SIMT ITS

PROCEEDINGS

FEBRUARY 5th, 2022

MOTIP 04

THE 4TH INTERNATIONAL CONFERENCE ON MANAGEMENT OF TECHNOLOGY, INNOVATION AND PROJECT

"How Covid-19 has Transformed Businesses?"

INTERDISCIPLINARY SCHOOL
OF MANAGEMENT AND TECHNOLOGY
INSTITUT TEKNOLOGI SEPULUH NOPEMBER

Program Book

International Conference on Management of Technology, Innovation, and Project (MOTIP) 2022

"How Covid-19 has Transformed Businesses?"

Editors:
R. Haryo Dwito Armono
Gita Widi Bhawika
Agus Santoso

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International Conference on Management of Technology, Innovation, and Project (MOTIP) 2022
"How Covid-19 has Transformed Businesses?"

February 5th, 2022
Surabaya, Indonesia

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

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- Ratna Sari Dewi
- A.A.B. Dinariyana Dwi Putranta
- Retno Aulia Vinarti
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- Dewanti Anggrahini
- Deqi Rizkivia Radita
- Dhimas Widhi Handani
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CONTENT

AGENDA

The conference will be held online on February 5th, 2022 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://linkr.bio/motip2022

Time (GMT+7)	Agenda
08.35-09.00	**Opening** *(Link Zoom https://bit.ly/openingmotip4)* Welcome Speech from Chair of MOTIP 04, R. Haryo Dwito Armono ST., M.Eng., Ph.D. Opening Speech from Dean of SIMT ITS, Prof. I Nyoman Pujawan, Ph.D, CSCP
09.00-09.50	**Keynote Speech** **"How COVID-19 has Transformed The Business?"** **Speaker: Associate Prof. Ammar Aamer, Ph.D, PMP, Northeastern University, Toronto, Canada** **Moderator: Reny Nadlifatin, S.Kom., MBA., Ph.D**
09.50-10.00	Break
10.00-11.45	**Parallel Sessions 1 (Room : A, B, C, D, E, F, G, H)** 10.00-10.15: 1st Presenter 10.15-10.30: 2nd Presenter 10.30-10.45: 3rd Presenter 10.45-11.00: 4th Presenter 11.00-11.15: 5th Presenter 11.15-11.30: 6th Presenter 11.30-11.45: 7th Presenter
11.45-12.45	Lunch Break
12.45-14.45	**Parallel Sessions 2 (Room : I, J, K, L, M, N, O, P)** 12.45-13.00: 1st Presenter 13.00-13.15: 2nd Presenter 13.15-13.30: 3rd Presenter 13.30-13.45: 4th Presenter 13.45-14.00: 5th Presenter 14.00-14.15: 6th Presenter 14.15-14.30: 7th Presenter 14.30-14.45: 8th Presenter
14.45-14.50	Break
14.50-15.20	**Closing Ceremony and Best Papers Announcement** *(Link Zoom https://bit.ly/closingmotip4)* Closing from Chair of MOTIP 04, R. Haryo Dwito Armono ST., 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. 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://linkr.bio/motip2022)
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://bit.ly/attendees_MOTIP04)
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 here.
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.

IMPORTANT LINKS

OPENING SESSION:
https://zoom.us/j/93144787698?pwd=Vk04TFBMKzRYRW5CanVMVlZ2ZHNOUT09

CLOSING SESSION:
https://zoom.us/j/9366872426

Room Name	Zoom Link
MOTIP 04 ROOM A	https://bit.ly/MOTIP04_RoomA
MOTIP 04 ROOM B	https://bit.ly/MOTIP04_RoomB
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MOTIP 04 ROOM G	https://bit.ly/MOTIP04_RoomG
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MOTIP 04 ROOM I	https://bit.ly/MOTIP04_RoomI
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MOTIP 04 ROOM M	https://bit.ly/MOTIP04_RoomM
MOTIP 04 ROOM N	https://bit.ly/MOTIP04_RoomN
MOTIP 04 ROOM O	https://bit.ly/MOTIP04_RoomO
MOTIP 04 ROOM P	https://bit.ly/MOTIP04_RoomP

SESSION 1

Room A

Topic : Industrial Management
Chair : Ratna Sari Dewi S.T, M.T, Ph.D
Assistant : Sri Wahyuni
Link Zoom : https://bit.ly/MOTIP04_RoomA

No	Time	ID Paper	Author	Affiliation	Title
1	10.00-10.15	1	Judis P. Utama, Nurhadi Siswanto	ITS	THE MULTI-CRITERIA INVENTORI MODEL OF AIRCRAFT ROTABLE SPARE PART INITIAL PROVISIONING
2	10.15-10.30	4	Irawan Hutama Putra and Tatang Akhmad Taufik	ITS	OPTIMIZATION OF AIRCRAFT MAINTENANCE MATERIAL DISTRIBUTION
3	10.30-10.45	7	Catur Prihantono Condro Saputro, Ervina Ahyudanari	ITS	SUPPLY CHAIN RISK ANALYSIS IN PT. BMI USING THE HOUSE OF RISK METHOD TO DETERMINE THE HIGHEST RISK MITIGATION
4	10.45-11.00	28	Fariszal Adhitya Mirza Putra and Niniet Indah Arvitrida	ITS	TRANSPORTATION FLEET SOURCING STRATEGY FOR A THIRD-PARTY LOGISTICS SERVICE PROVIDER USING A SIMULATION APPROACH
5	11.00-11.15	32	Mahar Bachtiar Hidayat and Ervina Ahyundanari	ITS	DESIGN OF OPERATIONAL RISK MANAGEMENT ON AIRCRAFT PROLONGED MAINTENANCE USING HOUSE OF RISK METHOD
6	11.15-11.30	34	Oki Agung Setiyanto and Niniet Indah Arvitridia	ITS	AIRCRAFT ALLOTMENT SPARE (WHEEL AND BRAKE) FULFILLMENT EVALUATION WITH A SIMULATION APPROACH
7	11.30-11.45	36	Fithro Rizki and Bambang Syairudin	ITS	PROJECT QUALITY IMPROVEMENT BY IMPLEMENTING THE LEAN CONSTRUCTION METHOD IN OFFSHORE GAS PIPELINE FREESPAN CORRECTION PROJECT AT PT XYZ

SESSION 1

Room B

Topic : Risk Management
Chair : Dr. A.A.B. Dinariyana Dwi Putranta
Assistant : Yusra Nusaibah Noor
Link Zoom : https://bit.ly/MOTIP04_RoomB

No	Time	ID Paper	Author	Affiliation	Title
1	10.00-10.15	2	Eka Anjang Pradana Dirgantara, Mohammad Arif Rohman	ITS	RISK ANALYSIS OF THE CONSTRUCTION DELAY IN TEMEF DAM PROJECT NUSA TENGGARA TIMUR
2	10.15-10.30	6	Traino Joko Priyono, Jerry Dwi Trijoyo Purnomo and I Putu Artama Wiguna	ITS	IMPROVEMENT THE EARNED VALUE MANAGEMENT RESULT USING ARTIFICIAL NEURAL NETWORKS IN EPC PROJECTS PT."R"
3	10.30-10.45	8	Novandita Rachmatullah, Ervina Ahyudanari	ITS	RISK ANALYSIS OF PROJECT REPLACEMENT TRANSFORMERS AND COS (CHANGE OVER SWITCH) TO PRODUCTION CONTINUITY USING HIRARC (HAZARD IDENTIFICATION, RISK ASSESSMENT AND RISK CONTROL) METHOD IN PT. XYZ
4	10.45-11.00	10	Mochammad Affandi , Farida Rachmawati	ITS	DELAY FACTORS IDENTIFICATION OF IMPLEMENTATION ASSET MANAGEMENT PROJECT USING FAULT TREE ANALYSIS
5	11.00-11.15	12	Ivan Sanjaya, Ketut Buda Artana	ITS	RISK ASSESSMENT OF DELAY FOR WHRU INSTALLATION PROJECT ON MAINTENANCE WINDOW SHUTDOWN AT CENTRAL PROCESSING GAS GUNDIH
6	11.15-11.30	17	Duto Nuswantoko, Tri Joko Wahyu Adi	ITS	OPERATIONAL RISK MANAGEMENT OF PT. PERTAMINA EP RANTAU FIELD POWER PLANT USING FAILURE MODE AND EFFECT ANALYSIS (FMEA)
7	11.30-11.45	19	Elfin Kurniawan	PT PLN	Study of Alternative Working Methods for Malalo Intake Trashrack Repair Singkarak Hydroelectric Power Plant

SESSION 1

Room C

Topic : Business Analytics
Chair : Retno Aulia Vinarti, S.Kom., MBA., Ph.D
Assistant : Widya Kusumawardhani
Link Zoom : https://bit.ly/MOTIP04_RoomC

No	Time	ID Paper	Author	Affiliation	Title
1	10.00-10.15	14	Muhammad Rizki Dzulkarnain and Jerry Dwi Trijoyo Purnomo	ITS	ONLINE TRAVEL AGENCY SERVICES OPTIMIZATION BASED ON CUSTOMER SENTIMENT ANALYSIS IN SOCIAL MEDIA USING MACHINE LEARNING METHOD
2	10.15-10.30	15	Josua Christanto and Jerry Dwi Trijoyo Purnomo	ITS	DESIGNING PREDICTION MODEL FOR FINDING POTENTIAL CHURN CUSTOMERS ON MORTGAGE USING MACHINE LEARNING
3	10.30-10.45	31	M Rahmat Akbar R	ITS	VARIABLE ANALYSIS OF DIGITAL CONTENT DESIGN TO MAXIMIZE DIGITAL MARKETING IN INCREASING BRAND AWARENESS IN B2B COMPANIES SURVEY SERVICES
4	10.45-11.00	57	Ngr Putu Raka Novandra Asta and Raden Venantius Hari Ginardi	ITS	DIGITAL MARKETING ANALYSIS OF TOURIST VILLAGES IN BANGLI REGENCY OF BALI PROVINCE
5	11.00-11.15	58	Ni Made Kartika Laksmi and Achmad Choiruddin	ITS	Risk Analysis of the Spread of Covid-19 in Surabaya Raya Using Cauchy Cluster Process
6	11.15-11.30	118	Syafrie Dwi Faisal and Bagus Jati Santoso	ITS	PREDICTION OF PRODUCT DEFECTS IN PRODUCTION LINES WITH RECURRENT NEURAL NETWORK(RNN) AND BAYESSIAN OPTIMIZATION APPROACH AS OPTIMIZATION MODELS: CASE STUDY OF PT XYZ
7	11.30-11.45	131	Raiza Ika Febriana and Suparno	ITS	SUPPLY CHAIN RISK MANAGEMENT USING ANP FMEA AND MACTOR METHOD

SESSION 1

Room D

Topic : Business Management
Chair : Gita Widi Bhawika S.ST.,M.MT
Assistant : Nurul Fadilah
Link Zoom : https://bit.ly/MOTIP04_RoomD

No	Time	ID Paper	Author	Affiliation	Title
1	10.00-10.15	11	Bagus Prasetyo Sarwono Putra and Bambang Syairudin	ITS	ANALYSIS OF WORKING CAPITAL MANAGEMENT: STUDY AT PT XYZ
2	10.15-10.30	24	Fariz Andriono and Erma Suryani	ITS	DESIGN OF COMPANY PERFORMANCE MANAGEMENT SYSTEM USING BUSINESS MODEL CANVAS, BALANCED SCORECARD, AND QUALITY FUNCTION DEPLOYMENT: CASE STUDY AT PT AGOS
3	10.30-10.45	43	Dedy Triono and Wahyu Wibowo	ITS	ANALYSIS OF COMMUNITY SATISFACTION MEASUREMENT INSTRUMENTS OF SERVICE UNIT USERS IN XYZ UNIVERSITY ENVIRONMENT
4	10.45-11.00	69	Rosi Nanda Amalia, Erma Suryani, Hari Ginardi and Mohamad Atok	ITS	STRATEGIC PLANNING OF KOPERASI AND MICRO BUSINESS SERVICES IN SURABAYA CITY TO DEVELOP A CULINARY TOURISM CENTER WITH FRED R DAVID STRATEGIC MANAJEMEN METHOD
5	11.00-11.15	70	Hilmi Aulawi, Ima Siti Komariah and Yusuf Mauluddin	ITS	KNOWLEDGE INFRASTRUCTURE DEVELOPMENT ANALYSIS TO INCREASE RESEARCH PRODUCTIVITY
6	11.15-11.30	71	Hilmi Aulawi, Usep Fahruroji and Dody Chandrahadinata	ITS	STRATEGIES TO MAINTAIN ARABICA COFFEE FARMING DURING THE COVID-19 PANDEMIC (CASE STUDY OF CINTA VILLAGE FOREST FARMER GROUP)
7	11.30-11.45	93	Ridas Mika and Christiono Utomo	ITS	REVIEW OF METHODS IN RESEARCH ON CUSTOMER SATISFACTION

SESSION 1

Room E

Topic : Business and Technology Innovation
Chair : Atikah Aghdhi Pratiwi, S.T., M.T.
Assistant : Erwina Adhyarini
Link Zoom : https://bit.ly/MOTIP04_RoomE

No	Time	ID Paper	Author	Affiliation	Title
1	10.00-10.15	5	Nur Hadian and Tony Dwi Susanto	ITS	Smart village-based sustainable village development: A Systematic Literature Review
2	10.15-10.30	29	Andri Setiawan and Agus Windharto	ITS	PROCESS of DESIGN RESEARCH & DEVELOPMENT as BUSINESS ACTIVITY at CREATIVE CENTER STP ITS
3	10.30-10.45	59	Wungu Shofrina Wijaya Putri and Tatang Akhmad Taufik	ITS	ANALYSIS OF INFORMATION SYSTEMS DEVELOPMENT STRATEGY PLAN FOR RESEARCH ASSISTANCE – ITS DIRECTORATE OF INNOVATION AND SCIENCE TECHNO PARK
4	10.45-11.00	61	Nuke Yulnida Aden Faradhillah and Tatang Akhmad Taufik	ITS	ANALYSIS OF BUSINESS MODEL CANVAS IN DEFINING MANAGEMENT STRATEGY AT DIRECTORATE OF INNOVATION AND SCIENCE TECHNOLOGY ITS
5	11.00-11.15	83	Ahmad Cahyono Adi, Dyan Puji Lestari, Elsa Elsa and Fiqrudina Sain Saputri	Universitas Tanjungpura	Analysis of the Potential of Microservices Architecture for MSME Websites in Indonesia
6	11.15-11.30	102	Nidia Avisyah Putri, Angelicha Aminah Zairuni Ussu, Niniek Fajar Puspita, Jani Raharjo, Yoshua Senna Januar and Aufar Ilham Adianto	ITS	DESIGN THINKING FOR INNOVATION: DEVELOPMENT OF “BILL SPLITTING” FEATURE IN DIGITAL PAYMENT
7	11.30-11.45	107	Rabitha Ajeng Syahdryani and Christiono Utomo	ITS	COMPONENTS THAT INFLUENCE THE SUCCESS OF PROJECTS IN START-UP COMPANIES IN SURABAYA

SESSION 1

Room F

Topic : Information Technology Management
Chair : Hadziq Fabroyir, S.Kom., Ph.D.
Assistant : Titien Eriyanawati
Link Zoom : https://bit.ly/MOTIP04_RoomF

No	Time	ID Paper	Author	Affiliation	Title
1	10.00-10.15	30	Ratna Nuringtyas, Tony Dwi Susanto and Bambang Setiawan	ITS	Evaluation of Knowledge Management System based on Various Technology Adoption Factor - A Systematic Literature Review
2	10.15-10.30	39	Zainul Arifin, Jakfar Sadiq, M Burhanudidin Hasan and Lukky Prasetyo	ITS	Technology Readiness for Commercialization of PLTS Apung Cirata Using Meter Technology Readiness Level Approach
3	10.30-10.45	56	Garis Narendra Kurniaji and Mudjahidin Mudjahidin	ITS	Development Of Webqual 4.0 Model On E-Commerce Services To Increase User Satisfaction
4	10.45-11.00	62	Andhika Bhaskara Jaya	ITS	HUMANWARE COMPETENCE IMPROVEMENT STRATEGY WITH TECHNOMETRIC APPROACH IN PERUM AIRNAV CABANG SURABAYA
5	11.00-11.15	73	Burhanuddin Hanantyo and Bambang Setiawan	ITS	THE FACTOR AFFECTED M-SERVICES ADOPTION IN AIRPORTS
6	11.15-11.30	103	Maufthauddin Mustaqim and Raden Venantius Hari Ginardi	ITS	EVALUATION OF CUSTOMER SERVICES USING ITIL V3 AND ISO 9001:2015 ON PT POS INDONESIA
7	11.30-11.45	108	Moch Riza Ali Fikri	ITS	INFORMATION TECHNOLOGY GOVERNANCE AUDIT AT A REGIONAL GENARAL HOSPITAL OF SIDOARJO REGENCY WITH THE COBIT 2019 FRAMEWORK

SESSION 1

Room G

Topic : Risk Management
Chair : Dr. Emmy Pratiwi , S.T.
Assistant : Maulita Nahdiyah
Link Zoom : https://bit.ly/MOTIP04_RoomG

No	Time	ID Paper	Author	Affiliation	Title
1	10.00-10.15	13	Muhammad Abdul Azis and Vita Ratnasari	ITS	THE EFFECT OF FEELING SAFETY ON WORKER PERFORMANCE IN CONSTRUCTION SITES DURING THE COVID 19 PANDEMIC
2	10.15-10.30	21	Iqhbal As-Shiddieq	ITS	evaluation of waste materials in the Ciputra World Surabaya project phase III
3	10.30-10.45	26	Edy Suyanto and Ervina Ahyudanari	ITS	APPLICATION OF HOUSE OF RISK (HOR) MODEL FOR RISK MITIGATION OF MATERIAL PROCUREMENT IN LABUAN BAJO MULTIPURPOSE TERMINAL PROJECT
4	10.45-11.00	27	Riezqi Fajar	ITS	CUSTODY TRANSFER ANALYSIS IN THE IMPLEMENTATION OF GAS STATION DIGITIZATION USING FAILURE MODE EFFECT ANALYSIS (FMEA) AND FUZZY PRIORITIZATION IN PT PERTAMINA REGIONAL JATIMBALINUS
5	11.00-11.15	49	Muhammad Rio Karno Saputra and Mohammad Arif Rohman	ITS	RISK ANALYSIS AND MITIGATION IN THE PROJECT OF HIGH VOLTAGE AIR TRANSMISSION LINE (SUTT) AT PT PLN (PERSERO) UIP JBTB
6	11.15-11.30	66	Indradjaja Manopol	ITS	ANALYSIS OF OBSTACLE AND SUPPORTING FACTORS FOR THE SUCCESSFUL IMPLEMENTATION OF CONSTRUCTION SAFETY MANAGEMENT SYSTEM (CSMS) IN CONSTRUCTION PROJECTS
7	11.30-11.45	77	Heru Pribadi and I Nyoman Pujawan	ITS	IMPROVING ON-SHELF-AVAILABILITY (OSA) OF GROCERY PRODUCTS IN ONE OF THE FOOD RETAIL NETWORKS IN GREATER JAKARTA AREA

SESSION 1

Room H

Topic : Industrial Management
Chair : Gogor Arif Handiwibowo ST., M.MT.
Assistant : Wahyu Aditya Rahman
Link Zoom : https://bit.ly/MOTIP04_RoomH

No	Time	ID Paper	Author	Affiliation	Title
1	10.00-10.15	18	Dody Arief Aditya and Erma Suryani	ITS	IMPLEMENTATION OF THE AHP – TOPSIS METHOD TO DETERMINE BASE OIL MANAGEMENT STRATEGY AT PERTAMINA LUBRICANTS PRODUCTION UNIT GRESIK IN ORDER TO INCREASE PRODUCTION CAPACITY
2	10.15-10.30	20	Ahnan N. Fadlil and Jerry Dwi Trijoyo Purnomo	ITS	ANALYSIS OF COVID-19 PREDICTION AND GOVERNMENT POLICY USING THE SIR MODEL: A CASE STUDY OF COVID-19 IN DKI JAKARTA
3	10.30-10.45	48	Kuat Watini and Moses Laksono Singgih	ITS	SERVICE QUALITY ASSESSMENT PT. DISTRIBUTOR REAGENT: COMBINATION OF SERVICE QUALITY AND IMPORTANCE-PERFORMANCE ANALYSIS METHODS
4	10.45-11.00	84	Ary Satriyo Hutomo Sarwono Putra and Reny Nadlifatin	ITS	IDENTIFYING THE CRITICAL SUCCES FACTORS OF INDONESIA MEDICAL DEVICE DISTRIBUTOR COMPANY IN E-PURCHASING ERA WITH ANALYTIC HIERARCHY PROCESS APPROACH
5	11.00-11.15	104	Ratna Andini and Eko Budi Santoso	ITS	ROAD SERVICE ANALYSIS FROM THE USER'S PERSPECTIVE (CASE STUDY: JALAN RAYA JATI – CEMENGKALANG SIDOARJO)
6	11.15-11.30	128	Andina Primadini Isnainia and Bustanul Arifin Noer	ITS	Operation Peformance Measurement in Finished Good Warehouse of Coffee Production Company
7	11.30-11.45	129	Sheli Isni Prafitri and Suparno	ITS	STRATEGY ANALYSIS OF SERVICES FREIGHT FORWARDING PT LINTAS BANGSA INTERNATIONAL IN FACING THE COVID-19 PANDEMIC

SESSION 2

Room I

Topic : Industrial Management
Chair : Dewanti Anggrahini S.T., M.T
Assistant : Indriani Puspitasari
Link Zoom : https://bit.ly/MOTIP04_RoomI

No	Time	ID Paper	Author	Affiliation	Title
1	13.00-13.15	41	Eko Yudi Setiawan	ITS	RISK ANALYSIS DUE TO DELAY IN MEZZANINE INSTALLATION AT PT. XYZ COMPANY USING THE MONTE CARLO METHOD SIMULATION
2	13.15-13.30	45	Dhyda Ardi Setyawan and Niniet Indah Arvitrida	ITS	A SIMULATION STUDY OF IMPROVING LOADING PERFORMANCE OF LIQUID AMMONIA IN A FERTILIZER COMPANY IN INDONESIA
3	13.30-13.45	50	Suluh Panjiarya guna and Iwan Vanany	ITS	Optimization of Raw Materials Inventory by Implementing Time-Phased Order Point System (TPOP) to Reduce Inventory Cost in The Lubricant Industry
4	13.45-14.00	52	Nyoman Gde Budhi Mulyantika and Mohammad Arif Rohman	ITS	PRIORITIZING OF REPAIR WORKS IN PIPELINE AND GAS DISTRIBUTION FACILITY USING AHP-TOPSIS
5	14.00-14.15	53	M. Akmal Bariklana and Mokhamad Suef	ITS	ANALYSIS OF EFFECTIVENESS OF PRODUCTION MACHINES USING OVERALL EQUIPMENT EFFECTIVENESS APPROACH TO REDUCE SIX BIG LOSSES
6	14.15-14.30	94	Nur Uddin, Hendi Hermawan and Barry Samuel Sirait	Universitas Pembagunan Jaya	Optimal Route of City Logistics Transportation System Based on Genetics Algorithm
7	14.30-14.45	132	Emha Diambang Ramadhany and Mahendrawathi Er	ITS	SOCIO-TECHNICAL ANALYSIS OF SMALL RETAIL DIGITAL TRANSFORMATION IN INDONESIA

SESSION 2

Room J

Topic : Project Management
Chair : Deqi Rizkivia Radita, S.T., M.S
Assistant : Mizati Dewi Wasdiana
Link Zoom : https://bit.ly/MOTIP04_RoomJ

No	Time	ID Paper	Author	Affiliation	Title
1	12.45-13.00	23	Malik Abdul Aziz and Ervina Ahyudanari	ITS	PENENTUAN PRIORITAS PENANGANAN JALAN KABUPATEN DI KABUPATEN KEDIRI
2	13.00-13.15	25	Cantik Puji Rahayu	ITS	FUEL OIL REPLENISHMENT STRATEGY TO SUPPORT AN INCREASING SUPPLY POINT USING SCENARIO PLANNING METHOD: CASE STUDY OF PERTASHOP AT PT PERTAMINA JATIMBALINUS REGION
3	13.15-13.30	40	Mujahidin Prasetyo Utomo	ITS	PROJECT SCHEDULING OF THE FEED FACTORY EXTEND MACHINE TOWER DEVELOPMENT PROJECT
4	13.30-13.45	46	Choliq Aufar Nugraha	ITS	ALTERNATIVE ANALYSIS OF OPERATION FINANCING & MAINTENANCE OF SURAMADU BRIDGE
5	13.45-14.00	51	Dewi Kurniawati and M.Arif Rohman	ITS	ASSESSMENT OF ROCK & NON-METAL MINING SUSTAINABILITY IN EAST JAVA USING FUZZY COMPREHENSIVES ASSESSMENT METHOD
6	14.00-14.15	68	Teguh Triyanto and I Putu Artama Wiguna	ITS	COST OVERRUN ANALYSIS OF CHEMICAL TREATMENT PROJECTS IN OFFSHORE OIL AND GAS PRODUCTION FACILITIES
7	14.15-14.30	75	Bastya Pratama Putra and I Putu Artama Wiguna	ITS	FINANCIAL FEASIBILITY ANALYSIS OF PRECAST PLANT DEVELOPMENT FOR CIVIL SERVANT APARTMENT PROJECT IN NEW STATE CAPITAL

SESSION 2

Room K

Topic : Project Management
Chair : Dr. Dhimas Widhi Handani
Assistant : Ahmad Enggal Maossyara Link
Zoom : https://bit.ly/MOTIP04_RoomK

No	Time	ID Paper	Author	Affiliation	Title
1	12.45-13.00	44	Chairil Azmi	ITS	MAPPING THE MATURITY OF THE PROCUREMENT OF GOODS/SERVICES WORK UNIT (UKPBJ) CASE STUDY : UKPBJ REGION OF RIAU ISLANDS PROVINCE
2	13.00-13.15	86	Muhammad Syaifuddin Zuhdi and Indra Gunawan	ITS	Grey Relational Analysis for Optimization in Opening Boiler Outlet Valve at Additional Start of Combined Cycle Power Plants
3	13.15-13.30	95	Adi Hermawan	ITS	TARGET OFF BLOCK TIME (TOBT) PERFORMANCE MEASUREMENT STRATEGY THROUGH BALANCED SCORECARD APPROACH AT THE AIRPORT : LITERATURE REVIEW
4	13.30-13.45	100	Yashinta Dianis Lestari and Christiono Utomo	ITS	Systematic Literature Review : Influence of Lifestyle, Visual Comfort and Living Area with Interest to Buy Multifloor Housing
5	13.45-14.00	101	Nabilla Yogananda and Christiono Utomo	ITS	METHODOLOGY REVIEW IN LAND USE SELECTION: COMBINING HIGHEST AND BEST USE AND DECISION MAKING
6	14.00-14.15	125	Aldi Margadita Sugieanto	ITS	THE OPTIMUM LOCATION OF PUBLIC ELECTRIC VEHICLE CHARGING STATION DETERMINATION USING SPATIAL ANALYSIS METHOD
7	14.15-14.30	130	Supani Supani, Tri Joko Wahyu Adi, Priyo Suprobo and Farida Rahmawati	ITS	PROBABILISTIC PIT GROWTH PREDICTION MODEL ON CONCRETE BRIDGE GIRDER USING HIDDEN MARKOV MODEL

SESSION 2

Room L

Topic : Industrial Management
Chair : Rindi Kusumawardani, S.Si., M.Sc.
Assistant : Indriyanti Nirmalasari
Link Zoom : https://bit.ly/MOTIP04_RoomL

No	Time	ID Paper	Author	Affiliation	Title
1	12.45-13.00	63	Iwan Vanany and Ekky Anastasia Pramita	ITS	EVALUATION OF LOCATION DECISION OF OPTIMAL TRUCK PARKING WITH INTEGER LINEAR PROGRAMMING: A CASE STUDY OF TRUCKING COMPANIES
2	13.00-13.15	78	Nugky Dyah Prastuti and Ahmad Rusdiansyah	ITS	THE EQUALIZATION DISTRIBUTION OF COVID-19 VACCINE WITH USING THE MAXIMUM COVERING LOCATION PROBLEM MODEL
3	13.15-13.30	80	Yanuar Triani, Udisubakti Ciptomulyono and Achmad Choiruddin	ITS	Household Natural Gas Demand Prediction In Surabaya Using Decision Tree Model
4	13.30-13.45	81	R. Adi Nugroho	ITS	RISK MITIGATION IN THE PROCUREMENT UNIT AT FERTILIZER COMPANY USING HOUSE OF RISK (HOR) METHOD
5	13.45-14.00	82	Saefudin Adi and Bustanul Noer	ITS	DESIGN SPREADSHEET BASED SUPPLIER SELECTION SYSTEM USING AHP & TOPSIS METHODS
6	14.00-14.15	92	Winsya H. Suryawan and Budi Rahardjo	ITS	Decision Analysis to Select New Branch Location for a Conveyor Belt Company by using Value Focus Thinking and Analytical Hierarchy Process
7	14.15-14.30	106	Hikmah Sekarningtyas and Ahmad Rusdiansyah	ITS	Development of Model Inventory Routing Problem for Blood Distribution Considering by Blood Life Factor

SESSION 2

Room M

Topic : Business and Technology Innovation
Chair : Jerry Dwi Trijoyo Purnomo S.Si, M.Si., Ph.D
Assistant : Maulita Nahdiyah
Link Zoom : https://bit.ly/MOTIP04_RoomM

No	Time	ID Paper	Author	Affiliation	Title
1	12.45-13.00	16	Citra Judith Lupitadevi and Jerry Dwi Trijoyo Purnowo	ITS	Designing Prediction Model and Business Model for Vehicles Financing Based on Data mining
2	13.00-13.15	33	Fathur Rahman	ITS	Implementation of Database Marketing For Maintain Spareparts Sales: Study in PT. YAMAHA INDONESIA MOTOR MFG.
3	13.15-13.30	37	Dimas Prabowo Rizkillah	ITS	THE ROLE OF ERM AND SRM RESPONDING TO THE RISK OF THE COVID-19 PANDEMIC IN PT. XYZ
4	13.30-13.45	60	Aditya Putra Prasetyo and Tatang Akhmad Taufik	ITS	INVESTMENT ANALYSIS OF ENTERPRISE DATA WAREHOUSE IMPLEMENTATION WITH IT BALANCED SCORECARD AND INFORMATION ECONOMICS
5	13.45-14.00	67	Fella Diandra Chrisandy and Tatang Akhmad Taufik	ITS	Business Model Innovation Formulation of XYZ Geprek Chicken Restaurant
6	14.00-14.15	74	Syaeful Ismar and Tatang Akhmad Taufik	ITS	FORMULATION OF FOOD AND BEVERAGE SECTOR BUSINESS STRATEGIES AT CV ABC
7	14.15-14.30	85	Sandy Risda Pratama and Reny Nadlifatin	ITS	Feasibility Study Of Rice Husk Pellets As Biomass Energy Based On Cost-Benefit Aspects
8	14.30-14.45	90	Ayu Wahyuni and Dominggo Baskara	ITS	ANALYSIS OF THE EFFECT OF VARIABLE PERCEIVED VALUE AND PERCEIVED RISK ON ADOPTION TECHNOLOGY BIG DATA ON MSMEs

SESSION 2

Room N

Topic : Industrial Management
Chair : Anny Maryani, S.T., M.T Assistant
: Widya Kusumawardhani
Link Zoom : https://bit.ly/MOTIP04_RoomN

No	Time	ID Paper	Author	Affiliation	Title
1	12.45-13.00	38	Widia Yuliati Puspaningrum	ITS	OPTIMIZATION MULTI-PRODUK MULTI-BAYS FOR FUELING PROCESS USING MIXED INTEGER LINEAR PROGRAMMING (STUDY CASE: A FUEL TERMINAL)
2	13.00-13.15	105	Dyah Palupi Anugrahing Hapsari and I. Nyoman Pujawan	ITS	THE DEVELOPMENT OF PREDICTIVE MODEL FOR MUNICIPAL SOLID WASTE IN MALANG CITY USING BAYESIAN NETWORK AND HOLT'S
3	13.15-13.30	109	Afrigh Fajar Rosyidiin and Moses Laksono Singgih	ITS	HAZARD IDENTIFICATION AND RISK CONTROL IN ROTARY KILN WITHIN THE CEMENT MANUFACTURING COMPANY
4	13.30-13.45	110	Andie Kusuma Sakty, Mokh Suef and Adithya Sudiarno	ITS	PORT SERVICE QUALITY FOR FERRY TRANSPORTATION IN PACIRAN LAMONGAN SEAPORT BY SERVQUAL AND KANSEI ENGINEERING APPROACH
5	13.45-14.00	112	Muhammad Iqbal Prathama Arindo and Iwan Vanany	ITS	FORECASTING MODELS FOR COVID-19 CASES IN INDONESIA
6	14.00-14.15	113	Muhammad Wisda Nugroho and Bagus Jati Santoso	ITS	AHP-Based Spare Parts' Criticality Assesment and Prioritization for Machine Availability and Reliability: Case Study at PT Solusi Bangun Indonesia Tbk
7	14.15-14.30	117	Gunadi Febry Sandy and Imam Baihaqi	ITS	Supplier Relationship Management Maturity Level Assesment: Case Study PT PJB Unit Pembangkitan Gresik
8	14.30-14.45	91	Tjatur Prasetyo and Tatang Akhmad Taufik	ITS	FORMULATION OF MARITIME SATELLITE TELECOMMUNICATIONS STRATEGY USING THE DELPHI TECHNIQUES AND ANP

SESSION 2

Room O

Topic : Marketing and Human Resource Management
Chair : Andre Parvian Aristio, S.Kom, M.Sc
Assistant : M. Kamil Hari Mulya
Link Zoom : https://bit.ly/MOTIP04_RoomO

No	Time	ID Paper	Author	Affiliation	Title
1	12.45-13.00	9	Elly Rahmad and Reny Nadlifatin	ITS	CORRELATION ANALITYC BETWEEN CSR AND DSIW IN PT PEMBANGKITAN JAWA BALI
2	13.00-13.15	22	Adelia Valentin and Reny Nadlifatin	ITS	ANALYSIS ON FACTORS INFLUENCE EMPLOYEE LOYALITY IN PT XYZ
3	13.15-13.30	47	Claudio Iroth	ITS	ANALYZING THE INFLUENCE OF LEADERSHIP STYLE ON EMPLOYEE PERFORMANCE AND JOB SATISFACTION AT PT PLN (PERSERO) UIW SULUTTENGGO
4	13.30-13.45	55	R. Muhammad Fahmidin and Reny Nadlifatin	ITS	INFLUENCE OF INSTAGRAM INFLUENCER'S CREDIBILITY AND ATTRACTION ON SKINCARE INDUSTRY SOCIAL MEDIA MARKETING
5	13.45-14.00	79	Iqbal Hakim	ITS	FACTORS AFFECTING CONSUMER BUYING INTEREST IN INTERIOR DESIGN SERVICES
6	14.00-14.15	114	Ruli Ayu and Reny Nadlifatin	ITS	Analyzing Factors that Influence Home Buying of Millenials Generation
7	14.15-14.30	115	Benedictus Bramantya Hendralaksono and Reny Nadlifatin	ITS	THE EFFECT OF VISUAL COMPLEXITY AND CONTEXTUAL RELEVANCE ON WEB ATTRACTIVENESS, TRUST, AND ONLINE PURCHASE INTENTION ON COMPANY WEBSITES

SESSION 2

Room P

Topic : Marketing and Human Resource Management
Chair : Satria Fadil Persada, S.Kom., MBA., Ph.D
Assistant : Nurul Fadilah
Link Zoom : https://bit.ly/MOTIP04_RoomP

No	Time	ID Paper	Author	Affiliation	Title
1	12.45-13.00	35	Fajar Dwi Kuncoro and Teuku Yuri M. Zagloel	ITS	IMPROVING SERVICE QUALITY IN HOTEL WITHOUT BUNGALOW TO INCREASE OCCUPANCY RATES DURING THE COVID-19 PANDEMIC
2	13.00-13.15	54	Graccia E. Wijaya and Moses L. Singgih	ITS	Quality Improvement of Corrugating Medium Paper Using Six Sigma in Paper Manufacturing Company
3	13.15-13.30	64	Ziana Ziana, Azmeri Azmeri, Alfiansyah Yulianur and Ella Meilianda	Universitas Syiah Kuala	SUSTAINABLE MANAGEMENT OF RIVER BASIN: A CASE STUDY OF FLOOD INUNDATION MAPPING
4	13.30-13.45	89	Nela Rachmawati and Bustanul Arifin Noer	ITS	DETERMINING FACTORS OF CONSUMER PURCHASE INTENTION ON THE MARKETPLACE PLATFORM IN THE COVID-19 PANDEMIC PERIOD: A CASE STUDY OF FROZEN FOOD PRODUCTS
5	13.45-14.00	98	Fathiyah Rifqul Ulya and Erma Suryani	ITS	Technology Acceptance Model of Using Biometric Technology With Taspen Otentikasi Using Modified UTAUT2 Method
6	14.00-14.15	99	Rosnia Robi and Christiono Utomo	ITS	A Literature Review of Methods in Research on Highest and Best Use Analysis
7	14.15-14.30	124	Prima Edy Setiawan	ITS	OPTIMIZATION OF THE UTILIZATION OF WIDE BODY AIRCRAFT HANGAR BASE MAINTENANCE SLOTS USING THE INTEGER METHOD

KEYNOTE SPEAKER

BUSINESS TRANSFORMATION AND PROJECT MANAGEMENT AMIDST THE COVID-19 PANDEMIC

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Abstract : The project management discipline has witnessed exponential global growth and evolved based on several applications and best practices. Project management has also received significant attention amidst the global disruptions. Meanwhile, the Covid-19 global pandemic has affected business delivery models significantly. Organizations had to adopt new and innovative approaches to their product and services, searching for alternatives. In some cases, organizations had to re-design their value chain to survive the long-lasting global disruption. It is predicted that it will take years for industries to rebound back to the pre-pandemic era with a variant level at different industries.
Project management played a significant role in the transformation process of businesses due to the Covid-19 pandemic. Today's work environment is characterized by a "world of change" that requires innovative projects in the era of emerging technologies. Researchers predict that project management would "fit well" with the emerging technologies, yet we do not clearly understand how this relationship would work in light of the principles-based project management.
This talk will provide an overview of the impact Covid-19 has had on businesses and the role of project management. In addition, a brief overview of ongoing activities on emerging technologies and the principles-based project management in a project economy will be presented.

Keywords : Covid-19, Business, Project Management

THE MULTI-CRITERIA INVENTORI MODEL OF AIRCRAFT ROTABLE SPARE PART INITIAL PROVISIONING

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ABSTRACT

Initial provisioning is unavoidably important for the airline to be initialized during entry into service of their new aircraft type. A state-of-the-art spare part provisioning model guarantees the availability set of spare parts in priority at an efficient cost while adopting the agility of a computerized system. Rotable spare part is known to be the most valuable of aircraft spare part type, therefore airline must carefully select the prioritized rotable spare parts and assign the appropriate strategies to respond to the corresponding needs of spare parts. This research proposes an inventory model as a new way for the airline to better deal with rotable spare parts during the initial provisioning of a new aircraft type. The model is developed using a hybrid AHP-TOPSIS method through R programming. It runs the classification of rotable spare parts through a multi-criteria ABC analysis and produces five strategies in terms of procurement and repair. As the result, this model manages to deliver 80.33% item reduction, 80% volume reduction, and 38,34% of cost-saving in comparison to the aircraft manufacturer's spare part recommendation, at an incredibly short evaluation time.

Keywords: Analytic Hierarchy Process (AHP), Initial Provisioning, Inventory Model, Multi-Criteria Classification, Technique for Order Preferences by Similarity to The Ideal Solution (TOPSIS).

1. INTRODUCTION

Entry into service can be simply described as a project entitled to a new type of aircraft that is carried out by an airline when they are about to operate one, the project is typically initiated a year before the first aircraft delivery. Initial provisioning is a task among a series of the entry into service's agenda that needs to be done before the first aircraft delivery, the objective is to arrange the aircraft spare part readiness for the first year aircraft operation. The airline will receive a document called recommended spare part list (RSPL) from the aircraft manufacturer, the document details the amount of spare part to be procured at once before the aircraft enters its operational.

The RSPL consists of thousands of items that are categorized into three types of parts (expendable, repairable, and rotable) as per the SPEC2000 specification. Rotable parts are considered to be high-value items since they are low in the number of items but valuation is much higher compares to others. As an example, GIA A330neo's RSPL is composed of 64% expendable, 19% rotable, and 17% repairable items, while 87.4% of total RSPL's expenditure falls into the scope of rotable parts. It is very logical for the airline to put every effort to arrange an effective and yet efficient initial provisioning arrangement for aircraft rotable parts.

Potentially, thousands of items may be held in inventory for maintenance operations, but only a small portion of them deserve management's close attention and accurate control (Braglia et al., 2004). Among all manufacturer-recommended rotable spare parts in RSPL, some of them might be considered not so critical to the airline's operation based on the airline's profile. Therefore, analyzing RSPL data plays a major role to identify which parts to be focused on. It is critical to finalize the RSPL evaluation process to figure out the best response for the anticipated demand. Enhancing RSPL data with other supporting documents might advance the evaluation result. The RSPL evaluation process usually takes months and involves various parties of the airline's unit.

The multi-criteria analysis approaches enable complex problems to be coped with (i.e. in the microlevel analysis) by imposing a disciplined structure that directs attention to the criteria in proportion to the weight which they deserve (Antosz et al., 2019). Upon identifying priority parts, the criteria of spare part priority must be first defined. Once criteria are known, the weight of each criterion is to be found using AHP. The ranking of priority for each part can be arranged by applying TOPSIS into each spare part alternative in RSPL. The part that comes at the top of the list is considered as the most prioritized part, the part considered as less priority as it goes down.

The classification methodology should be able to define groups for which a stock management policy will be associated, classification is carried out to identify the necessity and importance of spare parts for maintenance and after that, a multi-criteria classification is used for defining the groups (Teixeira et al., 2017). The classification of the ranked part is done through multi-criteria ABC analysis. The strategies that cover the scope of procurement and repair will be assigned to classes A, B, and C based on the profile represented by each class.

This paper proposes to construct a computer-aided inventory model that is capable to prioritize the RSPL items then classifying them into three classes and providing recommendations in terms of procurement and repair. The developed computer-aided model will benefit the entry into service project team by shortening the months required to evaluate the RSPL into minutes. The model is developed based on the entry into service experience of GIA A330neo aircraft in 2019.

2. LITERATURE REVIEW

Bacchetti (2010) proposed a hierarchical multi-criteria spare parts classification method developed for inventory management purposes. The classification method is developed through an intensive case study of a European white goods manufacturer. The classification scheme is built based on several key dimensions in an almost hierarchical fashion, resulting in 12 different classes of spare parts. The results demonstrate the reduction of the total logistics costs by about 20% whilst the service target level is achieved for each of the classes.

IATA (2015) explored the relevant issues regarding inventory and offer recommendations and techniques for use both in airline and cargo flight operations that will optimize the airline inventory strategy. The scope of the study ranges from initial provisioning for a start-up operation, to evaluating and improving operations of an existing carrier. Following this guidance, the aviation inventory professional should be prepared to make decisions regarding inventory provisioning which leads to an optimal solution.

May (2017) evaluates existing inventory prioritization methods and compares them against WSS4, the method currently in use by the logistics unit of a large navy. The purpose of this study is to determine an effective classification approach for a large spare parts inventory management system by comparing some of the classification methods in the literature. Of all the explored ABC analysis methods, the multicriteria weighted non-linear optimization (WNO) technique was shown to be the best option for WSS's prioritization goals.

Nurchayo (2017) built a practice based on accurate multi-criteria classification of aircraft spare part inventory management using the AHP approach. Fifteen subcriteria are derived from three criteria and then processed using AHP. The result of this study is the weight of each criterion and subcriterion. This study has described the use of AHP as an effective method to develop multi-criteria classification on aircraft spare part inventory. However, this study hasn't demonstrated the implementation of multi-criteria classification on a real object.

Teixeira (2017) developed the classification of a spare part for integration in a computerized maintenance management system (CMMS) of a manufacturing company. The first classification is done through a simple combinations matrix to identify the necessity and importance of spare parts, then a multi-criteria classification is used to define the groups for which a stock management policy will be associated. The method developed might work for small numbers of items, but it will not be able to handle a large number of spare part alternatives.

Rauf (2018) utilized TOPSIS to provide a way to combine multiple criteria for inventory classification. An inventory item measured under different parameters ranks differently from parameter to parameter, the portion in each class is kept the same. For some cases assignment of weights can be difficult and takes more time. However, the use of multiple criteria ABC analysis can improve the quality and completeness of the inventory analysis. One of the limitations of this method is an assignment of weights to the criteria.

Antosz (2019) developed an empirical model (EM), using a case study of a manufacturing system (MS). The EM enables a criticality analysis to be performed, considering the system perspective of spare part management, by taking maintenance-related and logistics-related factors into account. The pieces of machinery are categorized into groups, considering the factors related to the maintenance, logistics, and criticality levels. The second part presents how to perform spare part prioritization within a selected group via an AHP. However, an analysis should also be made of costs or availability, which would show that the proposed methodology influences the effectiveness of spare part management.

3. METHODS

3.1. Aircraft Rotable Spare Part Initial Provisioning Multicriteria Inventory Model

The design of the model is first to be defined as it is shown in Figure 1 below. The model is built through R programming, it will receive a dataset as its input. The dataset is a .csv file composed of 1165 rows and 41 columns wide. The row represents each rotable spare part of RSPL while the column represents spare part characteristic information as described in Table 1. These pieces of information are extracted from RSPL and other supporting documents including minimum equipment list (MEL), component removal record, shop capability list, and pooling list.

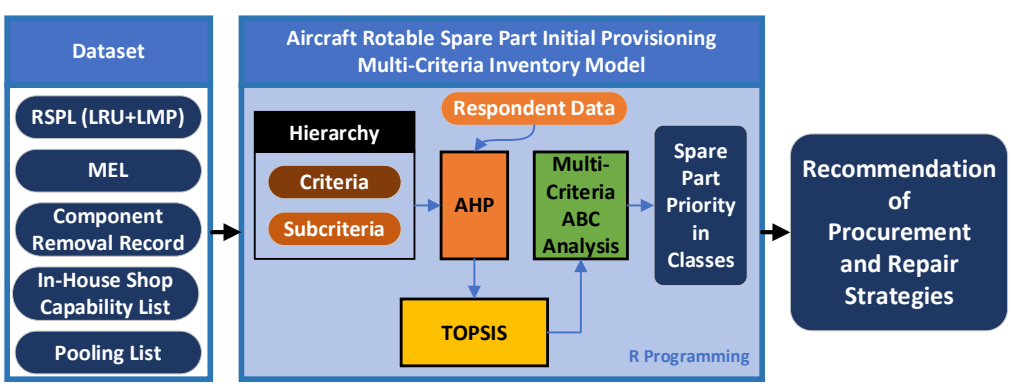

Figure 1. The Design of The Inventory Model

Table 1. Composition of Dataset

Spare Part Characteristic		
Part Number	Dispatch Category	MTBUR
Additional Descriptive Text	ETOPS Penalty	Removal Rate Indicator
Essentiality	Weather/Day/VMC Restriction	Unit Price
Existing Repair Scheme	Removal from Last 3 Years	Recommended Quantity
Mean Shop Processing Time	Reason for Selection	Scrap Rate
Quantity per Aircraft	Time Cycle Code	24 Aircraft MSN installed on

The model will process the dataset through a series of actions consisting of AHP, TOPSIS, multi-criteria ABC analysis. Rotable spare parts will be grouped into three classes, A, B, and C. Strategies of procurement and repair are developed based on the profile of each class, the associated strategy is then assigned to each rotable spare part recommended by RSPL.

3.2 Analytic Hierarchy Process (AHP)

The first step of AHP is to develop a hierarchical structure constructed from each factor that affects the spare part priority. These factors are based on characteristics that can be extracted from RSPL and other supporting documents, these factors are then constructed into hierarchical form as shown in Figure 2. Once the hierarchical structure is settled, the next step is to extract the weight of each criterion and subcriterion from the respondent's judgment. Six experts are selected covering the scope of engineering, operation control, component management, risk management, and finance, the pairwise comparison matrix of AHP is constructed based on their judgment as respondents.

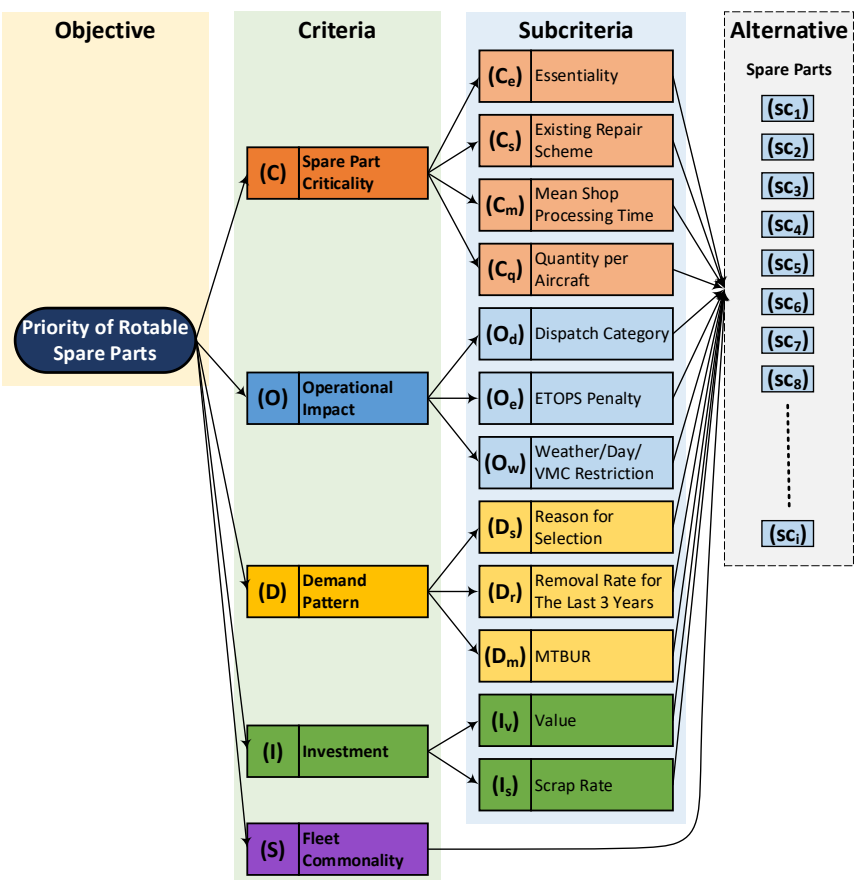

Figure 2. Hierarchical Structure of The Model

Table 2. Weight of Criteria

Criteria/ Subcriteria	Weight	
	Ind.	Cmp.
C	0.045	-
Ce	0.601	0.0269
Cs	0.115	0.0052
Cm	0.051	0.0023
Cq	0.233	0.0105
O	0.289	-
Od	0.759	0.2196
Oe	0.167	0.0483
Ow	0.074	0.0214
D	0.424	-
Ds	0.086	0.0365
Dr	0.699	0.2968
Dm	0.215	0.0911
I	0.129	-
Iv	0.875	0.1134
Is	0.125	0.0162
S	0.112	0.112

R computes the individual weight of each criterion and subcriterion through the combination of functions ahp.mat() and ahp.aggjudge(), the compounding weight is the multiplication product of criterion's weight and the associated subcriterion's weight below them. Both individual weight and compounding weight are shown in Table 2.

A valid pairwise comparison is measured through the value of consistency ratio (CR), CR value below 0.1 is considered to be valid. CR is computed through function ahp.cr() with the result of 0.04 for criteria level, 0.06 for subcriteria level of spare part criticality, 0.06 for subcriteria level of operational impact, 0.05 for subcriteria level of demand pattern, and 0 for subcriteria level of investment. This concludes that the constructed pairwise comparison is consistent.

3.3 Technique for Order Preferences by Similarity to The Ideal Solution (TOPSIS)

The first step of TOPSIS is to form a decision matrix. The data retrieved from the dataset is first run through a series of data preprocessing to remove missing values and quantify qualitative data into computable qualitative data. The decision matrix is 1165 rows and 13 columns, the columns are formed of 13 variables collected from the dataset as described in Table 3.

Table 3. Composition of Decision Matrix

Calculated from Dataset Element	
Fleet Commonality $= \frac{Number\ of\ Aircraft\ Installed}{Number\ of\ Aircraft\ in\ Fleet} \times 100\%$	
MTBUR $= MTBUR \times 10^{RRI} \times Hour\ Factor$	
Value $= Unit\ Price\ \times\ Recommended\ QTY$	
Removal Rate 3 Years $= \frac{Removal\ from\ Last\ 3\ Years}{3}$	
Grabbed from Dataset	
ETOPS Penalty	Skema *Repair* Eksisting
Weather Restriction	Mean Shop Processing Time
Reason for Selection	
Scrap Rate	Quantity per Aircraft
Essentiality	Dispatch Category

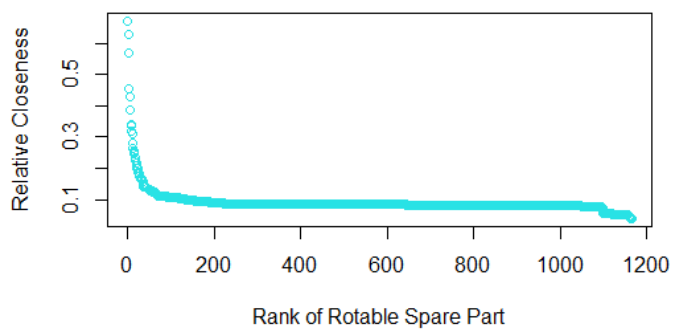

Figure 3. Descending Ranking of Relative Closeness

Once the decision matrix is formed, it is then normalized using the formula that follows, where $e'$is normalized decision matrix, g_i is the deterministic value of alternative i for criterion j.

$$e' = \left[\frac{g_j(a_i)}{\sqrt{\sum_{i=1}^{m}[g_i(a_i)]^2}}\right]$$

The compounding weight from AHP process is set to be the input weight for TOPSIS. The input weight is used to form a weighted normalized decision matrix by simply multiplying it with the correlated column of the normalized decision matrix.

The best and worst solution is now can be determined from the extreme values of the weighted normalized decision matrix, and then the Euclidean distance of each alternative is calculated using the following formula where s_i^+ is positive Euclidean distance, s_i^* is negative Euclidean distance, x^+ is the best solution, and x^* is the worst solution.

$$s_i^+ = \sqrt{\sum_{j=1}^{m}(e_{ij}^* - x_j^+)^2} \qquad s_i^* = \sqrt{\sum_{j=1}^{m}(e_{ij}^* - x_j^*)^2}$$

The relative closeness determines the spread of which alternative is closer to the ideal solution and which alternative is farther, the greater the relative closeness means the alternative is closer to the ideal solution. The relative closeness can be calculated by the following formula.

$$c_i = \frac{s_i^*}{(s_i^* + s_i^+)}$$

Once the relative closeness of each alternative is sorted and ranked, the spare part priority is concluded. The part at top of the list is the most in priority and as it goes down the priority gets less and lesser as shown in Figure 3.

4. RESULTS

4.1 Spare Part Classification

Classification of rotable spare parts is done through multi-criteria ABC analysis, but classical ABC analysis must be done first to figure out the capacity of each class. Based on the Pareto principle of the annual dollar usage, classical ABC analysis is done. It reveals that class A consists of 34 items, class B consists of 48 items, and class C consists of 1083 items.

Table 4. Result of Multi-Criteria ABC Analysis

Multi-Criteria ABC Analysis		Classical ABC Analysis			Annual Usage (USD)	Annual Usage (%)
Class	Number of Items	A	B	C		
A	34	7	-	27	5,865,258.62	40.44%
B	48	15	9	24	3,715,531.47	25.62%
C	1083	12	39	1032	4,923,471.26	33.94%

The class capacities discovered by classical ABC analysis are then applied to the product of TOPSIS that is the ranked rotable spare part. The first 34 items in the list must be class A, the next 48 items must be class B, and the rest of the items in the list become class C as shown in Table 4.

4.2 Procurement and Repair Strategies

The strategies of procurement and repair are developed based on the profile represented by each class. As shown in Figure 4 and Figure 5, class A represents parts with a relatively high score in demand pattern and medium score in operational impact, class B represents parts with a medium score in demand pattern and widespread score on operational impact, and at last class C represent parts with a relatively low score in both demand pattern and operational impact.

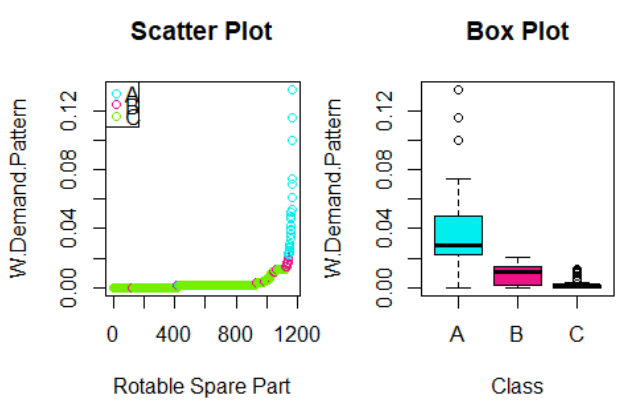

Figure 4. Weighted Normalized Demand Pattern

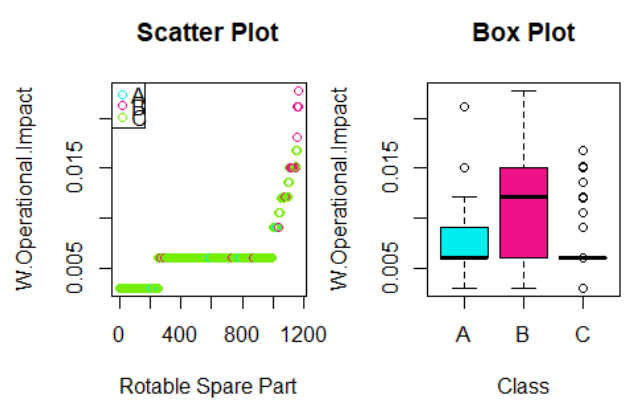

Figure 5. Weighted Normalized Operational Impact

Parts with a relatively high demand score (Class A) and greater operational impact (Class B – Immediately Required) deserve to have the parts available before the aircraft's operational period, this should be done through the purchase. Parts with a relatively low demand score and less operational impact involved (Class C and Class B – Not Immediately Required) are proposed to be procured on-demand basis. Table 5 shows the variation of strategies assigned to each class.

Table 5. The Proposed Strategy of Procurement and Repair

Class	Procurement	Repair	Recommendation
A	Stock will be procured before entering the aircraft's operational period.	Item is already included in pooling list or in-house shop capability list	**Strategy I** **Procurement:** • Purchase the item as recommended by RSPL. **Repair:** • Adding the new aircraft into the existing pooling contract or existing in-house repair contract. • Claim for warranty repair (as backup).
		Item is not in pooling list or in-house shop capability list	**Strategy II** **Procurement:** • Purchase the item as recommended by RSPL. **Repair:** • Developing in-house repair capability. • Sourcing for a new pooling provider. • Introduce the item into existing pooling existing. • Claim for warranty repair (as backup).
B	**Immediately Required:** Stock will be procured before entering the aircraft's operational period.	Item is already included in pooling list or in-house shop capability list	**Strategy I**
		Item is not in pooling list or in-house shop capability list	**Strategy III** **Procurement:** • Purchase the item as recommended by RSPL. **Repair:** • Claim for warranty repair.
	Not Immediately Required: Stock will be procured when the demand is initiated (on-demand).	Item is already included in pooling list or in-house shop capability list	**Strategy IV** **Procurement:** • Fulfilling the demand through robbing, borrow, or exchange. **Repair:** • Adding the new aircraft into the existing pooling contract or existing in-house repair contract. • Claim for warranty repair (as backup).
		Item is not in pooling list or in-house shop capability list	**Strategy V** **Procurement:** • Fulfilling the demand through robbing, borrow, or exchange. **Repair:** • Claim for warranty repair.
C	Stock will be procured when the demand is initiated (on-demand).	Repair is initiated once removal has been done (by case).	**Strategy V**

The proposed inventory model introduces a far better performance in comparison to the existing process being used by the airline, the improvements cover the scope of evaluation duration, evaluation method, and procurement cost. Table 6 shows the comparison of the proposed model versus the current situation.

Table 6. Performance Comparison between Existing Condition and Proposed Model

Subject	Current Process	Model
Evaluation Method	Formal Discussion	Computerized
Formulation		AHP, TOPSIS, ABC Multi-Criteria
Party Involved	5 Units	1 Person
Duration	5 Months	25 Seconds
Document	RSPL, MEL, Pooling List	RSPL, MEL, Removal Record, Shop Capability List, Pooling List
Number of Spare Part Item	1165 Item	1165 Item
Priority	-	√
Procurement Recommendation:	√	√
Number of Item •	244 Items	48 Items
Item Efficiency •	-	80.33 %
Volume •	300 Units	60 Units
Volume Efficiency •	0%	80%
Cost •	USD 14,504,261.35	USD 8,942,865.93
Cost Savings •	0%	38.34%
Repair Recommendation	-	Pooling Arrangement, In-House Repair, Warranty Repair
Operational Risk:	0%	13%
Dispatch Discrepancies •	0%	6%
ETOPS Degradation •	0%	5.33%
Weather Restriction •	0%	3%

6. CONCLUSIONS

The model manages to classify parts, this action is set to distinguish the treatment level between one group of parts with another. And thus, some parts that aren't significant based on the model might be given less concern. This set of actions is able to reduce the size of items to be procured by 80.33 % and the size of the volume to be procured by 80%.

By simulating the cost, the recommendation of the model proposes to focus the procurement for priority part with the total cost of USD 8,942,865.93, while the total cost of RSPL's recommendation is fixed on USD 14,504,261.35. This model will contribute a total cost saving of 38.34% to the airline's initial provisioning budget. The model is capable to cut off the 5 months evaluation time, and thanks to the computerized system, the new duration is set to 25 seconds.

Due to some parts that are managed on-demand basis, the operational risk rises by 13%. But this risk can be mitigated by preparing an adequate scenario of delay/cancelation management (i.e. aircraft change, readiness of secondary flight plan for non-ETOPS), and making sure that the source of on-demand parts is available and reachable at the nearest range as possible.

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RISK ANALYSIS OF THE CONSTRUCTION DELAY IN TEMEF DAM PROJECT NUSA TENGGARA TIMUR

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ABSTRACT

The implementation of dam construction there are usually many problems at the stages of work. Therefore, careful planning is needed so the project can run smoothly and finished on time. The Temef Dam Development Project Package 1 of NTT Province has an implementation time of 1560 calendar days. The purpose of this study is to analyze the risk of delays in the Temef Package 1 Dam construction project in NTT Province in the remaining time of its implementation, by identifying the root causes of the major/dominant risks. The method used in this study is to measure the probability (P) and impact (I) to obtain the dominant risk variable (major risk) and fault tree analysis (FTA) which is used to find the root cause of the dominant risk factor (major risk). Probability (P) is measured by how often the risk variable occurs, while impact (I) is measured based on the level of time constraints that occur. Data collection was carried out using a literature study approach, namely references to journals and similar research in the latest editions as well as field studies in the form of expert interviews and distributing questionnaired to stakeholders involved in the implementation of this project. Based the results of the risk analysis, there were 5 dominant risk variables, namely: unfinished land acquisition (R2), design changes (R9), material availability (backfill) volume requirement (R11), damage to work equipment and equipment (R18), and the influence of weather on the implementation work (R21). Literature review was also carried out to explore possible causes which were then carried out by expert interviews to develop a fault tree analysis (FTA). From FTA, obtained 60 basic events that caused dominant risk. Knowing the root cause of the dominant risk can be information/evaluation for all parties involved in the Package 1 Temef Dam Development Project (stakeholders) to be able to eliminate/minimize the risk.

Keywords: dam, root cause, dominant risk, fault tree analysis.

1. INTRODUCTION

The Temef Dam is located in the South Central Timor Regency, East Nusa Tenggara Province. The development process cannot be separated from problems that directly or indirectly affect the objectives of the activity. Therefore, risk management is needed to identify risks that have the potential to arise during the remaining time of dam construction. This is to obtain information about potential risks that arise and prevent early anticipation so the implementation of dam construction can be completed on time.

Given its complexity, the problems in the Temef Dam Project above are actually quite appropriate from a risk management perspective. This study proposes the concept of risk

management in solving this problem by applying fault tree analysis (FTA) to find the root cause of the dominant risk. It is important to provide better preventive measures to reduce losses due to the emergence of other problems in the work and ensure that construction can be completed on time. Based on the problems above, this study aims to present a more comprehensive method in exploring a cause and finding the core of the problem, so that it can produce an understanding and a complete picture of a problem, especially the risks in the Temef Dam construction project package 1.

2. LITERATURE REVIEW

Risk

Risk is the variation in things that may occur naturally in a situation (Fisk, 2006). There are 8 types of risk factors in construction projects, namely natural risk, design risk, resource risk, financial risk, legal and regulatory risk, political risk, legal and regulatory risk, and environmental risk.

Kerzner (2009) defined risk management as an action or practice related to risk. Among them are planning, risk identification, risk analysis, developing strategies to respond to risks, as well as monitoring and control to find out how these risks have changed. Risk management aims to increase the probability of a positive impact risk or opportunity and reduce the probability of a negative impact risk or threat (PMI, 2013).

In carrying out risk management, it is necessary to measure the risk. Measurements are carried out to determine risk priorities. Risk has 2 (two) main components in each risk event, namely the probability of a risk event occurring, and the consequences of the risk. In addition to assessing the amount of risk, it is important to analyze the risk of project delays to find the main root cause of the problem. Furthermore, the concept of Fault Tree Analysis (FTA) will be presented as a method to find the root cause of a risk.

Fault Tree Analysis (FTA)

A series of processes of occurrence of a risk can be analyzed using fault tree analysis (FTA). According to Kesuma (2019), there are several basic definitions that must be known in the discussion of FTA, including: (1) event is something that happens in the system, has two modes, namely it occurs or it does not; (2) fault event is an event where one of the two modes is an abnormal event, resulting in a failure or error; (3) normal event is an event which both modes are expected and tend to occur at a certain time; (4) basic event is an event in which both modes are expected and tend to occur at a certain time; (5) primary event is an event that is caused by a property within the component itself; (6) secondary event is event caused by external sources; (7) head event is the event at the top of the fault tree being analyzed, resulting in a failure.

According to Rosdianto (2017) Fault Tree analysis has important values in solving the following: (1) analyzing system failures; (2) look for aspects of the system involved in the main failure; (3) help the management know about changes in the system; (4) helps allocate the analyzer to concentrate on the failure part of the system; (5) helps provide qualitative, as well as quantitative, options for systems reliability analysis; (6) helps the analyzer use his knowledge to enter into the behavior of the system.

Research related to risk management

There have been several studies with the theme of controlling construction project delays in recent years, as did Bhavsar & Solanki (2020); Aftortu et al (2019); Kesuma (2019); Rifai (2018); Ramdhan (2017); Rosdianto (2017); Putra (2014); and Satria (2012). Based on previous research studied, there were still few studies that used risk management methods for dam construction projects. Aftortu et al (2019) conducted research on risk analysis of construction projects by taking a case study on the Way Sekampung dam package 2 using the failure mode and effect analysis and

domino methods . The purpose of this study was to identify and analyze the highest risk in the Way Sekampung Dam package 2 construction project. For the position of this research it self, the theme was risk analysis of delays in the Temef Dam package 1 construction project by using the fault tree analysis method. This method was used to analyze the root causes of the major risk that has the potential to occur and have a negative effect on the implementation of the Temef Dam package 1 construction project.

3. METHODS

Research Concept

In this study, a risk analysis of the Temef Dam Package 1 construction project was carried out by calculating the probability and impact factors of the risks that could potentially arise in the remaining time of the dam construction implementation. By knowing the probability and impact of the risk of dam construction implementation, several major risks are obtained. Fault tree analysis method is used to get the root cause of the major risk.

Research Data

Data collection in this study was divided into two types based on how to get it, namely primary and secondary data. Primary data collection in this study was carried out in two ways, namely through surveys using questionnaires and interviews. Secondary data included data such as books, journals or references, reports and others.

The sampling technique used was purposive sampling and snowball sampling. In this study, respondents took all stakeholders who were directly involved in the Temef Dam Package 1 construction project. The parties involved included: the government delegated to the Ministry of Public Works and Human Settlements, contractor, and supervisory consultant.

Risk Analysis

Risk analysis was carried out to determine the level of risk based on probability and impact. However, since the risk event assessments were from 10 respondents, there should be a method to combine the respondent assessments. The severity index (SI) method was used as a method to collect respondents' scores as stated in the following equation (Al Hammad, 2000).

$$SI = \frac{\sum_{i=0}^{4} ai.xi}{4\sum_{i=0}^{4} xi}(100\%)$$

Description:

ai : The weight given to i,

xi : Number of respondents who gave answers to i,

i : 0, 1, 2, 3, 4, .., n.

The probability value based on the respondent's assessment can be obtained using the severity index (SI). According to Kesuma (2019), SI values could be categorized as follows:
87.5% SI 100% categorized very often (SS)
62.5 % SI 87.5% categorized often (S)
37.5% SI 62.5% categorized as enough (C)
12.5% SI 37.5% categorized as rare (J)
0.00 % SI 12.5% categorized as very rare (SJ)

From the categorization above, it can be seen the probability value or the possibility of risk occurring. This value can be converted based on the probability and impact matrix which uses a Likert scale to distinguish the levels. The categories and probability values are presented in Table 1 below:

Table 1. Categories and Research Probability Values

Scoring scale	Description
Very rare	Very rare in dam projects with 0% probability P < 20%
Rare	Rarely occurs in dam projects with 20% probability P < 40%
Enough	Happens but not often in dam projects with 40% probability P < 60%
Often	Often occurs in dam projects with 60% probability P < 80%
Very often	Very often happens in dam projects with 80% probability P < 100%

Source: (Anwar, 2014)

Impact value based on respondent's assessment can be obtained using severity index (SI). According to Kesuma (2019), SI values could be categorized as follows:
87.5% SI 100% categorized as very big (SB)
62.5 % SI 87.5% categorized as big (B)
37.5% SI 62.5 % categorized as moderate (S)
12.5% SI 37.5% categorized as small (K)
0.00 % SI 12.5% categorized as very small (SK)

From the above categorization, it can be seen the value of the impact or risk impact . This value can be converted based on the probability and impact matrix which uses a Likert scale to distinguish the levels. The categories and impact values are presented in Table 2 below:

Table 2. Research Impact Categories and Values

Scoring scale	Description
Very small	Almost no effect on dam projects with possible delay I < 5 days
Small	Small impact on dam project with possible delay of 5 I < 10 days
Moderate	Influential in the dam project with a possible delay of 10 I < 20 days
Big	Great influence in dam projects with a possible delay of 20 I < 30 days
Very big	ery big influence in dam project with possible delay I 30 days

Source: (Anwar, 2014)

Risk events are sorted by level. To determine the level of risk, the Probability Impact Matrix is used as a guideline as presented in Figure 1 below (Komendantova, 2014). A series of processes of occurrence of a risk can be analyzed using FTA. The FTA diagram presents a graphic logical connection between a problem and its cause. Kabir (2017) mentioned that FTA was deductive in nature, where the analysis begins with a system failure or peak event and then works backwards from the top to the bottom as the root cause. Figure 2 below shows the levels in the structure of the FTA diagram (Ericson, 2005).

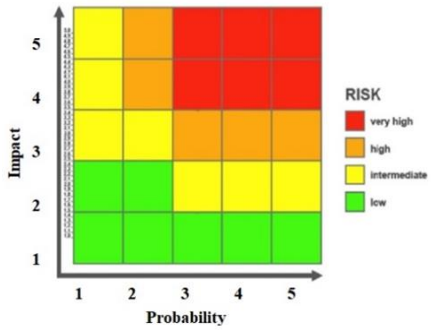

Figure 1. Probability Impact Matrix

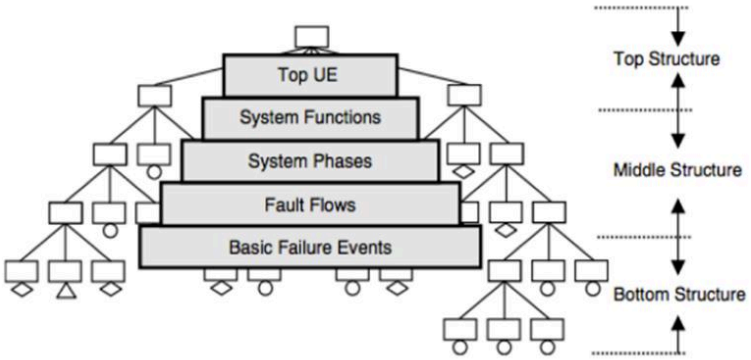

Figure 2. Levels in the FTA Diagram Structure

4. RESULTS

Preliminary Survey

This preliminary survey involved 4 (four) experts to provide an assessment of each variable through the interview process and filling out a questionnaire. This amount is considered sufficient to conduct a preliminary survey to determine the initial variables (Kesuma, 2019). The four experts who were successfully interviewed in the preliminary survey were the project manager who were carrying out the construction of a large dam construction project in Indonesia.

The preliminary survey was analyzed based on the expert's assessment of the relevance of the delay risk variable using a Semantic Scale from 1 (highly irrelevant) to 5 (very relevant). According to Rohman and Wiguna (2019) the value of 3.00 is the middle value of the value scale, so in this study the value of 3.00 means that a variable is included in the category quite relevant to the scope of research.

Table 3. Results of Survey Introduction

Delay Risk	Mean	SD	Description
Contractors have difficulty getting loans from financial institutions	4.75	0.50	Relevant
The acquisition of the work area has not been completed	4.75	0.50	Relevant
The project funding by the owner is not healthy	4.50	0.58	Relevant
Inappropriate allocation of payments to related parties	4.25	0.96	Relevant
Delay in material delivery from the supplier	4.25	0.96	Relevant
High rainfall in season	4.25	0.96	Relevant
There is a natural disaster	4.25	1.50	Relevant
Difficulty getting a work permit	4.00	0.82	Relevant
Image/design changes	4.00	0.82	Relevant
The accuracy of completing work items within a certain time duration	4.00	0.82	Relevant
Material availability	4.00	0.82	Relevant
Incompetent sub-contractor	4.00	0.82	Relevant
Low level of worker discipline	4.00	1.41	Relevant
Delay in solving design problems	3.75	1.26	Relevant
Inappropriate delegation of duties/authorities	3.75	0.50	Relevant
Poor coordination between departments	3.75	1.26	Relevant
Placement of Resources with uneven skills/skills	3.75	0.50	Relevant

Damage to work equipment and supplies	3.75	0.50	Relevant
Insufficient number of field workers	3.75	1.26	Relevant
Unskilled workforce	3.75	1.26	Relevant
The effect of weather on the execution of work	3.75	0.96	Relevant
Disputes regarding contract documents	3.50	1.29	Relevant
Poor job planning and scheduling	3.50	1.29	Relevant
Availability of work equipment	3.50	1.00	Relevant
Work accident	3.50	1.73	Relevant
Low labor productivity	3.50	1.29	Relevant
Inappropriate soil layer and topography of the work area	3.50	0.58	Relevant
Measurement data error	3.50	1.00	Relevant
The arrangement of the wrong working method	3.50	1.00	Relevant
Production monitoring and evaluation is not working	3.50	1.29	Relevant
Inappropriate pictures and details	3.25	0.96	Relevant
The volume of the material sent does not match the amount	3.25	0.96	Relevant
Working location conditions are difficult to reach	3.25	0.96	Relevant
Safety regulations/regulations are too high	3.00	0.82	Relevant
Improper project cost calculation	3.00	0.82	Relevant
Traffic and transportation at work	3.00	1.41	Relevant
Difficulty using new technology	3.00	0.82	Relevant
Noise and dust pollution in the workplace	3.00	0.82	Relevant
Job specifications are too high	2.75	1.50	Irrelevant
Employment-related government laws/regulations	2.75	1.50	Irrelevant
The project location got opposition from other agencies	2.75	1.50	Irrelevant
Unavailability of skilled engineers and project managers	2.75	1.26	Irrelevant
The storage space (warehouse) is not large enough	2.75	1.50	Irrelevant
Unfavorable political situation	2.75	1.26	Irrelevant
Limited/narrow work area	2.50	1.29	Irrelevant
Bad media coverage	2.50	1.00	Irrelevant
Air pollution. water. and land at work	2.50	0.58	Irrelevant
No material testing laboratory on site	2.25	1.26	Irrelevant
Differences in race/belief in the workplace	1.75	0.96	Irrelevant
Each employee's emotions are different	1.75	0.96	Irrelevant

Source: (Researcher Processed Data, 2021)

Main Survey and Risk Analysis

This stage uses a questionnaire survey technique in collecting data for risk analysis. Respondents involved here are parties directly involved in the construction of the Temef Dam package 1 construction project including the Ministry of Public Works and Human Settlements, contractor, and supervision consultant. The questionnaire was developed to assess the level or event risk is measured by the probability (P) and Impact (I) of the set ach research variables.

Based on Table 4, there are 5 (five) risks that have very high-risk value. The first is the acquisition of unfinished land (R2) with a risk value of 12. This R2 risk is considered very large in the implementation of the temef dam construction. Based on interviews with related parties, it was

stated that when the progress of the construction implementation reached 50% there was still land that had not been completed by the related parties.

Table 4. Risk Level Recapitulation

Delay Risk	Probability Value (P)	Mark Impact (I)	Risk Value (pxI)	Category
Contractors have difficulty getting loans from financial institutions	3	3	9	High
The acquisition of the work area has not been completed	4	4	16	**Very High**
Project funding by the owner is not healthy	3	3	9	High
Inappropriate allocation of payments to related parties	2	3	6	Intermediate
Delay in material delivery from the supplier	3	3	9	High
High rainfall in season	3	3	9	High
There is a natural disaster	3	3	9	High
Difficulty getting a work permit	2	3	6	Intermediate
Image/design changes	3	4	12	**Very High**
The accuracy of completing work items within a certain time duration	3	3	9	High
Material availability	4	4	16	**Very High**
Incompetent sub-contractor	2	3	6	Intermediate
Low level of worker discipline	2	2	4	Low
Delay in solving design problems	3	3	9	High
Inappropriate delegation of duties/authorities	2	3	6	Intermediate
Poor coordination between departments	2	3	6	Intermediate
Placement of Resources with uneven skills/skills	2	2	4	Low
Damage to work equipment and supplies	3	4	12	**Very High**
Insufficient number of field workers	2	2	4	Low
Unskilled workforce	2	2	4	Low
The effect of weather on the execution of work	3	4	12	**Very High**
Disputes regarding contract documents	2	2	4	Low
Poor job planning and scheduling	2	2	4	Low
Availability of work equipment	2	2	4	Low
Work accident	1	2	2	Low
Low labor productivity	2	2	4	Low
Inappropriate soil layer and topography of the work area	3	3	9	High
Measurement data error	2	2	4	Low
The arrangement of the wrong working method	2	2	4	Low
Production monitoring and evaluation is not working	2	2	4	Low
Inappropriate pictures and details	2	3	6	Intermediate
The volume of the material sent does not match the amount	2	2	4	Low
Working location conditions are difficult to reach	3	2	6	Intermediate
Safety regulations/regulations are too high	2	1	2	Low

Improper project cost calculation	2	2	4	Low
Traffic and transportation at work	2	2	4	Low
Difficulty using new technology	2	2	4	Low
Noise and dust pollution in the workplace	2	2	4	Low

Root Cause Analysis

For information related to the root cause of the fault tree in FTA method was developed to set ach risk events that hadvery high risk score based on the results of previous risk analysis. Meanwhile, several basic events were identified based on the literature and then compiled based on expert opinion through an interview process. This study used a qualitative approach based on expert judgment to determine an event that caused the peak event.

Three experts who were successfully interviewed to develop the FTA are project managers who have experience in handling large dam construction projects in Indonesia. Based on the results of the previous stages, five risk variables were considered important for root cause analysis, namely: R2, R9, R11, R18, and R21. The basic events are taken from several previous research literatures.

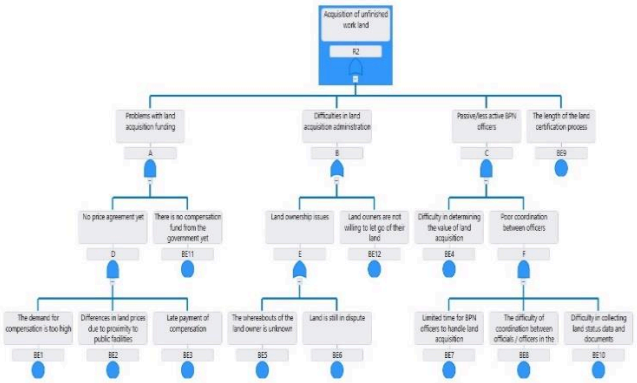

Figure 3. FTA #1 Risk Variable R2

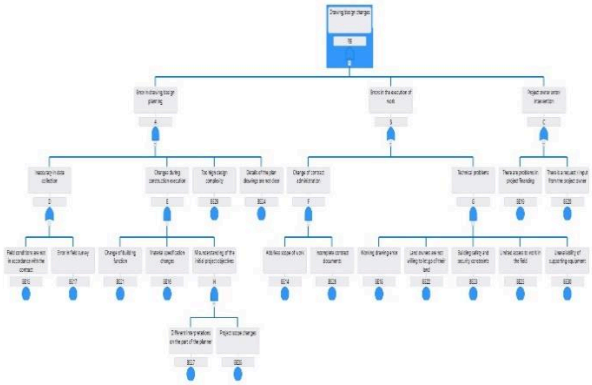

Figure 4. FTA #2 Risk Variable R9

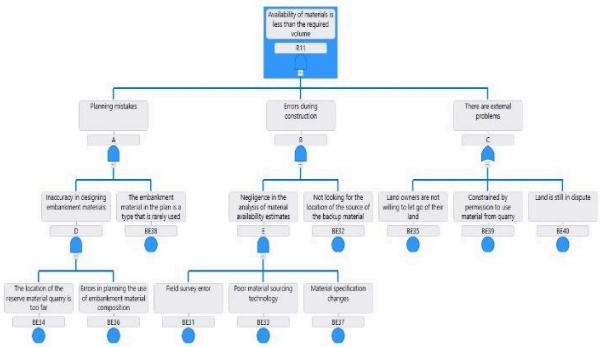

Figure 5. FTA #3 Risk Variable 11

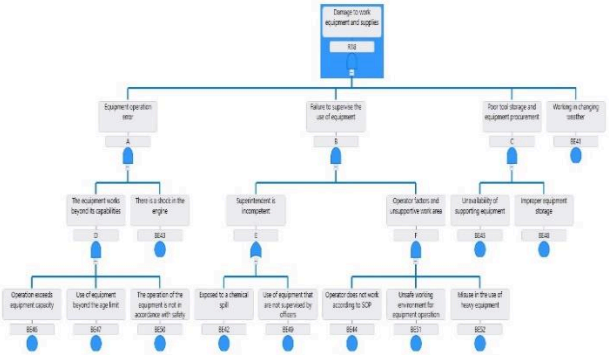

Figure 6. FTA #4 Risk Variable 18

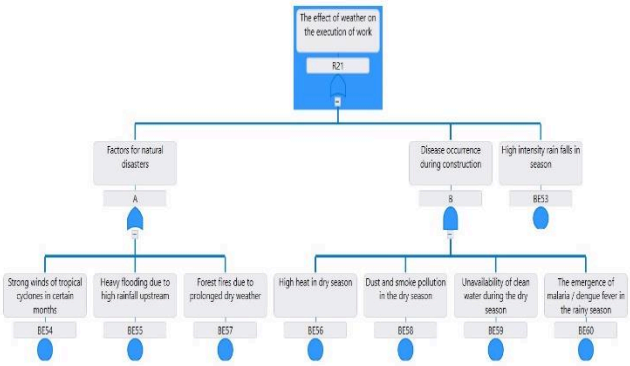

Figure 7. FTA #5 Risk Variable 21

Based on the results, the minimum cut set of risk events is calculated as in Table 5. The cut set is the set of events that together cause the top event to occur. Minimum cut sets are the minimum number of basic causes that cause the main event or top event (Kesuma, 2019). This research used Boolean Algebra method to calculate the minimum cut set. Boolean algebra is basic mathematics for analyzing and simplifying logic gates so that it can relate basic events to top events without gates (Ruijters and Stoelinga, 2015). The basic multiplication rule (AxB) for the AND gate and the addition rule (A+B) for the OR gate are used in the calculations using a top-down approach

Table 5. Calculation of Minimum Cut Set

FTA	Calculation	Calculation
1	R2 = (A+B+C+BE9)=[(DxBE11)+(E+BE12)+(BE4xF)+BE9] =[(BE1xBE2xBE3)xBE11)+(BE5+BE6)+BE12)+(BE4x(BE7 xBE8xBE10)+BE9)]	(BE1,BE2,BE3),(BE11),(BE5),(BE6),(BE12),(BE4),(BE7,BE8,BE10),(BE9).
2	R9 = (A+B+C) =[(DxExBE29xBE24)+(F+G)+(BE19+BE20)] = [((BE15+BE17)x(BE21xBE16xH)xBE29xBE24)+((BE14 xBE26)+(BE18xBE22xBE23xBE25xBE30))+(BE19+BE20)] = [((BE15+BE17)x(BE21xBE16x(BE27xBE28)x BE29xBE24)+((BE14xBE26)+(BE18xBE22xBE23xBE25xBE30))+(BE19+BE20)]	(BE21,BE15),(BE16,BE15),(BE27,BE15),(BE28,BE15),(BE21,BE17),(BE16,BE17),(BE27,BE17),(BE28,BE17),(BE2),(BE29),(BE14,BE26),(BE18,BE22,BE23,BE25,BE30),(BE19),(BE20).
3	R11 = (AxBxC) =[(DxBE38)x(ExBE32)x (BE35+BE39+BE40)]=[(BE34xBE36)xBE38)x(BE31xBE33x BE37)xBE32)x(BE35+BE39+BE40)]	(BE34,BE36),(BE38),(BE31,BE33,BE37),(BE32),(BE35),(BE39),(BE40).
4	R18 = (AxBxCxBE410 = [(DxBE43)x(ExF)x (BE45xBE48)xBE41]=[(BE46xBE47xBE50)xBE43)x((BE42 +BE49)x(BE44xBE51xBE52))x(BE45xBE48)xBE41]	(BE46,BE47,BE50),(BE43),(BE44,BE42),(BE51,BE42),(BE52,BE42),(BE44,BE49),(BE51,BE49),(BE52,BE49),(BE45, BE48),(BE41)
5	R21 = (A+B+BE53) = [(BE54+BE55+BE57)+ (BE56xBE58xBE59xBE60)+BE53]	(BE54),(BE55),(BE57),(BE56,BE58,BE59,BE60),(BE53).

Table 6 shows 54 basic events that have a frequency value or amount of involvement in each event at each risk.Basically the table above has at least shown the main causes, and provides a clear picture of how these basic events are connected and affect each other. There are several basic events that have similarities and are found in different dominant risk variables as attached in Table 7.

Table 6. Summary of Root Causes (Basic Event)

Basic Event	R2	R9	R11	R18	R21	Freq
The demand for compensation is too high	1					1
Differences in land prices due to proximity to public facilities	1					1
Late payment of compensation	1					1
Difficulty in determining the value of land acquisition	1					1
The whereabouts of the land owner is unknown	1					1
Land/land is still in dispute	1		1			2
Limited time for BPN officers in handling land acquisition	1					1
The difficulty of coordination between officials / officers in the field	1					1
The length of the land certification process	1					1
Difficulty in collecting land status data and documents	1					1
There is no compensation fund from the government yet	1					1
Land owners are not willing to let go of their land	1	1	1			3
The planned land is included in the protected forest area	1					1
Add/less scope of work		1				1
Field conditions are not in accordance with the contract		1				1
Material specification changes		1	1			2
Error in field survey		1	1			2
Working drawing error		1				1
There are problems in project financing		1				1
There is a request / input from the project owner		1				1
Change of building function		1				1
Building safety and security constraints		1				1
Details of the plan drawings are not clear		1				1
Limited access to work in the field		1				1
Incomplete contract documents		1				1
Different interpretations on the part of the planner		1				1
Project scope changes		1				1
Too high design complexity		1				
Unavailability of supporting equipment		1		1		2
Not looking for the location of the source of the backup material			1			1
Poor material sourcing technology			1			1
The location of the reserve material quarry is too far			1			1
Errors in planning the use of embankment material composition			1			1
Types of embankment materials that are rarely used			1			1

Constrained by permission to use material from quarry			1			1
Working in changing weather				1		1
Exposed to a chemical spill				1		1
There is a shock in the engine				1		1
Operator does not work according to SOP				1		1
Operation exceeds equipment capacity				1		1
Use of equipment beyond the age limit				1		1
Improper equipment storage				1		1
Negligence in controlling the use of equipment				1		1
Operation of the equipment is not in accordance with safety procedures				1		1
Unsafe working environment for equipment operation				1		1
Misuse in the use of heavy equipment				1		1
High intensity rain falls in season					1	1
Strong winds of tropical cyclones in certain months					1	1
Heavy flooding due to high rainfall upstream					1	1
High heat in dry season					1	1
Forest fires due to prolonged dry weather					1	1
Dust and smoke pollution in the dry season					1	1
Unavailability of clean water during the dry season					1	1
The emergence of malaria / dengue fever in the rainy season					1	1

Source: (Researcher, 2021)

Table 7. Basic Events With Similarities in Dominant Risk

Basic Event	R2	R9	R11	R18	R21	Freq
Land owners are not willing to let go of their land	1	1	1			3
Land is still in dispute	1		1			2
Material specification changes		1	1			2
Error in field survey		1	1			2
Unavailability of supporting equipment		1		1		2

6. CONCLUSIONS

In this study, it could be concluded that: 1) the researcher obtained 38 risk variables that met the requirements of relevance to the risk of delays in dam construction projects in the territory of Indonesia from 50 risk variables from the literature submitted to expert respondents. 2) risk analysis which was the first stage in the concept of the proposed framework produces five risk variables for project delays with very high value categories, namely: acquisition of unfinished work land, changed to drawings/designs, availability of material less than required, damaged to equipment and work supplies, and the effect of weather on the execution of the work. 3) at the root caused analysis stage based on fault tree analysis (FTA) which was developed from the five very high risk variables, it resulted in 60 basic events or root causes.

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OPTIMIZATION OF AIRCRAFT MAINTENANCE MATERIAL DISTRIBUTION

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ABSTRACT

Aircraft maintenance is an important activity to support flight operations. The goal of aircraft maintenance is to maintain aircraft airworthiness. PT. XYZ is an Aircraft Maintenance, Repair and Overhaul (MRO) company. Therefore, the Company has a Service Level Agreement (SLA) with customer to perform maintenance on time as agreed and with no operational delay. In 2019, more than 500 delays occurred, and 17 events caused by material factor. After deep analysis, material factor is caused by late material distribution from Central Warehouse to store. This research will be conducted at Material & Logistic Department PT. XYZ which is responsible of keeping and distributing aircraft maintenance material. The focus of research is related to Multi-product Vehicle Routing Problem with Multiple Trips (VRPM) with mixed integer programming (MIP) optimization method to find optimal solution for the distribution of aircraft maintenance materials. This study provides several solutions in the form of optimize the material delivery routes so that they become effective in the process and efficient in terms of shipping costs, so that it will reduce delay factors due to distribution and efficiency to company.

Keywords: Distribution, Vehicle Routing Problem, Mixed Integer Programming.

1. INTRODUCTION

PT XYZ is a company specialized in Aircraft Maintenance, Repair and Overhaul. PT XYZ provides services to airlines so that airworthiness is maintained and operations can run smoothly. Airworthiness that is not maintained can cause an aircraft to be unable to be flown by regulation. This will certainly have an impact on operations in that it will cause a shortage of aircraft. Because of this, PT XYZ needs to maintain its service quality to its customers by fulfilling the Service Level Agreement (SLA).

To provide its services, PT XYZ has 7 capabilities. These capabilities are: (1) Line Maintenance: is the capability of light aircraft maintenance such as Transit check, which is a maintenance during transit before continuing to the next destination, (2) Airframe Maintenance: is the capability of large aircraft maintenance such as overhaul maintenance, where a comprehensive maintenance is carried out right down to the aircraft frame, (3) Component Maintenance: is the capability of maintaining aircraft components such as communication, radio and navigation, (4) Engine Maintenance: is the capability of aircraft engines maintenance, both on a modular and overhaul manner, (5) Engineering Service: is the capability to analyse data and provide suggestions for good aircraft performance, (6) Cabin Maintenance: is the capability to carry out maintenance and modifications in the aircraft cabin area, and (7) Material service: is the capability

to provide materials, including chemicals, components and expendable materials to support aircraft maintenance and operations.

These capabilities are supported by aircraft maintenance facilities in the form of Central Warehouse (GADC), Hangar 1, Hangar 2, Hangar 3, Hangar 4, Workshop and stores in each hangar and apron area. Considering that the maintenance area is quite large, one of the activities in the Material Services capability is the distribution of aircraft maintenance materials. This distribution includes planned materials (those involving material forecasting) or materials for troubleshooting. Proper distribution can help avoid lateness for aircraft maintenance and provide materials so that operations go according to schedule.

Serviceable aircraft maintenance materials are stored in the central warehouse (GADC). As a result, the distribution will be centered at GADC and then sent to the maintenance areas that require materials. These areas are Hangar 1, Hangar 2, Hangar 3, Hangar 4 and Apron. Hangar 2 and Apron are used for aircraft maintenance that requires short time and for troubleshooting. Hangars 1, 2, and 3 are used for long and heavy maintenance. Therefore, there are unserviceable materials located in the aircraft maintenance areas that need to be sent to GADC before going to the shop to be serviced again. The delivery flow of serviceable and unserviceable materials at PT XYZ is described in figures 1 and 2 below.

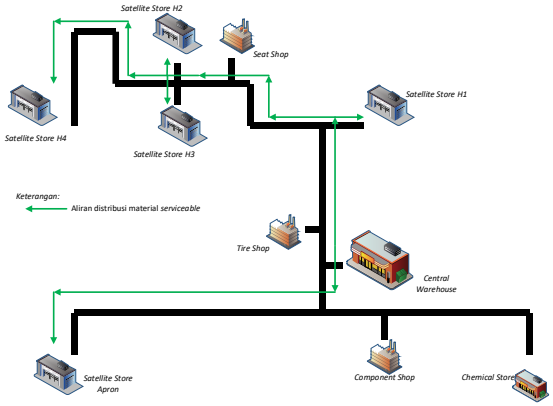

Figure 1 The delivery flow of serviceable materials from GADC to maintenance areas

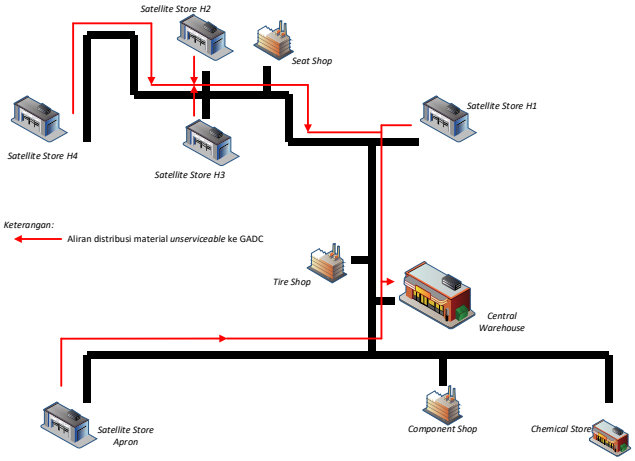

Figure 2 The delivery flow of unserviceable materials from GADC to maintenance areas

In 2019, PT XYZ received complaints from one of its customers about its failure to fulfill SLA regarding operational delays. PT XYZ performed an analysis of the factors causing the delay. There were five main factors that cause delays: (1) Technical Aspect, (2) Engineering Aspect, (3) Coordination, (4) Manpower Awareness, and (5) Material Aspect. Further examining these factors, it was found that material aspect has the largest delay time and thus distribution became the highlight of the issue that must be solved by PT XYZ.

PT. XYZ itself has resources in the form of 6 vehicles used for distribution. In response to the customer complaints, several observations were made on the distribution of these materials. It was often found that vehicles accumulate at one delivery point, causing maintenance materials to not be delivered according to demand. With vehicles piling up at one delivery point, other vehicles have to cover the delivery to other points and the routes traveled become inefficient. The time spent on delivery is also increasing because there are queues and the distance of the routes are becoming higher.

Investigating the problem further, the company saw that its problem fits with the problems in last-mile delivery. Last-mile delivery is a process or logistics activity carried out by manufacturers or retailers to customers who are in urban areas (Boysen, 2020). Challenges associated with Last-Mile Delivery are always related to route determination or the Vehicle Routing Problem (VRP) (Sitek, 2020). The company found that the route was ineffective and efficient in utilizing resources in the form of 6 vehicles for distribution. The company sees that it is necessary to optimize the material delivery routes so that they become effective in the process and efficient in terms of shipping costs. With the existing data and constraints, the optimization for solving the VRP problem on hand uses Mixed Integer Programming which will be run on LINGO software.

