Management System application tools developed by EPC Department personnel.
3	Delivery Time	Document collection process by document controller takes 1 day after review process.	Approved document review automatically generating and collect process to folder.
4	Safety	Engineers and document controllers shall be presence to IDCR process and can be infected Covid-19.	Engineers and document controllers do not presence in office, so Covid-19 transmission is decrease.

5	Morale	Engineers and document controllers are worry to WFO during Covid-19 pandemic.	Engineers and document controllers feel secure and safe to work.

3.3. Root Cause Analysis

The Ishikawa Diagram, also known as a fishbone diagram or cause-and-effect diagram, is a tool used in the quality control circle process to help identify the root cause(s) of a problem. After determining the theme or dominant issue, the Ishikawa Diagram can be used to visually organize and categorize potential causes of the problem.

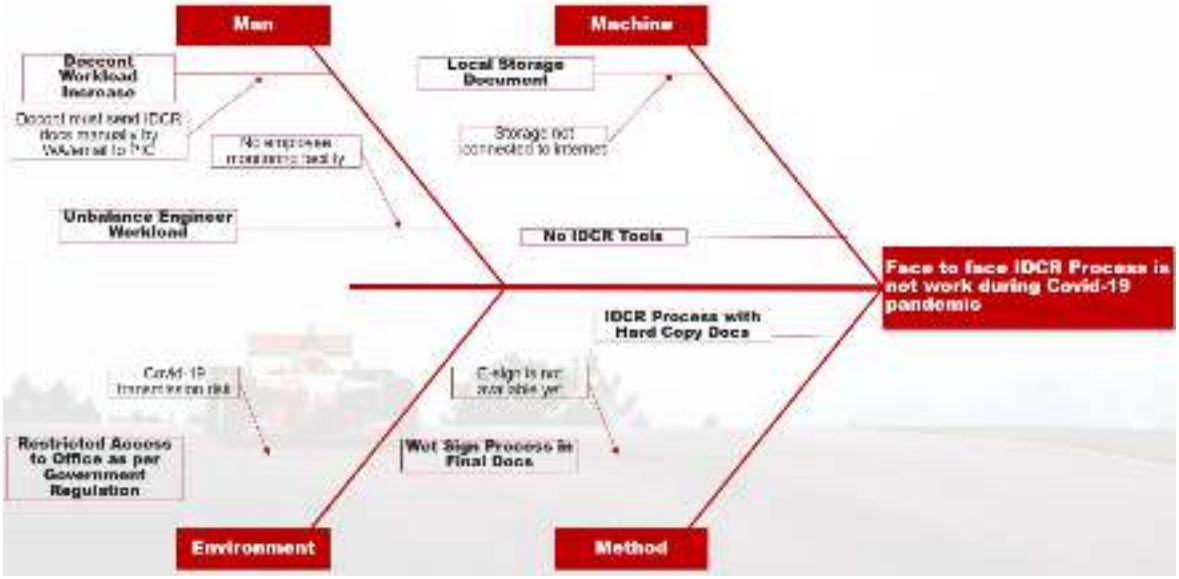

Figure 3. Ishikawa Diagram

After getting the root cause of the Ishikawa diagram, perform a comparative analysis of the problem as in the following table.

Table 2. Comparison Problems Matrix

Description		X1	X2	X3	X4	X5	X6	Total
Storage is not connected to internet	X1	#	1	1	2	2	2	6
No facility / tools IDCR	X2	3	#	3	3	3	2	12
Document controller shall send IDCR document to all person by WA / email	X3	3	1	#	3	1	3	8
No e-sign facility	X4	2	1	1	#	1	1	5
Covid-19 transmission risk	X5	2	1	3	3	#	2	9
No employee monitoring facility	X6	2	2	1	3	2	#	10

Notes:
Point 1 – Low Impact
Point 2 – Equal Impact
Point 3 – High Impact

Based on the comparison table above, it is decided that the dominant problem is that there are no IDCR facilities / tools

3.4. Solution Formula

The development of the document management system application is made easier due to the existence of similar applications that have already been utilized by large Engineering, Procurement, and Construction companies. These applications, such as BIM 360 Docs from Autodesk, Lotus Domino from IBM, and Odoo Document Management, have proven effective in managing the document approval process. The proposed application will utilize the Power Apps feature of Office 365, which has been made available to all WIKA employees through the company's subscription. This means that there will be no additional costs required for its usage. By leveraging these tools, the development of the document management system will be more streamlined, and the implementation of the application can be carried out more efficiently. The name "Docudo" is an original and unique identifier for this document management system application. It is a newly created application that has been developed specifically to manage the document approval process within an organization where all documents can be securely stored, easily accessed, and efficiently managed. The use of this application is intended to streamline the document approval process and improve the overall organization's document management practices.

Figure 4. Docudo Application

Figure 5. Docudo Dashboard

3.5. Evaluation and Value Added

This evaluation describes the results of a user satisfaction survey conducted to assess the effectiveness of an electronic document management system called "Docudo". The survey was conducted after making improvements to the application. The results showed that the users are very satisfied with the support they receive from the development team in case they encounter problems accessing the application. The users are also satisfied with the interaction points with the application and the data security measures. Most of the users interact with the application very frequently and trust the security of the data stored in it. The overall satisfaction score was 3.54 on a scale of 1-4, with 4 being the highest. To understand the adoption of the application in the engineering department, the usage of the application was monitored. The graph shows that 93% of the total 55 employees were active users for one month.

Figure 6. Docudo User and Customer Satisfaction Survey

After the QCC process, we gained efficiency in the form of Engineering Manhour Spending of 14.17%, study case for polypropylene tender.

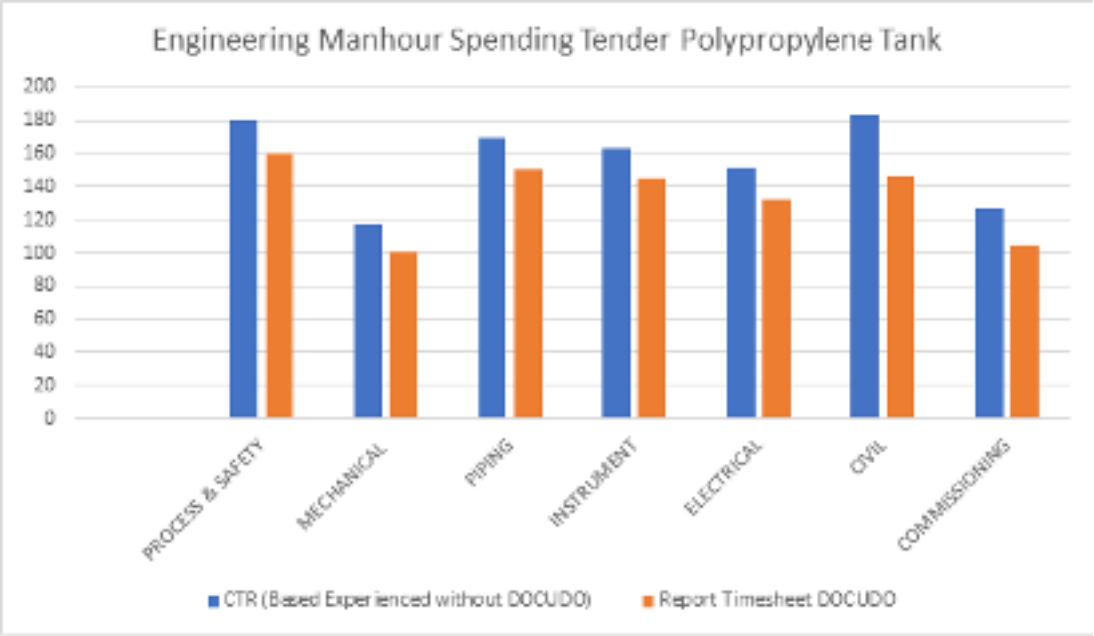

Figure 7. Manhour Engineering Efficiency

3.6. Confirmation of QCDSM Analysis

After implementing the improvements, a comparison was made between the conditions before and after the implementation of QCC. This comparison was presented in the form of a QCDSM table. The purpose of the comparison was to evaluate the effectiveness of the QCC methodology in addressing the areas that needed improvement and to assess the level of success in meeting the quality standards set by ISO 9001:2008.

Table 3. QCDSM Analysis After QCC

No	Aspect	Before	After	Improvement Result
1	Quality	IDCR control form does not work because engineers communicate by whatsapp. Document can archive and access only from office.	IDCR control form will be generate as per comment by system automatically. Document can archive and access in everywhere safely.	IDCR control form has been produced for monitoring process. Document can be accessed everywhere securely.
2	Cost	Documents shall be printed for distribution to all engineers in order to offline IDCR process. Besides, final document shall be printed to be submitted to client. So that, 1 document will be printed minimum 3 copies each cycle. No budgeting for document application development tools in RKAP.	Printed document is only final and submitted version. So, document will be printed once and will be reduce printing cost 66.6%. Document Management System application tools developed by EPC Department personnel.	Printing cost reduction 66.6% equivalent 98.4 million per year (only for final document that will be submitted to client).
3	Delivery Time	Document collection process by document controller takes 1 day after review process.	Approved document review automatically generating and collect process to folder.	Document controllers do not need time to collect final document. Time efficiency in production document 14.17% from overall document development process.
4	Safety	Engineers and document controllers shall be presence to IDCR process and can be infected Covid-19.	Engineers and document controllers do not presence in office, so Covid-19 transmission is decrease.	Personnel can work from everywhere
5	Morale	Engineers and document controllers are worry to WFO during Covid-19 pandemic.	Engineers and document controllers feel secure and safe to work.	Personnel can work from everywhere

4. CONCLUSIONS

A document management system named Docudo has been developed and implemented to support the requirements of ISO 9001:2008 Quality Management Systems. The methodology used in the implementation involves a Quality Control Circle approach to ensure that the system meets the quality standards set by ISO 9001:2008. The application is facilitated by the use of Power Apps

feature of Office 365, which all employees of WIKA have access to without any additional costs. A survey was conducted to measure user satisfaction, and the results showed that users are satisfied with the support from the development team, the ease of interaction with the application, and the data security measures applied. The majority of users frequently interact with the application, and the average satisfaction score was 3.54 on a scale of 1 to 4. The usage of the application has become an integral part of the document production work process in the engineering department, as indicated by a graph showing 93% of active users out of a total of 55 employees for 1 month. A comparison was carried out between the conditions before and after the implementation of the Quality Control Circle to measure the improvements made.

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POTENTIAL ANALYSIS OF GALAM WOOD FOR SIMPLE HOUSE CONSTRUCTION

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ABSTRAK

Galam (Melaleuca Sp) is a kind of wood that grows in swamp forest areas which can be used as a construction material. Based on the fact that this Galam wood is easily replanted and not in endangered species list, it has much potential in the world of construction. In order to use galam wood efficiently, it is necessary to understand the properties of galam wood and its potential strength. The benefit of this research is to know the basic properties of galam wood and its application in simple house designs. In terms of physical properties, galam wood has a specific gravity of 0.73 gr/W which is classified as strong class type II wood and has a moisture content of 16.16%. From the mechanical properties, the average tensile strength parallel to the grain is 136.42 MPa, the tensile strength perpendicular to the fiber direction is 5.18 MPa, the compressive strength parallel to the fiber direction is 52.17 MPa, the compressive strength perpendicular to the fiber direction is 32.31 MPa, the flexural strength of 89.23 MPa, and a shear strength value of 10.27 MPa. Construction dimensions for trusses are 10/12 cm, gording 10/12 cm, beams 10/18 cm and columns 12/25 cm.

Keyword: galam wood, physical properties, mechanical properties, simple house design

1. INTRODUCTION

As a result of population development in Indonesia, the need for houses is very large so that the need for building materials is also increasing. Among the construction materials used for houses, bridges, buildings, etc., is wood. Wood is a material that is widely used in Indonesia. Rilatupa (2016) suggests that wood is used as a construction material because it is light and requires simple handling tools. Construction materials that are widely used include stone, sand, cement, and so on. The availability of these construction materials can be exhausted because they cannot be renewed, so they require materials which are abundant in nature and can be renewed. Galam *(Melaleuca Sp)* is a type of wood that grows in swamp forest areas and is often used as a building material for houses. Galam wood is abundant in the peat swamp forests of Kalimantan

and the coasts of South Sumatra.

Wood obtained from different trees has unique properties in terms of fiber structure, moisture content, hardness, specific gravity, density and strength. Even within the same tree the properties of the wood are different. Properties that are closely related to the use of wood include physical properties (density, moisture content, surface roughness, shrinkage and expansion) and mechanical properties (properties exposed to external forces, such as flexibility, stiffness and resistance). The mechanical properties of wood are important parameters for understanding the use of wood as a building material. This basic property is used in the calculation of solutions for wooden structures. The mechanical properties of wood include compressive strength parallel and perpendicular to the grain, flexural strength (MOR), tensile strength parallel and perpendicular to the grain, shear strength and stiffness (Yoresta, 2015). The properties of wood can be affected by several factors. Wahyu (2008) suggested that natural factors such as growing location, age, tree species, trunk location and diameter can affect the physical and mechanical properties of trees. The physical properties of wood are part of the properties of wood, namely the physical, mechanical and chemical properties of wood. The physical properties of trees are very specific because the role of internal factors rather than the structure of the tree is very important, in addition to the role of the environment in which the tree is located. To use galam wood effectively and fully in the construction industry, it is necessary to understand the strength and properties of galam wood. This study aims to determine the basic properties of galam wood originating from the Balikpapan area of East Kalimantan. This study aims to determine the moisture content, specific gravity, flexural strength (MOR), compressive strength, tensile strength and shear strength of cassava wood. Galam wood will be designed for a simple house.

2. METHOD

Time and Location

This research was conducted for 6 months, namely July 2022 - December 2022. The wood used came from a wood distributor in Balikpapan City, East Kalimantan. The location of the test is that the physical test is carried out at the Integrated Laboratory, Kalimantan Institute of Technology and the mechanical test is carried out at the Industrial Laboratory for Testing Forest Products, Faculty of Forestry, Mulawarman University.

Materials and tools

In this study using galam wood that has been profiled according to the provisions of each test. Tests carried out included testing specific gravity, moisture content, tensile strength, compressive strength, flexural strength, and shear strength. The physical and mechanical test equipment used includes meters, calipers, ovens, scales, and universal testing machines (UTM). The sample code for galam wood can be observed in table 1 while the test objects for testing physical and mechanical properties can be seen in figure 1.

Tabel 1. Test object

No	Type of Testing	Amount Sample	Code Sample	No	Type of Testing	Amount Sample	Code Sample

No	Type of Testing	Amount Sample	Code Sample	No	Type of Testing	Amount Sample	Code Sample
1	Specific grafity	5	BJ-01 BJ-02 BJ-03 BJ-04 BJ-05	5	Undirectional Tensile Test Fiber	4	TES-01 TES-02 TES-03 TES-04
2	Water Content	5	KA-01 KA-02 KA-03 KA-04 KA-05	6	Upright Tensile Test Straight Fiber	4	TEL-01 TEL-02 TEL-03 TEL-04
3	Undirectional Tensile Test Fiber	3	TS-01 TS-02 TS-03	7	Flexural Test	4	L-01 L-02 L-03 L-04,
4	Upright Tensile Test Straight Fiber	3	TL-01 TL-02 TL-03	8	Shear Test	4	G-01 G-02 G-03 G-04

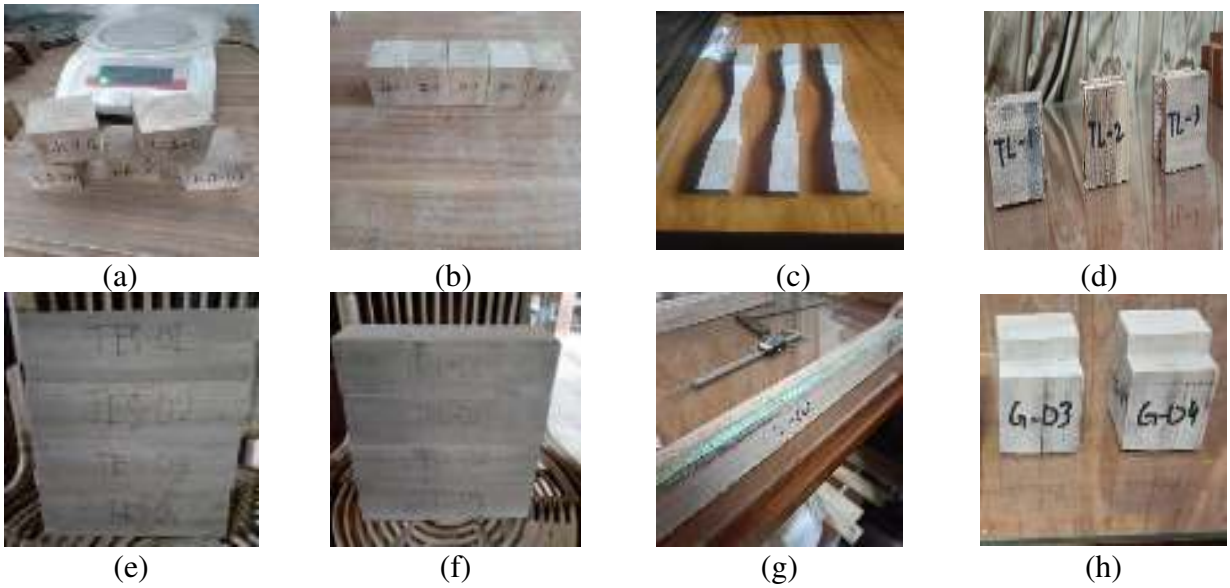


Figure 1. (a) Moisture content, (b) Specific gravity, (c) Tensile strength in the direction of the grain, (d) Tensile strength perpendicular to the grain, (e) Compressive strength in the direction of the grain, (f) Compressive strength perpendicular to the grain, (g) flexural strength, and (h) shear strength

Work Procedure

Making test specimens and testing refers to SNI 08-7070-2005 for water content and SNI 03-6844-2002 for specific gravity.Testing the mechanical properties of wood in the form of tensile strength, compressive strength, flexural strength, and shear strength. The implementation of the mechanical properties test refers to SNI 03-3399-1994, SNI 03-3400-1994, SNI 03-3958-1995, and SNI 03-3959-1995.