2. LITERATURE REVIEW

The distribution process in SCM can be grouped into 3 types: Long-haul delivery, Medium-haul delivery and Last-mile delivery. Last-mile delivery is a logistics activity related to the delivery of goods to final consumers in urban areas (Boysen, 2020). The development of Last-mile delivery is quite rapid, considering the development of urban roads that are increasingly congested and branching, the growth and development of urban areas that has led to the emergence of new regulations for transportation modes, and fluctuations in the number of deliveries due to the development of e-commerce. Last-mile delivery itself is one of the delivery processes that are expensive, inefficient and contribute the most pollution to the entire logistics chain (Gevaers, 2011).

Referring to the activities in last-mile delivery, one of the challenges that is often encountered is determining the delivery route, which falls into the category of Vehicle Routing Problem. Inefficient routes will cause an increase in shipping costs, making the value of goods more expensive. Because of this, the route determination process becomes quite vital in last-mile delivery activities. Govindan (2014) cites Liao (2010) that the purpose of VRP is to minimize total distance and number of vehicles which start and end their tours at the depot. VRP itself has often been used for calculations and applied in real conditions. The solution from VRP is a set of routes for each vehicle to reach the optimal destination with a predetermined objective function with a set of existing constraints and ensure the goods arrive at the customer (Sitek, 2020).

In this study, the Vehicle Routing Problem approaches the Vehicle Routing Problem with multi-trips type and is combined with the number of types of material sent. Multi-Product Vehicle Routing problem with multi-trips in the context of this research is a solution to a distribution problem involving materials and fleets within a certain time span. In the previous research on

Vehicle Routing Problem Multiple Trips, there are several topics that are often researched. Table 1 below explains the differences between previous research and current research.

Table 1 Comparison Vehicle Routing Problem Multiple Trips Research

Authors	Title	Vehicle Routing Problem Multiple Trips Topics			
		Time Windows	Service-dependent loading time	Limited trip duration	Profits (Efficiency)
Cattaruzza et al. (2016)	Vehicle routing problems with multiple trips	X	X		
Hernandez et al. (2014)	An exact algorithm to solve the multi-tripvehicle routing problem with time windows	X	X	X	
Azi et al. (2010)	An exact algorithm for a vehicle routing problem withtime windows and multiple routes	X	X	X	X
Hutama et al. (2021)	Optimization of Aircraft Maintenance Material Distribution			X	(X)

In scheduling, there is a difference between a static and dynamic production system. The production scheduling system has similarities to the scheduling of distribution routes. The static scheduling system is more organized and has few changes. This is because the parameters determined at the beginning and the end of production have little difference and tend to be constant. In contrast to dynamic scheduling, uncertainty is quite high, this is shown in the form of unexpected events, such as the arrival of orders in the midst of production, differences in demand every day, and the existence of external conditions that affect it (Amin, 2018).

Amin (2018) quoted from Ouelhadj (2009) that refer to the definition of dynamic scheduling under three categories: completely reactive, predictive-reactive and robust pro-active scheduling. Determining scheduling priorities is connected to the first category, which is completely reactive, where scheduling decisions are made in real time based on existing parameters. One of the parameters is the order of work and attributes in the system that previously had no scheduling.

Mixed Integer Linear Programming (MILP) is a topic that is often used to formulate problems related to scheduling. MILP models used in determining scheduling are divided into 4 categories: Position based modeling ideas (Wagner, 1959), sequence-based modeling ideas (Manne, 1960), time-indexed modeling ideas (Brandimarte, 1993), and adjacent sequence-based modeling idea (Mousakhani, 2013) (Meng, 2020). The main difference between the four models lies in the variables that define the problem in scheduling.

A problem is categorized into integer programming (IP) if all the variables in the decision-making model are discrete, where it can be assumed that their values are from a finite set or can be calculated. Whereas if the decision-making model has both discrete and continuous variables, it can be referred to as mixed integer programming (MIP) (Bhunia, 2019).

3. METHODS

3.1 Research Flow Method

The method in this research uses a quantitative approach with experimental methods. The approach in this research aims to see the effect that the independent variables have on the dependent variables in the parameters that have been determined (Sugiyono, 2010).

Research variables are attributes or properties or values of individuals, objects or activities that have certain variations determined by researchers to be processed, studied and concluded (Sugiyono, 2010).

The variable in this research is divided into two, namely independent variables and dependent variables. An independent variable is one that can cause changes to the dependent variable. The independent variables can refer to variable set X. Meanwhile, a dependent variable is a variable that varies following changes in the independent variable. These refer to variable set Y.

a. Independent variable : Material demand (X)
b. Dependent variable : Traveling distance (Y1)
Working hour (Y2)

The data used in this research are as follows:

a. Source of primary data

Primary data sources are data sources that are collected directly using time motion study process. The data generated from these observations are material loading and unloading time, as well as the traveling time of each material delivery and pickup points. Data collection using time motion study was carried out from December 2020 to February 2021.

b. Source of secondary data

Secondary data sources are resources that function as support for the primary data sources. Secondary data obtained for this research are in the form of documents that record material requests, the weight of each material derived from Original Equipment Manufacture (OEM) documents, facility data in the form of the distance of each delivery point, and the value of vehicle costs and manpower used in the distribution of materials.

After the data is collected, define mathematical model then the data will be processed using the LINGO software. the data processing process will use several days of data to see the determination of vehicle routes and see the effect of cost efficiency on management

3.2 Mathematical Model

In this research, the value of demand for material pick-up is the same as material delivery. Because of this, the pickup and delivery characteristic of the problem can be ignored. The mathematical model is then formulated as Multiple-product VRP with Multiple Trips (VRPM), or can also be called Multiple-product Multi-trip VRP (MVRP). The proposed model is also a modification of the model by Cattaruzza et al. (2016).

The decision variables in this research are as follows:

x_{ijk} = 1 if arc between node i and node j is traveled by vehicle k, 0 otherwise

y_{ik} = 1 if node i is visited by vehicle k, 0 otherwise

u_{ijk} = Dummy variable used in the subtour elimination constraint. It states the total load (kg) of a vehicle k while traveling through arc (i, j)

Meanwhile the parameters in this research are as follows:

t_{ij} = Traveling time from node i to node j
d_{ij} = Distance from node i to node j
q_{ip} = Demand of customer node i for product p (unit)
w_p = Weight per unit of product p (kg)
LT_p = Total loading and unloading time per unit of product p
Q = Vehicle capacity (kg)
H = Working hour per day
Then several sets are made based on the components of the model.

1. Set of all nodes including depot: N_0
2. Set of customer nodes (depot excluded): N
3. Set of all products: P
4. Set of all vehicles: K

The mathematical model used to solve the problem of this research is presented below.

$$Min \sum_i \sum_j \sum_k \left(t_{ij} * 722 + d_{ij} * 65878\right) x_{ijk} + \sum_i \sum_p q_{ip} * LT_p * 722 \quad (1)$$

$$\sum_{k \in K} y_{ik} = 1 \qquad \forall i \in N \quad (2)$$

$$\sum_{i \in N_0} x_{ijk} = \sum_{j \in N_0} x_{jik} \qquad \forall i \in N, k \in K \quad (3)$$

$$\sum_{j \in N_0} x_{ijk} = y_{ik} \qquad \forall i \in N, k \in K \quad (4)$$

$$\sum_{j \in N_0} u_{jik} - \sum_{j \in N_0} u_{ijk} = \sum_{p \in P} \left(q_{ip} w_p\right) * y_{ik} \quad (5)$$

$$u_{ijk} \leq Q * x_{ijk} \qquad \forall (i,j) \in N_0, i \neq j, k \in K \quad (6)$$

$$\sum_{i \in N_0} \sum_{j \in N_0} \sum_{t \in T} t_{ij} x_{ijk} + \sum_{i \in N} \sum_{p \in P} \sum_{t \in T} q_{ip} LT_p y_{ik} \leq H \quad (7)$$

$$x_{ijk} \in \{0,1\} \qquad \forall (i,j) \in N_0, i \neq j, k \in K \quad (8)$$

$$y_{ik} \in \{0,1\} \qquad \forall i \in N_0, k \in K \quad (9)$$

$$u_{ijk} \geq 0 \qquad \forall (i,j) \in N_0, i \neq j, k \in K \quad (10)$$

Equation (1) is the objective function of the model. It minimizes the total cost, which comprises car cost and manhour cost. Constraint (2) ensures that every customer is visited exactly once. Constraint (3) guarantees that a vehicle that enters customer i will leave on the same trip. Constraint (4) connects the two decision variables x and y. In constraint (5), if customer i is visited by vehicle k (y_{it} = 1), then the difference in load when entering and leaving customer i will be equal to the total weight of the customer's demand. Constraint (6) ensures that the load on arc i-j (u_{ijk}) will hold value only if the arc is traveled by vehicle k. Constraint (5)-(6) are the subtour elimination constraints. Constraint (7) guarantees that for each vehicle, the total travel time and loading/unloading time will not exceed the working hour limit H. Constraint (8) ensures that x_{ijk} is binary. Similarly, Constraint (9) ensures y_{ik} is binary while Constraint (10) ensures u_{ijk} is non-negative.

Table 2 Modifications in mathematical model of the research

Constraint	Original Equation	Modified Equation
4	$\sum_{j \in N_n} x_{ijk} = y_{ik} \quad \forall i \in N_0, k \in K$	$\sum_{j \in N_n} x_{ijk} = y_{ik} \quad \forall i \in N, k \in K$
5	$\sum_{j \in N_n} u_{jik} - \sum_{j \in N_n} u_{ijk} = q_i$	$\sum_{j \in N_n} u_{jik} - \sum_{j \in N_n} u_{ijk} = \sum_{p \in P} (q_{ip} w_p) * y_{ik}$
7	$\sum_{i \in N_n} \sum_{j \in N_n} \sum_{t \in T} t_{ij} x_{ijk} \leq H$	$\sum_{i \in N_n} \sum_{j \in N_n} \sum_{t \in T} t_{ij} x_{ijk} + \sum_{i \in N} \sum_{p \in P} \sum_{t \in T} q_{ip} LT_p y_{ik} \leq H$

The modifications in the mathematical model are made on constraints 4, 5 and 7. Further information on the modification of these constraints can be explained in Table 2 above. In constraint 7, a new component is added to the total working hours, which is loading and unloading time. For constraint 4, the repetition of the constraint is excluded for the depot. This is because a vehicle can exit the depot multiple times so that the value of $\sum_j x_{ijk}$ can be greater than 1. In this case, applying the rules of constraint 4, the variable y_{ik} will be forced to be non-binary. This contradicts constraint 9 and thus will always make the model non-feasible. In constraint 5, there are 2 modifications made to the right-hand side of the equation:

- The variable q_i is transformed into $\sum q_{ip} w_p$. In the original model, the customer demand is in the form of units of product and so the dummy variable u_{ijk} is also in units. In the proposed model, the dummy variable is in the form of total weight of a customer's demand. In other words, the demand for multiple products are "summarized" into the total weight of all those products that are ordered.
- Total weight is multiplied by y_{ik}, because previously the model returned error.

4. RESULTS

The forecasted demand for days 11-15 is input and the optimization model is run in LINGO 18 software. The results obtained are the optimized route and the cost incurred during the operations. For each day, the number of vehicles needed to fulfill the demand for materials is 4 vehicles. Tables 3 to 7 below show the routes taken to fulfill the demand.

Table 3 Optimization result for forecast of day 11

Forecast 11				
Vehicle	Trip	Load	Time	Total Vehicle Time
1	1-5-1	172.9	368	368
2	1-4-1	87.6	184	184
5	1-6-1	438.8	480	480
6	1-3-2-1	439.6	467	467

Table 4 Optimization result for forecast of day 12

Forecast 12				
Vehicle	Trip	Load	Time	Total Vehicle Time
1	1-4-1	248.3	374	374
2	1-5-1	165	364	364
4	1-6-1	478.4	458	458
5	1-3-2-1	422.9	419	419

Table 5 Optimization result for forecast of day 13

Forecast 13				
Vehicle	Trip	Load	Time	Total Vehicle Time
1	1-4-2-1	138.1	333	333
2	1-5-1	415.2	480	480
4	1-6-1	274.3	362	362
5	1-3-1	358.4	388	388

Table 6 Optimization result for forecast of day 14

Forecast 14				
Vehicle	Trip	Load	Time	Total Vehicle Time
1	1-2-1	120.3	92	92
2	1-5-1	461.6	448	448
5	1-4-3-1	348.5	421	421
6	1-6-1	546.6	478	478

Table 7 Optimization result for forecast of day 15

Forecast 15				
Vehicle	Trip	Load	Time	Total Vehicle Time
1	1-6-1	305.1	320	320
3	1-3-4-1	426.4	451	451
5	1-5-1	355.6	436	436
6	1-2-1	169.9	244	244

By analyzing the route and traveling time taken by each vehicle to fulfill the demands, the costs incurred in the operations are also obtained. Table 8 below provides the costs incurred during day 11 to day 15.

Table 8 Results of cost calculation for delivery of forecasted demand of day 11 to 15

Cost component	11	12	13	14	15
Existing Cost	4,167,088	5,880,124	5,723,714	4,009,841	4,065,201
Optimal Cost	3,180,542	3,264,298	3,226,752	3,071,342	3,080,007
Efficiency (Percentage)	24%	44%	44%	23%	24%

Based on the results of the LINGO software by determining the route of delivery of aircraft maintenance materials, there is efficiency in the operational costs of the distribution. This efficiency is due to the use of vehicles, where previously 6 vehicles were operational and after optimization there were 4 vehicles that could be optimized in operation. Efficiency that can be obtained by optimizing the delivery route is a savings of 32% from existing costs.

6. CONCLUSIONS

Optimization results using LINGO, in fulfilling requests for aircraft maintenance materials in hangar 1, hangar 2, hangar 3, hangar 4 and the apron area, only 4 vehicles are needed. Operational costs incurred by PT XYZ itself is not too high, with a day-to-day average of Rp. 3,164,588,- and reach efficiency around 32% to company. This is due to the route planning based on material demand. Determining the route based on demand affects the value of total traveling time and in addition to that, also optimizes the time required for loading and unloading material. It can be seen that vehicles do not pile up at one delivery point. It can also be observed that in the previous condition where the vehicle freely delivers material without any route determination, which causes vehicle accumulation, loading and unloading times are also longer. By optimizing the set of routes and vehicles, PT XYZ can exert more control on the delivery of aircraft maintenance materials so as to reduce delays in material delivery and increase the Service Level Agreement (SLA) to customers in the form of reducing operational delays. By implementing material delivery route scheduling, PT XYZ can also optimize the cost for the delivery.

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DEVELOPMENT OF THE INDONESIAN SMART VILLAGE MODEL: A SYSTEMATIC LITERATURE REVIEW

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ABSTRACT

Smart village is currently one of the alternatives for village development that has the potential to overcome village problems. Most research papers on smart villages discuss the implementation of information technology in villages while developing technology in villages is only an enabler. Therefore, this study aims to fill this gap by proposing a conceptual model of a smart village. The conceptual model was derived from a systematic review of quality journals. The journals selected were Google Scholar, Emerald Insight, Elsevier, and IEEE explore with the keywords "smart village,", "smart rural,", and "sustainable village. "We found 1703 research articles related to village governance. Then, from 1703 selected articles, 146 articles were accepted based on title and abstract reading. Then, I researched 146 articles on carefully selected topics and got 43 articles on the topics in this article, covering objectives, domains, and indicators. Each component also has its sub-components. The dimension component consists of eight main areas: the economy, ICT, people, business, environment, life, agriculture, and energy. This discovery enriches the theoretical exploration of smart villages.

Keywords: smart village, smart rural, sustainable village, systematic literature review.

1. INTRODUCTION

Many villages in Indonesia have been declared smart villages, such as Chemnin Village which handles all licensing issues online, Cinunuk Village, Cileunyi District, Bandung Regency which manages community data with database management, Batang Lor Village which successfully develops digital systems for community service, and Penganten Desa successfully implemented a mobile-based community service application. The district government has successfully implemented ICT as a service used by the community [1]. However, to get to a smart village is not only fixated on the use of technology but also on how technology can function according to existing needs. [2]. [3] In his study, initiatives to implement village development can be carried out with a smart rural approach or a smart village approach, depending on the circumstances and policies of each region. However, in implementing the smart city and smart village/rural concepts, regional aspects need to be considered, because the conditions, problems, and speed of development in each region are different [4]. The development of village development is still confused in its application. There are still few who know the main foundation or capital in building an advanced village. Most of the literature only discusses the application of technology to each of these village problems, even though besides technology there are still many things or components that make the village advanced, namely through the smart village concept.

Then, to reduce this understanding, the Ministry (LAIP), together with the Ministry Bappenas, the Ministry of PUPR, the Presidential Staff Office, the Ministry of Finance, the Coordinating Ministry for the Economy, and the PANRB Ministry, initiated several things must be met to build a village, including village branding, healthy housing, healthy environment, smart village government, smart community, and smart economy [5]. Then [6] He said a smart village could improve conditions in the region, but when building a smart village, it is important to know the basics of the smart village program. This is because the Smart Village Program cannot be implemented without knowing the foundation or preparing a solid foundation. Previously, the new concept of village development with smart villages was first introduced by Indian researchers. N. Viswandham and Townya Vendula, who developed this concept in 2010, describe village ecosystems and map out integrated design methods for building smart villages[7]. The smart village concept can be used as the basis for village development within the district in Indonesia, but this concept cannot be fully used, due to the different ecosystems of each village[8]. However, village development does not only focus on the use of information technology alone but comprehensively includes services, governance, and even people's lives.

This study aims to explore the components of the smart village conceptual model based on a systematic review. These components can then form a comprehensive picture of the smart village conceptual model to help understand smart village development. The methodology used in this literature review follows the guidelines carried out by Deborah.

2. LITERATURE REVIEW

Previous research studies discuss the relevance of previous research to the research conducted. Research on smart villages is still very rarely done by researchers and is not comparable to research on smart cities that have been studied by many researchers around the world. Below are some of the previous studies investigated by the researcher.

Table 1. Related research

Author	(Viswandham and Vedula, 2010)
Main findings	In this study, smart villages are built on four main components: modular services and modular service chains, technology, and service delivery mechanisms such as logistics and IT, institutions that affect governance and regulation, and their resources and management.
Author	(Ella and Andari, 2018)
Main findings	This study concludes that smart villages are built on five main components: resources, technology, service chain, institutions, and sustainability, as well as four phases of development in which the collaborative governance model is the main implementer.
Author	(Ranade, Londhe and Mishra, 2015)
Main findings	This study formulates that smart villages are built based on 4 main components, namely 1) smart infrastructure, 2) smart service delivery, 3) smart technology and innovation, and 4) smart institutions.
Author	(Aziiza, 2020)
Main findings	This study formulates that smart villages are built based on 6 main domains, namely 1) governance, 2) technology, 3) resources, 4), village services 5) environment, and 6) tourism.

3. METHODS

3.1 Design

There are six steps in managing and compiling a systematic literature review that is used as a guide in this paper [9]. First, it begins by determining the research question. Second, determine the characteristics of the main research by conducting inclusion and exclusion criteria on the literature. The third step is to select the relevant "base sample" of literature. Fourth, by sorting and synthesizing the most relevant "samples of synthesis" literature. The fifth step is to synthesize theories in the literature. Next, the sixth step is to make a literature study report. These steps are depicted in Figure 1.

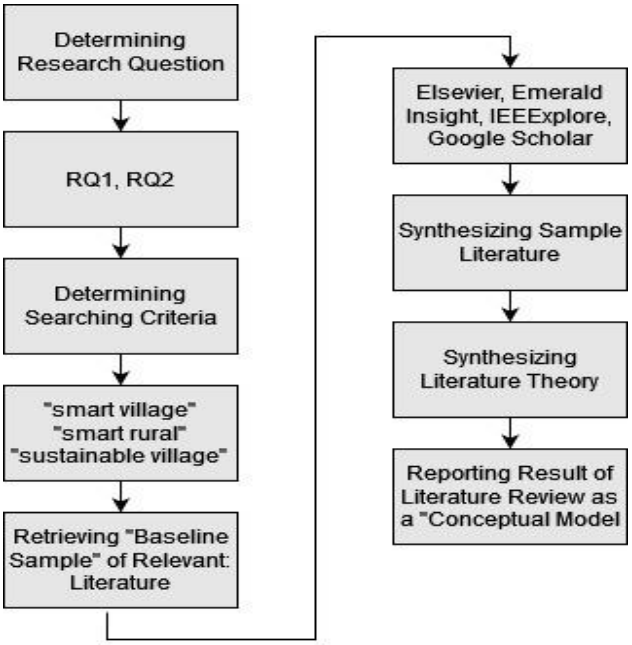

Figure 1. Research Design

3.2 Determining Research Question

3.3 Research Question to Provide an overview

This essay begins with several research questions, namely:

RQ1: What is the context in which the term "smart village" is used?

RQ2: What are the domains, focus areas, and indicators in the smart village?

3.4 Extraction and selection of related literature

In this Systematic Literature Review, the literature was selected from four leading journal databases, namely Elsevier, Emerald Insight, IEEEXplore, and Google Scholar, using the keywords "smart village", "smart rural," and "sustainable village.". The search results started from 2010 to 2021 and found 1703 articles related to the keywords used.

3.5 Synthesis of the literature

After finding 1703 articles, the next step was to select from those 1703 articles by reading the titles and some abstracts, which were finally found to be 164 related to the articles in this study. Then review and read carefully and select more strictly according to the topic so that there are 43 selected articles. Finally, 43 articles were selected that were most relevant to the topic. The

review and mapping of articles consist of paper titles, journal sources, journal years, objectives, and dimensions. The review and mapping of articles are in Table 2.

Table 2. Mapping article

No	Paper Title	Sources	Year	Objective	Dimension
1	[10]	IEEExplore	2014	Energy production village	Energy
2	[11]	Scholar	2018	Renewable energy production village	Energy, ICT
3	[12]	Elsevier	2016	Energy distribution	Energy, living, economy
4	[13]	Elsevier	2014	Renewable energy production village	Energy, living
5	[14]	E;sevier	2021	Agrarian structure	Farm, people
6	[15]	Elsevier	2015	Improve the quality of village life.	Living, people, economy
7	[16]	Elsevier	2016	Access energy	Energy, living, economy
8	[17]	Elsevier	2015	natural resources	Living, resources, ICT, institutions
9	[18]	Scholar	2018	IoT as an effective activity	ICT, people, energy
10	[19]	Scholar	2015	Digital literacy	ICT, Institution, infrastructure, service delivery
11	[20]	IEEExplore	2017	They improve their lifestyle.	ICT, people
12	[21]	IEEExplore	2017	They improve their lifestyle.	It, gis
13	[22]	IEEExplore		Sustainability village	ICT, governance, governance, people
14	[23]	Elsevier	2016	Reduce urbanization.	People, living
15	[24]	IEEExplore	2016	Integration of village culture into the city	It,learning, economy, farm
16	[25]	Scholar	2016	Telecommunications	Building, Irrigation, Farming, Dairy, Healthcare, Surveillance system, Education
17	[26]	IEEExplore	2015	Digital farming	Ict
18	[27]	Scholar	2019	Reduce urbanization.	People, ICT
19	[28]	Scholar	2018	Redefine the smart village of Surabaya.	Living, people
20	[29]	Scholar	2018	We support digital services to minimize the digital distance between towns and countries.	Ict
21	[30]	Scholar	2016	Researchers try to correlate various smart village factors and their implications.	Village services, economy, living
22	[31]	Scholar		Smart governance	Governance, people

23	[1]	Scholar	2020	Develop services to the community in the form of SID application development	Governance
24	[3]	Scholar	2019	It also reduces the number of people moving from town to city.	Governance
25	[30]	Elsevier	2016	Fixing village economic problems	Economy
26	[32]	Elsevier	2015	Smart growth	Economy
27	[33]	Scholar	2019	Developing a smart village model	Smart governance, smart people dan smart living
28	[34]	Elsevier	2018	Tourism village development	Tourism
29	[35]	Elsevier	2020	Green Village	ICT, smart governance, smart, farm
30	[8]			Developing a smart village model	Governance, Technology, Resources, Village Service, Living, and Tourism
31	[36]	Elsevier	2014	Integration of rural and urban communities	Economy, people,
32	[37]	Scholar	2020	Develop smart village mobility.	Governance, tourism, people
33	[38]	Scholar	2018	In this article, the Climate Mart Village approach is an agricultural study of development tools that uses a participatory approach to conduct in-depth research on agricultural climate change and technical and institutional options for addressing climate change.	Farm, governance, ICT
34	[35]	Elsevier	2020	Development of village potential through the green village program	ICT, governance, governance, farm
35	[39]	IEEExplore	2017	Develop a village geographic mapping system that can make it easier for residents and audit institutions to find out population information.	ICT, governance, governance, community
36	[40]	Scholar	2018	Comparison of the concept of smart city and smart village	ICT, economy, governance
37	[41]	Elsevier	2017	Overcoming the gap between living in cities and villages	Living, people
38	[42]	Scholar	2017	Develop a pedagogy education system.	People, living
39	[43]	EmeraldInsight	2021	A systems-based approach to smart rural design and development-Circular Economy Village Network (CEV)	People, energy, ICT, economy, farm
40	[44]	EmeraldInsight	2018	Augmented reality-based intelligent village development project detection tool	Ict
41	[45]	EmeraldInsight	2017	Adopt CSAP-based smart farming practices.	ICT, farm

42	[46]	EmeraldInsight	2021	In the case of Battir village, considering the conservation and proper management of the fostered heritage is an important step towards sustainability.	People, culture
43	[47]	EmeraldInsight	2018	This paper aims to revisit the focus of the smart city debate and open it up to political and strategic considerations.	People, governance

4. RESULTS

4.1 Context of Using the Term Smart Village

In the previous chapter, 43 articles were selected and mapped according to Table 1. It is known that there are four main article sources, namely Elsevier, IEEEXplore, EmeraldInsight, and Google Scholar. The three sources of the article adequately describe the source of the main article, which contains many articles related to the topic of this research. If grouped by proportion based on the number and percentage of articles selected, the three sources of articles are shown in **Figure 2**. Furthermore, the year of publication of the article is also mapped. Therefore, it is sufficient to describe in what year this research topic was mainly researched and published in selected article sources. The mapping of the year of publication of the article can be seen in **Figure 3**. Figure 2 shows that the source of most of the articles is Elsevier. Then, followed by Google Scholar, IEEExplore, and EmeraldInsight. **Figure 3** shows that the most articles were in 2016 and 2018. In 2016, most of the articles were dominated by articles about ICT as the main variable in smart village development. Meanwhile, in 2018, most articles were dominated by variable articles such as tourism, which began to appear and became one of the domains that must exist in smart villages.

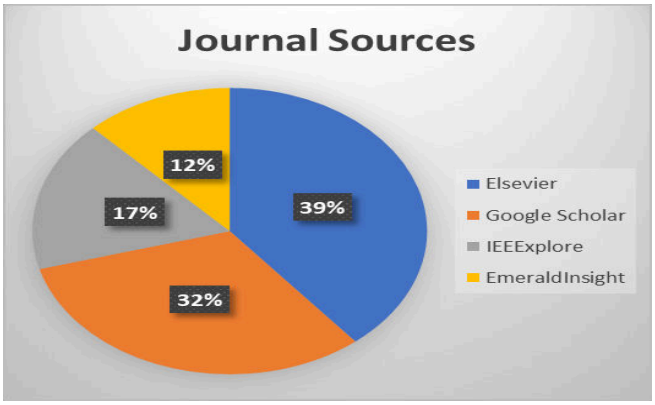

Figure 2. Journal sources

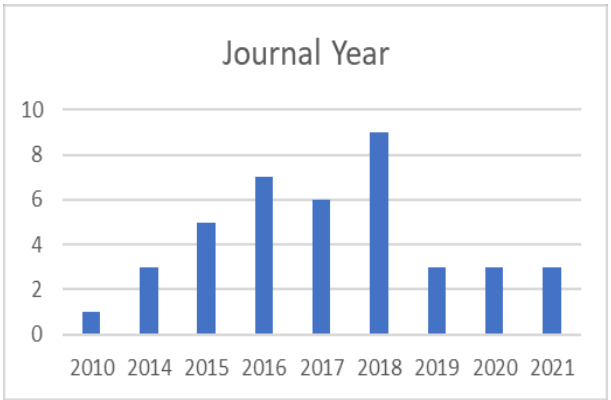

Figure 3. Journal year

4.2 domainn, focus area, and journal source mapping

Based on the previous discussion, it can be seen that there are many domains and their implementations to build smart villages based on the context of their respective problems. Several domains are the main components in measuring the domains that are often used for smart villages based on the focus area and journal sources. From these variables, calculations are made that are most often used and considered the most important in measuring the main domain of the model-

smart village builder. From the calculation of 43 selected articles, the proportion of variables that are most often used can be said to be the most critical variables for building a smart village model. The calculation of the proportion based on most of these variables can be seen in Table 3. The calculation is shown in the domain, the amount of the amount, and the source of the journal.

Table 3. Creating models by mapping variables

NO	Domain	Focus area	QTY	Sources
1	Energy	Renewable energi, Distribution energi, Energy storage, Energy resource management	7	[10,11,12,13,16,18,43]
2	Living	Green village, Safety, Security, environmental Hygiene	12	[8,12,13,15,16,17,23, 28,30, 33, 41, 42]
3	People	Health, Education, Food, Attitude, Human development	17	[14,15,18,20,22,23,28,27, 31,33,36,37,41,42,43,46,47]
4	Economy	Local business, Growth village, Sources finansial Supply and demand management	9	[6,15,16,24,30,32,36,40,43]
5	IT	Telecommunications, Internet utility, automatically process, IT infastructure	18	[11,17,18,19,20,21,22,24, 25,26,29,35,38,39,40,43,44,45]
6	Governance	Public services, Transparency, Policy, Social development, Local-self governance	13	[22,31,1,3,8,33,34,35, 37,38,39,40,47]
7	Farm	Agriculture, Farm, Fishing	7	[14,24,25,35,38,43,45]
8	Tourism	Village branding	3	[34,8,37]

Based on the explanations described above, this research has obtained domains, focus areas, indicators, and journal sources related to the topic of smart villages. These four main components form the big picture of the smart village conceptual model. The representation of these components is described through a conceptual model image, as depicted in Figure 4.

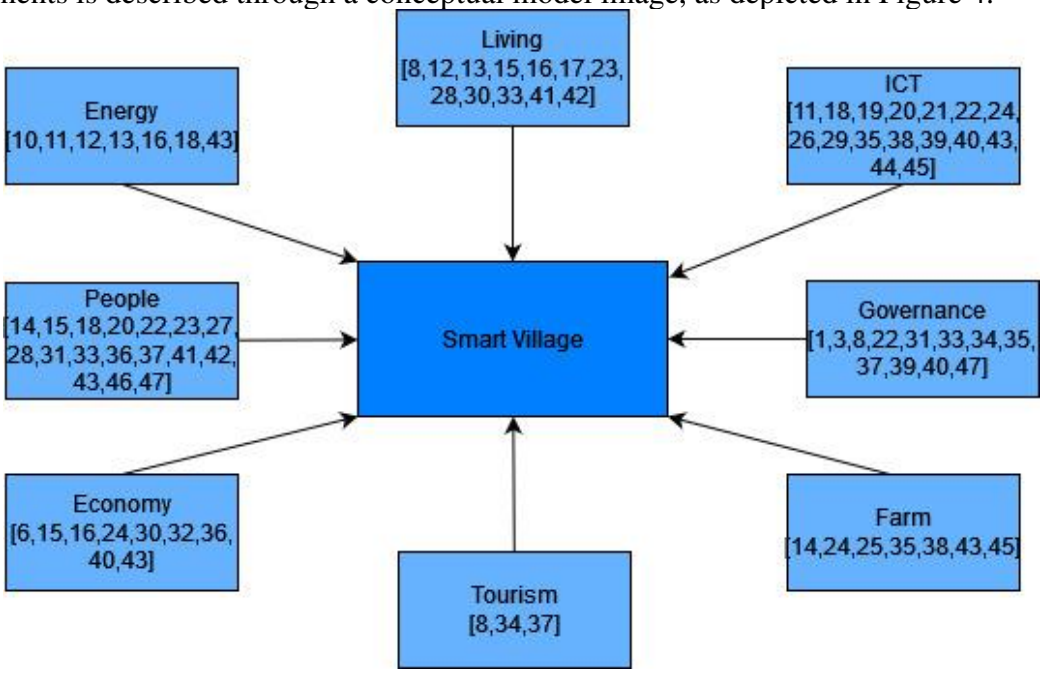

Figure 4. Conceptual model

5. CONCLUSIONS

This study builds a conceptual model based on a systematic review. Four main components are part of the model. objectives, indicators, dimensions, and journal sources are the main capital to build this concept. The dimension component consists of 8 focus areas: the economy, ICT, people, governance, environment, life, agriculture, and energy. This article is only a conceptual study, so empirical studies need to be tested.

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IMPROVEMENT THE EARNED VALUE MANAGEMENT RESULT USING ARTIFICIAL NEURAL NETWORKS IN EPC PROJECTS PT."R"

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ABSTRACT

Management of cost, quality, time, and scope are key parameters in the successful of EPC Project (Engineering, Procurement, and Construction) completion. Cost estimation for completion of EPC projects are very dynamic where the actual schedule and costs are greater than the planning cost budget. Therefore, the cost estimate at completion accuracy of the project is very important for determining how much cost to expend to complete the project until completion. Correct and accurate prediction of costs during project progress gives project managers the opportunity to identify projects that the revision is required in the project schedule in order to generate maximum profit. This research is to identify the most predominant parameters that affect the accuracy of the Cost Estimate at Completion (CEAC or EAC) of the EPC project and developing with comprehensive tool for estimating parametric costs using a combination of Earned Value Management (EVM) and optimal Artificial Neural Network models (ANN). The gas compressor installation project, also known as the "A" project for the construction of an EPC industrial plant at PT. "R", was selected for analysis in this study. The Artificial Neural Network (ANN) model is used to predict the cost performance index (CPI) of the project, thereby creating a more accurate symmetry between the predicted cost and the actual cost by considering the factors that affect the project's success. The input data from the ANN architectural model will be analyzed using MATLAB software. The results of this study are expected to show that combining the ANN models produces a Mean Square Error (MSE) of 0.0011674 and Mean Relative Error (MRE) of 6.97% are lower value than uses the traditional EVM model which has a value of 17.43%.

Keywords: EPC Project, Earned Value Management, Cost Estimate at Completion, Artificial Neural Network.

1. INTRODUCTION

EPC (Engineering Procurement and Construction) project is a complex business or activity which is starting from the engineering design phase until the construction is carried out within certain time limits, budgets, resources, where performance specifications are designed and determined to meet consumer needs. Ervianto (2005) explained about project management, it's all planning, implementation, control and coordination of a project from the beginning (ideas) to the end of the project to ensure timely, cost-effective and quality-appropriate implementation. However, in its implementation in project work, there are still many problems including the occurrence of errors in the calculation of project execution time and project cost estimates due to the calculation of project time and costs based on estimates. Delays in working on project work result in the project

not being able to be completed according to the scheduled time, resulting in an increase in project costs due to additional project work time.

In the execution of the EPC Project where the contracting company is engaged in Engineering, Procurement, and Construction, which is usually called the EPC contractor. EPC contractor in the industrial plant sector where the EPC contractor builds a factory where the factory is an asset of the project owner in running his business. When working on an EPC with a fixed price lump sum contract system, there is often a difference between the project execution budget planned and the actual cost. Based on research study by Moura (2007) that it was explained about construction projects experienced had cost overrun of 20.4% to 44.7% compared to the initial cost estimate.

Czernigowska (2008) explained that Earned Value Management (EVM) is a tool to help control the progress of a project. EVM is able to describe the current status of the project, as well as measure the current variance. In assessing project progress, EVM takes advantage of three constraints: time, scope and cost. In addition, EVM is able to predict future project parameters, including final costs, based on existing data.

Based on Adeli (1998) explained that the first application of artificial neural network (ANN) in construction activities occurred in the late 1980s. The researchers such as Adeli (1998), Sonmez (2004) and Arafa (2011), who were started using ANN as approaching in various fields of prediction and optimization techniques from 1998 to 2011, but the authors argue that research and studies on the use of neural networks to estimate construction project costs at various stages are still very limited especially for EPC project. Peško (2017) has suggestion that Artificial Neural Networks or ANNs be able to be used in various stages of a project, including design, construction, maintenance, renovation, and demolishing. Weckman (2010) One of the main benefits of using ANN is its ability to understand and simulate more complex functions than older methods such as linear regression. Moreover, Verlinden (2007) suggested that it can approximate functions well without explaining them. This means that outputs are generated based on different input signals and by training the network, accurate estimates can be generated.

Therefore, the importance of this study is that it enables EPC companies to use ANN to more accurately predict the cost status of future project completion and to fill the gaps mentioned in the Project Management Body of Knowledge.

2. LITERATURE REVIEW

Feng (2010) has explained that one part of project cost management is called cost estimation. It is an important part of projects, especially in EPC project execution, where costs are considered as one of the main criteria in making decisions at the early stages of the design process or engineering design. Accuracy in carrying out estimates is a critical factor in the success of any construction project, where bloating is a major problem, especially with the current emphasis on tight budgets. Swelling of costs in the project can lead to project projects. In some cases, potential overruns can result in turning the project into a design-to-cost task.

Henderson explained (2007) explained that Earned Schedule Analysis (ES) is a form of analytical technical breakthrough that comes from five components, namely schedule, measure, performance in units of time, not cost. On the same basis Earned Value Management (EVM) data points are used. Indicators are similar to costs, derived from the derivative of the schedule obtained by the measure. This indicator, provides status and predictive capabilities for schedules, analogous to costs. Because these metrics use time-based measures, they add to the traditional EVM and unified schedule analysis. A Work Analysis has also been carried out which provides a “bridging” analysis technique between schedule value and traditional integrated schedule analysis.

Edara (2003) has explained that Artificial Neural Network (ANN) as the name suggests is inspired by the biology of brain neurons. The human brain can perform various complex tasks in a relatively easy way compared to computers. Therefore, researchers are looking for ways that human intelligence can be fed into machines so that they too can perform certain complex tasks with ease.

Cheng (2010) explained that ANN concept resembles the human brain in two aspects; knowledge is acquired by the network through the learning process, and the strength of the connections between neurons known as synaptic weights is used to store knowledge. In the early stages of the project, there was limited availability of information, and limited application of traditional methods which required precise knowledge of all parameters and their interrelationships. Therefore, researchers have worked to develop a cost estimation system that maximizes the practical value of the limited available information to improve the accuracy and reliability of cost estimation by developing many cost estimation models. In recent years, new approaches to artificial intelligence have grown in popularity applicable to cost estimation problems related to expert systems, Case Based Reasoning (CBR), Artificial Neural Networks (ANN), Fuzzy Logic (FL), Algorithms Genetics (GA), and others.

3. METHODS

Methodology of the current study was determined according to the research aim. The purpose of this study is improve prediction traditional Earned Value Management for estimating the cost of completing an EPC industrial plant construction project by applying a new model Artificial Neural Network (ANN) with identification the most prominent parameters that affect the accuracy of the Estimate at Completion for the EPC project . This model is able to assist the parties involved in the EPC contractor project in obtaining cost estimates at the initial stage of the project with limited available information and in the time possible and with high accuracy. Matlab software was selected to conduct a simulation and prediction ANN model. The research process used to achieve the study objectives can be shown in the block diagram on **Figure 1** as follows:

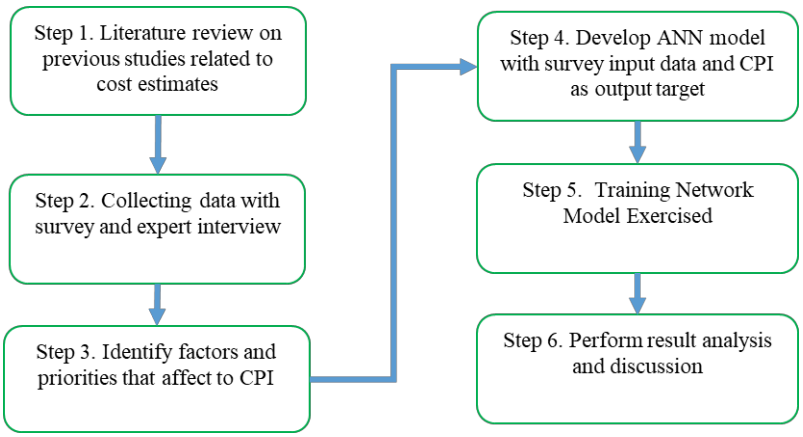


Figure 1. Research block diagram

3.1.Research variable

In this study, the variables that affect the cost of the EPC project industrial sector would be examined. There are two types of variables examination that would be used in the ANN modeling for the costs of the EPC Project was explained as follow:

3.1.1. Independent Variable

The independent variable factor is measured, manipulated, or determined to determine the relationship with a phenomenon under study. The data mentioned above are then quantified by measuring the measurement scale by assessing the variables from 1 to 4, where 1 and 4 represent the worst and best status of a variable, respectively. To make it clearer, the qualitative status of a variable and its correspondence to the qualitative status variable could be described in **Table 2** below:

Tabel 2. Qualitative status of a variable and its corresponding value for analysis.

Qualitative Status	Scale Value
Not affect and improvement	1
Little affect and improvement	2
Affect and improvement	3
Very affect and improvement	4

3.1.2. Specified Variable

Fixed variables are variables that react when served with independent variables. The factor variables were observed and measured to determine the effect caused by independent. If the magnitude of the effect is different, then the independent variable is to prove the relationship between the independent variable and the specified variable. In this case the research variables can be explained in **Table 3** below:

Table 3. Table of factors that affect cost performance

Project Phase	Indication Factor	EPC Project Performance Attributes
Engineering	X1	Front End Engineering Design information
	X2	BQ Accuracy Performance
Procurement	X3	Subcontractor or vendor finance performance
	X4	Weakness of Contract to vendor or subcontractor
Construction	X5	Site supervision work skill performance
	X6	Construction Control performance
	X7	Sub-contractor's or vendor Performance

The Cost Performance Index (CPI) of each project from Microsoft Project Excel and Primavera 6 (P6) files extracted was used for research study. Mean Square Error (MSE) validation results is used by Matlab simulation. Then, using Microsoft Excel, the Mean Relative Error (MRE) was calculated. This error is used to compare the results of ANN, and traditional EVM methods. The Box-Cox method is used to normalize the data using Microsoft Excel software. The data obtained is then exported to Matlab software for the next stage. The MSE, MRE and CPI formulas are presented as follows:

$$MSE = \frac{\sum(Desired\ Output - Predicted\ Output)^2}{No\ of\ Data} \quad (1)$$

Cost Performance Index (CPI) = BCWP/ACWP (2)

$$MRE = \frac{1}{n}\sum_{i=1}^{n} \frac{|actual_i - estimation_i|}{actual_i} \quad (3)$$

Where ACWP (Actual Cost Work Performed) represents the actual cost of the work performed BCWP (Budget Cost Work Performed) represents the budgeted cost of the work performed and *n* represents number of data.

3.2.Data collection

This primary data was data obtained directly in the form of interviews with the Project Manager, Project Control Manager as a person involved in the project or to an expert who an experienced person in the field by clarifying the components of activities or activities that become

sources of differences in the planning cost budget. The secondary data collection process in this study was obtained in one of the "A" projects carried out by PT. "R" in the gas compressor station facility construction project in the South Sumatra area on March 25, 2015 for 24 months until provisional acceptance where the project has been carried out. This “A” project scheme is Engineering Procurement and Construction lump sum with a contract value of 90,786,517 (USD) and actual cost was 81,456,999 (USD).

3.3.Prioritized data variables that affect the cost performance index

Before the neural network architecture further design, the next step was to identify the related variables. This is done through a series of literature studies and research object studies, as well as the results of interviews / discussions with several related parties, in this case the project manager and project control manager of the project.

3.4.Neural Network Architecture

In this stage, Kulkarni (2018) suggested that the number of input, hidden and output layers must be determined. In this study, an MLP (Multilayer Perceptron) network is used where the output of each layer is considered as the input vector for the next layer. Each layer neuron has a connection with the previous layer neuron. Each neuron's job is to calculate the net layer weight and pass the data through a function called the transfer function. This research, Logarithm Sigmoid is considered to be one of the most useful functions in this case and has been widely used by some experts. Therefore, the function mentioned above is used as a transfer function. The last network in this research is a multilayer perceptron artificial neural network with 7 input variables in one input layer, one hidden layer and one output layer. The schematic structure of the designed artificial neural network is illustrated in **Figure 2** as follows:

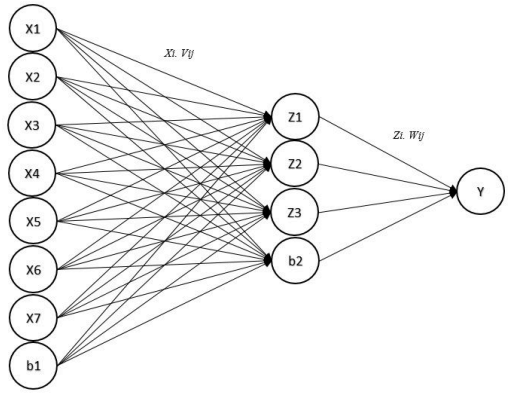


Figure 2 Schematic Structure of the Artificial Neural Network

4. RESULTS

4.1.Identification Variable Selection

The primary data collection process in this study was obtained from the results of interviews and surveys from the project manager, project control manager, functional manager on the "A" project carried out by PT "R" in the gas compressor station facility construction project in the South Sumatra area on March 25 .2015. This project research was carried out for 24 months. The interview data obtained an average value of month 1 (M-1) to month 24 (M-24) of the effective date contract. The top 7 rankings with values above 3.00 are taken as the choice of fixed variables in the input of the artificial neural network (ANN) modeling obtained in **Table 7** as follows :

Table 7. Survey table 7 factors that affect CPI

Project Phase	Indication Factor	EPC Project Performance Attributes	Mean
Engineering	X1	Front End Engineering Design information	3.07
	X2	BQ Accuracy Performance	3.17
Procurement	X3	Subcontractor or vendor finance performance	3.07
	X4	Weakness of Contract to vendor or subcontractor	3.03
Construction	X5	Site supervision work skill performance	3.06
	X6	Construction Control performance	3.00
	X7	Sub-contractor's or vendor Performance	3.15

4.2.Cost Estimate at Completion Using EVM method

In project "A", the budget for project execution has been set at USD 80.8 million from a contract value of USD 90.78 million. Therefore, the project team led by the project manager makes the project S-Curve with calculation steps using the traditional Earned Value Management method, which can be explained on **Table 8** as follows:

Table 8. EAC result using EVM method

Time	Earned Value (EV)	Actual Cost (AC)	CPI	Estimate at Completion (EAC)	%error
M1	33,550.77	39,978.47	0.839	108,179,514.813	32.81%
M2	400,992.66	442,874.19	0.905	100,268,681.616	23.09%
M3	1,356,551.46	1,460,156.00	0.929	97,720,198.319	19.97%
M4	2,288,469.99	2,494,256.41	0.917	98,950,326.125	21.48%
M5	5,567,525.77	6,618,047.90	0.841	107,916,791.653	32.48%
M6	7,879,346.43	8,901,124.70	0.885	102,559,535.315	25.91%
M7	9,757,962.03	11,446,251.12	0.853	106,494,088.496	30.74%
M8	13,376,273.73	13,543,066.19	0.988	91,918,559.227	12.84%
M9	14,827,512.30	16,670,690.82	0.889	102,072,008.120	25.31%
M10	17,233,269.61	20,692,167.74	0.833	109,008,324.061	33.82%
M11	22,682,047.96	24,032,948.78	0.944	96,193,594.008	18.09%
M12	24,314,330.77	27,502,108.51	0.884	102,689,260.316	26.07%
M13	29,147,812.70	30,825,894.11	0.946	96,013,227.060	17.87%
M14	32,472,090.32	34,356,367.07	0.945	96,054,638.662	17.92%
M15	42,999,561.92	37,812,816.69	1.137	79,835,555.798	1.99%
M16	53,508,712.37	42,025,486.31	1.273	71,303,295.443	12.47%
M17	60,415,248.64	45,926,583.01	1.315	69,014,273.763	15.28%
M18	68,789,206.30	52,585,644.25	1.308	69,401,403.838	14.80%
M19	78,014,258.38	60,320,468.39	1.293	70,195,953.189	13.82%
M20	83,499,092.73	67,539,099.95	1.236	73,433,608.017	9.85%
M21	87,351,986.40	72,633,416.24	1.203	75,489,237.849	7.33%
M22	88,786,517.00	77,045,628.38	1.152	78,781,153.800	3.28%
M23	89,901,047.60	79,793,330.92	1.127	80,579,245.600	1.08%
M24	90,786,517.00	81,456,998.56	1.115	81,456,998.558	0.00%
MRE					17.43%

4.3.Cost Estimate at Completion Using Artificial Neural Network

4.3.1. Data input normalization

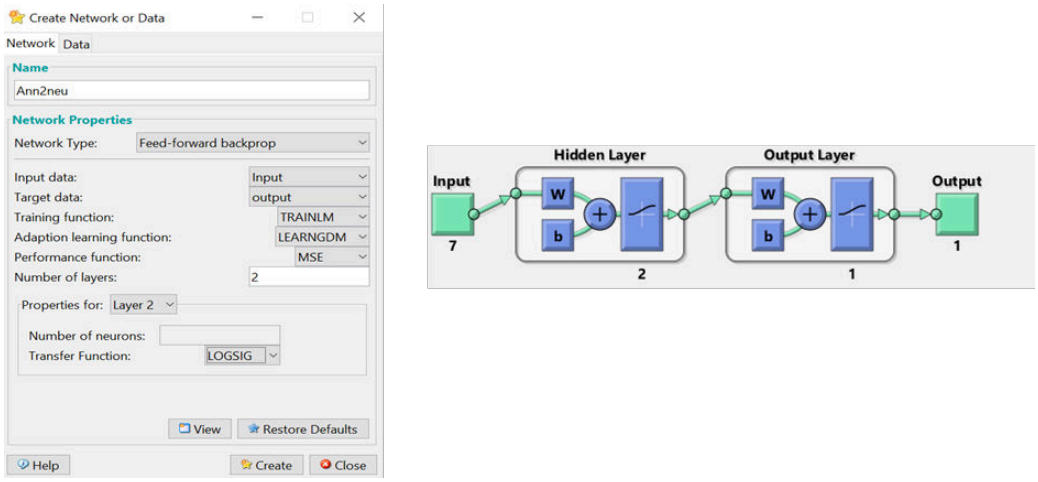
In explaining the calculation results of normalized data in the input data which based on **Table 7**, the normalized survey data results are shown in columns X1, X2, X3, X4, X5, X6, X7 and while the normalized output target data is shown in the output data column where CPI values from M1 to M24. The input data and output data that have been normalized can be shown in **Table 9** as follows :

Table 9. Table of input and output data normalization

	Input Data ANN Matlab							**Output Data ANN Matlab**
	X1	***X2***	***X3***	***X4***	***X5***	***X6***	***X7***	**CPI**
M1	0.80	0.90	0.67	0.77	0.90	0.70	0.90	0.111
M2	0.60	0.44	0.79	0.63	0.50	0.60	0.77	0.220
M3	0.20	0.33	0.33	0.63	0.63	0.50	0.50	0.259
M4	0.20	0.10	0.33	0.63	0.63	0.40	0.77	0.240
M5	0.60	0.56	0.56	0.90	0.90	0.70	0.63	0.114
M6	0.40	0.44	0.67	0.50	0.50	0.40	0.63	0.187
M7	0.60	0.67	0.67	0.77	0.63	0.40	0.63	0.133
M8	0.40	0.33	0.44	0.50	0.37	0.30	0.37	0.357
M9	0.50	0.56	0.10	0.63	0.77	0.60	0.37	0.194
M10	0.90	0.90	0.90	0.77	0.77	0.30	0.90	0.100
M11	0.40	0.44	0.21	0.37	0.50	0.40	0.37	0.284
M12	0.20	0.44	0.44	0.77	0.10	0.90	0.37	0.185
M13	0.30	0.44	0.44	0.63	0.37	0.60	0.10	0.287
M14	0.50	0.44	0.44	0.37	0.50	0.30	0.50	0.286
M15	0.20	0.10	0.33	0.10	0.23	0.20	0.23	0.604
M16	0.20	0.21	0.21	0.23	0.23	0.20	0.10	0.830
M17	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.900
M18	0.20	0.21	0.21	0.23	0.23	0.30	0.23	0.888
M19	0.30	0.21	0.33	0.23	0.37	0.20	0.37	0.863
M20	0.30	0.33	0.21	0.37	0.37	0.40	0.23	0.769
M21	0.40	0.21	0.44	0.23	0.23	0.20	0.50	0.713
M22	0.20	0.33	0.44	0.50	0.50	0.30	0.37	0.630
M23	0.30	0.21	0.44	0.50	0.63	0.30	0.23	0.587
M24	0.30	0.33	0.33	0.37	0.50	0.30	0.37	0.567

After the input and output data normalization has been done, the next step is the selection of the network model type. The selection of the network model in the selection of this research is supervised feed-forward back-propagation which has the advantage of being more adaptive in the training process that is supervised or monitored in viewing the ANN results. Then the step of selecting the training function algorithm with the Artificial Neural Network (ANN) Matlab software, namely Levenberg-Marquardt (LM) and Gradient Descent Method (GDM) for adaptation learning functions in the application. Yu and Wilamowski (2016) suggested that The Levenberg-Marquardt algorithm, developed independently by Kenneth Levenberg and Donald Marquardt, provides a numerical solution to the problem of minimizing non-linear functions which results in fast and stable convergence. In the practical of artificial neural networks, this algorithm is suitable for training

small and medium-sized problems. Therefore, the combination of LM and GDM can be used to predict what will happen based on existing data patterns in the past.



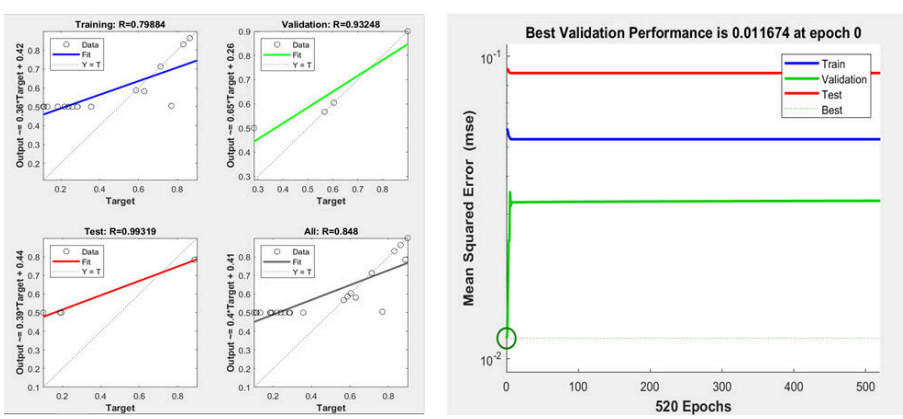
(a) (b)

Figure 3. (a) Create Network and (b) 2-neuron neural network architecture in Matlab

Figure 3 shows the first architectural trial commence with 2 neurons with 1 hidden layer were used with the simulation property input data in illustrates the network architecture illustration.

4.3.2. Best Selection of neural network architectural

In this study, the number of neurons in the input layer of the network is as much as the number of research variables, namely 7 neurons, namely survey data for affecting factors, while the number of neurons/nodes in the output layer is 1, namely cost performance index (CPI) data obtained from project “A” on PT. "R". Feed-forward Back-propagation is actually a training algorithm capable of having many hidden layers. In this study, neural network simulation was commenced with single hidden layer first with 2 neurons in the hidden layer up to 5 neurons in a single hidden layer. Activation of functions in the hidden layer using binary sigmoid (logsig) because the data used uses data normalization ranges 0 and 1. The artificial neural network architecture selection is 3 neurons 1 hidden layer as the optimal number of neurons as an artificial neural network model. The regression validation graph plot of the ANN calculations on Matlab software is as follows :



(a) (b)

Figure 4. (a) Regression result training and (b) MSE in Matlab

Figure 4 (a) shows the results of the ANN trial simulation during training and testing where the R value in training is 0.79 with a validation value of 0.93. While the test results or test values obtained an R value of 0.99 and a validation of 0.84 shows that the results of this trial and simulation can be used. Based on **Figure 4** (b) that shows the mean square error (MSE) of this calculation is 0.011674. In **Figure 2** is an illustration of a network with 7 neurons as input at the value of xi then in hidden layer 1 with the symbol z_j which consists of 3 neurons and there is a bias on the input neuron (b1) and the bias of hidden layer 1 neurons (b2) so as to produce a y value which in research target CPI value. Based on the iteration of the Matlab ANN software, the weight coefficient value of z_j can be generated in the table below:

Table 10. Table of weight coefficients from ANN 3 neurons for determining CPI

variable input	neuron	Z1	Z2	Z3
X11	X1	12.1785	-4.2047	-1.9197
X13	X2	4.908	6.154	-1.4238
X21	X3	-6.5245	-6.1662	1.2328
X23	X4	10.4452	-0.84382	1.3106
X31	X5	-2.3051	-1.6931	1.2138
X32	X6	1.7851	-8.1684	0.7658
X35	X7	6.6295	5.4791	-1.8117
Bias	b1	8.7128	-4.5198	-3.8509

Based on **Table 10** column input variables in ANN are input data on the architectural value of x_i where z_j and bias 1(b1) are the iteration results of ANN in Matlab. Based on Matlab ANN calculations, the following equation is used as follow:

$$net\ z_j = b1_j + \sum_{i=1}^{n=7} x_i v_{ij} \quad (4)$$

$$z_j = \frac{1}{1+e^{-net\ z_j}} \quad (5)$$

Based on equations 4 and 5 simulated in ANN Matlab software, the resulting weight value z_j and bias 2 as input to the target neuron value (y_k).

Table 11. Weight coefficient table on ANN 3 neuron output layer

	Y
Z1	-33.8821
Z2	19.8489
Z3	3.2277
b2	-2.1887

$$net\ y_j = b2_j + \sum_{i=1}^{n=3} z_i w_{ij} \quad (6)$$

$$Y = \frac{1}{1+e^{-net\ y_j}} \quad (7)$$

Table 11 explains the value of the weight or vector coefficient of the value of 3 neurons plus the bias value (b2) to the Y output, namely the CPI results. The calculation results to get the value of Y (CPI) using equations (6) and (7).

4.4.Comparison of ANN and EVM simulation results

Based on analyzing the influencing factors as primary data, project data as secondary data and several experimental scenarios to determine the artificial neural network architecture (ANN) of neurons 2, 3, 4 and 5 with 1 hidden layer. Based on Matlab study that 3 neuron is the best selection with smallest MRE value which described comparison **Table 10** as follow:

Table 10. Recapitulation table of the simulation errors results

Method	MRE
ANN 2 neuron 1 hidden layer	7.08%
ANN 3 neuron 1 hidden layer	6.97%
ANN 4 neuron 1 hidden layer	7.06%
ANN 5 neuron 1 hidden layer	7.11%
EVM	17.43%

Based on **Table 10** shows that comparison of the mean relative error value in the calculation using the traditional Earned Value Management (EVM) method has an error value of 17.43% where the value is greater than the value in ANN. So that in choosing the best network architecture in this study, 3 neurons in 1 hidden layer provide an accuracy of 6.97% with a mean square error (MSE) value in the calculation of 0.011674.

5. CONCLUSION

Based on this research, the factors which affect the final cost estimate in project "A" for the construction of gas compressor station facilities have 7 factors which are the highest have a parameter value above 3 with a scale of 4. The most influential factors in the final cost estimate are (1) Accuracy of Bill Quantity (BQ), (2) performance at the time of construction from sub-contractors or vendors, (3) financial performance of sub-contractors, (4) accuracy of information data from Front End Engineering Design (FEED), (5) work supervision performance during construction, (6) weak contracts with vendors or sub-contractors, and (7) Construction Control performance. It provides interactions that can influence the views of project managers and teams on the factors that affect the estimated cost of completion (EAC) based on the data of 7 key performance index (KPI) factors that affect the prediction of the actual final cost of the project using the method artificial intelligence modeling.

Development of a new forecasting model using artificial neural networks in Matlab software as a comprehensive tool in performing estimation methods. Based on this study, it was found that the tendency of the MRE value with 3 neurons to be smaller than neurons 2, 4 and 5 so that it can be concluded that 3 neurons are more accurate than other neurons. The simulation of the artificial neural network has a higher level of accuracy than traditional calculations where in this study the lowest result obtained was the MRE value of 6.97% while with EVM the MRE value was 17.43%. This artificial neural network can study project conditions based on input and output targets so as to get the coefficient weights on the hidden layer binary sigmoid equations that have been simulated in Matlab software.

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SUPPLY CHAIN RISK ANALYSIS IN PT. BMI USING THE HOUSE OF RISK METHOD TO DETERMINE THE HIGHEST RISK MITIGATION

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ABSTRACT

Data related to the national property market showed positive sentiment in the second quarter (Q2) 2020. The increasing property market in Indonesia will be followed by an increasing competition market as well as the manufacturing industry that makes concrete roofs for buildings, including PT. BMI. The trend of increasing product failures in 2020, the increasing number of customer complaints received, and problems that occur when importing goods from sister companies from the USA, make it urgency to see if the company is able to create a strong risk management supply chain. The purpose of this study is to identify supply chain business processes at PT. BMI, based on the SCOR approach, then, prepares a risk management plan, by identifying risk events and their causes and analyzing and prioritizing potential risks that arise, in order to provide a mitigation response in order to minimize or eliminate risks that may occur. This study uses the HOR (House of Risk) method which is a combination of two methods, namely the Modified Failure Mode and Effect Analysis (FMEA) and adapts the House of Quality (HOQ) method to determine the highest risk mitigation. Analysis of this research resulted in the conclusion of risk identification in the supply chain process at PT. BMI Indonesia using the SCOR model which is divided into the stages of plan, source, make, deliver, return and enable, obtained 52 risk events and 25 agents/causes of risk. From the HOR1 analysis, there are 12 main risk causes that must be considered, for preventive action to be taken, and can be started from the one with the highest total effectiveness value against the degree of difficulty (ETDk rasio).

1. INTRODUCTION

Data from Rumah.com (2020) shows the national property market showed positive sentiment in the second quarter (Q2) 2020. Property supply which had been stuck in Q1 2020, is now recovering. The Rumah.com Indonesia Property Market Index for the second quarter of 2020 indicates the recovery of stakeholder confidence in the property sector, especially from the supply side (developers and other property sellers). Rumah.com Indonesia Property Market Index – Supply (RIPMI-S) in the second quarter of 2020 was at 131.6, increasing 21% compared to the previous quarter. This increase seems to be compensation for where supply in the previous quarter was restrained and fell by 5% (QoQ) in the first quarter of 2020. The increasing property market in Indonesia will be followed by an increasingly competitive market that is increasingly competitive among players in the industry. The increasing property market includes manufacturing industries that make concrete roofs for buildings and houses. BMI Group is the largest manufacturer of flat and pitched roofing and waterproofing solutions throughout Europe, with a significant presence in Asia and Africa. BMI Group is a

Standard Industries company, like GAF, the leading manufacturer of roofing and waterproofing solutions in North America. Together, we are the largest roofing and waterproofing business in the world. Standard Industries is a privately-held global industrial company operating in over 80 countries with over 20,000 employees. The Standard ecosystem spans a broad array of holdings, technologies, and investments—including both public and private companies from early to late-stage—as well as world-class building solutions, performance materials, real estate, and next-generation solar technology.
BMI Group is the sales channel for all products from sister companies under Standard Industries Holding Company, each of which carries products marketed in all parts of the world and, without exception, the duties of PT. BMI in Indonesia, which of course, cannot be separated from the supply chain, which is in charge of bringing in imported goods for the company's business development needs and managing its core business as manufacturing and sales of concrete roof tiles. Companies must constantly improve their performance, including the performance of the Supply Chain Department, to continue to be competitive in the competitive market. In building a competitive advantage for an organization and company, supply chain management is one of the essential strategies in building a competitive advantage with competitors. Given the importance of supply chain management, every organization manager must plan, implement, control, and manage risk in the supply chain management process.

2. LITERATURE REVIEW

2. 1 Supply Chain Concept

Supply Chain is a network of companies/organizations that work together to create and deliver a product into the hands of end-users or consumers (Pujawan and Mahendrawati, 2010). The company or organization includes suppliers, factories or manufacturing, distributors, stores or retailers, and supporting companies such as logistics or transportation service companies. In a supply chain, it can be said that there are 3 (three) kinds of flows that must be managed in the supply chain, namely, first, the flow of goods flowing from upstream to downstream. Second is the flow of money, which flows from downstream to upstream. The third is the flow of information from upstream to downstream or vice versa.

2. 2 Model Supply Chain-Supply Chain Operation Reference (SCOR) Versi 11.0

Various supply chain models can be used by companies, depending on the suitability of the supply chain applied. One is the Supply Chain Operations Reference model, commonly abbreviated as SCOR. The SCOR model provides a unique framework that links business processes, performance metrics, best technology practices, and people into a unified structure.

Figure 1. Six core supply chain processes in SCOR version 12.0 (Supply Chain Council (SCC),2012)

2. 3 Supply Chain Risk Management (SCRM)

In managerial activities, SCRM can be defined as identifying and managing risks for the supply chain through a coordinated approach among supply chain members to reduce the supply chain's vulnerability as a whole. Supply chain vulnerabilities are exposed to severe disruptions stemming from supply chain risks and affect the supply chain's ability to serve customers' end-market needs effectively. According to the Supply Chain Council (2008), SCRM is the systematic identification, assessment, and quantification of potential supply chain disruptions, to control risk exposure or reduce negative impacts on supply chain performance.

2. 4 Supply Chain Risk Methods

Pujawan and Geraldin (2009) developed a model related to supply chain risk management using the House Of Quality (HOQ) and Failure Models and Effects Analysis (FMEA) concepts to develop a framework for managing supply chain risk, known as the House Of Risk (HOR) approach. The HOR approach aims to identify risks and design treatment strategies to reduce the probability of occurrence of risk agents by providing preventive actions to risk agents. The risk agent or the cause is the causative factor that drives the risk. Therefore, reducing risk agents means reducing the incidence of several risk events. The stages in the strategic planning framework using the house of risk (HOR) tool are divided into two parts or phases: risk identification and management.

HOR 1

The risk assessment aims to determine risk agents that need to be prioritized for preventive action. A ranking is carried out based on the magnitude of a value called "Aggregate Risk Potential" from risk agents, abbreviated as ARP.

Business Process	Risk Event (E*i*)	Risk Agents (A*j*)							Severity of risk event *i* (S*i*)
		A1	A2	A3	A4	A5	A6	A7	
Plan	E1	R11	R12	R13					S1
	E2	R21	R22						S2
Source	E3	R31							S3
	E4	R41							S4
Make	E5								S5
	E6								S6
Deliver	E7								S7
	E8								S8
Return	E9								S9
Occurrence of agent *j*		O1	O2	O3	O4	O5	O6	O7	
Aggregate Risk Potential *j*		ARP1	ARP2	ARP3	ARP4	ARP5	ARP6	ARP7	
Priority rank of agent *j*									

Source: Pujawan, 2009

$$ARPj = O_j \sum_i (S_i R_{ij}) \qquad \text{..... (Formulas 1)}$$

Where :

Oj = Probability of Occurance from risk causes j

Si = Severity of Impact if risk event I occur

Rij = Correlation between the causes of risk j with the event I, it can be interpreted how likely risk agent j can be caused risk event i

HOR2

HOR2 is risk management or risk response, which aims to perform a sequence of mitigation strategies that need to be carried out by the company to minimize the cause or source of the risk that occurs.

ETDk = Tek / Dk …… (Formulas 2)

Where :

ETDk = Ratio of Total Effectiveness to Difficulty Level

Tek = Total Effectiveness of each k mitigation action

Dk = Difficulty level in carrying out mitigation actions

To be treated RiskAgent (Aj)	Preventive Action (PAj)					Aggregate risk potentials (ARPj)
	PA1	PA2	PA3	PA4	PA5	
A1	E11					ARP1
A2						ARP2
A3						ARP3
A4						ARP4
Total effectiveness of action *k*	TE1	TE2	TE3	TE4	TE5	
Degree of difficulty performing action *k*	D1	D2	D3	D4	D5	
Effectiveness to difficulty ratio	ETD1	ETD2	ETD3	ETD4	ETD5	
Rank of priority	R1	R2	R3	R4	R5	

3. METHODS

The identification stage is the first step in this research that directly observes the problem at the research location. After identification, the problem formula is created and then set research objectives. Furthermore, library studies and field studies support research to run well and correctly. The second stage is the mapping stage of supply chain activity, where supply chain activity is divided into three parts: procurement, production, and distribution. Finally, interviews and observations obtain the mapping of supply chain activities. The data processing stage is the next after the data has been collected. Data processing aims to determine the severity of a risk event and the event of a risk agent. This risk analysis is then mapped to the House of Risk 1 (HOR1). Identification of risk events and agents is conducted by an interview with the Senior Manager who has worked more than five years at the company. In addition to business processes are also identified parts that are responsible for the business process for each business process. In such models, the risk event and the source of risk are given the value of its correlate, then the aggregate risk priority (ARP) value of each risk source is calculated. These results are then recorded using the principle 80/20 of the Pareto diagram to determine the selected risk agent. After HOR1 is mapped, mitigation actions are identified that are mapped on HOR2. In this phase, the total value of the effectiveness of mitigation actions (Tek) is calculated, the level of difficulty in mitigation actions (DK), and the total effectiveness of the level of difficulty in carrying out mitigation actions.

(ETDk).

4. RESULTS

4.1 Business Mapping Proses

Business processes at PT. BMI Indonesia is divided into two business fields: manufacturing sales of pitch roofs / concrete roof tiles and trading or sales of Flat Roofs and waterproofing. The manufacturing business process of selling concrete roof tiles describes as follow: First, the customer sending the purchase order/PO to the salesman/customer service; second, the customer service inputting the order into the ERP system (ACCPAC); third, compiling the OIH data (order in hand) and forecasts made by the sales team; fourth, makes a report to be sent to the Supply Chain, to make an MRP (Material Requirement Plan) and Manufacturing Planning Schedule/MPS for each product profile and color that will be produced on the production/manufacturing line. After that, the production department will produce products according to their specifications and quality standards. After that, the production results are stored in the Yard/FG storage until the product is mature and ready to be sent according to customer demand. As for the trading business or sales of Flat Roof and waterproofing, the process of the order follows this sequence: starting from the customer sending a purchase order/PO to the salesman/customer service, then customer service inputting the order into the ERP system (ACCPAC), compiling OIH data (order in hand) and forecast made by the Sales team, an OIH+Forecast report is made to be sent to the supply chain/inventory control section. Then, the supply chain section will make a PR (purchase request) to the purchasing department. Finally, purchasing will make a PO to the BMI sister company in Europe or the USA according to the product ordered by the customer. Trading products sold by PT. BMI, for now, is a manufacturing product from sister companies that are incorporated and under the Standard Industries Holding Company, namely GAF USA and ATLM Malaysia.

4.2 Risk Event and Risk Agents

From the mapping business process and supply chain activity, it is further identifying and measuring risk events and risk agents. These measurements are performed to determine the severity of a risk event and the risk agent's occurrence (level of probability occurring). In addition, an interview with a related Manager who has worked in the company for more than five years was conducted in FGD (Focus Group Discussion) and interview with key person in each process supply chain activity.

Table 1 Identified Risk Events Measurements Result

Business process	**Sub-Proses**	**Code (Ej)**	**Risk Events (Ej)**	***Severity***
Plan	Demands Forecast	E1	Significant Forecast error: Production *Tiles line*	7
		E2	Significant Forecast error: Production *Fittingline*	7
		E3	Significant Forecast error: *Trading Goods / RSC (Roof System Component)/Flat Roof Shingles dan TPO-Synthetic membrane*	6

Business process	Sub-Proses	Code (Ej)	Risk Events (Ej)	*Severity*
		E4	Not accurate Production Plan or *replenishment order*	2
	Calculation of Raw Material Usage Plan	E5	Sudden changes in forecasts or production schedules	2
	Inventory control for *raw material/supplies* and *spare part*	E6	There are differences in stock data in the system with actual goods	2
		E7	Ordering error (quantity of goods ordered)	4
		E8	Wrong *inputting data* and *item/part number* when GRN (*Good receive Note*) process	2
		E9	Occurrence of stock variance on the results of stock take	2
Source	Purchasing Process	E10	Delay in requesting RFQ (Request For Quotation) to Supplier	4
		E11	Delay in reviewing the RFQ (Request For Quotation) from the Supplier	2
		E12	Error shipping goods by the supplier	4
		E13	Delay in the PO approval process-if it requires approval	1
		E14	Late payment of invoices from suppliers	2
		E15	Purchase media (Accpac system) error or email RFQ/PO to supplier failed	2
	Supplier Evaluation and Developments	E16	Communication with Supplier not perform	2
		E17	Contracts violated by the Supplier	4
		E18	*Supplier closed/shutdown*	1
		E19	Supplier communication is not going well	2
		E20	Lack of production or supply capacity	1
Make To Order/Production	Production Process and Quality Control	E21	Product Reject/NG (Not Good)	4
		E22	Raw material Shortage	4
		E23	Existing Raw Material Inventory cannot be used	4
		E24	Production Process Delayed	3
		E25	Production Line Downtime	7
		E26	Changes in production schedule due to urgent orders	3

Business process	Sub-Proses	Code (Ej)	Risk Events (Ej)	*Severity*
		E27	Production has quality problems	6
		E28	Production workers strike	3
		E29	measuring tool or quality test is damaged	2
Delivery	Selection of transportation company/transporter	E30	Improper truck/fleet capacity planning	4
		E31	Space ships are complex during crowded / Peak Season	4
		E32	truck/transporter company Non-performing	3
		E33	The contract agreement is violated by the truck or transporter company	4
		E34	Wrong Delivery order	2
	Entry of Trading Goods to Finished Goods Warehouse	E35	Goods received do not match the PO, type, or quantity	4
		E36	Items damaged during the handling process	3
	Delivery of products to customers	E37	Late delivery	7
		E38	Product damaged during transportation	4
	Exim Process	E39	Contract Agreement violated by Forwarding Company	3
		E40	Wrong or late shipping/customs clearance documents	3
		E41	There is a problem with the regulation of the importation of goods	4
		E42	Late payment for customs Billing Duties &Tax	2
	Inter Plant product transfer delivery	E43	Product Loss during transport	4
		E44	Products need to be re-shorted at the branch warehouse/distributor warehouse	4
Return	Return of purchased items to Supplier	E45	The wrong item supplied	4
		E46	Expired Goods	4
		E47	Goods do not pass the incoming inspection	2
		E48	The supplier does not want to accept the returned goods	3
		E49	Late in process *Credit Note*	3
	Exim process	E50	Import return document not accepted	2

Business process	Sub-Proses	Code (Ej)	Risk Events (Ej)	*Severity*
Enable/ Maintenance and compliance	IT Infrastructure maintenance	E51	IT Infrastructure breakdown/Failure	4
	Laws and regulations do not comply.	E52	Changes in Export-Import regulation are not updated	4

Table 2 Identification of Risk Agents and Probability level

Code (Aj)	Rock Agents (Ej)	Probability
A1	Significant Increasing Demands	6
A2	Suppliers are still conventional or home industry	2
A3	Lack of knowledge about production planning and inventory control	2
A4	Error input/data entry in System Accpac	2
A5	PR (Purchase requisition) suddenly urgent	3
A6	The specification of the purchased item in PR is not clear	2
A7	Technical evaluation takes a long time	2
A8	Dependence on one supplier	1
A9	Natural Disaster or Force Majeure	2
A10	Internet line is disconnected	3
A11	Bankrupt supplier	1
A12	Customs rules change/customs process does not match	2
A13	There is wrong or inappropriate handling	4
A14	It takes time to process import permits affected by Lartas (limited prohibition)	3
A15	Breakdown/Crash system IT	2
A16	Irregularity in carrying out procedures in the storage area	6
A17	The arrival of the ship is not according to schedule	3
A18	The QA/QC process is not carried out optimally	3
A19	Freight fleets often do not arrive on schedule	4
A20	Breakdown of internal or external communication	2
A21	Incorrect Parts/ Items storage does not match the location	2
A22	Production machine parameter setting failure	6
A23	Blended Mortar failure for production	6
A24	Sales do not know the condition of the customer's project progress	8
A25	Cash Flow Problem	4

Once the risk event and risk agent have been identified, the next step is to determine the value of the inspection between those two. If there is no examination, the value of 0, low examination is represented by the number 1, intermediate examination by 3,

and 9 represents the high. Both data were collected using interviews with a manager who had worked at the company for a long time.

4.3 House of Risk 1 (HOR 1)

Activity mapping in this model is done by entering the severity of the measurement of risk events, as shown in Table 1. At the same time, the events of the risk agent and probability value can be seen in Table 2. The result of the mapping of the HOR 1 using formulas 1 (ARP=Aggregate Risk Potential) was then rendered by using the Pareto diagram shown in Figure 1.

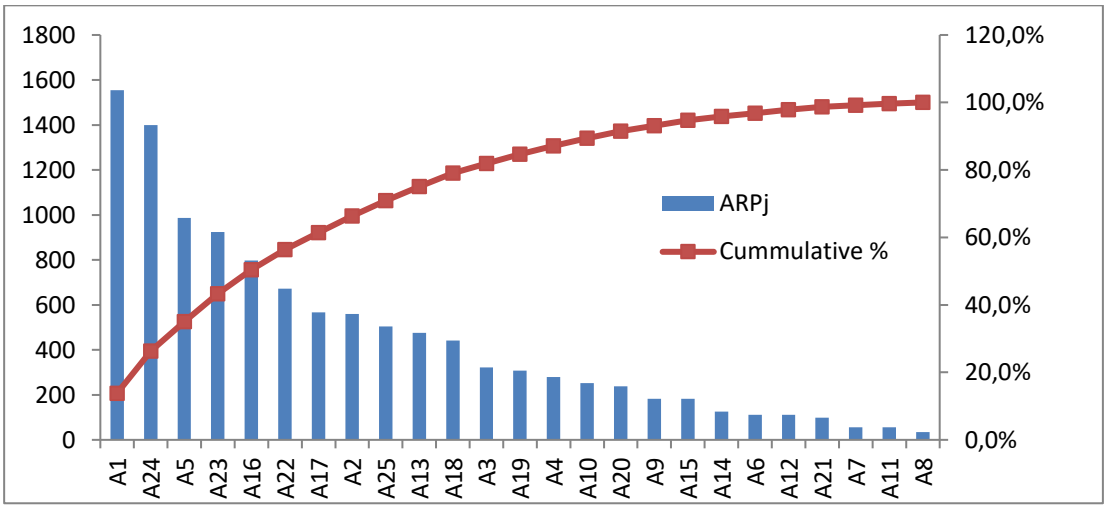

Figure 1 ARP Pareto Diagram

Based on the ARP diagram in Figure 1 and using the 80/20 principle from Pareto, risk agents will be chosen as a basis for consideration in choosing risk mitigation actions. Based on the Pareto diagram above, it can be seen that the ranked ARP values and the highest ARP values, above 80%, provide 12 (twelve) risk causes in the form of A1, A24, A5, A23, A16, A22, A17, A2, A25, A13, A18, A3 which contributed as much as 82% of the total ARP value. These risk agents will be included in the HOR 2 model to determine mitigation actions intended to reduce the impact of risk agents. Recommended mitigation actions are shown in Table 3.

Table 3 Identification of Mitigation Action Plan

Kode (Aj)	Penyebab Resiko (Aj)	Kode (Paj)	Tindakan Pencegahan
A1	Significant Increasing Demands	PA1	Creating a CRM (Customer Relationship Management) program
A24	Sales do not know the condition of the customer's project progress	PA6	Forecasting demand and inventory is made collaboratively
A5	PR (Purchase requisition) suddenly urgent	PA5	The need for collaboration with suppliers
A23	Blended Mortar failure for production	PA11	Improved integration between functions or departments within the company
A16	Irregularity in carrying out procedures in the storage area	PA7	SOP (Standard Operating Procedure) is adequately executed through reward and punishment
A22	Production machine parameter setting failure	PA8	Refreshment training to shop floor staff

Kode (Aj)	Penyebab Resiko (Aj)	Kode (Paj)	Tindakan Pencegahan
A17	The arrival of the ship is not according to schedule	PA9	Production Planning dynamically following demand conditions (Fast Moving, Slow Moving, obsolete)
A2	Suppliers are still conventional or home industry	PA10	The Supplier Development Program is carried out consistently
A25	Cash Flow Problem	PA14	Emphasizing communication culture in teamwork
A13	There is wrong or inappropriate handling	PA13	Implementation of 5S and Factory Excellent program
A18	The QA/QC process is not carried out optimally	PA4	Fulfillment of stock from the nearest warehouse plant
A3	Lack of knowledge about production planning and inventory control	PA12	The Job and external Training Skills and competency

4.4 House of Risk 2 (HOR2)

Measuring the effectiveness of the level of difficulty is a step that must be determined in the next stage by dividing the total value of effectiveness (Tek) by the level of difficulty through action. The level of effectiveness of the difficulty is aimed at ranking the priority of all mitigation actions, using the following formulas 2.

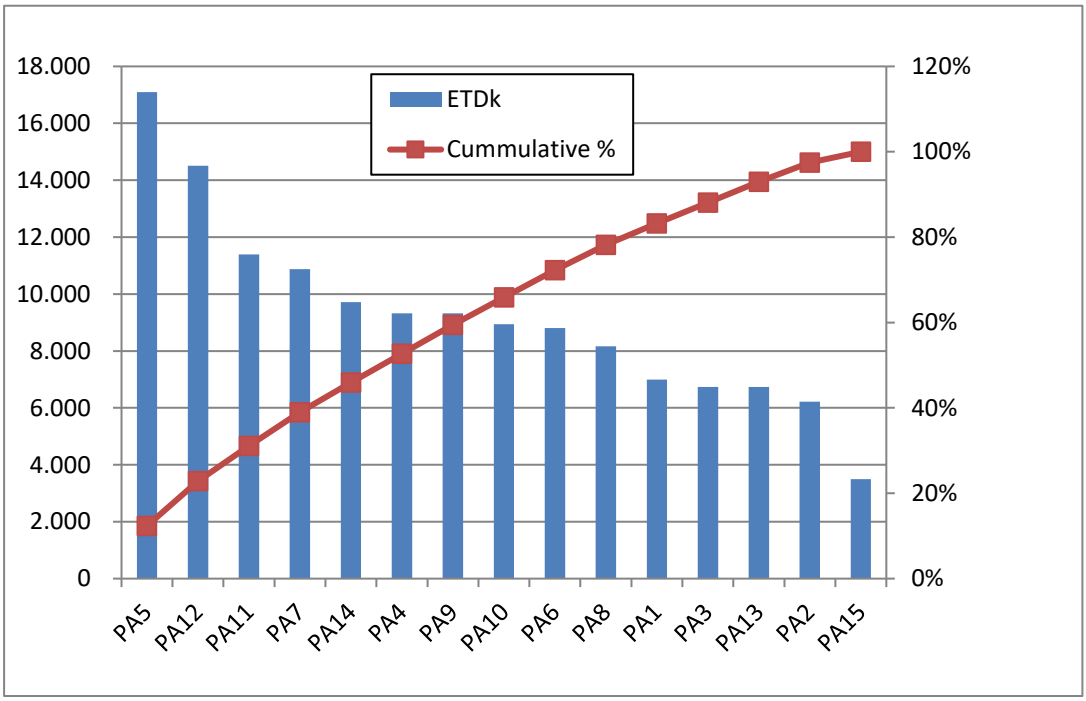

Figure 2 Priority of Mitigation Action Plan

Figure 2 shows mitigation actions carried out in sequence accordance with ETDk values. It can be seen that the highest ETD value is PA5 (The need for collaboration with suppliers) of 17,094, where mitigations actions are most likely to be done first to prevent A5 (Purchase requisition (PR) suddenly urgent). If we look at only 80% values of ETDK, The most challenging mitigation action to take is PA1 (Creating a

Customer Relationship Management/CRM program, which has an ETDk value of 6,993. This mitigation action is carried out to overcome A1 (Significant Increasing Demands).

5. CONCLUSION

This research has been carried out on the Supply Chain activities of PT. BMI Indonesia has identified 52 Risk Events and 25 Risk Agents. The results of the HOR1 mapping obtained 12 risk agents that need a mitigation action plan. The highest ARP value is 1554, which is Significant Increasing Demands, and the lowest is 35, dependent on one supplier. Furthermore, Mapping HOR2, using the 80/20 principle from Pareto, 12 draft mitigation action plans will be chosen as a basis for consideration in choosing risk mitigation actions. The highest ETDk value is 17,094, which collaborates with the supplier to mitigate risk whenever there is a need for support for the Supplier to fulfilling PR (purchase requisition) urgently. This can solve the issue of uncertainty forecast demands from Sales/Customers because the mitigation plan for these risk agents, ETDk value is low, which means that not easy to have and could be costly to do CRM (customer relation program) system base. Of course, there are still some mitigation action risk agents from the results of this research that might be done immediately and are not too difficult, and require much cost.

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RISK ANALYSIS OF PROJECT REPLACEMENT TRANSFORMERS AND COS (CHANGE OVER SWITCH) TO PRODUCTION CONTINUITY USING *HIRARC (HAZARD IDENTIFICATION, RISK ASSESSMENT AND RISK CONTROL)* METHOD IN PT. XYZ

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ABSTRACT

PT. Quadro is a contractor company focused on mechanical and electrical engineering collaborating with PT. XYZ includes maintenance and repair of electric power tools and power plants to supply production at PT. XYZ. In addition, there is also the implementation of ATS (Automatic Transfer Switch), which changes manual COS (change over switch) to automatic COS. The project has a high level of risk. This study aims to determine which actions to take to minimize the risks if the replacement process carries out without power outages or more detailed planning for a very high-risk process. Furthermore, relevant data collection determine the risks and mitigate the risks taken—interview at the start of the work permit. HIRARC (Hazard Identification, Risk Assessment and Risk Control) determines risk analysis by modelling to describe and analyze the path of a risk from cause to impact. Researchers expected this study to figure out danger and risk anything that could impact the project replacement cos and a transformer on the continuity of production in PT. XYZ risk mitigation and can do in order to reduce the risk.

Keywords: Risk, risk register, continuity production, HIRARC, industry

1. INTRODUCTION

PT. XYZ is a company engaged in food production. They have some sections such as production A, B, and C. This company use is supporting utilities including electricity as the main supply, steam boiler, air conditioner as cooling material for products A, B, and C, gas as fuel for steam boiler and fryer production B, wastewater treatment and process (WWTP) storage system for the decomposition of toxic substances through bacteria. Several production support facilities must operate 24 hours a day. Since if they are down, the material condition will get poor and cause environmental pollution.

PT. Quadro is a contractor engaged in mechanical and electrical engineering collaborating with PT. XYZ, which includes maintenance and repair of electric power tools and power plants to supply production at PT. XYZ. PT. XYZ plans to replace the SUTR network, which will carry out by PT. Quadro by the SPK that PT. XYZ has made with work standards that have electrical certification. This project carries out in stages following the time set by PT. XYZ because can affect work productivity and the level of supporting utility needs. Each replacement of the SUTR network will have its risks, therefore PT. Quadro and PT. XYZ must have a risk mitigation strategy if the transformer is required to turn off entirely during the project. This action dramatically affects the continuity of production and the security aspects of products A, B, and C. The position of the transformer plays an essential role in the production process because the transformer is the primary source of electricity supply at PT. XYZ, all production machines and utility tools depend on electrical energy generated from transformers.

The production team must meet several standards to meet production quality standards related to electrical energy, which are not allowed to turn off completely in a relatively long period because a prolonged blackout on product A will affect the quality of production. The product will get damaged due to room temperature. It becomes up, and RH also goes up because the AC is off.

The strategy is to maintain the room temperature in production A to follow standards and targets to prevent damage to raw materials. Fresh items in production B do not rot due to lack of air circulation. It keeps bacteria that appear on raw materials in production C because cold storage still requires electricity and the WWTP area, which includes a toxic waste treatment system where the bacterial decomposition system must not shut down due to blackouts. The hydrant pump must also remain on to maintain water pressure which must be ready in the event of a fire incident in an area.

Because of the COS and Transformer replacement project at company XYZ, there is a desire to conduct research on risk and hazard analysis that may occur and how to overcome them. The method used in this study is HIRARC (Hazard Identification, Risk Assessment, and Risk Control). The HIRARC method aims to identify hazards and risks, handle them, and prevent or control them. HIRARC (Hazard Identification, Risk Assessment, and Risk Control) is a risk management method that prevents or minimizes work accidents (Nurmawanti et al., 2013). The HIRARC method consists of Hazard Identification, Risk Assessment, and Risk Control (Wijaya et al., 2015). In other words, there are several stages in the HIRARC method, and the first is risk identification.

2. LITERATURE REVIEW

2.1. Definition of Risk

Risk is a combination of the likelihood and severity of an event. The greater potency for an event to occur and the greater its impact, consider the riskier incident. Risk describes the magnitude of the possibility that a hazard can cause product failure and the severity that can result from it. The risk of replacing a transformer is a combination of the possibility of an accident (probability) and consequences (consequences/severity) (Ramli, 2010).

According to Ramli (2010), the risks faced by an organization or company are influenced by various factors, both internal and external. Such as financial risk, market risk, catastrophes, operational risk, security risk, and socio-cultural risk are among them.

2.2. Risk Management

Risk management is all a series of activities related to risk. Among them are planning (planning), assessment (assessment), handling (handling), and monitoring (monitoring) risks (Kerzner, 2001). PT. XYZ adapts SNI ISO 31000:2018 in developing a risk management system. SNI ISO 31000:2018 consists of three components, namely principles, framework, and risk management processes. The principles guide the characteristics of effective and efficient risk management. The framework assists in integrating risk management into the organization's activities and functions. The process involves systematically applying policies, procedures, and practices to risk management activities. In other words, principles are the basic foundation of risk management. The framework is a risk management system with a PDCA cycle, while processes are actual risk management activities (SNI ISO 31000:2018). Here is an illustration diagram of SNI ISO 31000:2018

The six-stage process consists of three core stages (scoping, context, and criteria; risk assessment; and risk treatment) and three umbrella stages (communication and consultation; monitoring and review; and recording and reporting). The process begins with communication

and consultation among stakeholders. Furthermore, the determination of the scope, context, and criteria followed by risk assessment and risk treatment produces the output of the risk management process, such as a risk register. The outputs of this process are followed up by monitoring and review and recorded by recording and reporting. In order to establish the context in risk management, we must first know the goals and concerns of stakeholders, both internal and external stakeholders.

2.3. HIRARC (HAZARD IDENTIFICATION, RISK ASSESSMENT, AND RISK CONTROL)

HIRARC method has several stages. The first one is risk identification. Risk identification is carried out based on locations and activities that are dangerous or that may pose a risk. After identification of risks, then risk assessment, risk assessment is carried out to determine the level of risk or danger that exists in a location or activity. After completing the risk assessment, it is necessary to take a risk and hazard control plan to minimize risk and prevent accidents or losses at work.

Risks are analyzed by considering what will happen and how the impact will be on the entity, and later these risks can be managed or minimized so that they do not have a significant impact on the entity. In this study, risk assessment uses two techniques: qualitative risk analysis, determining priorities or practical response actions by combining and measuring the probability of risk occurrence and impact. Meanwhile, the quantitative risk analysis method is a numerical analysis process by identifying the overall project risks' effects. This quantitative risk analysis prioritized risks in the previous qualitative risk analysis as the most potential risks in project sustainability.

Risk assessment based on likelihood and severity. Likelihood shows how often accidents occur, while severity shows how severe the risk or hazard is. Likelihood and severity determine the risk rating. The definition of Risk rating is a value that indicates the risk is at a low, medium, high, or extreme level (AS/NZS 4360).

Table 2.1 *Likelihood* Scale on The HIRARC Guide Malaysia 2008 Standard

Level	LIKELIHOOD (L)	Description	Score
5	*Most Likely*	The most common hazards	E
4	*Possible*	It happens often but does not always happen	D
3	*Concelvable*	It can happen at any time	C
2	*Remote*	It never happened in years	B
1	*Inconcelvable*	Impossible to happen or never happened before	A

Table 2.2 *Likelihood* Scale on AS/NZS 4360 Standard

Level	Likelihood (L)	Description	Score
5	*Almost Certain*	There are ≥ 1 accident in every shift	E
4	*Likely*	There are ≥ 1 accident in every day	D
3	*Posibble*	There are ≥ 1 accident in every week	C
2	*Unlikely*	There are ≥ 1 accident in every month	B
1	*Rare*	There are ≥ 1 kejadian dalam setahun atau lebih	A

Table 2.3 *Severity* Scale on HIRARC Standard Guide (2008)

Level	Severity (S)	Description	Score
1	*Insignificant*	No injury, slight financial loss	A
2	*Minor*	Minor injury, slight financial loss	B
3	*Moderate*	The injury requires medical treatment, significant financial loss	C
4	*Major*	Serious injury ≥ 1 (one) person, significant loss, production interruption	D
5	*Catastrophic*	Fatal one person, considerable loss and far-reaching impact, cessation of all activities	E

After analyzing the risk using the Severity (S) and Likelihood (L) scales, it is necessary to carry out a risk assessment using the Severity (S) × Likelihood (L) matrix.
Risk Level = L × S

Table 2.4. *Severity* vs *Likelihood* Matrix

	Severity (S)				
Likelihood (L)	1	2	3	4	5
1	5	10	15	20	25
2	4	8	12	16	20
3	3	6	9	12	15
4	2	4	6	8	10
5	1	2	3	4	5

Source : Malaysia *HIRARC Guide* (2008)

Risk Level :

High = Moderate = Low =

Table 2.5 Scale Score and Risk Treatment

Score	Description	Treatment
15-25	High	HIGH risk requires immediate hazard control. The form of control must also be written in the Risk Assessment form along with the control date.
5-12	Moderate	MEDIUM risk requires risk control and periodic work supervision. The form of control must also be written in the Risk Assessment form along with the control date.
1-4	Low	LOW risk can be left, or control is not needed. However, if the risk can be eliminated, eliminate it immediately.

Source : HIRARC *Guide* 2008

After conducting a risk analysis and risk assessment, the next step is to control risk. Risk control is a way to overcome the potential hazards and risks in the work environment that can interfere with individual performance, cause accidents, disrupt the production process, and others (Wijaya A, 2015). According to Soehatman Ramli (2010: 102), risk control is a

decisive step in overall risk management. Concerning the risk of the production process, the strategy for risk control is carried out in several ways, such as: reducing the likelihood, reducing consequences, and transferring risk.

3. METHODOLOGY

This study serves to identify the risks before and during the project of replacing the distribution transformer 3500 kVA 20kV/380 v and replacing COS on the continuity of production at PT. XYZ. By finding out what risks will occur when replacing the 3500 kVA 20 kV/380 kV distribution transformer and replacing COS at PT XYZ, determining the level of risk using the HIRARC method, and mitigating risks using the ALARP technique.

After the researcher surveys the respondents, the research variable data will be known to determine the variables that influence the project phase of replacing the distribution transformer 3500 kVA 20kV/380 v and replacing COS on the production process at PT. XYZ. By using the following questionnaire design:

IDENTIFIKASI BAHAYA, PENILAIAN
DAN PENGENDALIAN RISIKO (IBPR)

Department :
Nama :

NO	IDENTIFIKASI BAHAYA				PENILAIAN RISIKO			PENGENDALIAN RISIKO	CATATAN
	AREA	PROSES/ AKTIFITAS	POTENSI BAHAYA	DAMPAK/POTENSI RISIKO	LIKELIHOOD	SEVERITY	KATEGORI		

Tanda Tangan

Figure 3.1 HIRARC Worksheet Table

4. RESULT

4.1 Result of Hazard Identification and Risk Assessment at Transformer Replacement Phase and COS

The following are the results of identifying potential hazards and risk assessment of product A when the transformer and COS are replaced:

Table 4.1: Risk Assessment on product A in a transformer and COS replacement

Product	Process/Activity	Potential Hazard	Likelihood Probability	Severity Consequence	Risk Level (L × S)	Risk Rating
Product A	1. Damage to the air conditioning in the packing area	1. Production material loss	5	3	15	Medium
		2. Damage to the electrical panel	2	4	8	Low
		3. WIP material melts (cracking)	5	2	10	Medium
	2. Damage to the AC system	1. Production material loss	5	2	10	Medium
		2. Blocking occurs in the pipe	5	3	15	Medium
	3. Production machine off	1. Electrical short	4	3	12	Medium
		2. Mechanical Breakdown	5	2	10	Medium

	4. Cannot use supporting tools	1. Difficulty using sanitation support tools	5	3	15	Medium
		2. There is no reasonable explanation	5	3	15	Medium

The risk identification is carried out by PT. XYZ for product A when there is a power outage for transformer replacement, and COS is an observation on materials and machines. The identification results occur in the potential damage to the AC packing area, damage to the AC system, the production machine is off and cannot use supporting tools.

Table 4.2 : Risk Assessment on product B in a transformer and COS replacement

Product	Process/Activity	Potential Hazard	Likelihood Probability	Severity Consequence	Risk Level (L × S)	Risk Rating
Product B	1. AC area off	1. Production material loss	3	5	15	Medium
		2. Moldy walls	1	3	3	Very Low
	2. Prodution machine off	1. The remaining raw materials	3	4	12	Medium
		2. Machine settings	2	3	6	Low
		3. Production reprocessing is hampered	5	2	10	Medium
		4. The conveyor is off, so manual handling	5	4	20	High
		5. There is a deposition of production material	3	2	6	Low
		6. Electrical short circuit due to damaged panels	1	5	5	Low
	3. Fresh material RM	1. Wet raw material shrink	5	3	15	Medium
		2. RM . decay occurs	2	5	10	Medium
		3. Damage to raw materials (RM Meet)	2	5	10	Medium
		4. Loading fresh RM is interrupted	3	3	9	Low
		5. Flycatcher goes out	2	4	8	Low
	4. Weekly sanitazion	1. Wet and slippery floors slip risk	2	3	6	Low
		2. The emergence of dirt deposits	2	3	6	Low
	5. Furnace replacement project	1. The oil furnace is fragile and damaged, so it is	2	3	6	Low

		dangerous if destroyed				
	6. Floor uncreate project	1. The floor has many holes so that the material is lost and microbes grow	2	3	6	Low
	7. Air conditioning project	1. Breathing is disturbed because there is no fresh air circulation	2	4	8	Low

Table 4.3 : Risk Assessment on product C in a transformer and COS replacement

Product	Process/Activity	Potential Hazard	Likelihood Probability	Severity Consequence	Risk Level (L × S)	Risk Rating
Product C	1. RM Dumping Room	1. Fall	1	1	1	Very low
		2. Bump	1	1	1	Very low
		3. Many sensor errors (proximity, PH proximity sensor, etc.)	2	2	4	Low
		4. RM cacking occurs because there is no AC supply	3	4	12	Medium
	2. Buffer space	1. Close the fall buffer	2	1	2	Very low
		2. The difficulty of sanitation	1	1	1	Very low
		3. Many sensor errors (proximity, PH proximity sensor, etc.)	2	2	4	Low
		4. RM cacking occurs because there is no AC supply	3	4	12	Medium
		1. Damage to the electrical panel (inverter)	2	1	2	Very low
		1. Damage to the process machine	2	3	6	Low
		2. Printing machine error	3	4	12	Medium
		3. Robot machine error	3	4	12	Medium
	3. Stirring room	1. WIP material is damaged	3	5	15	Medium

Table 4.4 : Risk Assessment on WWTP products in a Transformer and COS replacement

Product	Process/Activity	Potential Hazard	Likelihood Probability	Severity Consequence	Risk Level (L × S)	Risk Rating
WWTP Product	1. Microbes death	1. Environmental pollution	5	5	25	High
	2. Slip	1. Death	1	1	1	Very low
	3. Splash	1. Death	1	5	5	Low

4.2 Risk Control

Risk control aims to minimize the level of risk from the potential risk of existing losses. The following are the findings of risk control:

Table 4.5 : Risk control of potential risk at manufacturing stage

Manufacturing Stage			
Product A (Seasoning)	**Product B (Oil)**	**Product C (Flavor)**	**The manufacturing stage of the WWTP product**
In the AC packing area, risk control can be carried out in the forme AC must remain ON, the material must be moved to the appropriate place, repair the electrical panel, the AC must be ON first	In the AC area that is off, risk control can be carried out in the AC must remain ON. The material must be moved to a suitable place.	In the RM dumping room, risk control can be carried out in the form of installing emergency lights at several points, adding PPE, adding glow in the dark sticker markings, installing UPS systems at several critical sensor points, minimizing RMs that are already open, and providing area electricity supply. RM storage.	The AC must remain ON, and the power must be full.
In the AC system, risk control can be carried out in the AC must remain ON and flush the pipe.	When the production machine is off, risk control in the form of air conditioning must remain ON, communicate information about a power outage that was carried out two days before so that a solution can be prepared that will be carried out in the event of a power outage.	In the RM buffer room, risk control can be carried out in the form of making a unique holder for the buffer cover, installing an attention area if the area is dangerous, providing an electricity supply to the RM storage area, providing electricity supply in the form of a socket so that the sanitation machine can still run, installing a UPS system in the storage area. Several critical sensor points, minimizing the RM that is already open and minimize the electricity supply of the RM	

		storage area.	
In the off production machine activity, risk control can be carried out in the form of air conditioning must remain ON.	On fresh RM material, risk control can be carried out in the form of AC must be kept ON.	In the mixing room, risk control can be carried out in the form of closing the electric panel of the mixing room.	
When it is not possible to use supporting equipment, risk control can be carried out by providing emergency lights, providing alternative electricity supplies during blackouts so that they can still carry out sanitation and still get lighting	At weekly sanitation, risk control can be carried out in the form of providing electricity supply in the form of a socket so that the sanitation machine can still run.	In the packaging room, risk control can be carried out in the form of installing a UPS system at several critical sensor points, pressing the emergency button mode, and making a robot save the program on the PLC system.	
	In the fryer furnace replacement project, risk control can be carried out by replacing the damaged furnace as soon as possible with a new one before the furnace breaks/destroys.		
	In the uncreate floor project, risk control can be carried out in the form of immediate repair of the perforated floor.		

The risk rating reduction is focused on the main risks that occur in PT XYZ, are:

1. Risk in product B due to the production machine which has the potential to cause loss to the conveyor dies, so that manual handling that occurs seen in the completion of both in the production area which results in sprains of workers, low back pain and hernias. Risk reduction is expected to reduce from high risk to the low-risk category. The action that needs to be taken is to control the risk that the AC must be ON and communicate information about a power outage that was carried out two days earlier to prepare a solution that will be carried out in the event of a power outage.
2. The risk on the part of the WWTP product due to the death of microbes that impact the polluted environment by the presence of electricity for 24 hours that occurred in the transformer replacement project and COS. Risk reduction is expected to reduce risk from high-risk category to low risk. The action that needs to be taken is that in the WWTP product area, control can be carried out in the form of the AC must remain on, and the power must be maximum.

5. CONCLUSION

Based on the results of Risk Management research using the HIRARC (Hazard Identification Risk Assessment and Risk Control) method at PT XYZ, the authors draw the following conclusions that e risk of loss is relatively large. The risk of loss is quite significant in product A (seasoning products) due to the loss of production materials. There is blocking in the pipes, difficulties in using sanitation support tools, and no good lighting. The risk of immeasurable material loss in product B (oil product) will occur due to a dead conveyer requiring manual handling. Meanwhile, a significant loss of product B will occur due to the shrinking of wet raw materials. The risk of immeasurable material loss in product C (flavored product) will occur due to the presence of WIP material that becomes damaged due to the cessation of production. The risk of significant material losses in product C will occur due to RM cacking on the machine. There is no AC supply in the RM dumping room and buffer room, printing machine errors, and robotic machine errors in the packaging room. The risk of immeasurable material losses in product D (WWTP) will occur due to a polluted environment due to the death of microbes so that ammonia, methane, and H2S gases come out, which cause a very unpleasant stench that can cause health problems.

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CORRELATION ANALITYC BETWEEN CSR AND DSIW IN PT PEMBANGKITAN JAWA BALI

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The role of csr (corporate social responsible) which has been seen only as a charity has developed in such a way that it not only has a positive impact on the external side of the company but also the company's internal side. PT Pembangkitan Jawa Bali so far has received many awards in the field of csr both at national and international levels. Research on the impact of csr on external parties has also often been carried out on but the impact on employees has never been carried out, therefore this study wants to examine the relationship between csr and DSIW (Desire To Have Significant Impact Through Work) through the mediation of employee engagement, organizational pride, organizational identification, and internal community. This study uses the SEM method with data as many as 515 respondents from PT PJB employees who were carried out by the survey method. The results of the research show that csr has a positive and significant influence on employee engagement, internal communication, organization pride and organization identification. As for the dsiw variable, csr has a positive and insignificant effect. Then the research also shows the positive and significant influence of csr on dsiw through employee engagement, internal communication, organization pride and organization identification.

Keyword : CSR, DSIW, Employee Engagement, Organizational Pride, Organizational Identification, Internal Communication, SEM

1. Introduction

Prior to 1990, corporate culture was dominated by the mindset and economic actions that were limited to profit. Business interests are only for the sake of the needs of internal stakeholders without thinking about the public interest included in the stakeholders, with so many experiencing disharmony communication between the company and the community. Many companies have been strongly criticized for creating social and environmental problems. Corporate social responsibility (CSR)is one of the many corporate responsibilities to stakeholders. Stakeholders here are individuals or communities who can influence or get influenced by many decisions, regulations or company operations (Solihin, 2009).

The company's contribution which is manifested in collaboration with employees and their representatives, their families, local communities or the public in raising the standard of living cannot be separated from the principles of Good Corporate Governance (GCG). PT PJB continues to make improvements and continues to make many innovations while still based on the provisions of GCG. From the support provided by stakeholders, PJB grows and develops with a variety of businesses, but does not abandon its corporate social

responsibility in order to create community independence and environmental sustainability. PT PJB received awards including the Subroto Award and also the PROPER GOLD assessment for 3 consecutive years. In addition, at the Asian regional level, PT PJB also won an award, namely AREA 2018 in the Social Empowerment category.

Research related to CSR over the last three decades has been quite high in growth (Croker and Barnes 2017). According to Aguinis and Glavas (2015) since 2005, 181 CSR-focused studies have been published in top management science journals, illustrating the growing importance of it and the interest of researchers in this field. During the last 5 (five) years, there has been a lot of literature that focuses on studying the effects of CSR on employee behavior (Glavas, 2016). PT PJB itself is also very concerned with the welfare of its employees, and the behavior of its employees. Every year PT PJB itself conducts a survey to measure the level of employee satisfaction. In general, when an individual has a high engagement in the organization, he or she will have pride and show behavior to do the best. This is corroborated by John's research (2019) where if there is a significant positive correlation between employee engagement, organizational pride, organizational identity and job completion (task performance).

According to Maignan and Farrell's (2001) regarding CSR practices and internal communication as an internal marketing instrument, it can strengthen employee-related outcomes such as organizational commitment, cohesiveness. This is supported by research by Duthler and Dhanesh (2020) that CSR perceptions and internal communication have a positive relationship with employee engagement. The question that arises then is whether the number of awards in the CSR field is related to the high value of employee engagement based on the 2019 survey. Then it also appears whether the awards in the CSR field support the emergence of organizational pride and Organizational Identity within PT PJB. And do not forget whether the award in the field of CSR is supported by good internal communication. And lastly of all, does it encourage employees to work optimally in this case described by DSIW?

Based Based on the problems mentioned above, the objectives of this research are:

a) To analyze the relationship between CSR and Employee Engagement, internal communication, Organizational Pride, Organizational Identity and DSIW.
b) To analyze the relationship between CSR and DSIW through the mediation of Employee Engagement, internal communication, Organizational Pride, Organizational Identity.

2. RESEARCH FRAMEWORK

2.1 Desire to have Significant impact through Work (DSIW)

According to Gully et al. (2013) DSIW refers to “a natural instinct, which creates a desire to meaningfully improve the lives of others around us”. It is selfless behavior, which is not about one's personal gain, but rather it is an attempt to contribute towards improvement and convenience in the lives of others (John et al., 2019, 2017). Employee DSIW is the result of cognitive behavior (Barrick et al., 2013). According to Ajzen's (1991) theory of planned behavior, attitudes and intentions lead to planned behavioral outcomes.

2.2 CSR

CSR is a system within an organization so that it voluntarily mixes environmental and social concerns into its operations and interactions with stakeholders that go beyond responsibilities in the legal sector (Anggraini, 2016). The manifestation of the company's concern is to set aside some of the profits earned for the benefit of human and environmental development and sustainably in accordance with appropriate and professional procedures is

a tangible manifestation of the implementation of CSR in Indonesia as an effort to create prosperity for its people**.**

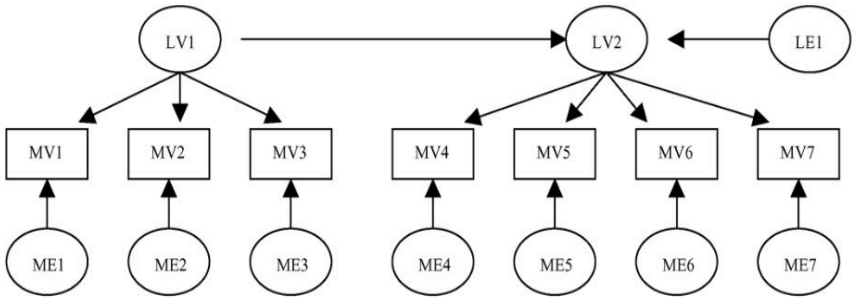
2.3 SEM Modeling Theory

In general, an SEM model can be divided into two main parts, namely:

a. Measurement Model The Measurement Model is part of the SEM model that describes the relationship between latent variables and their indicators.

b) Structural Model Structural Model is part of the SEM model that describes the relationship between latent variables or between exogenous variables and latent variables

Gambar 2.1
SEM Model



3. RESEARCH METHODOLOGY

3.1 Data Analysis

A study requires data analysis and interpretation whose purpose is to provide answers to research statements in revealing certain social phenomena. Data analysis is a step to simplify data so that it is easier to read and understand it. The selection of data analysis must be relevant to the variables to be studied. Here using SEM from the AMOS statistical application is used to develop the model and test the hypothesis.

a) Validity test

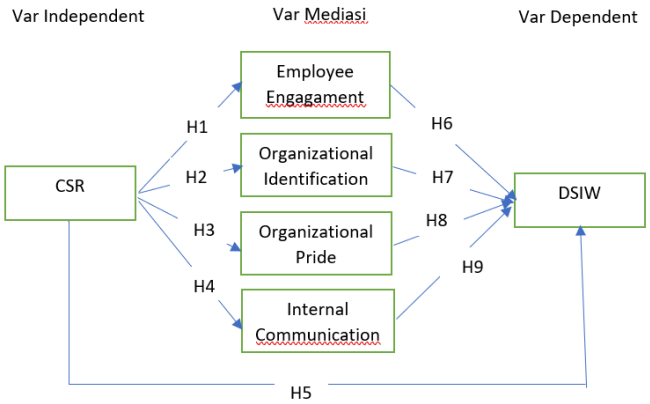
Aims to determine whether an instrument is valid or not. A questionnaire is declared valid if the statement in the questionnaire is able to describe something that will be measured by the questionnaire (Creswell, 2019). The measurement is declared valid if the measurement is real and correct, on the contrary, an invalid measuring instrument is the result of its size deviating from the expected goal (Jogiyanto, 2014). factor loading > 0.30 is stated in accordance with the minimum requirements, factor loading + 0.40 is stated to be better and relevant to the rules of thumb used by many researchers and factor loading > 0.50 is declared significant.

b) Reliability Test

It is a statistical test step that is considered appropriate in knowing how far the consistency of the research results is. A questionnaire is said to be reliable or reliable if the individual answers to the statement are consistent or fixed from time to time (Creswell, 2019). The reliability test was carried out using the Cronbach's Alpha technique with the help of SPSS software. If the alpha is worth 0.8 to 1.0, it is in the good category. Meanwhile, between 0.6 to 0.79 the reliability is acceptable and if the value is < 0.6 it is declared less good (Sekaran, 2000). The opinion of Ferdinand (2002) the value of the extracted variance is converted to the smallest level of 0.5. Thus, if the Alpha value > 0.50 is declared reliable.

3.2 Framework of thinking

To facilitate the discussion and not to cause bias in the analysis carried out, the framework of thinking and conceptual models in this study are:



3.3 Research Hypothesis

According to Farooq and Salam (2020) there is a positive relationship between CSR and Employee Engagement, Organizational Identity and Organizational Pride. This is in accordance with the current function of the CSR function which is not only charity but also as a way to increase the value of the company / organization so as to increase the company's identity in the eyes of employees, which also increases pride and attachment.

1. H1 : CSR has a significant positive relationship with Employee Engagement.
2. H2: CSR has a significant positive relationship with Organizational Identity.
3. H3: CSR has a significant positive relationship with Organizational Pride

According to Duthler and Dhanesh (2020), CSR has a positive relationship with Internal Communication, this is in line with the idea that the success of CSR today is closely related to how internal communication is carried out so that CSR execution is in accordance with the company's vision and mission.

4. H4: CSR has a significant positive relationship with Internal Communication.

According to Farooq and Salam (2020), there is a positive relationship between CSR and DSIW, this is in accordance with the thinking of employees now where he will try to work by having a significant impact on companies that care about CSR.

5. H5: CSR Has a significant positive relationship with DSIW.

According to Shahzadi et al (2018) There is a positive relationship between CSR and DSIW through the mediation of Employee Engagement, Organizational Pride and Organizational Identification, this is in line with the idea that DSIW will be greatly influenced by how much Employee Engagement, Organizational Pride and Organizational Identity, which has been explained above that CSR is able to affect Employee Engagement, Organizational Pride and Organizational Identity, so that CSR has a significant impact on DSIW through the mediation of Employee Engagement, Organizational Pride and Organizational Identity.

6. H6 : CSR has a significant positive relationship with DSIW through Employee Engagement mediation.
7. H7: CSR has a significant positive relationship with DSIW through Organizational Pride mediation.

8. H8: CSR has a significant positive relationship with DSIW through the mediation of Organizational Identity

According to Duthler and Dhanesh (2020), CSR has a significant positive relationship with DSIW through Internal Communication. This is in line with the idea that good communication will increase employee DSIW where CSR also affects Internal Communication as described above.

9. H9: CSR has a significant positive relationship with DSIW through the mediation of Internal Communication

4. RESULTS AND DISCUSSION

4.1 Instrument Validity, Reliability Test And Goodnes For Fit Test

The validity test in this study used Pearson Correlation, calculated using the computer-assisted SPSS version 20.0 program. An instrument is declared valid if it has a Pearson Product Moment Uj>r correlation coefficient (0.306), (Sugiyono, 2013). The results of the validity test can be shown in Table

Variabel	R hitung	R tabel	Keterangan
	0,81	0,09	Valid
CSR	0,82	0,09	Valid
	0,82	0,09	Valid
	0,84	0,09	Valid
	0,83	0,09	Valid
	0,82	**0,09**	Valid
	0,84	0,09	Valid
	0,81	0,09	Valid
	0,82	**0,09**	Valid
	0,83	0,09	Valid
	0,81	0,09	Valid
	0,81	0,09	Valid
	0,83	0,09	Valid
	0,81	0,09	Valid
	0,81	0,09	Valid
Variabel	**R hitung**	**R tabel**	**Keterangan**
Employee Engagement	0,82	0,09	Valid
	0,82	0,09	Valid
	0,83	0,09	Valid
	0,82	0,09	Valid
	0,8	0,09	Valid
	0,83	0,09	Valid
	0,81	0,09	Valid
	0,81	0,09	Valid
	0,81	0,09	Valid
	0,83	0,09	Valid
	0,82	0,09	Valid
	0,8	0,09	Valid
	0,84	0,09	Valid
Internal Communication	0,82	0,09	Valid
	0,82	0,09	Valid
	0,83	0,09	Valid
	0,82	0,09	Valid
	0,81	0,09	Valid
	0,84	0,09	Valid
	0,83	0,09	Valid
	0,82	0,09	Valid
Organizational Pride	0,82	0,09	Valid
	0,81	0,09	Valid

The reliability test uses Cronboach's Alpha, where the significant level used is 5% on the basis of decision making. The research instrument is said to be reliable if it has a Cranboach Alpha Coefficient above 0.6 (Ghozali, 2005). The results of the reliability test on

the variables of service quality, customer satisfaction, and loyalty can be summarized as presented in Table below:

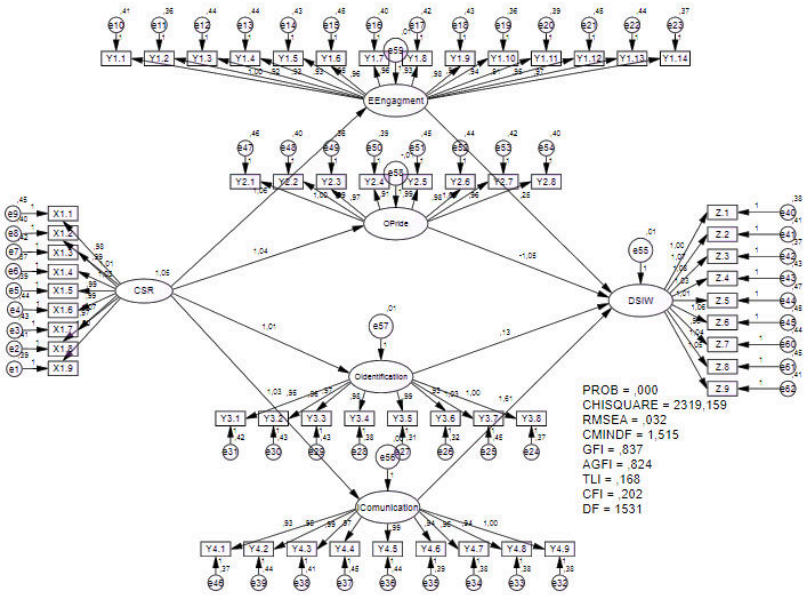
No	Variabel	Cronbach Alpha	Cutt Off	Keterangan
1	CSR	0.941		Reliabel
2	DSIW	0.938		Reliabel
3	Employee Engagement	0.962	0.6	Reliabel
4	Internal Communication	0.934		Reliabel
5	Organizational Pride	0.933		Reliabel
6	Organizational Identity	0.941		Reliabel

There is no single statistical test tool to measure or test hypotheses in SEM. Researchers can carry out testing using several goodness of fit indices to measure whether or not the proposed model is "correct" (Hair et al., 1998).

Goodness of Fit Index	**Hasil**	***Cut Off Value***	**Kriteria**
Likelihood chi square	2319,159	Diharapkan kecil	Not good
probability	0,000	≥0,05	good
CMIN/DF	1,515	≤2,00	good
RMSEA	0,032	≤0,08	good
GFI	0,936	≥0,9	good
AGFI	0,910	≥0,9	good
TLI	0,168	≥0,9	Not good
CFI	0,202	≥0,9	Not good

4.2 Hypothesis Testing Results

The test results of the research model can be described as follows :



Based on statistical analysis using the AMOS version 21.0 program, the results of the hypothesis test were obtained which were tests of the causality of each research variable as presented in the following table :

	Estimate	S.E.	C.R.	P	Label
EEngagement<---CSR	1,061	,048	22,051	***	Signifikan
ICommunication<---CSR	1,033	,051	20,455	***	Signifikan
OPride<---CSR	1,040	,049	21,228	***	Signifikan
OIdentification<---CSR	1,012	,046	21,881	***	Signifikan
DSIW <---- CSR	6,037	33,755	-0,179	0,858	Tidak Signifikan
DSIW<---EEngagement	0,555	0,529	1,050	0,002	Signifikan
DSIW<---OPride	0,957	0,711	-1,346	0,017	Signifikan
DSIW<---OIdentification	0,554	0,812	0,682	0,495	Tidak Signifikan
DSIW<--- ICommunication	6,626	32,667	0,203	0,839	Tidak Signifikan

a) The first hypothesis in this study which states "CSR has a positive relationship with employee engagement". The results of the calculation of the influence of CSR on employee engagement obtained t count of 22.051 and p = 0.000 < 0.08, thus the first hypothesis of this study is significant. The result of a positive path coefficient of 0.048 means that the relationship between CSR and employee engagement is unidirectional, this result supports the first hypothesis (H1).

b) The second hypothesis in this study which states "CSR has a positive relationship with Organizational Identity". The results of the calculation of amos CSR on Organizational Identity obtained t count of 21.881 and p = 0.000 < 0.08, then the second hypothesis is significant. The result of the positive Path coefficient is 0.046 . These results support the second hypothesis (H2).

c) The third hypothesis in this study which states "CSR has a positive relationship with organizational pride". The results of the calculation of the influence of CSR on organizational pride obtained a t-count value of 21.228 and a p-value of 0.000 <0.08, then the third hypothesis is significant. The result of a positive path coefficient of 0.049 means that the relationship between CRS and Organizational Identity is positive, this result supports the third hypothesis (H3).

d) The fourth hypothesis in this study which states "CSR has a positive relationship with internal communication". The results of the calculation of the influence of CSR on internal communication, obtained t count of 20.456 and p = 0.000 < 0.08, then the fourth hypothesis is significant. The result of a positive path coefficient of 0.050 means that the relationship between CSR and internal communication is positive, this result supports the fourth hypothesis (H4).

e) The fifth hypothesis in this study which states "CSR has a positive relationship with DSIW". The results of the calculation of the amos effect of CSR on DSIW are known to have a t value of -0.179 and p = 0.858 > 0.08, so the fifth hypothesis is not significant. Judging from the positive path coefficient of 33.755 , it shows that the relationship between CSR and DSIW is positive. These results do not support the fifth hypothesis (H5).

f) A variable can be said to have an indirect effect if the value obtained through the Sobel test is > 1.660 with a significant 5%. Vice versa if through the Sobel test < 1.660 with a significant 5%, the variable is said to have a direct effect. The results of the Sobel test get a z value of 1.343, 1.343 < 1.660 which means that there is a direct influence of the CSR variable on DSIW mediated through employee engagement, this result supports the sixth hypothesis (H6).

g) The variable can be said to have an indirect effect if the value obtained through the Sobel test is > 1.660 with a significant 5%, and vice versa if the Sobel test is < 1.660 with a significant 5%, the variable is said to have a direct effect. The results of the sobel test get a z value of 0.681, so 0.681 < 1.660 can be interpreted that there is a positive influence of the CSR variable on DSIW mediated through Organizational Identity, this result supports the seventh hypothesis (H7).

h) A variable can be said to have an indirect effect if the value obtained through the Sobel test is > 1.660 with a significant 5%. Vice versa if through the Sobel test < 1.660 with a significant 5%, the variable is said to have a direct effect. The results of the Sobel test get a z value of 1.343, so 1.343 < 1.660 which means that there is a direct influence of the CSR variable on DSIW mediated through organizational pride, this result supports the eighth hypothesis (H8).

i) A variable can be said to have an indirect effect if the value obtained through the Sobel test is > 1.660 with a significant 5%. and vice versa if through the Sobel test < 1.660 with a significant 5%, the variable is said to have a direct effect. The results of the Sobel test get a z value of 0.202, 0.202 < 1.660 which means that there is a direct influence of CSR variables on DSIW mediated through Internal Communication. These results support the eighth hypothesis (H8).

5. CONCLUSIONS

The results of the analysis of the quantitative test, namely the Structural Equation Modeling (SEM) test, researchers can draw a conclusion as follows:

1. CSR has a positive and significant influence on employee engagement, internal communication, organization pride and organization identification. This is in line with the initial hypothesis and previous studies that good CSR in addition to having an influence on external parties can also affect employees. So that employee involvement in the implementation of CSR programs can be increased.

2. CSR has a positive and insignificant effect on DSIW. This insignificant effect shows that CSR is not able to influence employees' instincts to act which has a significant impact on the company, although the effect is positive.

3. The relationship between CSR and DSIW through employee engagement, internal communication, organization pride and organization identification each has a significant positive effect. It also explains that although the impact of CSR on DSIW is not directly significant, but through mediation from employee engagement, internal communication, organization pride and organization identification, it has a significant impact. So it can be said that CSR which has a good program will ultimately make employees work optimally because it increases employee engagement, internal communication, organization pride and organization identification from these employees.

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DELAY FACTORS IDENTIFICATION OF IMPLEMENTATION ASSET MANAGEMENT PROJECT USING FAULT TREE ANALYSIS

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ABSTRACT

The electricity distribution process needs number of assets. PT ABC appointed PT XYZ as a service provider of asset management implementation project with 365 days contract period in the process of implementing asset management. However, PT XYZ was unable to complete the scope of work at the end of the implementation period and made up an extension 2 times the addendum agreement. This study aimed to identify the most influential causing factors on asset management implementation project delay by applying the fault tree analysis (FTA) method. FTA was used to identify and analyze the root causes of project delays, which will then be evaluated quantitatively through the combined analysis method of delay factors with a minimum cut set. There were 34 factors causing the delay in the PT XYZ asset management implementation project based on the preliminary survey. The results of the study obtained 9 basic events causing delays and obtained the probability value of the overall delay in asset management implementation projects of 0.1259.

Keywords: Project Delay, Asset Management, Fault Tree Analysis

1. INTRODUCTION

PT ABC is a company engaged in the electricity sector. The product is electrical energy which is distributed to company customers and society. There are many assets in the distribution process to customers. PT ABC has Key Performance Indicators (KPI) in the implementation of asset management. In the implementation process in order to improve operational performance. PT ABC appointed PT XYZ as a service provider for the implementation of electric power distribution asset management. PT XYZ was appointed directly due to sequence experience in the implementation of generation asset management at 9 different locations during 2012 to 2017.

Asset management implementation project began with the signing of the Letter of Agreement dated October 22th, 2018 with a duration of work execution time of 365 (three hundred sixty five) calendar days or until October 22th, 2019. However, there were obstacles that cause having extra time which was stated in addendum I and addendum II.

Table 1. Agreement duration

No	Information	Agreement Date	Total Duration
1	Agreement project	October 22th, 2018	365 days
2	Addendum I	October 16th, 2019	545 days
3	Addendum II	April 21th, 2020	730 days

This paper aims to analyze the main causes of project completion delay of the asset management implementation project. The output of this research is to figure out the main factors that cause delays in the completion of the asset management implementation project which can be used as consideration in future decision making to be able to complete the project according to the project completion time.

2. LITERATURE REVIEW

2.1 Asset Management

Wenzler (2005) described that asset management is a model that aims to optimize the company's resources. The success of asset management depends on the ability to determine the critical components of an equipment and how to define its condition. The asset management in grid company has an important role in detecting and evaluating leading decisions about long-term economic success and the best possible earnings. Asset management can cover aspects of technical issues such as network planning (for more economical investment planning and budgeting and strategic planning on network conditions.

2.2 Project Delay

Assaf et al (2006) defined delay as the addition of time beyond the agreed completion date in a contract or exceeding the completion date of a project that has been agreed by all parties involved in. Munir (2015) stated that the key to the success of project management is the availability of project resources, both qualitatively and quantitatively. The 6 components of the project's resources include the context of scope, time, quality, cost, human resources, communication, configuration and risk.

The survey result of the Standish Group (Chaos) (2001) in the United States shown that only 16.2% of projects were completed on time and according to the costs determined at the beginning of the project, 52.7% of projects completed but exceeded the cost and time specified at the beginning and there were a few functions and features that were not fulfilled, and the remaining 31.1% of projects were canceled which means the project was terminated before completion from 365 companies representing 8,380 applications. ,. There are 10 factors hindering the projectnamely, lack of user involvement; incomplete requirements & specifications; changing requirements & specifications; lack of support from the executive; technological incompetence; lack of resources; unrealistic expectations; unclear goals; unrealistic time limits; and new technology.

Rahikkala et al (2016) study case exhibit that there are impacts caused by delay causing factors delays in software projects, i.e. management, motivation, marketing tactics, sales tactics in which there are 17 detailed factors causing delays in the launch of software products. soft. The delay study at the Department of Software Development determine the difference between the plan and actual progress during the implementation of a software development project resulting from unavailable capacity or capability, personal, initial input requirements not being met, Product, Organizaton, Tool, with 24 details of the factors causing delays in software product development (Genuchten, 1991) there is a. based, there are 15 problems on a project manager control study that can be divided into 5 categories that cause cost overruns and delays in project implementation time, namely problems with project team organization; weak project leadership; communication problems; conflict and confusion; and insufficient upper management involvement (Thamhain, 1986). the journal of information technology and software engineering there are 14 factors that cause delays in software engineering projects (Mancas, 2014). 17 factors were found

to cause delays in his research on delay factors in small, medium and large software development organizations (Mohabuth, 2017).

2.3 Fault Tree Analysis

Rosyid (2007) determine fault tree analysis is a method to identify all possible causes (component failure or other failure events that occur alone or together) causing system failure and provide a basis for calculating the probability of the failure event. FTA is a deductive approach consisting of symbols and gates to describe the system failure process. To analyze the fault tree, Boolean Algebra is used as a tool for evaluation (Silvianita et al., 2015). Fault tree analysis can analyze the tendency of the causes of certain events and give priority to the available events (Leveson et al., 1983).

3. METHODS

3.1 Research Method

This is case study research, which is deeply analyze the object and reveal result that can be used as a reference to handle similar cases. The object in this study is the asset management implementation project.

The research stages carried out was followed this Figure 1.

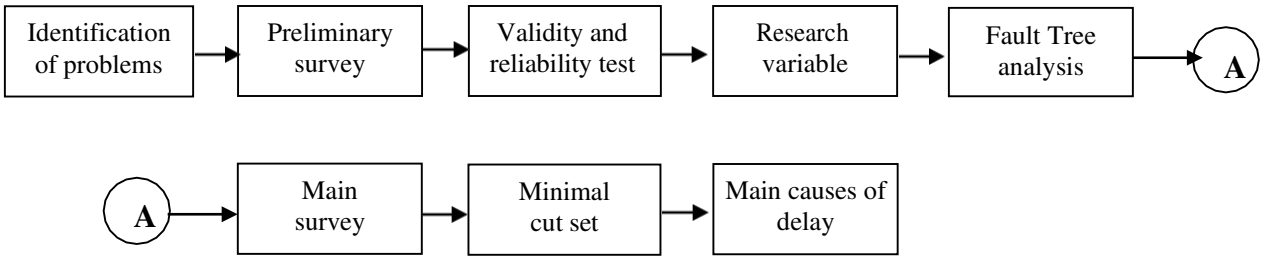

Figure 1. Research flow

3.2 Variables identification

The preliminary survey was conducted through a review of project documents and using several previous studies (Mutmainna, 2017; Thamhain, 1986; Undari, 2009; Genuchten, 1991; Dienillah, 2018; Mancas, 2014; Standish Group, 2001; Mohabuth, 2017; Rahikkala, 2016). The initial variables were compiled into the initial research draft. Variable synthesis was carried out on the initial research draft to determine the initial variables relevant to the asset management implementation project at PT XYZ. Based on the synthesis of variables, it was determined that there were 36 factors used in the study as variables causing delays in the PT XYZ asset management implementation project.

3.3 Data Collection

This study uses a preliminary survey and a primary survey to analyze the factors that cause project delays. The preliminary survey was carried out using a five-interval Likert scale to determine the variables to be used in the study. Preliminary survey respondents were employees of PT XYZ and outsourcing employees involved in project implementation with a total of 30 respondents. The main survey was carried out to obtain factor probability data based on the assessment given by expert respondents. The main survey respondents are experts at PT XYZ with a total of 9 respondents.

3.4 Data Analysis

The data and the value of the preliminary survey questionnaire results were analyzed using validity and reliability testing to determine whether the respondent's perception data was valid and reliable to use. Based on the data and the results of the questionnaires that have been obtained, then identification and translation of the data is carried out to be processed in a fault tree diagram, grouping of variables based on similarities in aspects, literature study and identification of data in the field is carried out.

The fault tree diagram model was developed based on the results of the analysis of the identification of the variables above. Once it is known that there are top events, intermediate events and basic events. Next, the fault tree diagram is drawn up by determining the relationship between levels using a logic gate. Through the combination analysis method of delay factors with a minimum cut set, the smallest combination of failure combinations in the basic event will be obtained. Thus, the basic event can be obtained which is even more narrow in number and gets the main factor of delay.

4. RESULTS

There were 34 factors causing the delay in the PT XYZ asset management implementation project based on the preliminary survey and research variables grouped into 4 main aspects. The top event aspect category, determined based on the identification of the literature study variables, re-identified to intermediate events, until the basic event is achieved with the logic gate relation in the preparation of the fault tree diagram model.

In case of intermediate event has 2 or more different basic events, then it can be linked through the relationships found in the fault tree diagram. The OR relation for an event means that the event can occur if one of the events occurs. While the AND relation on an event means that the event can occur if all events of the existing events occur. The following is the result of drawing a fault tree diagram.

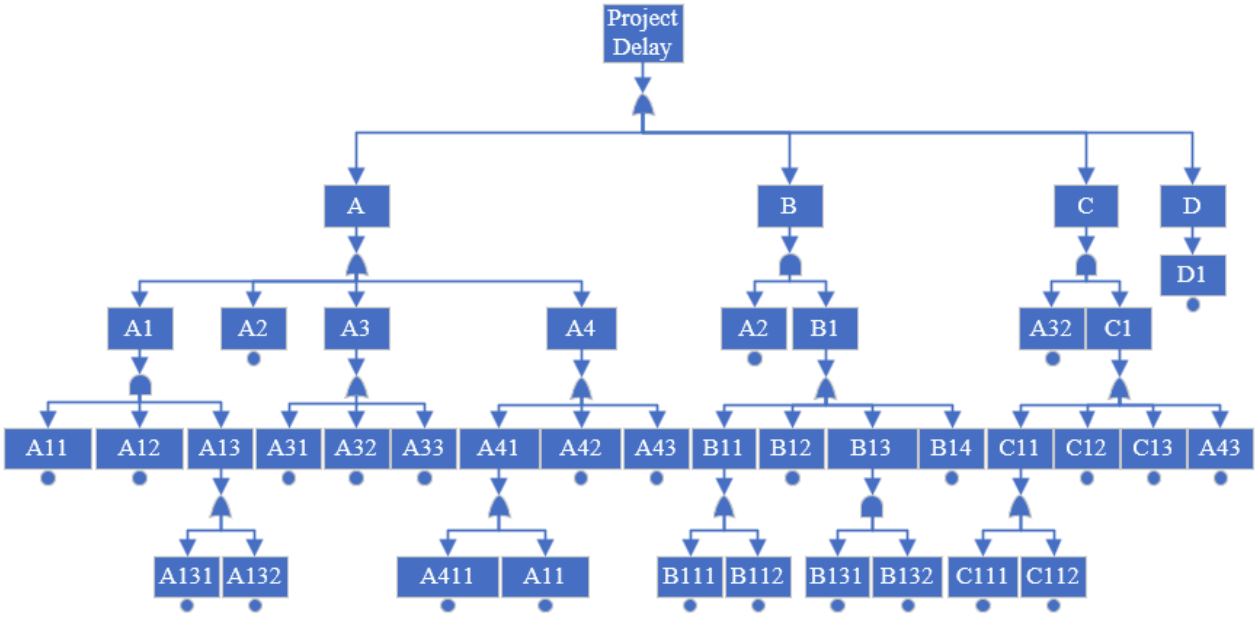

Figure 2. Fault tree asset management implementation project delay

Table 2. Fault tree diagram factors

Code	Aspects and Factors Overview
A	Management
A1	Dismatch work schedule
A11	Inability to know work progress
A12	Lack of schedule information available during project implementation
A13	Unrealistic Targets / time limits
A131	Unrealistic project plans
A132	Over optimistic scheduling delivery
A2	Lack of planning from start to finish
A3	Coordination problems
A31	Conflicts that arise between team members
A32	Poor communication among team members
A33	Lack of project manager decision making
A4	Priority shifts/changes to projects
A41	Lack of management over scope changes from customers
A411	No submission of updated scope and schedule changes
A42	Lack of support from executives
A43	Work on multiple projects at the same time
B	Configuration
A2	Lack of planning from start to finish
B1	Complexity of technical problems
B11	Delay in software acquisition
B111	Poor system design and specification structure
B112	Choosing the wrong development platform
B12	Lack of quality control
B13	Changes in requirements & specifications at the time of work
B131	Incomplete/late requirements & specifications
B132	Requirements specifications are not well defined
B14	Skip the development phase
C	Human Resources
A32	Poor communication among team members
C1	Limited human resources (HR)
C11	Unqualified personnel
C12	Lack of personnel commitment
C121	Underestimate the scope of project work
C122	Decrease in team morale
C13	Lack of support by related divisions/fields
A43	Work on multiple projects at the same time
D	External
D1	Force Majeure

Probability factor from each basic event is needed in the process of determining the probability value on the minimum cut set results that obtained from the expert survey questionnaire. The data was carried out by means of a questionnaire survey that distributed to 9 eligible expert respondents who have direct strategic position holders, more than 5 years work experience and handled similar projects. the probability value of the survey data processing results is tabulated in Table 3.

Table 3. Factor Probability Values

Code	Aspects and Factors Overview	Probability Value
A11	Inability to know work progress	0.0069
A12	Lack of schedule information available during project implementation	0.0069
A131	Unrealistic project plans	0.0058
A132	Over optimistic scheduling delivery	0.0169
A2	Lack of planning from start to finish	0.0079
A31	Conflicts that arise between team members	0.0050
A32	Poor communication among team members	0.0149
A33	Lack of project manager decision making	0.0157
A411	No submission of updated scope and schedule changes	0.0279
A42	Lack of support from executives	0.0159
A43	Work on multiple projects at the same time	0.0269
B111	Poor system design and specification structure	0.0067
B112	Choosing the wrong development platform	0.0146
B12	Lack of quality control	0.0070
B131	Incomplete/late requirements & specifications	0.0058
B132	Requirements specifications are not well defined	0.0179
B14	Skip the development phase	0.0039
C11	Unqualified personnel	0.0048
C121	Underestimate the scope of project work	0.0058
C122	Decrease in team morale	0.0058
C13	Lack of support by related divisions/fields	0.0070
D1	Force Majeure	0.0048

The minimum cut set is the smallest combination of events in the form of unwanted events. The minimal cut set is carried out through a quantitative evaluation (direct numerical approach) of the fault tree which called a bottom-up approach. The combination of basic events is obtained from the fault tree diagram which is analyzed with AND Gate or OR Gate relationships. There is a notation in the logic gate in the form of OR Gate and AND gate in calculating the minimum cut set. OR Gate describes a combination of events which is the sum of probabilities, while AND gate describes a slice of events which is a probability product. This following equation to calculate the combination of the minimum cut set from delays in asset management projects at PT XYZ.

$$
\begin{aligned}
\text{Project Delay} &= A + B + C + D \\
&= (A2 + A31 + A32 + A33 + A411 + A11 + A42 + A43) + ((A2 * B111) + (A2 * B112) + (A2 * B12) + (A2 * B131 * B132) + (A2 * B14)) + ((A32 * C11) + (A32 * C121) + (A32 * C122) + (A32 * C13) + (A32 * A43)) + D1 \\
&= A2 + A31 + A32 + A33 + A411 + A11 + A42 + A43 + D1
\end{aligned}
$$

Probability of delay in asset management implementation project (K)

P_K = A2 + A31 + A32 + A33 + A411 + A11 + A42 + A43 + D1

= 0.0079 + 0.0050 + 0.0149 + 0.0157 + 0.0279 + 0.0069 + 0.0159 + 0.0269 + 0.0048

= 0.1259

The minimum cut set determine the total probability for project delays in asset management implementation is 0.1259 and 9 basic events are the main factors that can cause delays in asset management implementation projects. Where based on the OR gate relation if one of the main factors occurs, then the delay will occur. The factors that cause delays in asset management implementation projects are following in this list:

1. Lack of planning from start to finish
2. Conflicts that arise between team members
3. Poor communication among team members
4. Lack of project manager decision making
5. No submission of changes to the updated scope and schedule
6. Inability to know the progress of work
7. Lack of support from executives
8. Work on multiple projects at the same time
9. Force Majeure

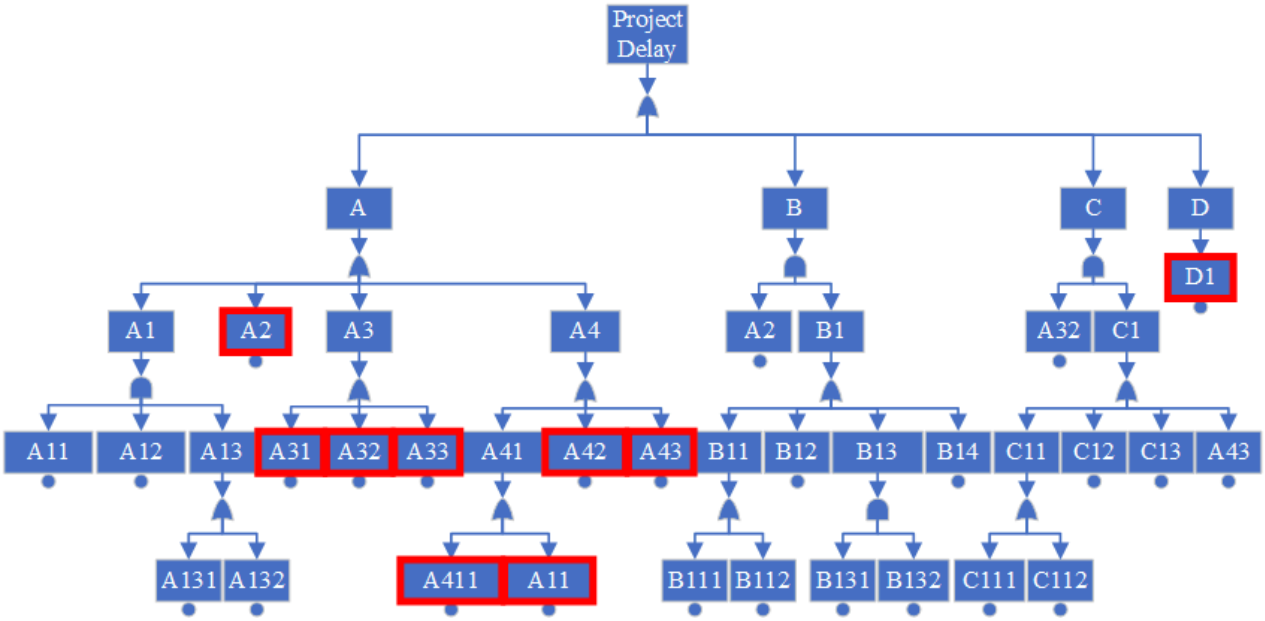

Figure 3. Fault tree results of minimal cut set delays in asset management implementation projects

5. CONCLUSIONS

The fault tree analysis (FTA) model revealed 4 top events, which are detailed into 10 intermediate events and 22 basic events., the delay probability calculation in the minimum cut set is 0.1259 with 9 basic events being the main factors causing project delays such as lack of planning from start to finish of the project, conflicts arising among team members, poor communication among team members, lack of project manager decision making, non-delivery of

updated scope and schedule changes, inability to know work progress, lack of support from executives, working on multiple projects at the same time and force majeure.

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WORKING CAPITAL MANAGEMENT ANALYSIS : STUDY AT PT XYZ

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ABSTRACT

PT XYZ is a company that was founded in 2014 in Surabaya and is engaged in fuel and gas distribution. PT XYZ managed to grow rapidly and get a large income that continues to increase every year, but there is a decline in 2019 and 2020. Large total income should make it easier for the company to pay off its short-term obligations, but the current conditions of the company show that management is facing difficulties in paying off its short-term liabilities and the company has a negative net working capital. This study was conducted to analyze how working capital management is carried out by PT XYZ. In this study, author conducted field observations, interviews and documentation of financial statements to obtain all the data needed. Calculation of financial ratios and Focus Group Discussion will be conducted to analyze conditions and recommendations that can be given to management to improve the performance of the company's working capital management. The results showed that the working capital management at PT XYZ is less than optimal. The calculated financial ratios show that there are several problems that must be resolved by the management of PT XYZ. The results of the Focus Group Discussion that have been carried out show that management is aware of these problems and has discussed several recommendations that can be implemented to improve PT XYZ's working capital management performance.

Keywords: Working Capital Management, Financial Ratio, Working Capital

1. INTRODUCTION

Working capital management is one of the important activities carried out by the energy distribution industry considering that the prosperity of the Indonesian people also depend on the use of the distributed energy or natural resources. Logistics companies need to maintain the company's performance in order to survive and help country to create the prosperity of the Indonesian people. Company performance is a reflection of the present and future conditions of the company which can affect the view of shareholders on the value of the company. Management needs to ensure that the resources owned by the company are managed effectively and efficiently.

PT XYZ is a company that was founded in 2014 in Surabaya and is engaged in fuel and gas distribution. At the start of the company, PT XYZ had a few income, but grew in the following years with a significant increase in revenue. With the amount of revenue that has been successfully generated by PT XYZ, the company's management should be able to pay off its short-term liabilities easily.

Based on observations, PT XYZ has problem making payments to suppliers. The company's management requires a long period of time to pay off their short-term liabilities due to the insufficient funds. This has a bad impact on the company because it creates obstacles in operating activities and bad relations with suppliers.

Cash receipts and disbursements are important aspects of working capital management. Based on observations made by authors, the management of PT XYZ is facing obstacles in managing their working capital. Poor working capital management will affect the performance and the going concern of the company.

Moussa (2018) finds that good working capital management positively affects company performance. Good working capital turnover has a positive effect on increasing company profitability. Authors such as Schiff and Lieber (1974), Smith (1980) and Kim and Chung (1990) state that working capital decisions affect firm performance.

Based on previous research that explains the importance of optimal working capital management and also working capital management problem that occur at PT XYZ, authors are interested in analyzing working capital management at PT XYZ.

2. LITERATURE REVIEW

2.1 Working Capital

Suteja (2020) explains that working capital is a company's investment in short-term assets or current assets which generally consist of balance sheet components including cash and cash equivalents, receivables, inventories. Djarwanto (2001) explains that working capital is the total funds used by the company to generate income in a certain accounting period. Munawir (2004) also argues that working capital is the excess value of assets owned by the company over all of its liabilities. James Sagner (2011), working capital is the arithmetic difference between two aggregate balance sheet accounts: current assets and current liabilities. According to Harahap (2001), working capital is a fund used for investment in non-current assets or to pay off non-current liabilities.

2.2 Working Capiral Management

Working capital management is an activity carried out by company management in managing current assets and current liabilities. According to Muslich (2005), working capital management is the management of the company's current assets and liabilities. According to Margaretha (2014), working capital management is a form of processing short-term investments related to the company's sources of funds. Working capital management is an important activity carried out by company management because this activity has an impact on the level of risk and company profits. In general, the company will try to manage its current assets so that the amount is greater than its current liabilities. The company's management must be able to manage its working capital properly in order to be able to maintain operational activities so that the company's performance will also remain at an optimal level.

2.3 Previous Study

Caballero (2014) show that working capital affects the company's performance, the existence of optimal working capital will balance costs, profits and maximize company performance. Khumar (2016) in his study of working capital management analysis – study of Udaipur Cement Works Ltd show that optimal working capital management is important for a company. Poor working capital management reduces the company's current ratio so that the company will face difficulties to pay off its short-term liabilities. Saad (2010) in his study shows

the results that working capital has an effect on company performance. he explains that companies listed on the Malaysian stock exchange tend to rely more on current assets to generate profits, so they must maintain optimal daily current asset needs in addition to meeting their short term liabilities, otherwise profitability will decrease drastically. Moussa (2018) explains that working capital affects the company's performance. Companies with a high level of profitability tend to maintain high accounts receivable balances because they have a large amount of cash.

3. METHODS

3.1 Field Observation

Observations made by researchers are not only by being observers of the problem but also playing a role and participating in problem solving. In this study, researchers directly observed the Head Office of PT XYZ. Observations were made regarding the activities of working capital management carried out by the company's management.

3.2 Interview

Author in this study will interview several persons who are experts and have long experience in managing working capital of PT XYZ, including Finance Senior Manager, Accounting & Budget Manager and Treasury & Tax Manager. The interview procedure is intended to obtain in-depth information related to the conditions of working capital management that occur in PT XYZ.

3.3 Financial Report Documentation

Documentation is a data collection procedure carried out by searching for data related to the object of research in the form of books, notes, newspapers, minutes, etc. In this study, the researchers collected financial data obtained through the company's financial statements from 2016 to 2020. The required financial data are elements on the balance sheet and income statement. The financial data that has been collected will be used to calculate the financial ratios that will be used in this study.

3.4 Financial Ratios Analysis

Based on the financial statement data that has been obtained, author will process the data using financial ratios. The purpose of calculating this financial ratio is to determine the company's financial condition and can then be used for decision making. The financial ratios used in the study are as follows:

1. Net Working Capital : Total Current Assets – Total Current Liabilities
2. Average Collection Period : (Average Account Receivable / Revenue) x 365
3. Average Payment Period : (Average Account Payable / Cost of Goods Sold) x 365

3.5 Identification of Working Capital Needs

The working capital requirement identification method used in this research is the working capital turnover method. The formula used to calculate working capital requirements based on this method is as follows:

a. Cash Turnover = Sales / Cash;

b. Accounts Receivable Turnover = Sales / Average Receivables;

The inventory turnover formula is not needed in this study because the research subject is a service company that does not have inventory. After getting the results of the working capital turnover

calculation above, it will be calculated by dividing the total sales prediction by the number of working capital turnover days.

3.6 Focus Group Discussion

The FGD conducted in this study aims to gain an understanding of the problems that occur and various alternative solutions that can be done to improve the working capital management performance of PT XYZ. The focus group discussion will be held through the media zoom meeting and the forum will be attended by 8 participants. Participants will be given information related to problems within the company and then participants will discuss solutions that can be given to the company

4. RESULTS

4.1 Net Working Capital

Net Working Capital shows the company's ability to meet all of its current liabilities by using its current assets. A good company will have a positive net working capital ratio which indicates the company is in a liquid state. **Table 1** below shows the results of the calculation of the net working capital ratio at PT XYZ.

Table 1. Net Working Capital

Year	Total Current Assets	Total Current Liabilites	Result
2016	147.230.908.936	140.353.679.837	6.877.229.099
2017	230.141.328.230	121.423.717.257	108.717.610.973
2018	286.172.731.387	265.776.769.660	20.395.961.727
2019	208.355.854.504	217.703.927.933	- 9.348.073.429
2020	145.811.331.376	212.151.550.312	- 66.340.218.936

Based on the calculation of the net working capital ratio of PT XYZ from 2016 to 2020 can be explained that in some years the company has negative net working capital. Negative net working capital shows that the company’s working capital is dominated by debt and the company needs more current assets to pay off its current liabilities.

4.2 Average Collection Period

Average Collection Period shows the average time required by the company to collect receivables in the form of cash. The smaller the value of the ratio will indicate a faster collection period of receivables by a company. **Table 2** below shows the results of the calculation of the average collection period at PT XYZ.

Table 2. Average Collection Period

Year	Avg Account Receivable	Sales	Result
2016	54.859.988.656	546.469.124.140	37
2017	111.774.270.223	571.229.890.511	71
2018	152.319.992.053	961.312.273.584	58
2019	148.230.861.129	688.576.354.795	79
2020	99.361.710.147	570.472.206.130	64

The calculation of average collection periode shows that PT XYZ takes a long time to collect their receivables. Based on information from the Management of PT XYZ that the average payment period given according to the contract agreement with the consumer is 25 to 30 days. This means that the performance of PT XYZ in collecting their receivables is still inadequate because there is no year in which the company has an average receivable collection ratio below the payment period given according to the contract.

4.3 Average Payment Period

Average Payment Period shows the average time needed by the company to pay off its current liabilities. The higher ratio value indicates that the company takes a long time to pay off its current obligations. **Table 3** below shows the results of the calculation of the average payment period at PT XYZ.

Table 3. Average Payment Period

Year	Avg Account Payable	COGS	Result
2016	80.453.126.102	500.510.175.911	59
2017	98.297.784.040	456.808.741.929	79
2018	81.705.289.923	891.077.328.166	33
2019	67.387.580.283	553.383.617.475	44
2020	53.528.149.892	438.350.375.886	45

The calculation of average payment period shows that PT XYZ takes a long time to pay off their short term liabilities. Based on information from the Management of PT XYZ that the average payment period given according to the contract agreement with the supplier is 30 days. This means that the liquidity level of PT XYZ is still below the standard because there is no year that has an average payment period below the period given by the vendor according to the contract.

4.4 Identification of Working Capital Needs

At this stage the Author identifies the working capital that should be owned by PT XYZ at the beginning of each year as funds to carry out its operational activities in a year. Author use working capital turnover method to determine the need for working capital each year. **Table 4** below shows the results of the calculation of the working capital needs of PT XYZ.

Table 4. Working Capital Needs

Description	Year	Cash Turnover (days)	Receivable Turnover (days)	Total (days)	Working Capital Turnover in a Year (x)	Next Year Sales	Working Capital Needs	Actual Working Capital
Working Capital Needs	2016	20	37	56	6	571.229.890.511	87.888.066.260	6.877.229.099
	2017	9	71	80	5	961.312.273.584	211.590.658.696	108.717.610.973
	2018	13	58	70	5	688.576.354.795	132.867.317.618	20.395.961.727
	2019	35	79	114	3	570.472.206.130	178.188.474.925	- 9.348.073.429
	2020	36	64	100	4	475.985.369.638	129.809.566.128	- 66.340.218.936

Based on the results of calculations and analyzes that have been carried out, it can be seen that PT XYZ does not have enough working capital from its current assets to finance its operations, therefore PT XYZ decided to look for other sources of financing. The data also shows that the working capital of PT XYZ is more dominant in using funds from debt to finance its operations.

Company with healthy finance are company that have a positive amount of working capital. Positive working capital is obtained from ownership of current assets which are greater than current liabilities. The availability of a small amount of current assets will cause the company to seek external funding or debt to maintain the continuity of the company's operations

4.5 Focus Group Discussion

The Focus Group Discussion was conducted with the aim of finding recommendations that could be used by the management of PT XYZ to improve the performance of the company's working capital management. Recommendations that can be applied to improve the performance of PT XYZ's working capital management are as follows:

1. Management believes that the initial capital owned by PT XYZ is not ideal for operating in the oil and gas industry. Therefore, PT XYZ requires additional capital from shareholders or the parent company so that the company's financial condition is more stable and able to support the company's operations;
2. Management believes that the long receivables turnover is caused by the majority of the customer also take a long time to make payment. Therefore, to solve this problem, the management intends to provide a reward and punishment system to every consumer.
3. Management believes that the company's cash flow problem is due to the company's debt payment period is faster than the company's receivables collection period. Therefore, management intends to adjust the debt payment period with the receivables collection period so that the availability of cash or company liquidity is more optimal and is at a safe level.

6. CONCLUSIONS

PT XYZ's working capital is in a poor condition based on the results of the financial ratio analysis. PT XYZ has a payment period faster than its receivables turnover. This causes the company to experience a decrease in the amount of cash available in the company and affect the company's liquidity level. A negative amount of net working capital indicates the company is more dependent on short-term debt to carry out its operations. This also signals that the company is currently illiquid and requires improvement in working capital management to make the company's financial condition more stable.

Based on the results of the Focus Group Discussion, company believes that PT XYZ requires additional capital from the parent company to be able to operate optimally considering that businesses in the oil and gas industry require a lot of asset investment. The other recommendation is that management will be more assertive in terms of collecting receivables from costumers by applying a reward and punishment system to each customer so that the company's receivables turnover period will be better.

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RISK ASSESSMENT OF DELAY FOR WHRU INSTALLATION PROJECT ON MAINTENANCE WINDOW SHUTDOWN AT CENTRAL PROCESSING GAS GUNDIH

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ABSTRACT

PEP as one of the oil and gas companies in Indonesia plans to organize planned maintenance through a Waste Heat Recovery Unit replacement project, which consists of three time-sharing steps, pre-shutdown, window shutdown and post shutdown. Referring to the Gas Sale and Purchase Agreement that the entire period of normal maintenance work which causes gas to not flow is no more than 15 days each year, so planning and implementation of maintenance are very important by utilizing a windows shutdown to avoid material and non-material losses. Reviewing the vulnerability of this project, it is necessary to conduct research that assesses the level of risk of project delays using the ISO 31000:2018 risk management concept approach, through identification of risk variables from several literature studies, risk analysis through Forum Group Discussions, and risk management efforts in order to reduce risk of delays. From the risk identification carried out, 30 risk variables that affect project delays consist of 2 categories of High, 3 categories of Moderate to high, 15 categories of Moderate, 6 categories of Low to moderate and 4 categories of Low. Risk Treatment carried out in the high and Moderate to high categories resulted in 9 mandatory RCOs to reduce delays and 1 RCO to accelerate the implementation schedule from 19 days to 13 days

Keywords: risk assessment, project delay risk, windows shutdown, waste heat recovery unit, ISO 31000, risk control option

1. INTRODUCTION

Thermal Oxidizer has two roles, burning waste acid gas into the flue gas and distributing heat energy from combustion to the Waste Heat Recovery Unit which is used to heat hot oil to 350°F as input for the Solvent Regenerator Reboiler. in the gas purification process. This Thermal Oxidizer does not have process redundancy so it is included in the Critical Equipment Ranking High category where the reliability of the equipment must be maintained properly. To maintain the reliability of the Thermal Oxidizer, PEP carries out planned maintenance through a WHRU replacement project which consists of three time-sharing steps, namely, pre-shutdown, window shutdown, and post-shutdown. Referring to the Gas Sale and Purchase Agreement between PT PEP and PT SPP that the entire period of normal maintenance work which causes gas to not flow is not more than 15 days per year. Referring to the agreement, each hour of delay that will be borne by the company is $307,500 per day or $12,812 per hour.

McKinsey Capital Projects & Infrastructure Practice (2017) estimates that for infrastructure, mining, and oil and gas projects, only 5 percent of projects are completed according to the initial budget and schedule. As shown in Figure 1.2 for completed projects, the average cost overrun is 37 percent, and the average schedule overrun is 53 percent. Based on the project performance, it is very urgent and important to organize a project delay risk assessment where the expected result is to be able to find out early the risks of project delays as a basis for optimizing and measuring the opportunities for losses from the installation project on shutdown period.

According to Pinto (2007), In the implementation of a construction project, three important things must be considered including time, cost, and quality. Technically the level of success of a project is judged by the extent to which these three limitations can be met. In addition, the delay resulted in a lost opportunity for another project work. For the owner, the delay in the completion of the project work will be caused losses to the operating time of the results of the project, so that the use of the results of the development project was delayed. Completing projects on time is an indicator of efficiency, but the construction process is subject to many variables and unpredictable factors, which result from many sources. These sources include the performance of parties, resources availability, environmental conditions, involvement of other parties, and contractual relations. However, it rarely happens that a project is completed within the specified time Assaf & Al-Hejji (2006). The main objectives of this study include the following:

- Obtain a project delay risk map through a risk assessment of the factors causing delays.
- Provide proposals for handling high risks that can cause delays in the project.
- Estimating the cost of risk management.

2. LITERATURE REVIEW

Many articles and studies conducted on causes of delay in construction projects, both locally and internationally have been reviewed. Assaf & Al-Hejji (2006) in their research on the factors causing delays in construction projects in Saudi Arabia, identified 73 factors causing delays which were grouped into nine categories, namely project-related factors, project owners, contractors, consultants, project design, materials, equipment, human resources, and related external factors. The results of survey data conducted on 23 contractors, 19 consultants, and 15 project owners, 76% contractors, and 56% consultants show that the average completion time of a project is around 10% to 30% of its initial duration. The most common cause of delays is a change in demand during construction.

Kaming et al. (1997) studied influencing factors on 31 high-rise projects in Indonesia and found out that cost overruns occur more frequently and are more severe problems than time overruns. They pointed out that the major factors influencing cost overrun are material cost increase due to inflation, inaccurate material estimation, and degree of complexity. While in time overrun, the most important factors causing delays are design changes, poor labor productivity, inadequate planning, and resource shortages.

Taha et al. (2007) identified through literature review and discussions with parties who are actively involved in the construction industry. The causes of delays in the research are divided into several groups, including project owners, contractors, consultants, subcontractors, contacts, project materials/materials, work equipment, labor, and external factors.

Sweis et al. (2008) studied through literature research and discussions with many parties involved in construction projects in Jordan. The causes of delays are grouped into Internal Factors (labor, materials, and equipment), Internal Environmental Factors (contractors, owners, and consultants), and Exogenous Factors (weather and government regulations).

Doloi et al. (2012) identified through questionnaires and interviews with several stakeholders. Lack of engagement/commitment to a contract, inefficient construction management, poor site coordination, inadequate planning, lack of clarity of project scope, lack of communication; and substandard contracts are the most influential factors for construction delays in India.

Verma (2020) In the study conducted there is a statistical analysis process of delay factors with several construction project stakeholders. 10 most important causes of delays: Decision making, improper site management, and supervision, complexity in financing the project by the contractor, shortage of construction materials, Shortage of equipment and/or equipment failure, improper communication and coordination with other parties, financing and payments by owner Inexperience of contractor (Poor qualification of contractors' staff), Lack of experience of consultants Shortage of utilities on site such as (water, electricity, etc.)

3. METHODS

The research methodology refers to ISO 31000:2018 and PMI:2017, it is contained 67 causes of delay that were identified through literature review and discussion with 16 technical experts in the PEP construction project. Due to the Covid-19 Pandemic, the implementation of Risk Identification was held through an online Forum Group Discussion (FGD) activity. Data collected and processed to obtain how much the inhibiting factors can affect the progress and delays in the completion of construction projects.

Time performance scale is follows:

1. No effect: there was an insignificant delay
2. Less influential: there is a small amount of delay (<5%)
3. Influential: there was a significant delay (5%-10%)
4. Moderately influential: there is quite a serious delay (10%-20%)
5. Very influential: there was a big delay (>20%)

The frequency scale is as follows:

1. Very Rare: Very rarely occurs only under certain conditions
2. Rarely: Sometimes occurs in certain conditions
3. Sometimes: Occurs under certain conditions
4. Often: Often occurs in every condition
5. Always: Always happens in every condition

After risk identification is carried out, the data analysis process begins by calculating the risk value obtained from the calculation of the probability and consequences. The results of the assessment are then calculated the mean value using the Geometric Mean for each variable on probability and consequences so that the values and risk maps are obtained.

Risk evaluation is carried out by comparing the risk value obtained with the company's ability to accept risk (risk acceptance). If the risk is unacceptable, then additional control recommendations are made on that risk then include a list of risks and controls provided in one risk register document file to obtain a comprehensive document in explaining the description of the risk of delays in the project.

4. RESULTS

Based on the validation results of the delay variables that have been carried out with the team from the integration project department, the next step is to identify the qualitative impact of the delay variables which are summarized as shown in **Table 1**.

Table 1. Tabulation of delay risk variables

Risk ID	Risk Event	Probability					Consequences					Risk
		1	2	3	4	5	1	2	3	4	5	
R12	Uncertain weather conditions				x					x		16
R15	Covid-19 infected during construction			x							x	15
R1	Insufficient availability of labor				x				x			12
R2	Low labor productivity				x				x			12
R6	Late delivery of materials			x					x			12
R14	Restrictions on work in the field			x					x			9
R16	Lack of workforce competence			x					x			9
R17	Less labor experience			x					x			9
R18	Insufficient amount of material			x					x			9
R19	Limited of equipment			x					x			9
R20	Work Equipment Damage			x					x			9
R3	Adding project scope			x					x			9
R4	There is a rework due to an execution error			x					x			9
R5	Improper project planning			x					x			9
R8	Poor project management from the contractor			x					x			9
R9	Inability to cope with work progress by service providers			x					x			9
R21	Poor site supervision and management		x						x			6
R22	Safety regulations that are not met by contractors			x				x				6
R25	Lack of communication between parties in the project		x						x			6
R26	The duration of decision making on the project		x						x			6
R10	The difficulty of obtaining a work permit third parties		x					x				4
R11	Changes to government regulations		x					x				4
R13	Problems with local people		x					x				4
R23	There is a termination of work by the project owner		x					x				4
R29	Delay in producing design documents		x					x				4
R30	Insufficient data collection completes at survey		x					x				4
R24	Contractors are not able to provide imported materials		x				x					2
R27	Poor interaction at engineering and procurement stages	x						x				2
R28	Delays in processing work payments	x						x				2
R7	Poor management of project cash arrangements contractor	x						x				2

After tabulating the risk variable data above, we plotted risk mapping all variables using a 5x5 risk matrix that has been agreed upon by the company's standard. Based on the Risk Map in **Figure 1**, it is seen that the majority of risks are in the moderate category which can be tolerated by conducting continuous monitoring and control. Referring to the Risk-Based HSSE Management Guidelines No. A7-003/ S00100/2019-S0, the risk level of each Risk ID is shown in **Table 2**. The main focus of risk level is High and High to Moderate with a risk level value of 10 to 25, a series of risk mitigation plans must be carried out to reduce risk to a medium level

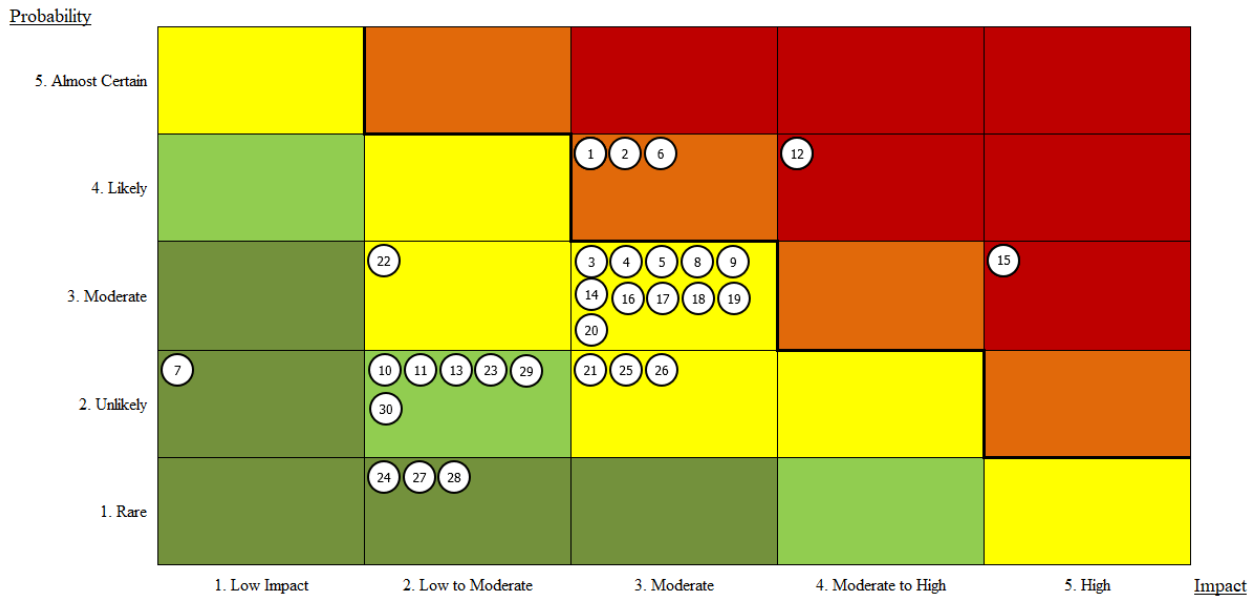

Figure 1. Risk map result

Table 2. List of delay risk variables

Risk Category	Risk ID List	ALARP
High	12, 15	Unacceptable
Moderate to High	1, 2, 6	Not tolerable
Moderate	3, 4, 5, 8, 9, 14, 16, 17, 18, 19, 20, 21, 22, 25, 26	Tolerable with control & monitoring
Low to Moderate	10, 11, 13, 23, 29, 30	Tolerable
Low	7, 24, 27, 28	Acceptable

Based on the list above, the main focus in implementing risk management is at high and moderate to high levels, where based on the FGD implementation there are risk control options including:

1. R12 (Uncertain weather conditions) is mandatory to add platform, install safety net and tarpaulin canvas with the total cost required to fulfill this mitigation is $4,604.
2. R15 (Covid-19 infected during construction) is mandatory. Implementation of random check using Antigen Swab on core workers who work during the project is carried out by 30% of the total core workers. The total cost required to fulfill this mitigation is $5,794. This is more effectively implemented compared to PCR which is not yet available in health facilities in the area closest to the plant, the results cannot be known quickly.
3. R1 (Insufficient availability of labor) and R2 (Low labor productivity) Changes in the 3-shift work method in critical activities (welding work) will certainly cause costs for the provision of labor, both welders, fitters, helpers to supervision. The total cost required to fulfill this mitigation is $5,794. With the change in work methods from 2 shifts to 3 shifts, this can speed up the work schedule to 6 working days.
4. R6 (Late delivery of materials) The mitigation carried out is the appointment of a PIC from Logistics & Project Support who will monitor the shipment process through the vessel tracker or marine traffic application that is already available and can be accessed at this time.

6. CONCLUSIONS

Based on the results of data analysis and discussion that implemented there are 30 risk events that can affect the delay in the WHRU installation project consisting of 2 High categories, 3 Moderate to high categories, 15 Moderate categories, 6 Low to moderate categories and 4 Low categories. In the risk variable due to weather factors, the mitigation needed is the creation of a platform, installation of a safety net and tarpaulin canvas where an implementation fee of $ 4,604 is required so that it can reduce the risk to Moderate. Risk variables due to accidents and Covid-19 factors, the mitigation carried out is by making platforms, installing safety nets, tarpaulin canvases, tightening Covid-19 procedures, implementing random antigen checks, localizing worker mobilization, and tightening supervision where an implementation fee of $ 5,794 is required so that it can reduce the risk to Moderate. Risk variable due to labor and productivity factors that are lacking, the mitigation carried out is by adding a welder team, changing the work pattern from 2 shifts to 3 shifts and adding supervision where an implementation cost of $ 2,415 is needed so that it can reduce the risk to Low to moderate. Risk variable due to material delivery factors, the mitigation carried out is by appointing a PIC for delivery supervision and customs management with an implementation fee of $14 so that the risk can be reduced to Moderate. From the list of risk control options that have recommended adding a welder team, changing the work system to 3 shifts and adding supervision can speed up the work schedule from 19 days to 13 days and earn a profit of $615,000 because the process of selling gas to consumers can be accelerated by 2 days.

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THE EFFECT OF FEELING SAFETY ON WORKER PERFORMANCE IN CONSTRUCTION SITES DURING THE COVID-19 PANDEMIC

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ABSTRACT

Since the emergence of Covid-19 at the end of 2019 it has infected millions of the world's populations, this situation has made many changes in people's lives both from an economic and social perspective. The construction industry, which is an important industry in the economy, is included in a critical sector, where workers are required to work 100%, This condition creates a sense of concern not only for the company but also for the workers. This research is quantitative research that uses Partial Least Square – Structural Equation Modeling (PLS-SEM) method. Data were obtained through questionnaires given to respondents, namely Labuan Bajo Multipurpose Pier construction workers. The results of this study indicate that all variables are valid and reliable with R^2 of 11.4%, 54.9% and 62.2% respectively and this model can explain the total coefficient of determination (Q^2) of 85.8%. It is found that a sense of feeling safety does not directly affect Performance, but it has an indirect effect on Performance through mediating variables of work skills and job satisfaction, where job satisfaction and work skills also have a direct effect on Performance, thus job satisfaction and job skills need to be increased in workers at construction sites.

Keywords: PLS-SEM, Performance, Satisfaction, Skills, Construction, Pandemic

1. INTRODUCTION

The beginning of the emergence of COVID-19 at the end of 2019 in Wuhan, China. Covid 19 spread very quickly to various parts of the world, where it only took 3 months to infect 10.2 million people in the world since the first case was reported (Nugroho, 2020). The prolonged Covid-19 pandemic has had an impact on various sectors of people's lives, both economically and socially. To break the chain of the Covid-19 virus, the Government has implemented many policies, one of which is the policy of implementing restrictions on community activities (PPKM). To minimize the impact of increased cases and more severe economic contractions, referring to the rules of the COVID-19 task force, economic activities are divided into three sectors, namely the non-essential sector with the implementation of 100% Work from home (WFH), the essential sector with the application of a maximum of 50 % Work from office (WFO) and Critical Sector with strict health protocols implement 100% Work from home (WFH).

According to data from the Central Statistics Agency (BPS) the Construction sector contributes 9.9% -the fourth largest - to Gross Domestic Product (GDP). so that the construction sector is no doubt included as a critical sector category with the implementation of 100% Work from home (WFH) along with other critical sectors, namely energy, health, security, logistics and transportation, food, beverage and supporting industries, petrochemicals, cement, national vital

objects. According to the Hierarchy of Needs Theory by Maslow (1954) there are 5 needs that must be met by humans, where the need for psychology and security are basic human needs. So that the implementation of 100% WFO for critical sectors at a time when the pandemic rate is getting higher and the threat of mutation of new variants of Covid-19 which is confirmed to be more virulent can disrupt the need for a sense of feeling safety for critical sector workers.

The existence of unexpected conditions such as the Covid-19 pandemic which lasted for quite a long time, even according to a survey conducted by Phillips, (2021) found that almost 90% of respondents consisting of immunologists, virologists, and health experts stated that Covid-19 could not be destroyed. making the above phenomena need to be studied further, especially in research on worker Performance, as theoretical and practical learning both now and in the future.

2. LITERATURE REVIEW

2.1. Feeling Safety

Hashiguchi et al., (2020) describes the feeling safety at work as a form of worker's perception of the feeling of security obtained at work. This sense of Feeling safety is related to the safety factor against stress at work or feelings of security from the psychological and physical aspects of dissatisfaction that may be experienced by workers in general. A sense of feeling safety is the existence of an individual's self-awareness in having a sense of care and affection, as well as acceptance (Maslow, 1954). He also divides security into two branches, namely physical and psychological security, according to Feist & Heist, (1976) physical security is related to dependence, stability, protection and freedom from bodily threats such as crime, riots, danger, fear, anxiety, and so on, while psychological security relates to human actions, namely good social and intrapersonal treatment, such as a good social environment and good social communication relationships at work.

2.2. Work Ability

Spreitzer (1995) in Dewettinck & Buyens, (2014) also revealed that there are 4 characteristics that must be possessed by individuals so that they can improve their abilities, namely as follows:

a) Sense of meaning is the value of the purpose of a money job seen from the relationship to individual standards or ideals.
b) Sense of Competence is an individual's belief in the ability they have in carrying out daily activities in their work. expertise possessed.
c) Sense of Self-determination is a feeling of being able to have a choice in making choices when doing work.
d) Sense of Impact is the degree to which a person can influence the results in work both in administrative, strategic, and operational.

2.3. Job Satisfaction

Review Job satisfaction is a complex and diverse concept that has different meanings according to different authors. Job satisfaction is usually related to motivation but is not the same as motivation and may be related to feelings of personal achievement (Mullins, 2005). From the explanation above, the source of worker satisfaction with a job can be concluded into 3 important things, namely the work environment, work facilities and incentives. According to (Sedarmayanti, 2009) the work environment is a series of facilities that will be faced in work activities including equipment, where a person can work well as an individual or an organization with predetermined work methods and arrangements. On the other hand, work facilities are supporting facilities in

physical work, which will later be able to support operational needs in work, so that work can be completed within the specified time (Lupiyoadi & Hamdani, 2006).

2.4. Work Performance

Quoting from Lengkong et al., (2019) Performance is the accumulation of three elements that are closely related to each other, namely skills, efforts, and external conditions. According to Sedarmayanti, (2009) the Performance of a job has the following indicators:

a) Quantity, measured from the perception of workers in the number of activities carried out in the company's tasks. Quality, measured by workers' perceptions of the quality of a job that has been produced, through the perfection of the company's tasks and on the skills and abilities of workers.
b) Punctuality, measured from the perception of workers in an activity that is completed from the beginning of the work to completion into a work output, where he can complete the work at the time determined by the company to maximize the remaining time for other activities.
c) Effectiveness is the maximum monitoring of the time and resources available in a company, to reduce company losses and increase profits.
d) Attendance is the frequency with which employees come to work in a company, where their presence will contribute more to the company.

2.5. Structural Equation Modelling – Partial Least Squares (SEM-PLS)

Structural Equation Modeling (SEM) is a statistical analysis method that can be used to build and test statistical models in a causal format. Basically, SEM modeling has a model that is almost like multiple regression, but the modeling is stronger. Because it uses an interactive, non-linear, correlation of independent variables, and error disturbances. In PLS-SEM Hair et al., (2013) explained that the outer model of the equation of the measurement model/outer model can be written in equation 2.3 for exogenous latent constructs and equation 2.4 for endogenous latent constructs.

Konstruk laten exogen (X):

$$x = \lambda_x \xi + \delta \quad (2.1)$$

Konstruk laten endogen (Y):

$$y = \lambda_x \eta + \varepsilon \quad (2.2)$$

The analysis on PLS-SEM consists of two models. namely, the measurement model (Measurement model), this model is often called the Outer Model, shows how an observed variable explains the latent variable to be measured and the Structural Model, often called the Inner Model, shows the power of estimation between construct/latent variables. The latent variables in PLS-SEM can be formative or reflective, without a minimum suggested sample size. Where in general the model is assumed to have a causal relationship between the observed variables as indicators with latent variables.

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2.6. Research position

Performance indicators according to PMI, (2018) include Motivation, Ability and Environment, previously research that discussed indicators both individually and the intersection between the two on worker performance had been carried out by many previous researchers..

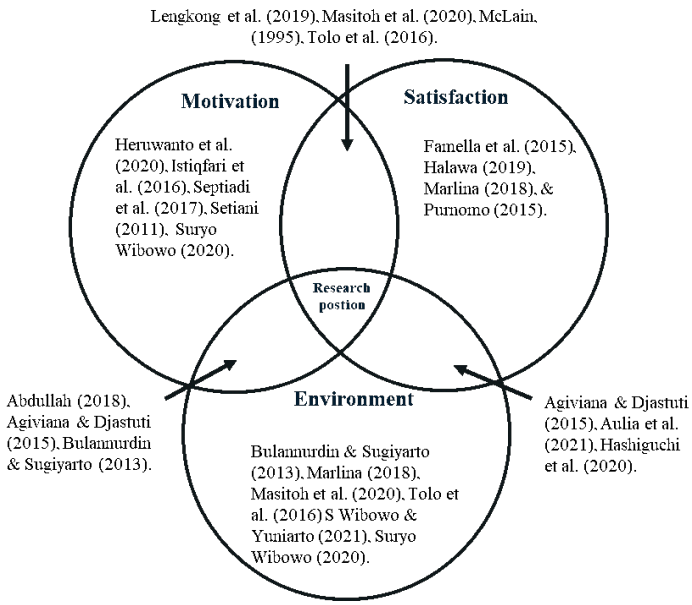

Figure 1.1 Research position

3. METHODS

3.1. Data type

In this study, the data used consisted of two data, namely primary and secondary data.

a) Primary Data
   Data from researchers obtained from first-party sources, namely filling out questionnaires by workers at the Labuan Bajo Multipurpose Pier construction work
b) Secondary Data
   Secondary data is obtained from a second party through articles, journals, books and can also be in the form of official reports

3.2. Population & sample

By maximizing the number of samples, it is assumed that the number of probabilities that have good and bad Performance is balanced (p=0.5 and q=0.5) in equation 3.1. Then the following is the calculation obtained using a significance level of 5%. (Scheaffer et al., 2011).

$$ni = \frac{\mathbf{N}i}{\mathbf{N}} x\ n \qquad (3.1)$$

which $D = \frac{B^2}{4}$ dan $q = 1 - p$

$$n = \frac{(218)(0,5)(0,5)}{(218-1)\frac{0,1^2}{4} + (0,5)(0,5)} = 68.77 \approx 69$$

Where:
n= Sample required
p= Probability of workers who have good Performance
B= Estimation error limit
N= Total population

From the number of calculations above, the total research population is 218 people, so the minimum sample that the researcher must obtain is 69 people.

3. Hypothesis

In this study, each factor has an indicator that is used to measure the respondent's perception. The work skills factor consists of 4 indicators, namely sense of meaning, sense of competence, sense of determination and sense of impact, while the work ability factor consists of environment, facilities, and incentives, which can be seen as follows:

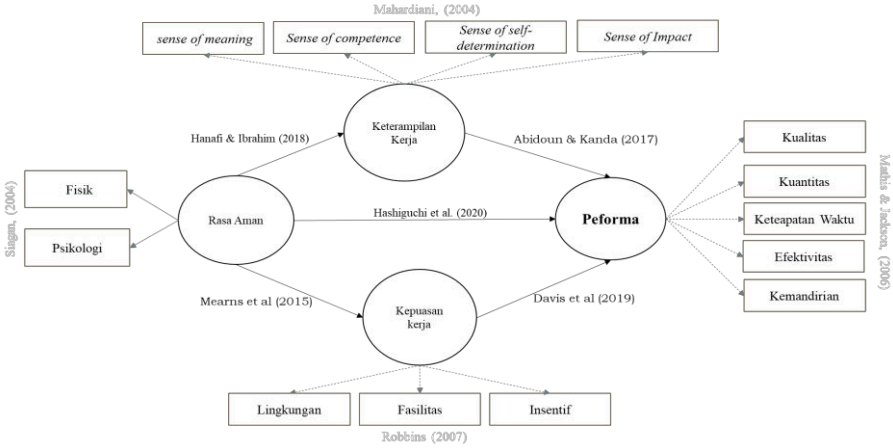

Figure 3.1 Research Construct Model on Worker Performance

Based on the proposed research model, the research hypothesis is compiled as follows:

H_1 : A sense of feeling safety has a positive effect on the Performance of workers in the workplace.
H_2 : A sense of feeling safety has a positive effect on job skills.
H_3 : Work skills have a positive effect on worker Performance
H_4 : A sense of feeling safety has a positive effect on worker Performance mediated by job skills.
H_5 : Safety has a positive effect on job satisfaction
H_6 : Job satisfaction has a positive effect on worker Performance.
H_7 : A sense of feeling safety has a positive effect on worker Performance mediated by job satisfaction.

4. RESULTS

4. 1 Outer Model

In this test, where the loading factor value will be used to see if there may still be some indicators that may not be significant to the variable, so that the expected output can be eliminated later for analysis at a later stage. In the early stages of research, the development of the loading factor value scale is considered sufficient if it exceeds a minimum of 0.5. This is done repeatedly until the best results are obtained where all variables have a loading factor value above 0.5 and pass the reliability test. After repeated iterations by removing invalid variables one by one with the smallest loading factor value, the following results are obtained:

Table 4.1 Test the final validity of the measurement model

Dimension	Indicator	*loading factor*	Dimension	Indicator	*loading factor*
Feeling safety	$X_{1.1}$	0.869	Job Skill	$Y_{1.1}$	0.802
	$X_{1.2}$	0.863		$Y_{1.6}$	0.784
	$X_{1.3}$	0.802		$Y_{1.7}$	0.755
	$X_{1.6}$	0.610		$Y_{1.8}$	0.789

Job satisfaction	$Y_{2.4}$	0.625	Performance	$Y_{1.9}$	0.539
	$Y_{2.5}$	0.782		$Y_{1.10}$	0.594
	$Y_{2.6}$	0.649		$Y_{3.4}$	0.730
	$Y_{2.7}$	0.709		$Y_{3.5}$	0.582
	$Y_{2.8}$	0.662		$Y_{3.8}$	0.862
	$Y_{2.9}$	0.913		$Y_{3.9}$	0.812
	$Y_{2.10}$	0.856			
	$Y_{2.11}$	0.740			

Based on Table 4.3, it can be concluded that all indicators on the final validity are all significant, so they can be included in the next analysis process without having to do a validation test again. Furthermore, a reliability test can be carried out on the questionnaire to see how far the consistency of the research results is by looking at the Cronbach's alpha value contained in Table 4.2 below.:

Table 4.2 Final reliability test of the questionnaire

Variable	**Indicator**	***Cronbach alpha's***	***Average variance extracted (AVE)***
Feeling safety	X_1	0.799	0.629
Job Skills	Y_1	0.830	0.515
Job satisfaction	Y_2	0.887	0.560
Job Performance	Y_3	0.748	0.568

From Table 4.2 Cronbach's Alpha values are obtained for each research variable where it is found that the values of all variables are above 0.7, then all variables can be said to be included in the high reliability category to be used as constructs in the study. Then for the Average variance extracted (AVE) on all variables it has also met the criteria above 0.5

The results and values of all validity and reliability tests meet the minimum values that have been set, namely the validity test is above 0.5 and the reliability test is above 0.7 on each variable. Where the final stage model construct can be seen in Figure 3.1.

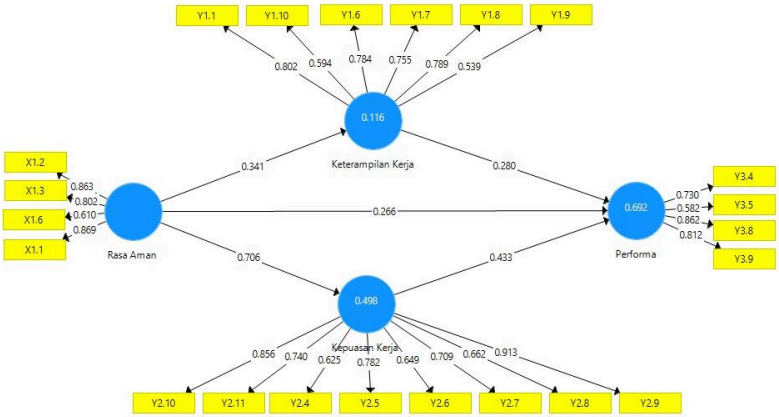

Figure 3.1 Structural equation path diagram

4. 2 Inner Model

From the data below, the variables of job satisfaction and job skills are only weakly explained by the Feeling safety variable in the model, individual job satisfaction is explained almost half by the Feeling safety variable. while Performance has a high R^2 value because this variable can be explained quite high by job satisfaction, and a sense of feeling safety. Meanwhile for Q^2 Predictive Relevance obtained 0.863 shows that modeling the effect of Feeling safety on Performance at construction sites during the Covid-19 pandemic have relevant and good predictions to explain Performance variables.

Table 4.3 Evaluation for Inner Model

Endogen	*R-Square*		Q^2	
	Result	criteria	Result	criteria
Job satisfaction	0.498	moderate	0.863	High
Job skills	0.116	low		
Job Performance	0.692	high		

4. 3 Modeling The Safety of Construction Workers

Testing the significance of the structural model for the safety of construction workers can be evaluated using a bootstrapping procedure. The basis used in testing the hypothesis is the value in the output Path Coefficients (Mean, STDEV, T-Values).

Table 4.4 The value of the path coefficients of the research model

Direct effects					
	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values
Feeling safety -> Performance_	0.266	0.246	0.138	1.927	0.055
Feeling safety -> Skills	0.341	0.356	0.096	3.555	0.000
Skills -> Performance_	0.280	0.293	0.102	2.743	0.006
Feeling safety -> Satisfaction _	0.706	0.719	0.055	12.932	0.000
Satisfaction _ -> Performance_	0.433	0.448	0.162	2.677	0.008
Indirect effects					
	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values
Feeling safety -> Satisfaction _ -> Performance_	0.306	0.320	0.114	2.674	0.008
Feeling safety -> Skills -> Performance_	0.096	0.104	0.048	1.990	0.047

The research hypothesis for the effect of a sense of feeling safety on worker Performance at construction sites during the Covid-19 pandemic can be concluded with a direct relationship between the hypothesized variables as shown in Table 4.5 below:

Table 4.5 Research model hypothesis

Hypothesis		$t_{statistics}$	t_{table}	Explanation
H_1	There is an influence between feeling safety and Performance	1.927	1.96	Accept H_0
H_2	There is an influence between a sense of feeling safety and job skills	3.555	1.96	Reject H_0
H_3	There is an influence between job skills and Performance	2.743	1.96	Reject H_0
H_4	job skills mediate Feeling safety and Performance	1.990	1.96	Reject H_0
H_5	There is an influence between a sense of feeling safety and job satisfaction	12.932	1.96	Reject H_0
H6	There is an influence between job satisfaction and Performance	2.677	1.96	Reject H_0
H_7	Job satisfaction mediates Feeling safety and Performance	2.674	1.96	Reject H_0

In Table 4.5 the influence relationship between latent variables is explained in more detail in the following terms:

1. The value of path coefficients obtained from the relationship between the feeling safety variable and the Performance variable with a $t_{statistics}$ of 1,927. This value is smaller than t_{table} by 1.96 and the p-value is 0.055. These results indicate that there is no effect on the relationship between feeling safety and Performance so that it is not in line with the hypothesis in H_1, So the assumption that the safety and protection factor at work is one of the factors that affect employee performance is not always true because the influence of feeling safety on performance is not directly but through the variables of job satisfaction and work skills, which can also be concluded even though a sense of feeling safety workers have been fulfilled, if workers do not have the work ability and work skills then the performance of workers cannot be achieved. So, if these two things are owned plus the employee has a sense of feeling safety and comfort because he feels he is getting good protection from the company, then the employee will also work with a calm feeling and will work well.
2. $t_{statistics}$ on the path coefficients the relationship between the feeling safety variable and the job skills variable is 3.850, which value is greater than t_{table} of 1.96 This shows that there is an effect on the relationship between feeling safety and work skills in which hypothesis H2 is supported, namely feeling safety has a significant positive effect and supports work skills. PUPR PERMEN No. 21/2019 concerning construction safety management system guidelines explains that construction safety includes feeling safety, health safety and sustainability. So that the act of controlling a sense of feeling safety as an indicator of sustainability both for workers, the environment and the public in the work environment is an important action in maintaining worker performance.
3. The amount of $t_{statistics}$ on the path coefficients obtained from the relationship between the work skills variable and the Performance variable is 2,743, where the number is greater

than t_{table}, these results support the hypothesis H_3 which states that there is a significant positive effect of the relationship between work skills on Performance. Due to a good emotional influence that can carry out good impulsive actions towards work. And if the lower the level of sense of skill possessed by workers, it can cause discomfort so that the performance of workers is low

4. The relationship between the feeling safety variable and the job satisfaction variable has a $t_{statistics}$ of 12,932. This value is greater than t_{table} 1.96 with a p-value of 0.00, which indicates that there is a significant positive effect on the relationship between feeling safety and job satisfaction, where the hypothesis H_5 is supported. By reducing the anxiety that employees have, they can reduce the stress at work during this pandemic. where in addition to carrying out the health protocol, employees are entitled to health insurance, periodic checks, and several additional incentives to the company as their safety and comfort at work so that they can work freely and reduce stress levels due to feelings of fear of the spread of the Covid-19 virus.
5. The $t_{statistics}$ value of the relationship between the job satisfaction variable and the Performance variable is 2,677, which is greater than $t_{statistics}$ and the p-value is less than = 5%, which is 0.008. This value indicates that there is a significant positive effect on the relationship between job satisfaction and Performance. Thus, the hypothesis H_7 is accepted that there is a relationship between job satisfaction and worker Performance. Positive job satisfaction and in accordance with that of employees can increase motivation, and stimulate employees to work even harder, or have a greater impact on the company.
6. In Table 4.5 it is explained that with a $t_{statistics}$ of 1.999, the test for an indirect relationship between feeling safety and Performance through the work skills variable on H_4. This value is smaller than t_{table} of 1.96 at the significance level and p-value is 0.047. That means that the indirect relationship between these variables is significant, where the influence on the hypothesis is supported. Even though the worker's sense of feeling safety has been fulfilled, if the worker does not have the work ability and work skills, the worker's performance cannot be achieved. So if these two things are owned plus the employee has a sense of feeling safety and comfort because he feels he is getting good protection from the company, then the employee will also work with a calm feeling and will work well.
7. Testing path coefficients for other indirect relationships between feeling safety and Performance through job satisfaction variables can be seen in Table 4.5 explaining that with $t_{statistics}$ of 2,674 smaller than t_{table} of 1.96 at the significance level, the indirect effect listed in hypothesis H_4 is supported, so it can be concluded that there is an indirect relationship between the two. So it needs to be noticed that job satisfaction is greatly influenced by a sense of feeling safety directly, if the worker's sense of feeling safety is not fulfilled it will reduce job satisfaction which will indirectly have an impact on performance. The importance of paying attention to the balance of work demands (Output), when worker satisfaction is lower than job demands, more fatigue will appear if on the contrary a feeling of boredom will arise.

6. CONCLUSIONS

Based on modeling regarding the effect of feeling safe on the Performance of workers at construction sites during the COVID-19 pandemic with exogenous latent variables being a sense of feeling safety and endogenous latent being job satisfaction, work skills and Performance, this study provides empirical evidence as follows:

1. The sense of feeling safety does not have a direct influence on the Performance of workers in the construction project of the Labuan Bajo Multipurpose Pier, but through the mediating variables of job satisfaction and work skills with a significant positive relationship of 0.306 and 0.096.
2. A significant positive direct relationship occurs in work skills of 0.341 and job satisfaction of 0.706, furthermore, work skills and job satisfaction also have a significant positive direct effect on Performance of 0.280 and 0.433 for workers in the construction project of the Labuan Bajo Multipurpose Pier.