3. RESULTS AND DISCUSSION

Water Content

The results of laboratory tests obtained the value of water content according to **Table 2** as follows.

Tabel 2. Value of water content after drying

Code Sample	w1 (gr)	P (cm)	L (cm)	T (cm)	w2 (gr)	Water Content (%)	Average Water Content (%)
KA-01	86,8	4,9	4,85	4,98	74,5	16,51	16,16
KA-02	88,89	4,85	4,84	5,04	76,5	16,20	
KA-03	89,62	5	4,9	5,05	77,06	16,30	
KA-04	87,6	5,05	4,86	5,06	75,86	15,48	
KA-05	88,08	4,86	4,83	5,06	75,71	16,34	

Firdausy (2020) states that the mechanical testing requirements for wood require a maximum moisture content of 20%. If the moisture content is still above 20%, natural drying is carried out. Table 2. Shows that the average water content of galam wood is 16.16%, so it meets the requirements for testing mechanical properties.

Specific Gravity

The results of laboratory test obtained the value of water content according to **Tabel 3** As follows.

Tabel 3. Specific Gravity Values

Sample Code	w1 (g)	p (cm)	L (cm)	t (cm)	w2 (g)	Specific Gravity (g/cm3)	Specific Gravity Average
BJ-01	90,01	4,88	4,87	5,12	77,8	0,74	0,73
BJ-02	88,27	5	4,75	5,25	76,72	0,71	
BJ-04	88,92	4,83	4,91	5,13	76,49	0,73	
BJ-05	87,85	4,82	4,83	5,13	75,91	0,74	

Based on the calculation above, it is known that the specific gravity of the kiln-dried galam wood is 0,73 gr/cm^3. According SNI 03-3527-1994 it is known that galam wood belongs to the strong class II because it has a specific gravity of 0.9 – 0.6.

Tensile Strength

The results of laboratory tests obtained values of tensile strength perpendicular to the fibers and tensile strengthparallel to the fibers according to **Table** 4. and **Table** 5. as follows.

Tabel 4. Tensile strength value perpendicular to the fiber

Code Sample	Diameter (mm)		Maximum Load (kN)	Maximum Load (N)	Tensile Strength (MPa)	Tensile Strength Average (Mpa)
	B (mm)	H (mm)				
TL-01	25,33	48,67	6,580	6580	5,34	5,18

TL-02	25,4	48,59	6,276	6276	5,09
TL-03	25,89	48,62	6,443	6443	5,12

Tabel 5. Tensile strength values parallel to the galam wood

Code Sample	Diameter (mm)		Maximum Load (kN)	Maximum Load (N)	Tensile Strength (MPa)	Tensile Strength Average (Mpa)
	B (mm)	H (mm)				
TS – 1	4,84	9,18	629	6.164	138,83	136,42
TS – 2	4,94	9,2	621	6.086	134,00	

Compressive Strength

Strength The results of laboratory tests obtained the compressive strength parallel to the fibers and the compressive strength perpendicular to the fibers according to **Table** 6. and **Table** 7. as follows.

Tabel 6. Compressive strength values parallel to the galam wood grain

Code Sample	Ukuran			Maximum Load (N)	Maximum Load (kN)	Compressive strength (Mpa)	Compressive strength average (Mpa)
	B (mm)	h (mm)	t (mm)				
TES-02	49	49	200	124900	124,9	52,02	52,17
TES-03	49	49	200	128700	128,7	53,60	
TES-04	49	49	200	122200	122,2	50,90	

Tabel 7. Value of compressive strength perpendicular to the galam wood grain

Code Sample	Diameter (mm)		Maximum Load (kN)	Maximum Load (N)	Compressive strength (MPa)	Compressive strength (MPa)
	B (mm)	H (mm)				
TEL-01	50,65	51,06	81,016	81016	31,33	32,31
TEL-02	50,15	50,27	84,232	84232	33,41	
TEL-03	50,15	50,29	84.370	84370	33,45	
TEL-04	50,19	50,24	78,289	78289	31,05	

Based on **Table** 6, the compressive strength parallel to the fibers of kiln-dried galam wood is 52,17 N/mm^2. SNI 03-3527-1994 it is known that galam wood belongs to the strength class II because it has a compressive strength parallel to the fibers of 411 - 561 kg/cm^2.

Based on **Table** 7, the compressive strength perpendicular to the fibers of kiln-dried galam wood is 32.31 N/mm^2. Base on SNI03-3527-1994, it is known that galam wood is classified as strong class II because has a compressive strength perpendicular to the fiber> 171 kg/cm^2.

Flexural Strengt

The results of the flexural strength test of galam wood can be seen in **Table** 8 as follows.

Tabel 8. Flexural strength values of galam wood

Code Sample	Size		L	Maximum Load	Maximum Load	Flexural strength	Flexural strength average
	B (mm)	H (mm)	mm	(Kgf)	(N)	N/mm2 (Mpa)	N/mm2 (Mpa)
L-01	48,66	48,5	71	916	9.523	83,72	89,23
L-02	49,34	46,9	71	998	9.787	96,17	
L-03	50,06	49,3	71	1021	10.013	87,79	

Based on the flexural strength of kiln-dried galam wood it is 89,23 N/mm^2. According table SNI 03-3527-1994 known that galam wood is included in the strong class II because it has a flexural strength of 795 - 1221 kg/cm^2 .

Shear Strength

The results of the shear strength test of galam wood can be seen in **Table** 9 as follows.

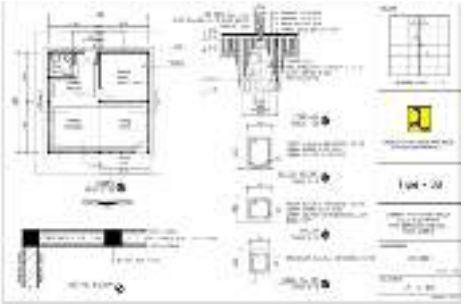
Tabel 9. Value of shear strength of galam wood

Code Sample	Size		Maximum Load	Maximum Load	Shear Strength	Shear Strength Average
	B (mm)	H (mm)	(Kgf)	(N)	N/mm2 (Mpa)	N/mm2 (Mpa)
G-01	48,83	49,66	2505	24.567	10,13	10,27
G-02	48,79	50,78	2669	26.175	10,56	
G-03	48,03	50,76	2445	23.978	9,84	
G-04	48,23	50,98	2641	25.900	10,53	

Based on the shear strength of kiln-dried galam wood is 10,27 N/mm^2.

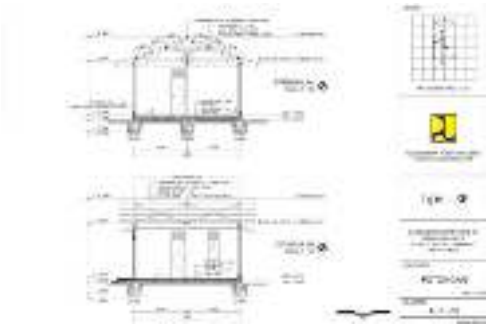
4. PRELIMINARY STRUKTUR

Structural planning using type 36 houses based on PUPR Ministerial Regulation No. 5 of 2016 is as follows.



Gambar 2. Simple house plan (Source: PUPR, 2016)

Gambar 3. Front View, Right Side, Left Side, and Back Design (Source: PUPR, 2016)



Gambar 4. Design Cross Section (Source: PUPR, 2016)

Pembebanan pada struktur kayu

Roof planning data for a simple house are as follows.

- Type of wood = galam (berat jenis = 0,73 g/cm^3)
- Wood Grade = kelas II
- Roofing Material = corrugated zinc
- Roof slope angel = 25°
- The distance between truss = 3 m
- Truss length = 6 m
- Distance between gording = 0,90 m
- Connection type = Nail
- Wind Pressure = 40 kg/m^2
- Plafond = 18 kg/m^2

Calculation of the length

Roof truss length can be seen in **Table 10.**

Tabel 10. Barcode Length

Kode Batang	Panjang Batang	Kode Batang	Panjang Batang
A_1	1,65	H_2	3,00
A_2	1,65	V_1	1,38
A_3	1,65	D_1	1,65
A_4	1,65	D_2	1,65
H_1	3,00		

The following is a picture for planning the roof truss shown in **Figure** 5.

Figure 5. Roof truss design

Planning for gording

Planned data for gording are as follows.

- Distance between trusses = 3 m
- Dimension of gording = 10/12 m
- Distance of gording = 0,90 m
- Roofing material = corrugated zinc
- Wind pressure = 10 kg/m^2

Tabel 11. Moments due to load variations and combinations

	Dead Load (kg.m)	**Live Load**		**Wind Load**		**Combined Load**	
		Concentrated load (kg.m)	**Distributed Load** (kg.m)	**Inward Wind** (kg.m)	**Outward Wind** (kg.m)	**Primary** (kg.m)	**Secondary** (kg.m)
1	2	3	4	5	6	7 (2+3)	8 (2+3+5)
M_x	8,44	31,70	2,85	4,05	-16,20	40,14	44,19
M_y	18,11	67,97	6,12	0	0	86,08	86,08

Galam wood with specific gravity = 730 kg/m3 including strong class II wood with $\bar{\sigma}lt$ = 100 kg/cm2, protected construction (β = 1), fixed / primary load (δ = 1), variable load (δ = 5/4), with the equation below, the dimensionsof the planned gording are 10/12.

Tabel 12. Calculation of Gording

Dimension	**Primary** $\sigma_{1\,tytb}$ kg/cm^2	**Secondary** $\sigma_{1\,tytb}$ kg/cm^2	$\bar{\sigma}lt$ kg/cm^2	f_{ytb} cm	f cm	**Control**		
						Stress $\sigma_{1\,tytb} < \bar{\sigma}lt$		**Deflection** $f_{ytb} < f$
						Primer	**Sekunder**	
10/12	59,76	64,45	124,1	1,443	1,5	**OK**	**OK**	**OK**

From the calculation above it can be concluded that the curtains that are planned to be 10/12

cm can be used,because they meet the applicable requirements.

Roof Dimension

For truss frames, class II wood is used, namely galam wood with an average specific gravity of 730 kg/cm2 , according to PKKI-1961 list II for class II wood.

Tabel 13. Recapitulation of Truss

Steam	Name	Dimension	$f_{tk//} = f_{tr//}$ kg/cm^2	σytb kg/cm^2	Control $\sigma ytb < f_{tk//} = f_{tr//}$
Pull	V_1	2 x 4/10	109,5	4,25	**AMAN**
	H_1, H_2	2 x 4/10	109,5	3,44	**AMAN**
Press	A_1, A_4	10/12	109,5	3,55	**AMAN**
	D_1, D_2	10/12	109,5	4,88	**AMAN**

Calculation of Beams

For the calculation of beams for simple house construction, use data from laboratory testing of galam wood, namelythe maximum load tested is 10013 N (Data in Table 4.9 sample L-03.

Tabel 14. Recapitulation of beam calculations

Dimension cm	Pu kN	V' kN	Vu kN	Δ	δ	Control	
						Flexible $V' > Vu$	Deflection $\Delta < \delta$
10/18	10,013	23,81	5	0,00968	10	**AMAN**	**AMAN**

From **Table 14.** that the bending and deflection controls, shear, meet the permit limits so that 10/18 cm blocks are **safe** to use.

Calculation of Coloumn

For this study, the load value was taken from the galam wood test, namely 125,3 kN. Galam wood is included in thestrong class II wood with an average specific gravity of 0,73.

Tabel 15. Recapitulation of column calculation

Dimension Cm	Pu kN	$\sigma_{tk//}$ kg/cm^2	$\bar{\sigma}_{tk//}$ kg/cm^2	Control $\sigma_{tk//} < \bar{\sigma}_{tk//}$
12/25	125,3	98	109,5	**AMAN**

From the calculations in **Table 15.** it is **safe to** use 12/25 cm wood as a column.

5. KESIMPULAN

In terms of physical properties, galam wood has a specific gravity of 0,73 gr/cm^3 which includes strong class II wood and water content of 16,16%. The mechanical properties of galam wood were

obtained with an average tensile strength parallel to the fibers of 136.42 MPa, tensile strength perpendicular to the fibers of 5.18 MPa, compressive strength parallel to the fibers of 52.17 MPa, compressive strength perpendicular to the fibers of 32.31 MPa, flexural strength values of 89.23 MPa, and a shear strength value of 10.27 MPa. Based on the results of the mechanical properties of wood, it can be concluded that galam wood is included in the strong class II. The dimensions of the planning of a simple house construction for trusses are 10/12 cm, curtains 10/12 cm, beams10/18 cm and columns 12/25 cm.

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CALCULATION OF MOTOR OPERATED VALVE LOOPING CABLE WITH TRAVELING SALESMAN PROBLEM METHOD

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ABSTRACT

The traditional approach used by WIKA engineers in calculating MOV cables is based on the tag number sequence. While this approach is legitimate, it lacks the essence of engineering and provides no guarantee on the total number of cables required. The Greedy Algorithm is a solution approach to the Traveling Salesman Problem (TSP) for cable routing optimization. It uses mathematical calculation to find the shortest and most efficient route for cable looping. The Greedy Algorithm offers a new approach in MOV cable calculation, providing an absolute guarantee of more optimal results and strengthening the essence of engineering and science within the WIKA instrument engineering team. In the Balongan LPG Project, the total MOV cable calculated using the Greedy Algorithm was 42 meters less than the traditional tag number sequence method, providing a savings for the project. As a result, the use of Greedy Algorithm can be considered and made a reference for future WIKA projects to avoid the gamble of luck in cable calculation and ensure more optimal results.

Keywords: MOV, Cable, Traveling Salesman, Greedy Algorithm, Optimal.

1. INTRODUCTION

The government's conversion program from kerosene to Liquid Petroleum Gas (LPG) for household use has proven successful, as demand for LPG continues to grow. The government has assigned state-owned Pertamina to increase LPG production to meet this demand. The entire process from processing to distribution to consumers is crucial in order to satisfy the need for this fuel. The Balongan LPG Depot serves as a storage facility for processed LPG gas products, which are transferred from sea tankers and then filled into gas transport tank trucks for distribution to various regions. The distribution of LPG can be partially automated, with the help of operators who monitor the process through the Control System. One of the important components in LPG distribution from storage tanks is the valve system. A valve regulates the opening or closing of a pipe through which a fluid (liquid or gas) passes. Its functions include directing, opening, stopping, mixing fluid flow or regulating fluid pressure or temperature. In the case of the Balongan LPG Terminal, the valve operating system is motorized using Motor Operated Valves (MOV).

An MOV is a type of valve that is equipped with a motor drive and electronic that activate the rotation of the gear system within the valve unit. A limit switch is installed to stop the moving motor, acting as a power breaker for the motor. Kang (2011). Kim (2010). MOV communication can be done through a hardwire cable or RS-485 communication cable. When a large number of MOVs are used, RS-485 cables are favored as they utilize a looping topology system for network

communication, allowing for cable savings. However, there is room for optimization in this looping concept. Typically, designers or engineers tend to make sequential looping according to the MOV Tag Number, as it is easier and requires less planning time. But a deeper calculation can reveal that MOV cable looping can be optimized through various methods, reducing the total cable requirements even if the looping is not done in order according to the Tag Number. This is possible because the MOV looping control system named "Pakscan" does not necessarily have to follow the Tag Number sequence. Therefore, the author of this paper aims to optimize the MOV cable calculation using the Travelling Salesman Problem method in order to minimize cable usage and make the most efficient use of resources.

2. LITERATURE REVIEW

2.1 Motor Operated Valve (MOV)

Motor Operated Valve is a vital component in the pipeline that functions to control the flow of products in the pipe. With MOV, the open/close control of product flow in the pipeline is carried out.

2.1.1 MOV Definition

A Motor Operated Valve is a type of control valve that uses an electric motor to actuate the valve. The valve is typically operated by a control system, such as a Programmable Logic Controller (PLC) or a Supervisory Control and Data Acquisition (SCADA) system, to control the flow of fluid in a process system. There are different types of MOVs, including pneumatic, hydraulic, and electric. The choice of MOV depends on the specific requirements of the process system, including the type of fluid, the temperature and pressure of the fluid, and the required flow rate. Kang (2011).