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ONLINE TRAVEL AGENCY SERVICES OPTIMIZATION BASED ON CUSTOMER SENTIMENT ANALYSIS IN SOCIAL MEDIA USING MACHINE LEARNING METHOD

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ABSTRACT

Based on data from the Association of Indonesian Internet Service Providers, Indonesian internet users in 2019-2020 have reached 196.7 million users or 73.3% of Indonesia's total population. Several sectors have also switched to digital online platforms which have proven to be more effective and efficient. One of the most massive sectors using the online digital platform is the online travel agency (OTA). The increase of internet users is directly in line with the increase of social media users. In the Digital 2021 report: *The Latest Insights into The State of Digital*, it is stated of the total population in Indonesia, 170 million or around 61.8 percent of them have used social media. Therefore, users of OTA services often express criticisms or complaints through social media in this case Twitter and Google Play Store reviews. They have provided data on all tweets and reviews that can be accessed with certain keywords publicly. This research will conduct crawling data on social media about one of OTAs, namely tiket.com. Crawling data results will be analyzed and classified using a random forest method to generate classification models. Then model accuracy will be evaluated using the Confusion matrix and Area Under Curve (AUC). This study obtained 3 (three) different classification models referring to the data sources, including Twitter data, Play store data, and combination data of both (Twitter and Play store). The Twitter data model has an accuracy of 80.78% and AUC of 72% (Fair/Acceptable), the Play store data model has an accuracy of 84.58% and AUC of 83% (Good/Excellent), then the combination has an accuracy of 77.30% and AUC of 73%. (Fair/Acceptable). So can be inferred from this research, the best classification model is the model which uses the Play store data.

Keywords: online travel agency, sentiment analysis, Twitter, Play store, machine learning, random forest

1. INTRODUCTION

Internet penetration in daily human life is undeniable because almost all aspect of life has been integrated with this technology. Based on data from the Association of Indonesian Internet Service Providers, Indonesian internet users in 2019-2020 have reached 196.7 million users or 73.3% of Indonesia's total population. Moreover, according to the Indonesian Ministry of Communication and Information, the number of Indonesian internet users in 2020 has reached 175,5 million people of 268,583,016 populations. This indicates that ±65% of Indonesia's population has connected to the internet or increased around 25 million or 17% compared to the previous year in 2019.

The significance of internet user growth in recent years will make people switch from conventional to online digital business (e-commerce). One of the businesses that have an internet user segment is an online travel agency (OTA). In contrast to "brick and mortar" companies, OTA is considered as the "brick and click" company where only a computer and internet are needed to operate the company. Because of more effectiveness and efficiency, offline travel agents have begun to build online digital platforms to expand their network and market share according to Tsang, Lai, & Low (2010). Customers who are certainly come from the internet user segment, often give comments or reviews for giving perspective and assessment about OTA services. The review can have two meanings that are positive and negative. Positive means a compliment as a sign of customer satisfaction and negative means a protest/complaint as a sign of customer disappointment with OTA services.

The reviews found on social media are commonly referred to sentiment analysis concept. Sentiment analysis is an intellectual process to define people's opinions, sentiments, evaluations, feelings, attitudes, and emotions from written language. Liu (2012) explained that sentiment analysis systems are being applied in almost every business and social domain because opinions are central to almost all human activities and are key influencers of our behaviors. Our beliefs and perceptions of reality, and the choices we make, are largely conditioned on how others see and evaluate the world. For this reason, when we need to make a decision we often seek out the opinions of others. This is true not only for individuals but also for organizations.

This study will conduct sentiment analysis on one of the Indonesian online travel agencies namely tiket.com using machine learning methods on two social media (Twitter and Play store review). The machine learning method that will be used is the random forest to classify data between positive and negative sentiment. The results of this descriptive and predictive analysis sequentially are recommendations for making decisions to improve services that keep customers satisfied and a classification model for tiket.com to predict the sentiment of written reviews in the future. This is very related to tiket.com's vision to become the best customer-centric OTA (customer satisfaction oriented).

2. LITERATURE REVIEW

A. Online Travel Agency (OTA)

E-Commerce engaged in the tourism sector is familiarly called Online Travel Agency (OTA). OTA provides several key services about the traveling/tourism business model. For example, there are main features for booking accommodations, tour packages, travel documents, vehicle rentals, and many more. There are also features that can provide information and tourism object reviews globally, nationally, and locally such as the travel review feature. In addition, OTA has the advantage to provide price comparisons between various airlines or other accommodations like online aggregators according to Standing & Vasudavan (2014).

B. Sentiment Analysis

Based on Devika, Sunitha, & Ganesh (2016), sentiment analysis is an intellectual process to define the feelings and emotions of persons from their written text in social media. Sentiment analysis is part of Natural Language Processing (NLP). Massive changes to the Internet-based applications development have led to a large number of user personalization reviews for various information. These reviews exist in various forms such as social media posts, blogs, Wikipedia, or special forums on websites. This technology is related to the hidden information analysis and prediction inside of the text. The hidden information also provides a valuable insight based on the full text on both a subjective and objective level. Figure 1 illustrates subjectively appropriate texts have three (3) categories of sentiment which are positive, neutral, and negative, or enough to be divided into two (2) sentiments which are positive and negative.

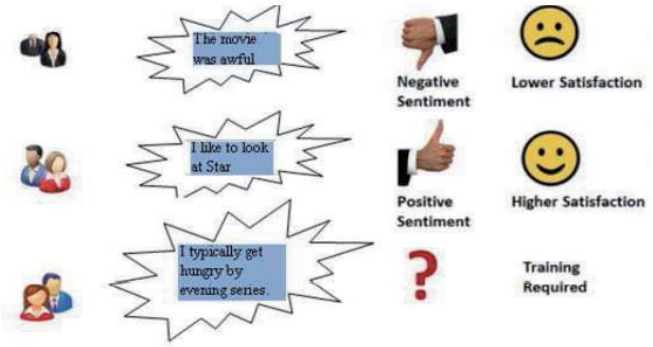

Figure 1. Sentiment Polarity (Anamin 2014)

C. Related Study

Several past studies related to this research explained sentiment analysis at an online travel agency (OTA) but there had not been much research using datasets in Bahasa from social media. This happens because there were not enough Natural Language Processing (NLP) libraries available in Bahasa but in this research, the author tries to improve using dataset in Bahasa. For example, Kim Phung, et. al (2021) applied the machine learning method to conduct sentiment analysis of customer reviews from abroad sites, namely Agoda.com. Moreover, random forest as a classification machine learning method that tends to have good accuracy, has not been widely applied in sentiment analysis cases. For example, Poernomo (2019) had research with a dataset in Bahasa about OTA sentiment analysis using machine learning method K-Nearest Neighbors (KNN), Naïve Bayes, and Support Vector Machine (SVM). So, in this research author propose random forest as a classification machine learning method to analyze the sentiment text from social media about OTA.

3. METHODS

A. Dataset

The data source in this research is used secondary data. It was taken from two social media which are Twitter and Google Play Store Review. It is obtained using the data crawling technique with a period of January 1, 2020 to April 30, 2021. Twitter and Google Play Store themselves have provided a platform to analyze text features such as tweets, retweets, comments, ratings, reviews, and others. This platform in familiar programming is called API (Application Programming Interface). Data that comes from social media is raw data that needs to be processed further to obtain value from the data.

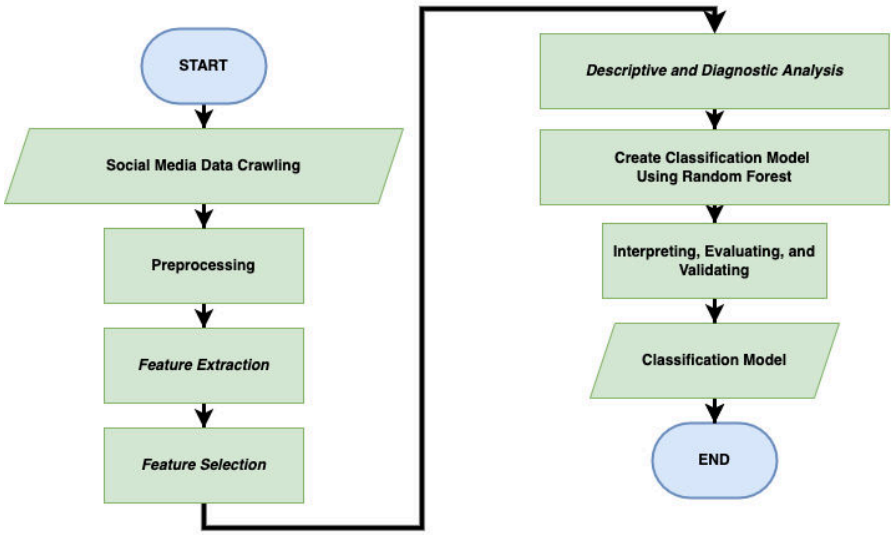

Figure 2. Flow Chart Research

Based on the following flow chart at Figure 2 above, here are several steps to processing the data until get the classification model :

- **Data Processing**: Case Folding, Remove Punctuation, Remove Link
- **Feature Extraction & Selection**: Term Frequency - Inverse Document Frequency (TF-IDF) Remove Stopwords, Tokenization, Stemming, Labelling,
- **Descriptive & Diagnostic Analysis**: Word Cloud Graphic
- **Classification Model**: Random Forest
- **Interpreting, Evaluating, & Validating**: Confusion Matrix, ROC Curve

B. Term Frequency dan Inverse Document Frequency (TF-IDF)

Before carrying out the classification process, the data is first transformed into a vector from the initial text. The transformation process is using the TF-IDF which is a method to measure the weight of a word contained in the text. The measurement is carried out by comparing the amount of word intensity that appears in a text document with the amount of intensity of a word that is distributed throughout the text document. The TF-IDF formula is as follows:

$$TF = \begin{cases} 1 + \log 10\left(f_{t,d}\right), & f_{t,d} > 0 \\ 0, & f_{t,d} = 0 \end{cases} \quad (1)$$

In Equation (1) where the value $f_{t,d}$ is the frequency(f) of a term(t) at document(d) text. For example, if a word is contained in a text document five (5) times then the obtained weight = 1 + log (5) = 1,699. But if the term is not contained in the document, the weight is zero (0).

$$IDF_j = \log\left(\frac{D}{df_j}\right) \quad (2)$$

In Equation (2) where D is the number of all documents in the collection while DF_j is the number of documents containing the term (t_j).

C. Random Forest Classification

Random forest is a bagging method, which is a method that generates a number of trees from sample data. The creation of one tree during training does not depend on the previous tree, then the decision is made based on the most votes. Two concepts that be the basis of random forest are building an ensemble of trees via bagging with replacement and random feature selection for each tree that is already built. First, each sample taken from the dataset to train the tree can be used again for another training tree. Second, the features used during training for each tree are a subset of the features owned by the dataset. The random forest method has two main parameters, which are $\boldsymbol{m}$ the number of trees to be used and $\boldsymbol{k}$ is the maximum number of features that are considered during the branching process. The larger of $\boldsymbol{m}$ values will produce better classification results, while $\boldsymbol{k}$ value is recommended to have value square root or logarithm of the total number of features according to Wibowo, Saikhu, & Soelaiman (2016).

D. Classification Method Performance Evaluation and Validation

This research uses two approaches for evaluating and validating the classification model, which are confusion matrix and Receiver Operating Characteristic (ROC)/Area Under Curve (AUC) Curve. First, actual data and predicted data from the classification model are presented using a cross-tabulation called Confusion Matrix as shown in Table 1. It contains information about the actual data class represented in the row matrix and the predicted data class in the column matrix according to Han & Kamber (2006). Based on the confusion matrix, the classification model will obtain accuracy, sensitivity, specificity, and precision value.

Table 1. Confusion Matrix

X	Predictive Positive Class	Predictive Negative Class
Real Positive Class	True Positive (TP)	False Negative (FN)
Real Negative Class	False Positive (FP)	True Negative (TN)

Second, for imbalanced data, classification accuracy from the confusion matrix is not sufficient as a validating and evaluating method, it can be handled with ROC/AUC Curve. AUC and metrics such as precision, recall, have been used to understand the performance of learning algorithms in minority classes. AUC provides a single measure of classifier performance for evaluating which model is better on average. The AUC measure is obtained by calculating the true positive rate (TPR) which is the number of objects in the positive class that are classified correctly, and the false positive rate (FPR) which is the number of objects in the positive class that are incorrectly classified. The AUC measure is used to summarize the classification model into a value where the larger value is the better model. For the details about the AUC measure, can be referred to Table 2.

Table 2. AUC Table Criteria

Predictive Positive Class	Predictive Negative Class
< 0,6	Failure
0,6 – 0,7	Poor classification
0,7 – 0,8	Fair classification
0,8 – 0,9	Good classification
0,9 – 1	Excellent classification

4. RESULTS

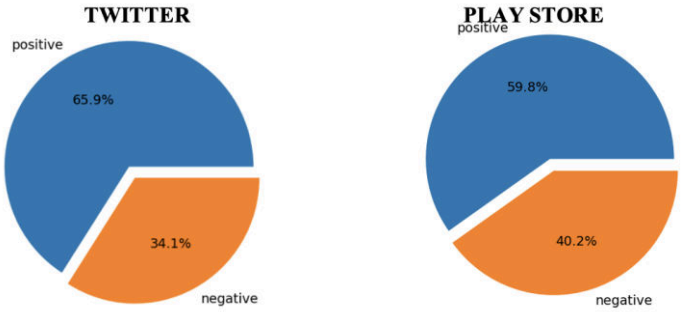

Figure 3. Twitter and Play Store Review Data Percentage

Twitter and Play store reviews were obtained from crawling data results starting from January 01st, 2020 to April 30th, got 2,686 tweets or 32,705 words and 1,360 play store review texts or 10,992 words. According to Figure 3. The positive text shows 65% on Twitter and 59.8% on Play store review of the total responses. Meanwhile, 34.1% on Twitter and 40.2% on Play store gave a negative response to tiket.com. Both data sources show that positive sentiment towards tiket.com is higher than negative sentiment. Then, looking at the number of different response variables, it can be concluded that the collected data is imbalanced.

Figure 4. Word Cloud

Based on Figure 4, the word cloud represents all the words in the data. It is very clear that "refund" is the word that is most often discussed on Twitter and Play store. A refund itself is a returning fee to the customer due to the cancellation of product purchases by the customer. This proves that during the Covid-19 pandemic, the most widely used feature is the refund feature. In terms of features used numbers which are represented by positive word cloud, this is certainly a credit to companies that have provided services to make it easier for users processing the refund request. The refund process can easily be submitted through the application for further follow-up by the relevant parties such as the airline when refunding air transportation products.

After doing some descriptive and diagnostic analysis, then the next step is predictive analytics to predict the text sentiment whether classified into positive or negative sentiment using the random forest method. Oshiro, Perez, & Baranauskas (2012) mentioned that mean and median AUC values did not change significantly from 64-128 trees. Therefore, a range of between 64 and 128 trees is recommended in a random forest method based on experiments. Several iterations using the number of trees with a range of 64 to 128 for Twitter data show that the best number of trees are 98 with an accuracy of 80.78%. The play store data found the number of trees are 91 with an accuracy of 84.58%, and the data combination of both with the best number of trees as much as 66 gets an accuracy of 77.30%.

Based on the classification model that has been obtained, the next process is to evaluate the model using the ROC Curve value. This value will identify whether a model can be implemented or not especially for data with an imbalance response variable. A model with Twitter data got an AUC value of 72%. Referring to the AUC value criteria in Table 2, the AUC value is included in the Fair Classification/Acceptable Classification category so that the classification model can be accepted and implemented. A model with Play store data gets an AUC value of 83% and is included in the Good Classification/Excellent Classification category. Then model with a data combination of Twitter and Play store has an AUC value of 73% is also included in the Fair Classification/Acceptable Classification.

5. CONCLUSION

Table 3 and Figure 5 below describe the results of each classification model using Twitter data, play store review data, and a combination of them.

Table 3. AUC Table Criteria

No.	Data Source	Accuracy (%)	AUC(%)	AUC Criteria
1	Twitter	80.78	72	*Fair/Acceptable*
2	Playstore	84.58	83	*Good/Excellent*
3	Twitter + Playstore	77.30	73	*Fair/Acceptable*

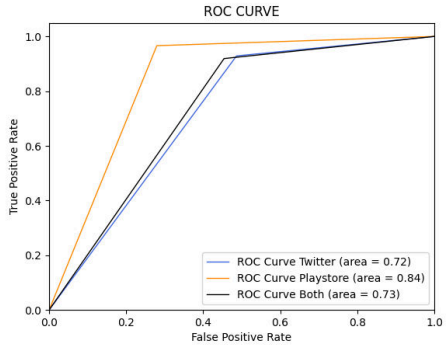

Figure 5. All Classification Model ROC Curve

It can be concluded that the model using play store data is the best classification model with an accuracy of 84.58% and an AUC value of 83%. This AUC value is categorized as good/excellent classification. It probably can be happened because the play store review data has a rating value that makes it easy to do text labeling on play store review data. Referring to the classification model output where all models can be implemented because it provides at least acceptable AUC value category, there are several important things related to the optimization procedure as a summary of the managerial implications:

- Optimization of employees numbers such as social media admin or customer call center according to the social media intensity users when giving reviews or complaints.
- Optimization in the form of an automation system that can provide each template response automatically on social media if it finds a review text with positive or negative sentiments.
- Optimization of using the early warning dashboard system in monitoring the sentiment that develops on social media towards the tiket.com service on an eventual basis.

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DESIGNING PREDICTION MODEL FOR FINDING POTENTIAL CHURN CUSTOMERS ON MORTGAGE USING MACHINE LEARNING

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ABSTRACT

A mortgage is a loan or financing system, whereas banks provide loans to customers to get houses and repay within a specified time. The more customers who take mortgages will impact the quality of a bank's mortgage portfolio. Along with the age of mortgage loans, churn customers can impact the growth of the mortgage portfolio and reduce the relationship between the bank and the customer. The lack of information about the factors affecting churn customers is limited due to an unbalanced population's lack of knowledge. Therefore, the purpose of this study is to create a predictive model that can classify churn customers on mortgage products so banking can do retention just in time. This paper will discuss binary logistic regression algorithms used to look for influential factors in distinguishing churn customers and loyal customers based on the forward selection method. This paper will also discuss the performance of logistics regression using oversampling methods to overcome imbalanced with the SMOTE (Synthetic Minority Oversampling Technique) method. The final result of this paper obtained seven variables that affect the model accompanied by the AUC value of the original binary logistic of 0.68 and the SMOTE binary logistic of 0.72.

Keywords: Mortgage, Churn customers, Predictive Analytics, Receiver Operating Characteristic, Area Under Curve, Early Warning System, SMOTE

1. INTRODUCTION

In managing a bank's mortgage portfolio, the portfolio's value constantly fluctuates in increases and decreases. According to Bank MRI annual report data, mortgage growth in the second quarter of 2020 fell significantly. The growth was minus 3% to minus 5% compared to last year or year on year (YoY). While in the fourth quarter of 2019, mortgage sales experienced growth of 2% to 3% (YoY). The increase and decrease in Bank MRI mortgage growth value are influenced by customer interest and churn customer behavior in existing debtors. Churn customers are defined as the number of customers or service users who unsubscribe or use the services, expressed as a percentage of the total customers in a specific time interval (Maldonado et al., 2021). This behavior is most likely to occur because customers are unsure how to benefit from a long-term commitment to the company (Zorn et al., 2010)

In dealing with churn customers, there are several facing the company. In general, the churn rate value found is very small compared to loyal customers, so the problem of the imbalance of the amount of data can affect the results of analysis and modeling to be made. In addition, the

factors underlying churn customers behavior are very diverse, so the analysis of these factors is in a high dimension (Bhanuprakash & Nagaraja, 2018). Therefore, to overcome this problem, predictive development of models is needed to look for factors and predict customer churn, so that mitigation in the form of retention can be done as early as possible.

In a previous study, Sabbeth (2018) described machine learning comparisons to customer retention shown with a variety of machine learning methods that can be used to predict customer churn, including Decision Tree, Support Vector Machine, Bayesian, Ensemble Learning, Linear Discriminant Analysis, and Deep Learning. So based on previous research, this paper will address this issue using logistic regression models to determine churn and prediction factors and using SMOTE (Synthetic Minority Oversampling Technique) oversampling methods to improve predictive outcomes.

2. LITERATURE REVIEW

2.1. Churn Customers

Churn can be interpreted as a customer or service user who stops using the service provider's services. In general, churn interest can occur due to customers who are not sure enough about the long-term commitment that can be obtained from the service provider. According to (Kotler & Keller, 2016), churn events can occur due to displeasure or disappointment between the results obtained and the expectations formed. Satisfaction can be measured in the same dimension as satisfaction. According to Bhanuprakash & Nagaraja (2018), the company's ability to conduct early detection of churn is needed because the costs provided to get new customers are needed greater than retention to churn customers.

2.2. Descriptive Statistics

Descriptive statistics are methods of collecting and presenting a data group to provide useful information (Walpole & Myers, 1995). Descriptive statistics aim to present data information as a description of facts in numerical, table, graph, or distribution curves so that a fact or event can be easily understood and inferred (Mustafid, 2003). Descriptive statistics in this study are used to describe the characteristics of risk factors that affect an event.

2.3. Logistic Regression

Binary logistic regression is a method of data analysis used to look for relationships between binary response variables and predictor variables (Hosmer & Lemeshow, 2013). Response variable y consists of 2 categories: success and failure, which are notated with y = 1 (success) and y = 0 (fail). Under such circumstances, variable y follows the Bernoulli distribution for every observation. The Probability function for each observation is given as follows:

$$f(y) = \pi^y(1-\pi)^y; y = 0,1 \tag{2.1}$$

A function π(x) is sought using a logite transformation i.e. g(x) expressed as follows:

$$\pi(x) = \frac{\exp(\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_p x_p)}{1 + \exp(\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_p x_p)} \tag{2.2}$$

whereas :

$\pi(x)$: Probability of a successful event

p : Number of predictor variables

X_1.. : independent variables, both qualitative and quantitative

β_0 : Constant
$\beta_1 \ldots . \beta_p$: Regression coefficient parameters

2.4. SMOTE (Synthetic Minority Oversampling Technique)

The SMOTE method as one of the solutions in dealing with unbalanced data is different from the previous oversampling method of randomly duplicated data (Chawla et al., 2002). The SMOTE method increases the amount of minor-grade data to be equivalent to the major class by generating artificial data. Artificial data or synthesis is made based on the nearest neighbor. The number of nearby k-neighbors is determined by considering the ease of carrying it out. Numerically generated artificial data generation is different from categorical. Numerical data is measured by proximity to Euclidean distance, while categorical data is simpler by mode values. Calculation of distance between examples of minor classes whose categorical scale is done with the formula Value Difference Metric (VDM) :

$$\Delta\ (X,Y) = w_x w_y \sum_{i=1}^{N} \delta\ (x_i y_i)^r \tag{2.3}$$

whereas :

$\Delta\ (X,Y)$: Distance between data X and Y
$w_x w_y$: Observation weight
N : The number of explanatory changes
R : 1 (Manhattan distance) or 2 (Euclidean distance)
$\delta\ (x_i y_i)^r$: Distance between categories

2.5. ROC and AUC

The ROC curve is divided into two dimensions, where the True Positive (TP) level is plotted on the Y-axis, and the False Positive (FP) level is plotted on the X-axis. But to represent the graphics that determine which classification is better, a method that calculates the area below the ROC curve is used, defined as a probability. The Under the ROC Curve area measures discriminatory performance by estimating the likelihood of output from a randomly selected sample of a positive or negative population. The larger the AUC, the stronger the classification used. Since the AUC is part of a square unit area, its value will always be between 0.0 and 1.0. See the following criteria of AUC (Table 1) (Hosmer & Lemeshow, 2013)

Table 1. AUC Criteria

Performance	Classification
ROC = 0,5	Very Poor
0,5 < ROC < 0.7	Poor
0,7 ≤ ROC < 0,8	Acceptable
0,8 ≤ ROC < 0,9	Excellent
ROC ≥ 0,9	Outstanding

3. METHODS

The data used in this study is secondary data resulting from data retrieval around as many as 18 variables consisting of the transaction, fund, and credit activities. The collection of customer churn and non churn data starts from 2019 to May 2021 with a total of 50,000 respondents, where observations of related variables are month-end data that will be observed relative to the repayment date made by each customer over the past 6 months.

3.1. Methodology for Obtaining Factors of Churn Customers

To find out the factors that affect churn customers using logistic regression, This analysis was carried out based on the research objectives, as for the steps as follows:

1. Modeling training data according to the proportion of training and testing data sharing with a proportion of 70:30
2. Perform simultaneous tests to see the effect of independent variables on dependent variables based on the G test with an alpha significance rate of 5%.
3. Perform a partial test to see the effect of each independent variable with an alpha significance rate of 5%
4. Interpret the model based on the Odds Ratio value to see the tendency of independent variables based on $\hat{\beta}_j$ values

3.2. Methodology for Obtaining Models with High Accuracy

To get a logistic regression model that has accurate predictions, This analysis was carried out based on the research objectives, as for the steps as follows:

1. Conduct business understanding by conducting interviews with related Business Units regarding the definition of churn customers
2. Conduct research on previous journals on how to deal with churn customers and logistic regression modeling
3. Perform data understanding through descriptive and agnostic processes to data
4. Perform factor selection using the forward selection method.
5. Divide training and testing data at a ratio of 70:30% (Lants, 2019).
6. Perform the process of logistic regression analysis by determining the response variable (Y) and variable predictor (X).
7. Oversampling by using SMOTE against training data to overcome imbalanced.
8. Make predictions on data testing to get the model's accuracy value. Accuracy values are assessed by looking at AUC values exceeding 70%.

4. RESULTS

This section will discuss the results of the methods used to determine the factors that affect customer churn and the accuracy value of the prediction model.

4.1. Result of Logistic Regression

This section will discuss variable selection results based on the forward selection method and interpretation of the logistic regression algorithm. The forward selection method is done by gradually entering the predictor based on the largest partial correlation. In the forward selection method, the predictor variables included in the model will no longer be able to be issued. The process is stopped when new predictors cannot significantly increase the effect (p-value below 0.05) of the response variable. Table 2 is the result of the last forward selection step that has been done to look for significant variables.

Table 2. Results of forward Selection

Variable	Beta	S.E.	Wald	df	p-value.	Odds Ratio
bade_per_limit	-1.293	0.068	358.359	1	0.000	0.274
rate			1109.815	3	0.000	
rate(1)	2.433	0.233	109.452	1	0.000	11.397
rate(2)	3.384	0.233	211.380	1	0.000	29.489
rate(3)	3.591	0.232	239.155	1	0.000	36.275
withdrawal_freq	-0.098	0.004	490.662	1	0.000	0.907
usia	-0.014	0.002	54.131	1	0.000	0.986
gender(1)	0.104	0.027	15.101	1	0.000	1.110
marital_status(1)	0.278	0.032	75.113	1	0.000	1.320
ttl_rek	0.131	0.008	284.384	1	0.000	1.140
Constant	-3.374	0.251	181.096	1	0.000	

Based on table 2, There is information about Beta, Standard Error, Wald Test values, and p-Values. Beta values on each variable are used to form logistic regression equations. Standard Error, Wald, and p-value values are used to see the significance of variables. Seven significant variables are obtained along with trend values based on the odds ratio. By looking at Odds Ratio in Table 2, the greater tendency to influence churn is rate, gender, marital_status, and ttl_rek. While the variables bade_per_limit, withdrawal_freq, and usia have a lower tendency to influence churn. To create a mathematic equation from the logistic regression model, input the beta value into the probability model equation. So that the model obtained for customer churn events on mortgage products is as follows:

$$\pi(x) = \exp\left(-3.374 - 1.293\,(x3) + 2.433(x11)_1 + 3.384(x11)_2 + 3.591(x11)_3 - 0.098\,(x6) - 0.014\,(x4) + 0.104(x12)_1 + 0.278(x19)_1 + 0.131\,(x16)\right) / \left(1 + \exp\left(-3.374 - 1.293\,(x3) + 2.433(x11)_1 + 3.384(x11)_2 + 3.591(x11)_3 - 0.098\,(x6) - 0.014\,(x4) + 0.104(x12)_1 + 0.278(x19)_1 + 0.131\,(x16)\right)\right)$$

Entering the value in the 7 variables that are significant in the probability model above will obtain the value of one's chances in churning. We also measure the contribution of each variable by giving a value of 1 to the observed variable and a value of 0 on other variables as follows :

- bade_per_limit (x3)
  The customer churn odds are affected by the variable bade_per_limit is 0.0093 assuming the other variable is considered constant.
- rate (x11)
  - rate(1) $(x11)_1$
    The customer churn odds are affected by variable rate(1) is 0.28 assuming other variables are considered constant.
  - rate(2) $(x11)_2$
    Customer churn odds are affected by variable rate(2) is 0.5 assuming other variables are considered constant.
  - rate(3) $(x11)_3$

Customer churn odds are affected by variable rate(3) is 0.55 assuming other variables are considered constant.

- withdrawal_freq (x6)
  The customer churn odds are affected by the variable withdrawal_freq is 0.03 assuming other variables are considered constant.
- Age (x4)
  The odds of customer churn being affected by the age variable are 0.03, assuming other variables are considered constant.
- gender(1) $(x12)_1$
  Customer churn odds are affected by the gender variable is 0.03 assuming other variables are considered constant.
- marital_status $(x19)_1$
  The customer churn odds are affected by the variable marital_status is 0.04 assuming other variables are considered constant.
- ttl_rek (x16)
  The customer churn odds are affected by the variable marital_status is 0.03 assuming other variables are considered constant.

4.2. Result of ROC and AUC

The following sections are the result of the ROC and AUC curves comparing the original logistic regression with the SMOTE logistic regression..

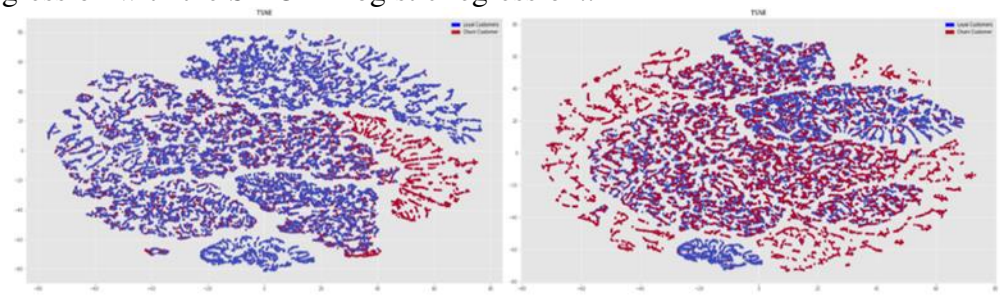

Figure 1 : Data Training Original vs SMOTE

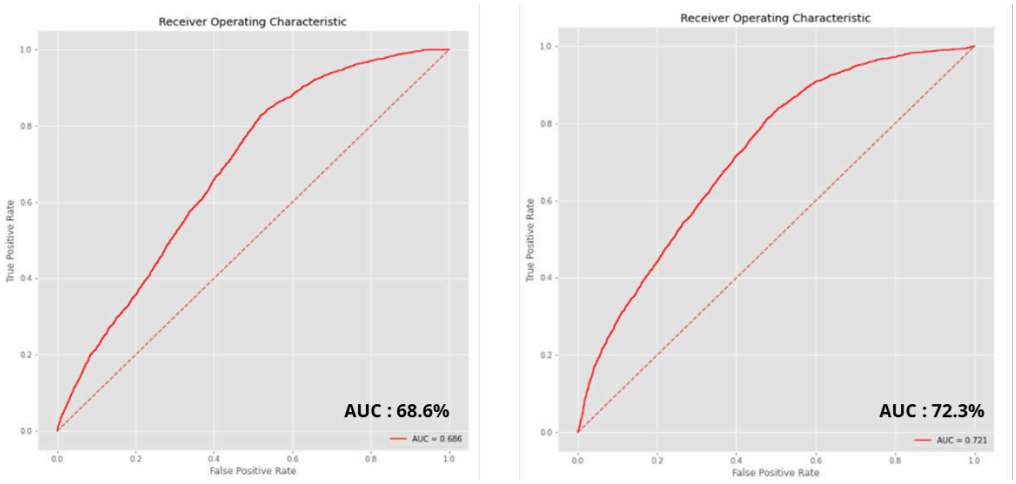

Figure 2 : ROC and AUC Original Logistic Regresion vs SMOTE Logistic Regresion

Based on figure 1 can be seen the SMOTE method that successfully synthesizes data imbalance. While in figure 2, the results of reducing the value of AUC logistic regression with SMOTE have a value of 72% while the original logistic regression of 68%.

6. CONCLUSIONS

This study has addressed how to find the factor affecting churn customers using logistic regression. Logistic regression can describe the tendency of independent variables to dependent variables through the odds ratio. Based on logistic regression results obtained 7 variables that affect the occurrence of churn, whereas the largest influence is on the variable rate and bade_per_limit. In addition, To create an accurate logistic regression model, oversampling methods such as SMOTE are needed to overcome imbalanced data. The results of measuring the predictive power based on AUC (Area Under ROC Curve) measurements, SMOTE Logistic Regression values provide higher AUC values than original Logistic Regression.

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DESIGNING PREDICTION MODEL AND BUSINESS MODEL FOR VEHICLES FINANCING BASED ON DATA MINING

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ABSTRACT

Vehicle financing is one of the financing products needed by consumers when buying a vehicle. PT "M" is one of the vehicle financing companies in Indonesia. The Covid-19 Pandemic condition that has occurred since the end of 2019, has had a significant impact on the financing business.

The main source of orders for financing companies comes from vehicles dealers. The decline in car sales had a direct impact on the company's business. To overcome this, it is necessary to develop other sources, from the company's customer data mining. In this research, the prediction model with binary logistic regression will be applied. A model will be used to predict which customers will take financing. In addition, the development of a data mining-based financing business model is also carried out using Business Model Canvass approach.

The results of models, predictor variables that affect customers in car financing are the period of previous financing, salary, type of product financed, homeownership status, marital status, customer employment type, and education. With the Area Under Curve approach, the accuracy of the model formed is 95.803%. In carrying out this data mining-based business model, companies need to form data analytic functions and build offering activities for customers.

Keywords: Vehicle Financing, Data mining, Binary Logistic Regression, Business model canvas, Financing Company, Area Under Curve.

1. INTRODUCTION

The Covid-19 pandemic, which began at the end of 2019, has had a significant impact on financing companies. Consumptive financing tends to decline, one of which is motor vehicle financing. Based on data from GAIKINDO (Indonesian Automotive Industry Association), motor vehicle sales decreased by 44.6% in 2020, compared to the previous year. Car sales in the retail segment in 2020 only amounted to 578 thousand units, while in 2019 car sales reached 1043 thousand units. This decrease in car sales certainly affects the decline in financing distribution in Indonesia by 40% from Rp. 214 trillion to Rp. 126 trillion in 2020. PT "M" as a vehicle financing company also experienced the same effect. This is because the source of prospects is still dominated by sales from vehicle dealers, both for the individual customer segment and for the corporate customer segment. To get a source of prospects other than dealers, PT "M" must look

for business growth through other ways, one of which is from its customer database (data mining). The process of taking vehicle financing back by existing customers is also obtained from vehicle dealer references. This is a potential that can be developed by PT "M" to be able to offer back based on data processing (data mining). This re-offer has advantages because, with data processing (data mining), historical customer payments are available so that they can be used as considerations in providing good quality refinancing.

In previous studies, research related to vehicle financing companies has not been widely carried out, this is due to different regulations in each country. However, the use of the logistic regression method has been widely used for the financial business sector. One of them is in the research conducted by Anand (2016), the logistic regression method is used to determine whether the customer is satisfied or not with a product or service, where these satisfied and dissatisfied conditions become the dependent variable and the independent variables are several attributes. which can be used to measure customers when using the product. Meanwhile, research related to the determination of purchasing other financial products, such as housing loans, household loans, also uses logistic regression as carried out by Strzelecka, Kujawska, and Zawadzka (2020) in research to access customer eligibility in taking loans for household appliances. To support the development of the model carried out into a complete business model for the customer segment that takes refinancing, another research that uses the business model canvas approach is the research conducted by Joyce and Paquin (2016). This research uses a three-layer business model canvas approach to create a more sustainable and sustainable business model.

Based on the description above and the research that has been done previously, this research will develop a model using a binary logistic regression approach. The response variable (Y) has two categories, namely customers who do not refinance the car and customers who do refinance the car. While the predictor variable (X), based on the PT "M" database, several factors are thought to influence customers in making repeat orders, including income, education level, historical conditions of financing, homeownership status, and others. The determination of significant variables is continued by measuring the accuracy of the model described in the Receiver Operating Characteristics (ROC) graph. To support the developed model, this research will also discuss the right business model for the financing business model derived from the existing database using the business model canvas method, to provide a new business model for PT "M" to channel new financing better and with greater ease. more measurable quality.

2. LITERATURE REVIEW

2.1 Regression Method

The regression method is a data analysis that describes a response variable and one or more predictor variables (Hosmer and Lemeshow, 2013). In research, the relationship between an independent variable where the dependent variable is categorical data, standard linear regression analysis cannot be carried out. Therefore, one approach that can be used is logistic regression. Logistic regression equation model is used to explain the relationship between x and $\pi\ (x)$ which is nonlinear, non-normal distribution of, response variability which is not constant and cannot be explained by ordinary linear regression models. According to Hosmer and Lemeshow (2013), logistic regression is a method that can be used to find the relationship between response variables that are dichotomous (nominal/ordinal scale with two categories) or polychotomous (nominal/ordinal scale with more than two categories) with on more predictor variables on a categorical or continuous scale. The multivariable logistic regression model with predictor variables is as follows

$$\pi(x) = \frac{e^{(\beta_0+\beta_1 x_1+\cdots+\beta_p x_p)}}{1+e^{(\beta_0+\beta_1 x_1+\cdots+\beta_p x_p)}}$$

By using the logit transformation of $\pi(x)$ to facilitate the estimation of the regression parameters, it is formulated as follows:

$$g(x) = ln\left[\frac{\pi(x)}{1-\pi(x)}\right] = \beta_0 + \beta_1 x_1 + \cdots + \beta_p x_p$$

2.2 Model Performance

The ROC curve is divided into two dimensions, where the True Positive (TP) level is plotted on the Y-axis and the False Positive (FP) level is plotted on the X-axis. However, to graphically represent which classification is better, the method that calculates the area below is used. ROC curve called (Area Under the ROC Curve) is defined as a probability. The Area Under the ROC Curve measures discriminatory performance by estimating the output probability of a randomly selected sample of a positive or negative population, the larger the AUC, the stronger the classification used. Since AUC is part of the unit area of a square, its value will always be between 0.0 and 1.0. The following are the AUC criteria (Table 2.1) (Hosmer and Lemeshow, 2013).

Table 2.1 Categories AUC

Performance	Category
ROC = 0,5	*Very Poor*
0,5 < ROC < 0,7	*Poor*
0,7 ≤ ROC < 0,8	*Acceptable*
0,8 ≤ ROC < 0,9	*Excellent*
ROC ≥ 0,9	*Outstanding*

2.3 Business Model Canvass

A business model describes the rationale for how organizations create, deliver, and capture value (Osterwalder & Pigneur, 2010). According to Afuah and Tucci (2001), most business executives identify the design of a new business model as a competitive advantage with greater product or service resources. Innovation in business models has proven to be an important concept for overall organizational sustainability and integrates sustainability strategies within (Osterwalder & Pigneur, 2011). One of the concepts that can provide everyone's understanding and can help in describing the course of a business is the concept of the Business model canvas (BMC). The business model canvas (BMC) consists of nine blocks consisting of the Customer segments block, the value propositions block, the channels block, the Customer relationships block, the revenue streams block, key resources block (main resource), key activities block (key activity), key partnership block (main partnership), and cost structure block (cost structure).

3. METHODS

In research with the main objectives are to develop a model to predict customers who will take vehicle financing and a business model for motor vehicle financing based on data mining. These can be achieved by the following steps:

3. 1 Designing Prediction Model

The steps used to achieve the research objectives of developing predictive models are:

- Preparing individual customer data that has taken car financing for the last 5 (five) years, January 2015 to December 2019 both active and expired, and customer data that already has a car or financed a second car up to 2015-2019.
- Performing data preparation steps, to check the condition of the data. Variables of research can be shown in Table 3.1

Table 3.1 Variables of Research

Variable	Variable Name	Description	Scale
X1	Gender	1: Woman 2: Man	nominal
X2	Education	1: High Education, 2. Low Education	nominal
X3	Occupation	1: Entrepreneur, 2: Employee, 3: Professional	nominal
X4	Income Category	1: < 10 Mio, 2: 10 s/d 25 Mio, 3: 26 s/d 50 Mio 4: >50 Mio	ordinal
X5	Marital Status	1: *Single*, 2: Married, 3: Divorce	nominal
X6	Homeownership	1: Self, 2: family, 3: Contract, 4: Credit, 5: Company	nominal
X7	Group Product	1: Retail, 2: KKB, 3: Multiguna	nominal
X8	Cat DP Gross	1: <20%,2: 20%-25%,3: >25% - 30%, 4:>30%	nominal
X9	*Days overdue*	Continue Data	ratio
X10	Jangka Waktu	Continue Data	ratio

- Understanding the data by conducting descriptive analysis and diagnostic analysis of the sample data used.
- Grouping training and testing data with a ratio of 70:30% (Lantz, 2019).
- Designing logistic regression model.
- Measuring the model's accuracy level uses data testing by measuring the Area Under Curve (AUC) value.
- Determining the variables that significantly affect the customer in taking vehicle financing by conducting simultaneous parameter tests and partial tests.
- Interpreting the model based on the Odds ratio value to see how much the independent variable tends to the dependent variable based on the value.

3.2 Designing Business Model

The steps used to achieve the research objective, designing a Business model based on Business Model Canvas (BMC) for vehicle financing based on data mining are:

- Mapping the current business processes using the Business model canvas, starting from Customer Segment, Value propositions, Channels, Customer relationships, revenue streams, Key resources, Key activities, Key partnerships, Cost structure.
- Conducting interviews and discussions with related divisions and company management to develop a new business model using the Business Model Canvas (BMC) method.
- Discussion of Data Processing Results, Discussing the results of data processing where an analysis of the best logistic regression model will be carried out and its implementation in PT “M” and the implementation of BMC.
- Conclusions and Suggestions

This is the last stage in the research where some conclusions and suggestions will be drawn on the research that has been carried out and its benefits for PT "M".

4. RESULTS

4.1 Designing Prediction Model

In developing a binary logistic regression model, it is necessary to prepare data before being processed in the modeling, among others by checking that each variable is filled in, transforming the data into categories. The transformation of data into categories is carried out for several variables such as customer income and down payments, this transformation is carried out so that the odds ratio comparison for each category can be analyzed against the main category. The amount of data used in this analysis is 95,411 application data for car financing distribution in 2019, grouped into two datasets, namely, training data and testing data. By using the stratification approach, the distribution of the training and testing datasets is obtained which is shown in Table 4.1 below:

Table 4.1 Data Grouping

Dataset	**Total Data**	*Training*	*Testing*
Total Data	95,411	66,605	28,806
RO	12,392	8,660	3,732
Non-RO	83,019	57,945	25,074
Total Data (%)	100%	70%	30%
RO (%)	13%	70%	30%
Non-RO (%)	87%	70%	30%

The next step is to do modeling with logistic regression and use the forward selection method to select variables, the variables that most significantly affect customers in taking new financing (RO) in the sequence is as follows: Time Buying (X10), Income Category (X4), Product (X7), Homeownership (X6), Marital Status (X5), Occupation (X3), Education (X2).

so that the logit equation is obtained as follows:

$g(x) =$

$$-5.634 + 0.169\,(X10) + 0.185\,(X4)_2 + 0.992(X4)_3 + 2.107(X4)_4 + 0.20(X7)_2 + 1.287(X7)_3 - 0.362(X6)_2 - 4.35(X6)_3 - 0.211(X6)_4 - 0.731(X6)_5 + 0.691(X5)_2 + 0.524(X5)_3 - 0.264(X3)_2 - 0.368(X3)_3 - 0.153(X2)_2$$

The logistic regression model formed is influenced by seven significant predictor variables. The predictor variables that increase the response of customers who will take financing are period (X10), income category (X4), product (X7), and marital status (X5). While the variables that decrease the customer's response to customers who will take financing are homeownership (X6), occupation (X3), and education (X2). Form the results of the simultaneous and partial logistic regression analysis are also used to see the contribution of each variable to the response of customers who will take financing. The contribution value is indicated by the odds ratio (ψ). In this case, it states that the tendency of the variable X category one has an effect of times the category zero. It can be seen in Table 4.2 below:

Table 4.2 *Odds ratio*

Predictor Variables	Exp(B)	Predictor Variables	Exp(B)
Education (X2)		Homeownership (X6)	
Education (X2)(2)	1.166	Homeownership (X6)(2)	0.696
Occupation (X3)		Homeownership (X6)(3)	0.647
Occupation (X3)(2)	0.768	Homeownership (X6)(4)	0.810
Occupation (X3)(3)	0.692	Homeownership (X6)(5)	0.481
Income Category (X4)		Product (X7)	
Income Category (X4)(2)	1.204	Product (X7)(2)	1.020
Income Category (X4)(3)	2.696	Product (X7)(3)	3.622
Income Category (X4)(4)	8.227	Period (X10)	1.184
Marital Status (X5)			
Marital Status (X5)(2)	1.996		
Marital Status (X5)(3)	1.689		

Based on Table 4.2 above, it can be seen that the effect of each variable on the response of customers who will take financing is as follows:

1. Education variable (X2), for the customer education variable has an influence on increasing customer responses who will take car financing, where customers with higher education from D1 to S3 are 1,166 times more likely to take car financing again than those with lower education.
2. Job Variable (X3), for the variable type of customer work influences on increasing customer response who will take car financing, where the type of self-employed job has a 1.3 times greater probability of taking car financing again compared to employees and the type of self-employed job are 1.44 times more likely to be in a professional type of work to take car financing.
3. The income category variable (X4) of the customer influences the increasing response of customers who will take car financing. Customers with higher incomes have a greater influence on taking car financing, for example, customers with incomes of 10-25 million are 1.2 times more likely than customers with incomes of <10 million. Customers with income >25-50 million are 2.69 times more likely than customers with income <10 million, and customers with income >50 million are 8.227 times more likely than customers with income <10 million to take car financing. Thus, the greater the income will increase the possibility of customers taking car financing.
4. Marital status variable (X5) affects increasing customer responses to take car financing, where married status tends of 1,996 times greater than a single status, and divorce status tends 1,689 times greater than single status in decision making take car financing.
5. Homeownership variable (X6) is known to affect customer responses in taking car financing, customers who have their own homes have 1,436 times greater probability when compared to customers with family home status, 1.54 times greater than customers who have contracted housing status, 1.23 times greater than customers who have credit home status and 2 times greater when compared to customers who have the status of a company/service house to take car financing.
6. Product variable (X7), where the product category variable taken influences on increasing customer response who will take car financing. KKB products are

equivalent to retail products, while multipurpose products tend of 3,622 times greater than retail products so an attractive product to offer again is a multipurpose product.

7. The variable period (X10) after the first financing has the effect of increasing customer response who will take refinancing of approximately 1,184 larger so that customers with a longer period between the previous financing will tend to take car financing again.

Meanwhile, for testing the binary logistic regression model using the testing dataset, it was obtained an AUC of 95.803%, the results of the accuracy-test with the dataset testing also showed outstanding results, where the model response prediction table using the testing dataset can be seen in Table 4.3 and Figure 4.1 ROC graph using the dataset testing.

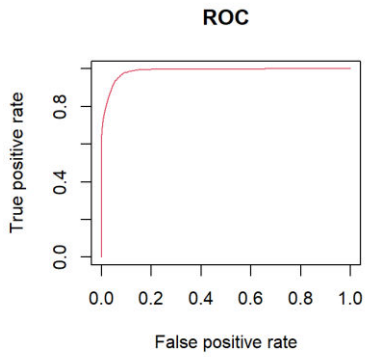

Figure 4. ROC Dataset Testing

Table 4.3 Model's Respons Dataset Testing

Respond	0	1
0	24634	440
1	769	2963

4.2 Designing Business Model

Based on interviewing subject matter experts and focus group discussion, business model car financing based on data mining can be shown in Figure 4.2

Figure 4.2 Business Model Car Financing based on Data Mining

The explanation of each block in the business model approach using the Business model canvas for business financing models using data mining is as follows:

- Customer Segment
  The target customer segment is the existing customer which is the result of modeling and data mining which is carried out using a logistic regression model approach. The results of this modeling will also always be updated according to the evaluation every month and also in collaboration with the Risk Management division to determine the quality of the portfolio of these existing customers. With this existing customer approach, it will be able to minimize credit quality costs because the company already knows the history of payments from customers while being a customer in the company.
- Value Proposition
  For existing customer segments with good payment history, it is necessary to pay attention to different products to be offered. The Value Propositions that can be offered are cheaper and more diverse financing products, simplification document requirements, this is done because the finance company already has customer data before, so it can only require data that has changed. The credit process is faster and easier because the finance company already knows customer data and payment history, some credit processes can be shortened.
- Channels
  In carrying out this business model, finance companies must be more active in making offers to the customer segment because data leads or customer prospects have been generated in the data mining process. Then the offer channels that can be done are telemarketing, Sales Officer, Media social, Wa/Email.
- Customer Relationships
  This relationship with the existing customer should be built since the customer first became a customer and maintained until the financing is completed and the customer refinances the car. Good relationships with customers can be maintained by the team at the branch and also assisted by using a mobile application that can be used by customers. Of course, this mobile application needs to have benefits for customers so that it can be actively used by customers in the long term, for example in the application it can accommodate customer needs related to financing products, insurance, installment payments, and other services. So that it will make it easier for companies to provide information to these customers.
- Revenue Stream
  In terms of revenue, the database-based financing business model is the same as the regular business model revenue. Income is derived from interest income, fee-based income, and administration paid by customers when taking financing products.
- Key Activities
  A significant difference from the data mining-based financing business model with regular financing is the existence of data mining activities on customer data that are predicted to take car financing again. From the results of the data mining, they will become prospects or leads that can be followed up or given an offer. In this business model, finance companies must be more active in providing offers to customers, which can be done through telemarketing, sales officers, or existing channels. With this condition, there is no need for a large acquisition cost because the source of the order comes from the database itself. After the customer is interested, the credit process will run as usual but with a faster service level, because customer data is already contained in the system and customer payment history is known.

- Key Resources
  In running this business model, there are at least two additional functions that are different from the regular business model, namely, the data mining function whose task is to analyze customer data owned by the company, study its behavior create models, and prepare prospect data. The second function is an active bidding function for prospect data that can be done by telemarketing, wa delivery, or directly by a sales officer. Regularly, the prospect data that has been followed up and given to the branch will be evaluated by the data mining function to improve the performance of the model used.
- Key Partner
  In this business model, there is no difference between key partners and regular business models because the main functions are carried out by the company's internals.
- Cost Structure
  For the cost structure of this business model, there is also no different from the regular business model, but because the customers who are offered the offer are customers whose payment history is known, the cost of credit quality can be managed better. It is hoped that the quality of customers who are processed with a data mining-based business model will be better than customers who are obtained from outside or dealers. More effective and efficient cost management will certainly provide a cheaper selling rate to these customers so that the expected value proposition can be achieved.

6. CONCLUSIONS

The research presents methodological assumptions regarding the logistic regression model and the model will be used to predict which customers will take car of financing (repeat order). The factors that influence the customer in car financing (repeat order) are the second take-up period with the previous one, income category, financing product, homeownership status, marital status, occupation, and education of the customer. The binary logistic regression model using dataset testing, it was obtained an AUC of 95.803% which indicates the outstanding category or this model can be used to predict customers who will take care of financing again. In terms of a data mining-based financing business model, several things need to be developed, namely, companies need to prepare data mining functions and offer functions actively to follow up on the prospect data generated from the model. Develop a different value proposition for existing customers, because the company already knows the history of customer payments and customer quality, both in terms of products offered and faster credit processes.

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OPERATIONAL RISK MANAGEMENT OF PT. PERTAMINA EP RANTAU FIELD POWER PLANT USING FAILURE MODE AND EFFECT ANALYSIS (FMEA)

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ABSTRACT

Pertamina Rantau Field is expected to produce 3,242 BOPD of oil and 3.68 MMSCFD of natural gas. One of the important things to do to achieve those targets is maintaining power plant responsible to generate and distribute electricity to all production facilities. For the last few years, there have been some technical problems happened in power plant system causing power blackout that disrupted operational activities, producing loss for the company as a result. This research has a purpose to identify and analyze critical risks from various failure variables of Rantau Field Power Plant. Failure Mode and Effect Analysis (FMEA) and Risk Failure Mode and Effect Analysis (RFMEA) are used to identify critical risks, then Fault Tree Analysis is used to search combination of basic factors that cause the identified critical risks. Based on the analysis using FMEA and RFMEA, from 27 risks identified, there are 5 risks categorized as critical risks: human error, engine failure to start, ground fault trip, cable short, and combustion chamber problem. From each of those risks, minimum cut sets have been identified using FTA and the results of the analysis will be used as guidelines to create risk response plans of those critical risks.

Keywords: Operational Risk Management, FMEA, RFMEA, FTA, Power Plant.

1. INTRODUCTION

Currently, the national demand for oil reaches 1.8 million BOPD, while as of August 2020 oil lifting only reached 706.9 thousand BOPD. PT. Pertamina (Persero) through PT. Pertamina Hulu Energi as upstream subholding has oil production target of 430,000 BOPD and natural gas production target of 2,471 MMSFCD. Those targets are divided into 5 regions, 17 zones, and 72 fields.

Rantau Field is one of the subsidiaries of PT. Pertamina Hulu Energi that operates in the oil and gas industry in Indonesia, located in Aceh Tamiang, Aceh, and Langkat, North Sumatra. In 2022, Rantau Field has production targets of 3,084 BOPD of oil and 3.28 MMSCFD of natural gas. One of the important things to do in order to achieve those targets is maintaining production surface facilities reliability and availability, since production surface facilities play a critical role in handling and processing oil and gas produced in the production business process.

One of the systems that support production activities and production surface facilities in Rantau Field is the electrical system generated by Rantau Field Power Plant. The electricity is used in production facilities starting from wells, gathering stations, main gathering station, and public

facilities. It can be concluded that power plant and electric system play a crucial role in Rantau Field business process.

Throughout 2018 until 2021, there have been 141 troubles happened in power plant system, with 20 of them caused power blackout in several production facilities and public facilities as a result, causing loss production opportunity of 165 barrels since some of the facilities are electric pumping units and electric submersible pumps that directly affect production wells, and total loss of IDR 2,889,720,749 from maintenance cost, loss production opportunity, and unexpected operational cost (fuel for emergency generator sets during power outage).

J. Davidson Frame (2003) stated that risks related to operational activities, for example office management risks, facility operations, power outages, and events that threaten operational activities can be classified as operational risks. The purpose of this study was to identify and analyze critical operational risks from various failure variables of Rantau Field Power Plant using Risk Failure Mode and Effect Analysis (RFMEA) proposed by Carbone and Tippet (2004), then using Fault Tree Analysis to get minimum cut sets of those critical risks identified before. The result of this research is expected to be used for assisting Pertamina Rantau Field in creating response plans to prevent those critical risks from happening in the future.

2. LITERATURE REVIEW

Risk Management

Risk management is a scientific approach to the problem of risk that has a purpose to reduce and eliminate risks faced by industry or organization and a systematic process to identify, analyze, respond, monitor, and control the risks. Risk management has evolved from the field of corporate insurance and is now used in most of business aspect and organizations around the world (Vaughan and Vaughan, 2008). Cooper (2005) stated that there are several processes of risk management: establish the context, identify the risks, analyze the risks, evaluate the risks, and treat the risks.

Failure Mode and Effect Analysis (FMEA)

FMEA is an analytical procedure in analyzing and prioritizing risks due to various forms of product or process failure, then prioritizing improvements for the highest ranking and implementing improvements until the results are acceptable (Barends, Oldenhof, Nauta, 2012). It is necessary in FMEA method to obtain severity, occurrence, and detection values to ensure the priority of failures. The prioritization will be done using Risk Priority Number (RPN) which is the multiplication of severity, occurrence, and detection values obtained before.

Risk Failure Mode and Effect Analysis (RFMEA)

Risk Failure Mode and Effect Analysis (RFMEA) is a modified method from Failure Mode and Effect Analysis (FMEA) developed by Carbone and Tippet (2004). There are several steps of RFMEA:

1. Identify risk events
2. Assign likelihood, impact, and detection values
3. Review RPN Pareto and determine RPN critical value
4. Review Risk Score Pareto and determine Risk Score critical value
5. Review scatter plot for RPN vs Risk Score
6. Determine intersection of Risk Score and RPN critical values
7. Develop risk response plans for critical risks
8. Re-evaluate Risk Score and RPN based on response plan

Fault Tree Analysis (FTA)

Fault Tree Analysis is a deductive top-down method that analyze system and performance failure that will be determined as top event, then followed by identifying all elements that become the root cause of the top event. FTA gives symbolic representation of event combinations that cause the top event to happen (Hoyland and Rausand, 1994). FTA uses structured steps in analyzing the system as follows: Identify top level event, create fault tree, and analyze the fault tree by simplifying the fault tree and reviewing the results of the analysis.

After getting the basic events from FTA, the minimum cut sets will be identified using Method to Obtain Minimal Cut Set (MOCUS). Akinode (2017) stated that the algorithm used in MOCUS is summarized as follows:

1. Giving label to every gate and event
2. Creating a two-dimensional array table consists of rows and columns
3. Initializing the first element of the matrix with the top event. The top event is placed in the first column of the first row
4. Substituting the top event with intermediate/basic event below the top event (separated by gates) with requirements as follow:
    a. If the gate is AND gate, substitute the events in the same row of the next column
    b. If the gate is OR gate, substitute the events in the different rows of the next column
5. Doing the iteration of step 4 until there is no gate or event left and all the basic events have been recorded in the MOCUS matrix
6. Generating minimum cut sets by removing non-minimum basic events using Boolean Laws as the guideline.

Power Plant

Power plant is a facility consists of machines and equipment to convert latent energy from several energy sources into electricity (J. W. Esterline, 1911). The electricity produced by power plant is distributed throughout transmission and distribution systems to various loads. There are many types of power plant: Hydroelectric, steam turbine, combustion turbine, internal-combustion engine, solar, wind, and compressed air (James E. Mack & Thomas M. Shoemaker, 2002). In this research, the power plant being studied is an internal-combustion engine power plant as this type of power plant is the one owned by Rantau Field that uses internal-combustion engines as the equipment to produce electricity.

3. METHODS

The approach used in this research is an exploratory approach. Arikunto (2010) stated that exploratory research is research that seeks to find out the causes of something and aims to map an object in depth. There are 4 main phase that needs to be done in this research:

1. Phase 1 preparation, consists of literature study
2. Phase 2 critical risks identification, consists of risks identification, risks analysis using FMEA and RFMEA, and critical risks identification
3. Phase 3 identification of critical risks basic factors using Fault Tree Analysis (FTA)

4. RESULTS

Phase 1 Preparation

In this phase, data and documents related to Rantau Field Power Plant from year 2018 until 2021 are collected for later processing. There are several documents used as data source for this research, divided into two categories of data:

1. Primary Data, data obtained directly from the object of the research. In this research, the data were obtained from group discussion with Supervisor and Operators of Rantau Field Power Plant, Supervisors and Mechanical Maintenance Team, Supervisors and Electrical Maintenance Team.
2. Secondary Data, data obtained from documents and history outside the primary data. In this research, the data were obtained from several documents: daily reports of Rantau Field Power Plant 2018-2021, Rantau Field mechanical maintenance contracts 2018-2021, Rantau Field electrical maintenance contracts 2018-2021, daily production reports 2018-2021, and Rantau Field Power Plant maintenance report 2018-2021.

Phase 2 Critical Risks Identification

From all data and documents collected, there are 27 risks identified in Rantau Field Power Plant system as shown in Table 1 below.

Table 1. Risks Variables of Rantau Field Power Plant

Code	(Risk Category) Risk Variables	Code	(Risk Category) Risk Variables	Code	(Risk Category) Risk Variables
V01	(Piping) Fuel Gas Piping Problem	V10	(Generator Set) Water Jacket Problem	V19	(Control Panel of Genset) Broken Breaker
V02	(Gas Compressor) Gas Compressor Problem	V11	(Generator Set) Ignition System Problem	V20	(Cable/Panel) Human Error
V03	(Gas Mixer) Regulator Problem	V12	(Generator Set) Lubrication System Problem	V21	(Cable/Panel) Degradation of Cable Integrity
V04	(Generator Set) Generator Bearing Problem	V13	(Generator Set) Oil Pressure Problem	V22	(Cable/Panel) Cable Replacement, Line Maneuver
V05	(Generator Set) Unstable Power Factor (Cos Phi)	V14	(Generator Set) Broken Sensor	V23	(Cable/Panel) Broken Cable Connector
V06	(Generator Set) Combustion Chamber Problem	V15	(Generator Set) Water Cooling System Leakage	V24	(Cable/Panel) Ground Fault Trip
V07	(Generator Set) Compensator Leakage	V16	(Generator Set) Overload	V25	(Cable/Panel) Cable Short MV
V08	(Generator Set) Engine Failure to Start	V17	(Generator Set) Engine Overspeed	V26	(Transformer) Transformer Problem
V09	(Generator Set) HT Pump Broken	V18	(Control Panel of Genset) Bad Cable Connection	V27	(Protection) VCB Problem

The next step in this phase is data analysis using FMEA method. There are 3 values that need to be assign to each risk before analysis: likelihood, impact, and detection. For likelihood, the value is determined based on frequency of failure happened for every risk identified using likelihood scale based on research done by Itsna Affandi Firdaus (2017) as shown in Table 2 below.

Table 2. Scale of Likelihood

Scale	Likelihood Category	Frequency Range
1	Rare	1 – 2
2	Unlikely	3 – 8
3	Moderate	9 – 13
4	Likely	14 – 20
5	Almost Certain	> 20

For impact, the scales refer to 2 categories as shown in Table 3. The value of impact will be determined using these 2 categories, where the one with higher scale of impact will be used as the impact values for each risk. The categories used in this research are:

1. Based on total loss (IDR), the range for each scale is determined on Focus Group Discussion (FGD) combined with the method of finding the average of loss for each failure that will be determined as the minimum scale of impact, then for each scale the loss range will be determined using company risk management guidelines.
2. Based in average of shutdown duration for each risk identified, based on the research parameter used by Danung Isdarto (2014).

Table 3. Scale of Impact

Scale	Impact Category	Impact Range (IDR)	Impact Range (Average of Shutdown Duration)
1	Insignificant	$n \leq 20$ m	$n \leq 2$
2	Minor	20 m $< n \leq$ 40 m	$2 < n \leq 8$
3	Moderate	40 m $< n \leq$ 60 m	$8 < n \leq 48$
4	Significant	60 m $< n \leq$ 80 m	$48 < n \leq 240$
5	Catastrophic	$n >$ 80 m	$n > 240$

For Detection, the scales are determined through interviews, discussions, and questionnaire delivered to trusted respondents related to Rantau Field power plant operational activities and Rantau Field maintenance teams. The criteria of detection for guidelines are shown in the Table 4 below, referring to the detection criteria used by Carbone and Tippet (2004) with modification of scale from 1 – 5 instead of 1 – 10.

Table 4. Scale of Detection

Guidelines	Scale
There is no detection method available or known that will provide an alert with enough time to plan for a contingency	5
Detection method is unproven or unreliable; or effectiveness of detection method is unknown to detect in time	4
Detection method has medium effectiveness	3
Detection method has moderately high effectiveness	2
Detection method is highly effective and it is almost certain that the risk will be detected with adequate time	1

The next step is determined the Risk Priority Number (RPN) of the risks. This step will put ranking of each risk starting with the most critical. The RPN value is obtained using this formula:

RPN = Likelihood x Impact x Detection

The next step is using RFMEA to categorize critical risks from all risks identified. The first step is calculating the Risk Score of the risks. The Risk Score value is obtained using this formula:

Risk Score = Likelihood x Impact

Once RPN and Risk Score are obtained, the data will be analyzed using scatter plot. In order to obtain the critical value that will determine the critical risks, critical value of RPN and Risk Score will be obtained first:

1. RPN critical value is obtained using this formula:

$$RPN_{critical\ value} = \frac{Total\ of\ RPN}{Total\ Risks} = \frac{482}{27} = 17{,}85$$

2. Risk Score critical value is obtained based on company risk management guidelines, in this case the value is 15.

The scatter plot of risk assessment done in this research is shown in Figure 1 below.

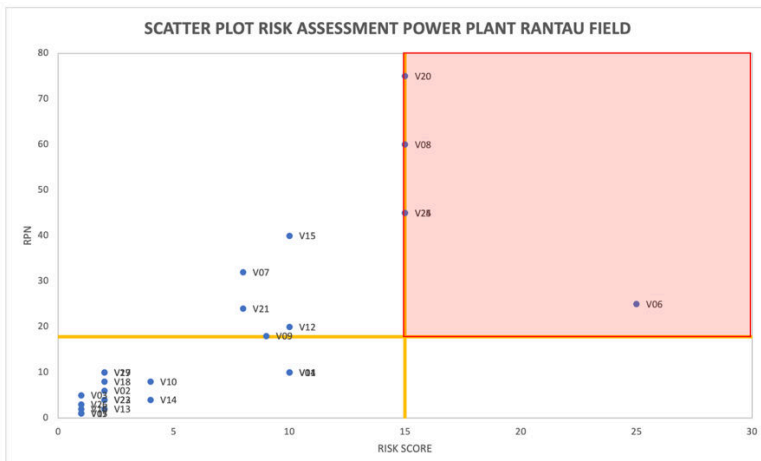

Figure 1. Scatter Plot of Rantau Field Power Plant Risk Assessment

Based on the scatter plot in Figure 3, there are 5 risks that are categorized as critical risks, as shown in Table 5 below.

Table 5. Rantau Field Power Plant Critical Risks

Code	Risk Variables	Risk Score	RPN
V20	Human Error	15	75
V08	Engine Failure to Start	15	60
V24	Ground Fault Trip	15	45
V25	Cable Short (MV)	15	45
V06	Combustion Chamber Problem	25	25

Phase 3 Identification of Critical Risks Basic Factors

In this phase, each of critical risks shown in Table 4 will be analyzed further to determine the basic factors that can cause the risks to happen using Fault Tree Analysis (FTA). Then Method

to Obtain Minimal Cut Set (MOCUS) will be implemented to determine minimum cut sets of each critical risks.

For human error risk, the human error here means failures on the transmission system caused by negligence or mistakes made by certain parties when doing work near underground transmission system. The analysis of this risk using FTA is shown in Figure 2 below.

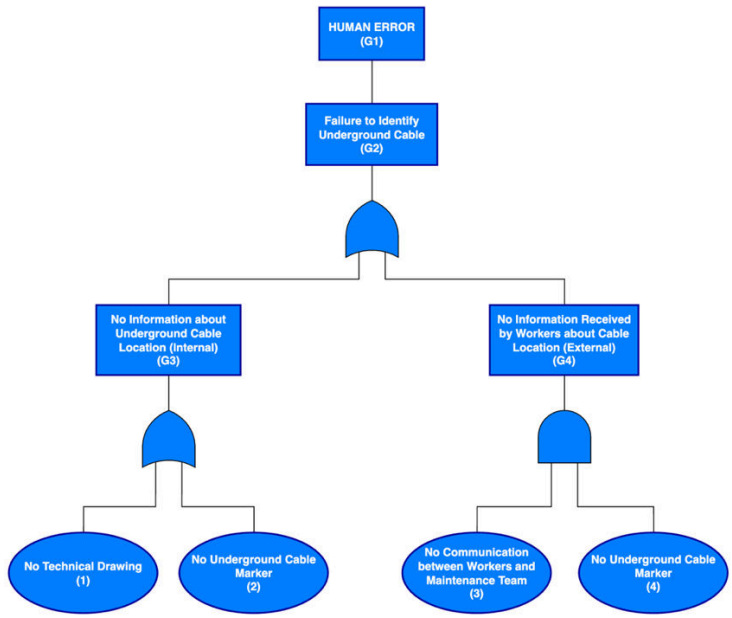

Figure 2. Fault Tree Analysis (FTA) of Human Error Risk

From the FTA in Figure 2, using MOCUS, the minimum cut sets are obtained as shown in Table 6 below.

Table 6. Minimum Cut Sets of Human Error Risk

Minimum Cut Sets	Description
1	No Technical Drawing
2	No Underground Cable Marker
3, 4	No Communication between Workers and Maintenance Team, No Underground Cable Marker

For engine failure to start risk, engine failure to start here means failure of power plant generator sets during start-up process when the generator is urgently needed to operate immediately. The analysis of the risk using FTA is shown in Figure 3 below.

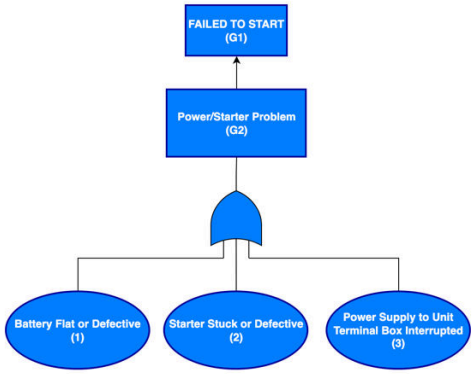

Figure 3. Fault Tree Analysis (FTA) of Engine Failure to Start Risk

From the FTA in Figure 3, using MOCUS, the minimum cut sets are obtained as shown in Table 7 below.

Table 7. Minimum Cut Sets of Engine Failure to Start Risk

Minimum Cut Sets	Description
1	Battery Flat or Defective
2	Starter Stuck or Defective
3	Power Supply to Unit Terminal Box Interrupted

For ground fault trip risk, ground fault trip here means a fault between transmission cable with ground/earth causing transmission system to shut down. In this case, the ground fault happened to the overhead transmission cable. The analysis of the risk using FTA is shown in Figure 4 below.

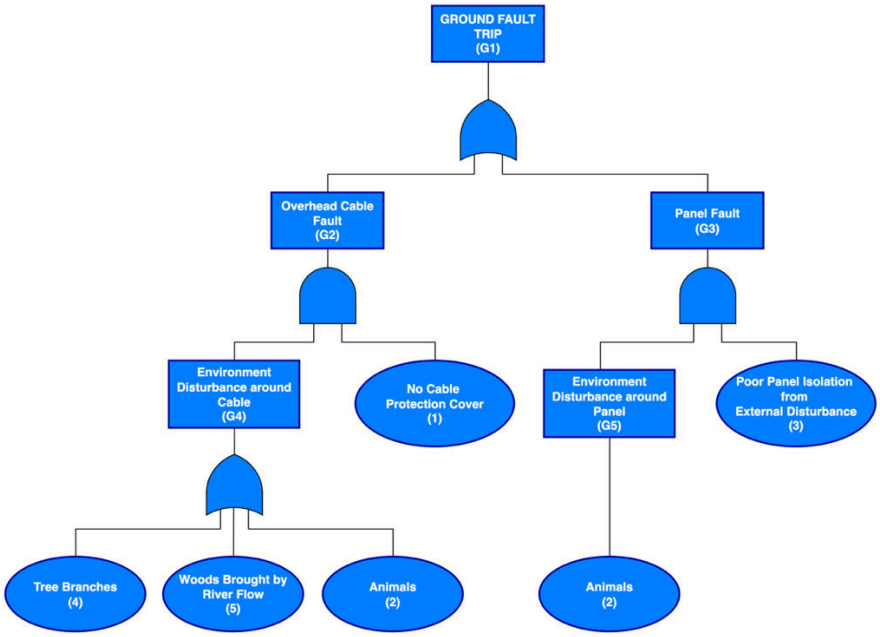

Figure 4. Fault Tree Analysis (FTA) of Ground Fault Trip Risk

From the FTA in Figure 4, using MOCUS, the minimum cut sets are obtained as shown in Table 8 below.

Table 8. Minimum Cut Sets of Ground Fault Trip Risk

Minimum Cut Sets	Description
4, 1	Tree Branches, No Cable Protection Cover
5, 1	Woods Brought by River Flow, No Cable Protection Cover
2, 1	Animals, No Cable Protection Cover
2, 3	Animals, Poor Panel Isolation from External Disturbances

For cable short (MV) risk, the cable short here means short circuit that happened to the medium voltage underground cable that disrupt transmission system to transfer electricity to loads. The analysis of the risk using FTA is shown in Figure 5 below.

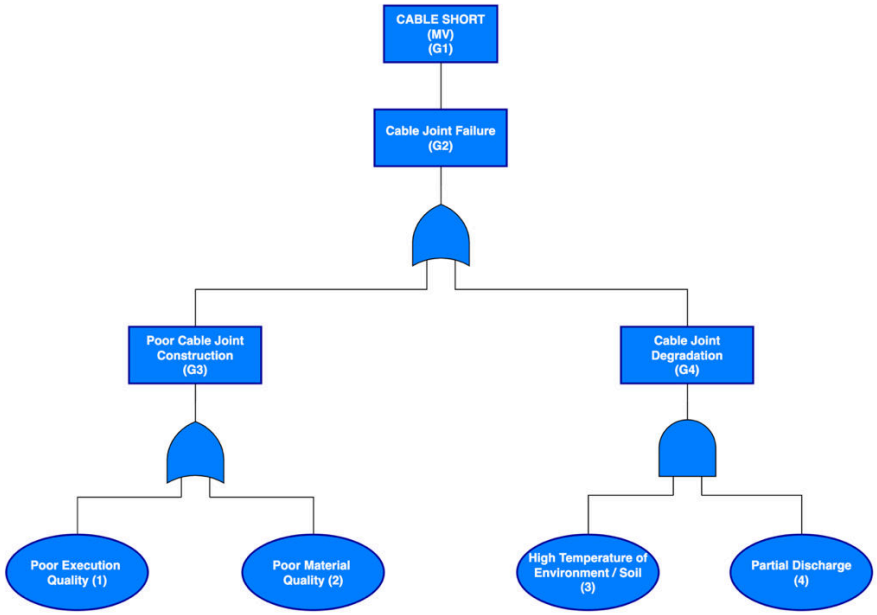

Figure 5. Fault Tree Analysis (FTA) of Cable Short (MV)

From the FTA in Figure 5, using MOCUS, the minimum cut sets are obtained as shown in Table 9 below.

Table 9. Minimum Cut Sets of Cable Short (MV) Risk

Minimum Cut Sets	Description
4, 1	Tree Branches, No Cable Protection Cover
5, 1	Woods Brought by River Flow, No Cable Protection Cover
2, 1	Animals, No Cable Protection Cover
2, 3	Animals, Poor Panel Isolation from External Disturbances

For combustion chamber problem risk, the combustion chamber problem here means abnormal temperature of combustion chamber which surpass the limit of temperature to be categorized as safe (450˚C). The analysis of the risk using FTA is shown in Figure 6 below.

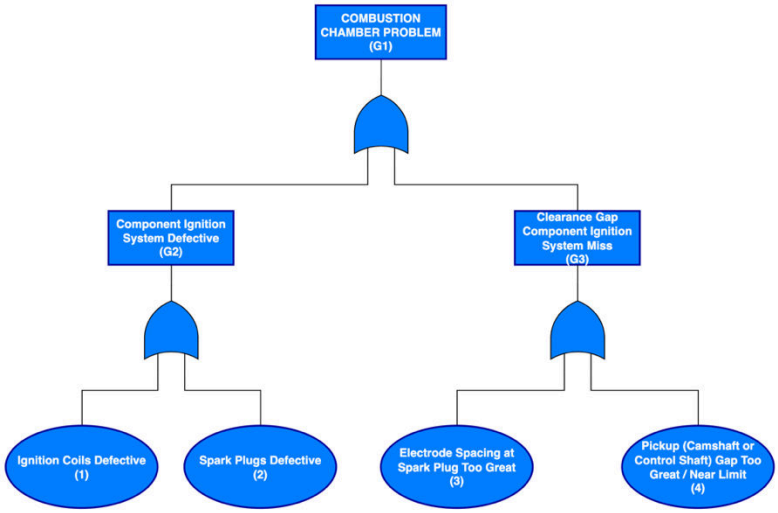

Figure 6. Fault Tree Analysis (FTA) of Combustion Chamber Problem

From the FTA in Figure 6, using MOCUS, the minimum cut sets are obtained as shown in Table 10 below.

Table 10. Minimum Cut Sets of Combustion Chamber Problem

Minimum Cut Sets	Description
1	Ignition Coils Defective
2	Spark Plugs Defective
3	Electrode Spacing at Spark Plug Too Great
4	Pickup (Camshaft or Control Shaft) Gap Too Great/Near Limit

6. CONCLUSIONS

Based on the results of research that have been conducted using RFMEA and FTA to identify Rantau Field Power Plant critical risks and basic factors of each critical risks, conclusions of the research can be drawn as follows:

1. From 27 risks identified, using RFMEA method to analyze the data collected, there are 5 risks that can be categorized as critical risks: human error, engine failure to start, ground fault trip, cable short (MV), and combustion chamber problem.
2. Based on the analysis using FTA, there are several minimum cut sets obtained that can cause 5 critical risks identified as shown in Table 6, Table 7, Table 8, Table 9, and Table 10 that can be guidelines for creating risk response plans to prevent the critical risks identified from happening in the future.

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IMPLEMENTATION OF THE AHP – TOPSIS METHOD TO DETERMINE BASE OIL MANAGEMENT STRATEGY AT PERTAMINA LUBRICANTS PRODUCTION UNIT GRESIK IN ORDER TO INCREASE PRODUCTION CAPACITY

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ABSTRACT

Production Unit Gresik as one of Pertamina's Lubricant factories, plans to increase the production capacity .To support this capacity upgrading program, an advance base oil management strategy is needed due to the importance of base oil as the main raw material. There are several alternatives that management can do in the area of base oil management such as building new tanks, increasing the frequency of tanker arrivals and leasing tanks to Bitumen Plant Gresik. To get the best objective decisions, this research applies the Analytical Hierarchy Process (AHP) and TOPSIS approaches. The criteria taken into consideration in making decisions in this study are financial criteria, technical criteria, risk and Delivery Time Project. The financial criteria include: Net Present Value, Internal Rate Return, Pay Back Period, Profitability Index, and value of investment. The technical criteria include: the complexity of the process and existing facilities. The risk criteria include the risk of operations, HSSE risk and contractor financial risk. Based on the calculation of AHP method, it is showed that technical criteria with 0,443 weight is the most important criteria in decision making. The best alternative decision is to increase the number of tanker carrying base oil because it has the nearest proximity to the ideal solution base on the TOPSIS method.

Keywords: base oil, project alternative, AHP, TOPSIS.

1. INTRODUCTION

Pertamina Lubricants was established on September 23, 2013 as PT Pertamina's (Persero) subsidiary. It specializes in the production, distribution and marketing of lubricants, greases, as well as other specialty products. Pertamina Lubricants built four Production Units, seven Sales Regions, as well as other facilities such as Depot Supply Point (DSP), Bulk Terminal and production laboratory in order to support its business activities. Production Unit is a kind of department whose main task is to conduct the process of production. Pertamina Lubricants currently has three Production Units in Indonesia - and one Production Unit overseas. Production Unit Gresik (PUG) is one of the lubricant factories owned by Pertamina Lubricants. It is located in East Java, and its work is to produce lubricants in order to supply them to East Java, Bali, Nusa Tenggara, as well as Eastern Indonesia (Sulawesi, Maluku and Papua).

The raw materials needed to produce lubricants are base oil and additives. Base oil is a hydrocarbon compound which resulted from the process of petroleum refining. It is also the main

component in the process of lubricant production; with a percentage that ranges from 70% to 80%, depending on the type of the product. That being said, the rest of the component to complete lubricants is additive.

Based on the estimation of national lubricant sales in previous years; it is predicted that the average increase in the sales volume would be around 3 - 4% per year. Considering the demand that keeps on increasing for these products; the capacity and reliability of the production facilities have both became vital factors in ensuring the availability of the products in market. The project to increase the production capacity of PUG requires a detailed calculation of the base oil requirement, along with the capacity from the storage tank(s) which would be used.

. Below is a list of PUG storage tanks and the calculation of the difference between their capacity and the needs for base oil in 2026, which is also the highest demand in the next five years:

Table 1. Comparison of Base Oil Volume Need with Tank Capacity

Base Oil Type	**Current Capacity (*KL*)**	**Name of Tanks**	***Keb BO* 2026 (*KL*)**	**The Difference Between the Capacity and the Needs for Base Oil**
Base Oil A	1392	TO-10	2,052	-660
Base Oil B	3889	TO-04&05	6,157	-2268
Base Oil C	2322	TO-06&07	1,026	
Base Oil D	2283	TO-01&02	3,665	-1382
Base Oil E	643	TO-11	586	
Base Oil F	1447	TO-03	440	
Base Oil G	805	TO-10	440	
Base Oil H	1862	TO-09	1759	

Based on the calculation, there are three types of base oil whose current tank capacity is smaller than the future demand for base oil. In order to ensure the availability of base oil; there are several alternatives which can be done here; namely the construction of new tanks (to increase storage capacity), renting storage tanks for Bitumen Plant Gresik, as well as increasing the frequency of arrivals of tankers that supply base oil.

The management must decide which alternative is the best to be implemented in gaining maximum benefit. However, before choosing an alternative, they must first consider several criteria such as financial aspects (investment costs), time, availability of facilities, how difficult it is to implement the alternative, *etc*. This study aimed to determine the best alternative (out of three) for base oil supply, using a multi-criteria decision-making method (MCDM). The MCDM methods implemented are Analytic Hierarchy Process (AHP) and the Technique for Preferences by Similarity to the Ideal Solution (TOPSIS).

2. LITERATURE REVIEW

AHP framework is originally developed by Thomas L. Saaty in the 1970s, refer to Emrouznejad & Marra (2017) and Supriyono et al (2011). This method is based on the process of getting numerical scores. The ranking of each decision alternative would be based on the suitability

between the alternative and the decision maker's criteria. The principles of subjectivity and objectivity are still included in AHP in the decision making. Furthermore, AHP is also used to help prioritize various options based on criteria. Therefore, due to its multi-criteria nature, it is often used in setting priorities.

AHP (Analytical Hierarchy Process) method belongs to MCDM (Multi Criteria Decision Making) category and is able to display some models of experts' opinion in the decision support system (Muhardono & Isnanto, 2014). However, its weakness is that it will be less efficient if the number of criteria and alternatives is large (Rouhani et al., 2012).Given the fact; to combine AHP with another method could be a wise choice - since it would be more effective.

According to Sudaryono (2010), some principles which are needed to be understood in solving problems using AHP are:

1. Presenting a simpler hierarchy system by breaking it down into various supporting elements, arranging elements in a hierarchical structure, as well as combining them.
2. Pairwise comparison can be used to assess alternative criteria. According to Saaty (1988); the range to express opinion is should be on a scale of 1 - 9.
3. Pairwise comparison can be used to set the priority of each criterion and alternative. The weights and priorities would adjust the judgment of comparative value to all alternative criteria. The calculation of weights and priorities can be conducted using either mathematical equations or matrix manipulation.
4. Logical consistency involves two meanings. The first is that it is the grouping of the same set of objects based on the degree of uniformity and relevance; while the second is that it is a way to examine the level of relationship between objects through certain criteria.

Yoon and Hwang presented the TOPSIS method for making decisions based on multiple criteria. Basically, the TOPSIS concept suggests that the best alternative will have the shortest distance from the positive solution and the furthest distance from the negative ideal solution. Meanwhile, the Euclidean distance geometrically determines the relative proximity of an alternative to the optimal distance.

The positive ideal solution is the sum of the best values of each attribute, while the negative ideal solution is the sum of the worst values of each attribute. TOPSIS calculates the distances to the positive and negative ideal solutions based on the relative proximity of the positive ideal solution. Their relative distances can also be compared to develop alternative preferences.This method is very popular for solving practical, uncomplicated, computationally efficient decision making. It can solve the current alternative differences and identify the cost and benefit rules for each criterion against positive and negative ideal solution. Based on these advantages, it can be said that integrating AHP and TOPSIS can be conducted in the decision support system (Berdie et al., 2017; Chamid & Murti, 2017; Prakash & Barua, 2015).

The reason why the combination of AHP and TOPSIS was chosen is because the advantage of AHP is that it is based on a pairwise comparison matrix and it can also provide consistent analysis; moreover, TOPSIS can address practical decision making because its concept is simple, computationally efficient and it is also capable of measuring the relative performance of decision alternatives (Juliyanti et al. 2011). Finally, AHP was used to weigh the criteria, while TOPSIS was used to evaluate each alternative.

3. METHODS

This research is a qualitative research and the research object is the strategic decision-making process for the supply management of raw materials for lubricant production in PT Pertamina

Lubricants – Production Unit Gresik. A series of research stages were in order to choose the best management strategy for the company to increase its production capacity.

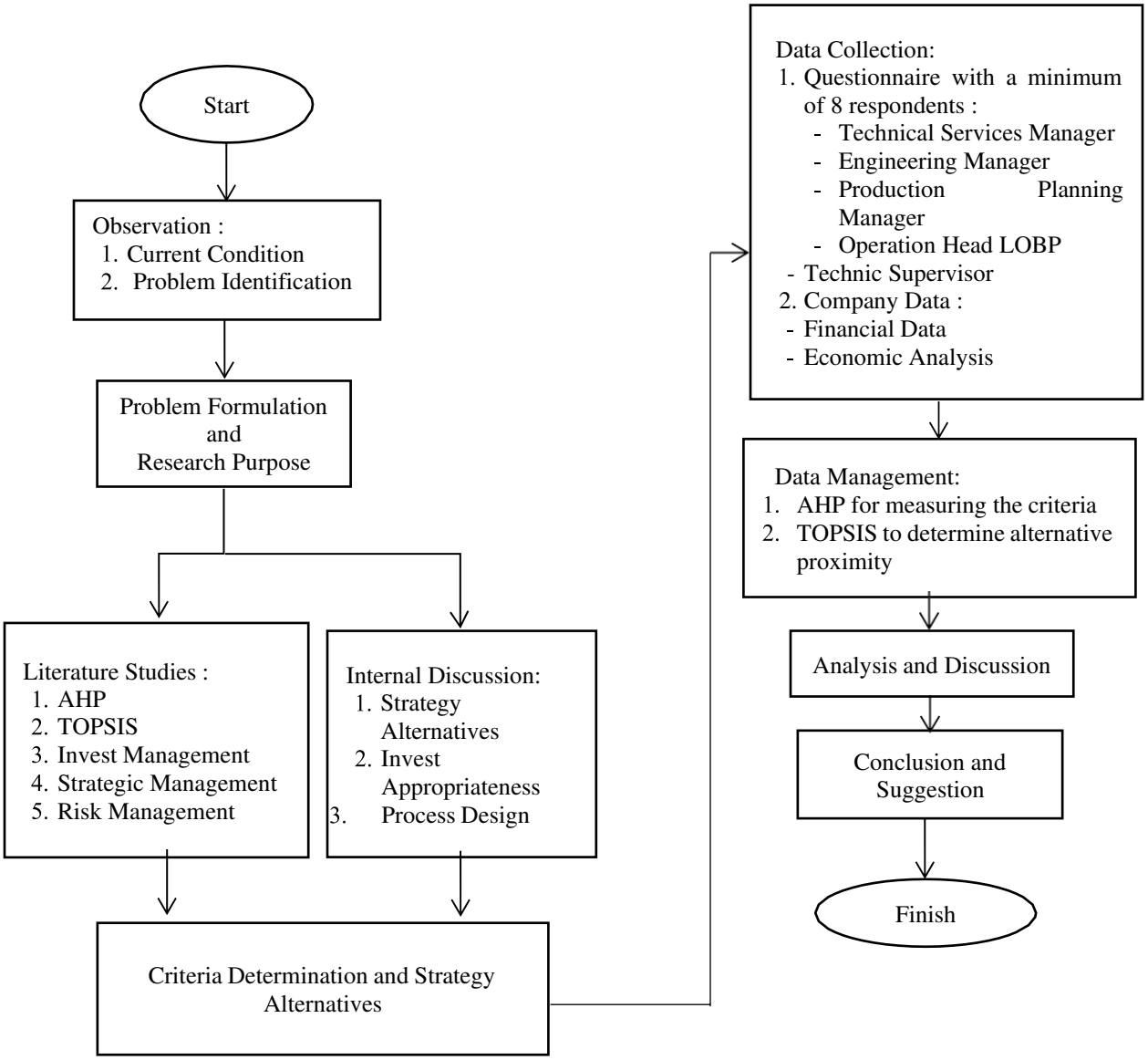

Figure 1. Research Flowchart

4. RESULTS

4.1 Determination of the Criteria and Sub Criteria used in the Investment

The weighting of the criteria is needed in this research so as to perform calculation which will serve as the basis in selecting the best strategy for base oil supply. The criteria and sub-criteria which needed to be weighted refer to Pertamina Lubricants Investment Management Guidelines, as well as the investment team's FGD result. The manual states that at the very least, investment proposal must include these documents:

1. Capital Expenditure
2. Identification of Technology Provider
3. Economic Aspect

4. Risk Register
5. Land Certainty

Moreover, the proposed criteria are obtained from the results of a comprehensive discussion with the Technical Services team. This discussion is conducted before implementing the data collection questionnaire, so as to prepare pairwise comparison in weighting each criterion. Questionnaires are given to company's internal parties - as mentioned in Chapter 3.

The data obtained from the questionnaire will then be processed in order to weight each criterion and sub-criterion. The data will be processed using AHP, where in ranking the alternative strategies; quantitative calculation is used while also applying TOPSIS method. In order to complete the TOPSIS algorithm, some supporting data and internal discussions are needed for several qualitative assessments. Furthermore, this Focus Group Discussion (FGD) will be led by the Production Unit Manager (as the proposing function) and attended by the Technical Services, Process Engineering, Production Planning and Operation teams. Based on the Guidelines and FGD; the important criteria to be considered included:

1. Financial Criterion
2. Delivery Time Project
3. Technical Criterion
4. Risk Criterion

Below is the hierarchy in the selection of base oil management strategy in Production Unit Gresik (PUG):

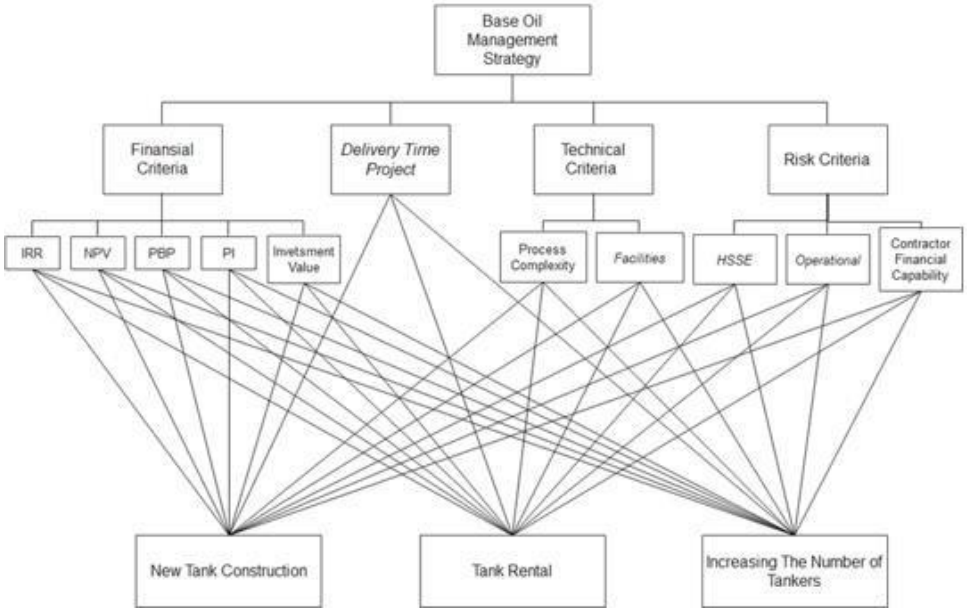

Figure 2. Hierarchy in the Selection of Base Oil Management Strategy

4.2 Weigthing Each of the Criterion and Sub-Criterion

AHP is used to calculate the weight of each criterion and sub-criterion in the research. In order to ease the process, the researcher uses Expert Choice software. After the results of the questionnaires are recapitulated, a pairwise comparison matrix is made for each criterion and sub-

criterion. This matrix is made by referring to the comparative judgment average value for each criterion and sub-criterion. Afterwards, the following results are obtained:

Table 2. Pairwise Comparison of Decision Making Criteria

	Financial Criterion	**Delivery Time**	**Technical Criterion**	**Risk Criterion**
Financial Criterion	1	3	1/3	1/2
Delivery Time	1/3	1	1/3	1/3
Technical Criterion	3	3	1	2
Risk Criterion	2	3	1/2	1

Table 3. Pairwise Comparison of Financial Sub Criteria

	IRR ***(Internal Rate Return)***	***NPV*** ***(Nett Present Value)***	***PBP*** ***(Pay Back Period)***	***PI*** ***(Profitability Index)***	**Investment Value**
IRR	1	4	4	3	5
NPV	1/4	1	3	3	4
PBP	1/4	1/3	1	3	3
PI	1/3	1/3	1/3	1	2
Investment Value	1/5	1/4	1/3	1/2	1

Table 4. Pairwise Comparison of Technical Sub-Criteria

	Facilities	**Complexity**
Facilities	1	2
Complexity	1/2	1

Table 5. Pairwise Comparison of Risk Sub-Criteria

	HSSE **(Health Safety Security Environment)**	**Contractor Financial**	**Operational**
HSSE	1	5	3
Contractor' Financial	1/5	1	¼
Operational	1/3	4	1

Based on the Expert Choice's calculation, if a table is to be presented for each criterion weight, then it will look like this:

Table 6. Local and Global Weights of Each Criterion

No	**Description**	**Local Weight**	**Global Weight**	**Ranking**
1	Financial Criterion	0,183	0,183	3
2	Delivery Time	0,096	0,096	4

3	Technical Criterion	0,443	0,443	1
4	Risk Criterion	0,278	0,278	2

Meanwhile, the tables for the local and global weights of each sub-criterion of the selection of base oil management strategy can be seen below:

Table 7. Local and Global Weights of Each Sub-Criterion

No	Description	Local Weight	Global Weight	Ranking
1	*IRR*	0,472	0,086	5
2	*NPV*	0,237	0,043	7
3	*PBP*	0,144	0,026	9
4	*PI*	0,09	0,016	10
5	Investment Value	0,056	0,01	11
6	Delivery Time	0,096	0,096	4
7	Facilities	0,667	0,295	1
8	Complexity	0,333	0,148	3
9	*HSSE*	0,627	0,174	2
10	Contractor Financial	0,094	0,026	8
11	Operational	0,28	0,078	6

The ranking is made based on the global weight value; where criterion and sub-criterion with the highest global weight value will be ranked as the first.

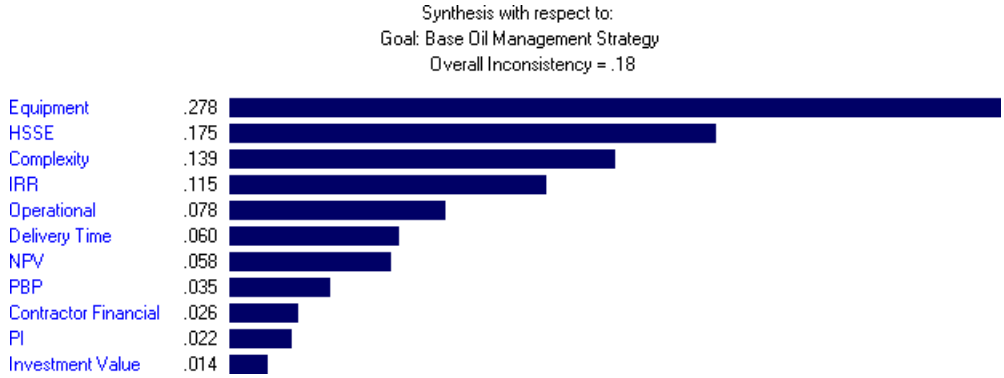

Figure 3. Synthesis of All Sub Criteria

Base on figure 3, it can be seen that the facilities sub criteria are the most influential sub criteria, while the investment value sub criteria is the least influential.

4.3 Calculation of Ideal Solution Using Technique for Order Preference by Similarity to Ideal Solution (TOPSIS).

After getting the local and global weights from each criterion and sub-criterion using AHP; TOPSIS will then be used to rank the alternative strategies to be chosen. In order to apply this method, it is necessary to do a quantitative calculation of the value of all criteria and sub-criteria.

In order to rank the alternative management strategies of Base Oil, both primary and secondary research data must be processed with TOPSIS, by using the weights obtained from AHP calculation results. The following are the steps for the data processing using TOPSIS:

1. Make the following table based on the secondary data which has been collected:

Table 8. Company Secondary Data for TOPSIS Calculation

	F1 y1	F2 y2	F3 y3	F4 y4	F5 y5	D y6	T1 y7	T2 y8	R1 y9	R2 y10	R3 y11
Alt 1 a1	42,64	1,39E+11	3,81	3,75	6,18E+10	2	30	30	68	68	52
Alt 2 a2	19,77	6,49E+10	8,54	1,5	3,74E+10	4	60	69	84	84	68
Alt 3 a3	25,35	8,80E+10	6,03	1,92	1,34E+11	4	90	90	96	96	96

2. Create a normalized decision matrix as shown in the table below:

Table 9. Normalized Decision Matrix

	y1	y2	y3	y4	y5	y6	y7	y8	y9	y10	y11
a1	0,7985	0,7862	0,3424	0,8385	0,4060	0,3333	0,2673	0,2557	0,4704	0,4704	0,4043
a2	0,3702	0,3667	0,7675	0,3354	0,2457	0,6667	0,5345	0,5882	0,6641	0,6641	0,7464
a3	0,4747	0,4974	0,5419	0,4293	0,8802	0,6667	0,8018	0,7672	0,5811	0,5811	0,5287

3. Create a weighted normalized decision matrix table by multiplying the normalized decision matrix with the weights of each criterion and sub-criterion obtained from AHP.

Table 10. Weighted Normalized Decision Matrix

	y1	y2	y3	y4	y5	y6	y7	y8	y9	y10	y11
a1	0,0690	0,0341	0,0090	0,0138	0,0042	0,0031	0,0790	0,0377	0,0820	0,0123	0,0315
a2	0,0320	0,0159	0,0202	0,0055	0,0025	0,0061	0,1579	0,0868	0.1013	0.0152	0.0412
a3	0,0410	0,0216	0,0143	0,0071	0,0090	0,0061	0,2369	0,1132	0.1158	0.0174	0.0581

4. Determine both the positive and negative ideal solutions.

Table 11. Positive Ideal Solution

	y1	y2	y3	y4	y5	y6	y7	y8	y9	y10	y11
A^+	0,069	0,0341	0,0202	0,0138	0,009	0,0061	0,2369	0,1132	0,1158	0,0174	0,0581

Table 12. Negative Ideal Solution

	y1	y2	y3	y4	y5	y6	y7	y8	y9	y10	y11
A^-	0,032	0,0159	0,009	0,0055	0,0025	0,0031	0,079	0,0377	0,082	0,0123	0,0315

5. Determine the distance of the positive and negative ideal solutions.

Table 13. Calculation of Solutions' Distance

	D+	D-
Alternative 1: New Tank Construction	0,2561	0,0421
Alternative 2: *BPG* Tank Rental	0,2056	0,1032
Alternative 3: Increasing the Number of Tankers	0,1871	0,1769

6. Determining the relative closeness coefficient.
   The calculation of relative closeness coefficient from each alternative strategy should be calculated using equation (2.8), and the following results are obtained:

Table 14. Calculation of the Alternative Relative Closeness Coefficient

	Relative Closeness Coefficient	**Ranking**
Alternative 1: New Tank Construction	0,1411	Ranking 3
Alternative 2: *BPG* Tank Rental	0,3342	Ranking 2
Alternative 3: Increasing the Number of Tankers	0,4861	Ranking 1

Based on the calculation of the TOPSIS method, the third alternative was chosen, namely the addition of tanker frequency as a strategy to be implemented by the Gresik Production Unit in order to support increased production. This is interesting to be discussed further because it is based on the calculation of alternative economic indicators for the construction of a new storage tank which has the highest value compared to the other two alternatives.

6. CONCLUSIONS

From the results of the data processing and analysis in the previous chapter, there are four criteria which are used as consideration for choosing the best management strategies of base oil in Production Unit Gresik to increase the production capacity. These criteria consist of financial criterion, delivery time, technical criterion, as well as risk criterion. The financial criterion consists of *NPV, IRR, PBP, PI* and investment value as its sub-criteria. The technical criterion consists of facilities and complexity as its sub-criteria. Lastly, the risk criterion consists of HSSE risk,contractor financial risk and operational risk as its sub-criteria. Criteria weights proportion which affects the selection of alternative investment strategies can also be seen (1) Financial Criterion: 0,183; (2) Delivery Time Project: 0,096; (3) Technical Criterion: 0,443; (4) Risk Criterion: 0,278. Therefore it can be concluded that technical criterion is the most important if compared to the otherthree criteria. Also, in this criterion, the most influential sub-criterion is facilities (with a weight of0.295), followed by complexity (with a weight of 0.148). The best alternative strategy according tothe results of the research is to Increase the Number of Tankers. This strategy is chosen based on the approach to calculate the ideal solutions' distance using TOPSIS; where this alternative has thelargest Relative Closeness Coefficient value compared to the others. Finally, based on the sensitivityanalysis (by reducing the weight of technical criterion by 25%); it is clear that there is still no changein the alternative strategies' ranking. Therefore, it can be concluded that the decision to increase thenumber of tankers will be a stable and consistent choice.

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STUDY OF ALTERNATIVE WORKING METHODS FOR MALALO INTAKE TRASHRACK REPAIR SINGKARAK HYDROELECTRIC POWER PLANT

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ABSTRACT

The Singkarak Hydroelectric Power Plant with a capacity of 175MW is the backbone of the Central Sumatra Subsystem in the Sumatran electricity interconnection system so that the reliability of the Singkarak hydropower operation must be maintained. However, after more than 12 years of operation the Singkarak Hydroelectric Power Plant suffered damage to the trash rack of the Malalo Intake caused by the September 30, 2009 earthquake that hit Padang-Pariaman. This results in waste originating from Singkarak lake being free to enter the head race tunnel and then to the generator engine generator which can interfere with the operation of the Singkarak hydropower plant so it is necessary to repair the Malalo trashrack intake.

This study aims to evaluate several alternative work methods for repairing the trash-rack intake of Malalo PLTA Singkarak to minimize disruption to the operation of PLTA Singkarak during repairs. Three alternative improvement methods were evaluated using the Zero-One technique and weighting. From the results of the evaluation, it was found that the underwater construction work method is the best alternative to repair among other methods. Furthermore, the details of the implementation plan for the underwater construction work method are presented as a reference for the implementation of the repair PLTA Singkarak trash rack.

Keywords: Singkarak hydroelectric power plant, trashrack, working method, coverdamp, under water construction.

1. INTRODUCTION

PT PLN (Persero) Unit Pelaksana Pembangkitan Bukittinggi (UPK Bukittinggi) manages three generating units, namely PLTA Batang Agam 3 x 3.5 MW started operating in 1976, PLTA Maninjau 4 x 17 MW started operating in 1983 and PLTA Singkarak 4 x 43.75 MW started operating 1998. The three hydropower plants have operational records to be proud of, that since the beginning of the handover of operations (STO) from PLN Pikitring West Sumatra Riau, the three hydropower plants continue to exist according to the installed power supplying electrical energy to the Sumatra interconnection system. The Singkarak hydropower plant was built in 1992 and started its commercial operation in April 1998 by utilizing the potential of Singkarak Lake water which is flowed through a 16.5 km headrace tunnel to turn the turbine generator in the powerhouse. The electrical energy produced is 175 MW or about 948 GWH per year, this can be seen in table 1 that the production of electricity for the singkarak hydropower plant under normal climatic conditions is 948,919 MWh. And with the productivity according to table 1, it can be proven that the Singkarak hydropower plant is the backbone of the Central Sumatra Subsystem in

the Sumatra electricity interconnection system, to be precise, the Central Sumatra subsystem (SumBagTeng).

Table 1. Table of energy production for PLTA Singkarak monthly and 1 year cumulative (Source: PLN)

PRODUCTION (MWh)	MONTHLY PRODUCTION OF SINGKARAK PLTA												TOTAL
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
WETTER	157.566	110.202	134.556	150.329	113.795	67.238	56.317	56.980	64.329	98.265	144.488	174.421	1.328.486
80%	146.311	102.330	124.945	139.592	105.667	62.435	52.295	52.910	59.734	91.247	134.167	161.962	1.233.594
WET	135.056	94.459	115.334	128.854	97.538	57.633	48.272	48.840	55.139	84.228	123.847	149.503	1.138.702
60%	122.676	85.800	104.761	117.042	88.597	52.350	43.847	44.363	50.085	76.507	112.494	135.799	1.034.321
NORMAL	**112.547**	**78.716**	**96.111**	**107.378**	**81.282**	**48.027**	**40.227**	**40.700**	**45.949**	**70.190**	**103.205**	**124.586**	**948.919**
40%	101.292	70.844	86.500	96.640	73.154	43.225	36.204	36.630	41.354	63.171	92.885	112.128	854.027
DRY	90.038	62.973	76.889	85.903	65.026	38.422	32.181	32.560	36.759	56.152	82.564	99.669	759.135
20%	78.783	60.611	67.278	75.165	56.897	43.425	30.975	31.339	32.164	52.515	79.468	87.210	695.830
DRIER	67.528	47.229	57.667	64.427	48.769	28.816	24.136	24.420	27.569	42.114	61.923	74.752	569.351

The operational reliability of the Singkarak hydropower plant as a base load carrier and to meet peak loads has been disrupted since the March 6, 2007 earthquake of 7.5 on the Richter scale and its peak on September 30, 2009 of 7.6 on the Richter scale. which serves as a separator from garbage and foreign objects that enter the delivery channel / tunnel is completely damaged.

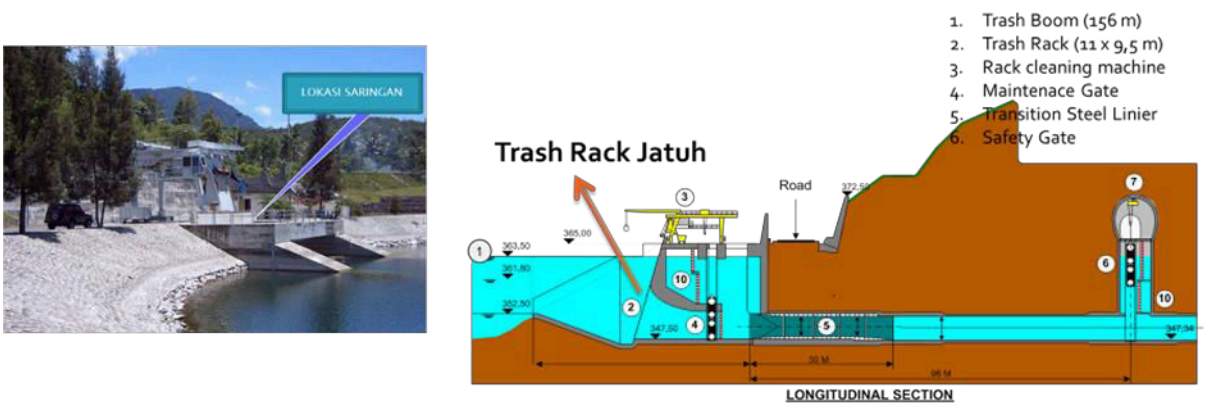

Figure 1. Picture of the situation documentation and the cross section of the Malalo intake (Source: PLN)

The installation of a new trash rack on the Malalo Intake of PLTA Singkarak must be carried out immediately to restore and improve the reliability of the generator so that the risk of damage and greater losses can be avoided. The existence of the Singkarak hydroelectric trash rack structure can be seen in Figure 1, which is a picture of the situation and a cross section of the Malalo Intake, where it can be seen that the trash rack structure is 15 m below the water level of Singkarak Lake. The trash rack structure in Hydroelectric Power Plants (PLTA) has the function of filtering and preventing the entry of large materials into the hydropower water way, which can cause damage to the generating machine, especially the penstock, spiral casing and turbine runner

of hydropower plants [1]. Trash rack consists of an array of steel strips mounted on the intake of hydropower [2].

To make improvements to the trash rack structure of the Singkarak hydropower plant, it is necessary to choose the right work method so that in the construction process it is minimally possible to interfere with the Singkarak hydropower operation, or when the new Singkarak hydropower plant's trash rack construction can still operate normally to generate electrical energy. This is because if the Singkarak PLTA does not operate (due to construction work) there will be a deficit of electrical energy in the SubBagTeng subsystem. Therefore, a study is needed to analyze the right work method for carrying out construction work to repair the trash rack of the Singkarak hydropower plant. Based on the literature review conducted by the author, there are studies that analyze the HEPP trash rack, but there has been no research that has analyzed the work method for repairing the HEPP's trash rack structure.

2. LITERATURE REVIEW

The literature review carried out is about various work methods, determining the selection of work methods, and the output will be in the form of the most optimal work method and the last is an explanation of the detailed work plan of the selected work method.

3. METHODS

The details of this research method can be conveyed as follows:

- Both primary and secondary data were collected in the form of field surveys, dimensional data collection from ass-built drawings, hydropower production data collection and interviews with hydropower experts and personnel regarding the chronology of failures and alternative improvements that might be made.
- Finding the theoretical basis for selecting the trash rack repair work method based on the initial input results, especially interviews.
- Determine the method and criteria for selecting alternative work methods which will later be selected as work methods in the implementation of trash rack repairs. The zero-one method and weighted final judgment were chosen as a way to select alternatives.
- Obtained the most optimal working method according to the best criteria for the implementation of trash rack repairs.
- An explanation of the details of the work sequence/work breakdown of the selected alternative work methods.

4. RESULTS

There are 3 (three) work methods that can be carried out (according to the scope) including:

- Coverdamp working method using sand bag (Alternative A)
  This method is a repair construction work by drying the front area of the trash rack by making a water protection wall (cover damp) as a protection against the entry of lake water during the construction process[6][7]. The intended coverdamp is made of soil bags/sand bags which are arranged in such a way as to be able to hold lake water so as not to interfere with the course of construction work. After the protective wall is completed in the construction of the lake water in front of the trash rack area, it will be pumped to dry the area, after it is dry, the trash rack repair construction process is carried out[8].
- Coverdamp working method using sheet pile (Alternative B)

This method is almost the same as the coverdamp sand bag method, namely by drying the front area of the trash rack, but the difference is that the water protective wall (cofferdamp) used as a protection against lake water is made of steel sheet pile arrangement [9]. This cover damper is quite familiar in work related to water resources or underwater civil construction.

- Underwater construction working method (Alternative C)
  Unlike the two previous work methods, underwater construction does not require a protective wall construction process, but the trash rack construction repair work is carried out partially in the water or by diving. Only the steel trash rack fabrication process is carried out above (workshop), and the new trash rack installation process is carried out with underwater construction[10]–[12].

The criteria that were calculated to get the right choice of the most optimal trash rack repair work method were obtained through literature reviews and interviews with experts in the field of hydropower construction and water resources. From these results, 7 (seven) criteria are taken into account as determining the choice of the optimal work method, namely cost, quality, time, availability of tools, potential loss of production, environmental impact and safety.

After the criteria have been determined, then a ranking of these criteria is carried out to select the top 4 (four) criteria that are used as input for the Zero-One method. This ranking is carried out by means of bainstroming with users of goods/services, consultants (PLN Pusenlis), and the Singkarak hydropower maintenance team. And the criteria and ranking results can be seen in table 2.

Table 2. Ranking of the determining criteria for selecting work methods

No	Criteria	total	Percentage	Rank
1	Execution time	10	19%	1
2	Potential loss of production	9	17%	2
3	Cost	8	15%	3
4	Quality	8	15%	4
5	Safety	7	13%	5
6	Availability of tools	6	11%	6
7	Environmental impact	6	11%	7
total		54	100%	

In accordance with the analysis carried out on the criteria data, the priority ranking of the most important criteria is obtained, namely time, followed by ease of implementation, cost, quality, safety, availability of tools, and environmental impact. And the top 4 (four) criteria will be weighted as input for the Zero-one method, which can be seen in table 3.

Table 3. Selected criteria for Zero-one method input

No	Criteria	%	Description
1	Execution time	40	Very high
2	Potential loss of production	30	high
3	Cost	20	moderate
4	Quality	10	low

After analyzing with the Zero-One method for each criterion (preference and assessment), the next stage is the final assessment by entering the index values of all criteria into the weighting matrix. The results of the final assessment are as follows:

Table 4. Final Assessment with Weighting

No	Alternative	Criteria				Total %
		I	II	III	IV	
		40	30	20	10	
1	A	1/3	1/3	2/3	1,5/3	
		13,33	10,00	13,33	5	41,67
2	B	0/3	0/3	1/3	1,5/3	
		0	0	7	5	11,67
3	C	2/3	2/3	0/3	0/2	
		26,67	20,00	0	0	46,67

6. CONCLUSIONS

Damage to the trash rack intake of the Malalo Singkarak hydropower plant has disrupted the Singkarak hydropower generation operation and resulted in an energy deficit in the Central Sumatra generation system. In order to repair the trash rack, 3 (three) alternative work methods were evaluated: the cover damp work method with sand bags, the cover damp work method with sheet piles and the underwater construction work method. After analyzing the selection of work methods using the Zero-One method and weighting where the main criteria assessed are implementation time, potential loss of production, cost and quality, it was found that the underwater construction work method is the best alternative for work methods in the implementation of the Singkarak hydropower trash rack repair. By using the underwater construction work method, the trash rack repair work does not interfere with the operation of the Singkarak hydropower plant for too long, so that the main factor is the implementation time and the potential for production loss due to the stop of the plant can be fulfilled properly while still paying attention to the quality of work and costs. Details of the implementation plan for the repair work using the underwater construction method are given as a general reference on how the process of repairing the Malalo PLTA Singkarak trash rack intake is carried out.

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ANALYSIS OF COVID-19 PREDICTION AND GOVERNMENT POLICY USING THE SIR MODEL: A CASE STUDY OF COVID-19 IN DKI JAKARTA

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ABSTRACT

Corona Virus Disease which is commonly referred to by the abbreviation Covid-19 is a disease that has hit the world in the past year, so it is categorized as a pandemic. Covid-19 is a virus that interferes with human respiratory function, sufferers of this disease will experience respiratory problems and have a greater risk in patients who have a history of cardiovascular disease, diabetes, chronic respiratory disease, and cancer. Covid-19 is spread through droplets of saliva or fluids that come out when coughing or sneezing from an infected person. The Indonesian government, especially DKI Jakarta, is not standing still in the face of the pandemic that is happening in Indonesia, while the actions taken by the government are issuing policies in the Vaccinations. This research was conducted by describing the spread of Covid-19 in DKI Jakarta using the SIR (Suspected, Infectious, Recovered) model and examining the influence of government policies on the spread. Based on the results of the analysis, vaccination is predicted to reduce the rate of positive cases in the future.

Keywords: COVID-19, Government Policy, SIR Model.

1. INTRODUCTION

Corona Virus Disease commonly referred to as Covid-19 is a disease that has hit the world in the last year so it is categorized as a pandemic. Leung et al. (2020) stated that Covid-19 was first discovered in December 2019 in Wuhan, Heibei, China, as a case of pneumonia of unknown etiology. Indonesia itself first found Covid-19 patients on March 2, 2020, infected patients were known to be a mother and daughter who had made contact with Japanese foreigners. (Nuraini, 2020). In early April 2020, a total of 1,677 new confirmed cases were confirmed, suddenly in the next 1 year in early April 2021 there were 1,517,854 total confirmed cases. Data from Covid-19.go.id noted that Indonesia had a cumulative total of Covid-19 patients in January 2021 as many as 751,270 patients with a total death of 22,138 patients. The area that has the most cases of Covid-19 in Indonesia come from the DKI province (24.4%) with 183,735 patients a total number of patients infected by Covid-19 and 3,270 cases of death. The number of patients in DKI Province is very much higher than other provinces such as East Java 84,412 patients, West Java 83,579 patients, Central Java 81,716 patients. The Indonesian government in dealing with the ongoing pandemic in Indonesia has implemented several policies in the form of Large-Scale Social Restrictions (PSBB), Enforcement of Restrictions on Community Activities (PPKM), and Vaccination.

Based on previous studies, the suitable model to be used in analyzing data for widely spread disease is the SIR model. The SIR model is very suitable for predicting epidemic trends due to the spread of disease because it can accommodate spikes and is adjusted to the recorded data (Cooper et al., 2020b). SIR Model uses data as a basis for predicting future conditions with certain parameters. Using the SIR model, researchers can analyze the success rate of a government policy based on Covid-19 disease data (Cooper et al., 2020a). Alanazi et al (2021) stated in his research that trend lines show that intervention by the government or self-isolation is not enough to stop the pandemic.

This research was conducted by describing the spread of Covid-19 in Indonesia using the SIR (Suspected, Infectious, Recovered) model and examining the influence of government policies on the spread. It is hoped that this research can be one of the government's references in implementing policies during the pandemic, especially in the case of the spread of Covid-19, as well as creating public awareness of DKI Jakarta and Indonesia in carrying out preventive measures against Covid-19 in accordance with the policy recommendations issued by the government.

2. LITERATURE REVIEW

2.1 Corona Virus

Corona Virus Disease or Covid-19 is a disease that is very easy to spread and has a risk of death in patients affected by Covid-19 disease. On January 2, 2020, it was reported that 41 patients who were being treated at the hospital were confirmed positive for Covid-19(Huang et al., 2020). Nearly half of those confirmed COVID-19 patients have congenital diseases such as diabetes, hypertension, and cardiovascular disease. Roberts et al (2021) report in his research stated that the first Covid-19 case was estimated to occur on November 17, 2020, where the spread of Covid-19 first occurred in early October to mid-November 2019, first spreading in China and after that it spread to several countries in the world. Abdullah, (2020) said Indonesia had the first confirmed case of Covid-19 on March 2, 2020. The first case allegedly started when a Japanese citizen met someone at a dance club in Jakarta.

This disease is also very contagious where the virus spreads through the nose or mouth in the form of droplets from an infected patient when talking, coughing, sneezing or breathing. Khan et al. (2020) stated that there are three ways to transmit the virus to positive patients, namely through coughing or sneezing from a Covid-19 patient with approximately 1 meter. Secondly is through airborne droplets where the virus that is released from the patient's body will survive in the air and the virus can move to other hosts while breathing the air. Finally, through touching objects where the virus can stick to the surface of objects that have been in contact with an infected person until it meets a new host.

2.2 Government Policy

Covid-19 cases that continue to increase are one of the problems that require more attention. In this case, the Indonesian government did not remain silent and immediately issued several policies related to the Covid-19 problem in Indonesia. The policies implemented by the Indonesian government include Large-Scale Social Restrictions, Enforcement of Restrictions on Community Activities, Vaccination. The first vaccine was invented intentionally by Louis Pasteur in 1881 where the pathogen can be weakened by environmental actions such as high temperature, oxygen, or using chemicals (Plotkin, 2005). Vaccines are biological products that contain antigens in the form of microorganisms or parts of them or substances that have been processed in such a way that they are safe, which when given to a person will actively induce specific immunity to certain diseases. Vaccines are considered to be one of the most effective means of preventing disease. Khan et al. (2021) stated that a single dose of the vaccine (Japanese encephalitis) could provide protection for

at least 6 years, with an effectiveness rate of 77% (95% CI: 67.0–83.0). In the Covid-19 virus itself, many vaccines have been found to be effective against high delta variant infections during the first month after full vaccination 93% (95% CI 85-97) but decreased to 53% (39-65) after 4 months (Tartof et al., 2021). Vaccines are expected if one day they are exposed to the disease, the person will have a lower possibility infected or only experience mild illness.

3. METHODS

3.1 Research design

In this study, we will use a conclusive - descriptive research model. Malhotra & Shaw (2006) states that descriptive research is research that describes the characteristics of a certain group of people or the percentage of units in a certain population that exhibit certain behaviors. Conclusive research tests specific hypotheses on the variables tested in the study to clearly define the required information (Malhotra & Shaw, 2006). This study aims to identify Covid-19 trends and how influential government policies are in dealing with Covid-19 cases in Jakarta.

3.2. Population and sample

Malhotra & Shaw (2006) Mention the population is the accumulation of all elements that share some common characteristics that are selected to determine the boundaries of the object under study to help complete the research with the required information. The population referred to in this study is data from Covid-19 cases in Indonesia. The sample of this research data is data from Covid-19 sufferers in the Jakarta area from March 3, 2020, to December 31, 2021. The research sample of this data can be accessed through the official website of the DKI Jakarta government https://corona.jakarta.go.id/id/data-pemantauan.

3.3 Analysis Method

The analytical method used in this research is descriptive analysis and SIR Model. Descriptive analysis is a statistical test used to analyze data by describing or describing the data that has been collected in research. The descriptive analysis in this study aims to determine the characteristics of the data from cases of Covid-19 patients in DKI Jakarta. The second analysis uses the SIR Model, the SIR Model is one of the most basic mathematical models of infectious diseases known as the Susceptible - Infected - Recovered model, in this model the population is divided into three parts: susceptible state, infected state, and recovered state. The transition from the susceptible phase to the infected phase is called the contact rate, β, which describes the speed at which the disease spreads within a population. The transition from the infected to the cured phase is denoted as γ. The basic model can be symbolized as follows:

(2.1)

S : Susceptible
I : Infected
R : Recovered and Fatal
β : Effective contact rate (1/min)
γ: Recovery rate (+Fatal) (1/min).

Ordinary Differential Equations (ODE) of the SIR model is as follows:

(2.2)

(2.3)

$$= \tag{2.4}$$

N = S + I + R where N represents the total population, T is the recorded time since the deployment first started. The ODE method is used in calculating the variable, ODE includes the rate of change of each variable. The implementation of the ODE model in this study is as follows:

$$= - \quad - \tag{2.5}$$

$$= \quad -1 = \quad -1 \tag{2.6}$$

$$\tag{2.7}$$

$$\tag{2.8}$$

Where $_0$ symbolizes the growth rate i.e., one infection will cause several new infections. Based on this, the infection rate is described as follows:

$$> 0$$

$$-1 \to 0 \tag{2.9}$$

4. RESULTS

4.1 Descriptive Analysis

The results of a descriptive analysis of data on patients with Covid-19 cases in DKI Jakarta can be seen in table 1. The results of the analysis showed that the average number of infected patients was recorded as 11,545 cases, with a maximum number of infected cases reaching 113,138 cases, this indicates an indication of an outbreak, namely a very high spike in cases of infected patients. Furthermore, the proportion of patients who recovered to the number of cases reached a value of 95%, this indicates that DKI Jakarta has passed the outbreak phase.

The fatal rate for Covid-19 patients in DKI Jakarta is quite low at 1.6% below the 3% threshold in accordance with the standards set by the Indonesian Ministry of Health.

Based on Figure 1, DKI Jakarta during the Covid-19 pandemic has experienced a number of spikes in cases. In early January 2021 to February 2021, it was seen that Covid-19 cases experienced an increase in the number of infected patient cases and experienced a peak on 5 February 2021 with 26,029 cases of infected patients, this increase in cases coincided after the new year. In addition, DKI Jakarta experienced a spike in cases again in June to July, this time the peak of cases was much larger with a total of 113,138 active cases of infected patients, the peak of cases was 5x greater in the previous spike.

Table 1. Statistical summary of EDA

Description	Confirmed	Infected	Fatal	Recovered
Count	669	669	669	669
Mean	349358	11545	5711	332102
Std	12773	18036	4976	323362

Min	3	2	1	0
Median	269718	7203	4267	242069
Max	865297	113138	13588	851222

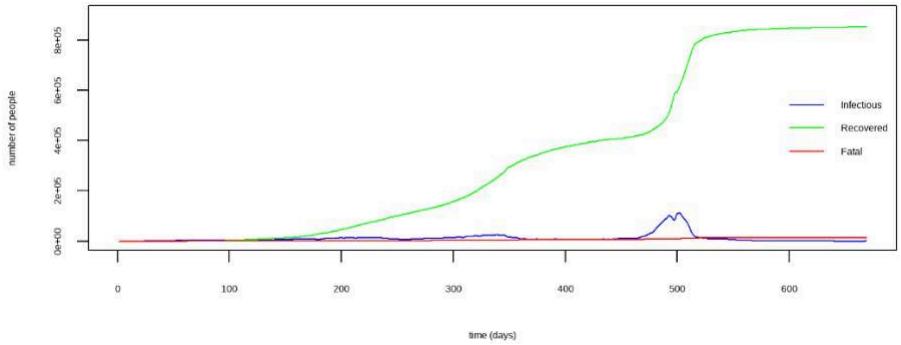

Figure 1. Actual Covid-19 cases on DKI Jakarta

4.2 SIR Model

Based on the results of the SIR Model simulation in the RStudio application in the first experiment, we found that based on the Covid-19 case data, the beta = 0.458 with gamma = 0.425 with $_0$ = 1.077 based on the method described previously. In the previous equation, if $_0$ is above 1, it indicates that an outbreak will occur, this indicates that there is a possibility of an outbreak. Based on Figure 2 The results of the first simulation on the SIR model show that an outbreak will occur with a peak point on day 333 or about 11 months after the appearance of the first case of the pandemic.

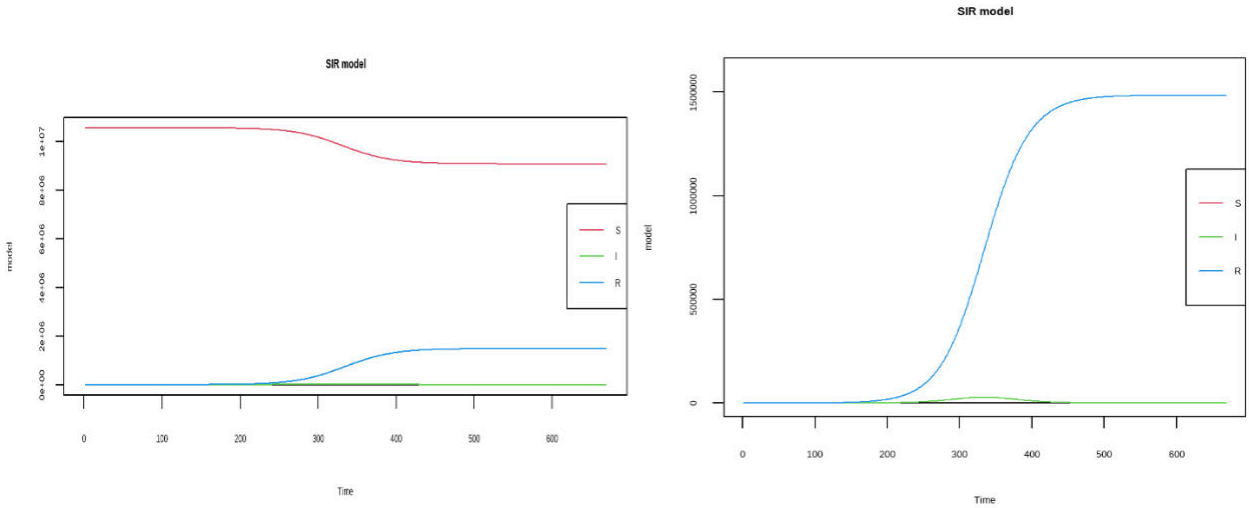

Figure 2. First simulation of Covid-19

The prediction results of the SIR model show that the number of infected patients at the peak of the outbreak reached 28,095 patients, this is slightly higher than the actual data where the number of infected patients was 23,389 cases. Figure 3 shows the comparison between the results of the first simulation and the actual data, the data from the first simulation corresponds to the actual data conditions. Outbreaks that occur may be caused by several reasons, namely the revocation of the

PPKM policy from the order. In addition, there is a possibility that it will occur after the New Year's holiday where people do not strictly implement health protocols.

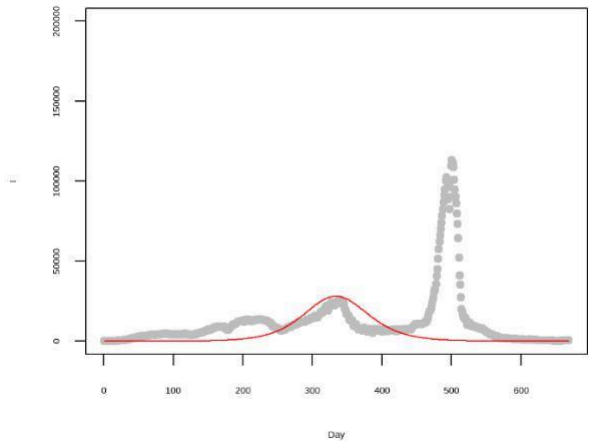

Figure 3. Comparison actual data with first simulation of Covid-19

In the second simulation, we found that beta = 0.165 with gamma = 0.14. Based on this data, it is known that $_0$ = 1.17. This value indicates the possibility of an outbreak during a pandemic. The value of $_0$ in the second simulation is higher than the first simulation based on this, it is estimated that the number of outbreaks that will occur will be higher. Figure 5 shows the peak period of the outbreak will occur on the day-502 after the first infection case. The peak of the outbreak showed the number of infected people reached 127,845 cases 5 times higher than the previous outbreak. The simulation results in Figure 4 show that the predictions are in accordance with the original data where in the actual data the peak of the outbreak was found as many as 113,138 active infected patients. Outbreaks that occur can occur for several reasons, namely coincided with the school holiday season where people have more free time that can be used to move out of the house. In addition, the transmission that occurs may be the result of Eid al-Fitr, where people are exposed to the virus when in direct contact.

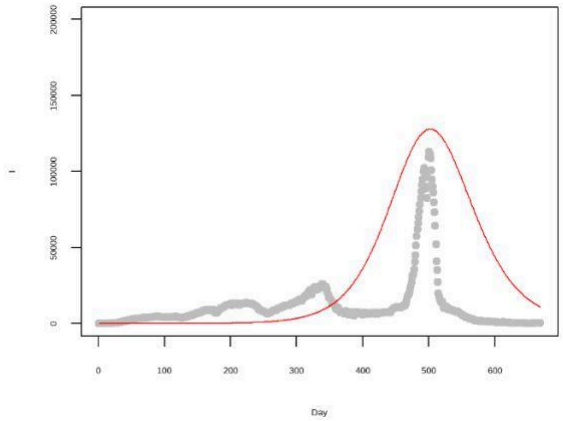

Figure 4. Comparison actual data with second simulation of Covid-19

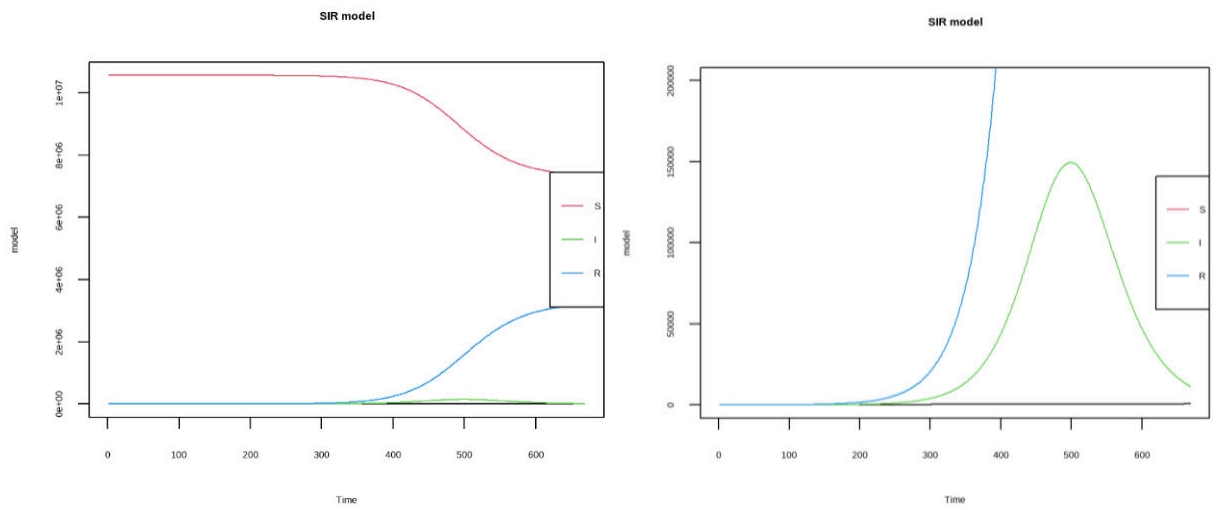

Figure 5. Second simulation of Covid-19

4.3 SIR Model with Vaccine

One way that is considered effective in preventing and reducing symptoms of disease is a vaccine. Patients have a lower probability of contracting the disease due to the formation of antibodies to the disease, while infected patients have milder symptoms with a faster recovery rate. The prediction results of the SIR model by considering the presence of a vaccine can be seen in Figure 6, where the prediction results indicate that there will be an outbreak in the future. It is known that vaccination does not eliminate the possibility of an outbreak, the vaccine has the effect of reducing the number of infected people. In the simulation scenario without the vaccine, the outbreak that occurred in June amounted to 127,845 infected cases, while the peak of cases during the outbreak with the vaccine was predicted to be only 30,962 patients infected with Covid-19

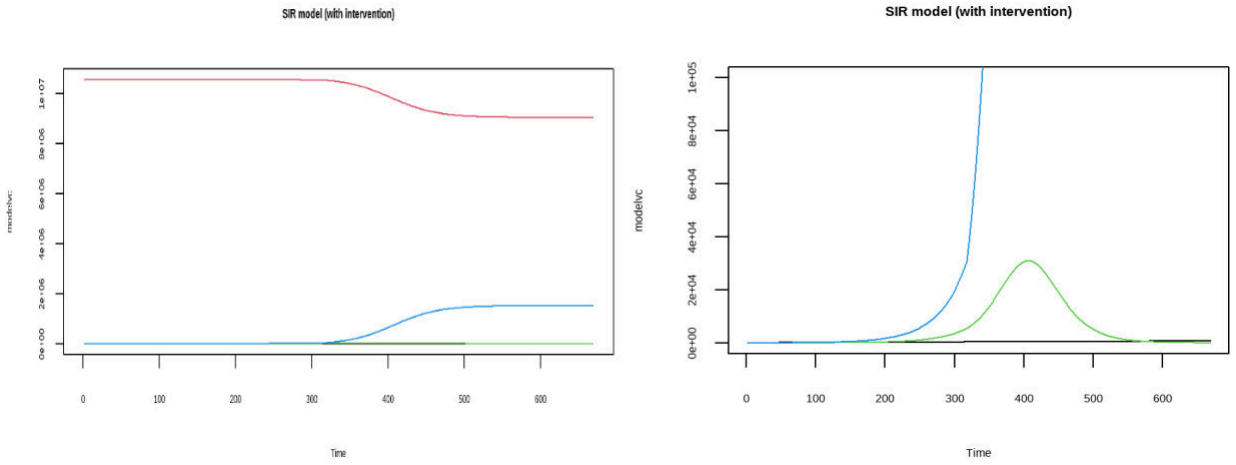

Figure 6. SIR Model simulation of Covid-19 considering vaccine

5. CONCLUSIONS

This study aims to predict the Covid-19 case and evaluate the current vaccination policy in DKI Jakarta. The government with a vaccination program can reduce the number of positive cases of Covid-19, but with long holidays and national holidays it will increase a person's risk of being exposed to the virus. Several outbreaks occurred in the period after the long national holiday.

The SIR epidemiological model is one of the oldest methods of analyzing epidemics. Where science can make modifications to the SIR model, some scientists separate the recovered state from being fatal. In this study, the condition of death was combined with the condition of recovery. It is known that the prediction results show that vaccination has an influence in reducing the number of positive cases of Covid-19 patients. However, this condition is not sufficient so that other policies are needed to reduce virus exposure.

In future research, it is possible to add fatal variables in the model. Constantly changing data and incomplete data can cause errors in prediction results.

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EVALUATION OF WASTE MATERIALS IN THE CIPUTRA WORLD PHASE III SURABAYA PROJECT

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Ciputra World Surabaya (CWS) Project Phase III was built on an area of 4 hectares. The remaining project material is currently not identified, so the contractor does not know the percentage of losses due to waste at the project site. Excessive losses can result in a decrease in the revenue received by the contractor. Therefore, research is needed to identify potentially wasteful materials and determine the cost of losses due to the generation of waste materials.

The objectives of this study are (1) to determine the largest percentage of residual material costs during project implementation, (2) to determine the ratio of the total remaining material costs to the total project costs, (3) to determine the causes of residual material and how to eliminate them. The method used is the value streaming map, the cost of the remaining material, evaluation of the residual material using a Pareto diagram, the factors causing the emergence of residual material using a fishbone diagram, and the efforts made to minimie and handle waste material.

The result were (1) During the project implementation, the largest proportion of the cost of the residual material fell from 44.79% K375 reinforced concrete or 30.98% K300 reinforced concrete. (2) The ratio of the total cost of the remaining materials to the total cost of the project was 0.22%, (3) The main factor causing the residue is the rest of the concrete that is scattered or mixed with the soil, some of which is still left in the mixer truck. The proposed effort to the project to prevent and minimi e residual material is to form a special departemenon, namely the waste control departemenon which is in charge of planning waste material and controlling its operations.

Keywords: material requirements, material purchases, waste materials, waste control

1. INTRODUCTION

Project management is the process of planning, leadership, and controlling the use of resources to achieve predetermined goals. The key aspects of the project management function that affect project success are the time management aspect, the cost aspect, and the quality aspect. (Ahadi, 2011). Construction projects, buildings, bridges, roads, apartment constructions produce residues or called Construction Waste (Rachmawati and Wahyu, 2013). More than 75% of the residue generated at construction sites has residual value and can be recycled, disposed of or reused. Therefore, the management of waste materials becomes very important for the protection of public health and natural ecosystems. (Yeheyis dkk, 2012)

Waste material management is still less important at this time. As seen in the construction project, after the project was completed, there were still a lot of leftover materials

such as wood, plywood, iron and other materials. Effective management of building materials waste requires the formation of a dedicated group of workers to manage building materials waste. (Jayamathan and Ramee deen 2014).

As the second largest city after Jakarta, Surabaya is known as a city of business, industry, trade and education. As a big city, Surabaya has big shopping centers such as Tunjungan Plaza, Pakuwon Trade Center, Royal Plaza, and Ciputra World Surabaya (CWS). Anchor developers do not want to waste the addition of tenant space, such as CWS which is building the third part or building expansion to add tenant space.

The CWS Project Phase III covers an area of 4 hectares which was built on Jl. Major General Sungkono. The residual material (waste) of this project was not identified, so the contractor did not know the percentage of losses due to waste at the project site. Excessive losses can result in a decrease in the revenue received by the contractor. Identification is carried out to identify potentially wasteful materials and determine the cost of losses due to the generation of waste material.

One of the lean building tools to identify losses during construction is the Value Streaming Map (VSM). VSM is used to describe the production system (starting from calculating the demand for raw materials to finished products) along with the value streaming contained within the company, so that later it can obtain an overview of the information flow and physical flow of the existing system, based on their respective characteristics when they arise, to determine where the residual material comes from. (Intifada and Witantyo, 2012)

Activities during the construction of the CWS Phase III project include foundation drilling (borepile), laying operations (poer), girder operations (tiebeam), column cutting operations (cuttings) and shearwalls, pitlift operations, and drainage operation.

Table 1.1 Waste Material Calculation

Type of Material [1]	Purchase of Material [2]	Stock of Material [3]	Material Needs [4]	Residual Material [5]=[2]-[3]-[4]
PC Cement	20.300 kg	350 kg	19.890,48 kg	59,52 kg
Concrete Sand	8,00 m^3	0,00 m^3	7,49 m^3	0,51 m^3
Tide Sand	72,00 m^3	0,00 m^3	70,96 m^3	1,04 m^3
Crushed Stone	8,00 m^3	0,00 m^3	7,91 m^3	0,09 m^3
Split Stone	46,50 m^3	0,00 m^{33}	46,20 m^3	0,30 m^3
Concrete Brick	15.755 pcs	0 pcs	15.691 pcs	64 pcs
Multiplex	259,20 m^2	0,00 m^2	253,08 m^2	6,12 m^2
Iron Ø10	9.408,04 kg	0,00 kg	9.379,45 kg	28,59 kg
Iron Ø12	18.607,01 kg	0,00 kg	18.531,61 kg	75,40 kg
Iron D13	687,02 kg	147,22 kg	509,83 kg	29,97 kg
Iron D16	16.130,72 kg	0,00 kg	16.064,85 kg	65,87 kg
Iron D19	54.571,43 kg	0,00 kg	54.462,42 kg	109,02 kg
Iron D22	54.810,52 kg	0,00 kg	54.671,07 kg	139,46 kg
Bendrat	930,00 kg	0,00 kg	892,37 kg	37,63 kg
Concrete K-300	656,50 m^3	0,00 m^3	650,27 m^3	6,23 m^3
Concrete K-375	473,50 m^3	0,00 m^3	469,41 m^3	4,09 m^3

Source: CWS Project Phase III

The steps in analyzing waste reduction are calculating material requirements, calculating material purchases and calculating waste materials. The calculation of residual

material costs based on the evaluation results is expected to determine the largest percentage of residual material costs and the percentage of total residual material costs during project implementation. The total cost of the project to determine the root cause. Once the root causes are identified, interviews with contractors and on-site observations help reduce material wastage. Situations arising as a result of reducing material waste may affect the contractor.

Based on the explanation above where the waste of work causes big losses for the contractor, so in this study the cost of the remaining material in the CWS Phase III project was calculated to find out waste by finding the factors causing material wastage. So that the problem can be formulated as follows:

1. What is the largest percentage of residual material costs during project implementation?
2. What is the ratio of the total cost of the remaining materials to the total cost of the project?
3. What factors make up the residual material and how is it removed?

The purpose of this research are 1) Knowing the largest percentage of residual material costs during project implementation, 2) Knowing the ratio of the total remaining material costs to the total project costs, 3) Determine the factors causing the residual material and how to eliminate it. And the scope of this research are1) VSM includes foundation drilling (borepile), laying operations (poer), girder operations (tiebeam), column cutting operations (cuttings) and shearwalls, pitlift operations, and drainage operations. 2) The steps for the analysis of waste reduction are calculating material requirements, calculating material purchases and calculating waste materials.

Based on the purpose of this research, this research can provide the following benefits, in theory, this research can be used as a theoretical basis to enrich the science of construction waste management, especially with regard to the percentage of waste costs and the percentage of total waste costs. Besides that, for organizations, this research can help organizations understand the importance of construction waste management, especially in terms of percentage of waste costs and percentage of total waste costs. For workers, a clearer understanding of construction waste management, is expected to help workers develop their careers because they receive a percentage of the waste cost and a percentage of the total waste cost. And for managerial, trying new tools for the construction world to pay more attention to the remaining material in the project, by adopting existing management in the industry to really suppress the remaining material.

2. LITERATURE REVIEW

Lean can be defined as a continuous effort to reduce waste and increase the value of a product in order to provide added value (customer value) to customers. The implementation of the lean concept is based on four principles, namely (Rossianti et al, 2014):

1. Specify Value
   Determine the value of a product from the customer's point of view and state the exact value of the product demanded by the customer.
2. Value Stream Analysis
   Design, order and manufacture products based on the total value stream to identify the steps needed to find value added waste.
3. Flow
   Adding value is structured in such a way that it flows smoothly from one process to another
4. Pull System

Manage the flow of materials, information and products to flow smoothly and efficiently throughout the process using a pull system. Pool system is a new system that uses demand as a production base.

At the construction implementation stage, the use of materials in the field often occurs which is quite large, so it is important to implement efforts to minimize waste material. The materials used in the construction can be classified into two major parts (Gavilan and Bernold, 1994), namely:

1. Consumable materials, materials that eventually become part of the physical structure of a building, such as cement, sand, gravel, steel, reinforcement, and others.
2. Non-consumable materials, are auxiliary materials during the construction process and are not a physical part of the building after construction is completed (eg scaffolding, formwork, temporary retaining walls and others).

The results of Bossink and Brouwers (1996) research in the Netherlands, concluded the sources and causes of construction waste based on the following categories:

Table 2.1. Sources and Causes of Construction Waste

CAUSATIVE FACTOR	DESCRIPTION
Design	1. Error in contract documentation 2. Incomplete contract documents 3. Design changes 4. Choice of product characteristics 5. Choose low quality products 6. Ignoring the size of the product used 7. Designers are not familiar with various types of products 8. Complicated details 9. Insufficient image information 10. Disagreement with contractors and construction ignorance
Material Procurement	1. Error order, advantages, disadvantages 2. Small orders are not allowed 3. Buying materials that not according to spesifications 4. Suppliers out of specifications 5. Damaged during transportation due to bad packaging
Handling	1. Damage caused by transportation to construction site 2. Improper storage causes damage 3. Incorrectly packaged materials 4. Throwing materials 5. Materials shipped loose/lack 6. Careless handling when unpacking materials to be sent to warehouse
Implementation	1. Error due to labor 2. Equipment not working properly 3. Bad weather 4. Worker accident in the field 5. The use of inappropriate materials so that must be replaced 6. How to lay the foundation 7. The amount of material required is unknown due to incomplete planning 8. Information on the types and sizes of materials used and then given to the contractor

	9. Mixing required materials replacement, negligence in handling, and error in use 10. Volume exceeded due to on-site measurement which is not accurate
Residual	1. The remaining cutting material is no longer available 2. Error while cutting the material 3. An error occurred while ordering the item because specification mismatch. 4. Packaging 5. Remaining usage
Others	1. Loss due to theft 2. Poor material control on project and management planning for material residue

Source: Bossink and Browser, 1996

According to Farmoso (2002), the causative factors and ways to reduce waste materials are as follows:

Table 2.2. Factors that cause and how to minimize waste material

NO	MATERIAL TYPE	CAUSATIVE FACTOR	HOW TO REDUCE
1	Ready mix concrete	1. The supplier has a small amount of concrete. 2. Deviation dimensions during casting	1. Calculate volume after install formwork. 2. Ensure structural integrity and design a formwork system that better. 3. Use clean measuring tools
2	Steel bar	1. Imperfect design 2. Cutting material is not optimal. 3. Excess inventory	1. Increase design power 2. Updating control system
3	Cement (in mortar form)	1. Different sizes of bricks 2. Structural dimensional deviation 3. Dispersed during handling and transportation 4. Excessive use of mortar on masonry joints	1. Updating control system 2. Ensure structural integrity and design a formwork system that better. 3. Use of equipment that in accordance 4. Use safe path 5. Construction work coordination and brick module
4	Ceramic	1. Remaining cuts materials	1. Centralization of ceramic cutting operations

VSM is a lean construction concept that shows an overview of all activities or activities carried out by a company (Prayogo and Octavia, 2013). VSM includes raw material suppliers, construction processes, and retail chains for users of the product. (Majid, 2018). VSM is used to describe the production system (starting from ordering raw materials to being ready to be distributed) along with the value streams contained within the company, so that later they can obtain an overview of the information flow and physical flow of the existing system and determine its location. Describes the waiting time required for each nature of the process in which waste is generated and is taking place. (Intifada and Witantyo, 2012).

Minimal waste material handling is required to perform a material management system.. In a construction project, material management typically includes the purchase, storage, handling and use of materials.

1. Material Procurement
   Material procurement is the expectation of material availability in the market. This matter to ensure that materials are always available on site when needed. This activity include:
   a. Estimate the quantity you will need, the type of material you will use, and your specific specifications. Schedule material delivery to the location according to the on-site delivery schedule, and transfer material requirements to the Purchasing/Logistics Department as needed to place orders.
   b. The selection of suppliers is preferably experienced (in good faith) and only the price factor is considered (Nugraha, 1985).
   c. Preparation and execution of purchase orders.
   d. Purchase in advance for planned orders to keep delivery on project schedule. Incoming material must be configured to fit the material usage schedule. Communication between contractors and suppliers must be in place to ensure that deliveries are error free.
2. Material Storage
   Each material has different properties that require different handling in terms of storage to avoid unwanted material residues. For example, cement must be grounded because storage conditions must not be wet because cement can be damaged/hardened. The following should also be noted:
   a. Store the material in the warehouse, taking care not to mix it with other materials and not to damage it. Separate brittle or brittle materials from heavy materials such as pottery and bricks, and do not place them too close to the concrete slab.
   b. Warehouses must be free from the risk of fire, theft, vandalism and flooding.
   c. In addition to the warehouse, the space around the project site also needs to be considered, which is needed to store materials such as heavy equipment, iron, concrete, sand, bricks, rubble, and material paths that leave the warehouse.
   d. Warehouses need to be well regulated the flow of goods in and out, as based on the FIFO (first in, first out) system. This method is to prevent damage to brittle materials before use.
   e. All products stored in the warehouse can be searched / found as easily as possible when they are about to be used. For this purpose, whenever possible, each material is marked or marked. (Nugraha, 1985)
3. Material Handling
   Every material that arrives at the site needs to be handled properly, so as not to cause residual material. Other things to note are:
   a. Lower the load carefully to avoid damaging the material too much. (Skoyles, 1976).
   b. This is to prevent receipt and verification of materials, materials that do not meet the required specifications, insufficient quantities, damaged materials, etc. from suppliers. (Stuckhart, 1995).
   c. Lamination of the correct material, the amount of lamination required is in accordance with the manufacturer's recommendations and the lamination method
   d. The movement of materials from storage to the work area must be carried out with care.
   e. The location of the site is made as good as possible so that the flow of material is kept short and safe (Thomas, 1989).
4. Material Usage

At this stage the residual material can arise due to:

a. Inadequate work equipment and poor work culture. (Gavilan, 1994).
b. Behavior of workers in the field. (Loosemore, 2001).
c. Using technology that is still new, where the craftsman is still not familiar with the method, causing errors in the use of the material, which in the end the material cannot be used again (Skoyles, 1976).
d. Cutting material into certain sizes without good planning (Gavilan, 1994)

The Pareto chart was first introduced by the Italian economist Vilfredo Pareto (1848-1932). Pareto charts are designed to find the root cause of a problem or problem. Knowing the root causes can help prioritize improvements. Eliminating this dominant cause has a significant impact. Pareto charts can be interpreted in a number of ways. 1) 20% of the input gives 80% of the output, 2) 20% of employees deliver 80% of results, 3) 20% of consumers earn 80% of their income, 4) 20% of the reason is 80% of the use, 5) 20% waste material is 80% of the total waste material

Fishbone diagram or more generally causal diagrams introduced by doctors. Japanese quality control expert Kaoru Ishikawa. Dr. Kaoru Ishikawa was the first to introduce 7 quality management tools (7 core quality tools). The seven basic quality tools are fishbone diagrams, Pareto charts (Pareto principles), control charts, bar charts, scatter charts, and flow charts. Fishbone diagram is a diagram that identifies all the factors and processes in a problem in detail so that the problem can be classified and solved (Vorley, 2008). Once you find the problem and its root cause, you can easily take action and corrective action. Fishbone charts are used to identify possible causes of problems and are used by organizations that tend to think about the mundane (Tague, 2005). Problems fall into different categories based on their causes and brainstorming sessions. Fishbone diagrams consist of two parts: the spine and the head of the fish. The spikes indicate the category of the cause of the problem and the fish head indicates the problem being analyzed.

3. METHODS

The research location is the construction of the Ciputra World Phase III Surabaya project which is located in the Jalan Mayjen Sungkono area number 89 Surabaya.

Figure 3.1. Project Location

The research stage is a sequence of procedure steps that are carried out systematically and logically according to the theoretical basis of the problem, so that an accurate analysis is obtained to achieve the research objectives and the research schedule is as follows

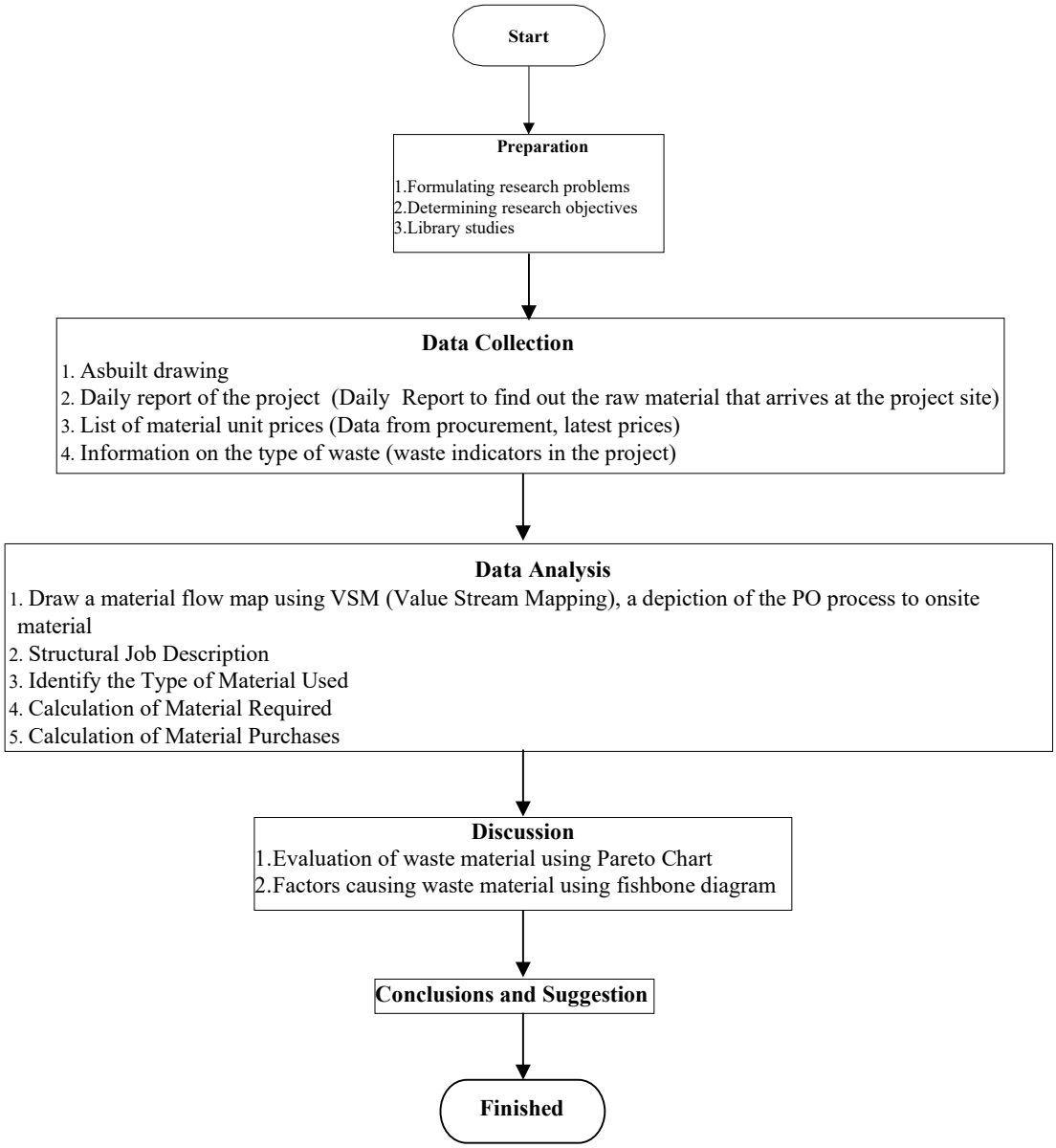

Figure 3.2 Research Flow Chart

After all data are collected, then the data analysis is carried out as follows:

a. Drawing material flow maps with VSM (Value Stream Mapping), namely borepile foundation work, poer work, tie beam work, column and shearwall cuttings work, pitlift work, drainage channel work.
b. Structural Job Description
   The Podium structure works for the Ciputra World Phase III Surabaya construction project include: foundation drilling (borepile), laying operations (poer), girder operations (tiebeam),

column cutting operations (cuttings) and shearwalls, pitlift operations, and drainage operation.

c. Identify the Type of Material Used
The steps taken are to identify each work item and the type of material used

Table 3.1. Material Type Form Used in Each Job

Work Item	PC Cement	Concrete Sand	Tide Sand	Crushed Stone	Split Stone	Concrete Brick	Multiplex	Iron Ø 10	Iron Ø 12	Iron D 13	Iron D 16	Iron D 19	Iron D 22	Bendrat	Concrete K-300	Concrete K-375
Borpile																
Reinforcement																
Concrete																
Poer																
Formwork																
Floor																
Reinforcement																
Concrete																
Tiebeam																
Formwork																
Floor																
Reinforcement																
Concrete																
Stek																
Column																
Shearwall																
Pitlift																
Reinforcement																
Reinforcement																
Concrete																
Drainase																
Floor																
River Stone																
Formwork																
Reinforcement																
Concrete																

According to the compilation of SNI 2002 House Construction and Construction Cost Analysis, unit price is the price that must be paid to buy one type of building material.

Table 3.2. Material Unit Price Form

TYPE OF MATERIAL	UNIT	UNIT PRICE
PC Cement	Kg	
Concrete Sand	m^3	
Tide Sand	m^3	
Crushed Stone	m^3	
Split Stone	m^3	
Concrete Brick	Pcs	
Multiplex	m^2	

Steel Bar	kg	
Bendrat	kg	
Concrete K-300	m^3	
Concrete K-375	m^3	

d. Calculation of Material Requirements

The steps taken are to identify each work item and the type of material used, then calculate the quantity of material needed (bill of quantity) based on construction drawings (asbuilt drawings) including foundation drilling (borepile), laying operations (poer), girder operations (tiebeam), column cutting (cutting) and shearwall operations, pitlift operations, and drainage operations.

Table 3.3. Bill of Quantity Calculation Form

Sketch Drawing	Bill of Quantity

Table 3.4. Material Requirements Recapitulation Form

Work Item	PC Cement	Concrete Sand	Tide Sand	Crushed Stone	Split Stone	Concrete Brick	Multiplex	Iron Ø 10	Iron Ø 12	Iron D 13	Iron D 16	Iron D 19	Iron D 22	Bendrat	Concrete K-300	Concrete K-375
Borpile																
Reinforcement																
Concrete																
Poer																
Formwork																
Floor																
Reinforcement																
Concrete																
Tiebeam																
Formwork																
Floor																
Reinforcement																
Concrete																
Stek																
Column																
Shearwall																
Pitlift																
Reinforcement																
Reinforcement																
Concrete																
Drainase																
Floor																
River Stone																
Formwork																
Reinforcement																
Concrete																

Table 3.5. Reinforcement Profile Form

Type	Diameter (mm)	Area (mm2)	Long (m)	Volume (m3)	Specific Weight (kg/m^3)	Weight (kg)

	a	b = 3,14*(a/2)^2	c	d = b*c*10^6	e	f = d * e
Ø10						
Ø12						
D13						
D16						
D19						
D22						

Table 3.6. Material Purchase Recapitulation Form

Day, Date	PC Cement kg	Concrete Sand m^3	Tide Sand m^3	Crushed Stone m^3	Split Stone m^3	Concrete Brick pcs	Multiplex m^2	Iron Ø 10 kg	Iron Ø 12 kg	Iron D 13 kg	Iron D 16 kg	Iron D 19 kg	Iron D 22 kg	Bendrat kg	Concrete K-300 m^3	Concrete K-375 m^3
Total																
Stock																

e. Calculation of waste materials

Calculating the quantity of waste material:

Type of material = ...

Purchase of materials = ... kg

Material stock = ... kg

Material requirement = ... kg

Unit price = Rp..... /kg

a. Calculating the quantity of waste material

Waste material = Purchase of materials–Stock materials–Requirement of materials (1)

b. Calculating the cost of waste materials:

Waste material cost=Waste material x Unit price (2)

c. Calculating the percentage of residual material costs:

$$\text{Percentage of waste material cost} = \frac{\text{Material waste cost}}{\text{Total cost of the remaining materials}} \times 100\% \quad (3)$$

d. Calculate the percentage of the total cost of waste materials to the total project cost:

$$\text{Percentage of total waste material cost} = \frac{\text{Total cost of the remaining materials}}{\text{Total project cost}} \times 100\% \quad (4)$$

The results of the calculation of the remaining material are as follows:

Table 3.7. Residual Material Calculation Form

Material Type [1]	Material Purchase [2]	Material Stock [3]	Material Needs [4]	Remaining Material [5]=[2]-[3]-[4]	Unit Price (Rp)[6]	Residual Material Cost (Rp) [7]=[5]*[6]	Percentage of Waste Material Cost to Total Waste Material Cost	Cumulative Percentage
PC Cement								
Concrete Sand								

Tide Sand								
Broken Stone								
Split Stone								
Concrete Brick								
Multiplex								
Iron Ø10								
Iron Ø12								
Iron D13								
Iron D16								
Iron D19								
Iron D22								
Bendrat								
Concrete K-300								
Concrete K-375								
Total Cost of Residual Materials								
Total Cost of Construction Project Podium Structure Works for Ciputra World Surabaya Phase III								
Percentage of Residual Material to Total Cost of Podium Structure Construction Project for Ciputra World Surabaya Phase III								

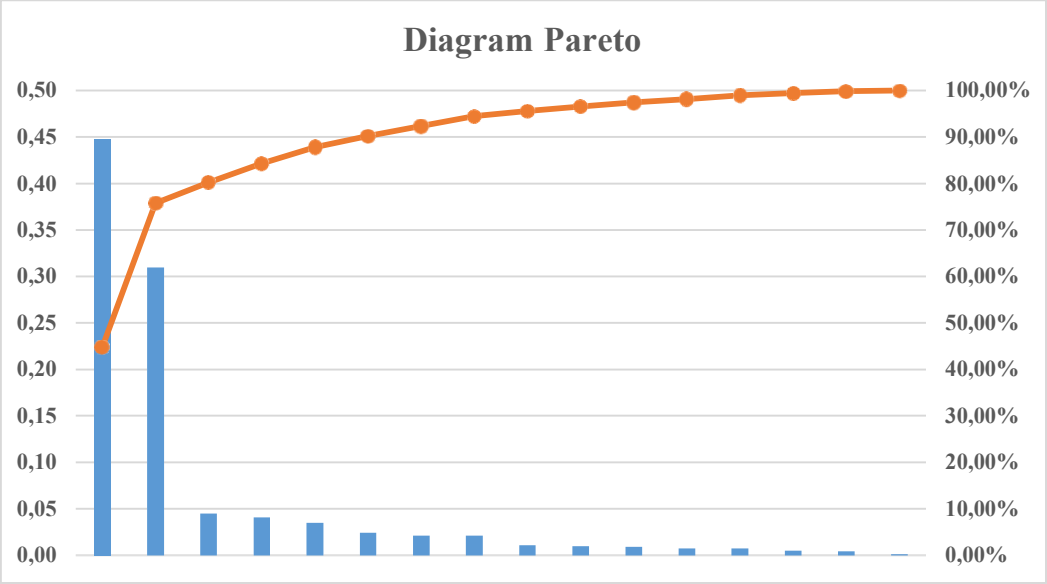

Figure 3.3. Pareto Chart Example

Table 3.8. Form Factors Cause Waste Material (Waste)

No	Material	Factors that Cause Waste
1.	PC Cement	
2.	Sand	
3.	Crushed Stone	
4.	Tide Sand	
5.	Concrete Brick	
6.	Multiplex	
7.	Steel Bar	
8.	Bendrat	

9.	Ready mix concrete	

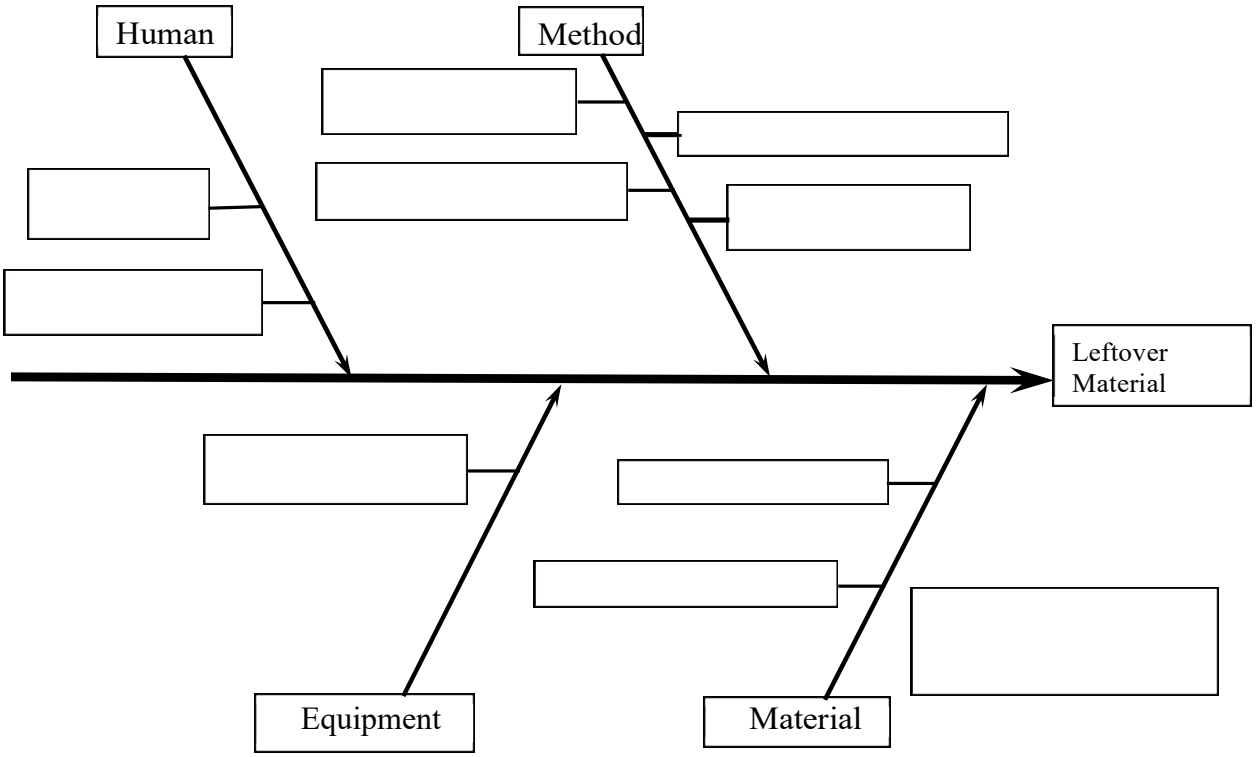

Figure 3.4. Fishbone Diagram Example

4. RESULTS

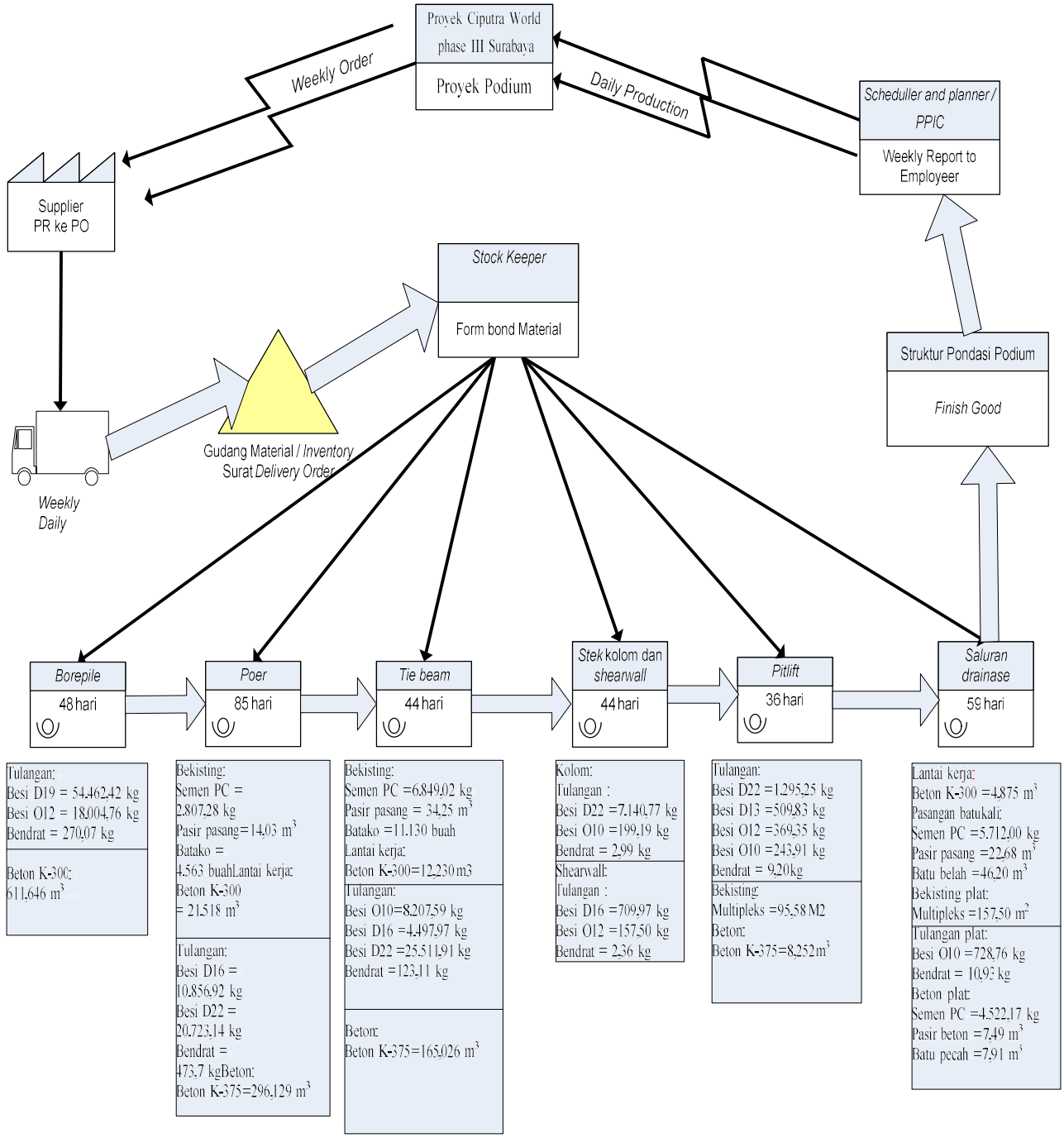

Figure 4.1. Material Flow Map With Current VSM

Table 4.1 Material Requirements Recapitulation

Work Item	PC Cement Kg	Concrete Sand m3	Tide Sand m3	Crushed Stone m3	Split Stone m3	Concrete Brick buah	Multiplex m2	Iron Ø10 kg	Iron Ø12 Kg	Iron D13 kg	Iron D16 kg	Iron D19 kg	Iron D22 kg	Bendrat kg	Concrete K-300 m3	Concrete K-375 m3
Borepile																
Reinforcement									18.004,76			54.462,42		270,07		
Concrete															611,646	
Poer 1																
Formwork	1.612,80		8,06			2.621										
Work Floor															7,296	
Reinforcement											4.778,51		9.158,98	209,06		
Concrete																99,883
Poer 2																
Formwork	810,88		4,05			1.318										
Work Floor															9,216	
Reinforcement											3.990,31		7.593,65	173,76		
Concrete																127,145
Poer 3																
Formwork	237,44		1,19			386										
Work Floor															3,136	
Reinforcement											1.310,78		2.492,55	57,05		
Concrete																43,287
Poer 4																
Formwork	146,16		0,73			238										
Work Floor															1,870	
Reinforcement											777,32		1.477,96	33,83		
Concrete																25,814
Tiebeam																
Formwork	6.849,02		34,25			11.130										
Work Floor															12,230	
Reinforcement								8.207,59			4.497,97		25.511,91	123,11		
Concrete																165,026
Stek Kolom dan Shearwall																
Column								199,19					7.140,77	2,99		
Shearwall									157,50		709,97			2,36		
Pitlift																
Reinforcement								243,91	369,35	509,83			1.295,25	9,20		
Formwork							95,58									
Concrete																8,252
Saluran Drainase																
Work Floor															4,875	
River Stone	5.712,00		22,68		46,20											
Formwork Plat							157,50									
Reinforcement Plat								728,76						10,93		
Concrete plat	4.522,17	7,49		7,91												
JUMLAH	**19.890,47**	**7,49**	**70,96**	**7,91**	**46,20**	**15.693,00**	**253,08**	**9.379,45**	**18.531,61**	**509,83**	**16.064,86**	**54.462,42**	**54.671,07**	**892,36**	**650,269**	**469,407**

Table 4.2 Reinforcing Steel Profile

Type	Diameter (mm)	Area (mm^2)	Long (m)	Volume (m^3)	Specific Weight (kg/m^3)	Weight (kg)
	a	$b = 3,14*(a/2)^2$	c	$d = b*c*10^6$	e	f = d * e
Ø10	10	78,50	12	0,000942	6165	5,81
Ø12	12	113,04	12	0,001356	6165	8,36
D13	13	132,67	12	0,001592	6165	9,81
D16	16	200,96	12	0,002412	6165	14,87
D19	19	283,39	12	0,003401	6165	20,96
D22	22	379,94	12	0,004559	6165	28,11

Table 4.3 DO Recapitulation and Stock Material

Material Type [1]	Material Purchase [2]	Material Stock [3]	Percentage of Residual Material [4] = [3] / [2]
PC Cement	20.300	350	2%
Concrete Sand	8,00	0,00	0%
Tide Sand	72,00	0,00	0%
Crushed Stone	8,00	0,00	0%
Split Stone	46,50	0,00	0%
Concrete Brick	15.755	0,00	0%
Multiplex	259,20	0,00	0%
Iron Ø10	9.408,04	0,00	0%
Iron Ø12	18.607,01	0,00	0%
Iron D13	687,02	147,22	21%
Iron D16	16.130,72	0,00	0%
Iron D19	54.571,43	0,00	0%
Iron D22	54.810,52	0,00	0%
Bendrat	930,00	0,00	0%
Concrete K-300	656,50	0,00	0%
Concrete K-375	473,50	0,00	0%

Source: DO and form bond material for the arrival of material for the podium foundation structure

Discussion

1. Residual Material Cost

   Example of calculation of PC Cement residual material:

   Material type = PC Cement
   Purchase of materials = 20.300.00 kg
   Material stock = 350.00 kg
   Material requirement = 19.890.47 kg
   Unit price = IDR 1.640 /kg

a. Calculating the quantity of the remaining material

   Residual Materials=Purchase of materials–Stock of materials–Material requirements
   = 20.300,00 – 350,00 – 19.890,47
   = 59,52 kg

b. Calculating the cost of waste materials

   Material waste cost = Material waste x Unit price
   = 59,52 x Rp 1.640
   = Rp 97.612,80

c. Calculating the percentage of residual material costs

   $$\text{Percentage of residual material cost} = \frac{\text{Material waste cost}}{\text{The total cost of the remaining materials}} \times 100\%$$

   $$= \frac{97.612,80}{19.591.992,34} \times 100\% = 0,50\%$$

d. Calculate the percentage of the total cost of the remaining materials to the total project cost

$$\text{Percentage of total waste material cost} = \frac{\text{The total cost of the remaining materials}}{\text{Total project cost}} \times 100\%$$

$$= \frac{19.591.992,34}{8.979.440.321,12} \times z100\% = 0,22\%$$

Table 4.4 Calculation of Residual Material Cost

Material Type [1]	Material Purchase [2]	Material Stock [3]	Material Needs [4]	Remaining Material [5]=[2]-[3]-[4]	Unit Price (Rp)[6]	Residual Material Cost (Rp) [7]=[5]*[6]	Percentage of Waste Material Cost to Total Waste Material Cost	Cumulative Percentage
PC Cement	20.300	350	19.890,48	59,52	1.640,00	97.612,80	0,50 %	0,50 %
Concrete Sand	8,00	0,00	7,49	0,51	289.255,00	147.520,05	0,75 %	1,25 %
Tide Sand	72,00	0,00	70,96	1,04	206.946,67	215.224,54	1,10 %	2,35 %
Broken Stone	8,00	0,00	7,91	0,09	283.305,28	25.497,48	0,13 %	2,48 %
Split Stone	46,50	0,00	46,20	0,30	265.738,33	79.721,50	0,41 %	2,89 %
Concrete Brick	15.755	0,00	15.691	64	2.293,35	146.774,40	0,75 %	3,64 %
Multiplex	259,20	0,00	253,08	6,12	67.610,42	413.775,77	2,11 %	5,75 %
Iron Ø10	9.408,04	0,00	9.379,45	28,59	6.300,00	180.117,00	0,92 %	6,67 %
Iron Ø12	18.607,01	0,00	18.531,61	75,40	6.300,00	475.020,00	2,42 %	9,09 %
Iron D13	687,02	147,22	509,83	29,97	6.300,00	188.811,00	0,96 %	10,06 %
Iron D16	16.130,72	0,00	16.064,85	65,87	6.300,00	414.981,00	2,12 %	12,17 %
Iron D19	54.571,43	0,00	54.462,42	109,02	6.300,00	686.826,00	3,51 %	15,68 %
Iron D22	54.810,52	0,00	54.671,07	139,46	6.300,00	878.598,00	4,48 %	20,16 %
Bendrat	930,00	0,00	892,37	37,63	21.165,00	796.438,95	4,07 %	24,23 %
Concrete K-300	656,50	0,00	650,27	6,23	1.408.530,75	8.775.146,57	44,79 %	69,03 %
Concrete K-375	473,50	0,00	469,41	4,09	1.484.089,80	6.069.927,28	30,98 %%	100 %
Total Cost of Residual Materials						19.591.992,34	100 %	
Total Cost of Construction Project Podium Structure Works for Ciputra World Surabaya Phase III						8.979.440.321,12		
Percentage of Residual Material to Total Cost of Podium Structure Construction Project for Ciputra World Surabaya Phase III						0,22 %		

Source: Results Of Data Processing

1. Material purchases are data recorded in the daily project report, namely the amount of material received every day during the project.
2. Material stock is data recorded in the logistics section, namely the last amount of material stored in the warehouse that can still be used.
3. Material requirements are data calculated from asbuilt drawings, namely the amount of material that should be used as a physical building.
4. Waste material is the amount of used material that is wasted that cannot be reused

Based on the results of the calculation of the remaining material costs, it can be seen that:

1. The largest percentage of residual material costs during project implementation came from K-300 steel material of 44.79%, valued at Rp. 8,775,146.57 and K375 iron concrete by 30.98%, valued at Rp. 6,069.927.28
2. The percentage of the total cost of the remaining materials to the total project cost is 0.22 %, worth Rp. 19,591,992.34.

Evaluation of Material Waste (Waste) Using Pareto Charts

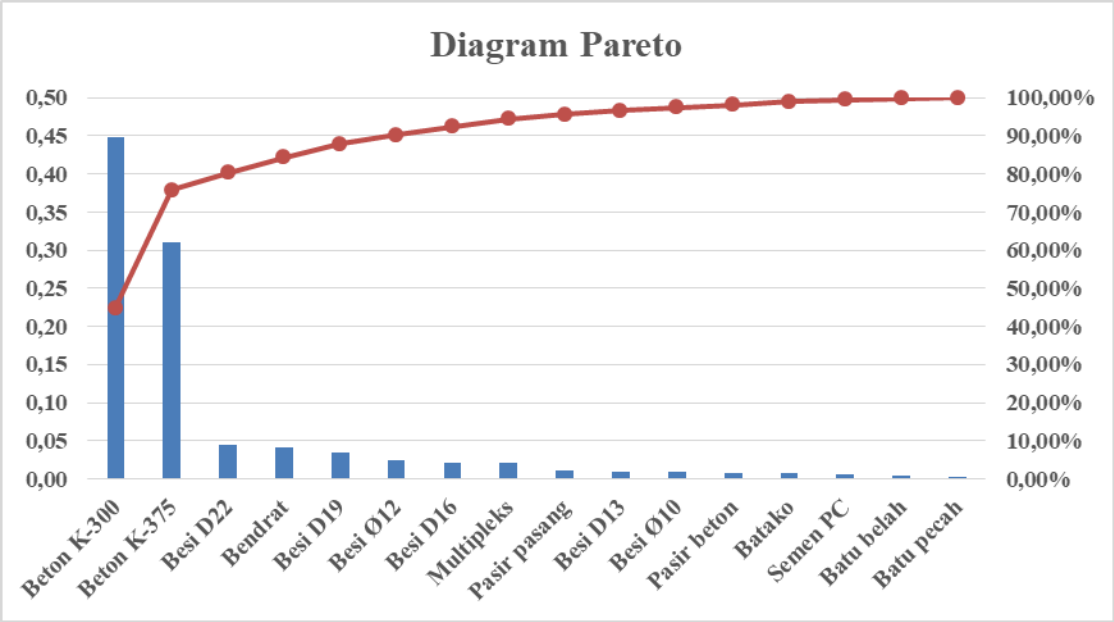

Figure 4.2. Pareto chart

In Figure 4.2, the right axis shows the cumulative percentage (percent cumulative), the left axis shows the percentage of residual material costs and the bottom axis is the type of material that causes material waste. The remaining dominant construction material is obtained by drawing a straight line on the 80% axis to cut the curve line, then the intersection point is pulled down. The remaining dominant material included in the Pareto Diagram is the value that is included in the cumulative 80%. The remaining dominant construction materials in this project are K300 steel and K375 steel.

The results of direct observations / analysis in the field are carried out and involve scheduler and planner, quality control, quantity surveyor, supervisor, site manager, project manager and project coordinator on the process flow / behavior in the field with a period of 14 days, then the data that has been collected is in the form of a table of materials and

factors. After the data is composited from the participants / expertise from each field, it can be seen the factors causing the emergence of waste material as follows:

Table 4.5 Factors Causing Residual Material (Waste)

No	Material	Factors Causing *Waste*	Factor
1	PC Cement	1. Scattered/mixed with soil 2. The rest of the plaster fell off 3. Manpower after the bond material is still in stock in the field, so it hardens 4. Mapping of material needs and foreman is not carried out	1. Inventory 2. Human 3. Human 4. Method
2	Sand	1. Scattered/mixed with the ground 2. Drifting away by the rain 3. The ratio measure with PC cement is not suitable (excess sand)	1. Material 2. Inventory 3. Measurement
3	Crushed Stone	1. Scattered/mixed with the ground 2. Drifting away in the rain	1. Inventory 2. Inventory
4	Split Stone	1. The size of the split stones varies 2. Stone fragments fall / scattered	1. Measurement 2. Equipment
5	Concrete Brick	1. Damaged/broken during transportation 2. Throwing materials 3. Field conditions do not match shop drawings (work floor)	1. Material 2. Equipment 3. Measurement
6	Multiplex	1. Sub-optimal cutting 2. Damaged due to tie road	1. Method 2. Equipment
7	Steel Bar	1. Cutting is not optimal 2. Supervisor does not monitor deductions from building foreman 3. The foreman does not follow the detailed standards set by the BBS (Bar Bending Schedule) 4. The supervisory consultant delegation makes requests outside the shop drawings	1. Equipment 2. Human 3. Human 4. Method
8	Bendrat	1. Excessive use by craftsmen	1. Human
9	Concrete Readymix	1. Scattered/mixed with the ground 2. The remaining concrete is still left on the mixer truck 3. The previous mixer truck already had concrete sediment that settles 4. PO (Purchase Order) exceeds (Purchase Requesting) in the field	1. Inventory 2. Measurement 3. Equipment 4. Method

The largest percentage of residual material costs during project implementation came from K-300 steel material of 44.79% and K375 iron concrete of 30.98%. The main causative factor comes from the rest of the concrete that is scattered/mixed with the soil and some is still left on the mixer truck. To reduce material waste that occurs, it takes a careful attitude when handling and using materials. The behavior of the workers is very influential on the emergence of residual material in the field. Workers need to be trained and guided so that they realize that the result of using incorrect materials can cause large amounts of waste material to reduce contractor profits.

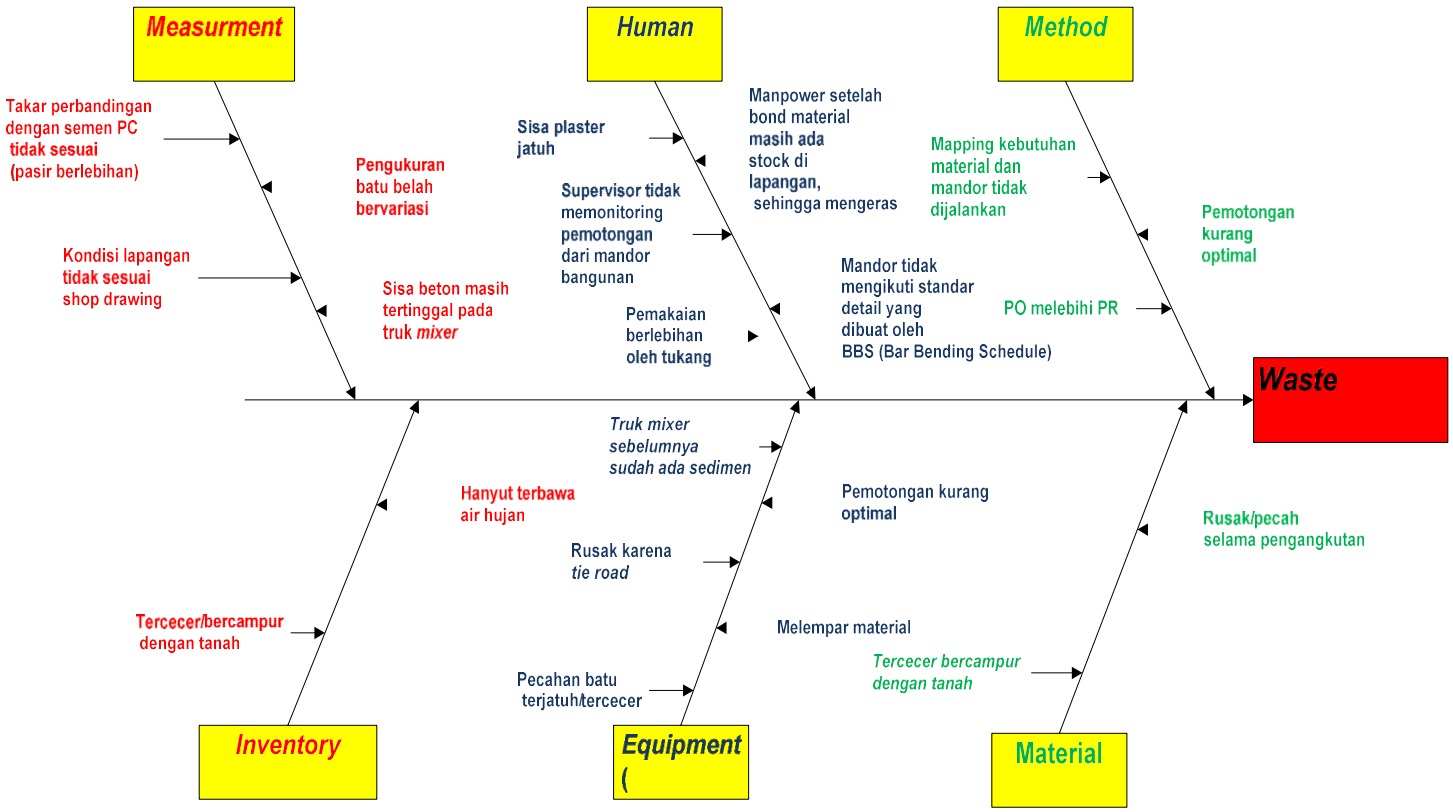

Figure 4.3. Fishbone Diagram

From figure 4.3. It can be seen that the factors causing the waste material are as follows:

1. Human factor
   a. The bricklayer throwing material
   b. The remaining readymix concrete is still left in the mixer truck
2. Method factor
   a. Excessive use of bendrat by craftsmen
   b. Cutting of multiplex and concrete iron is less than optimal
   c. Broken stone fell / scattered
   d. Sand, crushed stone washed away by the rain
3. Equipment factor
   Brick damaged/broken during transportation
4. Material factor
   a. The rest of the PC plaster fell off
   b. The size of the split stone varies
   c. PC cement, crushed stone, sand,
   d. Readymix concrete is scattered/mixed with soil

The ribs of the main problem were obtained from the results of 14 days of observation of the main problem, namely the remaining material, repeated error factors and not being aware of the major risk will be recorded as major category findings and some intermediate findings are minor and observation categories. Next, the participants gave brainstorming

proposals/solutions to the main problem and its causes, namely the rest of the material and its torso within a period of 120 minutes.

Actions taken by the project to date with respect to on-site waste have been ineffective as they have been limited to disposal after residual materials have emerged. The residue that still has value is sold to rescuers or used for future business, while the rest is stockpiled as waste material. Not only does the project have no commitment to waste disposal, there is no dedicated waste management department within the project contractor (Putra et al, 2018).

Efforts that must be made by the project party on residual material are preventive and minimization measures (reduce) which include 3 actions which are ranked as follows:

1. Optimization of the use of materials.
   Optimization of the use of materials can be realized by calculating the material requirements as accurately as possible according to the application plan based on the contractor and intensive and scheduled supervision during the job application.
2. Selection of effective and efficient construction methods.
   The choice of a synchronous construction method using the type of work can minimize the emergence of residual material in the field.
3. Improved forecasting and ordering accuracy.
   Estimating material requirements for each type of work and choosing the right time to place an order for materials will be able to minimize the generation of residual material in the field.

These three activities require project support, namely implementing contractors, to implement effective and sustainable measures. One of them is the establishment of a special unit for waste minimization or management in contract company organizations. A special department that periodically monitors or tracks the materials used in the work to design, plan, estimate or calculate the material requirements for each type of work, taking into account the waste materials that will occur, and taking effective actions to manage them.

The model for adding a Department to the organizational structure of a contractor company is as follows:

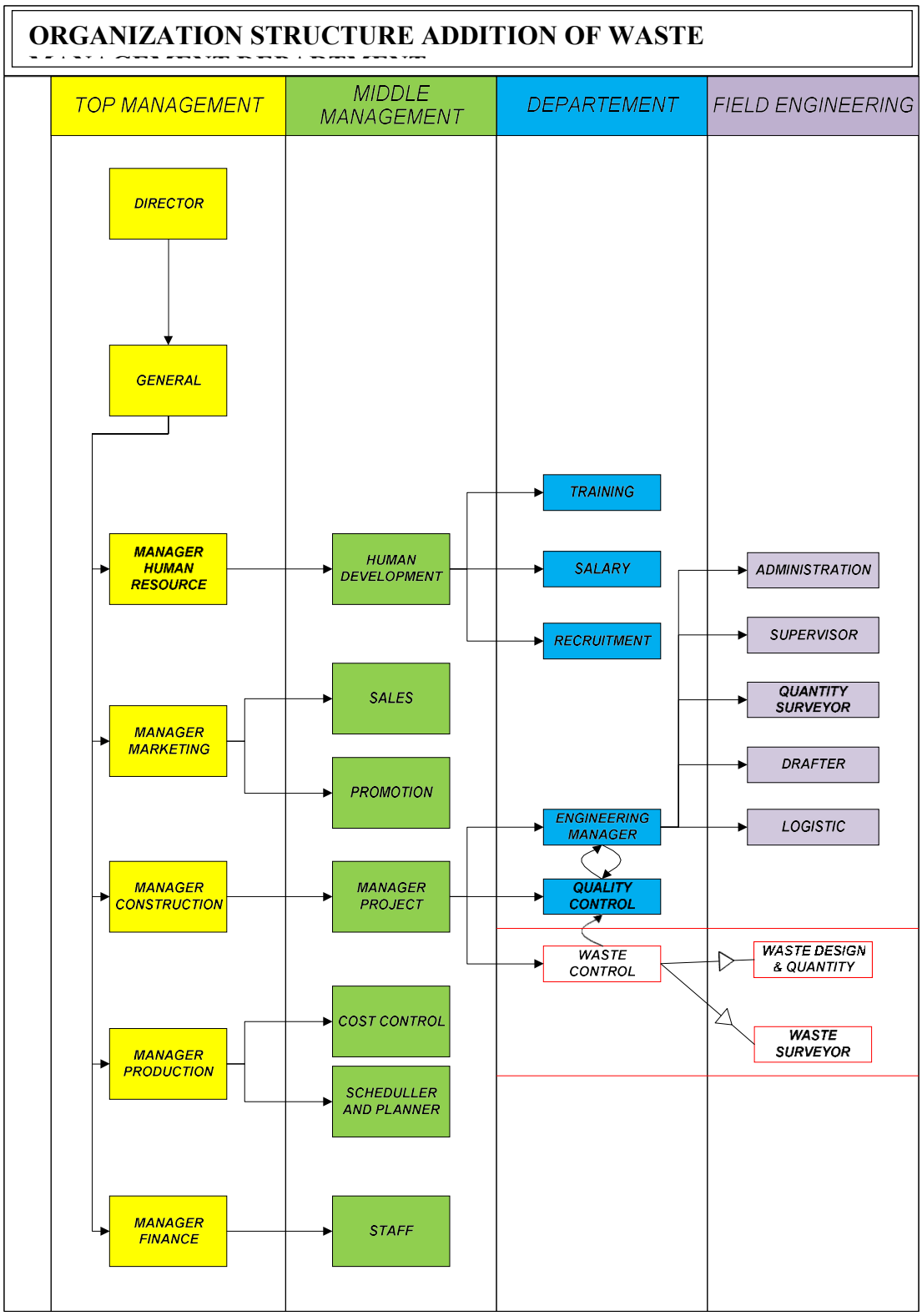

Figure 4.4. Contractor Company Organizational Structure and Additional Design of Waste Control Department

In Figure 4.4 the location of the Department of waste management according to the site manager and quality control. In fulfilling its responsibilities, waste management must always work closely with the site manager and QC to ensure that the waste management department does not deviate significantly from the site manager and QC work program. The waste management department is responsible for waste planning. Responsibilities include:

1. Prepare materials for planning and developing material requirements.
2. Make weekly and monthly schedules for ordering and using materials based on work schedules.
3. Planning work methods/implementation systems with site managers.
4. Find and cooperate with waste disposal companies.

The following is the job description for Waste Design and Quantity:

1. Estimate the detailed design, planning, and material requirements of the materials prepared by Waste Control.
2. Create a plan to deal with the material waste generated by each operation.
3. Develop detailed working methods for applying calculations and estimates.
4. Make weekly and monthly schedules for ordering and using materials according to the work contract schedule.

The Waste Surveyor has the following duties:

1. Carry out the design, planning and estimation that has been designed.
2. Controlling work methods according to what has been planned.
3. Implementation is monitored and checked periodically.
4. Management of warehouse materials.
5. Order management and material availability.
6. Recalculate the residual material generated after the implementation of the work and sort out the remaining material that can still be used from the waste.

In the waste management section, adjustments need to be made during operation to maximize work performance and not be too deviant and in accordance with the content developed. The line of interdepartmental coordination shown in Figure 4.4 shows the organizational structure of the design contractor with the addition of a waste management office.