2.1.2 MOV Working Principle

The working principle of a MOV is based on the use of an electric motor to actuate the valve. The electric motor is connected to the valve stem and is used to move the valve from an open to a closed position or vice versa. The valve stem is typically connected to the valve body by a linkage mechanism, which transmits the movement of the electric motor to the valve body. The operation of the MOV is controlled by PLC or a SCADA system. The control system sends a signal to the electric motor, which in turn moves the valve to the desired position. The position of the valve is monitored by a feedback mechanism, which sends a signal back to the control system to confirm that the valve has reached the desired position. The working principle of an MOV is simple, but the design and construction of the valve must be robust and reliable to ensure that it can operate in harsh industrial environments. MOVs are typically designed with features such as corrosion-resistant materials, sealing systems, and actuator protection mechanisms, to ensure that they can operate effectively in a variety of applications. Kim (2010).

2.1.3 MOV Status

This set of MOV input/output status parameters describe the state and control signals of a motor operated valve:

1. MOV Open status (DI): A digital input that indicates whether the valve is in the open position.
2. MOV Close status (DI): A digital input that indicates whether the valve is in the closed position.
3. MOV energize to Open Command (DO): A digital output that sends a command signal to energize the actuator and move the valve to the open position.
4. MOV energize to Close Command (DO): A digital output that sends a command signal to energize the actuator and move the valve to the closed position.
5. MOV Local status (DI): A digital input that indicates whether the valve is in local control mode, where control signals are generated locally.

6. MOV Remote/Auto status (DI): A digital input that indicates whether the valve is in remote/automatic control mode, where control signals are generated remotely or by a control system.
7. MOV Jammed/Stuck - as Alarm (DI): A digital input that indicates an alarm condition when the valve is jammed or stuck and unable to move.
8. MOV On Going (On Progress from Open to Close or Close to Open) (DI): A digital input that indicates whether the valve is in motion, either from open to close or from close to open.
9. MOV power On/Off/failure status (DI): A digital input that indicates the state of the power supply to the MOV, including whether it is on, off, or in a failure state.

These inputs and outputs can be monitored and used to control the MOV, and to diagnose and troubleshoot problems with the MOV.

2.2 MOV System Network

2.2.1 Conventional System

The main aim of this paper is to provide an in-depth analysis of the Motor Operated Valve (MOV) control system network. MOVs are typically installed with a Star topography type, which is considered as the conventional system in the industry due to its widespread use and popularity. The Star topography system provides a centralized control point for the MOVs, making it more manageable and easier to maintain compared to other control system topographies. This centralized control point feature of the Star topography system makes it a preferred choice for engineers and technicians alike. The conventional nature of the Star topography system has also established it as the go-to solution for most MOV control system installations. This paper will further explore the advantages of the Star topography system in the MOV control network and its impact on system maintenance and management.

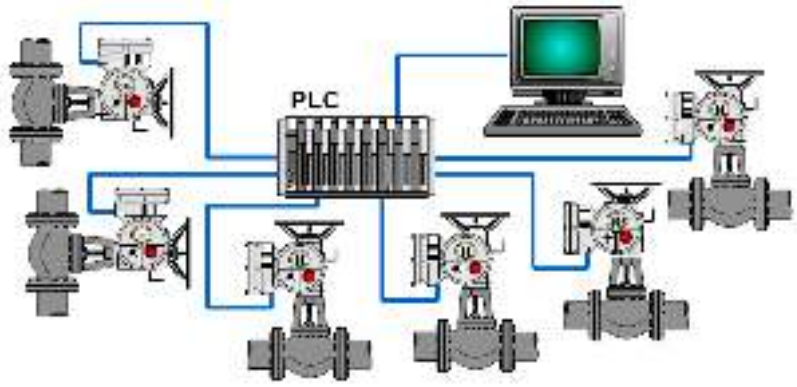

Figure 1. Topography of conventional MOV System

2.2.2 Pakscan™ System

The Pakscan™ system, developed by the company Rotork® is a cutting-edge solution for controlling the network technology of MOVs. Rotork® specializes in researching and manufacturing MOVs and their associated networks. The network topology used in the Pakscan™ system is a ring topography, which offers a more efficient way of connecting one MOV to another compared to traditional star topography. The cable configuration in the Pakscan™ system uses a multidrop system, which allows multiple MOVs to be connected to a single cable, as depicted in Figure 2.

Figure 2. Topography of Pakscan™ System

3. METHODS

3.1 Traveling Salesman Problem

The Traveling Salesman Problem (TSP) is a mathematical optimization problem that deals with salespeople who must visit a set of cities or locations for their product sales. The order of the cities visited must form a route where each city is passed only once and then return to the starting city, to achieve the shortest path. Assaf (2017). Palhares (2018). This problem dates back to the 1800s, when it was first addressed by Irish mathematician William Rowan Hamilton and British mathematician Thomas Penyngton. It is also referred to as the Hamilton circuit.

The conventional methods for solving TSP are difficult because they require finding all possible solutions, which leads to an exponential increase in the number of combinations and makes the time complexity of the algorithm extremely high. To obtain an exact solution for TSP, all possible routes must be calculated and then compared to determine the shortest one as the best optimization value. This means that if there are n cities to be visited, there are n combinations to compare, making the computational time grow significantly with an increase in the number of cities to be visited. To illustrate, for just 20 cities, a pathfinding process of 2.4329×10^{18} routes is required. This can be simplified by eliminating the same route combinations using the formula (n-1)!/2, resulting in 6.08226×10^{16} paths to be compared. Despite the simplification, there is still an explosion of combinations. This shows that the exact solution to the TSP problem that has many nodes is very difficult to do. Therefore, a solution is designed using Greedy Algorithm with a marker to provide an alternative solution that has a much faster computation time.

3.2 Greedy Algorithm

The Greedy Algorithm is a problem-solving strategy that operates by making the best choice at each step, without considering future or past steps. The algorithm selects the option that seems to be the best choice at the current moment, which is referred to as the local optimum. Alaidi (2018). Brecklinghaus (2015). The goal is to eventually find the global optimum by selecting the local optimum at each step. In the Greedy Algorithm, the shortest path search principle utilizes a selection function to determine the shortest path to a destination. The selection function is instrumental in selecting the best choice at each step of the algorithm. Although the algorithm may not always result in the optimal solution, it always finds a solution. Abdulkarim (2015). The advantage of the Greedy Algorithm is its efficiency in finding solutions with a large number of nodes quickly. The Greedy Algorithm is commonly used to solve linear trajectory problems, where the starting point and

destination are different nodes. However, its application becomes problematic when used to solve the TSP, where the path to be found is a hamiltonian path. To overcome this, markers can be used to implement the Greedy Algorithm for TSP. The mathematical model for the greedy algorithm in the traveling salesman problem is based on finding the minimum distance between two cities. Hassin (2008). The algorithm can be formulated as a linear programming problem, with the objective of minimizing the total distance traveled.

In this study, the focus is on the symmetric traveling salesman problem. To formulate TSP, it is important to consider that the direction in which the cities are visited is not significant. This means that the distance or cost between city i and city j, denoted as $L_{i,j}$, is equal to the distance or cost between city j and city i, denoted as $L_{j,i}$. Thus, in order to simplify the problem, the graph can be considered such that there is only one edge between every two cities, regardless of the direction of travel. Geng (2011). To find a closed tour in this graph, one must select a specific sequence of the n cities that form a feasible tour. Hence, the TSP can be formulated as the problem of finding a closed tour in a graph with a single edge between every two cities, with the goal of minimizing the total distance or cost of the tour. The TSP can thus be formulated as follows:

$$\min F(c) = \sum_{i=1}^{n-1} L_{C_i,C_j} + L_{C_1,C_n} \quad (1)$$

$$\begin{cases} c = (c_1, c_1, \dots c_n) \; and \; if \; i \neq j \; then \; c_i \neq c_j \\ c_1 \in \{1,2, \dots n\} \end{cases} \quad (2)$$

$$f(c^{best}) = min\,\{f(c^{new_1}), f(c^{new_2}), \dots, f(c^{new_m}),\} \quad (3)$$

By combining the objective function and the constraints, the greedy algorithm can be represented as a linear programming problem, which can be solved using linear programming techniques, such as the simplex method or interior-point methods. The solution to the linear programming problem gives the order of visiting the cities and the total distance traveled, which represents a solution to the TSP.

4. RESULTS

4.1 MOV System in LPG Balongan Project

The Balongan LPG Project has 15 Motor Operated Valves installed on three LPG Spherical Tanks. Each tank has 5 MOVs installed with specific functions: MOV-01 regulates the 16-inch LPG Liquid pipe from the pipeline, MOV-02 regulates the 10-inch LPG Liquid pipe to the metering, MOV-03 regulates the 6-inch LPG Vapor pipe from the metering, MOV-04 regulates the 6-inch LPG Vapor pipe to the pipeline, and MOV-05 regulates the 6-inch LPG Liquid return pipe. The wiring system of the MOV in the Balongan LPG Project uses the Pakscan MOV System. The wiring calculation uses a looping system with a specified tag number sequence.

Table 1. MOV Looping System Based on Tag Number

MOV Tag Number	Cable Length (m)
MOV-PC	0
MOV-041	389
MOV-042	10
MOV-043	19
MOV-044	8

MOV Tag Number	Cable Length (m)
MOV-045	34
MOV-051	57
MOV-052	8
MOV-053	17
MOV-054	7
MOV-055	32
MOV-061	63
MOV-062	9
MOV-063	18
MOV-064	8
MOV-065	33
MOV-PC	403
Total Panjang Kabel	1115

4.2 Application of Greedy Algorithm on Balongan LPG Project

The Greedy Algorithm is a method of solving the Travelling Salesman Problem by making the best local decision at each step. Khalil (2016). In order to perform this calculation, it requires a set of input data, specifically, the distances between the Motor Operated Valves. This information is displayed in a table format in Table 2, where the distances between each MOV are shown. The algorithm uses this distance data to determine the shortest path that visits each MOV in the system once and returns back to the starting point. By making the best local decision at each step, the algorithm hopes to reach the global optimum solution for the TSP.

Table 2. TSP Data Input

MOV	PC	041	042	043	044	051	051	052	053	054	055	061	062	063	064	065
PC	0	389	385	393	393	401	383	381	389	388	397	391	388	381	380	403
041	389	0	10	22	22	21	45	42	51	50	58	55	52	45	45	68
042	385	10	0	19	18	22	41	39	47	46	55	51	48	42	41	64
043	393	22	19	0	8	34	50	47	55	55	63	60	57	50	49	72
044	393	22	18	8	0	34	49	47	55	54	63	59	56	50	49	72
045	401	21	22	34	34	0	57	54	63	62	71	67	64	57	57	80
051	383	45	41	50	49	57	0	8	20	19	20	50	46	40	39	62
052	381	42	39	47	47	54	8	0	17	16	22	47	44	37	36	60
053	389	51	47	55	55	63	20	17	0	7	33	55	52	46	45	68
054	388	50	46	55	54	62	19	16	7	0	32	55	51	45	44	67
055	397	58	55	63	63	71	18	22	33	32	0	63	60	53	53	76
061	391	55	51	60	59	67	50	47	55	55	63	0	9	21	21	20
062	388	52	48	57	56	64	46	44	52	51	60	9	0	18	18	21
063	381	45	42	50	50	57	40	37	46	45	53	21	18	0	8	34
064	380	45	41	49	49	57	39	36	45	44	53	21	18	8	0	33
065	403	68	64	72	72	80	62	60	68	67	76	20	21	34	33	0

These results demonstrate the efficiency and effectiveness of the Greedy algorithm in finding the optimal solution to the wiring optimization problem in the MOV system. The results of the Greedy algorithm can be used to make informed decisions on how to best implement the wiring system in the MOV system, taking into account factors such as the distance between Motor Operated Valves and other relevant considerations.

Table 3. Greedy Algorithm Result

MOV	Cable Length (m)
MOV-PC	0
MOV-064	380
MOV-063	8
MOV-062	18
MOV-061	9
MOV-065	20
MOV-052	60
MOV-051	8
MOV-055	18
MOV-054	32
MOV-053	7
MOV-042	47
MOV-041	10
MOV-045	21
MOV-044	34
MOV-043	8
MOV-PC	393
Total Panjang Kabel	1073

4.3 Analysis

The application of Greedy Algorithm in MOV cable calculation is a new approach offered in design and engineering. So far, WIKA engineers have calculated MOV cables only based on the tag number sequence. The tag number sequence approach is actually legitimate, but the essence of engineering is not visible because it seems to simplify and take the fast way. If you look at the manhour required to calculate the MOV cable with the tag number sequence approach, the manhour required is smaller than using the Greedy Algorithm method approach. However, the tag number sequence approach does not provide a guarantee regarding the total number of MOV cables used, which could be small and too large. By using the Greedy Algorithm, it is absolutely certain that the total number of cables required is quite optimal.

In the Balongan LPG Project MOV Looping case study, the total cable required using the tag number sequence method was 1115 meters, while the total cable required using the Greedy Algorithm method was 1073 meters. There is a saving of 42 meters. Of course, saving 42 meters of MOV cable does not have a significant impact on the project cost. However, the number 1073 meters is an absolute certainty because it uses a computational algorithm, while the number 1115 meters is a "luck" because it uses a sequence of tag numbers that happens to be the total distance not too far from the algorithm results.

It could be that, in another project case study, the total MOV cable could be a "bad luck" because it uses the tag number sequence and the result is that the total MOV cable is very large. Moreover, if the number of MOVs in the project is even higher, then the total MOV cables may be much larger if the tag number sequence method is still used. Therefore, to avoid the gamble between "luck" and "bad luck" in calculating the total MOV cable using the tag number sequence method in future Wika projects, the use of the Greedy Algorithm can be considered and made a reference. Apart from providing an absolute guarantee of more optimal results, the use of the Greedy Algorithm method also strengthens the essence of engineering and science within the WIKA instrument engineering team.

6. CONCLUSIONS

The implementation of the Greedy Algorithm in the calculation of Motor Operated Valve (MOV) looping cables is a novel approach in the design and engineering field. Traditionally, the MOV cables were calculated using the tag number sequence method, which although simple, does not guarantee optimal results. The results of a case study at the Balongan LPG Project showed a saving of 42 meters of cable through the use of the Greedy Algorithm. The algorithm provides an absolute guarantee of more optimal results, which not only strengthens the scientific and engineering principles within the WIKA instrument engineering team but also provides a more reliable solution for future projects. It is therefore recommended that the Greedy Algorithm be considered and used for MOV cable calculations in future WIKA projects.

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COMPARATIVE ANALYSIS OF APBN AND ADB FINANCING SCHEMES AT PANTOLOAN PORT

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ABSTRACT

The damage caused by the natural disaster in Central Sulawesi in 2018 greatly impacted various sectors of the economy, with an estimated cost of losses of up to 1.9 trillion. Currently, the availability of funds on call for the APBN budget below the BNPB is only 5 trillion per year. However, if a natural disaster occurs, the APBN on-call budget for three years can be disbursed earlier, namely during the 2019–2022 period, with the APBN mechanism in accordance with applicable regulations. In order to accelerate post-disaster rehabilitation and reconstruction in Central Sulawesi Province, the government is also exploring alternative financing with foreign loans because they are considered more flexible and faster in terms of channeling funds using the on-budget off-treasury and on-treasury modalities. One of the foreign financing sources intended for infrastructure development is a loan from the Asian Development Bank (ADB).

This study aims to analyze and select the most efficient financing scheme between the conventional financing schemes of the state budget (APBN) and Asian Development Bank (ADB) foreign loans. The research is limited to the development, operational, and maintenance costs of the Pantoloan Port Project. The analytical methods used to compare include life cycle cost analysis (LCCA) and net present value. The results of the study for the calculation of NPV, without development NPV IDR. 107,539,838,435; development with APBN NPV funding of IDR. 622,291,989,347; and development with ADB financing of IDR. 250,434,968,150 allow it to be concluded that the NPV of all financing > 0 means that the investment is feasible, but for maximum profits the most suitable financing is financing at the state budget (APBN).

Keywords: post-disaster recovery, port, and net present value

1. INTRODUCTION

In the document for the Central Sulawesi Palu Earthquake Study on September 28, 2018 (M7.4) compiled by the National Earthquake Study Center Team, the Palu Earthquake occurred on Friday, September 28, 2018, at 18:02:44 WITA with a magnitude of Mw 7.4 and was located at 26 km north of Donggala, Central Sulawesi. This incident caused many fatalities and damaged various public facilities supporting the economy. The biggest loss and damage came from settlements, followed by the economic sector. The impact of this disaster requires a recovery plan through rehabilitation and reconstruction (in-situ). It is estimated that to rebuild disaster-affected areas later during the rehabilitation and reconstruction period will require a budget of more than IDR 19 trillion. The Indonesian government is trying to carry out post-disaster recovery, including the restoration

of public facilities in Central Sulawesi Province, which are listed in the Recovery and Relocation Master Plan.The central government provides financing for rehabilitation and reconstruction activities, some of which are sourced from the state budget (APBN) and foreign loans Asian Development Bank (ADB).