The forms of approval that need to be done are as follows:

1. Waste management and local managers jointly determine work methods/systems to minimize the generation of material waste.
2. Waste management is coordinated with quality control at each operation so that the application of the developed work method does not deviate and does not reduce the quality of materials and operations.
3. Waste management always adjusts and monitors the design and quantity of waste, as well as checks inspectors to ensure compliance with the concepts and designs developed.
4. The Design and Quantity Inspector and Waste Quantity will conduct a joint assessment of the work methods and material requirements developed by the Waste Management Manager and Site Manager.

5. Design drawings for design implementation and quantity of waste confirmed to shipper so that the planned contents can be displayed on factory drawings as reference data when working on site.
6. Regarding the material requirements for each job, the waste inspector coordinates the work with the designer and quantity, quantity inspector and local contractor during the work.
7. To ensure that waste-related planning and assessment is carried out efficiently and effectively, waste inspectors and site implementers carry out joint supervision and control at the site during the project period.
8. The waste inspector coordinates with the logistics department regarding ordering and availability of materials on site.

The addition of a special department for waste material management is expected to have a more positive impact on the implementation of construction projects. Since this special unit will focus on efforts to efficiently manage waste, the optimal use of materials will have a good impact on project costs and minimizing the amount of waste will have a good impact on the environment. The project manager also believes that the existence of this specialized department allows green building considerations and trends to be applied to almost any construction project.

The process flow implemented by the contractor in the Ciputra World Surabaya Project Phase III (Figure 4.1) with evidence of value added that is still not controlled by the process after observing/analyzing the calculations by the author, and from the results of the focus group discussions with expertise in each project field (example: scheduler and planner, quality control, quantity surveyor, supervisor, site manager, project manager and project coordinator) who are empirically very good in the field, so that if described in terms of the goal of mapping to be as follows:

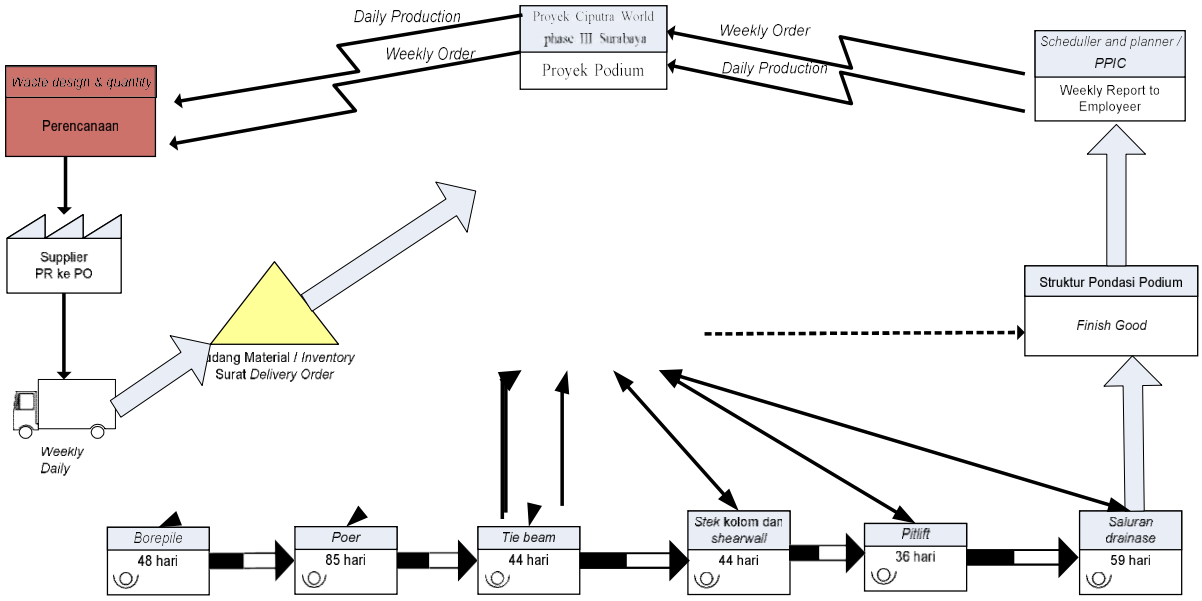

Figure 4.5. The Results of The FGD (Focus Group Discussion), Based On The Mitigation of The Remaining Material In The Field, After Brainstorming The Expertise In Each Field.

After evaluating the basement podium segment, the site project provides a proposal to the middle management for approval and top management to find out. The middle management party who conducts a review / review of proposals from the site project is the QSM (quality system management) department, if approved, it will be implemented in the next project, because if it is implemented in the Ciputra World Surabaya project, it will clearly increase the expenditure of the project budget plan, while in planning Initially there was no expenditure for the waste control department.

6. CONCLUSIONS

Based on the objectives and discussion of the evaluation of the residual material in the Ciputra World Phase III Surabaya project, it can be concluded that:

1. During project implementation, the largest proportion of the cost of residual materials fell from 44.79% K375 reinforced concrete or 30.98% K300 reinforced concrete.
2. The ratio of the total remaining material costs to the total project costs is 0.22%.
3. The main factor causing the residue is the rest of the concrete that is scattered or mixed with the soil, some of which is still left in the mixer truck. Other factors include: Builder throwing bricks, Builder using too much bending speed, Cutting paths in multiplex and concrete iron, falling/spilled crushed stone, sand, crushed stone exposed to rain, broken/broken bricks in transit, residue PC plaster, crushed stone of various sizes, PC cement, crushed stone, sand, ready-mixed scattered/mixed concrete.

Efforts proposed to the project to prevent and minimize (reduce) waste material are to establish a special Department, namely the Waste Control Department, which is in charge of the waste material planning and operational control, whose duties are as follows:

1. Prepare materials for planning and developing material requirements.
2. Make weekly and monthly schedules for ordering and using materials based on work schedules.
3. Planning work methods/implementation systems with site managers.
4. Find and cooperate with waste disposal companies.

The following is the job description for Waste Design and Quantity:

1. Estimate the detailed design, planning, and material requirements of the materials prepared by Waste Control.
2. Create a plan to deal with the material waste generated by each operation.
3. Develop detailed working methods for applying calculations and estimates.
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The Waste Surveyor has the following duties:

1. Carry out the design, planning and estimation that has been designed.
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3. Implementation is monitored and checked periodically.
4. Management of warehouse materials.
5. Order management and material availability
6. Recalculate the residual material generated after the execution of the work and sort out the remaining material that can still be used from the waste material

The addition of a special department for waste material management is expected to have a more positive impact on the implementation of construction projects. Since this special unit will focus on efforts to efficiently manage waste, the optimal use of materials will have a good

impact on project costs and minimizing the amount of waste will have a good impact on the environment. The project manager also believes that the existence of this specialized department allows green building considerations and trends to be applied to almost any construction project.

Based on the conclusions, it can be suggested to the project party to prevent and minimize (reduce) residual material including the following three actions:

1. Optimization of the use of materials.
   Optimization of the use of materials can be realized by calculating the material requirements as accurately as possible according to the application plan based on the contractor and intensive and scheduled supervision during the job application.
2. Selection of effective and efficient construction methods
   The choice of a synchronous construction method using the type of work can minimize the emergence of residual material in the field.
3. Improved forecasting and ordering accuracy.
   Estimating material requirements for each type of work and choosing the right time to place an order for materials will be able to reduce the incidence of residual material in the field

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ANALYZE ON FACTORS INFLUENCE EMPLOYEE LOYALITY IN PT XYZ

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ABSTRACT

PT. XYZ is a wall and floor ceramic tile manufacturing industry that applies advanced technology in its operational processes. This factory is one of the best factories in Indonesia yet also in Asia. This evaluation is to find solutions to problems that occur, where employees are company assets whom must be well maintained. Based on the outcomes of a literature review, there are many factors that cause employee rate of resignation, some of which are career paths, family, entrepreneurship, and the environment. This research identifies the influence of these factors on worker loyalty PT. XYZ. The method used is a quantitative approach where data is obtained by distributing online questionnaires to employees of PT. XYZ. This research involved 202 respondents from active employees who are still actively working there. Then data is analyzed using SEM - PLS (Structural Equation Modeling - Partial Least Square). Based on the outcomes of the SEM analysis, all variables have a remarkable effective impact on worker loyalty at PT.XYZ. The most dominant factor is the career path variable. The benefits of the research outcomes can be input for manufacturing industry companies, especially in the ceramics field.

Keywords: Worker Loyalty, Ceramic Industry, SEM – PLS.

1. INTRODUCTION

One of the most important factors in a company is Human Resource. why? Since Human Resource plays an important role for a company to achieve its goals and objectives. In an effort to realize this goal, the role of HR will continue to be optimized to be able to improve its performance for the sake of the continuity of the organization or company. In this era of globalization, companies really need competent and qualified human resources. Workers the main are human resources in organizations who are not only required to be able to carry out their duties well, but also are expected to have loyalty, and concern for the company in the future and always support the company to achieve its goals.

In the last five years, 50% of the *resigned* employees already have *skills* which are sufficient for their expertise. They came from several departments (laboratory, mechanic, electricity, and production). It takes more time to create or nurture new employees to replace the task of the resigned employees to have expected skills. Employee loyalty has the nature of dyadic communication, the participants of which are employers and employees, who are involved in this professional and hierarchical relationship, and must realize the importance and benefits of loyalty situations (Ineson et al., 2013). Worker commitment to the when a worker commits to the company, they will snow it

by means of loyalty and dedication itself. An employee who has an attitude of loyalty in whatever aspect he gets will work seriously and responsibly in carrying out his work (Oktavianda, 2018). The commitment is based on the environment, where a comfortable one will make an employee always put their best effort. A conducive environment could make an employee work at their best and also work effectively. Companies should apply a career development or career path to establish employee positions that will fit them, and hopefully match with their education, skills and expertise. Family is *a supporting system* that is important in the work, if the family fully supports the employees to work at the company, it will make the workers work hard for his family. Employee loyalty is a form of worker dedication for the company, therefore this research is to determine the most dominant factors that affect employee loyalty. These factors are career path, entrepreneurship, family, and environment.

2. LITERATURE REVIEW

2.1 Employee Loyalty

Employee loyalty is the capacity and willingness to dedicate to the company in a long term. Usually, it is based on the reality that representative dedication can be measured by the sum of time of working for a company or organization (Khuong & Tien, 2013). Dependability is dedication by the eagerness of representatives to preserve and guard the organization interior and exterior of work from the conversation of unreliable individuals (Oktavianda, 2018). Therefore, loyalty plays an important role in an organization. And it is very important to always improve the quality of an organization. An employee as an individual, has several factors that might bring loyalty to the company. Those factors include: Obedience to regulations, responsibility to the company, willingness to work together, sense of belonging, liking for work (Safitri, 2015).

2.2 Career Development

Good career development in order to develop one's career must be done to reach a higher level so that the sense of responsibility for employee will be greater in the future (Purnamasari & Sintaasih, 2019). If an employee who wants to develop their careers must look for the right career opportunities according to their *passions* and needs for the company, if they feel that what company provides to them are still inadequate, employee will usually look for other places that meet their *passions* to develop their careers.

2.3 Environment

The work environment is a physical life and social psychology that affects the work of employee in carrying out their duties in the company (Fajarullaili, 2018). The other factors that affect the environment are lighting, air temperature, air circulation, quietness of the room, work security, and equipment at work.

2.4 Partial Least Square Equation Modeling (PLS – SEM)

Partial Least Square is known as one of the variance-based SEM factual strategies that is outlined to illuminate different relapse when particular issues happen within the information such as the inquire about test measure. Concurring Ghozali (2016) Basic Condition Modeling or SEM for social science analysts give the capacity to perform way investigation (way) with inactive factors. The SEM method is used when researchers carry out three activities at once, namely: (1) checking the level of validity and reliability of a data, (2) conducting tests to determine the relationship between the influence of latent variables and other latent variables (path analysis), and (3) predicting a good model. The SEM method is a combination of simultaneous equation models

between latent variables. According to Joreskog (1973) in Ghozali (2016) the general model of structural equations consists of two parts, namely:

1. Outer Model

The measurement model is a technique to measure the relationship between the observed indicator towards a latent indicator (unobserved) which cannot be directly measured unless it is measured by dimension or variable. To connect observed or the manifest of variable to latent variable through confirmatory model, the test of the significance towards the variable measurement is called Confirmatory Factor Analysis (CFA).

Table 1. Testing Outer Model

Validity and Reliability	**Criteria**	***Rule of Thumb***
Convergent Validity	*Loading Factor*	0.7 *confirmatory research*
	Average Variance Extracted (AVE)	*Confirmatory research* must be > 0.5
	Communalty	0.7 *confirmatory research*
Discriminant Validity	*Cross Loading*	The value of each variable must be above 0.7
	AVE and correlation between latent constructs	• AVE > correlation between latent constructs • *Confirmatory research* must be > 0.7
Reliability	*Conbrach's Alpha*	• *Confirmatory research* must be > 0.7
	Composite Reliability	• *Confirmatory research* must be > 0.7

2. Inner Model

Structural model is a simultaneous regression model or structural equation composed of several constructs or variables. Among them are exogenous, *intervening, moderating*, and endogenous which link the latent variables through the system in simultaneous equations. The structural model was evaluated using R- *Square* for the dependent construct, t-test, and the significance of the coefficients of the structural path parameters.

Table 2. Inner Model

Criteria	***Rule of Thumb***
R - Square	0.75, 0.50, and 0.25 represent strong, medium and weak models
Impact Size (f^2)	0.02, 0.15, and 0.35 indicate weak, medium, and large impacts
Predictive relevance (Q^2)	• > 0 indicates the model has *predictive relevance*. • < 0 indicates the model lacks *predictive relevance*.
Significance (*one tailed*)	*The t-values of* 1.28, 1.65 and 2.33 indicate the *significance levels* of 10%, 5%, and 1%, respectively.

3. METHODS

To determinate the number of samples, it is based on the number of variables in the study, where the number of samples can be accepted based on the number of variables using a ratio of 10:1 (Hair et al., 1998). The minimum sample required if the variable is below 5 is 100 samples. There are 4 variables in this research, and they meet the requirements of the range of minimum sample. In this research, researchers used 202 sample from employees who are still active working at PT. XYZ, by using the 5% significance level. The model used in this research will be as follows.

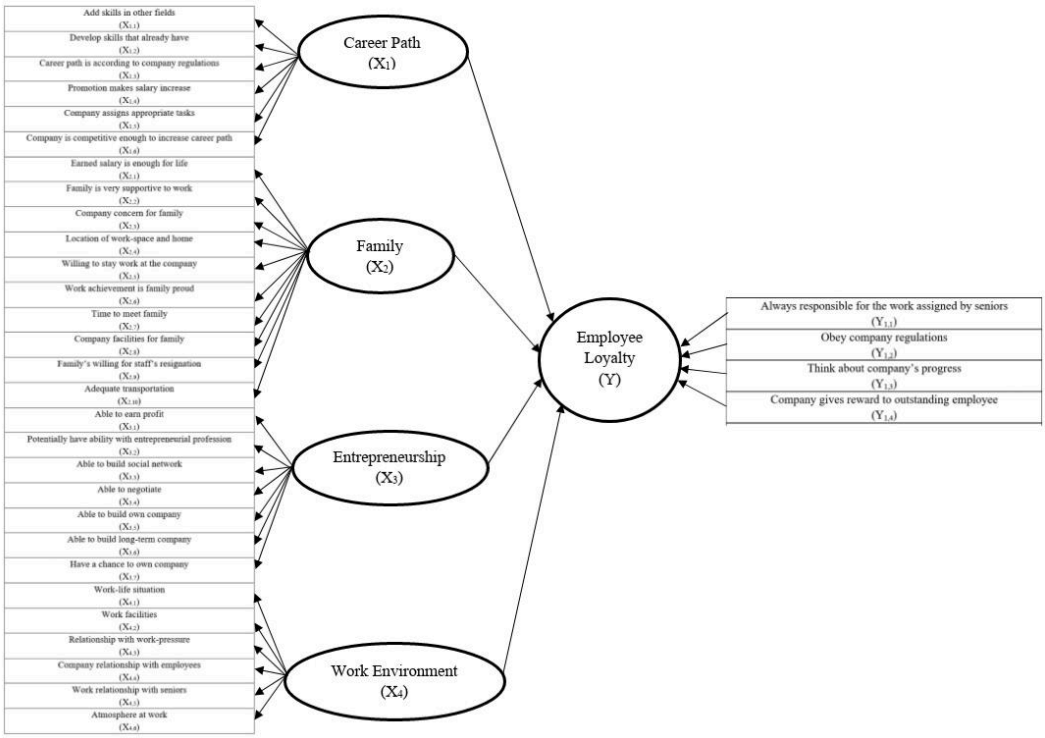

Figure 1. Research Path Diagram

The technique in the sampling process uses stratified random sampling with a proportional sampling approach. This sampling was done by distributing questionnaires based on five Likert

scales. The technique in the sampling process used stratified random sampling with a proportional sampling approach.

Table 3. Likert Scale Estimation

Mark	Estimation Scale		Explanation
	Criteria	Code	
5	Strongly agree	SS	Respondents strongly agree with the statement because it is in accordance with the perceived situation
4	Agree	S	Respondents consider the statement to be in accordance with the situation they feel
3	Neutral	N	Respondents assume that the statement does not know how he or she behaves, so it is possible that the "don't know" option facilitates the respondent's confusion about the statement
2	Do not agree	TS	Respondents consider the statement does not match the situation they feel
1	Strongly Disagree	STS	Respondents strongly disagree with the statement because it is not in accordance with the circumstances felt by the respondent

4. OUTCOMES

4.1. Outer Model

The reliability test in this research was carried out by assessing the outcomes of the Composite Reliability value for each construct. If the value shows the outcome > 0.70 then the model being tested is reliable. Table 4 below is the outcome of the reliability test of the estimation model:

Table 4. Estimation Model Reliability Test Outcomes

	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)	Description
LK	0.873	0.875	0.904	0.612	Reliable
L	0.897	0.901	0.924	0.709	Reliable
K_	0.902	0.905	0.921	0.593	Reliable
KW	0.942	0.945	0.953	0.717	Reliable
JK	0.823	0.83	0.876	0.587	Reliable

4.2 Inner Model

After the model has met the valid and reliable requirements, the next step in this research is the evaluation of the structural model or the inner model. The inner model test is done by predicting the relationship between the independent variable and the dependent variable.

4.2.1 *Coefficient of Determination (R^2)*

The first stage of testing in testing the inner model is to determine the R- Square value or coefficient of determination. This value is used to see how much predictive power the dependent variable has on the independent variable and can be seen in Table 5.

Table 5. R-Square Test Outcomes

Variable	Original Sample (O)	Description
Employee Loyalty	0.674	Moderate / Medium

4.2.2 Impact Size (f^2)

Impact size or f-square is used to assess the magnitude of the independent influence on the dependent variable of the research model. The values of 0.02, 0.15, and 0.35 indicate that the predictors of latent variables have small, medium and large impacts on the structural model of the study, which can be seen in Table 6.

Table 6. F-square test outcomes

Variable Relationship	Original Sample (O)	Description
Career Path > Employee Loyalty	0.327	Big Impact
Entrepreneurship > Employee Loyalty	0.052	Weak Impact
Family > Employee Loyalty	0.032	Weak Impact
Environment > Employee Loyalty	0.063	Weak Impact

4.2.3 Path Coefficient

Path Coefficient estimation is done by testing the bootstrapping calculation using SmartPLS through a two-tailed test type, it can be seen in Table 7

.

Table 7. Path Coefficient. test outcomes

Description	Path Coefficient	T Statistics	P Values
Career Path -> Employee Loyalty	0.505	6.037	0
Entrepreneurship -> Employee Loyalty	0.146	3.137	0.002
Family-> Employee Loyalty	0.128	2.22	0.026
Environment -> Employee Loyalty	0.204	3.09	0.002

5. OUTCOME AND DISCUSSION

The model testing in this research is based on the TPB model with 4 main constructs, namely Career Path, Entrepreneurship, Family, and Environment. The following is the research model using SEM-PLS in Figure 2.

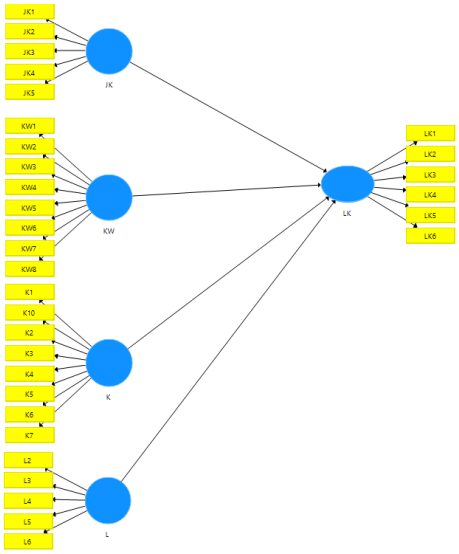

Figure 2. Structural Model of Research

The outcomes of *path analysis* using 4 tested hypotheses, all hypotheses are accepted. As has been explained in Table 4.13 that the hypothesis test is accepted if the value of *p-value* <0.05 and *t-statistic* > 1.96, therefore all the variables used in this research affect employee loyalty at PT. XYZ.

5.1 Hypothesis 1: Career Path has a remarkable effective impact on Employee Loyalty

The outcomes of hypothesis test 1 in this research, can be boldly concluded that career way features an effective impact on specialist dependability. Investigation that was conducted by Yuliyanti et al., (2020) Yuliyanti et al., (2020) also shows that career advancement contains an effective and noteworthy impact on work fulfillment which causes loyalty to the company.

5.2 Hypothesis 2: Entrepreneurship has a remarkable effective impact on Employee Loyalty

The outcomes of the hypothesis test 2 in this research concluded that entrepreneurship has an effective impact on employee loyalty. Research according to Hasanah et al., (2019) that Entrepreneurship has an effective impact too, because a company's competitive advantage is generated from its unique resources which are entrepreneurial competencies.

5.3 Hypothesis 3: Family has a remarkable effective impact on Employee Loyalty

The outcomes of the hypothesis test 3 in this research concluded that the family had an effective impact on worker loyalty. In accordance with the outcomes conducted by Aslam et al., (2011) which showed that there was a consistent effective relationship between long working hours, workload, and work-family conflict.

5.4 Hypothesis 4: Environment has a remarkable effective impact on Employee Loyalty

The work environment is a condition or place where a person carries out his duties and obligations and can influence employee in carrying out the assigned tasks (Martono, 2016). A study states that the work environment has an effective impact on employee productivity, meaning that the better the quality and comfortable work environment for employee, the higher their productivity would be.

6. CONCLUSIONS

This research is based on 202 respondent data from active employee at PT. XYZ for all divisions in the company. The outcomes of the analysis of the quantitative test, namely the *Structural Equation Modeling* (SEM) test, showed that factors such as Career Path, Family, Entrepreneurship, and Environment had a remarkable effective impact on Employee Loyalty at PT. XYZ. The outcomes obtained that Career Path, Family, Entrepreneurship, and Environment indeed affect worker loyalty. This is evident from the hypothesis, that the four hypotheses show a remarkable effective value. The most dominant variable influencing employee loyalty is the career path, but that does not mean that other variables are less influential. Career path is a factor that makes employee loyal or loyal to work in the company so that employee feel that working in the company makes their careers good according to the *skills* they have, then all of these variables have the potential for employee loyalty to the company.

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THE EFFECT OF FEELING SAFETY ON WORKER PERFORMANCE IN CONSTRUCTION SITES DURING THE COVID-19 PANDEMIC

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ABSTRACT

Since the emergence of Covid-19 at the end of 2019 it has infected millions of the world's populations, this situation has made many changes in people's lives both from an economic and social perspective. The construction industry, which is an important industry in the economy, is included in a critical sector, where workers are required to work 100%, This condition creates a sense of concern not only for the company but also for the workers. This research is quantitative research that uses Partial Least Square – Structural Equation Modeling (PLS-SEM) method. Data were obtained through questionnaires given to respondents, namely Labuan Bajo Multipurpose Pier construction workers. The results of this study indicate that all variables are valid and reliable with R^2 of 11.4%, 54.9% and 62.2% respectively and this model can explain the total coefficient of determination (Q^2) of 85.8%. It is found that a sense of feeling safety does not directly affect Performance, but it has an indirect effect on Performance through mediating variables of work skills and job satisfaction, where job satisfaction and work skills also have a direct effect on Performance, thus job satisfaction and job skills need to be increased in workers at construction sites.

Keywords: PLS-SEM, Performance, Satisfaction, Skills, Construction, Pandemic

1. INTRODUCTION

The beginning of the emergence of COVID-19 at the end of 2019 in Wuhan, China. Covid 19 spread very quickly to various parts of the world, where it only took 3 months to infect 10.2 million people in the world since the first case was reported (Nugroho, 2020). The prolonged Covid-19 pandemic has had an impact on various sectors of people's lives, both economically and socially. To break the chain of the Covid-19 virus, the Government has implemented many policies, one of which is the policy of implementing restrictions on community activities (PPKM). To minimize the impact of increased cases and more severe economic contractions, referring to the rules of the COVID-19 task force, economic activities are divided into three sectors, namely the non-essential sector with the implementation of 100% Work from home (WFH), the essential sector with the application of a maximum of 50 % Work from office (WFO) and Critical Sector with strict health protocols implement 100% Work from home (WFH).

According to data from the Central Statistics Agency (BPS) the Construction sector contributes 9.9% -the fourth largest - to Gross Domestic Product (GDP). so that the construction sector is no doubt included as a critical sector category with the implementation of 100% Work from home (WFH) along with other critical sectors, namely energy, health, security, logistics and transportation, food, beverage and supporting industries, petrochemicals, cement, national vital

objects. According to the Hierarchy of Needs Theory by Maslow (1954) there are 5 needs that must be met by humans, where the need for psychology and security are basic human needs. So that the implementation of 100% WFO for critical sectors at a time when the pandemic rate is getting higher and the threat of mutation of new variants of Covid-19 which is confirmed to be more virulent can disrupt the need for a sense of feeling safety for critical sector workers.

The existence of unexpected conditions such as the Covid-19 pandemic which lasted for quite a long time, even according to a survey conducted by Phillips, (2021) found that almost 90% of respondents consisting of immunologists, virologists, and health experts stated that Covid-19 could not be destroyed. making the above phenomena need to be studied further, especially in research on worker Performance, as theoretical and practical learning both now and in the future.

2. LITERATURE REVIEW

2.1. Feeling Safety

Hashiguchi et al., (2020) describes the feeling safety at work as a form of worker's perception of the feeling of security obtained at work. This sense of Feeling safety is related to the safety factor against stress at work or feelings of security from the psychological and physical aspects of dissatisfaction that may be experienced by workers in general. A sense of feeling safety is the existence of an individual's self-awareness in having a sense of care and affection, as well as acceptance (Maslow, 1954). He also divides security into two branches, namely physical and psychological security, according to Feist & Heist, (1976) physical security is related to dependence, stability, protection and freedom from bodily threats such as crime, riots, danger, fear, anxiety, and so on, while psychological security relates to human actions, namely good social and intrapersonal treatment, such as a good social environment and good social communication relationships at work.

2.2. Work Ability

Spreitzer (1995) in Dewettinck & Buyens, (2014) also revealed that there are 4 characteristics that must be possessed by individuals so that they can improve their abilities, namely as follows:

a) Sense of meaning is the value of the purpose of a money job seen from the relationship to individual standards or ideals.
b) Sense of Competence is an individual's belief in the ability they have in carrying out daily activities in their work. expertise possessed.
c) Sense of Self-determination is a feeling of being able to have a choice in making choices when doing work.
d) Sense of Impact is the degree to which a person can influence the results in work both in administrative, strategic, and operational.

2.3. Job Satisfaction

Review Job satisfaction is a complex and diverse concept that has different meanings according to different authors. Job satisfaction is usually related to motivation but is not the same as motivation and may be related to feelings of personal achievement (Mullins, 2005). From the explanation above, the source of worker satisfaction with a job can be concluded into 3 important things, namely the work environment, work facilities and incentives. According to (Sedarmayanti, 2009) the work environment is a series of facilities that will be faced in work activities including equipment, where a person can work well as an individual or an organization with predetermined work methods and arrangements. On the other hand, work facilities are supporting facilities in

physical work, which will later be able to support operational needs in work, so that work can be completed within the specified time (Lupiyoadi & Hamdani, 2006).

2.4. Work Performance

Quoting from Lengkong et al., (2019) Performance is the accumulation of three elements that are closely related to each other, namely skills, efforts, and external conditions. According to Sedarmayanti, (2009) the Performance of a job has the following indicators:

a) Quantity, measured from the perception of workers in the number of activities carried out in the company's tasks. Quality, measured by workers' perceptions of the quality of a job that has been produced, through the perfection of the company's tasks and on the skills and abilities of workers.
b) Punctuality, measured from the perception of workers in an activity that is completed from the beginning of the work to completion into a work output, where he can complete the work at the time determined by the company to maximize the remaining time for other activities.
c) Effectiveness is the maximum monitoring of the time and resources available in a company, to reduce company losses and increase profits.
d) Attendance is the frequency with which employees come to work in a company, where their presence will contribute more to the company.

2.5. Structural Equation Modelling – Partial Least Squares (SEM-PLS)

Structural Equation Modeling (SEM) is a statistical analysis method that can be used to build and test statistical models in a causal format. Basically, SEM modeling has a model that is almost like multiple regression, but the modeling is stronger. Because it uses an interactive, non-linear, correlation of independent variables, and error disturbances. In PLS-SEM Hair et al., (2013) explained that the outer model of the equation of the measurement model/outer model can be written in equation 2.3 for exogenous latent constructs and equation 2.4 for endogenous latent constructs.

Konstruk laten exogen (X):

$$x = \lambda_x \xi + \delta \quad (2.1)$$

Konstruk laten endogen (Y):

$$y = \lambda_x \eta + \varepsilon \quad (2.2)$$

The analysis on PLS-SEM consists of two models. namely, the measurement model (Measurement model), this model is often called the Outer Model, shows how an observed variable explains the latent variable to be measured and the Structural Model, often called the Inner Model, shows the power of estimation between construct/latent variables. The latent variables in PLS-SEM can be formative or reflective, without a minimum suggested sample size. Where in general the model is assumed to have a causal relationship between the observed variables as indicators with latent variables.

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2.6. Research position

Performance indicators according to PMI, (2018) include Motivation, Ability and Environment, previously research that discussed indicators both individually and the intersection between the two on worker performance had been carried out by many previous researchers..

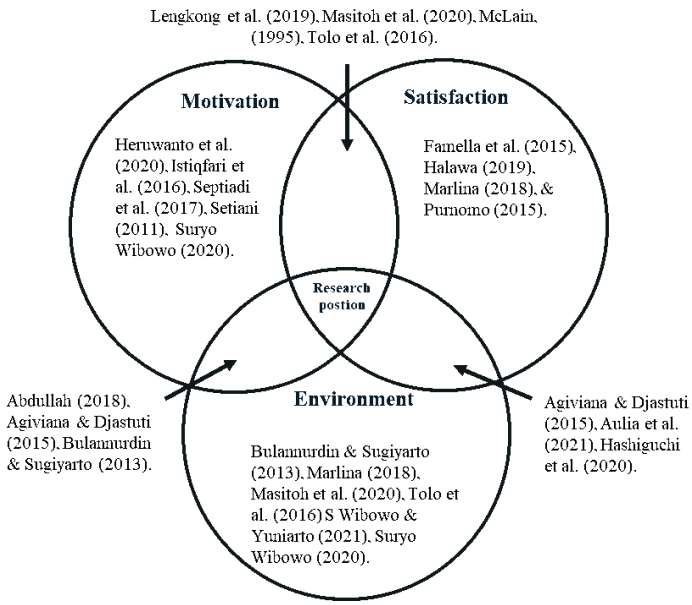

Figure 1.1 Research position

3. METHODS

3.1. Data type

In this study, the data used consisted of two data, namely primary and secondary data.

a) Primary Data
   Data from researchers obtained from first-party sources, namely filling out questionnaires by workers at the Labuan Bajo Multipurpose Pier construction work
b) Secondary Data
   Secondary data is obtained from a second party through articles, journals, books and can also be in the form of official reports

3.2. Population & sample

By maximizing the number of samples, it is assumed that the number of probabilities that have good and bad Performance is balanced (p=0.5 and q=0.5) in equation 3.1. Then the following is the calculation obtained using a significance level of 5%. (Scheaffer et al., 2011).

$$ni = \frac{\mathbf{N}i}{\mathbf{N}} x\ n \qquad (3.1)$$

which $D = \frac{B^2}{4}$ dan $q = 1 - p$

$$n = \frac{(218)(0,5)(0,5)}{(218-1)\frac{0,1^2}{4} + (0,5)(0,5)} = 68.77 \approx 69$$

Where:
n= Sample required
p= Probability of workers who have good Performance
B= Estimation error limit
N= Total population

From the number of calculations above, the total research population is 218 people, so the minimum sample that the researcher must obtain is 69 people.

3. Hypothesis

In this study, each factor has an indicator that is used to measure the respondent's perception. The work skills factor consists of 4 indicators, namely sense of meaning, sense of competence, sense of determination and sense of impact, while the work ability factor consists of environment, facilities, and incentives, which can be seen as follows:

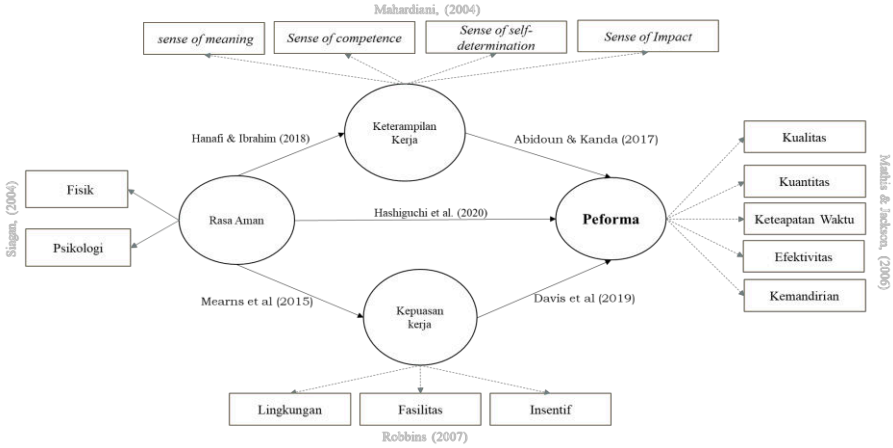

Figure 3.1 Research Construct Model on Worker Performance

Based on the proposed research model, the research hypothesis is compiled as follows:

H_1 : A sense of feeling safety has a positive effect on the Performance of workers in the workplace.
H_2 : A sense of feeling safety has a positive effect on job skills.
H_3 : Work skills have a positive effect on worker Performance
H_4 : A sense of feeling safety has a positive effect on worker Performance mediated by job skills.
H_5 : Safety has a positive effect on job satisfaction
H_6 : Job satisfaction has a positive effect on worker Performance.
H_7 : A sense of feeling safety has a positive effect on worker Performance mediated by job satisfaction.

4. RESULTS

4. 1 Outer Model

In this test, where the loading factor value will be used to see if there may still be some indicators that may not be significant to the variable, so that the expected output can be eliminated later for analysis at a later stage. In the early stages of research, the development of the loading factor value scale is considered sufficient if it exceeds a minimum of 0.5. This is done repeatedly until the best results are obtained where all variables have a loading factor value above 0.5 and pass the reliability test. After repeated iterations by removing invalid variables one by one with the smallest loading factor value, the following results are obtained:

Table 4.1 Test the final validity of the measurement model

Dimension	Indicator	*loading factor*	Dimension	Indicator	*loading factor*
Feeling safety	$X_{1.1}$	0.869	Job Skill	$Y_{1.1}$	0.802
	$X_{1.2}$	0.863		$Y_{1.6}$	0.784
	$X_{1.3}$	0.802		$Y_{1.7}$	0.755
	$X_{1.6}$	0.610		$Y_{1.8}$	0.789

Job satisfaction	Y 2.4	0.625		Y 1.9	0.539
	Y 2.5	0.782		Y 1.10	0.594
	Y 2.6	0.649	Performance	Y 3.4	0.730
	Y 2.7	0.709		Y 3.5	0.582
	Y 2.8	0.662		Y 3.8	0.862
	Y 2.9	0.913		Y 3.9	0.812
	Y 2.10	0.856			
	Y 2.11	0.740			

Based on Table 4.3, it can be concluded that all indicators on the final validity are all significant, so they can be included in the next analysis process without having to do a validation test again. Furthermore, a reliability test can be carried out on the questionnaire to see how far the consistency of the research results is by looking at the Cronbach's alpha value contained in Table 4.2 below.:

Table 4.2 Final reliability test of the questionnaire

Variable	**Indicator**	***Cronbach alpha's***	***Average variance extracted (AVE)***
Feeling safety	X_1	0.799	0.629
Job Skills	Y_1	0.830	0.515
Job satisfaction	Y_2	0.887	0.560
Job Performance	Y_3	0.748	0.568

From Table 4.2 Cronbach's Alpha values are obtained for each research variable where it is found that the values of all variables are above 0.7, then all variables can be said to be included in the high reliability category to be used as constructs in the study. Then for the Average variance extracted (AVE) on all variables it has also met the criteria above 0.5

The results and values of all validity and reliability tests meet the minimum values that have been set, namely the validity test is above 0.5 and the reliability test is above 0.7 on each variable. Where the final stage model construct can be seen in Figure 3.1.

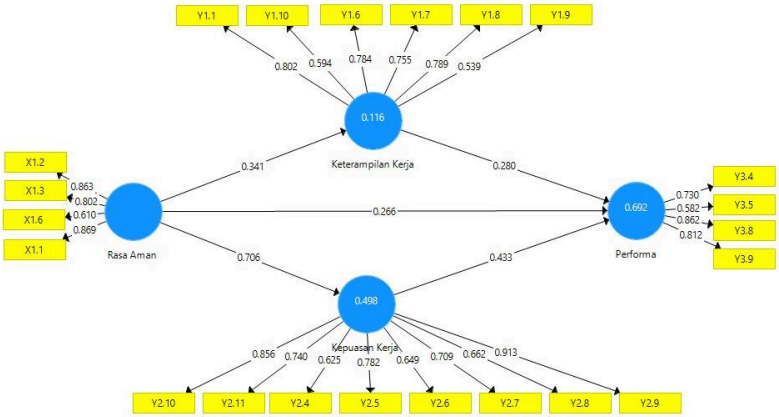

Figure 3.1 Structural equation path diagram

4. 2 Inner Model

From the data below, the variables of job satisfaction and job skills are only weakly explained by the Feeling safety variable in the model, individual job satisfaction is explained almost half by the Feeling safety variable. while Performance has a high R^2 value because this variable can be explained quite high by job satisfaction, and a sense of feeling safety. Meanwhile for Q^2 Predictive Relevance obtained 0.863 shows that modeling the effect of Feeling safety on Performance at construction sites during the Covid-19 pandemic have relevant and good predictions to explain Performance variables.

Table 4.3 Evaluation for Inner Model

Endogen	*R-Square*		Q^2	
	Result	criteria	Result	criteria
Job satisfaction	0.498	moderate	0.863	High
Job skills	0.116	low		
Job Performance	0.692	high		

4. 3 Modeling The Safety of Construction Workers

Testing the significance of the structural model for the safety of construction workers can be evaluated using a bootstrapping procedure. The basis used in testing the hypothesis is the value in the output Path Coefficients (Mean, STDEV, T-Values).

Table 4.4 The value of the path coefficients of the research model

Direct effects					
	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values
Feeling safety -> Performance_	0.266	0.246	0.138	1.927	0.055
Feeling safety -> Skills	0.341	0.356	0.096	3.555	0.000
Skills -> Performance_	0.280	0.293	0.102	2.743	0.006
Feeling safety -> Satisfaction _	0.706	0.719	0.055	12.932	0.000
Satisfaction _ -> Performance_	0.433	0.448	0.162	2.677	0.008
Indirect effects					
	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values
Feeling safety -> Satisfaction _ -> Performance_	0.306	0.320	0.114	2.674	0.008
Feeling safety -> Skills -> Performance_	0.096	0.104	0.048	1.990	0.047

The research hypothesis for the effect of a sense of feeling safety on worker Performance at construction sites during the Covid-19 pandemic can be concluded with a direct relationship between the hypothesized variables as shown in Table 4.5 below:

Table 4.5 Research model hypothesis

Hypothesis		$t_{statistics}$	t_{table}	Explanation
H_1	There is an influence between feeling safety and Performance	1.927	1.96	Accept H_0
H_2	There is an influence between a sense of feeling safety and job skills	3.555	1.96	Reject H_0
H_3	There is an influence between job skills and Performance	2.743	1.96	Reject H_0
H_4	job skills mediate Feeling safety and Performance	1.990	1.96	Reject H_0
H_5	There is an influence between a sense of feeling safety and job satisfaction	12.932	1.96	Reject H_0
H6	There is an influence between job satisfaction and Performance	2.677	1.96	Reject H_0
H_7	Job satisfaction mediates Feeling safety and Performance	2.674	1.96	Reject H_0

In Table 4.5 the influence relationship between latent variables is explained in more detail in the following terms:

1. The value of path coefficients obtained from the relationship between the feeling safety variable and the Performance variable with a $t_{statistics}$ of 1,927. This value is smaller than t_{table} by 1.96 and the p-value is 0.055. These results indicate that there is no effect on the relationship between feeling safety and Performance so that it is not in line with the hypothesis in H_1, So the assumption that the safety and protection factor at work is one of the factors that affect employee performance is not always true because the influence of feeling safety on performance is not directly but through the variables of job satisfaction and work skills, which can also be concluded even though a sense of feeling safety workers have been fulfilled, if workers do not have the work ability and work skills then the performance of workers cannot be achieved. So, if these two things are owned plus the employee has a sense of feeling safety and comfort because he feels he is getting good protection from the company, then the employee will also work with a calm feeling and will work well.
2. $t_{statistics}$ on the path coefficients the relationship between the feeling safety variable and the job skills variable is 3.850, which value is greater than t_{table} of 1.96 This shows that there is an effect on the relationship between feeling safety and work skills in which hypothesis H2 is supported, namely feeling safety has a significant positive effect and supports work skills. PUPR PERMEN No. 21/2019 concerning construction safety management system guidelines explains that construction safety includes feeling safety, health safety and sustainability. So that the act of controlling a sense of feeling safety as an indicator of sustainability both for workers, the environment and the public in the work environment is an important action in maintaining worker performance.
3. The amount of $t_{statistics}$ on the path coefficients obtained from the relationship between the work skills variable and the Performance variable is 2,743, where the number is greater

than t_{table}, these results support the hypothesis H_3 which states that there is a significant positive effect of the relationship between work skills on Performance. Due to a good emotional influence that can carry out good impulsive actions towards work. And if the lower the level of sense of skill possessed by workers, it can cause discomfort so that the performance of workers is low

4. The relationship between the feeling safety variable and the job satisfaction variable has a $t_{statistics}$ of 12,932. This value is greater than t_{table} 1.96 with a p-value of 0.00, which indicates that there is a significant positive effect on the relationship between feeling safety and job satisfaction, where the hypothesis H_5 is supported. By reducing the anxiety that employees have, they can reduce the stress at work during this pandemic. where in addition to carrying out the health protocol, employees are entitled to health insurance, periodic checks, and several additional incentives to the company as their safety and comfort at work so that they can work freely and reduce stress levels due to feelings of fear of the spread of the Covid-19 virus.
5. The $t_{statistics}$ value of the relationship between the job satisfaction variable and the Performance variable is 2,677, which is greater than $t_{statistics}$ and the p-value is less than = 5%, which is 0.008. This value indicates that there is a significant positive effect on the relationship between job satisfaction and Performance. Thus, the hypothesis H_7 is accepted that there is a relationship between job satisfaction and worker Performance. Positive job satisfaction and in accordance with that of employees can increase motivation, and stimulate employees to work even harder, or have a greater impact on the company.
6. In Table 4.5 it is explained that with a $t_{statistics}$ of 1.999, the test for an indirect relationship between feeling safety and Performance through the work skills variable on H_4. This value is smaller than t_{table} of 1.96 at the significance level and p-value is 0.047. That means that the indirect relationship between these variables is significant, where the influence on the hypothesis is supported. Even though the worker's sense of feeling safety has been fulfilled, if the worker does not have the work ability and work skills, the worker's performance cannot be achieved. So if these two things are owned plus the employee has a sense of feeling safety and comfort because he feels he is getting good protection from the company, then the employee will also work with a calm feeling and will work well.
7. Testing path coefficients for other indirect relationships between feeling safety and Performance through job satisfaction variables can be seen in Table 4.5 explaining that with $t_{statistics}$ of 2,674 smaller than t_{table} of 1.96 at the significance level, the indirect effect listed in hypothesis H_4 is supported, so it can be concluded that there is an indirect relationship between the two. So it needs to be noticed that job satisfaction is greatly influenced by a sense of feeling safety directly, if the worker's sense of feeling safety is not fulfilled it will reduce job satisfaction which will indirectly have an impact on performance. The importance of paying attention to the balance of work demands (Output), when worker satisfaction is lower than job demands, more fatigue will appear if on the contrary a feeling of boredom will arise.

6. CONCLUSIONS

Based on modeling regarding the effect of feeling safe on the Performance of workers at construction sites during the COVID-19 pandemic with alpha 5% as exogenous latent variables being a sense of feeling safety and endogenous latent being job satisfaction, work skills and Performance, this study provides empirical evidence as follows:

1. The sense of feeling safety does not have a direct influence on the Performance of workers in the construction project of the Labuan Bajo Multipurpose Pier, but through the mediating variables of job satisfaction and work skills with a significant positive relationship of 0.306 and 0.096.
2. A significant positive direct relationship occurs in work skills of 0.341 and job satisfaction of 0.706, furthermore, work skills and job satisfaction also have a significant positive direct effect on Performance of 0.280 and 0.433 for workers in the construction project of the Labuan Bajo Multipurpose Pier.

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DESIGN OF COMPANY PERFORMANCE MANAGEMENT SYSTEM USING BUSINESS MODEL CANVAS, BALANCED SCORECARD, AND QUALITY FUNCTION DEPLOYMENT: CASE STUDY AT PT AGOS

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ABSTRACT

When a company is experiencing growth, the job of the chief executive officer will be even more difficult if he has to handle the management of his business alone. Manual business administration makes activities take longer, more expensive, and less controllable, thereby hindering the company's competitive advantage in the market place. Companies must find ways to solve the problems above. One of them is by implementing a performance management system. This descriptive case study aims to improve the performance of a linen distributor named PT AGOS using the BMC, BSC, and QFD methods. The function of the BMC building blocks is to map the company's business model, while the BSC KPI is used to evaluate the company's performance. Meanwhile, the HOQ QFD matrices was built to consider recommendations for improvement. The results showed that the customer segments of PT AGOS were: public hospitals, private hospitals, and retail buyers. Value proposition comes from: linen and consumables. The marketing channels are: visits, RTD, joint venture, etc. Customer relationships are forged by: partnerships and consulting. Revenue streams are sourced from: project completion, wholesale sales, and consulting fees. The company's key resources are: linen, tangible fixed assets, intangible fixed assets, etc. The company's key activities are: electronic auction, production, marketing and sales, and so on. Key partners consist of: raw material providers, transportation services, software developers, etc. Cost structures consist of: COGS, operating expenses, and capital expenditures. The results of the evaluation of the financial performance perspective have not been able to meet the target, while customer knowledge has succeeded in satisfying customers. In the internal business process perspective, there are indicators that can exceed the target, but there are also those that have not. This also applies to the perspective of learning and growth. The improvement initiatives prioritized by HOQ are: ERP subscription, website development, CCTV & GPS installation, human resource system development, and training program under agreement.

Keywords: Performance Management System Design, BMC, BSC, and QFD.

1. INTRODUCTION

The outbreak of Corona Virus Disease 2019 (Covid-19) caused Indonesia's Gross Domestic Product (GDP) in 2020 to contract by -2.07% compared to 2019 (Badan Pusat Statistik, 2021). Industries such as hotels and tourism, aviation, Meeting-Incentives-Converences-Exhibitions (MICE), bars and restaurants, cinemas and concerts, sports, malls and retail, consumer electronics, and automotive are negatively affected and even lose money due to this pandemic (Nurhaliza, 2020). However, the industries that have actually experienced an increase in the midst of the pandemic are the medical equipment industry, pharmaceuticals, and drugs (Allianz Indonesia, 2021). Examples of medical equipment in question are Hazardous Materials (HAZMAT) suit, hand sanitizer, ethanol, masks, and gloves.

In addition to being produced by large industries, there are also Small and Medium Enterprises (SMEs) that are capable of producing medical equipment as long as they meet the standards set, one example is PT Anugerah Global Sukses (PT AGOS). PT AGOS is a distributor of hospital and hotel linen (fabric) trade with an asset value of Rp 1.5 billion (Financial Report 2020). The various products include medical clothing, bedding, anti-blood cloth, uniforms, etc. The classic problem faced by PT AGOS as an SME is informality. The company does not have an Enterprise Resource Planning (ERP) system, Standard Operating Procedures (SOP), and any Key Performance Indicators (KPI). Everything is done manually because the Chief Executive Officer (CEO) has not been able to make a well structured and systematic business administration. He handles very tough jobs starting from determining contracts, managing business licenses, reporting transactions to tax consultants, managing Human Resources (HR), negotiating and helping stakeholders, as well as seeking funding sources. Whereas the person concerned has a marketing, operational, and administrator manager. However, their ability is felt to have not been able to replace the function of the CEO.

Although PT AGOS has an organizational structure, several jobs such as multimedia, administration, and customer service are still carried out by employees of different departments overlapping. Employee work compensation has not appreciated the education and employee performance elements, only based on the structure of the position in the form of monthly salary. This will reduce employee work motivation if it is assessed from the equity theory of motivation belonging to Terpstra & Honoree (2003). Marketing operational costs that should have been used to get clients are still being used for purposes that have nothing to do with marketing (eg traveling, buying food, etc.). Employee expense reports are also not completely transparent. These are forms of waste experienced by the company that can affect its competitive advantage in the market. Therefore, companies need a performance evaluation system to control existing business processes. One of the performance evaluation methods that can be used is the Balanced Scorecard (BSC) from Kaplan & Norton (1992).

Because the BSC only shows how well the company is working or answering the question "how of doing business?", so the company still has not received information about the ins and outs of the business or answered the question "what of doing business?" (Keane *et al*., 2018 and Zott *et al*., 2011). To understand it, companies need a business model. The problem was that the CEO only relied on his intuition when planning his business. The company has experienced the failure of its unrelated diversification strategy in the form of developing an incinerator (waste burner) in 2020 because the company's cash flow is not strong and the cost of experts is also expensive. Therefore, this research will add the Business Model Canvas (BMC) method belonging to Osterwalder & Pigneur (2010) which aims to model business at the company level integrally into nine building blocks.

Due to limited resources, the company will not be able to implement all the improvement recommendations at once. Companies need an approach to prioritizing improvements. For this reason, the research proposes the Quality Function Deployment (QFD) method from Akao (1972). In this case, QFD is used to determine the weight of improvement initiatives (as Engineering Characteristics)/EC against Strategic Objectives (SO) BSC (as Customer Requirements)/CR so that the CEO can know which initiatives should be prioritized. Therefore, the purpose of this research is:

- To map the business model using BMC building blocks.
- To evaluate the performance of PT AGOS using BSC KPI.
- To recommend improvement initiatives using the QFD HOQ.

2. LITERATURE REVIEW

2.1 *Business Model*

The definition of a business model according to Osterwalder & Pigneur (2010: 14) is an explanation of how organizations create, deliver, and achieve value. A business model is a conceptualization of an organization in three aspects, namely (Chesbrough, 2009 and Osterwalder, 2004): (1) How components, functions, or key parts are integrated to deliver value to customers; (2) How these parts are interconnected in the supply chain and stakeholder network of the organization; and (3) How the organization generates value or revenue from the linkage. Magretta (2002: 88) states that all business models have two parts, the first part consists of activities that are making something: designing, buying raw materials, producing, and others; while the second part contains activities that are selling something: finding and reaching customers, buying and selling transactions, distributing products, or delivering services.

2.1.1 *Business Model Canvas*

The Business Model Canvas (BMC) is an instrument to describe a business model at the enterprise level that shows the "what" of doing business through nine building blocks (its elements), analyzes their interrelationships, and observes their impact on value creation; so that everyone has the same understanding of the business model (Osterwalder, 2004; Osterwalder *et al*., 2005; Osterwalder & Pigneur, 2010; Joyce & Paquin, 2016; and Urban *et al*., 2018). The main goal of BMC according to Osterwalder & Pigneur (2010: 15) is the application of business model concepts that are simple, relevant, and easy to understand while not underestimating how the company works. BMC allows its users to discuss, debate, and explore the potential for innovation that underlies the business model itself (Wallin *et al*., 2013 and Bocken *et al*., 2014). BMC integrates various aspects of assessment so that this approach is considered solid (Urban *et al*., 2018). The description of the nine elements of BMC is as follows:

1. Customer segments : Describes the different kinds of people or organizations that the company wants to reach and serve.
2. Value propositions : Describes a set of goods or services that provide value for a particular customer segment.
3. Channels : Explain how a company communicates and reaches its customer segments to deliver a value proposition.
4. Customer relationships: Describe the types of relationships a company builds with certain customer segments.
5. Revenue streams : Shows the revenue the company generates from each customer segment (sales must be reduced by costs to generate revenue).

6. Key resources : Describes the most important assets a company needs to run a business model.
7. Key activities : Describes the most important work a company must do to run its business model.
8. Key partners : Describe the network of suppliers and partners of the company to run its business models.
9. Cost structure : Describes all costs incurred in the company to run its business model.

2.2 *Performance Management System*

A performance management system is a process, metric, or series of evaluations used to calculate both the efficiency and effectiveness of an action (Bourne *et al*., 2003: 4). Bititci *et al*., (1997: 522) define a performance management system as an information system that is the core of the performance management process, and plays a critical role in the effectiveness and efficiency of the performance management function. The definition of a performance management system according to Artley & Stroh (2001: 1) is the core of a performance-based management process that flows from the organizational mission and strategic planning process, and provides data to be collected, analyzed, reported, and used to make business decisions. The purpose of the performance evaluation system is to improve performance.

2.2.1 *Balanced Scorecard*

Professors Robert Kaplan and David Norton of Harvard Business School introduced the Balanced Scorecard (BSC) strategy evaluation and control tool in 1992 to address the limitations of traditional evaluation systems that rely on historical financial reports and lack of indicators. The name Balanced Scorecard comes from the company's demands to always balance the measurement of its financial ratios (quantitative-objective) which is often prioritized in strategy evaluation with non-financial (qualitative-subjective) measurements such as product quality, customer service, employee morale, pollution abatement, business ethics, social responsibility, community involvement, and the like to get more representative information (David & David, 2016: 369; Dincer *et al*., 2017; and Kaplan & Norton, 1996). The overall goal of the BSC is to balance the external (capital owners & customers) and internal (operational) goals of the company (David & David, 2016: 369 and Kaplan & Norton, 1996). These sets of goals are interrelated as well as contradictory. For example, customers who want low prices and excellent service will be against the wishes of investors for a high rate of return on investment. The BSC evaluates the company's strategy from four perspectives, namely:

1. *The financial performance perspective* is the dominant aspect related to the company's profitability. This perspective only shows the company's past status, while the BSC shows the past and future strategic plans. The effectiveness of the other three BSC perspectives will be evaluated based on their achievement of financial objectives.
2. *The customer knowledge perspective* evaluates the target customer and market share. Managers must recognize these two elements so that their strategy can meet customer needs and expectations.
3. *The internal business process perspective* evaluates all operational activities aimed at satisfying expectations, demands, and retaining customers and owners of capital. These activities include short-term and long-term objectives.

4. *The learning and growth perspective* is the most explicit driver of performance because it focuses on employee culture and competence. Managers must play a role in improving the abilities of their employees.

Four BSC perspectives have a causal relationship, for example: increased customer satisfaction, innovative products, use of new technologies, and employee training can affect financial performance (Sarraf & Nejad, 2020).

2.3 *New Product Development*

New Product Development (NPD) is a process of a series of tasks and activities, methods, and tools that are applied when a company wants to develop goods or services for sale or distribution (Maritan, 2015: 6). Herstatt *et al*. (2004) divide the NPD process into five phases, namely:

1. *Idea generation and assessment*: Creating ideas which will be evaluated repeatedly based on important things such as company strategy, market, technology, and planned investment.
2. *Concept development and planning*: Create product concepts and plan projects.
3. *Development*: Carry out the actual product development process.
4. *Prototype development and testing*: Build and test prototypes.
5. *Production, market introduction, and diffusion*: Complete pre-production and launch the product on the market.

Muffatto & Panizzolo (1992) identified six critical variables that influence the NPD process, namely:

1. *Strategy*: The product development strategy covers how to innovate goods or services (leader/follower innovation); and means how the company manages competitor analysis, the market, and its relationship to technical design.
2. *Co-design and supplier involvement*: Co-design means the involvement of the supplier's role at the beginning of product development. Suppliers control component innovation, while buyers take the initiative to design innovations (Rosell & Lakemond, 2012).
3. *Organizational structure and technical staff:* The management of various projects singly or as a whole within the company can affect product development.
4. *Methods*: Defined as a way to manage the lead time, quality, and cost of the product development process (Maritan, 2015: 8).
5. *Design technologies*: The rapid development of technology brings both opportunities and risks in every sector of work. Some examples are Computer-Aided Design (CAD)/Computer-Aided Manufacturing (CAM) systems are becoming increasingly sophisticated and affordable.
6. *Performance*: Today, organizations must have a creative NPD team to face global competition and turbulence in the external environment (Fain & Kline, 2013), and focus on technological and technical innovation in order to maintain its competitive advantage (Haverila, 2011).

2.3.1 *Quality Function Deployment*

QFD was developed in Japan in the late 60s (Akao, 1972 and Akao, 1990) as a product development method based on Total Quality Management (TQM) (Akao & Mazur, 2003). This method was created to: (1) develop products according to customer requirements, and (2) describe Quality Control (QC) charts of a process before production takes place (Cristiano *et al*., 2001). The term House of Quality (HOQ) refers to a quality matrix or graph whose top is covered by a triangular roof introduced by Tsuneo Sawada of Toyota Auto Body in 1979 at the Japanese Society for Quality Control (JSQC) conference (Akao & Mazur, 2003). QFD consists of two things, namely: (1) a bi-

dimensional mathematical matrices (graph) that connects the same or different aspects of the NPD, and (2) a model/framework that connects the matrices. The HOQ matrices relates Customer Requirements (CR)/Demanded Qualities (DQ) or whats in rows with Engineering Characteristics (EC)/Quality Characteristics (QC) or hows in columns (Hauser & Clausing, 1988).

3. METHODS

3.1 *BMC Mapping*

In the BMC mapping process, researchers conducted interviews and brainstormed with the CEO to map the business model. Brainstorming is gathering a group of people, with the aim of generating fresh new thoughts (Minter & Reid, 2007: 46). This process generates data in the form of a PT AGOS business model.

3.2 *BSC Evaluation*

In the BSC evaluation process, researchers must make non-behavioral observations in the form of record analysis of the company's secondary sources. Record analysis is an analysis that involves historical records as well as public or private records, usually in the form of writing, print media, sound recordings, images, or video recordings (Cooper & Schindler, 2017: 204).

1. The secondary sources that were observed were company profiles to obtain data about its vision, mission, and motto. This data will later be used as material for making strategic themes so that they can focus and not widen. Strategic results are the expected results from the implementation of the strategy. From there, the researchers created strategic themes and results for PT AGOS as shown in **Table 3.1** below:

Table 3.1 Strategic Themes and Results

Strategic Themes	Strategic Results
Profesionalism	Employees who receive training and wages based on more objective variables are expected to increase their productivity.
Digitalization	Automation through ERP software is expected to increase the speed, reliability, and efficiency of business processes.
Operational Excellence	The company's operational excellence is expected to increase customer satisfaction.

Source: vision, mission, and motto.

2. Then the researcher develops Strategic Objectives (SO) for each BSC perspective to be achieved. SO must be quantitatively measurable and have direction (eg increase/decrease). SO is a development of strategic themes. Once formed, the influence between SO will be mapped as shown in **Figure 3.1** below:

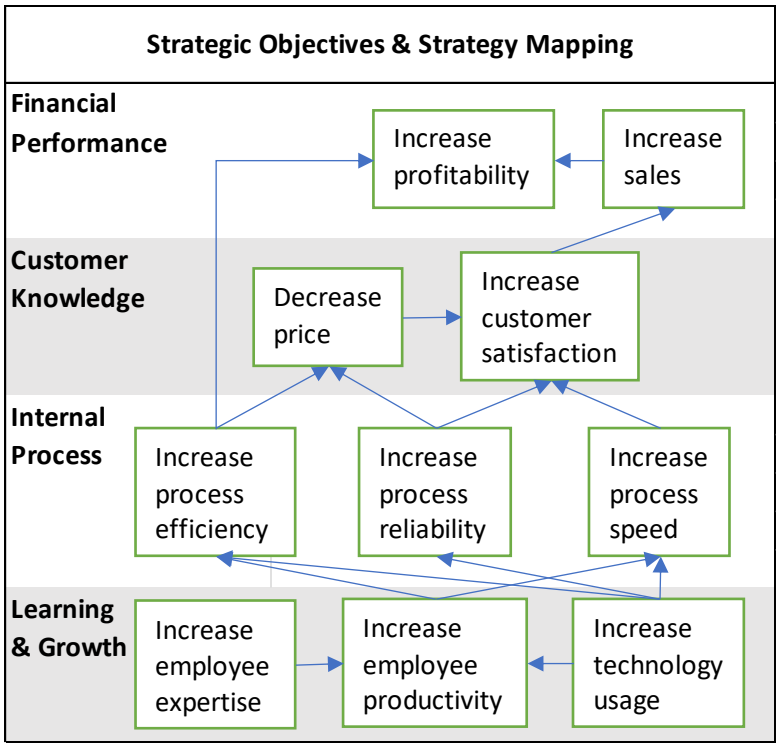


Figure 3.1 Strategic Objectives and Strategy Mapping

3. After that, the researcher will create KPIs for each SO. These KPIs were built on various considerations, ranging from observations on the 2019-2020 financial and sales reports, interviews, and brainstorming with the CEO to see their relevance to the research object, which is a small company. If the data obtained is insufficient, the researcher will replace it with another KPI. If it is relevant, the researcher and the main director will set a minimum achievement target based on the literature study that has been done previously. The list of 13 BSC KPIs can be seen in **Table 3.2** below:

Table 3.2 KPIs for each Strategic Objectives

Strategic Objectives	Key Performance Indicators	Formula
Increase sales	Sales growth (% max): shows sales growth compared to the previous period.	$\text{Sales growth} = \frac{\text{current sales} - \text{previous sales}}{\text{previous sales}}$
Increase profitability	Net Profit Margin (NPM) (% max): shows the percentage of net profit obtained from sales turnover.	$\text{NPM} = \frac{\text{net profit}}{\text{sales}}$
Decrease price	Price Index (PI) (% max): shows the average relative price of a product in the market compared to the price of our product.	$\text{PI} = \frac{\text{average competitor price}}{\text{your price}}$
Increase customer satisfaction	Ratio of complaints (% min): shows the percentage of customers who are disappointed with our service.	$\text{Ratio of complaints} = \frac{\text{number of complaints}}{\text{number of transactions}}$

Strategic Objectives	Key Performance Indicators	Formula
Increase process speed	Order fulfillment lead time (days min): shows the length of time between the customer ordering until they receive the order.	Order fulfillment lead time = average of (source time + production time + delivery time)
Increase process reliability	Delivery performance (% max): shows the percentage of orders sent according to schedule.	Delivery performance $= \frac{\text{number of on time delivery}}{\text{total delivery}}$
	Warranty cost to sales (% min): shows the percentage of expenses for warranty of damaged/defective products to the sales value.	Warranty cost to sales $= \frac{\text{number of deffective units} * \text{replacement cost}}{\text{sales}}$
Increase process efficiency	Factory capacity utilization (% max): shows the level of use of assets in producing an item to its maximum capacity.	Factory capacity utilization $= \frac{\text{actual output level}}{\text{maximum output level}}$
	Ratio of standard wage to regional minimum wage (% max): shows the comparison between the level of employee wages paid and the regional minimum wage according to the company's location.	Ratio of wage to minimum $= \frac{\text{standard wage}}{\text{regional minimum wage}}$
Increase technology usage	Ratio of system automated (% max): shows the percentage of the company's functional systems that are automated.	Ratio of system automated $= \frac{\text{number of automated function}}{\text{total function}}$
Increase employee expertise	Ratio of employee trained (% max): shows the percentage of trained employees compared to all employees.	Ratio of employee trained $= \frac{\text{number of trained employees}}{\text{total employees}}$
	Annual training frequency (times/year max): shows the frequency of employee training in one year.	Annual training frequency $= \frac{\text{number of training performed}}{\text{number of training planned}}$
Increase employee productivity	Daily labor productivity (item/day max): shows the ability of a worker to produce goods every day.	Daily labor productivity $= \frac{\text{average daily production}}{\text{number of workers}}$

Source: Balanced Scorecard Institute (2021), Pujawan & Er (2017: 289-290), and Sarraf & Nejad (2020).

4. Furthermore, KPI will be filled according to the results of interviews and observations. The end result of this process is data on the performance achievements of PT AGOS and improvement initiatives to overcome the problems.

3.3 *QFD's HOQ Weighting*

How to fill in the HOQ according to Van de Poel (2007) and Hauser & Clausing (1988) are as follows:

1. Determine the CR's criteria and subcriteria.
2. Fill the degree of importance CR-i (d_i) with some scale, in this case using 1-5 likert scale according to Parasuraman's (1988) SERVQUAL theory.
3. Compare our product quality by the competitor's with 1-5 integer scale.
4. Write the product improvement plan target by 1-5 scale.
5. Count the rate of improvement of product by dividing improvement plan score with existing product score.

6. Determine the demand sales point score which is expected to affect above average sales using 1.5 (strong), 1.2 (medium), and 1 (weak) scale.
7. Absolute weight CR-i score is the multiplication between degree of importance, rate of improvement, and sales point (King, 1987 and Akao, 1990).
8. Relative weight CR-i score is the percentage of $(\text{absoulute weight } CR_i / \sum \text{absolute weight } CR_i)x100\%$.
9. Determine the EC in measurable units and must influence customer perceptions directly.
10. Determine the EC's direction of improvement into three kinds of criteria, namely: ▼= minimize (lower is better), ◇= target (feature existence) dan ▲= maximize (higher is better).
11. Score the corelation type (trade-off) between EC on the HOQ's roof in five type, namely: ++ (very positive), + (positive), no symbol (without correlation), - (negative), and -- (very negative).
12. Score the correlation intensity (a_{ij}) between EC j-column to CR i-line achievement in relationships matrix that located in the middle of the HOQ using correlation scale of: 9 (strong), 3 (medium), 1 (weak), and no symbol (without correlation).
13. Count the absolute weight EC-j (w_j) using formula: $w_j = \sum_{i=1}^{m} \text{relative weight } CR_i a_{ij}$.
14. Count the relative weight EC ke-j using formula: $(w_j / \sum w_j)x100\%$.
15. Rank the EC from the most important up to the least important.
16. Compare the existing EC's performance by competitors in its units, as well as determine our new EC target.
17. Assess the EC implementation's technical difficulties using 1-5 scale.
18. Assess the estimated cost and time which will be performed in scale of 1-5.
19. Prioritized EC's improvement based on previous ratings.

4. RESULTS

4.1 *Mapping PT AGOS Business Model Using BMC Building Blocks*

Business Model Canvas

Designed for: PT AGOS
Designed by: Fariz & Agus
Date: 01/01/2022
Version: 1

Key Partners

(1) Material vendor.
(2) Logistic carrier.
(3) Software developer.
(4) Consultant:
- Taxation.
- Legal.
- Public procurement.
- Waste management.
(5) Government procurement platform (LPSE).
(6) Bank.

Key Activities

(1) E-auction.
(2) Purchasing, production, & distribution.
(3) Marketing & sales.
(4) Information technology.
(5) General administration & customer service.
(6) Finance, legal, & human resource management.

Key Resources

(1) Linen: TR Drill Taipan, WR Blue Diamond, CVC Treatcount 200, WR Soil Release, etc.
(2) Garment factory & office.
(3) Patent: Goster scanner, SMILE software, & UCL brand.
(4) Certification: production license, material lab test, etc.
(5) Skill set: sew, design, edit, programming, & accounting.
(6) Capital: shareholder equity, retained earning, & Bank loan.

Value Propositions

(1) Products and Services:
- Linen.
- Disposable Equipment (BHP).
- Linen Inventory Control Software “SMILE”.

(2) Gain Creators:
- Free linen consulting.
- Cheaper price.
- Quality assurance.
- Workday contact person.

(3) Pain Relievers:
- Deffect or mismatch replacement warranty.
- Triple packaging.
- Shipping and insurance cost coverage.

Customer Relationships

(1) B2B partnership.
(2) Product consultant.

Channels

(1) Marketing trip.
(2) Round Table Discussion (RTD).
(3) Joint Operation.
(4) Corporate Social Responsibility (CSR).
(5) Social media.

Customer Segments

(1) Public hospital.
(2) Private hospital.
(3) Retail buyer.

Cost Structure

(1) Cost of Goods Sold (COGS):
- Linen production.
- Disposable equipment resale.
(2) Operating Expense (OPEX):
- Employee compensation.
- Transportation (1st/3rd party).
- Utilities.
- Equipments.
(3) Capital Expense (CAPEX):
- Net Assets Value (NAV).
- Maintenance, Repairs, & Operation (MRO).

Revenue Streams

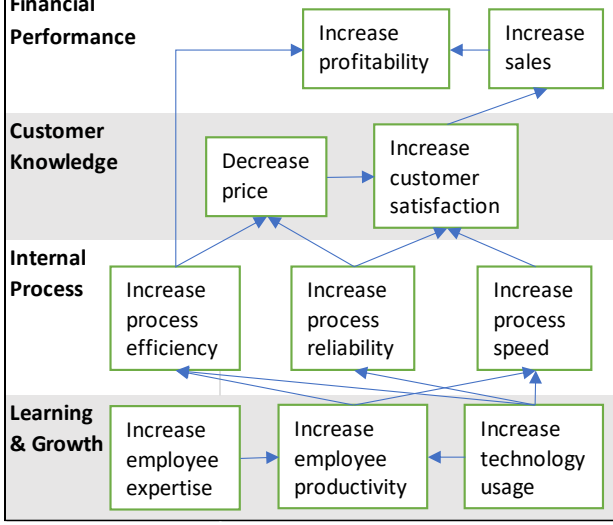
(1) Project accomplishment.
(2) Retail sale.
(3) Consulting fee.

Figure 4.1 PT AGOS Business Model in BMC

Based on the mapping of BMC building blocks in **Figure 4.1**, PT AGOS' **customer segment** consists of three segments, namely: (1) public hospital, (2) private hospital, and (3) retail buyers. The **value proposition** offered comes from two product groups, namely: (1) linen and (2) BHP, as well as a SMILE software. The company's *gain creators* provide: free consultation, low prices, quality assurance, and a contact person, while the *pain relievers* include: warranty on defective products, three-layer packaging, and cost and shipping insurance coverage. The five selected marketing **channels** are: (1) visits, (2) RTD, (3) joint operation, (4) CSR, and (5) Instagram. **Customer relations** are established using: (1) business-to-business partnerships and (2) linen consulting. **Revenue streams** obtained are sourced from: (1) completion of government e-procurement projects, (2) wholesale sales, and (3) linen consulting fees. The company's **key resources** are grouped into six types, including: (1) various types of linen, (2) tangible fixed assets in trading offices and convection factories, (3) intellectual property, (4) business licenses, (5) technical expertise employees, and (6) sources of funding. The company's **key activities** include: (1) electronic auctions, (2) production processes, (3) marketing and sales, (4) information technology, (5) general administration and customer service, and (6) finance, law, and human resources. **Key partners** who were invited to work together consisted of: (1) raw material providers, (2) transportation services, (3) software developers, (4) consultants (tax, legal, government e-procurement, waste), (5) LPSE officials, and (6) banking. The **cost structure** of PT AGOS consists of: (1) COGS, (2) operating expenses, and (3) capital expenditures.

4.2 *PT AGOS Performance Evaluation Using BSC KPI*

Company:	**PT ANUGERAH GLOBAL SUKSES**						
Address:	Bratang Binangun 1, No. 73	**City:**	Surabaya	**State:**	East Java	**Zip:**	60284
Vision:	Become an innovative technological-based medical & hotel linen supplier.						
Mision:	Create a high quality medical & hotel linen in Indonesia.						
Strategic Themes:	Profesionalism	Digitalization	Operational excellence				
Strategic Results:	Employees that receive training and salaries based on more objective variable are expected to increase their productivity.	Automation through ERP software are expected to increase business process speed, reliability, and efficiency.	Company's Operational excellence are expected to increase the customer satisfaction.				



Strategic Objectives & Strategy Mapping	Measurements			Performance			Initiatives
	Key Performance Indicator	**Unit**	**Objective**	**Target**	**Actual**	**Completed**	
Financial Performance	Sales Growth	%	Max	10%	5%	No	(1) Subscribe to ERP software for SME.
	Net Profit Margin (NPM)	%	Max	10%	0,32%	No	(2) Develop a human resource rules that contain standard operating procedures, performance evaluation, and work compensation.
Customer Knowledge	Price Index (PI)	%	Max	100%	125%	Yes	
	Ratio of complaints	%	Min	5%	2%	Yes	
Internal Process	Order fulfillment lead time	days	Min	35,6	30	Yes	(3) Train employee's technical skills under binding agreement.
	Delivery performance	%	Max	93%	98%	Yes	
	Warranty cost to sales	%	Min	1,2%	10%	No	
	Factory capacity utilization	%	Max	85%	62%	No	(4) Create a website for digital marketing and transaction.
	Ratio of wage to minimum	%	Max	100%	116%	Yes	
Learning & Growth	Ratio of system automated	%	Max	100%	29%	No	
	Ratio of employees trained	%	Max	100%	28%	No	(5) Install CCTV & GPS for surveillance.
	Annual training frequency	times/year	Max	1	1	Yes	
	Daily labor productivity	item/day	Max	10	11,13	Yes	

Figure 4.2 PT AGOS Performance in BSC KPI

In **Figure 4.2** above, it can be seen that the perspective of PT AGOS's **financial performance** as reflected in sales growth (5%≤10%,"No") and NPM (0.32%≤10%,"No") still has not been able to meet the target, but from the perspective of **customer knowledge**, price index (125%≥100%,"Yes") and the ratio of complaints (2%≤5%,"Yes") the company succeeded in satisfying customers. From an **internal business process** perspective, the company's order fulfillment lead time (30 days≤35.6 days, "Yes") can be faster than the specified target time. The delivery performance of PT AGOS (98%≥93%,"Yes") can be more reliable than benchmark companies. Unfortunately, the warranty cost to sales (10%≥1.2%, "No") has increased due to human negligence and factory capacity utilization (62%≤85%, "No") has not been very efficient. The workforce can be happy because the ratio of standard wage to regional minimum wage (116%≥100%,"Yes") exceeds the regional minimum wage for the City of Surabaya 2020. From the perspective of **learning and growth**, traditional practice makes the ratio of system automated (29%≤100%, "No") becomes low. The ratio of trained employees (28%≤100%,"No") is also not evenly distributed. Fortunately, the annual training frequency (1 times/year 1 times/year, "Yes") was well planned by the company. This can increase their daily labor productivity (11.3≥10,"Yes").

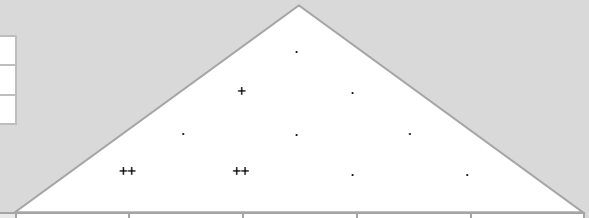
Referring to the achievement of the indicators above, the study recommends five improvement initiatives, namely:

1. Subscribe to ERP software for SMEs.
2. Develop HR regulations that contain SOPs, performance evaluations, and work compensation.
3. Train the technical capabilities of employees under a binding agreement.
4. Create a website for digital marketing and transactions.
5. Install Closed-Circuit Television (CCTV) and Global Positioning System (GPS) for surveillance.

4.3 *Recommendations for PT AGOS According to QFD HOQ*

Quality Function Deployment

Project Title: The Improvement of PT AGOS
Project Leader: Fariz & Agus
Date: 01/01/2022



Correlation:

++	+	.	-	--
Very Positive	Positive	No correlation	Negative	Very Negative

Relationships:

9	3	1	
Strong	Moderate	Weak	None

	1: low, 5: high	Desired direction of improvement (↑,0,↓)	◇	◇	◇	◇	▲		Competitive evaluation (1: low, 5: high)				
	Degree of Importance	Engineering Charactheristics (How's) → Customer Requirements - (What's) ↓	ERP subscription	Human resource system development	Training program under agreement	Website development	CCTV & GPS Installation	Relative Weight	Existing Product	Improvement Plan	Improvement Rate	Sales Point	Absolute Weight
1	4	Increase sales	1	9	9	9	9	8%	3	4	1,33	1,5	8,00
2	5	Increase profitability	9	3	1	3	9	20%	1	4	4,00	1	20,00
3	5	Decrease price	3			1		8%	5	5	1,00	1,5	7,50
4	5	Increase customer satisfaction		3	1	3		8%	5	5	1,00	1,5	7,50
5	4	Increase process speed	9	3	3	9	9	6%	4	4	1,00	1,5	6,00
6	5	Increase process reliability	9		3	9		10%	3	4	1,33	1,5	10,00
7	4	Increase process efficiency	9	3	1	3	9	6%	3	4	1,33	1,2	6,40
8	5	Increase technology usage	9			9	3	24%	1	4	4,00	1,2	24,00
9	4	Increase employee expertise	3	3	9	1		5%	3	4	1,33	1	5,33
10	5	Increase employee productivity	3	9	9	3	9	5%	5	5	1,00	1	5,00
		Absolute Weight	6,61	2,53	2,48	5,63	4,82	100%					
		Relative Weight	30%	11%	11%	26%	22%	100%					
		Priorities Rank	**1**	**4**	**5**	**2**	**3**						
		Current Performance	1	1	2	1	3						
		Benchmark	5	5	5	5	5						
		Target	5	5	3	3	5						
		Technical Difficulties	4	5	3	4	3	1: very easy, 5: very difficult					
		Estimated Cost and Time	4	4	3	4	3	1: low, 5: high					
		Priority to improve	**1**	**4**	**5**	**2**	**3**						

Figure 4.3 Improvement Initiative Weight in QFD HOQ

According to the relative weight of each EC in the HOQ QFD in **Figure 4.3**, the ranking of improvement initiatives that must be prioritized starts from: (1) ERP subscription (30%), (2) website development (26%), (3) CCTV & GPS installation (22%), (4) human resource system development (11%), and (5) training program under agreement (11%). Therefore, the repair investment to be made must be in accordance with the EC order above.

6. CONCLUSIONS

The performance of this linen distributor will be improved by:

1. *Subscribe to ERP software*: ERP, which used to be a means of control in large companies, is now being used more generally. This can be seen from the trend of software companies offering ERP at the Small Medium Enterprise (SME) level, such as: SAP Business One, Oracle Enterprise Resource Planning Cloud, Microsoft Dynamics 365 Business Central, etc.
2. *Create a company website*: Instead of actively offering our goods or services to customers, companies can passively promote their products via the official website to potential customers. The website will have features ranging from company profiles, contact persons, company product and service specifications and prices, availability of special stock for certain products, transaction accounts, service feature upgrade options, etc. This website will be integrated with the existing ERP for transactions and digital marketing purposes.
3. *CCTV & GPS installation*: Apart from being used for outdoor security reasons, CCTV can be installed indoors to monitor the performance of office and factory employees. The aim is none other than eliminating laziness and wasting time because the president director will have evidence regarding employee behavior during working hours during evaluation meetings. CCTV can also be installed in vehicles along with GPS to control the behavior of marketers so that they really take advantage of the facilities provided for marketing purposes, not others.
4. *Develop HR regulations*: This company must have clearly defined directives on: how the pattern of employee recruitment, job descriptions for each section, provisions for promotions, assessment of performance achievements, details of output-based work compensation variables, and termination of employment (layoffs). If the company's internal HR is still not able to build this system, the researchers suggest that the company employs a team of consultants who are experts in the field of Human Resource Management (HRM) to develop it.
5. *Train employees' technical skills*: Companies must have competent employees to be able to win market competition. Employee competence can be improved through training. However, to prevent brain drain, the company must make a binding agreement that the corporation will only conduct training if the employee concerned is willing to serve for the required period of time after attending the training. Because if this is not done, then the employee has the potential to leave and result in a loss of the company's investment in the intangible assets made.

Researchers suggest the following methods for further research:

1. *Value Proposition Canvas* (VPC): Osterwalder et al., (2014) offer VPC to create and improve the value proposition of goods and services to suit customer desires.
2. *Employee satisfaction survey*: researchers can survey employee satisfaction using various variables in Herzberg et al., (1959) two-factor theory, namely: motivators (advancement, recognition, responsibility, work itself, achievement, growth) and hygene factors (technical

supervision, relationship with peers, supervisors, and subordinates, salary, personal life, status, job security, company policy and administration, working conditions).

3. *Appraisal tools*: Dessler (2020: 283-290) explains that a superior can use traditional tools to assess employee performance, such as: (1) graphic rating scale, (2) alternation ranking, (3) paired comparison, (4) forced distribution, (5) characteristic incident, (6) narrative forms, (7) Behaviorally Anchored Rating Scale (BARS), and (8) Management by Objectives (MBO).

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APPENDIX

Balanced Scorecard Calculation

No	Formula	Calculation
1	$\text{Sales growth} = \frac{\text{current sales} - \text{previous sales}}{\text{previous sales}}$	$\frac{\text{Rp } 8.589.247.563 - \text{Rp } 8.218.357.628}{\text{Rp } 8.218.357.628} = 5\%$
2	$\text{NPM} = \frac{\text{net profit}}{\text{sales}}$	$\frac{\text{Rp } 27.549.639}{\text{Rp } 8.589.247.563} = 0{,}32\%$
3	$\text{PI} = \frac{\text{average competitor price}}{\text{your price}}$	$\frac{(\text{Rp } 585.000 + \text{Rp } 525.000 + \text{Rp } 485.000)/3}{\text{Rp } 425.000} = 125\%$
4	$\text{Ratio of complaints} = \frac{\text{number of complaints}}{\text{number of transactions}}$	$\frac{1}{58} = 2\%$
5	Order fulfillment lead time = average of (source time + production time + delivery time)	3 days + 20 days + 7 days = 30 days
6	Delivery performance $= \frac{\text{number of on time delivery}}{\text{total delivery}}$	$\frac{57}{58} = 98\%$
7	Warranty cost to sales $= \frac{\text{number of deffective units} * \text{replacement cost}}{\text{sales}}$	$\frac{11.000 * \text{Rp } 75.000}{\text{Rp } 8.589.247.563} = 10\%$
8	Factory capacity utilization $= \frac{\text{actual output level}}{\text{maximum output level}}$	$\frac{8}{13} = 62\%$
9	Ratio of system automated $= \frac{\text{number of automated function}}{\text{total function}}$	$\frac{2}{7} = 29\%$
10	Ratio of employee trained $= \frac{\text{number of trained employees}}{\text{total employees}}$	$\frac{5}{18} = 28\%$
11	Annual training frequency $= \frac{\text{number of training performed}}{\text{number of training planned}}$	$\frac{1}{1} = 1$
12	Ratio of wage to minimum $= \frac{\text{standard wage}}{\text{regional minimum wage}}$	$\frac{10\frac{\text{item}}{\text{day}} * \text{Rp } 25.000 * 20 \text{ work days}}{\text{Rp } 4.300.000} = 116\%$
13	Daily labor productivity $= \frac{\text{average daily production}}{\text{number of workers}}$	$\frac{(12 + 11 + 11 + 10 + 10 + 11 + 12 + 12)}{8 \text{ workers}} = 11{,}13 \text{ item/day}$

FUEL OIL REPLENISHMENT STRATEGY TO SUPPORT AN INCREASING SUPPLY POINT USING SCENARIO PLANNING METHOD: CASE STUDY OF PERTASHOP AT PT PERTAMINA JATIMBALINUS REGION

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ABSTRACT

To increase public accessibility to fuel oil, PT PERTAMINA has set a business strategy to build 10,000 Pertashops throughout Indonesia. The increase in the number of Pertashops has an impact on expanding the distribution network and increasing the number of fuel oil supply points. In several Pertashops that have been operating, there are still frequent problems with delivery delays, stockouts, and the cessation of sales operations. This study develops strategies for fuel oil replenishment to Pertashop using a combination method. Qualitative analysis is carried out with a scenario planning approach. Scenario planning can improve the quality of strategic decisions in uncertain environments and formulate flexible strategies that can counteract volatility. Quantitative analysis with the Decision-Making Trial and Evaluation Laboratory (DEMATEL) approach is carried out to determine the pattern of relationships (trends) between driving factors and uncertainty. Based on the analysis, 12 variables were identified as driving factors (DF) to Pertashop fuel oil replenishment process, and 2 critical uncertainties, namely the point of supply and demand for fuel as the dimensions of the scenario. As a result, 4 scenarios were built with 6 optional replenishment strategies.

Keywords: Scenario Planning, Replenishment Strategy, DEMATEL

1. INTRODUCTION

Pertamina has set a business strategy to present 10,000 Pertashops throughout Indonesia. In the regions of East Java, Bali and Nusa Tenggara, it is targeted to build 2,736 Pertashops. The increase in the number of Pertashops has impact on the expansion of the distribution network and the increase in the number of fuel supply points. Integrated Terminal (IT) Surabaya Group as a distribution center, distributes fuel to part of East Java. The supply location and volume of fuel deliveries to Pertashop has been increasing every month, and it will continue to increase with a target of 600 Pertashops in the IT Surabaya work area. This growth of supply points certainly needs to be accompanied with the operational capabilities to supply fuel to many new supply points.

Table 1 Growth of Pertashop's Outlet and Volume of Fuel Delivery to Pertashop from Surabaya Fuel Distribution Center

Month	Number of Pertashop (Unit)	Volume of Distributed Fuel (kL)
May 20	3	10
June 20	3	28
July 20	11	73
August 20	17	156
Sept 20	21	166
Oct 20	21	201
Nov 20	22	277
Des 20	25	369
Jan 21	32	416
Feb 21	36	410
Mar 21	40	283
Apr 21	46	819
May 21	53	785

From the results of the survey and preliminary observations, several problems were discovered, for instance delays in fuel delivery, Pertashop outlet experiencing stockout (inventory to be sold), and the cessation of fuel sales operations for 3 days. To overcome the problems, the strategy of filling fuel stock to Pertashop is very important to prevent shortages of supplies in the future. Replenishment is an important part of retail supply chain management (Ray, 2010). With the proper stock filling strategy, material flow will be directed and inventory levels will be maintained (Schroeder, 2016). This study develops Pertashop's fuel stock filling strategy using the Scenario Planning method.

2. LITERATURE REVIEW

2.1 Scenario Planning

The Scenario Planning is a strategic planning method that can be used to explore future situations and development pathways (Schoemaker, 1995). The Scenario Planning method aims to design a different picture of the future; therefore, the policy makers may discover the potential trends, key factors and players that might trigger the alteration in existing circumstances, and the unknown opportunities and threats posed by each anticipated future condition (Wack, 1985). The Scenario Planning approach is based on identifying the main driving forces based on the logic on the whole scenario storyline (Yoe, 2004). The Scenario Planning stages include defining the scope, gathering information, analyzing trends and uncertainties, building scenarios, and defining strategy (Wulf, 2010).

2.2 Supply Chain Strategy

Successful supply chain management requires many decisions regarding the flow of information, materials, and money. This decision is divided into three categories or phases, for example supply chain strategy, supply chain planning, and supply chain operations. Every decision must take into consideration the uncertainty throughout the decision period (Chopra, 2013). Supply chain strategy become crucial to operationalize and support the company's business strategy. Longer supply chains require more accurate forecasts to make strategies (Zylstra, 2006). Meanwhile, uncertainty in the supply chain can arise from the direction of demand, supply, and internal operations (Pujawan, 2017). According to (Chopra, 2013), there are 6 driving forces in the supply chain that will affect performance, i.e., Facilities, Inventory, Transportation, and Sourcing, and Price.

Replenishment Cycle is a term used in supply management that describes the process by which stock is supplied again when it reaches the desired condition (Wahono, 2019). The replenishment cycle occurs between retailers and distributors. The processes that occur in the replenishment cycle include retail order triggers, retail order fulfillment, dan retail order receiving (Wizard, 2021).

2.3 Decision-Making Trial and Evaluation Laboratory (DEMATEL)

DEMATEL (Decision-Making Trial and Evaluation Laboratory) is a model for resolving cause and effect problems structurally, and be able to handle dependency problems involving relationships among complex factors (Gölcük, 2016). DEMATEL is one of the MCDM (Multi Criteria Decision Making) methods in being able to accommodate subjective human opinions in determining the relationship among components in a complex system or subsystem (Ru-jen, 2011).

3. METHODS

The scenario-based approach to strategic planning used in this study is organized into six stages referring to the Scenario-Based Strategic Planning (Wulf,2013).

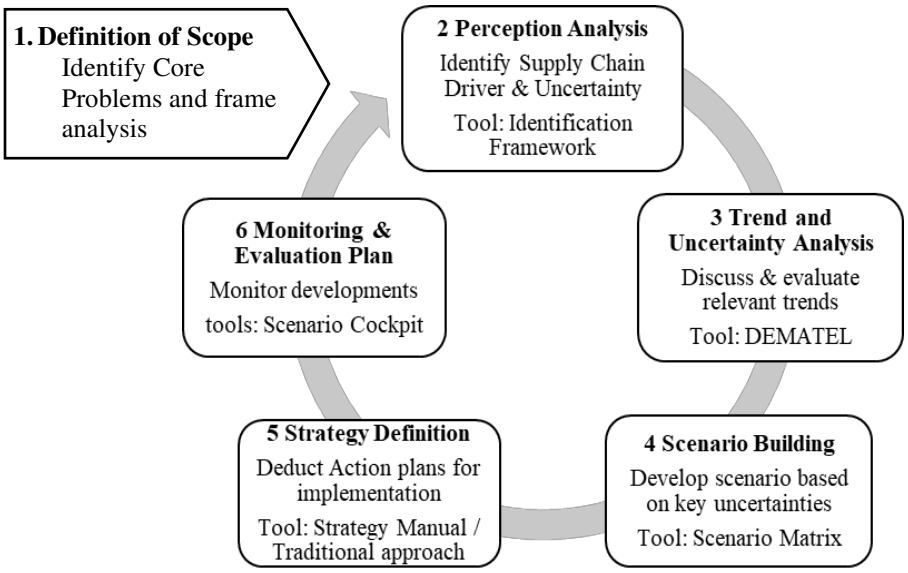

Figure 1. Stages and Tools in Scenario Planning Approach

At the trend and uncertainty analysis stage, quantitative analysis is carried out using the DEMATEL method with 6 stages i.e., (Wang, et.al., 2012):

1. Determine the intensity of relationship between factors (evaluation scale)

At this stage, an assessment of the intensity of the relationship between factors is carried out to determine the impact of the relationship. The analysis conducted by listing the factors or driving forces that have been identified into a matrix of columns and rows. Each pair of factors, then tested, (1) “To what extent is there a direct relationship between these factors?”, (2) “What is the impact or influence of one driving force (DF row) on another (DF column)?”. To measure the influence, the following scale is used:

0 = No relationship and influence;
1 = There is relationship and has low influence;
2 = There is relationship and has medium influence;

3 = There is relationship and has high influence;
4 = There is relationship and very high influence.

2. Create a direct-relation matrix (X)

With the assessment of the study subjects regarding the relationship and impact then a list is made into a direct-relation matrix. At this stage, the average value between expert is pursued. In the matrix, Xij is the impact of the influence caused by i on j. While the main diagonal line of the matrix is set to 0.

$$X = \begin{bmatrix} 0 & X_{12} & \cdots & X_{1n} \\ X_{21} & 0 & \cdots & X_{2n} \\ \vdots & \vdots & 0 & \vdots \\ X_{n1} & X_{n2} & \cdots & 0 \end{bmatrix}$$

3. Normalize the direct-relation matrix

The X direct-relation matrix is then normalized to become a Z matrix with equations (1) and (2). The main diagonal matrix remains 0 and the maximum number of each row and column is 1.

$$Z = k\,.X \tag{1}$$

$$k = \min\left[\frac{1}{\max i \sum_{j=1}^{n} |x_{ij}|}, \quad \frac{1}{\max j \sum_{i=1}^{n} |x_{ij}|}\right] \quad , j = 1, 2, ...n \tag{2}$$

4. Create total-relation matrix

The Z matrix that has been created is then constructed in relation to the direct and indirect matrix (T) with equation 3.

$$T = Z(I - X)^{-1} \text{ , I= matrix of identity} \tag{3}$$

5. Calculating the total of Dispatcher and Receiver

After the T matrix is formed, it is continued by calculating the total of row (Di) and total column (Rj) with equations 4 and 5.

$$D_i = \sum_{i=1}^{n} T_{ij} \quad , i = 1, 2, 3, \ldots n \tag{4}$$

$$R_j = \sum_{j=1}^{n} T_{ij} \quad , j = 1, 2, 3, \ldots n \tag{5}$$

6. Create a DEMATEL causal model

Creating a DEMATEL causal model in the form of a diagram (diagraph), (C+R) is used as a horizontal line, and (D-R) as a vertical line. (D+R) demonstrate the general level of the variables that influence one to another and (D-R) as the relationship means that the different levels of the variables are influenced and affect the others. A variable with a positive (D-R) value has a greater influence than other variables and is assumed to be the top priority, usually called a dispatcher. Meanwhile, the variable with a negative (D-R) value receives a greater influence and is assumed to be the last priority, usually called the receiver. For the value (D+R) indicates the relationship between variables so that if the variable with a value (D+R) is greater, it means that it has a greater relationship. The graph can be obtained by determining the threshold value.

4. RESULTS

4.1 Scenario Planning Scope Definition

In the primary stages of planning with a scenario, the scope is determined which includes the objectives, basis for analysis, the team involved and the planning period for the strategy for filling fuel stock to Pertashop (as shown in table 2).

Table 2 Scope Definition of Scenario Planning for Fuel Stock Filling Strategy

The purpose of Scenario Planning in the Pertashop Fuel Stock Filling Process	1. Identifying Key Factors / Potential Driving Forces and Critical Uncertainties that have an impact on the process of filling fuel stock to Pertashop. 2. Develop a scenario for the Pertashop fuel stock replenishment plan based on key driving forces. 3. Recommend Pertashop's fuel stock replenishment strategy based on selected scenarios.
Basic Strategic Level Analysis	The scenario for the plan to fill fuel stock to Pertashop needs to be carried out due to an increase in fuel supply points which refers to the company's target, specifically the construction of 2,736 Pertashops in the MOR V area. Thus, there is a change in demand (uncertain demand) in a number of distribution areas, therefore it is necessary to adjust the distribution pattern to fuel stock replenishment to Pertashop to meet customer needs. The planning process for stock filling patterns to Pertashop requires considerations and decisions at the strategic level, especially in relation to investment. Planning and strategy determination is carried out at the Marketing Operation Region (MOR) level based on demand patterns and characteristics of the operational area. 1. Memorandum of Understanding between the Ministry of Home Affairs of the Republic of Indonesia and PT PERTAMINA (Persero) 2. Memorandum of Director of Retail Marketing to Director of Logistic, Supply Chain and Infrastructure 3. Memorandum of VP Retail Fuel Sales to VP S&DP regarding the necessity for Tank Cars for Fuel Delivery to Pertashop 4. Memorandum of VP Supply & Distribution Planning to S&D Region Manager regarding the Preparation of Additional Fuel Tank Cars to Pertashop
Audience & Stakeholder	Teams involved in Scenario Planning: 1. Sales Branch Manager PT Pertamina Regional Jatimbalinus 2. Region Manager Supply & Distribution V PT Pertamina 3. Region Manager HSSE V PT Pertamina 4. Integrated Terminal Manager Surabaya Group 5. Operation Manager PT Patra Niaga Surabaya 6. Operation Manager PT Prolindo 7. Pertashop Operators/Partners
Planning Period	5 years (2021-2025)

4.2 Identification of Driving Factors and Uncertainty

Identification of Driving Factors (DF) was carried out by the researcher and the scenario planning team through observation and Focus Group Discussion (FGD). Observations were made by conducting a document review to sharpen the analysis of internal factors, field reviews and literature reviews to sharpen the analysis of external factors. Furthermore, the results of the DF Identification carried out by the researcher and the scenario planning team can be seen in table 3.

Table 3 DF Identification Results

Driving Factors (DF)	
Supply Point	Government Policy
Demand	Economic conditions
Availability of Tank Car	Population Growth
Stock Availability	Covid-19 Pandemic
Order System Development	Electric Car Development
Readiness of Infrastructure	Licensing

4.3 Trend Analysis and Uncertainty

4.3.1 Evaluation Scale of Intensity of the relationship between DF

Table 4 Direct Relation Matrix

Driving Factors		Supply Point DF1	Demand DF2	Availability of Tank Car DF3	Order System Development DF4	Infrastucture readiness DF5	Licencing DF6	Population Growth DF7	Govement Policy DF8	Economic Condition DF9	Electric Car Development DF10	Stock Availability DF11	Covid-19 Pandemic DF12
Supply Point	DF1	**0**	4	4	4	4	2	0	1	2	0	3	0
Demand	DF2	4	**0**	4	4	4	2	0	3	1	0	3	0
Availability of Tank Car	DF3	2	2	**0**	3	3	0	0	0	0	0	1	0
Order System Development	DF4	1	1	2	**0**	3	0	0	0	0	0	1	0
Infrastucture readiness	DF5	1	1	2	2	**0**	0	0	0	0	0	1	0
Licencing	DF6	3	3	1	1	1	**0**	0	0	0	0	0	0
Population Growth	DF7	1	1	0	0	0	0	**0**	2	3	0	0	1
Govement Policy	DF8	3	3	0	0	0	2	1	**0**	2	3	1	2
Economic Conditions	DF9	1	2	0	0	0	1	3	3	**0**	0	1	1
Electric Car Development	DF10	0	3	0	0	0	0	0	3	0	**0**	0	0
Stock Availability	DF11	1	1	1	2	2	0	0	0	0	0	**0**	0
Covid-19 Pandemic	DF12	0	2	0	0	0	0	1	2	3	0	0	**0**

Based on the direct relation matrix above, it can be obtained an analysis of the correlation assessment or the relationship of influence, that the growth of supply points has a relationship and very high influence on demand, availability of tank cars, development of order systems, and infrastructure readiness; relationship and high influence on stock availability or inventory management; relationship and moderate influence on licensing and economic conditions; relationship and low influence on government policies, and has no relationship and influence on population growth, development of electric cars, and the covid-19 pandemic.

The amount of fuel demand has a relationship and very high influence on the growth of supply points, the availability of tank cars, the development of the order system, and the readiness of infrastructure; relationship and high influence on stock availability and government policies; relationship and moderate influence on licensing; relationship and low influence on economic conditions; has no relationship and influence on population growth, electric cars development, and covid-19 pandemic.

4.3.2 Total-Relation Matrix

Table 6 Total-Relation Matrix

Driving Factors		Supply Point DF1	Demand DF2	Availability of MT DF3	Order System Development DF4	Readiness of Infrastructure DF5	Licensing DF6	Population Growth DF7	Government Policy DF8	Economic Condition DF9	Electric Cars Development DF10	Stock Availability DF11	Covid-19 Pandemic DF12	DISPATCHER
Supply point	DF1	**0,1094**	0,2506	0,2783	0,2961	0,3071	0,1108	0,0110	-0,0238	0,0985	-0,0029	0,2014	0,0025	1,6389
Demand	DF2	0,2567	**0,1221**	0,2825	0,3006	0,3117	0,1163	0,0103	0,0390	0,0705	0,0047	0,2056	0,0064	1,7264
Availability of Tank Car	DF3	0,1303	0,1309	**0,0782**	0,1955	0,2028	0,0217	0,0020	0,0014	0,0161	0,0002	0,0911	0,0008	0,8710
Order System Development	DF4	0,0768	0,0772	0,1268	**0,0601**	0,1734	0,0128	0,0012	0,0009	0,0095	0,0001	0,0733	0,0005	0,6126
Readiness Infrastructure	DF5	0,0741	0,0744	0,1222	0,1294	**0,0601**	0,0123	0,0012	0,0008	0,0092	0,0001	0,0707	0,0005	0,5550
Licensing	DF6	0,1752	0,1760	0,1204	0,1270	0,1317	**0,0291**	0,0027	0,0019	0,0217	0,0002	0,0583	0,0011	0,8454
Population Growth	DF7	0,0839	0,0939	0,0375	0,0403	0,0417	0,0275	**0,0235**	0,0923	0,1472	0,0111	0,0357	0,0542	0,6890
Government Policy	DF8	0,1878	0,2095	0,0876	0,0946	0,0981	0,1131	0,0557	**-0,0415**	0,1168	0,1150	0,1019	0,0836	1,2222
Economic Condition	DF9	0,1019	0,1429	0,0550	0,0601	0,0623	0,0688	0,1312	0,0938	**0,0437**	0,0113	0,0820	0,0545	0,9073
Electric Cars Development	DF10	0,0533	0,1598	0,0444	0,0474	0,0492	0,0275	0,0079	0,1197	0,0225	**0,0144**	0,0369	0,0108	0,5938
Stock Availability	DF11	0,0719	0,0723	0,0855	0,1268	0,1315	0,0120	0,0011	0,0008	0,0089	0,0001	**0,0314**	0,0005	0,5429
Covid-19 Pandemic	DF12	0,0512	0,1274	0,0377	0,0404	0,0419	0,0277	0,0620	0,0948	0,1461	0,0114	0,0359	**0,0159**	0,6923
RECEIVER		1,3726	1,6370	1,3561	1,5183	1,6116	0,5796	0,3097	0,3802	0,7106	0,1656	1,0242	0,2312	

Following the Total-Relation Matix above, it can be obtained the average value of the matrix or Threshold Value is 0,0757.

4.3.4 Determining the Value of Dispatcher and Receiver

Table 5 Calculation Results of (D+R) and (D-R)

Driving Factors		D	R	D+R (X)	D-R (Y)
Supply Point	DF1	1,6389	1,3726	3,0114	0,2663
Demand	DF2	1,7264	1,637	3,3634	0,0893
Availability of Tank Car	DF3	0,871	1,3561	2,2271	-0,4850
Order System Development	DF4	0,6126	1,5183	2,1309	-0,9057
Readiness of Infrastructure	DF5	0,555	1,6116	2,1666	-1,0566
Licensing	DF6	0,8454	0,5796	1,4250	0,2658
Population Growth	DF7	0,689	0,3097	0,9987	0,3792
Government Policy	DF8	1,2222	0,3802	1,6024	0,8420
Economic Condition	DF9	0,9073	0,7106	1,6180	0,1967
Electric Cars Development	DF10	0,5938	0,1656	0,7594	0,4282
Stock Availability	DF11	0,5429	1,0242	1,5671	-0,4814
Covid-19 Pandemic	DF12	0,6923	0,2312	0,9235	0,4611

4.3.5 Causal Model of DEMATEL

From the calculation results table, D+R is used as the value on the X-axis, while D-R is used as the value on the Y-axis, therefore the distribution of DF values is obtained in the form of a diagram in Figure 2.

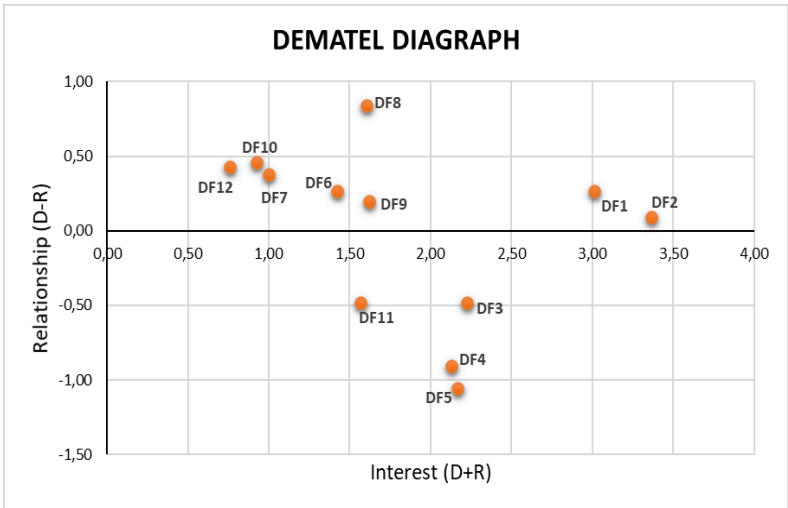

Figure 2 DEMATEL Diagraph

Dematel Digraph demonstrate the distribution of DF based on the value of interest and relationship. The results (D+R) of all risk events have a positive value on the X-axis (horizontal) thus all DFs can be stated to have positive interaction values. The DF category that has the highest interaction value and becomes the first priority is demand (DF2) and the number of supply points (DF1) with a significant and positive level of influence. These DF1 and DF2 are referred to as dispatchers and are driving factors with a high degree of interaction and influence other driving factors. Government Policy (DF8) has a very high influence on other DFs, however, the value of the level of interaction between other factors is still below DF1 and DF2. Tanker availability (DF3), order system development (DF4), readiness of infrastructure (DF5), and stock availability (DF11) have a significant interaction value with other factors, however have a negative Y value, in other words DF3, DF4, DF4, and DF11 are affected by other factors (receiver).

From the analysis of the relationship between these DFs, two factors can be selected that influence the process of filling Pertashop's fuel stock with critical uncertainty, that is Demand and Supply Point. These two factors are quite significant and most influence the other factors directly. Meanwhile, government policies are also quite significant and influence many other factors, however government policy factors are factors that cannot be intervened directly. These Demand and Supply Point factors then become dimensions in scenario development at the next stage.

4.4 Scenario Development

From the analysis of trends and uncertainties, two critical uncertainties are obtained, those are the driving factors for the process of filling the fuel stock with very high uncertainty, namely the supply points and demand. Four basic scenarios are determined based on supply points and demand as scenario dimensions. The four scenarios can be described in the four quadrants of the scenario planning matrix in Figure 3.

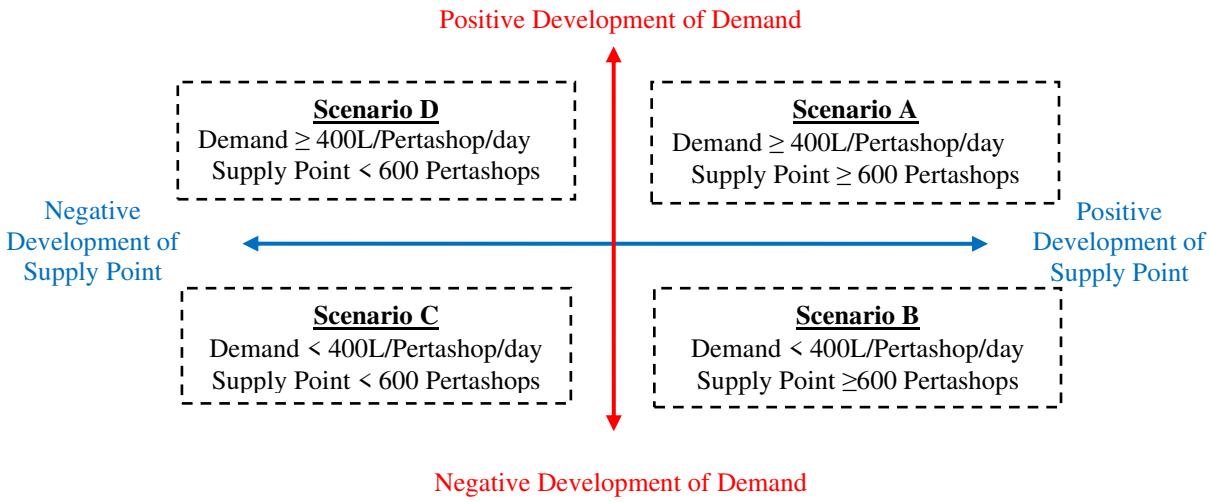

Figure 3 Scenario Dimension

4.5 Strategy Definition

In the primary stage of the FGD, several experts discussed several proposed strategies for filling Pertashop's fuel stock which can be used as reference for determining the appropriate replenishment strategy based on critical uncertainty. In the final stage of this scenario planning, the proposed strategy is then reconsidered with several experts and decision makers through interviews and limited discussion thus the most suitable fuel stock filling strategy is selected based on the selected scenario.

Table 6 Optional Strategies

	Optional Strategies
a	Procurement of new PTO Tank Car
b	Upgrade Regular Tank Car to PTO (with POMET)
c	SPBU Hub + Pick Up Car & IBC Tank
d	Optimization of Pertashop inventory management (Safety Stock & ROP)
e	Order system integration with MS2
f	Optimization of automatic routing & scheduling, and Smart Tank Car

Based on the scenario development analysis, the results obtained are 4 scenarios that may occur. From the four scenarios, the scenario planning team brainstormed to adapt the optional fuel stock filling strategy into the four scenarios, in order to obtain strategic recommendations for the four possible conditions. The following are the details of the selected strategies that can be carried out in the four scenarios.

Table 7 Scenario A and B

	Scenario A	Scenario B
Key Drivers	1. The growth of supply points or the number of Pertashop reaches the target (≥600 Pertashops) 2. Pertashop's fuel demand reaches the	1. The growth of supply points or the number of Pertashop reaches the target (≥600 Pertashop) 2. Pertashop's fuel demand did not reach

	target ≥400 liters/Pertashop/day	the target < 400 liter/Pertashop/day
Impact to Organization	Fuel sales increase, thereby increasing the company's profit and growth. Public accessibility to products and official prices increases, thereby increasing customer satisfaction.	The increase in traffic in distribution patterns and the fuel replenishment process, however, was not correspond with a significant increase in sales to increase company's profit. Operational Cost Increase
Opportunity/Threat	Opportunity	Threat
Strategy Plan	1. SPBU Hub + Tank dedicated to Pertashop 2. Procurement of Pick-Up Cars with IBC Tanks 3. Optimization of Pertashop Inventory Management 4. Integration of the Pertashop Order System	1. SPBU Hub without dedicated tank 2. Procurement of Pick-Up Cars with IBC tanks 3. Optimization of Pertashop Inventory Management 4. Integration of Pertashop Order System

Table 8 Scenario C and D

	Scenario C	**Scenario D**
Key Drivers	1. The growth of supply points or the number of Pertashop did not reach the target (<600 Pertashops) 2. Pertashop's fuel demand did not reach the target < 400 liters/day	1. The growth of supply points or the number of Pertashop did not reach the target (<600 Pertashops) 2. Pertashop's fuel demand reaches the target ≥ 400 liters/Pertashop/day
Impact to Organization	The increase in traffic in distribution patterns and the fuel replenishment process, however, was not correspond with a significant increase in sales to increase the company's profit. Operational Cost Increase	The significant increase in fuel sales increased the company's profit, however, was not followed by the achievement of the Pertashop KPI Target. There is a risk of losing sales and customers turning to competitors because they company is less responsive to demand.
Opportunity/Threat	Threat	Opportunity
Strategy Plan	1. Procurement of PTO Tank Cars 2. Increase Pertashop promotion 3. Optimization Automatic Routing & Scheduling, and Smart MT 4. Optimization of Pertashop Inventory Management 5. Integration of Pertashop Order System	1. Regular tank car modification with POMET 2. Optimization of Automatic Routing & Scheduling, and Smart MT 3. Optimization of Pertashop Inventory Management 4. Integration of Pertashop Order System

Based on the Pertashop growth master data and Pertashop fuel order demand at the Surabaya Group Integrated Terminal which have not reached the target (as presented in Table 1), the currently selected scenario (cut off in May 2021) is in scenario D where the total number of Pertashops is operating only 53 outlets with a total fuel demand of 785 KL. With a simple calculation, it is known that the average Pertashop fuel stock demand is 494 Liters/Pertashop/day.

4.6 Managerial Implications

Currently, the company is faced with conditions of high volatility, uncertainty, complexity, and ambiguity (VUCA world). Thus, the adjustment of Pertashop's fuel oil replenishment strategy is needed in every possibility that can occur in order to achieve supply chain resilience (Supply Chain Resilience).

The results of the scenario development show 4 possible conditions that may occur in the future, so that an overview of the strategies that can be carried out in the four conditions may occur. If there is a change, so that the currently selected scenario D becomes invalid, then the

company already has a strategic plan in scenarios A, B, and C. For example, the PTO tank car procurement strategy in scenario B can be a substitute for a pick up car procurement strategy by IBC tanks in scenario A and Scenario B. Thus, if scenarios A and B occur, the PTO tank car can be converted as a substitute for a pick up car with IBC to supply fuel from the gas station Hub to Pertashop.

Monitoring and Evaluation is planned periodically every month by coordinating with all stakeholders related to the Pertashop fuel replenishment process. Things that can be used as a reference for monitoring and evaluation include an overview and status update of Pertashop, monitoring the adequacy of tank cars to distribute Pertashop fuel, strategies for fulfilling Pertashop fuel distribution facilities, including making a strategy matrix for tank car preparation and a master plan for adding a tank car with POMET.

6. CONCLUSIONS

Through this study, 12 factors were identified that influence and have an impact on the Pertashop fuel stock filling process. Followed by analysis using the DEMATEL method, as well as brainstorming from experts, two critical uncertainties were obtained, those are the Growth of Supply Points (Pertashop Outlets) and the Total of Pertashop Fuel Demand. Scenario development using the scenario planning method, obtained 4 scenarios for filling the Pertashop fuel stock. The currently selected scenario is in scenario D with 4 strategic plans that can be carried out, namely procurement of PTO tank cars and modification of regular tank cars using POMET; optimization of automatic routing & scheduling, and Smart MT; optimization of Pertashop Inventory Management; and integration of the Pertashop Order System.

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APPLICATION OF HOUSE OF RISK (HOR) MODEL FOR RISK MITIGATION OF MATERIAL PROCUREMENT IN LABUAN BAJO MULTIPURPOSE TERMINAL PROJECT

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ABSTRACT

The Labuan Bajo Multipurpose Terminal Project is a multipurpose port built in a fairly short construction schedule to replace the existing port to improve the economy in Manggarai Regency, where the construction consists of: Jetty, Trestle, Causeway, Container Yard Area, and supporting facility buildings. Accuracy in project completion is closely related to the accuracy of the material procurement during the project construction period. Risk analysis had been carried out based on ISO 31000: 2009, where the risk of delay in material procurement is included in the high-risk category with high probability level and heavy impact. This study uses House of Risk (HOR) method, where the first phase begins with the identification of risk events and the second phase is risk management. The advantage of this method is in the framework that can cover the entire analysis process of risk management. HOR is a method that focuses on preventive actions by determining the main cause of risk, then determines the priority mitigation measures to be implemented. The results show 14 risk events and 15 risk agents that could potentially occur during material procurement process. From these results, 4 risk agents were selected as the cause of risk based on the Pareto diagram that required further handling from the management. Based on the analysis of preventive actions, 3 proposed mitigation measures were chosen to be followed up in this study, including request of material do not to mention clear specifications, accelerated construction schedule, and material fabrication taking time.

Keywords: Risk management, House of Risk (HOR), Risk Mitigation, Material Procurement

1. INTRODUCTION

Terminal, as marine transportation infrastructure, has a very important and strategic role in the growth of industry and trade. Sea transportation is the backbone of international trade and the main engine driving globalization. The construction of this terminal is designed to improve the economy in Labuan Bajo. The location of this multipurpose terminal to be built is separated from the existing port and the passenger and cruise (tourism) port.

Accuracy in project completion is closely related to the accuracy of material procurement during the project construction period. Procurement of project material is a high-risk challenge so it needs to be controlled properly according to a predetermined procurement schedule. It becomes the author's background in conducting a risk analysis regarding material procurement in Labuan

Bajo Multipurpose Terminal Project so that appropriate mitigation measures can be taken. PT Wijaya Karya has established a Risk Management System policy using a framework that implements ISO 31000:2009. The application of risk management system in PT Wijaya Karya uses qualitative risk analysis, which is a method that determines the priority of risk by using the probability of events and their impact on project performance. This research complements the risk analysis of material procurement which is originally carried out using the ISO 31000:2009 method according to Driantami, et. al. (2018). The author uses another approach, namely the House Of Risk (HOR) method which is different from the method based on ISO 31000.

The House of Risk (HOR) model is a framework developed by Geraldin and Pujawan (2009) by developing FMEA (Failure Mode and Effect Analysis) and QFD (Quality Function Deployment) method. This method is generally used to identify problems (risks) in the supply chain. The advantage of this method lies in the framework in mapping out a proactive strategy to mitigate the risks that arise and create a healthy supply chain (Ulfah, 2016). In the HOR method, the risk agent with the highest probability of occurrence and the severe risk event is selected. Then, prepare mitigation measures that can reduce the risk agent with the highest priority. By using the House of Risk (HOR) method, it is hoped to obtain a more appropriate result of risk analysis and mitigation measures in the Labuan Bajo Multipurpose Terminal Project.

2. LITERATURE REVIEW

Risk is an event or occurrence that may occur (Uncertain) and has a negative or positive influence on the project objectives. The definition of risk explained according to Sirait (2016) is the possibility of events that can harm the company. Meanwhile, the meaning of risk management is a logical and systematic method of identifying, analyzing, overcoming, and monitoring the risks involved in each activity or process. Risk management is a methodology that helps a manager make the best available resources. The purpose of risk management is to identify project risks and develop strategies to significantly reduce the risk or take action to avoid the risk. House of Risk, which is abbreviated as HOR, is the development of the Failure Modes and Effects Analysis (FMEA) method and the Quality Function Deployment (QFD) model aims to determine the priority of the selected risk sources to take the most effective action to reduce risks and risk sources. By reducing the causes of risk, it will usually prevent the occurrence of some risk events. The House of Risk is a method based on the need for risk management that focuses on preventive actions to determine the cause of risk that becomes the main priority, then the appropriate mitigation measure is determined. (Pujawan & Geraldin, 2009).

In House of Risk method, the calculation of RPN (Risk Potential Number) value is obtained from the probability of the sources of risk and the impact of damage if the sources of risk occur. The ranking of each source of risk or called the Aggregate Risk Potential (ARP) is used to determine the priority of preventive actions taken. Pujawan & Geraldin (2009) adapted the HOQ (House of Quality) model to determine which risks are prioritized first for preventive action. If there are many sources of risk, then the project can determine which has great potential that can cause risk. Based on the HOQ standard, two HOR models are proposed, namely:

1. HOR phase 1 to determine the sources of risk that become the main priority for preventive Action
2. HOR phase 2 is for priority mitigation measures by considering the most efficient mitigation costs.

HOR Phase 1 is the identification of risks that may occur during the project construction period. This stage begins with mapping each type of work sequence. HOR 1 focuses on ranking the ARP which consists of 3 main factors, namely the possibility of risk occurrence and failing

(Occurrence), the magnitude of the impact that may occur (Severity), and Interrelationship or in other words, this phase focuses on the process of risk identification, which includes risk agents and risk events (Sankar, N. Prabhu, B. 2001). This phase consists of several work steps as follows:

1. Identify the sequence of work to find out where the sources of risk are. This is usually done by mapping supply chain processes such as Plan, Source, Deliver, Make and Return (Supply Chain Operations Reference Model).
2. Measurement of the severity or impact that can be caused if the risk occurs in the project being studied. Where can be given a scale rating of 1-10 regarding the severity of Si (Severity).
3. Identification of the causes of risk Aj (Risk Agents) and measurement of the opportunity value of risk Oj (Occurrence) from a cause of risk. This Occurrence states the level of opportunity of risk events that can interfere with the construction of the project. Identify the risk agent by giving a scale of 1 – 10.
4. Preparation of a matrix that connects the relationship between risk agents and risk events is shown in the correlation value (Rij).
5. Perform ARP calculation to determine the level of occurrence of the risk agent (j) and impact caused by a risk event triggered by the risk agent.
6. Determination of risk agent rating based on ARP value

$$ARP = O \Sigma S Ri \qquad \text{..... (1)}$$

Where:
ARP = Aggregate Risk Potential
O = Occurrence
S = Severity
Ri = Correction Value

7. Determine the rating of risk agents based on potential risk from the largest value to the smallest value.

Table 1. House of Risk Phase 1

		Risk Agents (A*j*)							
Business Processes	**Risk Event (E*i*)**	A1	A2	A3	A4	A5	A6	A7	**Severity of Risk Event *i* (S*i*)**
Plan	E1	R11	R12	R13	…	…	…	…	S1
	E2	R21	R22	…	…	…	..	..	S2
Source	E3	R31	…	…	…	…	…	…	S3
	E4	R41	…	…	…	…	…	…	S4
Make	E5	…	…	…	…	…	…	…	S5
	E6	…	…	…	…	…	…	…	S6
Deliver	E7	…	…	…	…	…	…	…	S7
	E8	…	…	…	…	…	…	…	S8
Return	E9	…	…	…	…	…	…	Rij	S9
Occurrence of Agent *j*		O1	O2	O3	O4	O5	O6	O7	
Aggregate Risk Potential *j*		ARP1	ARP2	ARP3	ARP4	ARP5	ARP6	ARP7	
Priority Rank of Agent *j*									

HOR phase 2 has the following steps:

1. Choose the risk trigger (risk agent) with the highest priority level based on the output of HOR phase 1
2. Identify relevant measures to prevent risks
3. Determine the relationship between each preventive action on each risk (risk agent) using 0, 1, 3, or 9. Those numbers indicate a relationship that is respectful, no low, moderate, and a strong relationship between measures as follows:
4. Provide an assessment of the difficulty level by presenting each mitigation measure (Difficulty Dk).

Table 2. House of Risk Phase 2

	Preventive Action (PAk)					
To be treated risk agent (Aj)	PA1	PA2	PA3	PA4	PA5	**Aggregate Risk Potentials (ARPj)**
A1	E11	E12	E13	...	...	ARP1
A2	E21	E22	...	...	...	ARP2
A3	E31	...	...	...	...	ARP3
A4	...	...	...	...	...	ARP4
A5	...	...	...	...	Ejk	ARP5
Total efectiveness of action k	TE1	TE2	TE3	TE4	TE5	
Degree of difficulty performing action k	D1	D2	D3	D4	D5	
Effectiveness to difficulty ratio	ETD1	ETD2	ETD3	ETD4	ETD5	
Rank of priority	R1	R2	R3	R4	R5	

.

3. METHODS

This research aims to determine the risk mitigation of the material procurement process in the Labuan Bajo Multipurpose Terminal project using the House of Risk (HOR) method. Previously, a qualitative risk analysis, an analysis based on the impact and probability of the risk event to be followed up according to the priority scale, had been carried out. According to the result of the literature study, to analyze the risk management in the supply chain system, the House of Risk (HOR) method was used. By this method, the identification of risks and the mitigation measures taken could appropriately minimize the risk of procuring material in the Labuan Bajo Multipurpose Terminal project.

This description of the Labuan Bajo Multipurpose Terminal project can be used as a basis for identifying risk agents and risk events. The steps of this research can be seen in the following figure 1.

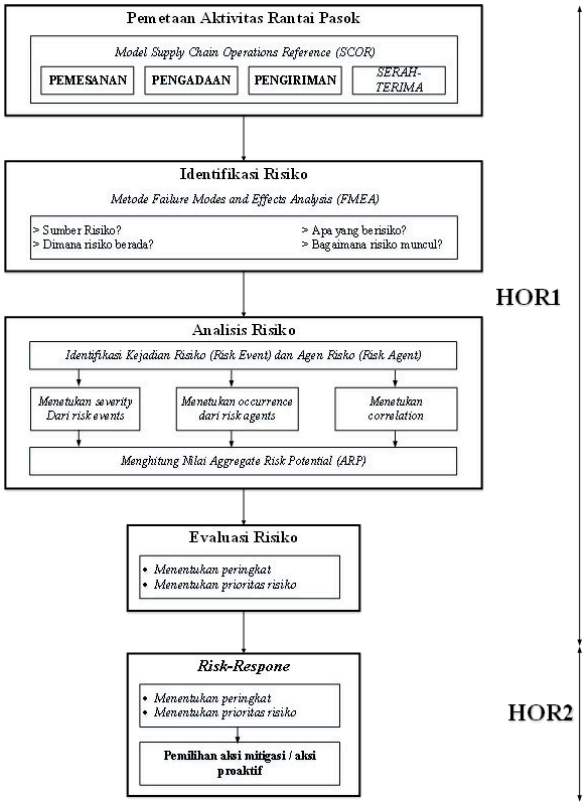

Figure 1. Flowchart of the Research

4. RESULTS

The selected respondents were managers, employees and suppliers who work in the Labuan Bajo Multipurpose Terminal Project. The recapitulation of respondent data aims to obtain an overview of the respondent's background. Respondent data can be seen in the following figure:

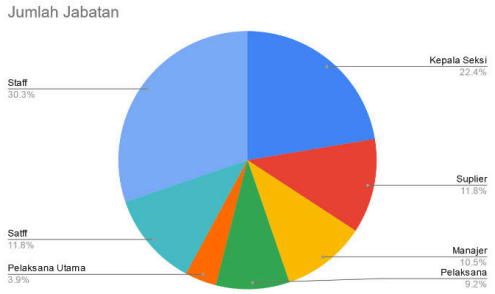

Figure 2. Respondent of the Research

The identification of risk events of the material procurement in the Labuan Bajo Multipurpose Terminal project was carried out through literature study and brainstorming with the project management team, where 14 risk events were obtained in the material procurement process. Furthermore, risk events that had been identified were measured on a scale of severity (risk impact) through a questionnaire to the respondent's. Severity assessment (risk impact) has a scale of 1 – 5 on risk events. The following are the results of the severity scale assessment obtained from the results of related respondents.

Identification of risk agents is the identification of factors that trigger the emergence of risk events so that by carrying out mitigation strategies against risk agents can reduce the risk events that may occur. Based on the results of brainstorming, a total of 15 risk agents were obtained in the material procurement process. In the next step, similar to risk events, the measurement of the scale of occurrence (probability of events) using a questionnaire to the respondents was carried out for each risk agent. Assessment of occurrence (probability of events) on a scale of 1 - 5 on the risk agent.

Table 3. Risk Impact

Proses	Kode	Kejadian Risiko *(Risk Event)*	*Severity*
Pemesanan	E1	Evaluasi teknis berlarut larut	4
	E2	Perubahan jadwal pengadaan material dipercepat	4
	E3	Vendor/supplier tidak dapat memenuhi kontrak	4
	E4	Kenaikan harga material saat pelaksanaan	4
	E5	Kesalahan perhitungan volume material	4
	E6	Keterlambatan negosiasi dengan suplier	4
	E7	Ketergantungan pada pemasok tunggal	5
Pengadaan	E8	Proses produksi material terlambat dari jadwal	5
	E9	Pengujian / pengecekan material belum dilakukan	4
	E10	Row material tidak mencukupi	4
Pengiriman	E11	Ekspedisi tidak dapat mengirim sesuai jadwal	4
	E12	Material rusak/hilang saat proses pengiriman	4
Serah Terima	E13	Material rusak / hilang saat proses bongkar muat	4
	E14	Keterlambatan pembayaran material kepada suplier	4

Table 4. Probability of Risk Agent

Kode	Pemicu Risiko *(Risk Agent)*	*Occurence*
A1	Permintaan barang tidak menyebutkan spesifikasi yang jelas	4
A2	Perubahan jadwal pelaksanaan menjadi lebih cepat	4
A3	Persetujuan pengadaan membutuhkan waktu lama	4
A4	Kenaikan harga material pada masa pelaksanaan	4
A5	Kesalahan dalam pemilihan suplier	4
A6	Terjadi ketidaksepakatan harga / jadwal pengiriman	3
A7	Terjadi kelangkaan raw material / bahan baku material	3
A8	Material butuh waktu untuk fabrikasi	4
A9	Material dikirim dari luar negeri	3
A10	Ekspedisi tidak memiliki performa yang memadai	3
A11	Terjadi bencana alam seperti gempa bumi/banjir	4
A12	Permasalahan dokumen pengiriman material	3
A13	Bongkar muat tidak dilakukan & diawasi dengan baik	4
A14	Pembayaran tagihan memerlukan jangka waktu yang lama	4
A15	Belum ada sanksi untuk supplier yang wanprestasi	4

The next step is to calculate the Aggregate Risk Potential (ARP) which is obtained by multiplying the risk probability and the risk impact. After correlation and calculation of Aggregate Risk Potentials (ARP) was carried out, then the last step of House of Risk method phase 1 was to create a table of House of Risk phase 1 by combining data of risk events, risk agents, correlation, and the results of the calculation of Aggregate Risk Potentials (ARP). From the results of ARP value, the priority of risk agents was classified from the overall risks to take appropriate handling measures as an effort to minimize the occurrence of risks by using a Pareto diagram.

In HOR phase 2, preventive actions were prepared against the causes of risk (risk agents) resulting from HOR phase 1. Based on the application of the Pareto diagram, from the cumulative percentage of ARP, 1 priority risk agent was obtained, namely (A1) Request of material do not mention clear specifications. However, based on the input from the project manager of Labuan Bajo Multipurpose Terminal, the top 4 risks, which needed preventive actions, were selected because according to the project management team, these risk agents were considered to cause delay in the procurement of project material.

The selected risk agents were then included in the House of Risk model phase 2 to determine the level and priority of the mitigation measures carried out by considering several factors that affect the level of ease of realizing the mitigation measures.

In the next step, the total effectiveness of each preventive action (PA) was calculated to be used as a calculation of the effectiveness ratio or ETD (Effectiveness to Difficulty Ratio) value of the implementation of preventive actions, where the ratio value was obtained from the division of the total effectiveness towards the degree/level of difficulty in the application of PA (preventive action). The measurement of the effectiveness ratio or ETD (Effectiveness to Difficulty Ratio) value aims to determine the ranking of each preventive action variable that can be carried out first according to the level of ease and effectiveness.

Based on the calculation result in House of Risk model phase 2, the first priority of preventive action that must be carried out is (PA 1) During Clarification and Negotiation, the specifications and schedule of material arrival are detailed. This precaution can reduce the risk agent (A1) Request of material do not mention clear specifications. According to the goods/services procurement procedure of PT Wijaya Karya, a procurement work instruction, which refers to the technical specifications of each work item, must be made when procuring material/goods and it must be approved by the engineering bureau manager, procurement manager, and project manager. This requires a fairly strict process in order that the risk of delay in material procurement due to non-detailed specifications can be mitigated.

The second preventive action is (PA3) Coordinate with suppliers so that the request for goods is following the plan and on time. This preventive action is simply carried out in the form of coordination meetings with suppliers/ subcontractors related to the monitoring of material procurement. This coordination can be done periodically or by assigning personnel from the project team to oversee the material delivery process at the factory/quarry location. Hence, if there is any obstacle, it will be easy to overcome

The third precaution is (PA4) Binding the price at the beginning of the negotiation and clarification and signing a framework contract. This precaution is quite easy to do with the implementation of procurement procedure of PT Wijaya Karya, namely the signing of a framework contract with the related material vendors at the beginning of the current year. By signing the framework contract, the future price increase during construction could be mitigated.

Table 5. House of Risk Phase 2

Risk Agent (Ai)		*Preventive Action (Pak)*							*Aggregate Risk Potential (ARP)*
		Pada Saat Klarifikasi Negosiasi mendetailkan spesifikasi dan jadwal kedatangan material	Berkoordinasi dengan bagian produksi untuk mendapatkan jadwal pengadaan yang akurat	Melakukan koordinasi dengan Suplier agar permintaan barang sesuai dengan rencana dan tepat waktu.	Mengikat harga pada saat awal kalrifikasi negosiasi dan membuat kontrak payung	Mempercepat proses aproval material dengan koordinasi dg Konsultan dan Owner	Melakukan evaluasi saat penunjukan supplier	Membuat evaluasi diawal untuk kesiapan material pendukung sebuah produk barang/material	
		PA1	**PA2**	**PA3**	**PA4**	**PA5**	**PA6**	**PA7**	
A1	Permintaan barang tidak menyebutkan spesifikasi yang jelas	9					3	3	208
A2	Perubahan jadwal pelaksanaan menjadi lebih cepat		9						180
A8	Material butuh waktu untuk fabrikasi			9		3			180
A4	Kenaikan harga material pada masa pelaksanaan				9				144
Total Effectiveness (Tek)		1872	1620	1620	1296	540	624	624	
Degree of Difficulty (Dk)		2	4	2	3	2	3	3	
Effectiveness to Difficulty ratio (ETDk)		**936**	**405**	**810**	**432**	**270**	**208**	**208**	
Rank of Priority		1	4	2	3	5	6	7	

6. CONCLUSIONS

From the results of the identification of risk events in the material procurement process of the Labuan Bajo Multipurpose Terminal project, 14 risk events were obtained. Meanwhile, from the results of the identification of risk agents, 15 risk agents were obtained. These two variables became the input for House of Risk model phase 1 through measuring the impact (severity) and the probability of risk occurrence obtained from the results of a questionnaire to 77 stakeholder respondents of Labuan Bajo Multipurpose Terminal project to obtain the correlation value of each risk event.

The results of the House of Risk model phase 1 were processed using a Pareto diagram, where the top 4 risk agents have a significant effect up to 50% of material procurement risk events, namely: (A1) Request of material do not mention clear specifications, (A2) Accelerated construction schedule (A8) material fabrication takes time (A4) Increasing of material prices during the construction period.

Based on the results of House of Risk phase 2, 6 preventive actions were obtained to calculate ETD value (Effectiveness to Difficulty Ratio), then the 3 highest priorities were immediately followed up by the project team, namely (PA1) Request of material do not mention clear specifications, (PA3) Coordinate with suppliers so that the request for goods is following the plan and on time and (PA4) Binding the price at the beginning of the negotiation and clarification and signing a framework contract.

Further research could be more detailed in identifying risk events and risk agents with all sections related to procurement activities and to facilitate identification in the House of Risk model, it is better to use the advances of integrated information technology, so that the House of Risk model could be used as alternative risk management of material procurement process in PT Wijaya Karya's further projects.

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CUSTODY TRANSFER METHOD SELECTION ANALYSIS IN THE PROCESS IMPLEMENTATION OF GAS STATION DIGITIZATION USING FAILURE MODE EFFECT ANALYSIS (FMEA) AND FUZZY PRIORITIZATION IN PT PERTAMINA REGIONAL JATIMBALINUS

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ABSTRACT

The operational activity of fuel distribution, which is the process of distributing goods / services from producers (companies) to consumers (gas stations), really requires efficiency and the application of international standardization with a technological approach. The application of digitization gas stations is the solution in the era of the industrial revolution 4.0. One of the efficiency efforts is by optimizing the equipment handover system for fuel products at gas stations. Based on the hierarchy, there are 3 measuring instruments for the custody transfer process: the metering system, automatic tank gauging (ATG), and manual dipping. ATG is an automatic instrument that measures and displays the level of liquid in one or more tanks either continuously, periodically, or on demand. At this time, Custody Transfer at gas stations still uses a manual measurement system (Manual Gauging). Hence, ATG is used only as a monitoring tool only. Based on these conditions, it is necessary to analyze the selection of the most suitable custody transfer measurement method for effort of efficiency. This study uses the Failure Mode and Effect Analysis (FMEA) method to identify all failure modes in a custody transfer system, assess their impact, and plan corrective actions. Fuzzy logic and Fuzzy Analytical Hierarchy Process (F-AHP) are used to overcome the limitations of traditional FMEA., Thus, the analysis can be more measurable and efficient. This study aims to provide the best solution for PT Pertamina (Persero) Regional Jatimbalinus in implementing the custody transfer system. Based on the research, it is concluded that Automatic Tank Gauging is a custody transfer method that has a residual risk with a Risk Priority Number (RPN) value of remaining risk less than 8 and in accordance with the As Low As Reasonably Practicable (ALARP) principle to be applied at gas stations.

Keywords: Custody Transfer, Failure Mode and Effect Analysis (FMEA), Fuzzy-AHP

1. INTRODUCTION

Pertamina continues to improve services for the community, including through the Digitalization of gas stations. With the digitalization program of gas stations, Pertamina can monitor the condition of fuel stocks, fuel sales and payment transactions at gas stations. In addition, all these data can also be accessed directly by a number of authorities such as the Ministry of energy, Ministry of State-owned Enterprise (SOEs), Ministry of finance, and BPH oil and gas. This method is a concrete step pertamina in implementing transparency in carrying out assignments from the government while increasing the convenience for the community in buying Pertamina products (PT Pertamina, 2020).

This phenomenon is the impact of the disruption of the industrial revolution 4.0 so that companies are forced to implement marketing practices 4.0. Marketing 4.0 is a marketing approach that combines online and offline interaction between companies and customers, blends style with substance in brand building, and ultimately complements machine-to-machine connectivity with a human-to-human touch to strengthen customer engagement. Marketing 4.0 helps marketers move into the digital economy, which redefines the key concepts of marketing. (Kotler, Kartajaya, & Setiawan, 2020).

Based on these conditions, it is necessary to analyze *Custody Transfer* as one form of efficiency towards a better company operational process.

2. LITERATURE REVIEW

2.1 Digitization of gas stations

There are several scenarios with good potential applications in the context of the "Oil and Gas 4.0" era shown in the following image.

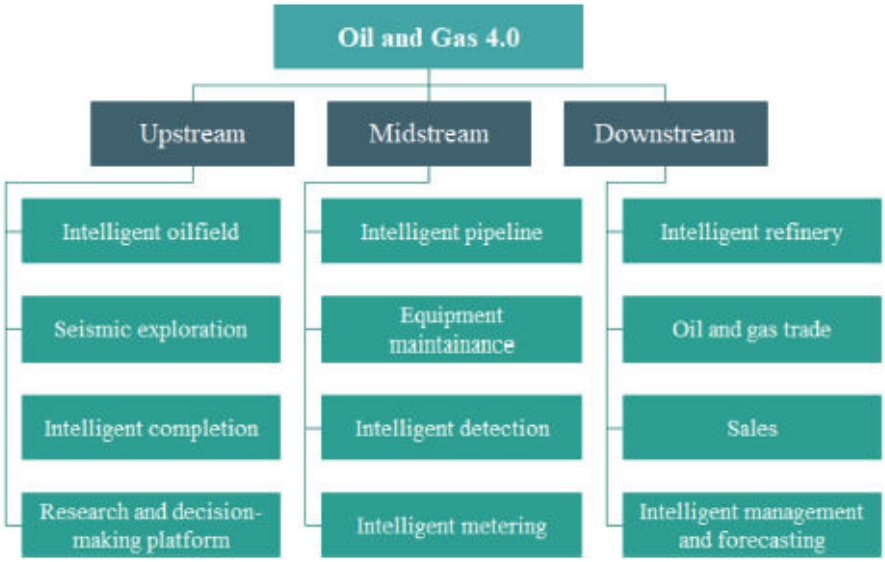


Figure.1 Scenario with good application potential in the context of the era of "Oil and Gas 4.0". (Image source: (Lu, Guo, Azimi, & Huang, 2019)

This step was also carried out by PT Pertamina (Persero), a producer and distributor of fuel oil (BBM). The energy of digitization of public refueling stations (gas stations) as part of Pertamina downstream business. Digitalization of gas stations is the answer to the desires of customers in the era of the industrial revolution 4.0 (Gaikindo, 2019).

The main benefits of adopting digital technology in the supply chain are the occurrence of increased operational efficiency of the supply chain, including operation speed, cost, quality, flexibility, agility, and reliability (Yang, Fu, & Zhang, 2021).

Some of the benefits of digitalization of gas stations include in terms of supply reliability, through digitalization Pertamina in real time can conduct sales or sales monitoring, monitoring the stock available at gas stations, monitoring fuel receipts when loading and unloading from tank truck, and developing auto scheduling in fuel delivery to gas stations. All this real time data and information can be monitored through the monitoring dashboard that has been developed.

Thus, the digitization of this gas station can ensure the distribution of fuel that is on target and ensure the condition of stock at the gas station is always in a safe condition to serve the needs of the community (PT Pertamina, 2021).

2.2 Custody Transfer

Custody transfer is the process of transferring energy/products from *shipper* to *transporter* or from *transporter* to *customer* requiring high accuracy. *Custody transfer* is transfer of commodities at the point of transfer of ownership rights between sellers and buyers. In this case, *custody transfer* is a buying and selling transaction activity involving the volume of goods *(fluid)* transferred from the first party to the second party by not reducing the quantity and quality of goods and timeliness in accordance with the agreement agreed by both parties.

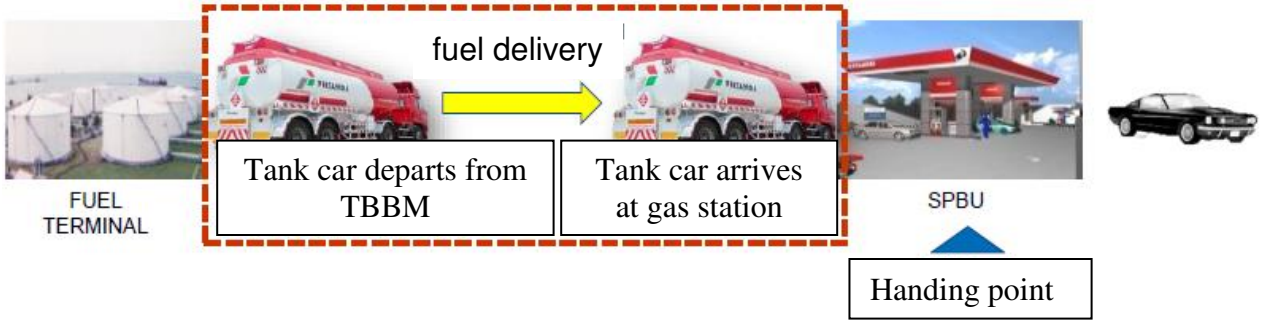
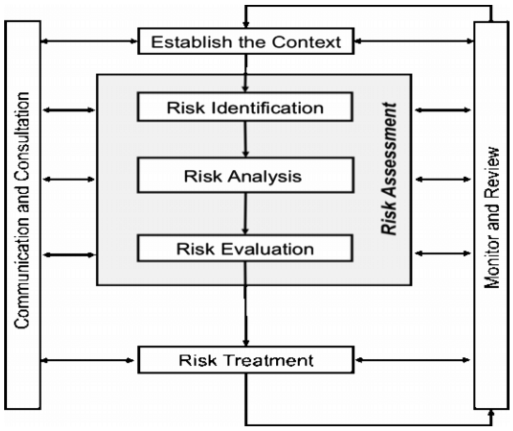


Figure 2. The flow of the fuel handover process at the gas station.

In *custody transfer,* both *crude oil* and *product* are needed accuracy in the measurement of large flows to determine *internal quantity accounting* and for *external quantity accounting.* When oil buying and selling transactions occur, the best *flow* measurement tool is needed, even expected the *flow* measurement tool used has a 100% accuracy rate. This is because oil buying and selling transactions are usually done in very large quantities, so if there is a slight measurement *error* then the losses incurred are very large. On the basis of equivalence between *volumetric oil* transferred and profit (provit) this is the benchmark for the importance of accurate *flow* measurement tools in *custody transfer.* Based on the above description, most *oil and gas* companies use gauges that have been *proven* by standards for *custody transfer*, the following is a custody transfer measuring instrument according to its hierarchy (Wahyuningtyas, 2019).

1. *Metering System* (Hierarchy I)
2. *Automatic Tank Gauging* (Hierarchy II)
3. *Manual Dipping* (Hierarchy III)

Figure 3. Quality Risk Management process according to ISO 31000 : 2009



2.3 Risk Management Process

The risk management process is a critical activity in risk management, as it is the application rather than the principles and frameworks that have been built. The risk management process consists of three major processes, include:

1. Establishing the context
2. Risk assessment (risk assessment)
3. Risk treatment (risk treatment)

The three major processes are accompanied by two processes, namely:

1. Communication and Consulting
2. Monitoring and Review

2.4 *Failure Mode and Effect Analysis* (FMEA) Method

Failure Mode and Effect Analysis It is a systematic assessment of elements per element to highlight the consequences of the failure of a component, product, process or system to meet consumer desires and specifications. *Failure Mode and Effect Analysis* can systematically describe a collection of activities in terms of; knowing and evaluating the potential failures of the product/process and the effects of those failures, identifying actions that must be eliminated or mitigated to gain the chances of a potential failure and as a document of all processes. FMEA focuses more on design for both products and processes.

1. Failure: Unexpected conditions
2. Mode: Identifying the cause of failure
3. Effect: Consequences of failure
4. Analysis: Identification, looking for ways of prevention by detecting

The FMEA process has 3 main variables including severity, occur, and detection. Severity is a rating or level that refers to the serious impact of a potential failure mode. The impact of the rating starts on a scale of 1 to 10, where scale 1 is the lightest impact while 10 is the worst impact and determination on ratings. *Occurrence* is a rating that refers to some frequency of defects in insulator products. The frequency value of failure indicates the frequency of a problem that occurs due to a potential *cause.*

On one occasion, McDermott delivered ten steps in the FMEA stage (McDermott, Mikulak, & Beauregard, 2008), include:

1. Review of a process or product
2. *Brainstorming* potential failure mode
3. List potential effects for each failure mode
4. Assess the severity *of* the impact
5. Assess the degree of likelihood of *occurrence* failure
6. Assess the detection rate of any failure and/or impact
7. Calculate the priority level of risk (RPN) of each failure
8. Sort failure priorities that require further handling
9. Taking action to eliminate or reduce high-risk failures
10. Recalculate the remaining RPN to find out the results of the follow-up.

RPN = *Severity x Occurrence* (1)

2.5 ***Fuzzy Analytical Hierarcy Process* (F-AHP)**

Fuzzy Analytical Hierarchy Process (Fuzzy-AHP) It is a development of AHP, one method that can solve problems with many criteria while fuzzy logic is a logic that has a value between two values. Fuzzy-AHP is a combination of AHP method with Fuzzy concept approach. Fuzzy-AHP covers the weaknesses contained in AHP, which is a problem with criteria that have more subjective properties. The uncertainty of numbers is represented by a sequence of scales (Nuzulita, Hidayat, & Dewi, 2013). In the AHP method, the comparison between the criteria uses a scale of 1-9. While in F-AHP must transform TFN (Triangular Fuzzy Number) to the scale of AHP(Ansori, 2012).

Table 1. Examples of linguistic scales for relative purposes

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

3.1. Initiate Quality Risk Management (QRM)

In this methodology, quality risk management will be initiated on the development of existing problems in accordance with the stages of the process regulated in ICH Q9 by conducting initial communication to decision makers (Decision Maker) to get sponsorship.

3.2. The stages of FMEA

The team that will be involved has received approval from decision makers. Next, the team will conduct a Focus Group Discussion (FGD) to conduct Failure Mode Effect Analysis (FMEA) in identifying risks. The team involved is the same person in conducting risk assessment and

control on gas station transfer custody consisting of Retail Sales V Function, Supply & Distribution V Function, HSSE MOR V Function, Operation Manager of PT Patra Niaga Surabaya, Manager &Supervisor of gas station.

3.2.1. Identifying risks and fuzzy comparison matrixes for occurrence and severity

For each of the criteria in the company against severity and *occurrence values,* it is determined as follows:

Table 2. Criteria of Severity

	Quality	Business/Process	Reputation
1 Minor (Mn)ACTUAL/POTENTIAL	• Meet the specifications of the quantity of fuel handover. The effect never causes losses in the process of handing over fuel at gas stations.	• No facilities and infrastructure damage or minor damage (≤ 10K$). • Does not cause operational disruption.	• Raise concerns from the surrounding community but do not cause public attention, there are no demands. • Does not cause damage to the company's image. • Internal company rumors. • Does not cause news in the media.
2 Moderate (Md)ACTUAL/POTENTIAL	• Simply meet the specifications of the quantity of fuel handover. The effect almost never causes losses in the process of handing over fuel at gas stations.	• Cause facilities and infrastructure damage (≤ 100K $). • Causing operational disruption ≤ 6 hours.	• To the public's attention, no lawsuits. • Does not cause damage to the company's image. • Customer satisfaction levels do not reach the target. • Raises news on a local scale.
4 Serious (S)ACTUAL/POTENTIAL	• Less meets the specification of the quantity of fuel handover. The effect can cause losses below the tolerance limit that repeatedly in the process of handing over fuel at gas stations.	• Cause significant facilities and infrastructure damage (≤ 1M$). • Causes operational disruption of more than 6 hours but ≤ 12 hours.	• Allows lawsuits. • Causes a drop in the company's image on a local scale. • Causes a significant decrease in customer satisfaction. • Causes news on a provincial scale.
8 Major (Mj)ACTUAL/POTENSI	• Failed to meet the fuel handover quantity specification. The effect can cause losses exceeding the tolerance limit repeatedly in the process of handing over fuel at gas stations.	• Cause significant facilities and infrastructure damage (< 10M$). • Cause damage outside the operational area. • Cause operational disruption of more than 12 hours but ≤ 24 hours.	• Causing lawsuits. • Causing a decline in the company's image on a national scale. • Causes a significant decrease in the level of customer satisfaction. • Causing news on a national scale.

16 Catastrophic (C)ACTUAL/POTENTIAL	• Significant quality and quantity impact whose effects can make fuel handover activities at gas stations inoperable.	• Cause significant facilities and infrastructure damage (≥ 10M$). • Cause significant damage outside the operational area.	• Can cause operational activities to be closed. • Causes a decrease in the company's image on an international scale. • Causes a decrease in the number of customers. • Causing news on an international scale.

Table 3. Criteria of Probability of occurrence

Quantitative		
Score	**Category**	**Criterion**
16	Very Likely (VL)	It must happen routinely.
8	Likely (L)	It has happened several times in the company environment.
4	Possible (P)	Occurs once in a company environment or in other oil &gas activities.
2	Unlikely (U)	It never happens in a corporate environment but it has happened in other oil &gas activities.
1	Very Unlikely (VU)	It never happens in corporate environments and in other oil &gas activities.

Based on the Triangular fuzzy number according to Table 2, then evaluate the determination of the degree of Severity and Occurrence with the Cheng's (1996) model through an extent analysis approach. Determine the object, namely X = {x_1, x_2, …..x_n} and the goal is U = {u_1, u_2,… u_m }. Due to the method of Cheng's (1996) extent analysis of each object to show each goal (g_i), then each object, namely the m extend analysis, is written as Eq. (2) on below:

$$M^1_{g_i}, M^2_{g_i}, \ldots\ldots, M^m_{g_i}, \quad i = 1,2,\ldots, n, \tag{2}$$

While the triangular fuzzy values $M^j_{g_i}$ $(j=1, 2, \ldots m)$. (3)

From the description above, the next steps are:

a. Fuzzy synthetic extent

$$S_i = \sum_{j=1}^{m} M^j_{g_i} \otimes \left[\sum_{i=1}^{n}\sum_{j=1}^{m} M^j_{g_i}\right]^{-1} \tag{4}$$

After that calculate, $\sum_{j=1}^{m} M^j_{g_i}$ for additional fuzzy operations on m extent analysis,

$$\sum_{j=1}^{m} M^j_{g_i} \left(\sum_{j=1}^{m} l_j, \sum_{j=1}^{m} m_j, \sum_{j=1}^{m} u_j\right), i = 1, 2, \ldots, n \tag{5}$$

And get, $\left[\sum_{i=1}^{n}\sum_{j=1}^{m}\sum_{g_i}^{j} M\right]^{-1}$, for additional fuzzy operations on $M^j_{g_i}$ $(j=1,2,\ldots m)$.

Invers $\sum_{i=1}^{n}\sum_{j=1}^{m} M^j_{g_i} = \left(\sum_{i=1}^{n} l_i, \sum_{i=1}^{n} m_i, \sum_{i=1}^{n} u_i\right)$, $\left[\sum_{i=1}^{n}\sum_{j=1}^{m} M^j_{g_i}\right]^{-1} = \left(\frac{1}{\sum_{i=1}^{n} u_i}, \frac{1}{\sum_{i=1}^{n} m_i}, \frac{1}{\sum_{i=1}^{n} l_i}\right)$ (6)

b. Determination of the degree of probability (7)

$M_2 = (l_2, m_2, u_2) \geq M_1 = (l_1, m_1, u_1)$

is $V(M_2 \geq M_1) = \sup_{y \geq x}\left[\min\left(\mu_{M_1}(x), \mu_{M_2}(y)\right)\right]$ (8)

or similar with Eq. (9)

$$V(M_2 \geq M_1) = hgt(M_1 \cap M_2) = \mu_{M_2}(d) = \begin{cases} 1 & if\ m_2 \geq m_1 \\ 0 & if\ l_1 \geq u_2 \\ \dfrac{l_1 - u_2}{(m_2 - u_2) - (m_1 - l_1)} & otherwise \end{cases} \quad (9)$$

Where,

d= ordinate of the highest point of intersection D between μ_{M_1} and μ_{M_2}, to $V(M_1 \geq M_2)$ and $V(M_2 \geq M_1)$

c. The degree of probability for a convex fuzzy number is more than k convex fuzzynumbers

M_1 $(I = 1,2,\ldots,k)$ is $V(M \geq M_1, M_2, \ldots\ldots) = V[(M \geq M_1)$ and $(M \geq M_2)$ and.....$(M \geq M_k)] = minV((M \geq M_i), (i=1,2,\ldots k)$ (10)

assumption that

$$d'(A_i) = \min V(S_i \geq S_k) \quad (11)$$

Which $k = 1,2,\ldots n$; $k \neq i$. then weight vector is

$$W' = \left(d'(A_1), d'(A_2'), \ldots, d'(A_n)\right)^T \quad (12)$$

where, A_i $(i=1,2,\ldots.n)$, n is elements.

d. Normalization of the value of the weight vector

$$W = \left(d(A_1), d(A_2), \ldots, d(A_n)\right)^T \quad (13)$$

W is nonfuzzy number

3.1.1. Determining importance coefficients (weight vectors) by fuzzy prioritization method

The determination of the most important coefficients (Weight Vectors) using the fuzzyprioritization method is carried out after obtaining the fuzzy matrix. In each matrix comparison, the equations that can be used are the following equations (Yayla, 2013)

$$W^{Occurrence} = (w_1^O, w_2^O, w_3^O, \ldots\ldots\ldots\ldots, w_n^O) \quad (14)$$

$$W^{Severity} = (w_1^S, w_2^S, w_3^S, \ldots\ldots\ldots\ldots, w_n^S) \quad (15)$$

$$W^{Detection} = (w_1^D, w_2^D, w_3^D, \ldots\ldots\ldots\ldots, w_n^D) \quad (16)$$

3.1.2. Converting the importance coefficients (weight vectors) into FMEA degrees

The most important coefficients (weight vectors) are the probability values of risk events according to each other. This value can be obtained using the FMEA conversion. First, the risk that has the highest Occurrence value is given the symbol P1. Furthermore, the overall risk of Occurrence, Severity and Detection scoringcan be seen in the following Table 6 - 8 (Özfırat, 2014).

Table 4. Severity coefficient conversion using fuzzy prioritization method into FMEA

A	B	C	D
Risk	Weight Vector for Severity	Severity (The highest valuefrom Table 3)	Degree by according tocoefficients
R_1	w^S_1	S_1	S_1
R_2	w^S_2	-	$S_1 . (w^S_2 / w^S_1)$
…..	…..	-	…..
R_n	w^S_n	-	$S_1 . (w^S_n / w^S_1)$

Table 5. Occurrence coefficient conversion using fuzzy prioritization method into FMEA

A	B	C	D	E
Risk	Weight Vector for Occurrence	Occurrence (The highest value from Table 4)	Occurrence By coefficients	Degree (According to Table 4)
R_1	w^O_1	P_1	-	O_1
R_2	w^O_2	-	$P_1 . (w^O_2 / w^O_1)$	O_2
…..	…..	-	…..	….
R_n	w^O_n	-	$P_1 . (w^O_n / w^O_1)$	O_n

Table 6. Detection coefficient conversion using fuzzy prioritization method into FMEA

A	B	C	D
Risk	Weight Vector for Detection	Detection (The highest valuefrom Table 5)	Degree by according tocoefficients
R_1	w^D_1	D_1	D_1
R_2	w^D_2	-	$D_1 . (w^D_2 / w^D_1)$
…..	…..	-	…..
R_n	w^D_n	-	$D_1 . (w^D_n / w^D_1)$

3.1.3. Finding RPN values

For all risks the RPN values are calculated by Equation (1). In an evaluation of RPN value if RPN value is less than 8 then there is no need for precaution. However, if RPN value ≥ 8 the company must take precautions and suggestions for reducing RPN values (Referring to the internal Standard Operating Procedure (SOP) provided by the company where the case study is conducted)

4. RESULTS AND DISCUSSION

4.1. Identifying Risks

In the early stages it is necessary to determine the scope and team that will be involved in conducting a risk and assessment. So that preliminary information can be obtained in the form of knowledge and understanding of the risks posed by each measurement method used as *custody transfer* at the gas station. The agenda and stages of *Focus Group Discussion* (FGD) are as follows:

1. Scope determination of *Risk Identification* Which will be done.
2. Team discusses the possibility that might go wrong (what might go wrong), if each stage of the flow process custody transfer process does not meet the requirements.
3. Team discusses to compare each custody transfer method that is being/will be used.

The first stage in the risk *identification* process is to determine the mode of failure (risk) of each *custody transfermethod,* the next determines the Potential Cause of Failure,sothat the risks and causes that have been obtained can be determinedthe potential effect of failure(Potential Effect). The risk identified as shown in Table 7.

Table 7. Identification Risk

Risk Identification				
Code	**Process / Function**	**failure fashion (risk)**	**Potential Causes/ Mechanisms of Failure (potential Cause of failure)**	**failure effect (potential Effect)**
R1	Manual dipping	Measurement readings are not updated in real time	The measurement process still uses manual methods.	Data recording is not real time
R2	Manual dipping	Measuring Error	Human Error	Inaccurate recording
R3	Manual dipping	Measuring Error	Measuring Instrument (deep stick) is not calibrated and in a damaged condition (broken / bent)	Inaccurate recording
R4	Manual dipping	Fraud	Human behavior, no surveillance	Losses and material losses
R5	Manual dipping	Manual Measurement Error dipping	Deformation on the tank is measured, so the tank table is inaccurate and must be recalibrated	Inaccurate recording
R6	ATG	ATG Reading Error	ATG is note calibrated.	Inaccurate recording
R7	ATG	ATG Reading Error	ATG Hardware Damage (Sensors, Motherboard)	Inaccurate/unreadable recording
R8	ATG	ATG Reading Error	ATG Software Malfunction (Screen play)	Inaccurate/unreadable recording
R9	ATG	ATG doesn't work.	loss of power source	Unable to do reading/recording
R10	ATG	ATG Reading Error	Tank table settings error on ATG, at prime settings	Inaccurate recording
R11	ATG	ATG Reading Error	Deformation on the tank is measured, so the tank table is inaccurate and must be recalibrated	Inaccurate recording
R12	ATG	Installation Changes	ATG is not placed in a different hole than a manual dipping hole	Cannot be verified manually dipping
R13	Metering System	Measuring Error	Minimum flowrate not met because it does not use pump (using gravity method)	Inaccurate recording
R14	Metering System	Installation Changes	Existing piping systems have not been designed for metering system use	Significant installation changes
R15	Metering System	Measuring Error	The meter is not done tera	Inaccurate recording

4.2. Developing fuzzy pairwise comparison matrixes

In fuzzy prioritization method the AHP method is performed firstly. In fuzzy AHP, the questionnaire can be performed for the comparison of the importance or preference of risk accordingto others for understanding the importance degree of the risks for each other.

The 15 identified risks (as show in Table 9) were weighted for each component, namely severity and occurrence by decision makers (weighted criteria follow Table 2).

The results of the pairwise comparison matrixes are shown in Figure 3 and 4. It was show fuzzy assessment matrixes for severity and occurrence of the risks respectively for custody transfer manual dipping method.

SEVERITY															
Risiko	**R1**			**R2**			**R3**			**R4**			**R5**		
R1	**1,00**	**1,00**	**1,00**	2,50	3,00	3,50	1,50	2,00	2,50	2,50	3,00	3,50	1,50	2,00	2,50
R2	0,29	0,33	0,40	**1,00**	**1,00**	**1,00**	1,50	2,00	2,50	2,50	3,00	3,50	1,50	2,00	2,50
R3	0,40	0,50	0,67	0,40	0,50	0,67	**1,00**	**1,00**	**1,00**	2,50	3,00	3,50	1,50	2,00	2,50
R4	0,29	0,33	0,40	0,29	0,33	0,40	0,29	0,33	0,40	**1,00**	**1,00**	**1,00**	1,50	2,00	2,50
R5	0,40	0,50	0,67	0,40	0,50	0,67	0,40	0,50	0,67	0,40	0,50	0,67	**1,00**	**1,00**	**1,00**

Figure 3. Fuzzy pairwise comparison matrix for severity of risks in custody transfer manual dipping method

OCCURRENCE															
Risiko	**R1**			**R2**			**R3**			**R4**			**R5**		
R1	**1,00**	**1,00**	**1,00**	2,50	3,00	3,50	1,00	1,00	1,00	1,50	2,00	2,50	0,67	1,00	1,50
R2	0,29	0,33	0,40	**1,00**	**1,00**	**1,00**	1,00	1,00	1,00	1,50	2,00	2,50	0,67	1,00	1,50
R3	1,00	1,00	1,00	1,00	1,00	1,00	**1,00**	**1,00**	**1,00**	1,50	2,00	2,50	0,67	1,00	1,50
R4	0,40	0,50	0,67	0,40	0,50	0,67	0,40	0,50	0,67	**1,00**	**1,00**	**1,00**	0,67	1,00	1,50
R5	0,67	1,00	1,50	0,67	1,00	1,50	0,67	1,00	1,50	0,67	1,00	1,50	**1,00**	**1,00**	**1,00**

Figure 4. Fuzzy pairwise comparison matrix for occurrence of risks in custody transfer manual dipping method

4.3. Converting importance coefficients into FMEA degrees and calculating RPN values

After operating fuzzy AHP steps we calculated weight vectors for three dimensions such as severity and occurrence. The importance coefficients is converted FMEA degrees as shown on Table 10.

Table 10. Computing occurrence and severity degrees

Risk	W-Occurrence	Occurrence (The highest value)	Occurrence by coefficients	Degree (According to Table Scoring Criteria)	W-Severity	Severity (The highest value)	Severity by coefficients	Degree (According to Table Scoring Criteria)
R1	0,27	1,00	-	10	0,36	0,80	-	8
R2	0,18	1,00	0,65	6	0,23	0,80	0,52	6
R3	0,22	1,00	1,23	10	0,19	0,80	0,67	6
R4	0,13	1,00	0,60	6	0,11	0,80	0,43	4
R5	0,20	1,00	1,54	10	0,11	0,80	0,80	8

After calculating the degrees of occurrence, severity, and detection, the RPN values are computed according to Eq. (1). The calculated RPN values and mitigating action are shown in Table 11. Some RPN values shown in these tables are higher than 8. That's mean we have to suggest proactive and reactive precautions (mitigating action) for these risks. After the follow-up risk is carried out, a re-measurement or estimate of the impact value and the value of the possibility of failure. After that, the calculation of the priority level value of the risk of re-failure is carried out. The results of the follow-up should result in a significant decrease in the value of RPN to a fairly safe level. If it has not been achieved, further action is needed to minimize RPN by using the rules of As Low ***As Reasonably Practicable*** **(ALARP).** After the recalculation process to obtain residual risk.

Table 11. RPN Values and mitigating action

Risk Identification					Risk Analysis			Risk Treatment	Residual Risk		
Kode	**Proses / Fungsi**	**Mode Kegagalan (Risiko)**	**Potensi Penyebab/ Mekanisme Kegagalan (*Potential Cause of Failure*)**	**Efek kegagalan (*Potential Effect*)**	**Keparahan (*Severity*)**	**Probabilitas Kejadian (*Occurrence*)**	***Risk Priority Number (RPN)* S x O**	**Rekomendasi Tindak Lanjut**	**Keparahan (*Severity*)**	**Probabilitas Kejadian (*Occurrence*)**	***Risk Priority Number (RPN)* S x O**
R1	Manual dipping	Pembacaan pengukuran tidak update secara real time	Proses pengukuran masih menggunakan metode manual	Pencatatan data tidak real time	8	10	80	Merubah proses custody transfer dari metode manual menjadi metode digital	2	2	4
R2	Manual dipping	Kesalahan Ukur	Human Error	Pencatatan tidak akurat	6	6	36	1. Pelaksanaan program shift dan prosedur shift hand over untuk menjaga kondisi tetap 'fit to work' 2. Pelaksanaan program extra fooding	4	4	16
R3	Manual dipping	Kesalahan Ukur	Alat Ukur (deep stick) tidak terkalibrasi dan dalam kondisi rusak (patah/bengkok)	Pencatatan tidak akurat	6	10	60	1.alat ukur harus selalu dikalibrasi secara berkala 2. Pelaksanaan program maintenance peralatan dilaksanakan dengan baik.	4	4	16
R4	Manual dipping	Fraud	Human Behaviour, tidak ada pengawasan	Losses dan kerugian material	4	6	24	Merubah proses custody transfer dari metode manual menjadi metode digital	2	2	4
R5	Manual dipping	Kesalahan Pengukuran Manual dipping	Deformasi pada tangki yang diukur, sehingga tabel tangki tidak akurat dan harus dikalibrasi ulang	Pencatatan tidak akurat	8	10	80	Pelaksanaan program maintenance peralatan dilaksanakan dengan baik.	4	4	16
R6	ATG	Kesalahan Pembacaan ATG	ATG tidak dikalibrasi	Pencatatan tidak akurat	4	8	32	1.alat ukur harus selalu dikalibrasi secara berkala 2. Pelaksanaan program maintenance peralatan dilaksanakan dengan baik.	1	1	1
R7	ATG	Kesalahan Pembacaan ATG	Kerusakan Hardware ATG (Sensor, Motherboard)	Pencatatan tidak akurat / tidak terbaca	4	2	8	Pelaksanaan program maintenance peralatan dilaksanakan dengan baik.	2	2	4
R8	ATG	Kesalahan Pembacaan ATG	Kerusakan Software ATG (Screen play)	Pencatatan tidak akurat / tidak terbaca	0	0	0	Pelaksanaan program maintenance peralatan dilaksanakan dengan baik.	2	2	4
R9	ATG	ATG Tidak Berfungsi	Hilangnya sumber daya listrik	Tidak dapat melakukan pembacaan / pencatatan	0	0	0	Penyediaan Sumber daya cadangan (Genset)	2	2	4
R10	ATG	Kesalahan Pembacaan ATG	Kesalahan setting tabel tangki pada ATG, pada saat setting perdana	Pencatatan tidak akurat	0	0	0	Pelaksanaan pendampingan dan pengawasan (supervisi) pada saat setting perdana dengan fungsi yang kompeten	2	2	4
R11	ATG	Kesalahan Pembacaan ATG	Deformasi pada tangki yang diukur, sehingga tabel tangki tidak akurat dan harus dikalibrasi ulang	Pencatatan tidak akurat	0	0	0	Pelaksanaan program maintenance peralatan dilaksanakan dengan baik.	2	2	4
R12	ATG	Perubahan Intalasi	ATG tidak ditempatkan pada lubang berbeda dengan lubang dipping manual	Tidak dapat dilakukan verifikasi dengan manual dipping	0	0	0	Pelaksanaan pendampingan dan pengawasan (supervisi) pada saat commisioning dengan fungsi yang kompeten	2	2	4
R13	Metering System	Kesalahan Ukur	Minimum flowrate tidak terpenuhi karena tidak menggunakan pompa (menggunakan metode gravitasi)	Pencatatan tidak akurat	4	4	16	Penambahan armada mobil tangki menggunakan sistem PTO	4	4	16
R14	Metering System	Perubahan Intalasi	Sistem perpipaan eksisting belum didesain untuk penggunaan metering system	Perubahan instalasi yang cukup significant	4	4	16	Perubahan sistem instalasi perpipaan	4	4	16
R15	Metering System	Kesalahan Ukur	Meter tidak dilakukan Tera	Pencatatan tidak akurat	8	10	80	1.alat ukur harus selalu dikalibrasi secara berkala 2. Pelaksanaan program maintenance peralatan dilaksanakan dengan baik.	6	6	36

5. CONCLUSIONS

In this paper, we applied FMEA technique with fuzzy prioritization method for a oil & gas company. Failures and risks were determined in a Focus Group Discussion by selected Teams. For all potential risk's severity and occurrence values were determined. As a result, Risk which identified from whole method *custody transfer* totaling 15 risks, consisting of 5 risks for *custody transfer* method *Manual Dipping*, 7 risks for *custody transfer* method *Automatic Tank Gauging,* and 3 risks for *custody transfer* method *Metering System*, where all of these risks own Mark *Risk Priority Number (RPN)* more from 8. So the whole method *custody transfer* it is necessary to control and mitigate risk. Risk reduction or control actions are required. Risk control recommendations for all high and medium risks must be reviewed and approved by Decision Makers. *Custody transfer* method *Manual Dipping* has a high risk that has an impact on the risk of recording data not in real time, risk of losses and risk of inaccurate recording. So it is necessary to control this risk by changing the custody transfer process from a manual method to a digital method to obtain the value of *Risk Priority Number (RPN)* less residual risk from 8. *Custody transfer* method *Metering system*has a high and medium risk that has a risk impact in the form of inaccurate records so that it is necessary to control this risk by adding a fleet of tanker cars using the PTO system and changing the piping installation system.

However, the residual risk generated is still a medium level risk and has a value *Risk Priority Number (RPN)* residual risk more from 8 so it is not suitable to be implemented at gas stations. *Custody transfer* method *Automatic Tank Gauging,* is method *custody transfer* selected to be implemented because it has a residual risk with a value of *Risk Priority Number (RPN)* less residual risk from 8 and according to the rules ***As Low As Reasonably Practicable*** **(ALARP)** namely actions taken based on the level of risk to reduce and control the potential risk as low as possible and which can be applied at gas stations.

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TRANSPORTATION FLEET SOURCING STRATEGY FOR A THIRD-PARTY LOGISTICS SERVICE PROVIDER USING A SIMULATION APPROACH

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ABSTRACT

Today's logistics market competition is getting tighter and more complex, so companies must make efficiencies to compete with competitors. PT X is a 3PL company in Indonesia has a core operational process: transportation, that customers urgently need to deliver their goods and services to their expected destinations at a low cost. Nowadays, a truck trailer is a fleet that is always used to support transportation activities; the current operational process at PT X uses a combination of the private fleet 42.7% and 57.3% outsourcing (vendor and spot market). To compete with competitors, PT X improves efficiency by using a discrete-event simulation approach with three trade-off performance indicators: total cost, utilization, and shipment reliability. After getting the simulation results, an analysis was carried out using the Simple Additive Weighting approach and the results obtained that the selected scenario was a vendor based scenario with the percentage of fleet usage fulfilled from the outsourcing fleet: six vendor fleets and the other necessary fleet will be supported by the spot market.

Keywords: truck trailer, proportion sourcing, cost, utilization, shipment reliability, discrete-event simulation

1. INTRODUCTION

Today's logistics market competition is getting tighter and more complex, so companies have to make efficiencies to compete with competitors. In logistics, transportation is one of a core process that will determine the success of these logistics activities. Without transportation, there will be no logistics process and the movement of goods from one point to another (Collignon, 2016). The importance of efficiency in transportation for companies has different objectives, but in general, the problem of efficiency and optimization of transportation has the aim of minimizing costs (Stojanović & Nikolić-Đorić, 2014). In carrying out this efficiency process, logistics actors will face problems that tend to be complex. This is due to the many uncertainties that come from various aspects of the scope of transportation. According to (Kantari et al., 2020) and (Wang & Wallace, 2016), some aspects include fleet availability and transportation demand. In this case, several companies have adequate facilities and assets for their operational activities is an essential factor for companies to determine the most appropriate strategy in terms of fleet procurement, whether the company must invest or use a third party fleet. It is an anticipation to minimize the chance of delays in operational activities while taking into account the economic aspect, as of

many companies choose to collaborate at the same logistics level to achieve economies of scale and increase the company's level of responsiveness (Li et al. al., 2016).

This research takes a case study on determining the optimal proportion of truck trailer sourcing in the company's distribution process between the company's fleet and outsourcing (long-term and spot market) with performance indicators: utilization, cost, and shipment reliability. This research was conducted in one of the third-party logistics companies, PT X, Indonesia's logistics service providers. As a logistic company, PT X does the activities according to orders from its customers. Truck trailer is the most used fleet for operation distribution than other fleets, but it still needs to improve strategy because it is still inefficient on performance indicators of the utilization, cost, and shipment reliability (customer satisfaction).

Nowadays, a truck trailer is a fleet that is always used to support transportation activities; the current operational process at PT X uses a combination of the private fleet 42.7% and 57.3% outsourcing (vendor and spot market). Currently, PT X has four private fleets and one vendor (long-term), but the percentation shows that vendor is more common than the use of private fleets and on the other hand, PT X still needs support from other spot market to handle customers demand. It is one of some factors will requires higher operational costs and the selling price will be uncompetitive. Another factor that decreases customer satisfaction is the occurrence of delays in delivery, the impact of the delays is not only deliveries that do not arrive on time but customers also have to pay demurrage and detention fees. This is due to the fact that PT X has not conducted a quantitative analysis of the fleet in order to determine the real number of fleets required. In complex and dynamic conditions: uncertain demand, limited resources, cost and time, and the distribution of proportions in fleet sourcing activities, both companies and outsourcing (long-term contracts and spot markets) cannot be solved by simple mathematical calculations. This research will use a discrete-even simulation approach to facilitate problem-solving and describe the company's operational situation in real terms.

This research has three main objectives. The first objective is to model the transportation sourcing issues that exist in PT X by evaluating the implementation of the company's optimal proportion of in-house and outsourced truck trailers. The second objective is to determine a different proportion of truck trailers carried out in-house and outsourced. The third objective of this study is to conduct a robustness analysis for the application of alternative sourcing proportions based on utilization, cost, and shipment reliability parameters.

2. LITERATURE REVIEW

Distribution activity is one of the operational forms of logistics companies, and one of the essential thing is transportation. Kantari et al. (2020) stated that transportation sourcing has two types: in-house sourcing and outsourced. In-house sourcing is a fleet owned by a company in which the responsibility for the fleet rests entirely with the company. While the outsourcing referred to here is a fleet that is functioned to assist the running of the company's operational processes, with the responsibility of the fleet being on the company providing the fleet (vendor). Angkiriwang et al. (2014) suggest that companies must provide the best quality service to customers and deliver goods to customers at competitive costs and on time according to customer expectations to stay in this business with increasingly competitive market competition. The operational costs also depend on how often the company uses its private fleet. Stojanović & Nikolić-Đorić (2014) argue that the size of the company's fleet size and the structure of the logistics system depends on the characteristics of demand, especially the characteristics of on-time demand in the supply chain.

To strengthen the effectiveness of their strategy and operations, companies need to support several factors, including financial support with the availability of assets that will support the company's financial health. Logistics companies that routinely deal with the distribution of goods can use their owned fleet to run their operations when they have a stable demand for a certain period. This case provides economies of scale and lower transportation costs than using a fleet from an external party (Stojanović et al., 2011). However, in practice, not all companies have complete fleets to handle all customer requests, so they need to collaborate with other parties (partners/vendors) by establishing cooperation, both in vendor and spot markets. Companies need to consider when deciding to increase the number of contract carriers, which will increase the company's reliability in meeting customer needs (Kantari et al., 2019). This study divides the company's contract-based operational needs into vendors and spot markets. A long-term contract is an agreement made by a company with a service provider or vendor to provide a specific fleet within a certain period to be used as agreed upon in the agreement. The spot market is an agreement between a company and a third party (service provider/vendor) to make delivery/distribution in a travel activity with a specific route according to the request from the company without tying up the fleet used within a certain period. Wang & Wallace (2016) state that companies may use the spot markets fleet if the owned fleets are overcapacity. It's to avoid stock-outs and maintain customer satisfaction.

The collaboration process between private fleets, vendors, and spot markets challenges companies to determine the optimal proportion to streamline utilization and costs. It can be done with a discrete-event approach. According to Barrett et al. (2008), discrete event simulation (DES) is a method used to model real-world systems that can be decomposed into a series of logically separate processes that develop autonomously over time. Discrete-event simulation models are increasingly being used to solve synchronization problems between resources. A few companies have handled many cases using this simulation method to evaluate operational activities, productivity, and other evaluation activities (Parola & Sciomachen, 2005). Several researchers have expressed their opinions about discrete-event simulation to solve some problems. Kantari et al. (2020) stated that discrete-event simulations had been used to identify the right combination and effect of demand fluctuations as measured by three performance indicators: product fill rate, shipment reliability, and truck usage. In another study, Babulak & Wang (2010) stated that companies must create a balanced system between customers and efficient operations, shortening processing time, reducing waiting times, and increasing resource utilization. The researchers argue that many companies get better at decision-making by using discrete-event simulations.

In addition, the selection of the discrete-event simulation method also considers the advantages of the discrete-event simulation method, including: (1) Not all systems (incredibly complex systems) can be represented in mathematical models so that simulation is the suitable alternative; (2) The model that has been made can be used repeatedly for further analysis for data accuracy; (3) Simulation can estimate the performance of a system under certain conditions; (4) Can provide the best alternative design based on the desired specifications; (5) Easy for users to understand with the help of animations and graphics built into the software package; (6) Has unlimited flexibility to determine the behavior of entities; (7) Easier to model once the problem is clearly defined. Of the several advantages, discrete-event simulation also has several weaknesses, including (1) Being less effective in showing the true impact of variability; (2) It is not very suitable to analyze models related to human behavior. The software used in the discrete-event simulation method includes Promodel and Arena.

3. METHODS

This study is an application in a case study in determining the integration analysis on distribution activities performed by PT X, namely determining the optimum proportion between company assets and outsourcing (vendor and spot market) in the case of sourcing truck trailers in the company and determining the percentage of fleet procurement for operations (with performance indicators: utilization, cost, and shipment reliability) with optimal proportion. The approach in this integration analysis is made by using and developing the DES (Discrete-Event Simulation) method, which is supported by the Arena software. This software was chosen because the Arena software tends to be easier to understand and access in the simulation process. The passed stages have a systematic relationship because the output in the previous step is the input in the next step. The output used in this research is fluctuating customer demand, while the output is different cost, utility and shipment reliability, and operational efficiency. The results obtained in the previous step will be used as data for data processing at a later step. The research presentation is carried out in three steps, as follows.

- Level 1: Data collection - The first level, which will be the first step in the research process, begins with a literature review and field studies to obtain the needed data.
- Level 2: Data processing - The second level is a data processing and system modeling. In the system modeling stage, a simulation process will be carried out on existing data and data integration analysis to obtain the optimal proportion between company assets and outsourcing.
- Level 3: Analysis of results and conclusions - The third level in this research is analyzing the results to compare existing data results with the results of data integration analysis, which will then be interpreted to obtain final results and conclusions.

In addition to doing the steps correctly, it is also necessary to describe the logistics distribution system and develop a model. In the logistics distribution system description, the input used is fluctuating customer demand, with truck trailer resources that need to be adjusted in proportion. At the same time, the outputs are different costs, utilities, and shipment reliability. The improvement is successful until the company finds an efficient proportion strategy. In this logistics distribution process, several factors determine the success of the shipper, including factors that can be controlled: company resources (truck trailers) in terms of using their private fleet, vendor, and spot markets. On the other hand, customer demand is one factor that cannot be controlled because it is unpredictable.

This study also carried out the development of a work pattern model for the appointment and activity of trucks in the distribution process. In the process, the initial stage of the shipper (company) determines what fleet will be assigned to carry out distribution activities. The shipper has three options for carrying out this task: the shipper prioritizes the company's owned fleet and the vendor already available at the company's location. However, if the prioritized fleet is insufficient to handle customer demand, the company will use a fleet from the spot market. In the next step, after the shipper has succeeded in determining what fleet will be assigned to the distribution process, the assigned fleet will carry out the loading process. The next stage is to carry out the distribution process to the destination. When arriving at the destination, container will be unloaded and the fleets will be returns to the initial location. The standby fleet waits for the next distribution activity (private fleet & vendor) and returns to the spot market fleet.

Figure 1 illustrates the development of a work pattern model for the appointment and activity of trucks in the distribution process

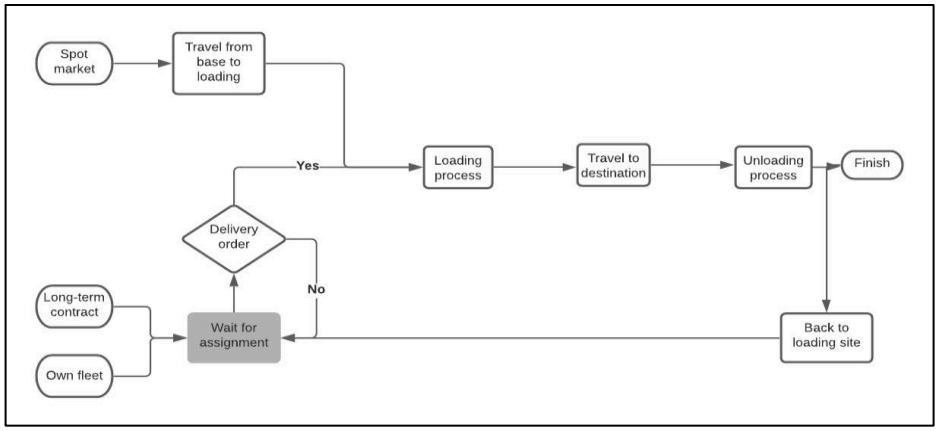


Figure 1. Work Patterns and Truck Activities

In this research, two kind simulations will be carried out: existing simulation and proposed simulation. The processed or simulated data is the company's existing and analyzed data to get the optimal proportion. In addition, system modeling will also be carried out. The model is built by exploring several variables, including the distribution process, mileage, delivery time, shipping costs, and company historical demand/order data using a discrete-event simulation system approach. The modeling of this system begins with creating a distribution system concept based on actual conditions. The conceptual system is used to describe the discrete-event simulation. It will use the Arena software based on the available menu by inputting predetermined parameters: fleet utilization, cost, and shipment reliability. The system built on the software is expected to be close to the actual condition until existing shipments' utilization, cost, and reliability, and integration analysis results with optimum proportions are obtained. The existing simulation and integration analysis data will be analyzed to determine what factors influence the expected final result, whether it is successful or not.

4. RESULTS

This section will describe the results of data collection, the simulation process, and the simulation results obtained.

4.1 Data Collection Results

In collecting data, the results of the percentage of fleet use at PT X are shown in Figure 2 below. Based on the data obtained, PT X uses trailers much more often in its operational activities than other fleets. It is shown that the usage with the highest percentage is the trailer: 61% and the usage with the lowest percentage is tronton: 1% only.

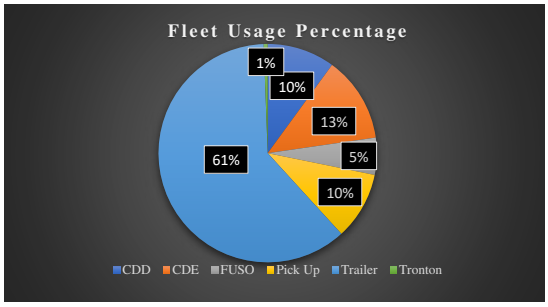
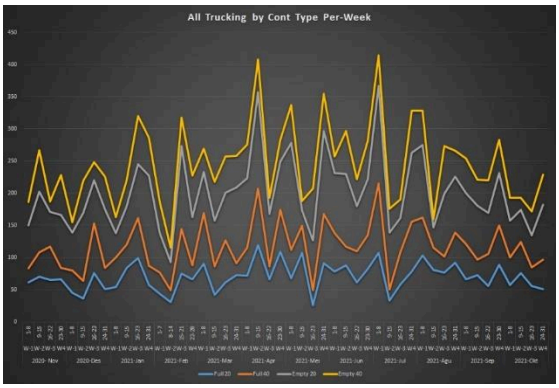
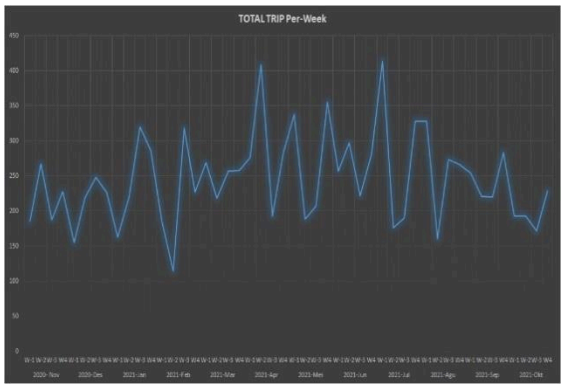


Figure 2. Fleet Usage Percentage

(a) In addition to the results of the percentage of fleet usage, based on historical company data, data on the number of trucking container volumes per week and the number of trips per week are obtained, which are illustrated by the graph below. The number of trucking container volumes shows that each container that has been delivered with different capacities and type. One illustration that can be seen is a full container with a capacity of 20 ft (blue line). The highest volume is shown in the second week of April 2021 as many as >100 containers, while the lowest volume is shown in the third week of May 2021 with <50 containers of 20 ft. For details on the number of trucking container volumes, other capacities can be seen in (b)

Figure 3(a). In contrast to the number of trucking volumes, Figure 3(b) is a graph of the number of trips per week which shows that the number of trips per week with the highest number of trips is about > 400 trips that occur in the first week in July 2021. While the second week in February 2021 is the lowest number of trips per week that does not reach 150.





(b) **(b)**

Figure 3 (a). Weekly Volume Trucking Per-Fleet ; **(b)**. Weekly Total Volume

Shipping costs per unit container are classified into three categories based on available fleet: private fleet delivery costs, vendors, and spot markets. The shipping costs for each fleet are shown in Table 1. The most expensive option for an empty 20-ft container is to use a spot market fleet (Rp. 300,000 per unit container), while the cheapest option is to use a private fleet (Rp. 240.000 per unit container). The following table contains information on other costs.

Table 1. Delivery Cost Per Unit Container

Delivery Cost Per Unit Container											
Private Fleet				*Vendor*				*Spot Market*			
20' Feet		40' Feet		20' Feet		40' Feet		20' Feet		40' Feet	
Empty	Full	Empty	Full	Empty	Full	Empty	Full	Empty	Full	Empty	Full
Rp240,000	Rp400,000	Rp375,000	Rp650,000	Rp250,000	Rp500,000	Rp500,000	Rp700,000	Rp300,000	Rp556,000	Rp600,000	Rp800,000

4.2 Simulation Process

As a reference in simulation modeling, a conceptual model (Figure 4) is created during the simulation process. The conceptual model that corresponds to the actual conditions is then modeled into a simulation using the Arena software. Several parameters associated with the conceptual model are designed to correspond to PT X's distribution system characteristics. Some of these parameters include cost, utilization, shipment reliability, and taking into account other

factors with the expectation that the model will be built based on actual conditions in the company.

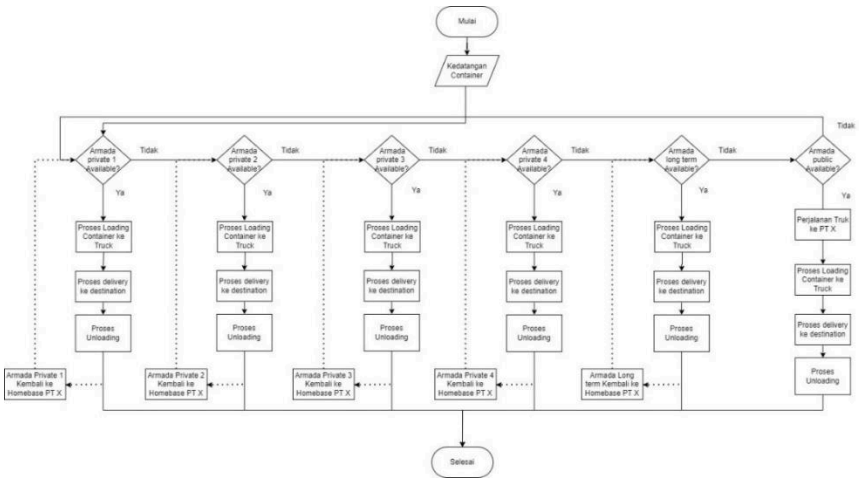


Figure 4. Conceptual Model

In determining the number of replications, the simulation is carried out as many as n replications to reduce the number of variations. The process of obtaining the value of n necessitated an initial replication of n_0, which is ten replications. The following data is result from initial replication for 10 times.

Table 2. Number of Replications and Container Shipments Per Year

Numbers of Replications	1	2	3	4	5	6	7	8	9	10
Annual Container Shipment Report Data	12027	11955	11847	11864	12063	11878	11592	11933	11808	11404

Verification and validation process is needed for the model created. The verification process is a process of correctly checking the conceptual simulation model (from the flowchart made and the assumptions built) into the programming language. The verification process aims to detect logical errors or program algorithms, syntax, model design, and model implementation. Model verification is classified into model structure verification, syntax error verification, and semantic error verification. Model validation is the process of determining whether the conceptual model reflects the real system. In this study, model validation was carried out by testing the number of container receipts in one year. When the actual conditions are successfully modeled and simulated, the next step of this research is to look for improvement scenarios that can be implemented in the system.. After the improvement scenarios are identified, the improvement scenario analysis is continued by modeling and observing the parameters attached to the distribution system.

In this study, several improvement scenarios were made with changes to several private fleet resources, vendors, and spot markets. The whole proposed scenarios are 11 scenarios and one existing scenario with details on the number of private fleets, vendors, and spot markets, as shown in Table 3 below.

Table 3. Proposed Scenario with Fleet Changes

SCENARIO	Existing	Proposed Scenario 1	Proposed Scenario 2	Proposed Scenario 3	Proposed Scenario 4	Proposed Scenario 5	Proposed Scenario 6	Proposed Scenario 7	Proposed Scenario 8	Proposed Scenario 9	Proposed Scenario 10	Proposed Scenario 11
PRIVATE ARMADA	4	5	3	2	1	0	6	5	0	1	3	1
VENDOR	1	0	2	3	4	5	0	1	6	5	1	3
SPOT MARKET	Optional	Optional	Optional	Optional	Optional	Optional	Optional	Optional	Optional	Optional	Optional	Optional

4.3 Simulation Results

Several comparison results are obtained based on several scenarios run in the simulation: a comparison of the total utility of trucks for each fleet in a year, the total cost of each fleet in a year, and the total delay of containers for each fleet in a year. The outcomes of this comparison are depicted in the graph below.

Figure 5 shows a graph comparing the total utility of each truck using the existing scenario and 11 proposed scenarios with a percentage of 10% -100%. Based on the graph, it is known that the highest average utilization of private fleets and vendors is using repair scenario 11, which is 92% and the lowest utilization is using repair scenario 7, which is 60%. The target set for weekly fleet deliveries is 40 trips.

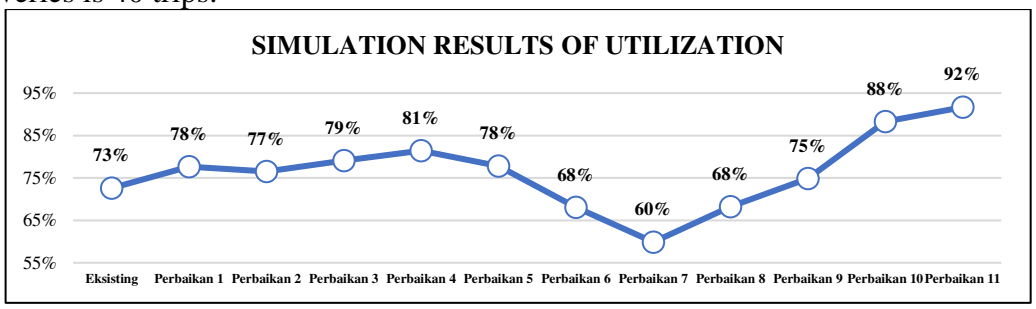


Figure 5. Simulation Result of Utilization

Figure 6 is a graph of the total cost of all fleets owned by PT X which shows that the highest total cost is to use repair scenario 5 of Rp. 2,895,016,175 and the lowest total cost is using repair scenario 1, which is Rp. Rp2,498,652,346.

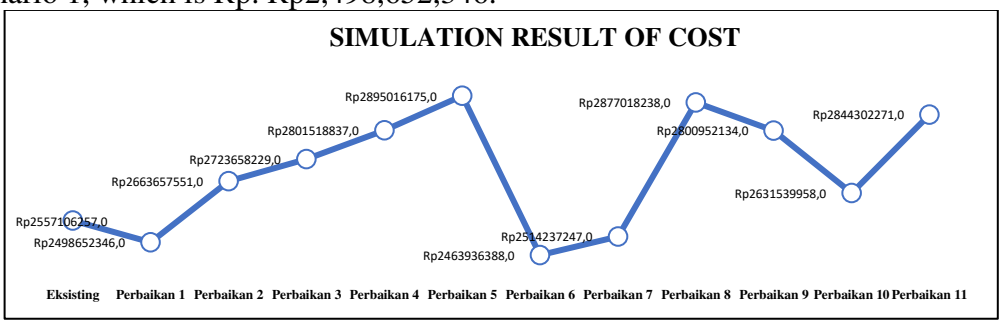


Figure 6. Simulation Result of Cost

Figure 7 is a The following is a graph of the total delay in delivery. Based on the graph, it is known that the highest total delay in delivery in a year is using scenario 11 repair, which is around 2042 units per year. While the lowest is to use the 8 repair scenario with a total of 4 units per year. The delivery process is said to be late if the process is more than 2.5 hours or 150 minutes.