The rehabilitation and reconstruction of Pantoloan Port is one of the cost recovery sub-projects that will be carried out and is expected to include a higher standard of disaster resilience. This project consists of two stages of development, including:

1. Construction of Phase 1, namely the development of the extension of the wharf and the Port Authority and KSOP Office Building.
2. Construction of Phase 2, namely the construction of the container yard, port support facilities, and procurement of port equipment

However, to be eligible for funding, the project must meet the standard criteria set by the Asian Development Bank (ADB). The standard criteria required are attached to the document Project Administration Manual, Republic of Indonesia: Emergency Assistance for Rehabilitation and Reconstruction, Component 2: Transportation Infrastructure, namely that the sub-projects funded must be able to provide social, gender, environmental, and economic benefits.

2. LITERATURE REVIEW

2. 1. Port Description

According to UU No. 17 of 2008 concerning Shipping, a port is an area in the form of land or waters that has positive barriers as a place for the exercise of power and organizational activities. Physically, the port is used as a place for ships to dock, board passengers, and/or load and unload goods. As such, ports are usually in the form of terminals and provide berths equipped with transport protection and safety centers in addition to different port assistance activities.

Apart from functioning socially and economically, ports are also important from a political perspective (Indrayanto, 2005:3). That is, the port has a very strategic political value to maintain and safeguard its life and sovereignty because of its strategic function as an intermediary for interactions with monetary costs and because it is at the heart of a nation's socio-cultural dynamics.Guidelines for handling ports that are sovereign, transparent, safe, and non-discriminatory against foreign groups and implemented properly and effectively will foster good political aspects in the village where the port is located.

In addition, as one of the centers of financial activity, the port usually offers five main activities. First, ship services (anchoring, scouting, tugging, and mooring). Second, managing loading and unloading (containers, liquid bulk, dry bulk, general cargo, roro). Third, passenger embarkation and debarkation Fourth, stacking services (popular cargo, containers, tanks, silos) Fifth, bunkering (the filling of substances, which includes the delivery of water and fuel) Sixth: reception; equipment; commercial land. Seventh: rent, equipment, and commercial land (Pelindo: 2013).

2.2 Project Life Cycle

The project life cycle is the life cycle of a project from the time it is determined and planned until it enters the termination and evaluation stage.

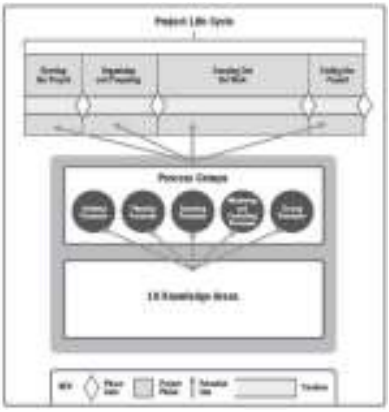

Figure 1. Project Life Cycle Diagram

In the PMBOK 6th edition, the stages or phases consist of a minimum of 4 stages, depending on the size and complexity of the project itself. Among them are the stages of starting the project (starting the project), the stage of preparation (organizing and preparing), the stage of implementation (carrying out the work), and the stage of completion of the project (closing the project).

2.3 Activities and Categories of Development, Operational and Maintenance Costs

2.3.1 Capital Cost

Capital costs (capital costs), which are often referred to as development costs, are costs that include physical development, the purchase of land, and the procurement of other goods that are funded through the development budget. In this construction, the costs incurred for the construction of the Pantoloan Port were initiated by the Ministry of Transportation and PT. Pelindo IV.

2.3.2 Operational Cost

In the Regulation of the Minister of Transportation Number PM 95 of 2015 Port Business Entities in compiling the calculation of the amount of costs for the supply and/or service of goods, and passenger services at terminals whose services are managed by Port Business Entities is carried out by taking into account the components of production costs which consist of:

a. Direct Operating Costs
b. Indirect Operating Costs;
c. Profit Margins

2.3.3 Maintenance Cost

Maintenance costs or maintenance costs are a number of budget funds intended to maintain business assets in optimal condition during use. In PM No. 95 of 2015 also regulates maintenance costs for port business entities.

2.4 Net Present Value

Net present value, or what is often referred to as "net present value," is a standard method of valuation for long-term projects. This method uses a discount rate, which will affect cash flow. What is meant by the "discount rate" is the interest rate set by the government for commercial banks.

$$NPV = \sum_{t=1}^{n} \left(\frac{A_t}{(1-k)^t} \right)$$

k = discount rate

A_t= cash flow t period

n = last period in which cash flow is expected

2.5 Present Value

Present value is a concept that explains if the value of money in the present is greater than in the future, even though the nominal value is exactly the same.

Present Value = Future Value / (1+r) n

PV = Present Value / Nilai saat ini
FV = Future Value / Nilai yang akan datang
r = rate
N = period

2.6 Life Cycle Cost

According to Weber (1996) Life Cycle Cost (LCC) is a cost calculation modeling concept from the initial stage to the dismantling of an asset from a project as a means of decision making on an analysis study and calculation of the total costs that exist during its life cycle.

LCC = OC + MC + RC

LCC : Life Cycle Cost
OC : Operational Cost
MC : Maintenance Cost
RC : Rehabilitation Cost

3. METHODS

The method used to process the collected data and present it in a systematic and structured scheme in depth, in order to achieve the stated research objectives.

3.1 Cost identification

3.1.1 Construction Cost

a. Initial construction cost

ITEM	COST
MAIN FACILITIES	173.068.000.000
SUPPORTING FACILITIES	39.457.700.000
EQUIPMENT PROCUREMENT	160.000.000.000
TOTAL	372.525.700.000

Table 1. Initial Construction Cost

b. Development Construction cost

ITEM	COST
PLANNING AND SUPERVISION	17.865.550.652
PHASE 1	60.525.000.000
PHASE 2	280.204.100.000
TOTAL	358.594.650.652

Table 2. Development construction cost

3.1.2 Maintenance Cost

a. Initial maintenance cost

ITEM	COST
ROUTINE MAINTENANCE A YEAR	3.725.257.000
MAINTENANCE 5 YEARS	7.450.514.000

Table 3. Initial Maintenance Cost

b. Development maintenance cost

ITEM	COST
ROUTINE MAINTENANCE A YEAR	
PHASE 1	572.207.000
PHASE 2	2.757.041.000
MAINTENANCE 5 YEARS	
PHASE 1	1.144.414.000
PHASE 2	5.604.082.000

Table. 3 Development Maintenance Cost

3.1.3 Revenue

ITEM	UNIT	CAPACITY WITHOUT PROJECT	CAPACITY WITH PROJECT	UNIT PRICE	
Passenger	OH	57.600	57.600	Rp	240.000
Container Berth	TEUs	60.450	161.649	Rp	693.586
Container Yard	TEUs	110.084	113.588	Rp	4.540
General Cargo Berth	ton	241.500	241.500	Rp	1.470
General Cargo Storage	ton	24.403	24.403	Rp	420

Table 4. Revenue

Port Revenue for 20 years with 2% escalation

ITEM	WITHOUT PROJECT		WITH PROJECT	
Passenger	Rp	56.977.108.992	Rp	56.977.108.992
Container Berth	Rp	854.477.530.013	Rp	1.999.981.338.022
Container Yard	Rp	10.184.422.361	Rp	10.444.014.939
General Cargo Berth	Rp	7.235.001.900	Rp	7.235.001.900
General Cargo Storage	Rp	208.879.919	Rp	208.879.919
TOTAL	Rp	929.082.943.185	Rp	2.074.846.343.772

Table 5. Revenue for 20 years

3.2 Analysis of the Financing Scheme

The Pantoloan Port project consists of two stages of development; the next financing scheme will be calculated in order to get the most suitable alternative. The costs that will arise in the financing scheme consist of construction costs, operational costs, maintenance costs, and other costs.

NO	KOMPONEN BIAYA	TAHAP 1		TAHAP 2	
		APBN	ADB	APBN	ADB
I	Komponen biaya pembangunan	√	√	√	√
1	Biaya Perencanaan	√	√	√	√
2	Biaya *Environment Social Management Plan*	x	x	x	√
3	Biaya Konstruksi	√	√	√	√
4	Biaya Pengawasan	√	√	√	√
II	Komponen Biaya Operasional	Konsesi KSOP Teluk Palu dan PT. Pelindo IV sehingga Biaya Operasional menjadi beban masing-masing instansi dan tidak masuk ke skema pembiayaan			
1	Biaya Tetap				
2	Biaya Tidak Tetap				
III	Komponen Biaya Pemeliharaan	√	√	√	√
1	Pemeliharaan Rutin	√	√	√	√
2	Pemeliharaan Berkala	√	√	√	√
IV	Biaya lain-lain				
1	Front End Fee	x	√	x	√
2	Commitment Charge	x	√	x	√
3	Bunga	x	√	x	√

Table 6. Financing Scheme

3.3 Cash Flow Analysis

3.3.1 Initial Project Cash Flow

ITEM	PERIOD										
	0	1	2	3	4	5	6	7	8	9	10
Investment cost	(372.525.700.000)										
Cash Receipt											
Cash Sales		56.616.239.166	57.748.563.949	58.030.573.549	58.318.223.341	43.648.083.949	43.648.083.949	43.648.083.949	43.648.083.949	43.648.083.949	43.648.083.949
Total cash receipt	-	56.616.239.166	57.748.563.949	58.030.573.549	58.318.223.341	43.648.083.949	43.648.083.949	43.648.083.949	43.648.083.949	43.648.083.949	43.648.083.949
Cash Paid Out											
Routine Maintenance A year		(3.725.257.000)	(3.799.762.140)	(3.875.757.383)	(3.953.272.530)	(4.032.337.981)	(4.112.984.741)	(4.195.244.436)	(4.279.149.324)	(4.364.732.311)	(4.452.026.957)
						(7.450.514.000)					(7.599.524.280)
Maintenance 5 Years	-	(3.725.257.000)	(3.799.762.140)	(3.875.757.383)	(3.953.272.530)	(11.482.851.981)	(4.112.984.741)	(4.195.244.436)	(4.279.149.324)	(4.364.732.311)	(12.051.551.237)
TOTAL	(372.525.700.000)	52.890.982.166	53.948.801.809	54.154.816.166	54.364.950.810	32.165.231.968	39.535.099.208	39.452.839.513	39.368.934.625	39.283.351.638	31.596.532.712
Cash Flow	**YEAR 0**	**YEAR 1**	**YEAR 2**	**YEAR 3**	**YEAR 4**	**YEAR 5**	**YEAR 6**	**YEAR 7**	**YEAR 8**	**YEAR 9**	**YEAR 10**
Net Operating Income	(372.525.700.000)	52.890.982.166	53.948.801.809	54.154.816.166	54.364.950.810	32.165.231.968	39.535.099.208	39.452.839.513	39.368.934.625	39.283.351.638	31.596.532.712
Net Cash Flow	(372.525.700.000)	52.890.982.166	53.948.801.809	54.154.816.166	54.364.950.810	32.165.231.968	39.535.099.208	39.452.839.513	39.368.934.625	39.283.351.638	31.596.532.712
Discount Factor	1,00	1,06	1,13	1,19	1,27	1,34	1,43	1,51	1,61	1,70	1,81
Discounted Cash Flow	(372.525.700.000)	49.850.124.567	47.923.776.681	45.340.983.286	42.900.016.953	23.922.676.544	27.713.445.904	26.065.771.186	24.514.926.255	23.055.262.928	17.477.752.631
NPV	**107.539.838.345**										
PV Cummulative	(372.525.700.000)	(322.675.575.433)	(274.751.798.752)	(229.410.815.466)	(186.510.798.512)	(162.588.121.968)	(134.874.676.065)	(108.808.904.879)	(84.293.978.624)	(61.238.715.695)	(43.760.963.064)
Pay Back Period	12										

ITEM	11	12	13	14	15	16	17	18	19	20
Investment cost										
Cash Receipt										
Cash Sales	43.648.083.949	43.648.083.949	43.648.083.949	43.648.083.949	43.648.083.949	43.648.083.949	43.648.083.949	43.648.083.949	43.648.083.949	43.648.083.949
Total cash receipt	43.648.083.949	43.648.083.949	43.648.083.949	43.648.083.949	43.648.083.949	43.648.083.949	43.648.083.949	43.648.083.949	43.648.083.949	43.648.083.949
Cash Paid Out										
Routine Maintenance A year	(4.541.067.496)	(4.631.888.846)	(4.724.526.623)	(4.819.017.155)	(4.915.397.498)	(5.013.705.448)	(5.113.979.557)	(5.216.259.149)	(5.320.584.332)	(5.426.996.018)
					(7.751.514.766)					(7.906.545.061)
Maintenance 5 Years	(4.541.067.496)	(4.631.888.846)	(4.724.526.623)	(4.819.017.155)	(12.666.912.264)	(5.013.705.448)	(5.113.979.557)	(5.216.259.149)	(5.320.584.332)	(13.333.541.079)
TOTAL	39.107.016.453	39.016.195.103	38.923.557.326	38.829.066.793	30.981.171.685	38.634.378.500	38.534.104.391	38.431.824.800	38.327.499.617	30.314.542.870
Cash Flow	**YEAR 11**	**YEAR 12**	**YEAR 13**	**YEAR 14**	**YEAR 15**	**YEAR 16**	**YEAR 17**	**YEAR 18**	**YEAR 19**	**YEAR 20**
Net Operating Income	39.107.016.453	39.016.195.103	38.923.557.326	38.829.066.793	30.981.171.685	38.634.378.500	38.534.104.391	38.431.824.800	38.327.499.617	30.314.542.870
Net Cash Flow	39.107.016.453	39.016.195.103	38.923.557.326	38.829.066.793	30.981.171.685	38.634.378.500	38.534.104.391	38.431.824.800	38.327.499.617	30.314.542.870
Discount Factor	1,92	2,04	2,16	2,29	2,43	2,58	2,74	2,90	3,08	3,27
Discounted Cash Flow	20.388.508.715	19.171.686.005	18.026.546.534	16.948.902.382	12.745.799.425	14.980.551.014	14.082.629.165	13.237.747.582	12.442.802.101	9.275.628.485
NPV										
PV Cummulative	(23.372.454.349)	(4.200.768.344)	13.825.778.191	30.774.680.572	43.520.479.998	58.501.031.011	72.583.660.177	85.821.407.758	98.264.209.859	107.539.838.345
Pay Back Period										

Table 7. Initial Project Cashflow

Based on the cash flow table above, the NPV is IDR. 107,539,838,435 or NPV > 0 (greater than 0) it can be concluded that the project without development is feasible

3.3.2 Project with APBN Financing

ITEM	PERIODE KE-										
	0	1	2	3	4	5	6	7	8	9	10
Investment cost	(2.548.582.598)	(4.247.637.663)	##############	(202.089.562.728)							
Cash Receipt											
Cash Sales		56.616.239.166	57.748.563.949	58.030.573.549	58.318.223.341	115.258.296.486	115.258.296.486	115.258.296.486	115.258.296.486	115.258.296.486	115.258.296.486
Total cash receipt	-	56.616.239.166	57.748.563.949	58.030.573.549	58.318.223.341	115.258.296.486	115.258.296.486	115.258.296.486	115.258.296.486	115.258.296.486	115.258.296.486
Cash Paid Out											
Routine Maintnance a year											
PHASE 1					(572.207.000)	(583.651.140)	(595.324.163)	(607.230.646)	(619.375.259)	(631.762.764)	(644.398.019)
PHASE 2						(2.757.041.000)	(2.812.181.820)	(2.868.425.456)	(2.925.793.966)	(2.984.309.845)	(3.043.996.042)
Maintenance 5 Years											
PHASE 1									(1.144.414.000)		
PHASE 2										(5.514.082.000)	
Total Cash Paid Out	-	-	-	-	(572.207.000)	(3.340.692.140)	(3.407.505.983)	(3.475.656.102)	(4.689.583.225)	(9.130.154.609)	(3.688.394.061)
TOTAL	(2.548.582.598)	54.067.656.568	53.500.926.286	(90.803.294.114)	(144.343.546.387)	111.917.604.346	111.850.790.503	111.782.640.383	110.568.713.261	106.128.141.877	111.569.902.424
Cash Flow	**YEAR 0**	**YEAR 1**	**YEAR 2**	**YEAR 3**	**YEAR 4**	**YEAR 5**	**YEAR 6**	**YEAR 7**	**YEAR 8**	**YEAR 9**	**YEAR 10**
Net Operating Income	(357.719.650.652)	54.067.656.568	53.500.926.286	(90.803.294.114)	(144.343.546.387)	111.917.604.346	111.850.790.503	111.782.640.383	110.568.713.261	106.128.141.877	111.569.902.424
APBN	2.548.582.598	4.247.637.663	148.833.867.663	202.089.562.728							
Net Cash Flow	(355.171.068.054)	58.315.294.231	202.334.793.949	111.286.268.614	(144.343.546.387)	111.917.604.346	111.850.790.503	111.782.640.383	110.568.713.261	106.128.141.877	111.569.902.424
Discount Factor	1	1,06	1,13	1,19	1,27	1,34	1,43	1,51	1,61	1,70	1,81
Discounted Cash Flow	(357.719.650.652)	54.962.577.032	179.737.958.116	93.174.147.795	(113.903.176.492)	83.237.971.082	78.405.540.746	73.852.750.846	68.850.830.676	62.286.238.649	61.715.352.549
NPV	**729.831.827.692**	**LAYAK**									
PV Cummulative	(357.719.650.652)	(302.757.073.620)	##############	(29.844.967.709)	(143.748.144.201)	(60.510.173.120)	17.895.367.627	91.748.118.473	160.598.949.149	222.885.187.798	284.600.540.347
Pay Back Period	5	Layak									

ITEM	11	12	13	14	15	16	17	18	19	20
Investment cost										
Cash Receipt										
Cash Sales	115.258.296.486	115.258.296.486	115.258.296.486	115.258.296.486	115.258.296.486	115.258.296.486	115.258.296.486	115.258.296.486	115.258.296.486	115.258.296.486
Total cash receipt	115.258.296.486	115.258.296.486	115.258.296.486	115.258.296.486	115.258.296.486	115.258.296.486	115.258.296.486	115.258.296.486	115.258.296.486	115.258.296.486
Cash Paid Out										
Routine Maintnance a year										
PHASE 1	(657.285.980)	(670.431.699)	(683.840.333)	(697.517.140)	(711.467.483)	(725.696.833)	(740.210.769)	(755.014.985)	(770.115.284)	(785.517.590)
PHASE 2	(3.104.875.963)	(3.166.973.482)	(3.230.312.951)	(3.294.919.210)	(3.360.817.595)	(3.428.033.947)	(3.496.594.626)	(3.566.526.518)	(3.637.857.048)	(3.710.614.189)
Maintenance 5 Years										
PHASE 1			(1.167.302.280)					(1.190.648.326)		
PHASE 2				(5.624.363.640)					(5.736.850.913)	
Total Cash Paid Out	(3.762.161.942)	(3.837.405.181)	(5.081.455.565)	(9.616.799.991)	(4.072.285.078)	(4.153.730.779)	(4.236.805.395)	(5.512.189.828)	(10.144.823.245)	(4.496.131.779)
TOTAL	111.496.134.543	111.420.891.304	110.176.840.921	105.641.496.495	111.186.011.408	111.104.565.706	111.021.491.091	109.746.106.657	105.113.473.240	110.762.164.706
Cash Flow	**YEAR 11**	**YEAR 12**	**YEAR 13**	**YEAR 14**	**YEAR 15**	**YEAR 16**	**YEAR 17**	**YEAR 18**	**YEAR 19**	**YEAR 20**
Net Operating Income	111.496.134.543	111.420.891.304	110.176.840.921	105.641.496.495	111.186.011.408	111.104.565.706	111.021.491.091	109.746.106.657	105.113.473.240	110.762.164.706
APBN										
Net Cash Flow	111.496.134.543	111.420.891.304	110.176.840.921	105.641.496.495	111.186.011.408	111.104.565.706	111.021.491.091	109.746.106.657	105.113.473.240	110.762.164.706
Discount Factor	1,92	2,04	2,16	2,29	2,43	2,58	2,74	2,90	3,08	3,27
Discounted Cash Flow	58.128.697.023	54.749.734.999	51.025.859.051	46.112.553.285	45.742.446.887	43.080.998.816	40.573.785.562	37.801.776.667	34.124.483.953	33.890.951.101
NPV										
PV Cummulative	342.729.237.370	397.478.972.368	448.504.831.419	494.617.384.704	540.359.831.592	583.440.830.407	624.014.615.970	661.816.392.637	695.940.876.590	729.831.827.692

Table 8. Project With APBN Financing

Based on the cash flow table above, the NPV is IDR 729,831,827,692 or NPV > 0 (greater than 0) it can be concluded that projects with APBN financing are feasible.

3.3.3 Project With ADB Financing

ITEM	PERIOD									
	0	1	2	3	4	5	6	7	8	9
Investment cost	(358.594.650.652)									
Cash Receipt										
Cash Sales		56.616.239.166	57.748.563.949	58.030.573.549	58.318.223.341	115.258.296.486	115.258.296.486	115.258.296.486	115.258.296.486	115.258.296.486
Total cash receipt	-	56.616.239.166	57.748.563.949	58.030.573.549	58.318.223.341	115.258.296.486	115.258.296.486	115.258.296.486	115.258.296.486	115.258.296.486
Cash Paid Out										
Routine Maintnance a year										
PHASE 1					(572.207.000)	(583.651.140)	(595.324.163)	(607.230.646)	(619.375.259)	(631.762.764)
PHASE 2						(2.757.041.000)	(2.812.181.820)	(2.868.425.456)	(2.925.793.966)	(2.984.309.845)
Maintenance 5 Years										
PHASE 1									(1.144.414.000)	
PHASE 2										(5.604.082.000)
Total Cash Paid Out	-	-	-	-	(572.207.000)	(3.340.692.140)	(3.407.505.983)	(3.475.656.102)	(4.689.583.225)	(9.220.154.609)
TOTAL	(358.594.650.652)	56.616.239.166	57.748.563.949	58.030.573.549	57.746.016.341	111.917.604.346	111.850.790.503	111.782.640.383	110.568.713.261	106.038.141.877
Cash Flow	**YEAR 0**	**YEAR 1**	**YEAR 2**	**YEAR 3**	**YEAR 4**	**YEAR 5**	**YEAR 6**	**YEAR 7**	**YEAR 8**	**YEAR 9**
Net Operating Income	(358.594.650.652)	56.616.239.166	57.748.563.949	58.030.573.549	57.746.016.341	111.917.604.346	111.850.790.503	111.782.640.383	110.568.713.261	106.038.141.877
Loan	358.594.650.652									
loan repayment		(31.263.915.751)	(31.263.915.751)	(31.263.915.751)	(31.263.915.751)	(31.263.915.751)	(31.263.915.751)	(31.263.915.751)	(31.263.915.751)	(31.263.915.751)
Net Cash Flow	-	25.352.323.414	26.484.648.197	26.766.657.797	26.482.100.589	80.653.688.594	80.586.874.751	80.518.724.632	79.304.797.510	74.774.226.125
Discount Factor	1,00	1,06	1,13	1,19	1,27	1,34	1,43	1,51	1,61	1,70
Discounted Cash Flow	(358.594.650.652)	23.894.744.028	23.526.831.424	22.410.316.750	20.897.334.538	59.985.642.456	56.490.056.651	53.197.252.170	49.382.877.164	43.884.734.161
NPV	**357.974.806.495**	**LAYAK**								
PV Cummulative	(358.594.650.652)	(334.699.906.624)	(311.173.075.200)	(288.762.758.449)	(267.865.423.911)	(207.879.781.455)	(151.389.724.804)	(98.192.472.634)	(48.809.595.470)	(4.924.861.309)
IRR	22%	Layak								
Pay Back Period	9	Layak								

ITEM	10	11	12	13	14	15	16	17	18	19	20
Investment cost											
Cash Receipt											
Cash Sales	115.258.296.486	115.258.296.486	115.258.296.486	115.258.296.486	115.258.296.486	115.258.296.486	115.258.296.486	115.258.296.486	115.258.296.486	115.258.296.486	115.258.296.486
Total cash receipt	115.258.296.486	115.258.296.486	115.258.296.486	115.258.296.486	115.258.296.486	115.258.296.486	115.258.296.486	115.258.296.486	115.258.296.486	115.258.296.486	115.258.296.486
Cash Paid Out											
Routine Maintnance a year											
PHASE 1	(644.398.019)	(657.285.980)	(670.431.699)	(683.840.333)	(697.517.140)	(711.467.483)	(725.696.833)	(740.210.769)	(755.014.985)	(770.115.284)	(785.517.590)
PHASE 2	(3.043.996.042)	(3.104.875.963)	(3.166.973.482)	(3.230.312.951)	(3.294.919.210)	(3.360.817.595)	(3.428.033.947)	(3.496.594.626)	(3.566.526.518)	(3.637.857.048)	(3.710.614.189)
Maintenance 5 Years											
PHASE 1				(1.167.302.280)					(1.190.648.326)		
PHASE 2					(5.716.163.640)					(5.830.486.913)	
Total Cash Paid Out	(3.688.394.061)	(3.762.161.942)	(3.837.405.181)	(5.081.455.565)	(9.708.599.991)	(4.072.285.078)	(4.153.730.779)	(4.236.805.395)	(5.512.189.828)	(10.238.459.245)	(4.496.131.779)
TOTAL	111.569.902.424	111.496.134.543	111.420.891.304	110.176.840.921	105.549.696.495	111.186.011.408	111.104.565.706	111.021.491.091	109.746.106.657	105.019.837.240	110.762.164.706
Cash Flow	**YEAR 10**	**YEAR 11**	**YEAR 12**	**YEAR 13**	**YEAR 14**	**YEAR 15**	**YEAR 16**	**YEAR 17**	**YEAR 18**	**YEAR 19**	**YEAR 20**
Net Operating Income	111.569.902.424	111.496.134.543	111.420.891.304	110.176.840.921	105.549.696.495	111.186.011.408	111.104.565.706	111.021.491.091	109.746.106.657	105.019.837.240	110.762.164.706
Loan											
loan repayment	(31.263.915.751)	(31.263.915.751)	(31.263.915.751)	(31.263.915.751)	(31.263.915.751)	(31.263.915.751)	(31.263.915.751)	(31.263.915.751)	(31.263.915.751)	(31.263.915.751)	(31.263.915.751)
Net Cash Flow	80.305.986.673	80.232.218.792	80.156.975.553	78.912.925.169	74.285.780.744	79.922.095.657	79.840.649.955	79.757.575.339	78.482.190.906	73.755.921.489	79.498.248.955
Discount Factor	1,81	1,92	2,04	2,16	2,29	2,43	2,58	2,74	2,90	3,08	3,27
Discounted Cash Flow	44.421.588.364	41.829.202.032	39.387.345.752	36.546.698.592	32.425.771.468	32.880.325.226	30.958.358.230	29.148.111.118	27.032.997.738	23.944.435.301	24.324.833.982
NPV											
PV Cummulative	39.496.727.055	81.325.929.087	120.713.274.839	157.259.973.431	189.685.744.899	222.566.070.125	253.524.428.356	282.672.539.474	309.705.537.211	333.649.972.513	357.974.806.495
IRR											
Pay Back Period											

Table 9. Project With ADB Financing

Based on the cash flow table above, the NPV is Rp. 357,975,806,695 or NPV > 0 (greater than 0) it can be concluded that projects with ADB financing are feasible

3.4 Sensitivity Analysis

3.4.1 Project with APBN Financing

NO	REVENUE DECREASING	NPV	PAYBACK PERIODE
1	5%	674.225.095.895	6
2	10%	563.011.632.301	6
4	15%	396.191.436.910	7
5	20%	173.764.509.722	11
6	25%	(104.269.149.263)	20
7	30%	(437.909.540.045)	20
8	35%	(827.156.662.623)	20
9	40%	(1.272.010.516.999)	20
10	45%	(1.772.471.103.172)	20
11	50%	(2.328.538.421.142)	20

Table 10. Revenue Decreasing APBN

NO	INCREASED MAINTENANCE COSTS	NPV	PAYBACK PERIODE
1	5%	Rp 729.831.827.692	5
2	10%	Rp 713.800.638.958	5
3	15%	Rp 688.146.415.816	5
4	20%	Rp 646.510.638.092	5
5	25%	Rp 578.466.415.841	5
6	30%	Rp 467.106.696.306	5
7	35%	Rp 285.337.663.506	5
8	40%	-Rp 9.742.353.723	6
9	45%	-Rp 485.259.049.617	7
10	50%	-Rp 1.245.010.251.758	9
11	0%	-Rp 2.447.664.353.373	10
12	0%	-Rp 4.333.071.901.165	11

Table 13. Increased Maintenance Cost ADB

3.4.2 Project With ADB Financing

NO	REVENUE DECREASING	NPV	PAYBACK PERIODE
1	0%	357.974.806.495	9
2	5%	320.297.807.230	9
3	10%	244.943.808.702	10
4	15%	131.912.810.909	12
5	20%	(18.795.186.149)	20
6	25%	(207.180.182.471)	20
7	30%	(433.242.178.057)	20

Table 12. Revenue Decreasing ADB

NO	INCREASED MAINTENANCE COSTS	NPV	PAYBACK PERIODE
1	0%	Rp 357.974.806.495	9
2	5%	Rp 341.932.077.930	9
3	10%	Rp 316.265.635.830	9
4	15%	Rp 274.616.937.220	9
5	20%	Rp 206.559.069.357	9
6	25%	Rp 95.184.956.685	9
7	30%	-Rp 86.599.239.575	11
8	35%	-Rp 381.695.213.387	13
9	40%	-Rp 857.228.681.784	16
10	45%	-Rp 1.616.997.495.148	18

Table 13. Increased Maintenance Cost ADB

4. RESULTS

A comparison of net present value in APBN and ADB financing can be seen in the following table:

	WITHOUT DEVELOPMENT	DEVELOPMENT WITH ADB FINANCING	DEVELOPMENT WITH APBN FINANCING
		NPV ADB-INITIAL	NPV APBN-INITIAL
NPV	**107.539.838.345**	**250.434.968.150**	**622.291.989.347**

From the table above, it can be concluded that both NPVs from APBN and ADB financing have shown positive results, meaning that these two funds are feasible as alternative financing for the Pantoloan Port project. However, for an NPV with a higher value, it means that it is much more profitable, namely by using the APBN scheme with a value of Rp. 622,291,989,347.

From the two tables sensitivity, it can be concluded that the limit for decreasing revenue in APBN financing is 25%, while ADB's is 20%. The higher the revenue reduction limit, the higher the ability to finance in maintaining the feasibility of business continuity. So that for appropriate financing based on the revenue reduction limit is APBN financing.

From the two tables sensitivity, it can be concluded that the limit for increasing maintenance costs in APBN financing is 40%, while ADB is 30%. The higher the limit for increasing maintenance costs, the greater the ability to finance maintaining the feasibility of business continuity. So APBN financing is the appropriate financing based on the revenue reduction limit.

6. CONCLUSIONS

From the above research, it can be concluded that:

1. For the costs of planning, construction, and maintenance of the Pantoloan Port project for the next 20 years, the total requirement is IDR 1,633,908,711,217 based on the results of cash flow calculations that have been calculated by the author.
2. Analysis based on life cycle cost, discount factor, present value, and discounted cash flow then produces the net present value of the two financing schemes between APBN and ADB as follows:

	WITHOUT DEVELOPMENT	**DEVELOPMENT WITH ADB FINANCING**	**DEVELOPMENT WITH APBN FINANCING**
		NPV ADB-INITIAL	NPV APBN-INITIAL
NPV	**107.539.838.345**	**250.434.968.150**	**622.291.989.347**

Table.2 NPV Result

The two financing schemes are feasible, but the difference is significant because the ADB financing scheme includes an environment and social management plan fee as well as other cost obligations such as commitment fees and interest.

3. For this financing, it can be concluded that APBN financing is better and more profitable than ADB financing. However, if using a foreign loan, one of which is from ADB, the urgency of the loan must be taken into account, as must the selection of the right project to be funded from outside. The project being funded must be a cost recovery project so that the income from the project when it is operational can repay the loan.

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ANALYSIS OF PUBLIC SATISFACTION IN PUBLIC SERVICES SUMEKAR HOSPITAL IN SUMENEP CITY

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ABSTRACT

The Sumekar hospital must be able to meet the quality of service which is the benchmark for service success. To be able to measure the success of the service, the people's satisfaction will be analyzed using the service quality method.

This study aims to measure community satisfaction with public services by using the service quality method to determine service improvements and to analyze the gaps in public satisfaction with public services at Sumekar hospital. In 2021 there be a very significant decrease in patient visits. It can be concluded that the services provided by the Sumekar general hospital have problems. Therefore, researchers need to research "Analysis of Public Satisfaction with Public Services at Sumekar General Hospital".

This study will use quantitative methods along with service quality and GAP analysis. Data collection will be carried out using close-ended questionnaires, prioritizing the ethics of writing scientific papers. The research variables that will be used include the characteristics of respondents based on five dimensions of service quality, including responsiveness, reliability, empathy, assurance, and tangibles.

The results of measuring satisfaction with the SERVQUAL method show that the overall GAP value (–0.85), the more negative the servqual value, the lower the service quality of Sumekar hospital. The strategy that needs to be carried out to increase community satisfaction at Sumekar hospital is to implement a hospital management system, hospital staff training, and complete facilities, infrastructure, and medical devices at the Hospital.

Keywords: *Satisfaction, service, responsiveness, reliability, empathy, assurance*.

1. INTRODUCTION

Private sector which is divided into three groups, namely the first is administrative services, the second is services in the goods sector, and the third services. Service has the meaning of providing a service that is a community need in all fields, service activities to the community are one of the duties and functions of the state administration. (Ibrahim, 2018)

Public service providers must of course prioritize quality and have guidelines in the implementation process, bearing in mind the importance of implementing public services, the government has regulated guidelines regarding public services through the Decree of the Minister for Administrative Reform (KEMENPAN) Number Kep/25/M.PAN/2/2004 concerning Guidelines General The formulation of the Community Satisfaction Index (IKM) based on the decree contains guidelines for all government agencies, from the central to the regional level, to always conduct community satisfaction surveys which will later be used as a benchmark for achieving success in the implementation of public services.

One of the institutions that are oriented to public services is the housing agency. Sick. agency. This hospital is one of the work units of government agencies that provide services in the health sector and has an important role in improving health and being a service provider that is most needed by the community. Given the importance of the role of the hospital, of course, it must be balanced with the existence of benchmarks for success in its services, which have the aim of knowing the level. service unit performance. Periodically and as material for establishing a public service policy in order to increase service satisfaction. (Source: Guidelines for Public Service Innovation for Sumenep Regency, 2019).

The importance of the role of the hospital in the health sector makes the demand even higher for the hospital to improve the quality of its services to meet community satisfaction. Hospitals in Indonesia in general still do not meet the satisfactory criteria for the community in terms of providing health services. What is meant by services in the health sector is the provision of a service that has speed, accuracy, low cost, and is friendly. Hospitals are required to be able to serve the community and be able to provide a quality service that is affordable to the community. In fact, from several cases, we often find how complicated hospital procedures are in treating patients, and it even takes quite a long time to fulfill administrative matters.

The Sumekar General Hospital (RSU) is a private hospital located in Sumenep Regency which was founded by the Asri Husada Sumenep Foundation with the slogan of implementing the values of pro-community health services. Sumekar General Hospital was established to actively participate in development. and improving the quality of public health services in the Sumenep district. The very minimal availability of health facilities and infrastructure in Sumenep Regency is certainly an opportunity for Sumekar General Hospital to compete in providing more adequate services, being a private hospital is of course also one of its tasks to continue to provide and provide optimal services.

To realize an optimal quality of public service, Sumekar Hospital must be able to meet the Community Satisfaction Index, which is a benchmark for service success, which has not been fully implemented by Sumekar General Hospital, as evidenced by the number of service users, which has fluctuated quite a bit.

This study aims to measure community satisfaction with public services at Sumekar General Hospital based on five dimensions of service quality including responsiveness, reliability, empathy, assurance, and tangibles (Sedarmayanti, 2017).

2. LITERATURE REVIEW

According to Sedarmayanti (2017) public service by the bureaucracy the public is one of the manifestations of the function of the state apparatus as servants of the community in addition to their role as servants of the state. Public services by the public bureaucracy are intended for the welfare of society. Public services by the State Administrative Institute in Rajab (2018) are defined as all forms of public service activities carried out by central government agencies, in the form of goods and or services both in the context of efforts to meet the needs of the community and in the context of implementing provisions of laws and regulations. Whereas Sinambela (2019) argues that public service in society and public information disclosure cannot be separated, even though this has been regulated in a separate law. the state must serve every citizen and fulfill their basic rights and needs within the framework of public services.

Sedarmayanti (2017) states that community satisfaction is the level of community feelings that arise as a result of the services they receive after the community compares them with what they expect. The new community will feel satisfied if the services they get are the same as or

exceed their expectations and vice versa, dissatisfaction or feelings of disappointment in the community will arise if the services they get do not match their expectations.

Parasuraman et al (1988) said perceived service quality is defined as the level of difference between customer perceptions and expectations. The marketing view of service quality is perceived satisfaction will bring customers back to the same service provider (Browers and Kielfe 2022). Parasuraman, et al (1988) states that service quality is calculated as the difference between perceptions and expectations for each dimension, known as the "gap". The gap is the difference in the perception of the service owner with the expectations expected by the public for the service.

3. METHODS

3.1 Types of Research

In this study, this research will explain public services at the Sumekar General Hospital using quantitative methods. According to Sujarweni (2014) Quantitative research is a type of research that produces findings that can be obtained using statistical procedures or other methods of measurement. The qualitative method used in this study is the calculation of the community satisfaction index using service quality analysis.\

3.2 Data Collection Techniques

3.2.1 Data source

Primary data is data obtained directly from the main source by distributing a list of questions (questionnaires) to respondents using the services of the Sumekar General Hospital related to the community satisfaction index. Questionnaires were distributed directly or privately to individuals who were respondents by prioritizing the principle of confidentiality, the questionnaire used was a written question format that had been formulated previously and had been clearly defined.

Secondary data is data obtained directly from Sumekar General Hospital, including documents such as administrative records, company analysis by various media, environment or situations and special events and data on patient visits at Sumekar General Hospital. The data taken is only related to research.

3.2.2 Collecting data

The interview technique is carried out systematically, what is meant systematically is that the interview is carried out by first preparing the interview guideline instrument, in addition to being systematically the interview is also carried out in depth, as an effort or process of proving the information or information that has been obtained.

Quisioner method It is data collection that is carried out by distributing a list of questions (questionnaires) to respondents using the services of the Sumekar General Hospital. Previously, the researcher first compiled a list of questions related to the community satisfaction index, and so that respondents could answer the questionnaire properly, the researcher explained beforehand related to filling out the questionnaire.

The data source used in this analysis is primary data because it is collected directly by the researcher from the source. The selected collection method is the questionnaire method.

3.2.3 Validity Test

In empirically knowing whether the measurement is in accordance with the theory that forms the basis of the research, a correlation measurement is carried out between the variables and the variable's total score. Therefore, we carry out a validity test, which is used to determine the

level of validity of the data on the object of research on the data to be reported. Data is said to be valid if the value of $r_{count} > r_{table}$.

3.3 Service Quality

The customer is the main evaluator who plays an important role in measuring the quality of a service or product. In the health care sector, the customer is the patient. Their perception is considered as the main indicator when assessing service quality (Cronin and Taylor, 1994) in the journal Rezarta, 2016. The SERVQUAL method is used to determine the gap between the quality of service perceived by service owners and the quality of service expected by the public. This is a measuring tool to find out the quality of service so that you can find out which variables should be prioritized in order to minimize the gaps that might occur.

The SERVQUAL score for each pair of questions in each community filling out the questionnaire can be calculated using the following formula by Parasuraman, et al 1990.

3.4 Analysis Method

If it is appropriate, then a survey is carried out again and makes validity and reliability for determining the questionnaire based on characteristics, service satisfaction, service interests and community preferences. From here, the results obtained are used as an analysis using the service quality method. After the results are obtained, it is followed by a GAP analysis to determine what gap is between the service owner and the community being served.

4. RESULTS

The Servqual is a method used to measure service quality from the attributes of each dimension, so that a gap value will be obtained which is the difference between consumer perceptions of services that have been received and expectations of those that will be received. The measurement of this method is by measuring the quality of service from the attributes of each dimension, so that a gap value will be obtained which is the difference between the consumer's perception of the service received and the consumer's expectation of the service to be received.

Tabel 1. Overall Service Quality Dimensions Patient Satisfaction with Sumekar Hospital Services

SERVICE QUALITY DIMENSIONS	AVERAGE		GAP
	SATISFACTION	EXPECTATION	
Responsive	3,7	4,6	**-0,93**
Reliability	3,6	4,5	-0,83
Emphaty	3,7	4,6	-0,86
Assurance	3,6	4,4	-0,84
Tangible	3,8	4,5	-0,74
GAP (Unweight Score)	3,7	4,5	-0,84

Based on the data in Table 1 above, the results are obtained about servqual which is a tool to measure the quality of service by an information from service providers that has been carried out by researchers through several variables, namely Responsiveness, Reliability, Empathy, Assurance, Tangible while the data generated is on the variable responsiveness responsible for providing and assisting fast service for Sumekar Hospital users (accountability), on the reliability variable the ability to provide promised services to Sumekar Hospital users, the empathy variable approaches, provides protection, and tries to find out the wants and needs of service users

Sumekar General Hospital, the assurance variable provides knowledge and insight, an attitude of courtesy, and respect for service users of Sumekar General Hospital, for the last variable is the tangible variable where in this variable Sumekar General Hospital public services are able to provide the appearance of the employees is beautiful and all the physical facilities of Sumekar General Hospital are complete and good.

The results showed that overall patient satisfaction at Sumekar General Hospital was rated low, indicating a negative value. The overall satisfaction measurement results can be seen from table 1 above, that the overall average GAP value (–0.84), the more negative the servqual value, the lower the service quality of Sumekar General Hospital.

Based on the value obtained, it can be interpreted that the low satisfaction of Sumekar General Hospital service users is found in the responsive variable, followed by a smaller GAP value, namely reliability, empathy, assurance, and tangible. In the responsive variable that has the lowest value among other variables, it can be interpreted that the lack of ability of Sumekar General Hospital in carrying out services with the response or alertness of employees in helping Sumekar General Hospital service users is felt to be lacking.

This is very contrary to the main goal of a social institution engaged in the social sector by prioritizing maximum service by providing fast, accurate, and good service so this becomes one of the indicators that is quite important to be a major highlight by improving management in an overall manner. comprehensively by prioritizing service improvement so that in the future Sumekar General Hospital, which is currently one of the newly established hospitals in Sumenep Regency, can compete with several other existing hospitals. In one study, it was stated that although it is most likely that the relative ranking of each variable will change in the future, researchers believe that the biggest concern that needs to be addressed for service user satisfaction at Sumekar General Hospital is responsive variables without neglecting other variables.

5. CONCLUSIONS

Based on the results of the ServQual test with 94 respondents using the closed questionnaire filling method that was carried out in the previous chapter, it shows that the quality of service at Sumekar General Hospital is still far from the expectations of the community as service users.

This is evidenced by the resulting GAP value which shows that the overall value is negative, so the analysis shows that there is dissatisfaction with the services implemented by Sumekar General Hospital. There is a conformity with the annual report data of Sumekar General Hospital from 2017 to 2021 which does not meet the standard target of achieving Sumekar General Hospital.

All dimensions of service quality have a significant positive effect on service user satisfaction. The better the quality of service provided by Sumekar General Hospital to service users, the significantly higher the satisfaction of public service users of Sumekar General Hospital.

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EVALUATION OF SEA HIGWAY ROUTES USING CARGO ROUTING MODEL IN THE EASTERN INDONESIA REGION

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Abstract*—As an archipelagic country, Indonesia needs adequate connectivity to improve the balance between prosperity and economic reality. However, there is an imbalance in the supply of goods between the western part of Indonesia and the eastern part of Indonesia. Looking at the conditions, the correct operation pattern in dealing with the situation in the Eastern Indonesia Region is the liner shipping operation pattern. Currently, the design of the route network in Liner Shipping Network Design only designs a new route pattern involving the main port and feeder port. However, neither regional nor local feeder ports have been involved. Therefore, this study evaluates existing routes and designs a route network involving regional feeder ports and local feeder ports with the Cargo Routing Model (CRM) which will produce new, more optimal routes. From the results of the study, it was found that there were two routes, namely T-9 and T-11, which could be included in the sea highway program, and 1 route, namely T-30, was not eligible to enter the sea highway (because the distribution results still provided an advantage). In addition, it is known that the most optimal and effective route from the results of modelling with CRM is the T-30 route with the Tanjung Perak – Kaimana – Tanjung Perak route.

***Keywords*— Liner Shipping Network Design, Route Design, Artificial Neural Network, Mixed Integer Linear Programming.**

1. Introduction

Trade has a close relationship with the economic growth of a region because trade is one of the ways to meet needs [1-3]. This allows traders to become a link between one region and another, especially those that are side by side. Indonesia as an archipelagic country requires adequate connectivity to improve the balance between prosperity and economic reality [4-6]. The supply in various regions of Indonesia is not evenly distributed [7-10].

The supply of goods between the western part of Indonesia and the eastern part of Indonesia is unequal. Economic growth that is concentrated in the western region results in inefficient sea transportation in Indonesia and logistics costs that tend to be expensive because there is no return cargo from areas with low economic growth, especially the Eastern Indonesia Region [11-14]. It was noted that during the last 5 years from 2015 to 2019, the Distribution of GRDP (Gross Regional Domestic Product) national was still dominated by the GRDP of Java Island, which is the Region of West Indonesia by 59% in 2019; while the Islands of Maluku and Papua which are in the Eastern Indonesia Region only contributed 2.24%. This shows the imbalance of connectivity between regions in Indonesia.

Therefore, the government as the policy holder must be able to attend in terms of availability, accessibility and affordability to all regions in Indonesia starting from the Western Region of Indonesia to the Eastern Region of Indonesia, especially the Disadvantaged, Outermost, Frontier and Border areas continuously to achieve equity GRDP [15-17]. There have been many government programs to reduce the impact of connectivity imbalances between the West Indonesia Region and the East Indonesia Region by intervening in the market by making technical and non-technical planning and decisions as well as providing operational assistance needed in the process of moving people, livestock and goods connecting West Indonesia Region and East Indonesia Region

The Directorate General of Sea Transportation has established pilot ship transportation programs, sea highway freight transportation, livestock ship transportation, and rede ship transportation. Activities for carrying out public service obligations for pilot ships totalling 117 routes, organizing sea toll cargo ships as many as 35 routes, organizing special ships for livestock transportation as many as 6 routes and organizing rede ships as many as 16 routes. Where, the entire implementation of these activities requires subsidies by the Government of Indonesia through the Ministry of Transportation. Total subsidies for sea transportation in 2022 are around IDR 1.3 trillion, divided into subsidies for pioneering sea transportation of IDR 782 billion, sea highway transportation of IDR 435 billion, operation of livestock vessels IDR 63.4 billion, and operation of rede (feeder) vessels IDR 35 billion.

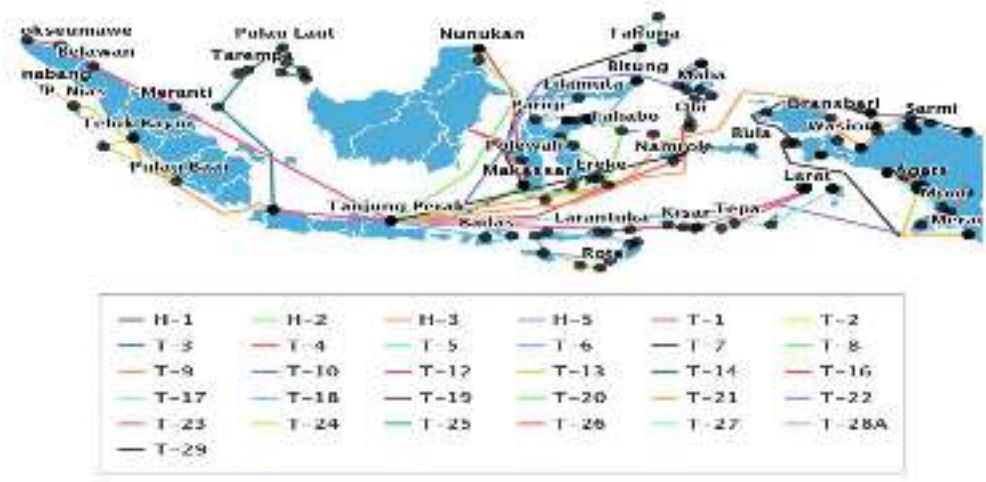

Figure 1. Sea Highway Route Map

This subsidy program has been running for approximately 7 years. Therefore, the purpose of this research is to evaluate the routes that have been determined in the pilot ship program and sea highway ships which are considered to have been able to grow economic activity in eastern Indonesia. Thus, the subsidy program can be channeled to open new routes to encourage equity in accordance with the principle of ships promotes the trade.

In previous research and practice, only the main ports and national collection ports were involved in the sea highway program. However, it has not yet involved regional collection ports. In this research, a sea highway route design will be carried out using the Cargo Routing Model (CRM) modeling which involves regional and local collection ports for routes serving the Eastern Indonesia Region with the assumption that if the results of the calculations show a minus number (-) the route is still considered eligible to be included in the sea highway program whereas if the calculation results show a positive number (+) the route is declared not eligible to be included in the sea highway program.

2. Methods

In this study, data was collected to support solving and analyzing problems that arise based on the research focus. The data were taken over a certain period, namely for approximately 4 (four) months in the fourth quarter of 2022. The required data were obtained using two methods, namely direct observation and interviews with regulators and sea highway operators.

Based on the method used, the data needed in this study include Routes and Ports that serve West Papua (sea highway cargo ship routes stipulated by the Ministry of Transportation of the Republic of Indonesia in 2022, namely T-9, T-11, and T-30); Distance Between Ports using an application to measure the distance between ports; Flow of goods (the overall flow of goods, both the flow of goods out and the flow of incoming goods as a database for the level of demand for each port); Vessels (limited to ships that have executed operational contracts in the maritime highway program between the Government of Indonesia); Ship speed (limited to 10 Knots); Shipping Costs (it is assumed that only loading and unloading costs and boat rental costs are included in operational costs); revenue (the total amount of goods distributed at each port multiplied by the price set by the Government of Indonesia).

Because the sea highway is a program that is subsidized by the government. So by the Regulation of the Minister of Transportation of the Republic of Indonesia Number PM 22 of 2018 concerning the components of income and costs that are calculated in subsidized activities for the implementation of sea freight transportation, the calculation of government subsidies is calculated from the difference in total shipping costs minus total revenue. So with the calculation of the cargo routing model, it will be assumed that if the results of the calculations show a minus (-) number, the route is still considered eligible to be included in the sea highway program, whereas if the calculation results show a positive number (+), the route is declared not eligible to be included in the program sea highway.

3. Results and Discussion

Cargo Routing Model (CRM) is a model to determine optimization in a route for shipping goods via cargo ships. In this study, CRM was applied to 3 routes in the Eastern Indonesia Region. A total of 3 (three) routes in this study include:

1st Route (T-9): Tanjung Perak - Oransbari - Wasior - Nabire - Serui - Waren - Sarmi - Tanjung Perak.
2nd Route (T-11): Tanjung Perak – Fak Fak – Tanjung Perak

3rd Route (T-30): Tanjung Perak – Kaimana – Tanjung Perak

The route is a route that includes the depot port with the regional feeder port, while the local feeder port is connected with the regional feeder port. This means that the demand from the local feeder port is lowered at the nearest regional feeder port. Based on the description of the route and map of the Papua Region, the following details the route taken by the ship.

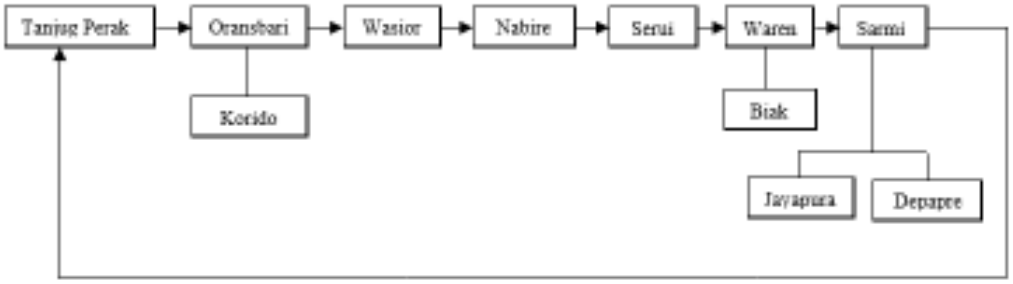

Figure 2. 1st Route

1st route carries various commodities for 10 ports consisting of 6 regional ports and 4 local ports. All transported commodities are presented in the following table:

Table 1. 1st route commodities

No	Harbor	Location	Population (soul)	*Food* (TEUS)	*General* (TEUS)	*Cargo demand* (TEUS)
1	Tanjung Perak	Surabaya city				
2	Oransbari	Manokwari Selatan district	35,949	3.46	9.21	12.67
3	Korido	Biak district	134,650	11.57	31.55	43.12
4	Wasior	Teluk Wondama district	41,644	5.42	11.51	16.93
5	Nabire	Nabire district	169,136	19.68	60.39	80.07
6	Serui	Serui district	112,676	8.94	27.09	36.03
7	Waren	Waropen district	33,943	4.44	9.07	13.51
8	Biak	Biak district	134,650	11.57	31.55	43.12
9	Sarmi	Jayapura district	41,515	3.73	9.23	12.96
10	Jayapura	Jayapura city	398,478	45.24	212.67	257.91
11	Depapre	Jayapura district	166,171	12.87	54.08	66.95
	Total			**126.92**	**456.35**	**583.27**

Based on the number of requests that must be met on 1st route, namely 583.27 TEUS, 5 ships can be used, namely:

Table 2. 1st route ships

Ship name	Capacity (TEU)	Speed (knot)	Consumption (Ton/day)	Rental costs (IDR/day)
KM Kendhaga Nusantara	100	10	4	Rp 2,250,000
KM Caraka Jaya Niaga III – 32	118	10	5	Rp 2,250,000
KM Logistik Nusantara IV	126	10	8	Rp 2,250,000
KM Logistik Nusantara III	126	10	4	Rp 2,250,000
KM Logistik Nusantara II	145	10	4.5	Rp 2,250,000
Total	**615**			**Rp 11,250,000**

1st route travels for 24 days, so the total boat rental fee is IDR 11,250,000 x 24 = IDR 270,000,000. The fuel consumption of each ship is different. Ship fuel uses Marine Fuel Oil (MFO) at a price of IDR 19,500/L which is effective in November 2022. Based on this data, the amount of fuel costs for each ship can be calculated: KM Kendhaga Nusantara (cost for 24 days IDR 1,889,001,009.08); KM Caraka Jaya Niaga III – 32 (cost for 24 days IDR 2,361,251,261); KM Logistik Nusantara IV (cost for 24 days IDR 3,778,002,018.16); KM Logistik Nusantara III (cost for 24 days IDR 1,889,001,009.08); KM Logistik Nusantara II (cost for 24 days IDR 2,125,126,135.22). Based on these costs, the total costs incurred on 1st route, namely rental costs and fuel costs, are IDR 12,312,381,433. As is known from the previous calculation data, the total revenue on 1st route is IDR 4,004,464,891.32, so that the difference between income and expenses of ships from 1st route can be calculated, namely IDR 4,004,464,891.32 - IDR 12,312,381,433 = (-) IDR 8,307,916,541.22. Based on the results of the calculations above which show that the value is minus (-), the route on that route is still considered feasible to be included in the maritime highway program.

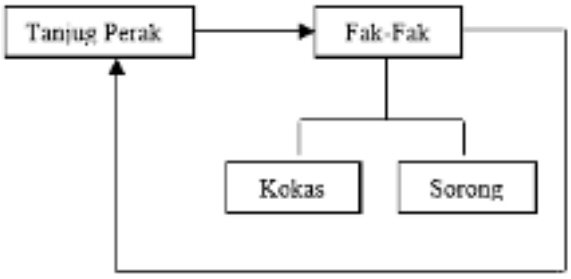

Figure 3. 2nd Route

Route 2 carries various commodities for 3 ports consisting of 1 regional port and 2 local ports. All transported commodities are presented in the following table:

Table 3. 2nd route commodities

No	Harbor	Location	Population (soul)	Food (TEUS)	General (TEUS)	Cargo demand (TEUS)
1	Tanjung Perak	Surabaya city				
2	Fak-Fak	Fakfak district	85,197	9.04	24.65	33.69
3	Sorong	Sorong city	284,410	27.27	96.79	124.06
4	Kokas	Fakfak district	85,197	9.04	24.65	33.69
	Total			**45.35**	**146.09**	**191.44**

Based on the number of requests that must be met on route 2, namely 191 TEUS, 2 ships can be used, namely:

Table 4. 2nd route ships

Ship name	Capacity (TEU)	Speed (knot)	Consumption (Ton/day)	Rental costs (IDR/day)
KM Kendhaga Nusantara	100	10	4	Rp 2,250,000
KM Caraka Jaya Niaga III – 32	118	10	5	Rp 2,250,000
Total	**218**			**Rp 4,500,000**

Route 2 travels for 13 days, so the total boat rental fee is IDR 4,500,000 x 13 = IDR 58,500,000. Fuel consumption is based on the price per liter, which is IDR 19,500 and the amount consumed per day. The amount of fuel costs per ship is presented in the following calculation. KM Kendhaga Nusantara (cost for 13 days IDR 1,023,208,879.92); KM Logistik Nusantara IV (cost for 13 days IDR 1,279,011,099.90). Based on these costs, the total costs incurred on route 2, namely rental costs and fuel costs, are IDR 58,500,000 + (IDR 1,023,208,879.92 + IDR 1,279,011,099.90) = IDR 2,360,719,980. As is known from the previous calculation data, the total income on route 2 is Rp. 984,878,133.75, so that the difference between income and expenses for ships from route 2 is Rp. 984,878,133.75 - Rp. 9,951,130,172 = (-) Rp. 1,375 ,841,846.07. Based on the results of the calculations above which show that the value is minus (-), the route on that route is still considered feasible to be included in the maritime highway program.

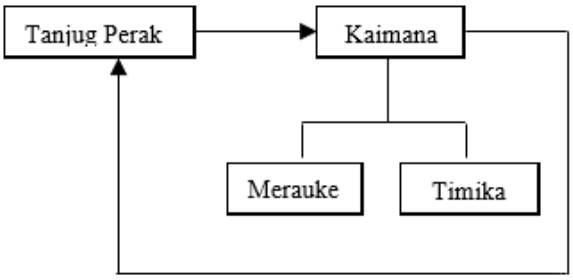

Figure 4. 3rd Route

Route 3 carries various commodities for 3 ports consisting of 1 regional port and 2 local ports. All transported commodities are presented in the following table:

Table 5. 3rd route commodities

No	Harbor	Location	Population (soul)	*Food* (TEUS)	*General* (TEUS)	*Cargo demand* (TEUS)
1	Tanjung Perak	Surabaya city				
2	Kaimana	Kaimana district	62.256	5.73	17.63	23.36
3	Merauke	Merauke district	230.932	24.58	102.57	127.16
4	Timika (Pomako)	Timika district	311.969	30.39	113.38	143.77
	Total			**60.7**	**233.58**	**294.29**

Based on the number of requests that must be met on route 3, namely 294.29 TEUS, it can use 1 ship, namely KM Logistik Nusantara I with a capacity of 305 TEUS and fuel consumption of 4.5 tons per day. The rental fee per day is IDR 2,850,000. Route 3 travels for 13 days, so the rental fee is IDR 2,850,000 x 13 = IDR 37,050,000. Fuel consumption is based on the price per liter, which is IDR 19,500 and the amount consumed per day. The amount of fuel costs per ship is presented in the following calculation. KM Logistik Nusantara I (cost for 13 days IDR 1,151,109,989.91). Based on these costs, the total costs incurred on route 3, namely rental costs and fuel costs, are IDR 37,050,000 + IDR 1,151,109,989.91 = IDR 1,188,159,990. As is known from the previous calculation data, the total income on route 3 is Rp. 1,786,634,722.63, so that the difference between income and expenses for ships from route 3 can be calculated = Rp. 1,786,634,722.63 - Rp. 1,188,159,990 = Rp. 598,474,732. 72. Based on the calculation results above which show that the number is positive (+), the route on that route is not feasible to be included in the sea highway program.

The Sea Highway Program is one of the national programs of the President of the Republic of Indonesia in order to ensure the stabilization of the supply of Staple and Important Materials and cut distribution costs so as to reduce price disparities in Disadvantaged, Remote, Outermost and Border Areas (T3P) as stated in the Regulation President Number 27 of 2021 concerning Implementation of Public Service Obligations for the Transportation of Goods to and from Disadvantaged, Remote, Outermost, and Border Areas (T3P). The implementation of the sea highway program is a program implemented to serve and facilitate the distribution of goods in archipelagic areas, especially areas that have not been served by commercial ships such as the Eastern Indonesia Region. The existence of this sea highway is a form of state involvement in participating in meeting the needs of the community, especially the T3P area [18-21].

From the results of calculations, routes 1 and 2 have enormous costs, so they require the support of the sea highway program to cut distribution costs. It also aims to provide services for regional needs through 7 regional ports, namely Oransbari, Wasior, Nabire, Serui, Waren, Sarmi, and Fak Fak, as well as 6 local ports, namely Korido, Biak, Jayapura, Depapre, Sorong, and Kokas. These areas are included in areas with high population and very large demand. Therefore, the toll road program is appropriate for the T-9 and T-11 routes.

The T-30 route, which is the Tanjung Perak – Kaimana -Tanjung Perak route, reaches 1 regional port, namely Kaimana, and 2 local ports, namely Merauke and Timika. This route is almost the same as the T-11 route, which covers 1 regional port and 2 local ports. The difference is that the T-30 route does not require the maritime highway program because it provides an advantage, while the T-11 has minus income. Even the T-30 transported more commodities, namely 294.29 TEU compared to the T-11 which only transported 191.44 TEU. This is because the capacity of ships varies, so it is necessary to re-evaluate which ships are selected to be able to transport commodities in accordance with the demands of each region in Eastern Indonesia.

Ship capacity is still limited causing more and more ships to be used. It can be seen in the calculation that the cost of fuel contributes to the expense. That is if the ship used has a large capacity, it can transport more commodities so that it does not require many ships to transport it [22-25]. This step can cut fuel costs thereby reducing expenses. In addition, areas with very large demand, such as Jayapura, Sorong, Merauke, and Timika, need attention to become regional port routes so that distribution is easy. With more and more regional ports opening according to demand, it will be easier to meet demand in areas with high populations. This can also reduce disparities between regions, especially the western and eastern parts of Indonesia.

4. Conclusions

From the discussion, it can be concluded that the results of modeling using the Cargo Routing Model (CRM) for routes involving regional collection ports found 2 routes, namely T-9 and T-11 which can be included in the sea highway program, while the T-30 route is not feasible to enter sea highway because the results of the distribution still provide benefits. The sea highway program through the T-9 and T-11 routes reaches areas in the Eastern Indonesia Region through 7 regional ports, namely Oransbari, Wasior, Nabire, Serui, Waren, Sarmi, and Fak Fak, as well as 6 local ports, namely Korido, Biak, Jayapura, Depapre, Sorong, and Kokas. In addition, the description of the most optimal and effective route from the results of modeling with CRM is the T-30 route with the Tanjung Perak - Kaimana - Tanjung Perak route. This route only requires 1 ship capable of carrying commodities for 1 regional port,

namely Kaimana, and 2 local ports, namely Merauke and Timika. Based on the results of this study, it is recommended that ships tasked with transporting commodities to the Eastern Indonesia Region be chosen with large capacities and should open regional port routes that have high demand, such as Jayapura, Sorong, Merauke, and Timika.

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DETERMINATION OF BANKING OUTLET LOCATIONS USING ANALYTICAL HIERARCHY PROCESS : (CASE STUDY AT BSI MAIN BRANCH OFFICE YOGYAKARTA KUSUMANEGARA)

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ABSTRACT

The decision to choose a location is a decision that requires careful consideration and may be one that is difficult for solved by the management of a bank. The strategic location is a priority factor in a consideration of Bank Syariah Indonesia (BSI) for investment in Main Branch Offices (KCU). Currently BSI Kusumanegara Branch has three (3) alternative investment outlets, namely the Diponegoro Street Building, the KFC-UIN Sunan Kalijaga Building, and the People's Sovereignty Building (GKR) P. Mangkubumi Street. The problem faced by the company is that it is difficult to determine which location is strategic from the three (3) alternative locations that have the best performance, including from 6 main criteria, namely in terms of infrastructure, geographical location, investment costs, number of competitor Islamic financial institutions, economic potential, and the criminal rate. In this research, the initial step is to determine the criteria for choosing the outlet location, then collect data using a pairwise comparison questionnaire with pre determined criteria and alternatives and this questionnaire is given to the respondents. The data obtained from the questionnaire became input in the analysis of the selection of the best outlet investment locations for BSI Kusumanegara branch through the Analytical Hierarchy Process (AHP) approach. Data analysis using the Analytical Hierarchy Process (AHP) method shows that Diponegoro Street Building has the highest priority as the location of the BSI Kusumanegara Main Branch Office.

Keywords: Analytical Hierarchy Process (AHP), Location, Bank Syariah Indonesia

1. INTRODUCTION

Bank Syariah Indonesia (BSI) was established on 1 February 2021. This bank is a merger of three sizable Islamic banks in Indonesia, namely BNI Syariah, BRI Syariah, and Bank Syariah Mandiri. Assets owned by Bank Syariah Indonesia amount to IDR 240 trillion, Third Party Funds (DPK) IDR 210 trillion, financing IDR 157 trillion, and core capital reaching IDR 22.6 trillion. Because this bank is the result of a merger, it has 1,200 branch offices. Then, its employees reached 20,000 people. In total assets, BSI ranks seventh in Indonesia and ranks first as an Islamic bank in Indonesia. In 2017, the market share only reached 5%. However, in 2020 the market share has exceeded 5%, which is 6.3%. Including growth in the city of Yogyakarta which is a tourism city with good economic growth where according to DIY economic data for the first quarter of 2021 to the first quarter of 2020 experienced growth of 6.14 percent (year on year) (BPS Yogyakarta, 2021) and supported by some of the community the majority are Muslims, namely 92.5% (Bappeda Yogyakarta, 2021), driving the need for Islamic financial institutions and conducting sharia transactions to increase. Therefore, activities carried out to increase market share must be directed at prospective customers or legacy customers in order to attract and encourage them to make purchases and prevent them from switching to other products. According to Swastha and Handoko

(2000) the factors that influence purchasing decisions are different for each buyer, one of which is strategic location. In the banking service business, determining the location where the bank will operate is an important factor.

There are several types of BSI office locations, namely the location of the head office, regional, area, main branch, sub-branch, cash office, and the location of Automated Teller Machines. In this study focused on the Yogyakarta BSI Area Main Branch Office (KCU) Kusumanegara. The Kusumanegara branch (legacy BNI Syariah) has been around longer, namely in 2003. For Bank place is one of the means to provide its products to customers in a certain place. Determining the right location will provide benefits for the Bank and customers. The goal of the location strategy is to maximize the company's location advantage.

Currently BSI Kusumanegara Branch has three (3) alternative investment outlets. The problem experienced by the company is the difficulty in determining which strategic location out of the three (3) alternative locations has the best performance, including in terms of investment costs, economic value, location, facilities, design, distance between outlets, and the potential of the surrounding market. The method used in this study is the Analytical Hierarchy Process (AHP) method.

2. LITERATURE REVIEW

Islamic Commercial Banks (BUS) are also called full branches, because they are not under the coordination of conventional banks, so their activities are separate from conventional ones, meaning that Islamic Commercial Banks can be owned by conventional banks, but their activities and reporting are separate from the parent bank (Ismail, 2011). The merger of Bank Syariah Mandiri, BNI Syariah, and BRI Syariah which are engaged in the same field, namely the Islamic financial sector by forming Bank Syariah Indonesia, is a horizontal merger. Thus the goal of cooperation here is to become one of the 10 largest Islamic banks based on market capitalization globally.

In this study, the authors refer to studies related to site selection that have been carried out previously. Research on the selection of representative office locations of PT. X through the integration of objective and subjective factors carried out by Bhawika and Pujawan (2013). The goal to be achieved is to determine the location of the representative office of PT. X by considering objective and subjective factors, determines the allocation of employees from the head office and representative offices to the client's power plant, minimizes employee transportation costs to the power plant location, and determines how much influence changes in objective and subjective factors have on location determination. The ANP method is appropriate because it has been clearly stated regarding the location of origin and destination.

Furthermore, research on decision support systems using the TOPSIS method for selecting locations for wholesale credit establishments by Kristiana (2018). One method that can be used to solve problems in choosing the location for the establishment of wholesale pulses is the TOPSIS (Technique for Orders Preference by Similarity to Ideal Solution) method, which is a multi-criteria decision-making method that uses the principle that the chosen alternative must have the shortest distance to the ideal solution. positive and the farthest distance to the negative ideal solution. However, in the TOPSIS method there is no determination of priority weights which are priority calculations for the criteria, which is useful for increasing the validity of the weight values for calculating the criteria.

Research on determining ATM locations was carried out by Mahendra and Aryanto (2019) using the Analytical Hierarchy Process (AHP) and Simple Additive Weighting (SAW) methods.

The AHP and SAW methods are appropriate because in the case of choosing an ATM location using multiple criteria and quite a lot of alternative choices. The SAW method is appropriate because there is a lot of data to process.

Then the research conducted by Windiani (2013) discusses the analysis of location selection for bank sub-branch offices (a case study at Bank BJB Cibinong Branch). The aim is to determine the selected location based on BJB Bank management policies, AHP theory, and after the selected location is then formulated an implementation strategy for the selected location using SWOT analysis.

Furthermore, other research related to the analysis of the best branch locations uses the AHP method by Yusuf (2012) to reduce the risk of errors in choosing a location. The AHP method used in research solves problems by breaking them into groups and then organizing them into a hierarchical form. The AHP method uses human perception which is considered an expert as its main input, besides that the method takes into account quantitative and qualitative matters and has a clear comparison scale, is reciprocal in nature and the decision results are easy to analyze. The goal is to produce optimal solutions in site selection, calculating the weight of site selection criteria and location alternative weights.

3. METHODS

1. Research Material
   The material used in this study was a questionnaire for selecting the best outlet investment locations for the BSI Kusumanegara branch.
2. Research Object
   The observable research object is the criteria for selecting and evaluating the best outlet investment locations for the BSI Kusumanegara branch.
3. Data Necessary
   In this study, there is one type of data, namely primary data as input. The data collected consists of the results of the answers to the AHP questionnaire from respondents in the form of an assessment of the criteria, sub-criteria, and alternatives that will be used to determine the weights needed in the AHP calculation.
4. Research Stage

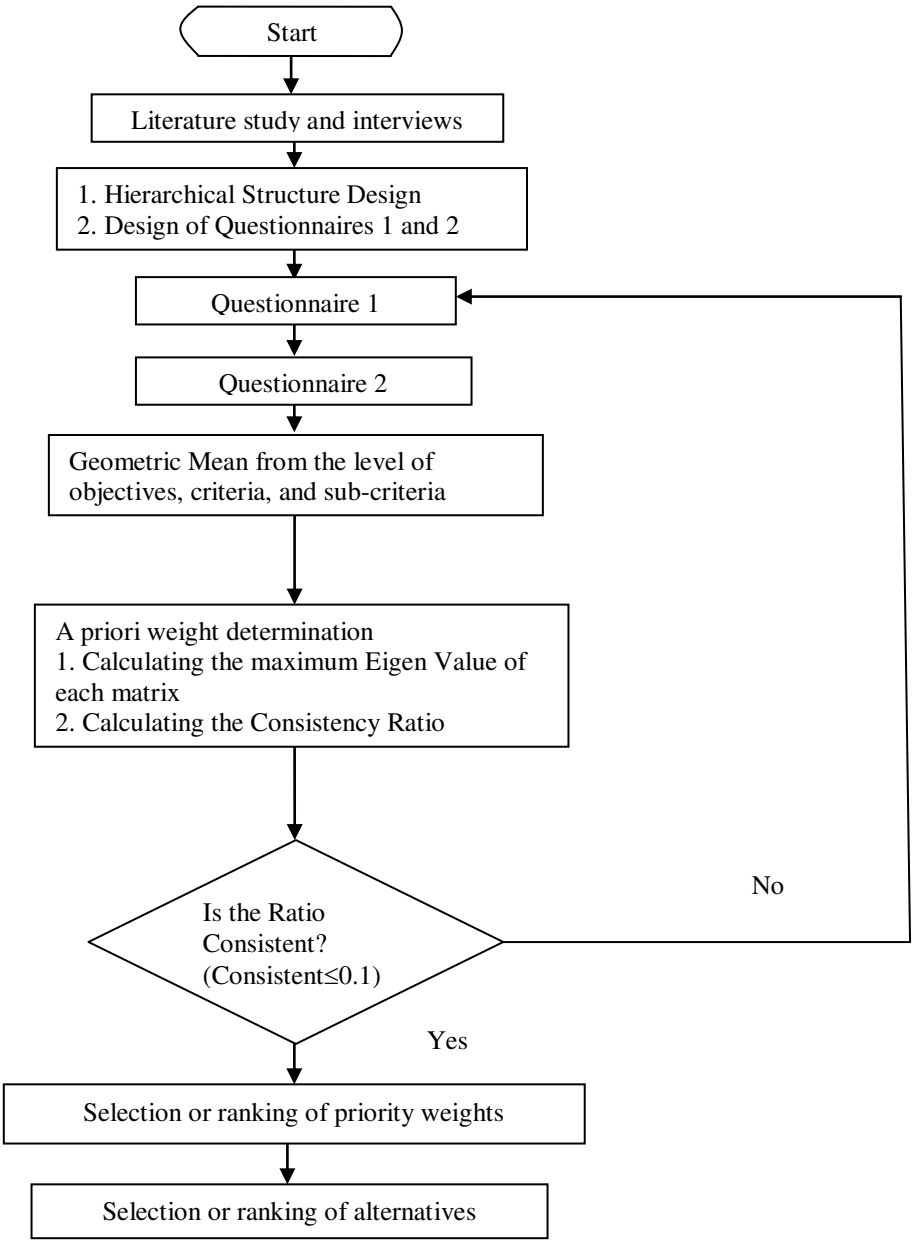

Figure 1. *Research Flowchart*

4. RESULTS

The object used in this research is the location of the BSI KCU Yogyakarta Kusumanegara outlet which consists of 3 alternative locations namely the Jalan Diponegoro Building, the KFC-UIN Sunan Kalijaga Building, and the People's Sovereignty Building (GKR) Jalan P. Mangkubumi. Information for the three proposed alternatives has been determined from the BSI Yogyakarta Area Management Operations Section which has pre-screened them based on the shape of the building, which is already a multi-storey building. These alternative locations will be evaluated for the process of selecting the best outlet locations.

After conducting an interview, 1 open-ended question related to what criteria and or sub-criteria are involved in determining investment in outlet locations with respondents in this case more inclined to operational and structural management (top and middle management) which are directly related in terms of site selection and brainstorming of literature studies , create a hierarchical structure.

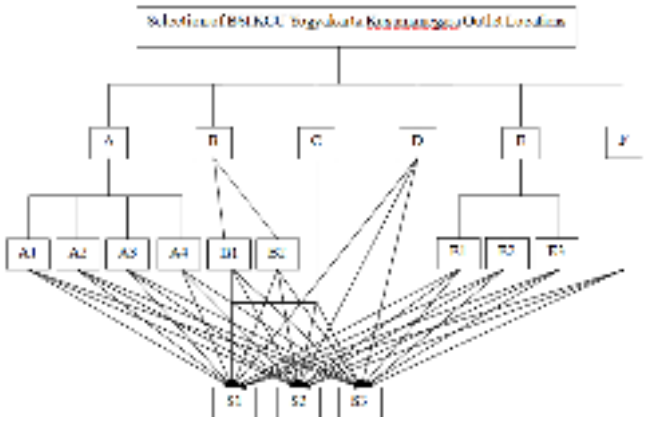

Figure 2. *Hierarchical Structure for Selection of BSI KCU Kusumanegara Outlet Locations*

Caption:

A : Infrastructure
A1 : Ease of Access Location
A2 : Proximity to Public Facilities
A3 : Availability of Electricity Network and Internet
A4 : Level of Availability of Clean Water
B : Geographic Location
B1 : Area of Location
B2 : Area of Parking Lot
C : Investment Cost
D : Number of Competitor Islamic Financial Institutions
E : Economic Potential
E1 : Local Market Potential
E2 : Local Community Income
E3 : Density of the surrounding population
F : Crime rate

S1 : Diponegoro Location
S2 : Location of KFC-UIN
S3 : Location of GKR

Profile of 8 Respondents who are operational and structural management (top and middle management), i.e. 5 people S1, 5 men, 4 people serving between 11-20 years.

From the 8 respondents obtained, then a data consistency test was carried out. Consistent data has a consistency ratio (CR) ≤ 0.1. At this early stage, as shown in Tables 1 for a summary of the criteria and sub-criteria weights and the CR value of each respondent, all respondents had a consistency ratio ≤ 0.1 for completing the pairwise comparison questionnaire related to the criteria

and sub-criteria in selecting outlet locations, so that the data is continued for use in AHP calculations. Below the result of calculating by AHP method.

Responden	CR		
	Main Kriteria	Infrastructure Sub Criteria	Economic Potential Sub Criteria
Ayu	0.063	0.093	0
Lala	0.071	0.029	0.025
Nisda	0.087	0.093	0.025
Agung	0.078	0.093	0
Anshka	0.095	0.093	0
Edi	0.083	0.093	0.025
Jusun	0.099	0.093	0
Wachjono	0.075	0.093	0.025

Table 1. Level of Consistency of Each Respondent for Main Criteria and Sub Criteria

No.	Criteria	Average Weight							
		Ayu	Lala	Nisda	Agung	Anshka	Edi	Jusun	Wachjono
1.	Infrastructure	0.24	0.14	0.3	0.22	0.1	0.19	0.17	0.27
	a. Ease of Access Location	0.35	0.39	0.41	0.32	0.48	0.52	0.53	0.41
	b. Proximity to Public Facilities	0.46	0.41	0.41	0.37	0.31	0.19	0.17	0.16
	c. Availability of electricity and internet	0.12	0.11	0.06	0.14	0.09	0.23	0.15	0.16
	d. Level of Availability of Clean Water	0.07	0.09	0.11	0.14	0.11	0.06	0.14	0.26
2.	Geographic Location	0.3	0.31	0.22	0.26	0.5	0.4	0.29	0.26
	a. Location Area	0.2	0.83	0.75	0.23	0.75	0.2	0.2	0.72
	b. Parking Area	0.2	0.17	0.25	0.77	0.25	0.8	0.8	0.28
3.	Investment Cost	0.1	0.11	0.12	0.22	0.1	0.22	0.29	0.26
4.	Number of Competitor LKS	0.05	0.08	0.14	0.11	0.1	0.12	0.1	0.13
5.	Economic Potential	0.12	0.25	0.08	0.11	0.13	0.14	0.1	0.14
	a. Local Market Potential	0.43	0.41	0.43	0.43	0.33	0.43	0.43	0.43
	b. Local Community Income	0.44	0.43	0.43	0.44	0.63	0.43	0.43	0.47
	c. Neighborhood Population Density	0.13	0.11	0.11	0.13	0.33	0.11	0.13	0.11
6.	Crime Rate	0.07	0.06	0.06	0.09	0.06	0.04	0.06	0.09

Table 2. Average Weight of Each Respondent for Main Criteria and Sub Criteria

No.	Criteria	Average Weight	Ranking	CR
1	Infrastructure	0.199	3	0.017
	a. Ease of Access Location	0.423		0.022
	b. Proximity to Public Facilities	0.233		0.033
	c. Availability of electricity and internet	0.122		0.033
	d. Level of Availability of Clean Water	0.165		0.022
2	Geographic Location	0.279	1	
	a. Location Area	0.854		0
	b. Parking Area	0.318		0
3.	Investment Cost	0.243	2	0.017
4	Number of Competitor LKS	0.106	5	0.017
5.	Economic Potential	0.114	4	0.017
	a. Local Market Potential	0.444		0.011
	b. Local Community Income	0.422		0.011
	c. Neighborhood Population Density	0.134		0.011
6.	Crime Rate	0.062	6	0.017

Table 3. Average Weight and CR Outlet Location Selection Criteria

Alternatives	Ease of Access Location	Proximity to Public Facilities	Availability of electricity and internet	Level of Availability of Clean Water	Location Area	Parking Area	Investment Cost	Number of Competitor LKS	Local Market Potential	Local Community Income	Neighborhood Population Density	Crime Rate
LKS PANDEGLANG	0.267	0.496	0.331	0.228	0.438	0.377	0.466	0.388	0.482	0.234	0.321	0.398
LKS CBD	0.580	0.345	0.581	0.318	0.525	0.411	0.302	0.358	0.372	0.514	0.451	0.362
LKS 3	0.153	0.159	0.217	0.454	0.234	0.211	0.233	0.256	0.147	0.252	0.228	0.240
Total	1	1	1	1	1	1	1	1	1	1	1	1
CI	0.053	0.016	0.032	0.014	0.007	0.002	0.045	0.001	0.001	0.001	0.001	0.001
CR	0.06	0.027	0.054	0.017	0.012	0.004	0.078	0.013	0.001	0.001	0.002	0.002

Table 4. Rating and Consistency Ratio of Alternative Locations

Criteria	Average Score	Average Weight	Total Score
Level of Access Location			
DIPONEGORO	0.597	0.083	0.049
KFC-UIN	0.180	0.082	0.023
GKR	0.124	0.083	0.010
Proximity to Public Facilities			
DIPONEGORO	0.466	0.056	0.026
KFC-UIN	0.345	0.056	0.019
GKR	0.189	0.056	0.010
Availability of electricity and Internet			
DIPONEGORO	0.601	0.021	0.012
KFC-UIN	0.181	0.024	0.003
GKR	0.217	0.021	0.004
Level of Availability of Clean Water			
DIPONEGORO	0.526	0.033	0.017
KFC-UIN	0.348	0.032	0.010
GKR	0.154	0.032	0.005
Location Area			
DIPONEGORO	0.138	0.191	0.026
KFC-UIN	0.329	0.191	0.063
GKR	0.231	0.191	0.044
Parking Area			
DIPONEGORO	0.377	0.088	0.033
KFC-UIN	0.441	0.088	0.039
GKR	0.211	0.088	0.019
Investment Cost			
DIPONEGORO	0.166	0.249	0.041
KFC-UIN	0.502	0.242	0.074
GKR	0.333	0.249	0.057
Number of Competitor UKS			
DIPONEGORO	0.556	0.106	0.047
KFC-UIN	0.358	0.100	0.038
GKR	0.156	0.106	0.027
Local Market Potential			
DIPONEGORO	0.480	0.051	0.025
KFC-UIN	0.372	0.051	0.019
GKR	0.148	0.051	0.007
Local Community Income			
DIPONEGORO	0.254	0.048	0.012
KFC-UIN	0.517	0.048	0.025
GKR	0.232	0.048	0.011
Neighborhood Population Density			
DIPONEGORO	0.331	0.015	0.005
KFC-UIN	0.451	0.015	0.007
GKR	0.218	0.015	0.003
Crime Rate			
DIPONEGORO	0.338	0.012	0.004
KFC-UIN	0.351	0.012	0.004
GKR	0.310	0.012	0.015

Table 5. Alternative Final Value on Each Site Selection Criteria

Alternatif	Score	Rate
DIPONEGORO	0.444	1
KFC-UIN	0.343	2
GKR	0.213	3

Table 6. Final Value and Rating of Alternative Locations Using the AHP Method

5. CONCLUSION

1. The criteria used in selecting BSI KCU Yogyakarta Kusumanegara outlet locations include 6 main criteria, namely infrastructure, geographical location, investment costs, number of competing Islamic financial institutions, economic potential, and crime rate. There are 4 sub-criteria for supporting infrastructure, namely easy access to locations, proximity to public facilities, availability of electricity and internet networks, and level of availability of clean water. There are also 2 sub-criteria for geographic location related to the size of the location and parking area and then 3 sub-criteria for economic growth, namely the potential of the surrounding market, the income of the people around the location, and the population density around the location.
2. The order of the most important criteria in selecting the location for the BSI KCU Yogyakarta Kusumanegara outlet, namely according to the AHP method starts from the criteria of geographical location (location area, area of parking space), investment costs, infrastructure facilities (ease of location access, proximity to public facilities, level of water availability cleanliness, availability of electricity and internet), economic potential (potential of the surrounding market, income of the surrounding community, the density of the surrounding population), number of competing LKS, and crime rate.
3. Based on the analysis carried out in this study, the use of the AHP method regarding the location selection for BSI KCU Yogyakarta Kusumanegara outlets resulted in a sequence of locations starting from the Jalan Diponegoro Building, the KFC-UIN Sunan Kalijaga Building, and the People's Sovereignty Building (GKR) Jalan P. Mangkubumi.

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11th February 2023

MOTiP 06

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