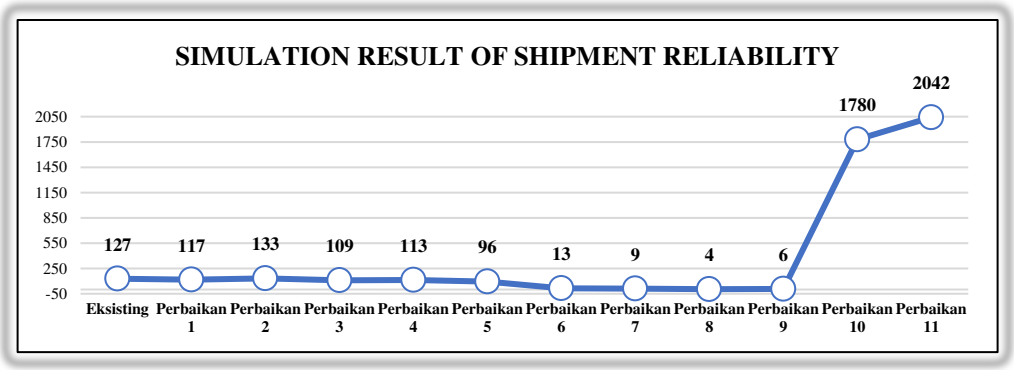


Figure 7. Simulation Result of Shipment Reliability

To achieve the best results, simulations were run with several improvement scenarios based on three-parameter categories: cost, shipment reliability, and utility. Table 4 summarizes the best results for some of these parameters and their improvement scenarios. The best result for cost in scenario proposed 6 is Rp. 2.463.936.388. It is known that the results of shipment reliability are 4 units in scenario proposed 8, and the best result for fleet utility is 92% in scenario proposed 11.

Table 4. Summary Result

PARAMETER	BEST RESULT	BEST SCENARIO
Cost	Rp 2.463.936.388	Scenario Proposed 6
Shipment Reliability (*late*)	4	Scenario Proposed 8
Utility	92%	Scenario Proposed 11

After getting the results from running the simulation, this study make a comparison to find out the significance using a confidence interval. Based on the results obtained from the simulation with 12 scenarios after running, conclusions are drawn to determine the optimum scenario based on the parameters that have been set and also by weighting each parameter using Simple Additive Weighting (SAW). Then depending on the ranking, the optimal scenario was determined. The first best result is Scenario proposed 8, the second is Scenario proposed 9, and the third was Scenario proposed 7, and so on as can be seen in the following Table 5.

Table 5. Result of Simple Additive Weighting

RANKING	SCENARIO	VALUE
1	Scenario Proposed 8	0.8761865
2	Scenario Proposed 9	0.8151169
3	Scenario Proposed 7	0.7293645
4	Scenario Proposed 6	0.7143147
5	Scenario Proposed 1	0.6351669
6	Scenario Proposed 10	0.6318122
7	Scenario Proposed 11	0.6116645
8	Eksisting	0.6110800
9	Scenario Proposed 3	0.6060571
10	Scenario Proposed 2	0.6050799
11	Scenario Proposed 4	0.6013783
12	Scenario Proposed 5	0.5822315

5. CONCLUSIONS

This research takes a case study on determining the optimal proportion of truck trailer sourcing in the company's distribution process between the company's fleet and outsourcing (long-term and spot market) with three performance indicators: utilization, cost, and shipment reliability by using and developing the DES (Discrete-Event Simulation) method, which is supported by the Arena software. In this research, two kind simulations have ben carried out: existing simulation and proposed simulation. The simulate was adapted to eksisting condition and proposed simulation is an improvement by changing the proportion of the company resourch fleet to get the optimal proportion. the simulation was carried out with several scenarios: 1 existing scenario and 11 proposed scenarios. to get the conclusion, analysis of the results has been carried out using Simple Additive Weighting approach (SAW). After the analysis is carried out based on the weighting that has been set, the best scenario is obtained based on the ranking. The best result is Scenario proposed 8, second is Scenario proposed 9, and third is Scenario proposed 7, and so on.

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PROCESS OF DESIGN RESEARCH AND DEVELOPMENT AS BUSINESS ACTIVITY AT CREATIVE CENTER STP ITS

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ABSTRACT

Creative Center, Science Techno Park (STP) is one of organization as part of ITS's goal for becoming Research and Innovative University in 2025. STP-ITS has concept of self-sustainability and professional management in generating economic values trough technology innovation for society wellbeing along with Creative Industry as Indonesian competitive sector. At internal side, all of technology and study group in ITS are welcomed to take a role moreover doing collaboration along with any other group or Center of Excellent to bring new products and or services innovation. On the other side, Technology based Industry, creative communities and local authority invited as external important part of ITS within creative ecosystem functionality. The rate of innovation, creation and creativepreneurship fostering certainly varies across different sectors and subject as technology is frequently progressing and must develop with it to stay competitive. As early 2020 Covid-19 hits hard in Indonesia, all these previous paradigms forced to make adaptation to survive. Priorities was changed including all process in Creative Center, but innovation process and business must go on. While Industry 4.0 era still the primary transformation agent for many activities, it's crucial to look toward the future, yet new standard operation procedure haven't been defined, as new strategic plan, and business model got this challenged too. Design Thinking used as method for determining approach of changes. This method lining up the action plan of Creative Center's value preposition, culture and strategic plan, instead of about how to design physical product. Trough humanity phases of Empathize, Define, Ideate, Prototype, and Testing, this research will explore any possible solution from STP-ITS key stake holder. This research expected to bring some recommendations for Design Research and Development implementation as business transformation for Creative Center.

Keywords: Creative Center STP ITS, Creative Industry, Research and Development, Design Thinking, Business Innovation Process

1. INTRODUCTION

Creative era trough innovation has contributed to advancement of global civilization and improvement of society's welfare. The Creative (and Culture) sector has open so many opportunities for economic growth to achieve a sustainability. ITS as part of global and especially Indonesian's technology society trough new motto, "Advancing Humanity" that means to advance the civilization within technology for humanity, took important engagement. Vision of being Research and Innovative University in 2025 and then Entrepreneurial University in 2035, become

innovation driver of ITS development including at creative sector within technology. Since technology become core of ITS as at Creative Center too, Research and Development activity surely leading activity and competitive factor. There are good quotes from Joko Widodo, President of The Republic of Indonesia "*If we try to compete with Germany and China in high tech industries, we'll lose. But in Creative Economy, the odds are in our favour*!" - (OPUS BEKRAF 2019) and "*Creative Economy is the materialization of added values from an intellectual property born of the human creativity, based on science, culture, and technology*." Republic of Indonesia Creative Economy Bill. Furthermore, the creative economy considered as an ecosystem that comprises a wide range of activities by the generation through individual creativity driving the generation and use of intellectual property. "The creative economy is likely to be a key driver of economic growth over the long term. The importance of the creative economy for overall economic performance is therefore likely to grow, this means its importance for policymaking is also likely to continue to grow, with countries more or less well-positioned to take advantage of that underlying growth in global demand", *Deloitte (2021),* From global view to STP-ITS, main concept of Creative Center is creative sectors implementation for self-sustainability within professional management in generating economic values trough technology innovation. In internal of STP ITS, all of technology and study group are welcomed to take a role, moreover doing collaboration along with any other group or Center of Excellent for products and or services innovation. On the other side, Technology based Industry, creative communities and local authority invited as external important parts of ITS within creative ecosystem. Then March 2020 COVID19 pandemic occur in Indonesia, things changed including how to conduct design research and development as business activity at Creative Center STP ITS.

2. LITERATURE REVIEW

2.1. ITS Preparation and Support for Creative Sector

Since 2016, preparation had been made by ITS. The business implementation is not a "brick and mortar type" rather than comprehensive one as real assets do count. Human Resources, facilities, Infrastructures, activity program plan was designed in masterplan for STP Zone area within 21 Hectare ITS's land

Figure 1, Masterplan location for STP ITS, Image by Creative Center Team 2020

Figure 2. Facilities Design for Creative Center - Image by Creative Center Team 2020

Masterplan design for STP ITS was estimated to complete in 2024, (ITS 2020, *STP ITS Masterplan Final Report)*. Figure (1) and (2) show the design that ongoing progress status for construction and procurements. As all the infrastructure and facilities is not available yet, STP office become headquarters for Creative Center while every related activity on progress.

Figure 3. Creative Center STP ITS Office - Documentation by Creative Center Team 2020

In Creative Center STP ITS, Technology Subjects that exist on ITS's departments under Faculty stands as contributor and woven within internal collaboration directed by Creative Center Manager. As Covid-19 cause activity interaction changed, research priorities forced to support medical subject, including at Creative Center although the business aspects still unknown, but innovation process must go on. This COVID-19 outbreak delivered both supply and demand shocks. Supply was disrupted through lockdowns and materials production stoppages, logistics disruptions and change of working interaction from offline to online. Global Pandemic did matter. "These shocks had adverse effects on production, trade & FDI, on Global Value Chains (GVCs)". *UNCTAD,2021.* All Activities in STP ITS Office got adjusted, even more some was on hold.

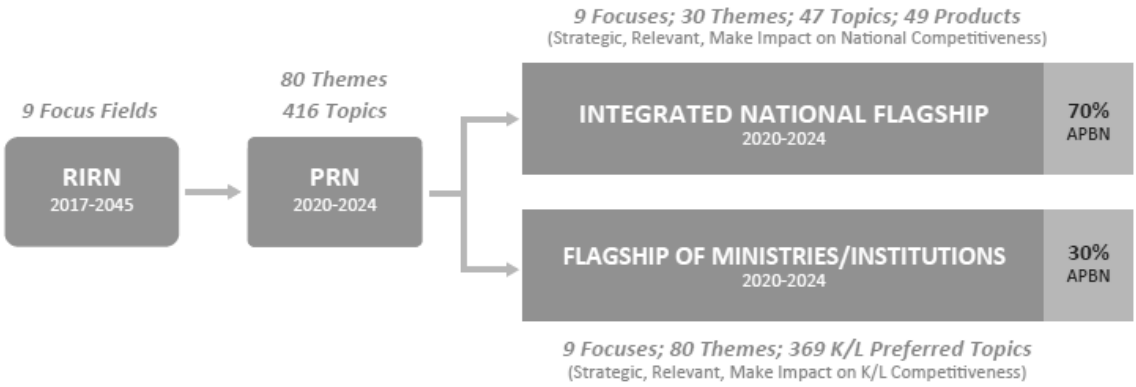
2.2. Process of Design Research and Development as Business Activity.

North Star of R&D as business activity reflect on this good Indonesian quote *"Indonesia 2045: Berdaulat, Maju, Adil, dan Makmur".* "First, the development of human resources will be our main priority; building a workforce that is hard-working, dynamic, skilled, with a mastery of

science and technology, [as well as] inviting global talents to work together with us". *President Joko Widodo (2019) Inauguration Speech, 20 October 2019*.

Furthermore, the scheme of R&D refers to 9 (nine) research fields are listed as the focus fields of Indonesia's 2017-2045 National Research Master Plan (RIRN) that are (1). Food, (2). Energy (3). Health, (4). Transportation, (5). Engineered products, (6). Defence and security, (7). Maritime, (8). Social, humanities, and (9). Other research fields (as determined by the Indonesian Ministers).

The RIRN is then translated into the National Research Priorities (PRN), to "Establishment of Focuses, Themes, Topics, And Products in 2020 - 2024 National Research Priority (PRN) as described below:



Graphic 1, Type of Indonesia National research, *Source: Exposé of National Research Priority, Deputy of RD Reinforcement, Ministry of Research and Technology/BRIN, 2020 National Coordinating (Rakornas)*

Although the concept meant to be professional and self-sufficient, Creative Center STP under ITS is still under government guide line, so that general indicator of achievement must in-line and support to national indicators. Historical data and future projection of Targets for Indicators of Indonesia Achievement can be seen on table below:

INDICATORS OF ACHIEVEMENT OF GOALS	2015 (BASELINE)	2020	2025	2030	2035	2040	2045
Number of science and technology researchers per 1 million population	1.071	1.600	3.200	4.800	6.400	8.000	8.600
GERD/PDB (%)[b]	0,20	0,84	1,68	2,52	3,36	4,20	5,04
Ratio of Master (S2) & Doctoral (S3) students to number of undergraduate (S1) students to approximate total 'research candidates for science and technology (%)'	5,6	20	40	60	80	90	100
Number of total publications in globally indexed journals[c]	2	4	8	10	14	18	22
Multi-factor productivity (MFP) (%)[d]	16,7	20,0	30,0	40,0	50,0	60,0	70,0

Table of Targets for Indicators of Indonesia Achievement of 5-Year Goals

(a) Source: Presidential Regulation No. 38 of 2018, (b)Data provided by Science and Technology Development Research Center (Puspiptek) LIPI, (c) Based on SCImago, the proprietary ranking system for journal impact (Scopus) https://www.scimagojr.com, (d) Multi factor productivity (MFP)—that is also often called total-factor productivity (TFP)—reflects contribution of economic growth outside the growth of capital and work force.

Research and development characteristics actor for activities in Indonesia are conducted by different kinds of actors and institutions, both within and outside the government, including: (1)

Higher Education Institutions, (2) Government Research and Development Institutions, and (3) research and development actors in the private sector including industry, and non-government civil society organizations (CSOs) such as Policy Research Institutes (PRIs). Each research institution has its own characteristics: focus, research activities, funding sources and quality of its researchers. Creative Center STP ITS considered as the (1) that synergy with (2) and (3) As Lecturers (dosen) are the main actors for research activities conducted at Higher Education Institutions, in accordance with Article 4 of the Administrative and Bureaucratic Reform Ministerial Regulation No. 17 of 2013, lecturers have three principal duties: (1) providing education; (2) conducting research; and (3) performing community service (*tridharma*).

2.3. Creative Center Sector in business turn at era and post Covid19.

By the early 2020 Covid-19 declared as pandemic in Indonesia, adaptation to survive and thrive was set. Priorities changed including all process in Creative Center, but innovation process and business activity must go on. To be clear about creative sector that the term often seen various subject fields, including the idea, arts and culture, science and technology, business and trade. "At its root, the creative economy deals in ideas and money" (Howkins, 2013).

Indonesia state creative economy is generating by activities within creative industry's 17 sub-sectors: (1) architecture, (2) culinary, (3) product design, (4) visual communication design, (5) film, animation, and video, (6) photography, (7) crafts, (8) interior design, (9) music, (10) fashion, (11) game developers, (12) application, (13) advertising, (14) television and radio, (15) performing arts, and (16) fine arts (17) publishing. Previously before year 2020, this sub sectors were defined 16 as apps split out from game developers. All these sub sector implementations that trough R&D and related with both ITS's technology subject or networking will be proceed as business activities Creative Center. This mean that there are managerial and all related activity would be financially supported such as procurement for materials, service fee etc. to be consider for next coming year from 2020. The 2020-2024 National Medium-Term Development Plan (RPJMN) sets out 4 (four) pillars of national development: 1. Human development and mastery of science and technology; 2. Sustainable economic development; 3. Development based on principles of justice and fairness; and 4. National security and excellent state administration. These pillars are intended to be the foundations for achieving the vision of Indonesia becoming one of the world's biggest and economic powers by 2045 (*Indonesia Maju 2045*) Bappenas. 2019.

The progress of innovation, creation and creativepreneurship fostering certainly varies across this different sub-sectors and subject as technology is frequently progressing and develop with it to stay competitive even in pandemic era. Although Covid-19 pandemic has further exposed a dichotomy, technology has been a critical tool for addressing the spread of the disease, but not everyone has equal access to the benefits. Covid-19 give double or twin effects of the pandemic and the pivot towards digital adoption are disrupting the norms of the creative economy, where lives and livelihoods have been significantly impacted. According to the report on Cultural and Creative Industries in the Face of COVID-19: An Economic Impact Outlook (UNESCO, 2021), the global creative economy, composed of the cultural and creative industries (CCI), contracted by 750 billion US dollars in gross value added (GVA). This is equivalent to around 1 per cent of global nominal gross domestic product (GDP) in 2019 and 10 million job losses globally, degrade many cultural and creative workers mostly in the informal sector. However, the creative economy still considered as a potential sector rather than cultural economy or any other sector.

3. METHODS

Design Thinking used as method for determining approach of both process and business activity description. This method lining up the action plan of Creative Centre's value preposition, culture and strategic plan, instead of about how to design physical product. Trough human centered phases of Empathize, Define, Ideate, Prototype, and Testing, this research will explore any possible solution from STP-ITS key stake holder. Why design method? the quotes would be: *"Design isn't just about making things beautiful; it's also about making* ***things work beautifully****"* (*Prof. Roger Martin*). What distinct between Creative Center than all others Center in ITS is the priority set of aesthetic/ beauty in human centered technology as top of mind culture. Everything made or will be created must be beautiful. Types of Design Thinking method traits furthermore to be reach out are: (1) Design thinking is iterative in nature. It incrementally addresses challenges, improving solutions step by step, considering what has previously been learned, and using resources (time and money) wisely. It allows avoiding unfocused data gathering and analysis. With characteristics: Well-defined systematic process leading to validated results, focused approach avoiding non-value-adding data gathering and analysis, Agile, just-in-time, process due to its iterative nature. (2) Design thinking tends to combines the best of the some though of analytical and intuitive thinking, resulting in a so-called abductive reasoning approach which is insight from experts and stakeholders take an important part.

Data and opinion method:

Group Interviews: are a familiar and accepted form of gathering views to inform research in Indonesia, as they are elsewhere in the world (e.g. Creswell, 2014). For this study, writer used a group interview (online) to launch interviews and seek the opinions of high ranking policymakers in Indonesia, who are critical to this study. This took the form of policy round-table discussion over 1.5 hours on 'Accelerating the Improvement of Indonesia's Research Competitiveness', and an invitation to help shape the study's research focus. Interviewer identified and iterated the five themes chosen for this report in part from the views and opinions that were put in that first group interview. Two further group interviews were conducted during 2021 and these focused-on research institutions and research funding. Each of these took place over 1 hours.

Documentation. This study used documentary and report sources of data including Indonesian laws and regulation, public policies, Presidential state-of-the-nation addresses, national development plans, institutional reports, ITS policies, news articles, and publications of research results related to the themes of this. It also drew on international data bases and self-reported qualitative and quantitative data from OECD and ASEAN economies that are also engaged in reforming and strengthening their national research and development capabilities. Comparisons of 'best practice' drawn from academic literature and researchers across multiple disciplines

This paper expected to bring some description and recommendations for Design Research Development implementation as business transformation for Creative Center

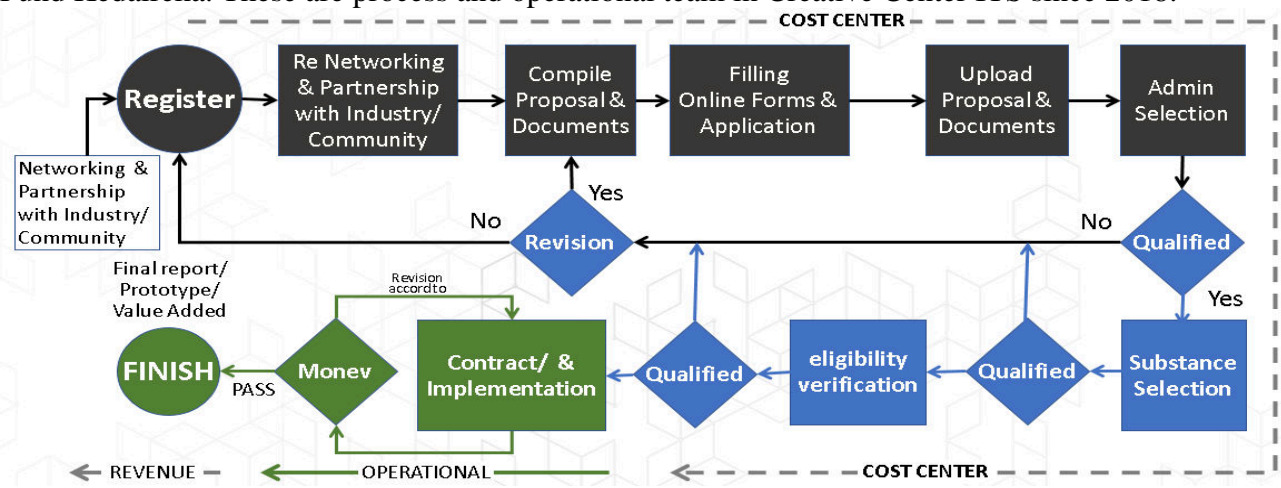
4. RESULTS & DISCUSSION

R&D is one of 7(seven) designed activities of Business at Creative Center STP ITS, that means business as source of revenue though not defined as income. The 7 (seven) are:

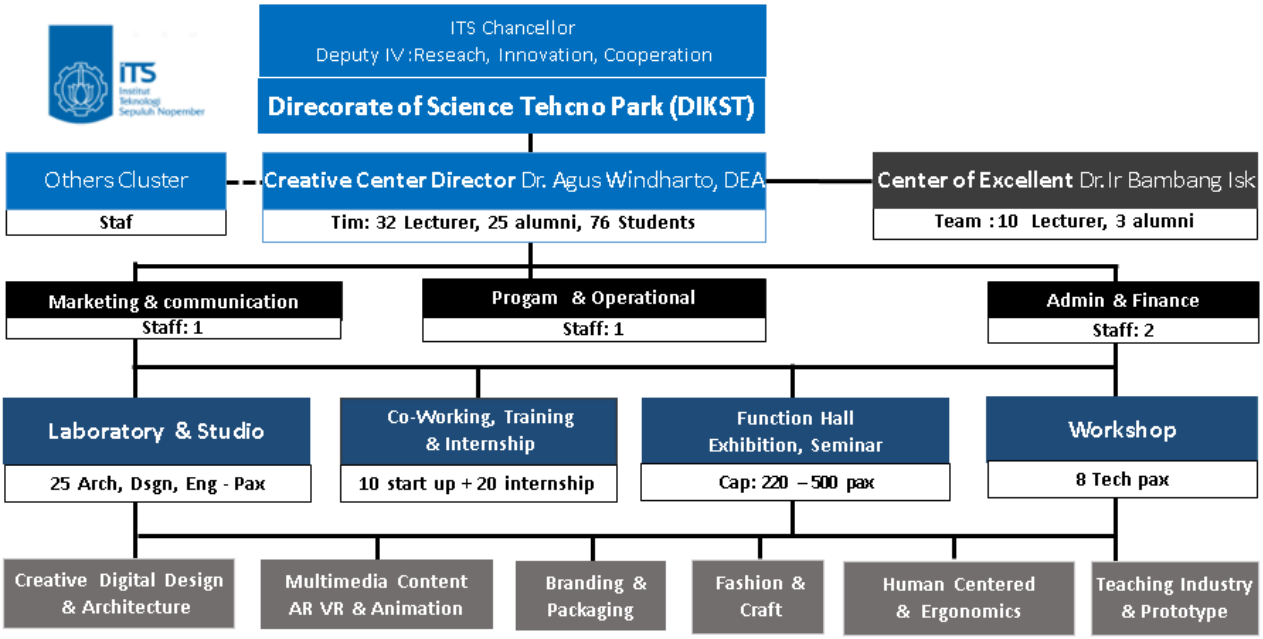
1) **Innovation Research & Commercialization,** assisting local industry/ government, design services, prototyping, engineering mockup etc.
2) **Capacity Building**: Internship, Training, Masterclass, Certification → online and hybrid
3) **Transfer of Technology**: IPR, Legal, licensing, etc. → online/ digital
4) **Business Incubator** for Pre Start Up and Creativepreneurship → online through hybrid process
5) **Marketing Communication:** Branding, Mar-com & Networking → Digital

6) **Industrial Services:** Consultant, Product Development → online through hybrid process
7) **Event**: Exhibition, Seminars, Workshop → online through hybrid process
Although, there are other activities (e.g. materials publishing, renting facility, etc.) that possible become values/ income generator, but so far they not considered as the main or priority activities.

R&D as one of seven main activities of business at Creative Center STP ITS is defining how self-sufficient and sustainability can be achieved. This is the Process of R&D Flow in Indonesia that was mostly online conducted online due COVID -19, adopted from RISPRO LPDP (*Lembaga Pengelola Dana Pendidikan* - Management Agency for Education Fund) and Matching Fund Kedaireka. These are process and operational team in Creative Center ITS since 2018.



Graphic 2, R&D Process from proposal to reporting



Graphic 3 Organization and Personnel

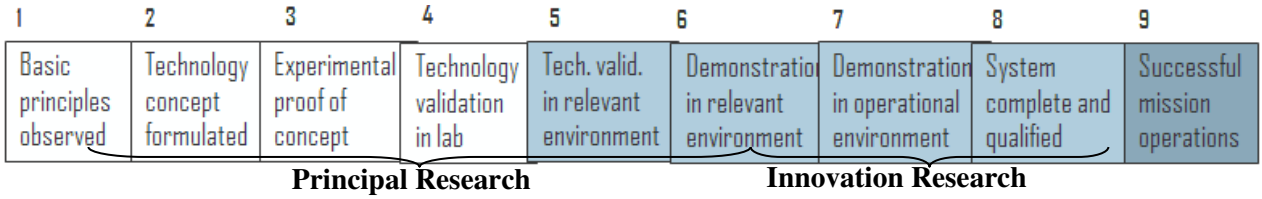
This Team consist of Manager as mentioned previously is Lecturer and team personnel consist of young lecturer professional, technician, etc. Figure below describe organization and Key Stakeholder that defined as ITS personnel in area Deputy IV, Manager and Staff related to decision making in creative Center. Funding for R&D that come from Government become major

financial source that gain from competition or mandatory program to ITS as PTNBH institution with mostly provision of Industry partnership. Networking with industry, community and local government combined to internal capacity building stand as important points of business cycle. Covid19 emphasized importance of change as adaptation.

Design Research and Development (activity 1) implementation very related to Capacity Building especially training ((activity 2) because in creative sector, personnel capacity take important role. Subject suggestion for choosing online Training programs to sub training are

1) Digital Design (local training) consist of: (1a) Building Information Modelling (BIM) course, (1b) Conceptual Design Course, (1c) Workflow, Spaces, Traffic & Environment course.
2) Industrial Design & Engineering training, consist of: (2a) Alias Class (A) Surface Modelling, (2b) Alias Rendering, (2c) Alias for Product Design, (2d). Fusion 360: Design to Prototyping & Fabrication, (2e). Inventor Design to Manufacture: CAM, Nesting, FEA, Design process.
3) Creative Digital, UI/UX, Animation, AR & VR training, consist of: (3a) Autodesk Maya for Movie & Animation, (3b) 3D Studio Max for Engineering Visualization & Games, (c) Motion Builder for Motion Capture, Animation Production. (d) Mud Box Digital Sculpting & Assets
4) Innovation Ecosystem Management training (International)
5) Design Thinking and Market Research training (International)
6) Marketing Communication and Digital Branding training (International)
7) Creative E-Commerce, E-Business and Finance training (International)

As ITS internal assessment stated that the Implementation of creative sector is on right track, although Research and Development (R&D) conducted by ITS and all University in Indonesia merely almost all financing by Government, and continuous this way along with Covid19 impact. The occurring happens because neither Indonesia industry doesn't have any capacity for the research nor they state that no need to conduct any research, however if it there any, market research would be the chosen one. With minimal amount of product or service innovation R&D, luckily Indonesia has endowment fund for this activity, although this fund mix with capacity building fund. Then the financial battle field of research and development would be Institutional funding versus competitive funding. On organizational ITS management, R&D activity classified as definition of TRL (Technology Readiness Level: 1 to 9) so Creative Center STPT – ITS must refers to this policy as described below:



Graphic 4 Technology Readiness Level (TRL) refer to National Innovation System

Creative Center as unit of Directorate Innovation & Science Technopark (DIKST) ITS focuses on downstream research and development activities (Technology Readiness Levels [TRL] 6 to 9).

In ideal term, STP ITS managers are lecturers that supported by professional, experts and or technical assistant whom dedicated working for the program, therefore business aspect especially financial has critical role because support personals must be hired with certain standard of fee and considered as fix cost.

Recommendations for Design Research and Development implementation as business transformation for Creative Center are

1) Define Vision of R&D along with Creative Center STP ITS values and culture
2) Establish research mission and operational plan

3) Emphasize Capacity Building and professionalize management of research funds
4) Nurture competitive researcher for efficiency and excellence
5) Design research funding for infrastructure on digital
6) Attract non-government and private sector contributions
7) Accelerate Growth of Researcher Numbers and Quality
8) Grow Research networks for sustainability

Creative Center → Business → Self Sufficient→ Sustainability aspects		
Organization Core	Design Thinking	Tech Access
• Values and Culture • Strategic & Operational Plan • Human Resources • Management & Technology • Finance and Networks	Empathize: Interviews, Shadowing, Understand Define : Personas, Challenges, Pain Points Ideation : Prioritize, Share Ideas, Divergence Prototyping: Storyboard, Simplify, Clear& Bold Testing : What Works, Role Play, Iterate fast	Availability Affordability Awareness Accessibility Ability
Design Research & Development trough **Competition and or Mandatory** Programs		

Graphic 5, Matrix Table of Creative Center Organization Core - Design Thinking - Technology Access

Matrix table above indicate that efficient organization (agile and Lean team) for implementation should be the suitable form of solution and so the strategy can be simply formulating as:

- Era Covid → facilities preparation → Digital Migration → emphasize on Capacity Building
- Post Covid → maximizing assets usage as competitive factor → wide Synergetic Networks

In order to develop from cost based activity into self-sufficient even more profitable activity, Design Research and Development should be treat as directed project not a program. With certain duration, budged, an implementation of program and target, business aspect of Design R&D can be assessed trough IPO (Input→ Process→Output) classification to values of Key Performance Indicator.

5. CONCLUSIONS

This study type is Qualitative Descriptive, that giving close perspective about process of design research and development as important business activity at Creative Center ITS. Hybrid, combination of online and offline or onsite process on Indonesia's creative industry continues to grow, indicated by the increase in the value of the economy and the number of creative workers every year, hopes thus contributing to an increase in national GDP and helping to reduce unemployment by creating jobs opportunity with creativity.

Business transformation conduct by Hybrid way combine online and offline or onsite - process to increase added values and number of creative workers by spreading across platforms and wider area of communities.

Creative Research and Development as business activity at Creative Center STP ITS transform from Interactive physical activity to be more interactive Digital, Virtual media and Online

Since there are various technology study, ITS Interdisciplinary collaboration would be a competitive advantages as ITS has seven faculties that become centres of excellence for teaching science, technology, and design in Indonesia trough Advancing Humanity

Creative Research and Development as business activity at Creative Center STP ITS considered as self-sustainable Project based activity instead of cost centre, trough participating at both competitive and mandatory scheme.

. Future research in Indonesia is expected to use data and official creative industry reports released by the Creative Economy Agency and refer to a globally recognized creative index such as the GCI (Global Creativity Index).

This article still not covered many things and has several shortcomings. The essential about creative business and its processes on the object of this research available to be explored to further contribute to the progress of the Creative Center STP ITS development and the welfare of surrounding society. Next following studies definitely would be needed both by qualitative and moreover quantitative methods to give more perspective about creative sectors including Research and Development activity in any other subject of discussion.

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EVALUATION OF KNOWLEDGE MANAGEMENT SYSTEM BASED ON VARIOUS TECHNOLOGY ADOPTION FACTOR A SYSTEMATIC LITERARURE REVIEW

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ABSTRACT

Organization nowadays, must learn to manage the intangible asset or "Knowledge" for competing and becoming successful in the global economy. Knowledge management Systems is important as a key factor in success and growing of an institution. Analysis factor can be simplify the Knowledge Management System, while for KMS evaluation of comprehensive management. This study will take a look on international level on journal papers through some sources related on similar keywords and factor that affected evaluation external factor based on TAM method. Technology Acceptance Model proposes that external factors such as organizational factors will influences knowledge management system acceptance by affecting perceived usefulness and perceived ease of use. External factors may include system feature, job relevance, usage experience, and document support consultations. External factor provides "the bridge" between the internal beliefs, attitude and intention represented in TAM and the various individual different situation constrains and managerially controllable intervention impinging on behavior.

Keywords: KMS, TAM, Technology Adoption Factor, Systematic Literature Review.

1. INTRODUCTION

Organization nowadays, must learn to manage the intangible asset or "Knowledge" for competing and becoming successful in the global economy. The practice of managing organization's intangible asset is generally known as Knowledge Management (KM). The concept of KM focuses on ensuring that the right information is delivered to the right person at the right moment for decision purpose. Despite the fact that the areas and scope of KM applications have increased but the underlying principles governing it remain the same [34]. Knowledge Management (KM) is the process of creating, capturing, developing, sharing, and optimizing the organizational knowledge. Knowledge Management System (KMS) is subset of knowledge Management process that can be in web application or software, which support KM process based on a range of practices used by company or institution. Knowledge management Systems is

important as a key factor in success and growing of an institution. Analysis factor can be simplify the Knowledge Management System, while for KMS evaluation of comprehensive management. So, the analysis factor has feasibility and applicability to the Knowledge Management System evaluation [35].

This research aims to do systematical analytics towards newest literature review on knowledge management system based on TAM method with focusing on evaluating external factors used. This study will take a look on international level on journal papers through some sources related on similar keywords and factor that affected evaluation external factor based on TAM method on KMS next step is reviewing selected journal to get list various external factor TAM that used. We define the core dimensions of KMS as follows: Small Medium Enterprise University, Healthcare, Organization Performance, Tourism, and Optimize the Knowledge.

2. LITERATURE REVIEW

Literature review describes the literature relevant to this research. Use mostly references from international journals.

Table 1. Comparison of related work

Study	Year	Context	Model	Method	Factor
[2]	2017	Small Medium Enterprise	TAM & TPB	SEM	Perceived ease of use (PEOU), perceived entertainment value (PEV), perceived usefulness (PU), Voluntariness using (VU), Web KM Usage (WU)
[3]	2016	Univesity	TAM	Questionnaire	Perceived usefulness (PU), Perceived ease of use (PEU), attitude and Behavioral intention to use (BI)
[4]	2016	Healthcare	DeLone and McLean	cross-sectional survey	Perceived usefulness, User satisfaction, and Perceived security
[5]	2019	University	TAM	SEM	Independent variable Habit (H), System quality (SQ), Perceived usefulness (PU), Perceived ease of use (PEOU), Behavioral intention to use app (BI).
[6]	2017	University	TAM	PLS-SEM	Perceived usefulness (PU), Perceived ease of use (PEOU).
[7]	2019	Organization	TAM	Questionnaire	Ease of use (PEOU), Perceived usefulness (PU), and Attitude (ATU)
[8]	2016	University	TAM	PLS, survey	Ease of use (PEOU), Perceived usefulness (PU), and Attitude (ATU), Perceived interactivity, Satisfaction.
[9]	2021	University	KM Perform ance	SEM PLS, Questionnaire	KM success, KM strategy, KM processes and psychological empowerment
[10]	2018	Organization	TAM	Questionnaire	Perceived ease of use (PEU),
[11]	2019	Tourism	TAM	Questionnaire	Perceived usefulness (PU), Perceived ease of use (PEU)
[12]	2018	Organization	TAM	Questionnaire	Perceived usefulness (PU), Perceived ease of use (PEU)
[13]	2019	Organization	TAM	SEM-PLS	Perceived usefulness (PU), Perceived ease of contributing (PE), Attitude

					toward using (A)
[14]	2019	Organization	TAM	SEM	Perceived ease of use (PEU)
[15]	2018	Organization	TAM	SmartPLS	Perceive ease of use (PEOU), Perceive usefulness (PU)
[16]	2018	Health Care	TAM	SEM	Perceive ease of use (PEOU), Perceive usefulness (PU)
[17]	2017	Organization	TAM	PLS	Perceived ease of use, Perceived usefulness, Perceived ease of use, Aattitude, Behavioral intention to use, Actual use.
[18]	2016	Academic	TAM	Questionnaire	Perceive ease of use (PEOU)
[19]	2016	Organization	TAM	Questionnaire	Perceived effort, Perceived benefit, Organizational factor.
[20]	2020	Organization	TAM	Questionnaire	Perceived usefulness (PU), Perceived ease of use (PEOU), Organizational culture against attitude toward computer.
[21]	2020	Academic	TAM	Questionnaire, SEM	Perceived usefulness, Perceived ease of use, Acceptance of IT
[22]	2018	University	TAM, CSF	Questionnaire, SEM	Ease of use (EU), Benefits/Usefulness, User satisfaction
[23]	2019	Tourism	TAM	Questionnaire	Perceived usefulness (PU), perceived ease of use (PEU), Attitude, Entertainment, Intention of use, Actual system use.
[24]	2020	Organization	TAM, UTAUT	SEM, Questionnaire	Attitude towards using (ATU)
[25]	2020	University	TAM	SEM PLS	KM Factor, Perceived ease of use (PEOU), Perceive usefulness (PU)
[26]	2016	Organization	TAM	Questionnaire	Perceived ease of use (PEOU), Perceive usefulness (PU)
[27]	2020	SME	TAM	Questionnaire	Perceived ease of use (PEOU), Perceive usefulness (PU)
[28]	2018	University	TAM	Questionnaire	Perceived usefulness (PU), Perceived ease of use (PEOU), Social influence, Facilitating conditions, Trust and usage intention.
[29]	2021	Organization	TAM	Questionnaire	Perceived ease of use (PEOU), Perceive usefulness (PU), Attitude toward using (ATU), Behaviour intention to use (BIU)
[30]	2021	Academic	TAM	Questionnaire	Perceived ease of use (PEOU), Perceive usefulness (PU)
[31]	2017	Organization	TAM	Questionnaire	Perceived ease of use (PEOU), Perceive usefulness (PU), Attitude toward using (ATU), Behaviour intention to use (BIU), Actual System Usage.

From the table 1 above, it can be conclude that the research model which utilized by order researchers is dominated of TAM model with common model : Questionnaire and Structural Equation Modelling(SEM). The additional variables of TAM is dominated Perceived ease of use (PEOU), Perceive usefulness (PU).

3. METHODS

The review method was conducted by systematic literature review, there are four differences according to a systematic review and conventional expert literature:

A. Conduct Literature Search Method

Based on a specific search strategy aimed at finding as many eligible journals. Publish or Perish Software used to findings the journals. Some keywords which applied in the research such as: "knowledge management system", "technology acceptance model", "evaluation external factor". Keywords search on well-known journal sites i.e (1) IEEE, (2) Elsevier, (3) Emerald Insight from 2016-2021 shown on table.2.

Table 2. Journals based on year

Year	Frequency
2016	9
2017	4
2018	6
2019	12
2020	10
2021	2

B. Selection Journal

The founded journals are selected to the eligible and suitable ones. Researcher will check and verified related to several of factor analysis. The content of selected journals should contain topic of knowledge management evaluation factors based on TAM.

C. Selected Journal Review

The result of selected journals will be analyzed to gain list of external factor TAM which affected in Knowledge Management System. In total there are 30 reviewed journals from 3 well-known sites journal i.e (1) IEEE, (2) Elsevier, (3) Emerald Insight shown on table.3.

Table 3. Number of related Journals

Sites Name	Total Journal
IEEE	17
Elsevier	8
Emerald Insight	5

D. Extraction and Synthesis Data

Journals that match the criteria are assessed for quality by extracting and grouping based on the analysis of predetermined factors, individual perspectives and organizational perspectives. In the extraction process the adoption factors are collected. A literature review was carried out to obtain a synthesis. The review process is carried out to analyze gaps and make possible research recommendations.

4. RESULTS

In this section, the results of literature synthesis is being discuss. The following is a description of the results of the research synthesis.

A. Technology Acceptance Model used for KMS Adoption

The mapping various journal form the latest 5 years shown in Table 4. TAM adoption for Knowledge Management System refers to former researches bring out the factor that affected TAM. Based on the review several journals, there are 5 factors which mostly affect Knowledge Management System, as follows:

Table 4. Knowledge Management System Adoption Factor

The Factor Adoption	Explanation	References	Journals
Organizational Factor	Organizational Factors are related with knowledge infrastructure capability (technology, structure, and culture) along with knowledge process capability (acquisition, conversion, application and protection) which is essential organization capabilities and precondition for effective knowledge management.	King and Marks (2008)	[4][8][19]
Perceived Usefulness	Perceived Usefulness is the degree to which an individual finds using and contributing in KMS give benefit and useful. Eight indicators have been adapted for these studies.	Davis et al (1989)	[1][3][10] [14][15][17] [26][27][29]
Perceived Ease of Use	Perceived Ease of Use is the of degree to which an individual finds using and contributing in KMS free of effort and or cost. We adapted eight indicators to measure perceived.	Davis et al (1989)	[5][9][11][13]
Attitude Toward Using	Attitude Toward Using is a pro or con stance towards the application of a product. The pro or contra attitude towards a product can be applied to predict a person's behavior or intention to use a product or not to use it. Attitude toward using technology is defined as the user's evaluation of his curiosity in using technology.	Aakers dan Myers (1997)	[2][6][7] [12] [22][23] [28][30]
KMS Acceptance	KMS Acceptance is the decision to using or using the KMS. We adapted eight indicators to measure KMS acceptance construct in this study.	Xu and Quaddus (2007)	[8][20][24]

Technology acceptance model proposes that external factors such as organizational factors will influences knowledge management system acceptance by affecting perceived usefulness and perceived ease of use. External factors are postulated to have a direct effect on PU. External factors may include system feature, job relevance, usage experience, and document support consultations. External factor provides "the bridge" between the internal beliefs, attitude and intention represented in TAM and the various individual different situation constrains and managerially controllable intervention impinging on behavior.

B. Conceptual Model of External Factor for KMS

The conceptual model of external factor for Knowledge Management System will be explain in this part of study. There are 5 variables affected for KMS, as follows:

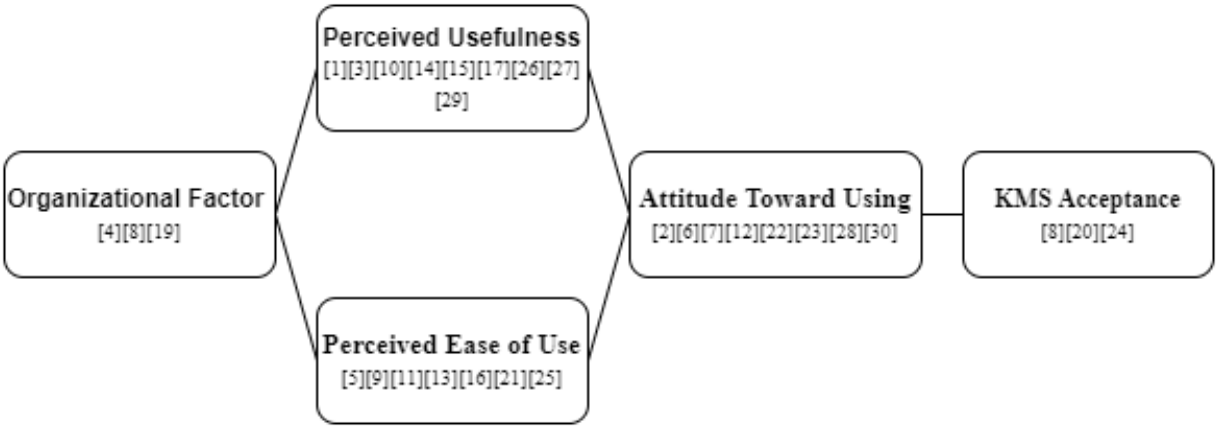

Figure 1. Conceptual Model External Factor Adoption

5. CONCLUSIONS

Based on systematic literature review which has done by this study, it could be concluded variable factor TAM and external factor that affected for Knowledge Management System and also determined the effect of the relationship between variable factors on the TAM model by replacing external factors replaced with subjective norm variables and facilitating the condition to analyze acceptance of the KMS application. KMS acceptance is became critical process for organization.

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VARIABLE ANALYSIS OF DIGITAL CONTENT DESIGN TO MAXIMIZE DIGITAL MARKETING IN INCREASING BRAND AWARENESS IN B2B COMPANIES SURVEY SERVICES

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ABSTRACT

The use of digital platforms as a forum for marketing and promotion of a product is one of the most widely practiced nowadays. Moreover, the use of digital platforms can also be used to increase brand awareness of a product or company. The current use of digital content is more likely to be used by the B2C business model to increase sales, so in this study an analysis was carried out on the use of digital content in the B2B business model. Designing digital content on a digital platform is the main key to attracting user interest, coupled with a good and appropriate digital marketing strategy. Appropriate digital content design is needed to get good interaction from users. Digital content design is based on a digital content value chain framework that involves the value flow of digital content which consists of three main components, namely (1) value creation, (2) value interaction and (3) value use. In this research, a modeling design was carried out using the Structural Equation Modeling (SEM) method. This modeling is carried out to produce a conceptual model that can describe the relationship of the hypotheses made about the expected value of users in consuming digital content.

Keywords: Digital Marketing, Digital Content, B2B, Brand Awareness, Structural Equation Modeling (SEM).

1. INTRODUCTION

Digital marketing is a marketing method that is quite developed today. This method is a marketing strategy or promotion of a brand or product using digital media or the internet. Digital marketing is a marketing activity including branding that uses various media. For example, blogs, websites, e-mail, AdWords and various social media networks (Sanjaya and Tarigan, 2009).

Basically, the concept of marketing activities is to increase sales of a brand. Moreover, digital marketing can also be used to build the brand name of a company or business to be good and gain the trust of customers and potential customers. The wide geographical reach of digital marketing is one of the main advantages that can help companies spread their brand throughout the world. The use of digital marketing in the Business to Customer (B2C) model is to increase sales directly to consumers, but for companies with the Business to Business (B2B) model digital marketing can be used to increase brand awareness of the company or product being sold, to increase the level of trust from potential customers.

Digital marketing is closely related to digital content which is the main tool in supporting the digital marketing strategy carried out. Digital content created must be able to convey the message that will be given to potential consumers and can be used by various types of digital platforms available. To optimize the applied digital marketing, the digital content created must

also be able to make digital platform visitors interested and provide interaction with the content. Thus, it is necessary to conduct research related to the suitability of digital content design according to the wishes of the end user.

The research was conducted using the Structural Equation Modeling (SEM) method to measure the quality between the factors contained in the interconnected variables to help describe how strong a relationship is in the hypothesis to produce a model that can describe the relationship between these variables.

2. LITERATURE REVIEW

2.1. Digital Marketing

Digital marketing is the use of digital technology to create integrated, targeted, and measurable communications that help acquire and retain customers while building deeper relationships with them (Wymbs, 2011). Digital marketing includes the use of devices such as personal computers, tablets, and mobile phones to access consumers through platforms (Chaffey, 2018). Digital marketing also makes use of digital media, which can be characterized as owned, paid, and earned media (Lovett & Staelin, 2016).

2.2. Digital Content

Digital content is information that is available through media or electronic products. The media and electronic products in question are a means of presenting content using electronic devices such as television, radio, computers, and smartphones, either through the internet or not. Digital content itself includes several types of digital information and digital products such as e-books, e-journals, e-newspapers, digital music, online digital games, videos, digital animation, and others (Vaknin, 2009).

Based on the process that is passed from design to content consumption, the value flow of digital content is divided into three stages, namely (1) creation, (2) interaction and (3) use.

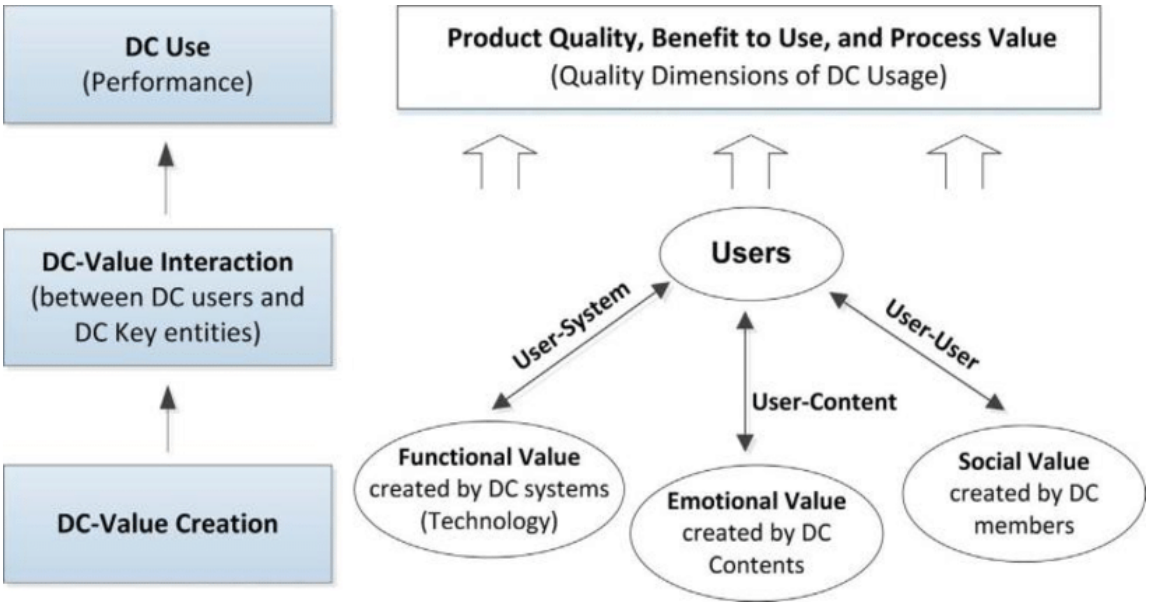

Figure 1. Digital content value chain framework (Kim & Kim, 2017).

There are several things that need to be considered in presenting digital content that will be created (Rattan, 2018), such as:

1. To entertain, it will have a strong emotional appeal to consumers, thus making the content easy to share.
2. To educate, it will be possible to provide a broad reach of consumers especially for those who may not know about the product or service.
3. To persuade, it also has an emotional appeal, content that can gradually change the minds of consumers.
4. To convert, this is very important, the content created can make consumers to make decisions when considering what is offered by the product or service offered.

2.3. B2B

Business to Business or B2B is a business transaction carried out both electronically and physically that occurs between one business entity and another. B2B is a market for products and services, both local and international, in which transactions are carried out between companies, governments and institutions that are used for the consumption of the company itself or for resale (Hutt and Speh, 2009). B2B is the sale of products or services provided by one business and intended for other businesses, not to consumers directly. B2B is a business process in selling products and services to other companies (Miletsky and Smith, 2009).

2.4. Brand Awareness

Brand awareness is the ability of a customer to remember a certain brand or a particular advertisement spontaneously or after being stimulated by key words (Rangkuti, 2004). Meanwhile, to measure Brand Awareness through four stages which can be described in a pyramid as follows:

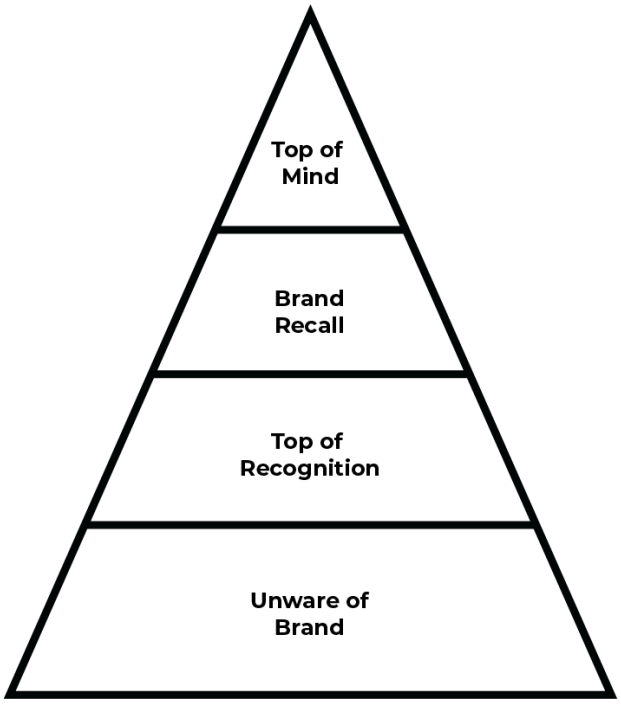

Figure 2. Brand Awareness Pyramid (David A. Aaker, 1991)

1. Unaware of Brand is the lowest level in the brand awareness pyramid where consumers are not aware of a brand.
2. Brand Recognition is the minimum level of brand awareness, where the introduction of a brand appears again after being reminded again through assistance (aided recall).
3. Brand Recall is an unaided recall of the brand.
4. Top of Mind is a brand that is first mentioned by consumers or the first that appears in the minds of consumers or the brand is the main brand of various brands in the minds of consumers.

There are several marketing strategies in increasing brand awareness proposed by Kotler & Keller (2009), namely advertising, sales promotion, direct marketing, and publicity.

1. Advertising is a marketing communication strategy that is carried out to increase consumer brand awareness of services, products and services that are owned by the company. The activities that can be carried out by this strategy are digital advertising on digital platforms.
2. Sales promotion consists of several strategies to increase brand awareness such as product or service promotions that are combined to get cheaper prices. In addition, in its application to digital content, this strategy can also be in the form of marketing products promoted by Influencer Marketing or commonly called KOL.
3. Direct marketing is marketing that is done directly. In this strategy, products, services and services are presented directly with the aim of selling service products and services from the business. The form of digital content in this strategy is content that presents information on products and services.
4. Publicity is a marketing program carried out to directly communicate the company's brand to the public to attract the attention of users. In its application, the form of digital content of this strategy can be in the form of quiz content with prizes or giving prizes at certain events.

2.5. Structural Equation Modeling (SEM)

SEM (Structural Equation Modeling) is the second generation of multivariate analysis technique that allows researchers to examine the relationship between complex variables, both recursive and non-recursive to obtain a comprehensive picture of the entire model (Ghozali, 2008). Maruyama (1998) mentions SEM is a statistical model that provides an approximate calculation of the strength of the hypothetical relationship between variables in a theoretical model, either directly or through intermediate variables.

Broadly speaking, SEM methods can be classified into two types, namely Covariance Based Structural Equation Modeling (CB-SEM) and Variance Component Based SEM (VB-SEM) which includes Partial Least Square (PLS) and Generalized Structural Component Analysis (GSCA). In this study, researchers used the variant-based SEM method with the PLS model. This model was chosen because in general PLS-SEM aims to test the predictive relationship between constructs by seeing whether there is a relationship or influence between these constructs. SEM-PLS is very appropriate to be used in research that aims to develop theory (Siswoyo H, 2016).

3. METHODS

Data processing will be carried out using the SEM-PLS method with the support of the library study method to determine the interrelated variables to compile the SEM model that will be made. The modeling is based on a digital content value chain framework consisting of creation, interaction, and use. The basis for the value chain framework is developed and structured based on

the types and criteria of digital content (entertaining content, educational content, persuasive content and converting content), marketing strategies to increase brand awareness (advertising, sales promotion, direct marketing, and publicity) and stages of brand awareness (Top of Mind, Brand Recall, Brand Recognition and Unaware Brand).

4. RESULTS

The SEM model is generated based on the literature study conducted. After collecting and analysing the related data, then the design of the model that will be observed will be carried out and then the design of the questionnaire will be carried out based on the model that has been designed. The design of the model in this study is as follows:

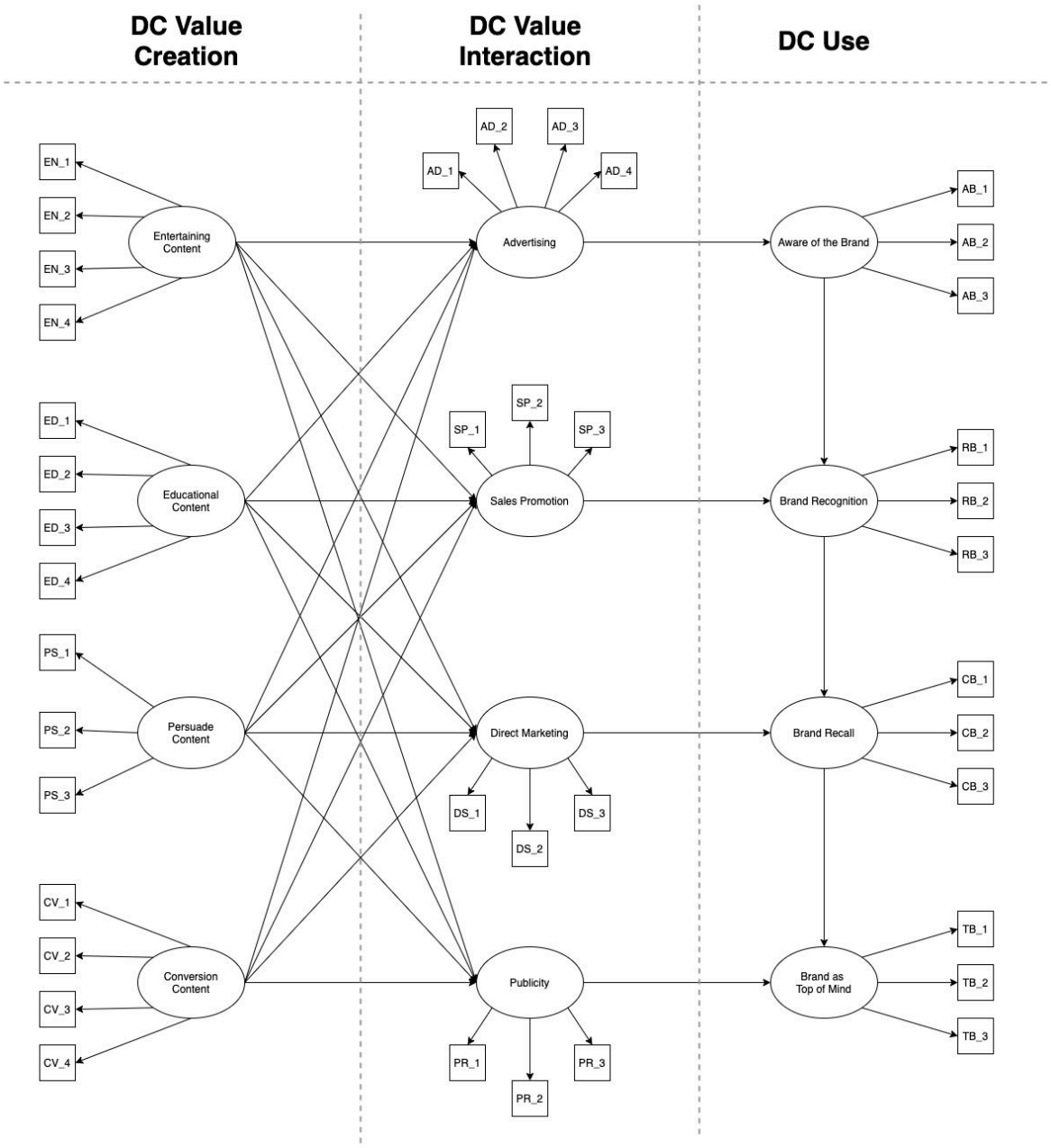

Figure 3. SEM Model Design

The design of the model is based on the flow of digital content values consisting of DC Value Creation, DC Value Interaction and DC Use. The explanation of the latent variables and indicator variables used in the model is as follows:

Table 1. Definitions of latent variables and constituent indicator variables with literature sources.

Latent Variables	Indicators Variables	Basic of Literacy
Entertaining Content	Content using the game	Koshy, Vinay (2021)
	Content contains the latest/viral information	Koshy, Vinay (2021)
	Content discusses something fun	Koshy, Vinay (2021)
	Content provides information that makes readers smart	Koshy, Vinay (2021)
Educate Content	Using humor in content	Koshy, Vinay (2021)
	Using content that stimulates reader interactivity	Koshy, Vinay (2021)
	Content tells an extraordinary and historic story	Koshy, Vinay (2021)
	Content discusses someone's biography	Koshy, Vinay (2021)
Persuade Content	Content displays brand credibility	Warwick, Jacob (2018)
	Content provides an understanding of the value to the brand	Warwick, Jacob (2018)
	Content creates emotional appeal with empathy for readers	Warwick, Jacob (2018)
Conversion Content	Create attractive content titles	Braker, Shane (2021)
	Content uses data to support the theme being discussed	Braker, Shane (2021)
	The content uses visual elements to make it easier to read the content	Braker, Shane (2021)
	Content directs visitors to other content or company services (e.g. hashtags, display other products)	Braker, Shane (2021)
Advertising	Content displays informative ads to introduce brands	Kotler, P and Keller K. L, (2016)
	Content displays persuasive ads to convince readers	Kotler, P and Keller K. L, (2016)
	Content shows ads repeatedly so readers can remember the brand	Kotler, P and Keller K. L, (2016)
	Content displays ads in the right places to convince readers to trust the brand	Kotler, P and Keller K. L, (2016)

Sales Promotion	The content displays information about the facilities and advantages of the company's services	Kotler, P and Keller K. L, (2016)
	Content displays promotional activities/events carried out with business relations	Kotler, P and Keller K. L, (2016)
	Content featuring promotions from the company	Kotler, P and Keller K. L, (2016)
Direct Marketing	Content provides information about offers directly to customers	Kotler, P and Keller K. L, (2016)
	Content maintains relationships with existing customers	Kotler, P and Keller K. L, (2016)
	Content provides customers with the latest company information	Kotler, P and Keller K. L, (2016)
Publicity	Content displays the company's services positively to build the company's image	Kotler, P and Keller K. L, (2016)
	Content showing company or brand support in company activities	Kotler, P and Keller K. L, (2016)
	Content displays good communication in the company's internal and external environment	Kotler, P and Keller K. L, (2016)
Aware of the Brand	Display brand ads regularly	Bhasin, Hitesh (2021)
	Displays slogan and/or tagline ads from brands that are easy to remember	Levy, Scott (2013)
	Display logo ads and attributes that are easily recognizable and visually describe your brand.	Levy, Scott (2013)
	Display image and/or video ads that highlight the company culture and products or services.	Levy, Scott (2013)
Brand Recognition	Showing promotions of products or services related to the brand	Milano, Steve (2021)
	Showing promos for the company's main products or services to strengthen the company's business focus	Milano, Steve (2021)
Brand Recall	Show direct marketing using videos from customers/clients	Kotler, P dan Keller K. L, (2016)
	Display a list of services and products on websites and social media	Kotler, P dan Keller K. L, (2016)
	Distribute e-catalog to regular customers	Kotler, P dan Keller K. L, (2016)
Brand as Top of Mind	Content shows the superiority of the brand in an activity/job	Kotler, P dan Keller K. L, (2016)
	Content showcases the role of brands in a community	Kotler, P dan Keller K. L, (2016)
	Content featuring brands can provide solutions to problems that occur	Kotler, P dan Keller K. L, (2016)

Source: data obtained from various literacy sources

5. CONCLUSIONS

Based on the results of the literature review, it was found that the latent variables and indicator variables used in making SEM can support the author's assumptions as the basis for designing appropriate digital content and can be used to increase brand awareness in B2B companies with appropriate digital marketing methods.

The selection of the SEM-PLS method was assessed according to the research conducted because the model can be used to test predictive relationships between constructs by seeing whether there is a relationship or influence between these constructs. SEM-PLS is very appropriate to be used in research that aims to develop theory (Siswoyo H, 2016). It is hoped that with the SEM-PLS method, which will be carried out at the next stage, the value of the attachment between the latent variable and the selected indicator variable will be obtained.

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DESIGN OF OPERATIONAL RISK MANAGEMENT ON AIRCRAFT PROLONGED MAINTENANCE USING HOUSE OF RISK METHOD

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ABSTRACT

One of Covid-19 pandemic's impacts is the airlines need to storage their aircrafts for a certain period because they could not serve the passengers via air travel. During storage period, there are maintenance tasks should be performed for parked aircrafts as called prolonged maintenance to prevent the aircraft from deterioration as one of operational risks. Therefore, it is necessary to manage the risk during prolonged maintenance to anticipate these operational risks. This study aims to design risk management in aircraft prolonged maintenance implementation using a framework referring to ISO 31000 and to mitigate the risks using the House of Risk (HOR) method as development of the Quality Function Deployment (QFD) and Failure Modes and Effect Analysis (FMEA) method. The design of risk management includes the process of risk identification, risk analysis, risk evaluation, risk treatment, control, and monitoring. As HOR1 output, the risk event identification obtained 33 risk events and 30 risk agents. Through brainstorming with management, there are 13 risk agents were taken to be prioritized as risk agents to take preventive actions. Then, HOR2 output resulted 29 preventive actions and only 20 effective preventive actions were selected to address operational risks to be carried out immediately.

Keywords : maintenance, prolonged, risk agent, risk event, house of risk

1. INTRODUCTION

Aircraft maintenance is the most important activity to do to ensure the aircraft is in airworthy condition by keeping the aircraft serviceable and reliable that can prevent deterioration and malfunction condition to reduce operational costs, besides to comply the authority requirements and generates revenue (Marnewick, 2020). In normal flight operation condition at daily basis, the aircraft will be carried out the routine maintenance after the last flight, commonly called as a daily maintenance check. This daily maintenance checks are performed during remain over night at the airport gates before first flight on next day.

As the decreasing of the number of commercial flights due to the Covid-19 pandemic as seen in Figure 1 and in accordance with the authority policy to park and store several aircrafts, the company PT. ABC as a maintenance provider supports airline PT. XYZ to perform additional maintenance for their aircrafts. Prolonged maintenance is the one of the additional maintenances procedures to be performed for non-flying aircrafts when parked or stored at certain period (maintenance start at day 14th since last flight refer ATA Chapter 10 Boeing Aircraft Maintenance Manual). The prolonged maintenance procedure is based on instructions from the International Air Transport Association (IATA, 2021). However, there is complexity in the implementation of prolonged maintenance because all aircrafts are stored relatively at

the same time without previously planned and there are many potentials of operational risks that constraints the process of prolonged maintenance.

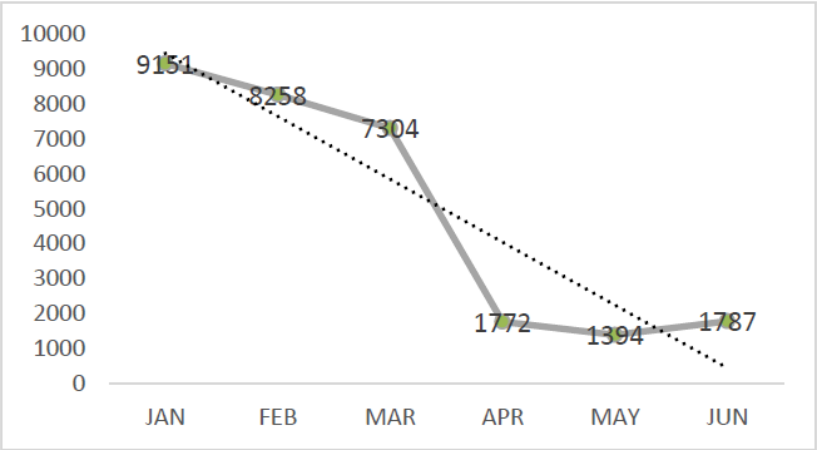

Figure 1. Number of flights airline PT. XYZ in first semester of 2020

Based on aircraft maintenance manual from the aircraft manufacturer (Boeing), briefly explained the prolonged maintenance can be classified into three main parts; a) normal parking; is the aircraft parked in serviceable condition within 14 days from the last flight, b) active storage; is the aircraft parked and storage in a serviceable condition, and c) prolonged parking; is the aircraft parked in a maintenance storage and preserved condition. For active storage and prolonged parking, the aircraft will be stored for a certain period and there are periodic maintenance tasks should be performed according to its interval.

Risk is the probability of an event resulting in a loss when the event occurs during a certain period (Frosdick, 1997). This study examines how the company PT. ABC determines the strategy in dealing with new risks related to the prolonged maintenance implementation and examines how to control the operational risks that occur during prolonged maintenance process on PT. XYZ fleet aircrafts to get the operational activities can be done effective and efficient. As an explanation above, this study designs an operational risk management framework for the prolonged maintenance by implementing risk management. The implementation of risk management is most important thing that should be carried out by the company because the risks that occur can be managed and minimized so that the company's goals can be achieved.

This study identifies risk events & risk agents and mitigates the preventive actions during implementation of aircraft prolonged maintenance using the House of Risk (HOR) model, the method developed by Pujawan & Geraldin (2009). This HOR model was developed by combination of two methods of the House of Quality from Quality Function Deployment (QFD) and Failure Modes and Effect Analysis (FMEA). FMEA is a method used to identify failure mode that causes a functional failure and its failure effect. And the term of failure then next will be mentioned as a risk. This risk identification process as a risk assessment that include in a risk management framework.

In this study, the process of risk management framework is divided into two phases. The first phase is risk identification, then the second phase is risk treatment. The house of risk phase 1 (HOR1) is the risk identification phase where risk events and risk agents are identified, measured, and prioritized. Then the second phase (HOR2) is the risk treatment phase which risk agents are selected based on a high priority level from the output of HOR1. After that identify the relevant actions to prevent risks from arising and determine the relationship between each preventive action on each risk agent. Then, calculate the level of effectiveness and measure the level of difficulty of each action that is used as a response or risk mitigation.

2. LITERATURE REVIEW

2.1 Aircraft Maintenance

Aircraft maintenance is all activities carried out to maintain the condition of the aircraft, aircraft components and equipment in an airworthy condition including inspection, repair, service, overhaul, and part replacement. Every single aircraft is required to have a maintenance program to carry out the maintenance properly (Minda Mora, 2012). The maintenance process for each airline may differ but the initial requirements remain the same. Activities required during aircraft maintenance are included in the maintenance process and include management, planning, preparation, implementation, assessment, and repair (Ahmadi, 2010).

Normally, the aircraft maintenance activities are divided into scheduled and unscheduled maintenance. Scheduled maintenance is planned based on the interval with calculated by flight hours, flight cycles, and calendar period. Unscheduled maintenance is initiated by technical failures, reported defects, and faults identified during inspection (Marnewick, 2020). However, impact of covid-19 pandemic, there is additional requirement maintenance activity that should carry out which is not include into those both normal maintenance activities, namely prolonged maintenance.

2.2 Risk Management

Risk management is a management approach to manage the risk. Risk management refers to planning, monitoring, and controlling activities based on information generated by risk analysis activities (Frosdick, 1997). In general, risk management is used to avoid, reduce, transfer, share or accept these risks. The risk management aims to create a system or mechanism within the organization so that risks that can harm the organization can be anticipated and managed for the purpose of increasing company value (Mamduh *et al*, 2006).

ISO 31000 (2018) as a risk management framework to design of risk management includes the process of risk identification, risk analysis, risk evaluation, risk treatment, monitoring and review. This risk management process should be an integral part of management and decision-making and integrated into the structure, operations, and processes of the organization. It can be applied at strategic, operational, program or project levels.

2.3 HOR Model

This model is used to identify risk events and risk agents and mitigate their preventive action during implementation of prolonged maintenance.

The steps for implementing the HOR model are as follows:

1) **HOR Phase 1**

a. Identify risk event (Ei) and risk agent (Aj). This risk identification was obtained through RBS mapping which was compiled based on the WBS of each business process in the company.
b. Measure or assess the likelihood of occurrence of Aj variable and severity of Ei variable.
c. Develop correlation matrix between Ei and Aj where 0 represents no correlation and 1, 3, and 9 represent, respectively, low, moderate, and high correlations.
d. Calculate the aggregate risk potential of agent *j* (*ARPj*) which is set as the likelihood product of occurrence of the risk agent *j* with equation:

$$ARPj = Oj \cdot \sum Si \cdot Rij$$

e. Rank risk agents according to their aggregate risk potentials from high to low values.
f. Develop diagram pareto Aj (priority option of agent *j*). HOR Phase 1 can be shown in Figure 2 below.

Risk Breakdown Structure	Risk Event (Ei)	Risk Agents (Aj)							Severity of risk event i (Si)
		A1	A2	A3	A4	A5	A6	A7	
Technical	E1	R11	R12	R13					S1
	E2	R21	R22						S2
Management	E3	R31							S3
	E4	R41							S4
External	E5								S5
	E6								S6
Commercial	E7								S7
	E8								S8
	E9								S9
Occurrence of agent j		O1	O2	O3	O4	O5	O6	O7	
Aggregate risk potential j		ARP1	ARP2	ARP3	ARP4	ARP5	ARP6	ARP7	
Priority rank of agent j									

Figure 2. HOR Phase 1

2) **HOR Phase 2**

a) Identify relevant actions (PAk) for preventing the risk agents (Aj). There is a possibility occurred that one risk agent could be addressed by more than one actions, and one action could concurrently reduce the likelihood of occurrence of more than one risk agent.

b) Determine the correlation (Ejk) between each preventive action and each risk agent where 0 represents no correlation and 1, 3, and 9 represent, respectively, low, moderate, and high correlations. Ejk could be viewed as the effectiveness degree of action k in decreasing the likelihood of occurrence of risk agent j.

c) Assess the degree of difficulties (Dk) in performing each action.

d) Calculate the total effectiveness of each action (PAk) with equation:

$$TEk = \sum (ARPj \cdot Ejk)$$

e) Calculate the total effectiveness to difficulty ratio with equation:

$$ETDk = TEk / Dk$$

f) Assign priority rank to each action based on value of $ETDk$. HOR Phase 2 can be shown in Figure 3 below.

Note:

Oj	:	Occurrence of risk agent j
Si	:	Severity level of risk
Rij	:	Correlation between risk event i and risk agent j
$ARPj$	:	Aggregate risk potentials of risk agent j
PAk	:	Preventive action k
Ejk	:	Correlation between risk agent j and mitigation action k
TEk	:	Total effectiveness of each mitigation action k
Dk	:	Degree of difficulty performing preventive action
$ETDk$	:	Total effectiveness to difficulty ratio

To be treated risk agent (Aj)	Preventive Action (PAk)					Aggregate Risk Potensials (ARPj)
	PA1	PA2	PA3	PA4	PA5	
A1	E11					ARP1
A2						ARP2
A3						ARP3
A4						ARP4
Total effectiveness of action k	TE1	TE2	TE3	TE4	TE5	
Degree of difficulty performing action k	D1	D2	D3	D4	D5	
Effectiveness to difficulty ratio	ETD1	ETD2	ETD3	ETD4	ETD5	
Rank of priority	R1	R2	R3	R4	R5	

Figure 3. HOR Phase 2

3. METHODS

This section explains the activities have been performed during the study. There are four stages in this study, as follows:

i. Initial
This chapter initiates the processing of problems formation and set research objectives, consists of the literature theory, literature review and field studies and process of problems identification based on mapping of the risk breakdown structure in designing of operational risk management during implementation of aircraft prolonged maintenance.

ii. Data Collection
This chapter consists of the data collection and processing by doing observation on business process, company data and maintenance documents, deployment of the questionnaire and brainstorming or focus group discussion with the experts and management.

iii. Data Processing and Analysis
This chapter explains the data processing and analysis of the HOR phase 1 and HOR phase 2 and as an initial section of risk management process to do risk assessment and risk treatment.

iv. Conclusion
This chapter is a summary of the studies as a result of identifying problems and addressing the stated objectives of operational risk management during prolonged maintenance.

4. RESULTS

The following is the result of the identification of risk events that occurred during the implementation of aircraft prolonged maintenance in operational risk management process design. The identification of these risk events is carried out based on the results of the risk breakdown structure (RBS) mapping which has previously been determined based on the work breakdown structure of prolonged maintenance business process. This RBS was developed by risk grouping based on the sources of risk that determine vulnerabilities during implementation of the project or whole business (Hillson, 2003). The identified risk events are then grouped based on technical, management, external and commercial aspects. As HOR phase 1, the results of the risk event identification obtained 33 risk events, including 18 risk events of technical aspect, 10 risk events of management aspect, 3 risk events of external aspect and 2 risk event

of commercial aspect. Then, the results of the risk agent identification obtained 30 risk agents. After assessing the likelihood of occurrence of Aj, severity of Ei and develop correlation between risk event and risk agent, then calculate the aggregate risk potential of agent j ($ARPj$) which was ranked from high to low values as shown on Table 1 separated below.

Table 1. Rank of ARP Risk Agent on HOR phase 1

Rank	Risk Agent	ARP
1	A14	960
2	A25	482
3	A5	471
4	A19	389
5	A15	323
6	A20	279
7	A1	244
8	A16	175
9	A9	174
10	A4	172
11	A29	157
12	A27	155
13	A30	152
14	A24	115
15	A17	114

Rank	Risk Agent	ARP
16	A18	102
17	A13	97
18	A21	97
19	A23	68
20	A2	68
21	A26	67
22	A10	64
23	A3	56
24	A28	51
25	A7	49
26	A6	43
27	A11	35
28	A8	12
29	A12	11
30	A22	7

Pareto diagram of risk agent is then developed as priority option of agent j by using the 80/20 principle as shown on Figure 4 below. Based on the pareto diagram, the cumulative percentage of more than 80% will be eliminated and under 20% there are obtained 13 risk agents as a priority for preventive action. Those 13 risk agents are A14, A25, A5, A19, A15, A20, A1, A16, A9, A4, A29, A27 and A30. This will be used as HOR phase 2 input to identify the relevant actions (PAk) for preventing the risk agents (Aj) and to determine the correlation (Ejk) between each preventive action and each risk agent as shown on Table 2.

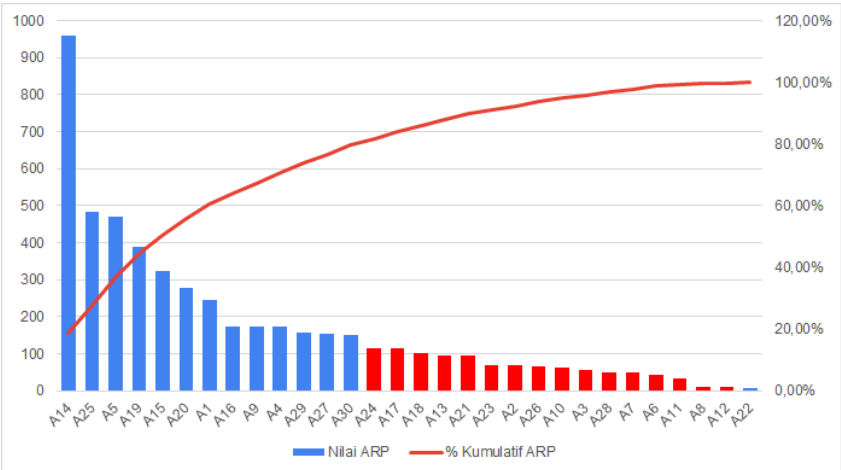

Figure 4. Pareto diagram of risk agent ranked ARP on HOR phase 1

On the Table 2 below shows correlation (Ejk) between each preventive action (PAk) and each risk agent (Aj). Correlation (Ejk) could be considered as the degree of effectiveness of action k in reducing the likelihood of occurrence of risk agent j.

Table 2. Correlation (*Ejk*) and Degree of Difficulty (*Dk*)

Rank	Risk Agent (*Aj*)	Preventive Action (*PAk*)	Correlation (*Ejk*)	Degree of Difficulty (*Dk*)
1	A14	PA1	9	2
		PA2	3	2
		PA3	9	4
		PA4	3	4
		PA5	9	3
2	A25	PA6	9	3
3	A5	PA7	9	4
		PA8	9	3
4	A19	PA9	9	5
5	A15	PA10	9	5
		PA11	3	5
		PA12	3	4
6	A20	PA13	9	5
		PA14	3	3
7	A1	PA15	9	5
		PA16	9	4
		PA17	9	4
		PA18	3	4
8	A16	PA19	3	3
		PA20	1	2
		PA21	3	4
9	A9	PA22	1	3
10	A4	PA23	3	5
11	A29	PA24	9	5
12	A27	PA25	9	4
		PA26	9	3
		PA27	3	2
13	A30	PA28	3	3
		PA29	3	3

After calculating total effectiveness (*TEk*) of each action and total effectiveness to difficulty ratio (*ETDk*), then as seen on Table 3 separated below shows rank of priority to each preventive action.

Table 3. Rank of preventive action with the highest to lowest *ETDk*

Rank of Priority	PA	ETD
1	PA1	4320
2	PA5	2880
3	PA3	2160
4	PA6	1446
5	PA2	1440
6	PA8	1413
7	PA7	1060
8	PA4	720
9	PA9	700
10	PA10	581
11	PA16	549
12	PA17	549
13	PA13	502
14	PA26	465

Rank of Priority	PA	ETD
16	PA25	349
17	PA24	283
18	PA14	279
19	PA12	242
20	PA27	233
21	PA11	194
22	PA18	183
23	PA19	175
24	PA28	152
25	PA29	152
26	PA21	131
27	PA23	103
28	PA20	88
29	PA22	58

5. CONCLUSION

Based on the results of the identification of risk events in the operational business processes of PT. ABC obtained 33 risk events and 30 risk triggers. The results of the HOR1 model are then arranged by Pareto diagram and through brainstorming with management, obtained 13 risk agents that need a mitigation action plan. The highest ARP value is 960 that was contributed by risk agent A14: There is no control, review, and evaluation on the status of prolonged aircraft and the lowest is 35 that was risk agent A22: There is no crew shift rotation on production level. The results of the HOR2 model, there are 29 preventive actions which are then calculated the Effectiveness to difficulty ratio (*ETDk*) value. Brainstorming with management resulted 20 of the 29 actions reviewed above requires follow up immediately. This is based on several factors including the costs incurred, time constraints, and considering the level of difficulty to be implemented immediately. The sequenced 20 preventive actions were reviewed and selected as follows.

PA1 : Appoint responsible person as project manager for prolonged maintenance control
PA3 : Develop a dedicated team for prolonged implementation in a certain period
PA2 : Develop a particular work breakdown structure for prolonged maintenance
PA5 : Provide periodic progress reports on the status of prolonged aircraft to customers and accountable persons, management, and prolonged teams by the project manager
PA6 : The project manager provides status reports, aircraft highlights, and requests decisions on problems to top management at the board of management meeting
PA7 : Perform weekly internal coordination meeting with concerned units to discuss the progress status
PA8 : Communicating with aircraft manufacturers to get recommendations for deviations that occur outside of normal procedures
PA1 : Appoint responsible person as project manager for prolonged maintenance control
PA4 : Perform weekly coordination meeting with concerned units to discuss capacity planning and implementation status led by project manager
PA14 : Consider permission for the implementation of maintenance outside of normal procedures by considering risk identification, assessment, and mitigation
PA27 : Provide additional / alternate maintenance procedures as part of corrective action in preventing deterioration due to external factors
PA28 : It is necessary to establish a documentation coordinator in controlling the administrative completeness
PA25 : It is necessary to periodically control prolonged aircraft and provide regular reports regarding findings that need to be followed up
PA9 : Design a detailed list of maintenance costs per each treatment package
PA10 : Make an inventory list of material requirements and components needed for each aircraft
PA16 : Expedite the fulfilment of spare components with a component exchange scheme
PA17 : Expedite the fulfilment of consumable materials by finding new sourcing and renegotiating with suppliers
PA11 : Designing a specific Material Required Planning for prolonged maintenance based on consumption history
PA22 : Conducting socialization/dissemination related to the procedures for implementing prolonged maintenance in the initial phase of the project at all levels of positions in the organization's functions concerned
PA19 : Setting the maintenance work priority sequence by completing the unscheduled task in the last phase when the aircraft will return to operation

MANAGERIAL IMPLICATIONS

This study may be a recommendation to the PT. ABC management as an input in implementing the aircraft prolonged maintenance project so that potential of operational risks can be minimized, and the planning can be executed smoothly. The implications of managerial policies that can be used as input to company management are as follows.

1. The company gains new capabilities, particularly as a maintenance services provider for aircraft prolonged or storage maintenance.
2. There is an improvement in the quality of business processes because the obstacles or limitations on each work function on business process can be identified, mitigated, and improved.
3. There is an increasing the quality of human resources by playing roles in the dedicated team project on this prolonged maintenance implementation. By developing a dedicated team project, all project members can maintain and improve the quality of the team so that the planning can run properly, and the prolonged project can be managed optimally.
4. There is additional revenue generated from this prolonged maintenance which can increase profit so that the employee's welfare also rises.

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IMPLEMENTATION OF DATABASE MARKETING FOR MAINTAIN SPAREPARTS SALES: STUDY IN PT. YAMAHA INDONESIA MOTOR MFG.

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ABSTRACT

After-sales conditions are the main consideration for consumers who want to buy a new motorcycle, because after-sales will continue until the motorbike is no longer used or has been sold. Sales of spareparts are still quite good in terms of sales volume and nominal rupiah despite the impact of the pandemic. For this reason, finding methods to manage sales and marketing of motorcycle parts is very important for companies to maintain their sales.
Identify the clustering category using spareparts that sold in the last 3 years. Then market segmentation A-D to determine the type of marketing category for spareparts that can compete in that area. The appropriate activities are then determined for each segment A-D under conditions of market leader and market challenger.
The results of clustering category divided into 3 categories, where captive parts are dominating with 60.1% of total spareparts sales. Then, based on the clustering of segments A-C with perfect competitive market conditions, only 8 marketing category spareparts can compete in national market. Lastly, there are 4 activities that can adapt to the current condition of national sales. This study can be studied further of market condition each region in Indonesia with national conditions examples.

Keywords: Analytical Hierarchy Process, Clustering, Customers, Data, Spare Part.

1. INTRODUCTION

To commute to work every day, Indonesians need an efficient means of transportation for their daily trips. Private vehicle is always the choice of the people of DKI Jakarta even though there are many means of public transportation. This can be seen in the number of motorbikes in the past 3 years at DKI Jakarta which continued to increase by 0.7% compared to 2019, reaching 77,158 vehicles compared to the previous year (DKI Jakarta Province Services, 2020). The condition is that motorbikes are the most popular means of transport with 69% or 8,194,590 units (DKI Jakarta Industrial Statistics Portal, 2020). The reason is because the price is relatively affordable for many people, helping to save fuel, parking costs and maintenance costs.

Although not a market leader in motorcycle unit sales in Indonesia, PT. Yamaha Indonesia Motor Mfg. (PT. YIMM) also has another business mode, namely after sales service, where in 2019 revenue from the aftersales service business already represented 36.7% of the company's total turnover. And it continues to increase in its business lines from year to year, where sales growth can reach 105% or the same as getting an additional IDR 500 billion from last 2020, with

national conditions still shrouded in the COVID-19 pandemic (YIMM Sales, 2021). This is because PT. YIMM since 2000 has been committed to maintaining the satisfaction of its after-sales customers by establishing a special division that focuses on motorcycle spare parts, which is named the parts operation division (POD). Until now, POD has registered more than 80,000 parts numbers in order to continue to maintain the after-sales business line of Yamaha motorcycles, because the company's commitment is to maintain the availability of spare parts stocks even though the motorcycles have ceased to be produced in discontinuous production for the next 10 years.

So, in order to manage the sales of 80,000 parts number of spare parts that are actively sold, the first step required is the management of a good and strong company database. The first step is that companies must streamline information from various available sources first. By processing and streamlining data, companies can use this data for evaluation and determine future targets. Then the benchmark if an activity is carried out becomes more focused, considering that previous grouping and streamlining have been carried out. So that the weak part can be taken action. A good database can also be used as a more targeted delivery of information, both from the field team and management. And most importantly when making sales through a database approach the costs will be more efficient and organized. Because as previously stated, all activities become narrower according to their needs. The benchmark for the success of activities can also be seen, so that the budget used to lift less successful activities becomes safer. Because the success and longevity of the company depends on the organization's ability to build and maintain long-term relationships with its customers (Ferreira & Gustafson, 2006).

For this reason, the importance of research carried out to be applied further by PT. YIMM in managing stock levels, sales activity campaigns, based on the categories to be formed. Then as the data on the increase in sales of motorcycle units, the need for spare parts is also needed in the after-sales condition of PT. YIMM or other brands that can use the same parts. Moreover, the high level of competition between Brand Holder Sole Agent (ATPM) companies that also play in the spare parts segmentation, or other brands that often enter the after-sales trade market. The last is in order to understand the characteristics of consumers based on the category to be carried out. The main purpose of maintaining inventory is to provide components and materials whenever demand arises (Williams & Tokar, 2008).

2. LITERATURE REVIEW

Database Marketing

In a database marketing (DBM) strategy, organizations collect customer-related data. The data then stored, monitored, and regularly updated. It aims to develop more personal relationship with the company's current customers. Service companies that do not make effective use of databases will be left behind in this increasingly difficult economy. It is also stated that companies that use databases well will position themselves for superiority when the economic recession reverses (Brough, 2009).

It's important to get information and build strong relationships with new members as quickly as possible. It is also necessary to strengthen and create long-term relationships with existing members as well. Using techniques such as DBM, information about interests and demographics can lead to more precise communications, repeat business, satisfaction of needs, and increased profits. More innovative DBM techniques can also help in achieving customer loyalty through relationship building, needs assessment, and providing appropriate solutions (Petrison, Blattberg, & Wang, 1997).

It also enables a corporation's ability to segment its marketing efforts more effectively for potential customers, while realizing benefits such as profitability and cost reduction as well. Very often an organization does not care about technological advances, so it often loses the direction of the company's goals. Whereas focusing on the customer will help keep the organization on the ground during company development (Iriana & Buttle, 2006).

Database Mining

Data mining is the extraction of an important pattern from large amounts of data, a very complex method and has great potential to help companies discover patterns in their databases (Hung, 2006). More and more tools are available to extract this data that can answer business questions that often take too long to solve. Data mining is the application of data discovery and analysis algorithms to identify patterns in data for prediction and description. With a database of the right size and quality, data mining technology can provide business intelligence for knowledge generation and opportunity detection (Hung, 2006).

Every step is very important to take. What matters is knowing what data is best used and how best to interpret that data. Modeling makes it possible for us to apply it to new data. On the other hand, data modeling without proper understanding and careful data preparation will cause many problems later on. Ultimately, the whole process of data mining is useful for new knowledge (Vesanto & Alhoniemi, 2000).

Cluster analysis is a way to explore data structures. The essence of cluster analysis is the process of grouping objects into clusters such that items in the same cluster are similar and items in different clusters are dissimilar. Cluster analysis can be performed in customer databases to identify homogeneous subpopulations of customers. These clusters or segments may represent individual target groups for marketing purposes. (Han & Kamber, 2006).

Customer

A new generation of customers with very different shopping needs has set new standards for what they expect from modern auto dealers (Schmidt & Trenka, 2019). Inspired by their experience in industries other than automotive and the emergence of new technology, customers have been looking for new and productive experiences in their car buying journey for several years (Aureso, 2016). Existing technology makes it easier for younger customers to set higher expectations, and younger customers can easily be dissatisfied with the traditional way of selling cars.

Young customers, especially the younger generation, do not have the patience to wait for the goods to be available to serve them, and they are willing to pay more for a shorter wait time (Brown, 2019). According to Aureso (2016), technology supports the perception of younger generation customers, who focus on providing quick service. For example, most millennials order food through their mobile phones, with just a few clicks, or choose to shop online with the hope of receiving it the next day and want to be delivered 24/7 support to serve them through live chat. Changes that occur in customer expectations can also occur in the automotive retail sector, where customers expect real-time connections with commodity manufacturers and auto dealers (Aureso, 2016).

The auto retail industry is one of the few industries that profit from vehicle sales and after-sales service. Some automakers, working with their distributors or dealers, have developed brand and customer loyalty improvement initiatives that involve selling cars with service packages and extended warranties. According to Yarrow (2015), auto dealers that sell cars with

service-maintenance options have a customer retention rate of about 60%, hence the view that offering a service package can help build Building their loyalty and increasing sales is right.

In addition, the provision of included service gives customers confidence and assurance that service maintenance costs will be included with each purchase and customers will not incur repair and maintenance costs. car maintenance. But according to PRNewswire (2017), customer retention strategies such as service plans have made some car dealers complacent and affected the improvement of the customer experience. Some car dealerships fail to improve the customer experience because they believe car buyers will come to their service center for free service.

Customer Value Measurement

Buying behavior is difficult to measure. Because it includes a lot of information to measure with a limited number of variables and of course high accuracy. Different market segmentation approaches are widely adopted in the retail market, such as traditional demographic segmentation, buyer motivational segmentation, and usage preference segmentation (Marcus, 1998). With the rapid development of technology, consumer purchasing information is becoming increasingly available in the retail market, allowing marketers to develop more sophisticated methods of market segmentation. Therefore, any research that takes place requires only necessary data based on information needs. In parts sales data, all relevant variables to measure buying behavior can be used. This section presents some basic variables that can be applied as an illustration.

To apply segmentation methods such as RFM (recent hits, frequency, and monetary value) to the small business retail environment (Marcus, 1998) a simple segmentation method was created. simpler and more powerful, called the customer value matrix. The customer value matrix method focuses on two variables that best describe customer value: number of purchases and average number of purchases. Two variables are applied to determine the axes of a simple two-by-two matrix of values. Finally, each customer is assigned to one of the qualitative segments, identified as best, frequent, spend more, and uncertain. In other studies, other variables may be considered in this customer value matrix, such as purchase hits, product categories, geographic distribution, and demographic distribution. According to Marcus (1998), the use of customer value matrix is sufficient to simplify segmentation in retail trade. The author emphasizes that the number of purchases and the average number of purchases are the variables that best represent customer value.

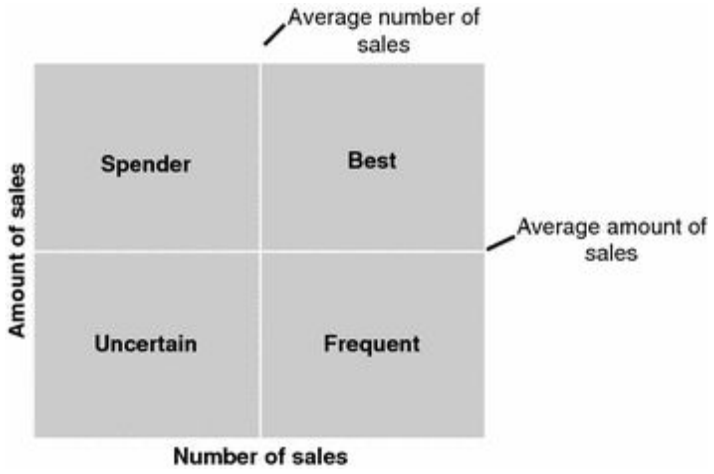

Figure 1. Customer Value Matrix

3. METHODS

Source Data

This study is carried out according to the mixed method, which is a study that combines two research approaches, quantitative and qualitative (Creswell, 2010). A mixed methods approach is needed to solve the existing problem, where big data is first processed and then decisions are made.

In qualitative research, data collection can be done in a variety of ways, one of which is through in-depth interviews and documentation (Sugiyono, 2008). An interview is a conversation and question-and-answer activity aimed at achieving a goal. For this reason, interviews were performed to determine the characteristics of the department itself at the time. The parties involved are:

Table 1. List of Interview Subjects

No	Nama	Jabatan
1	RS	*Senior Manager Aftersales Service*
2	FR	*Coordinator Sales*

In this study, sales data from PT. YIMM to their distributors for the past 3 years. Its main function is to see the average sales of each part, then re-evaluate any parts that have been sold during that time. For this reason, the sales data of 40 main dealers throughout Indonesia are summarized again into one sales data.

4. RESULTS

Clustering Category Identify

After getting a total registration list for all active part numbers sold by PT. YIMM on the market so far, the filter was remade to remove engine oil and accessory groups in this study. So by eliminating the two commodity groups, we get the remaining 75,600 references, the marketing category groupings or the remaining up to 150 marketing categories (brake pads, light bulbs, frames, etc.). In addition, from 150 marketing categories, categories were grouped based on research on sales conditions in the market.

Meanwhile, as explained above, the first type concerns goods that enter a perfectly competitive market for sale. So, the first step is to conduct an interview with the field sales team about the current market conditions. The sales team here also gets information from the public workshop they interact with. Then, information is collected from the sales coordinator as a reference that the goods should be classified into category groups, because the market categories are already different. Maintenance herein discloses certain information, including brand status of alternative products other than those owned by PT. YIMM, then the prices and the pros and cons of competing brands.

The next step in the synthesis process, if the good is not placed in a perfectly competitive market, its sales are classified in a monopoly market. Where in this second category if the goods are currently well produced and consumers only use the PT spare parts. YIMM. If the goods fall into this category, they are called captive parts. Where there are 83 spare parts marketing categories in this spare parts group. With a total of 71,644 references per category. End market activity can be understood as an authoritarian market, or a market structure in which an industry is dominated by a small number of competing firms. Or the current condition is only PT. YIMM or other ATPM companies are capable of producing these goods. Then between brands that regulate

the territory for motorcycles it is also possible to use products from each brand, so that this type of product group receives a name as a focal point. Where there are 13 categories of spareparts marketing in this group. With a total of 1,915 references for each category.

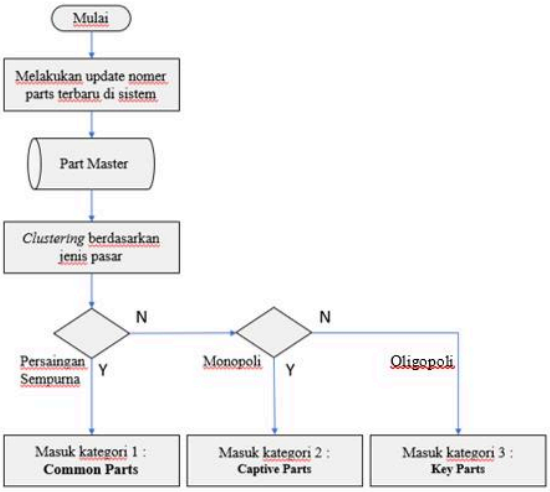

Figure 2. Clustering Planning

Market Segment Identify

As was done at the spareparts clustering category stage according to market conditions, spare parts from other ATPM companies produced for their motorcycle aftermarket needs, as well as products from the second brand can also be used for PT. YIMM. Market segmentation is carried out on marketing categories that have been grouped previously, using sales data for the last 3 years, then using a customer value matrix, comparing the nominal rupiah to the average number of goods sold outside.

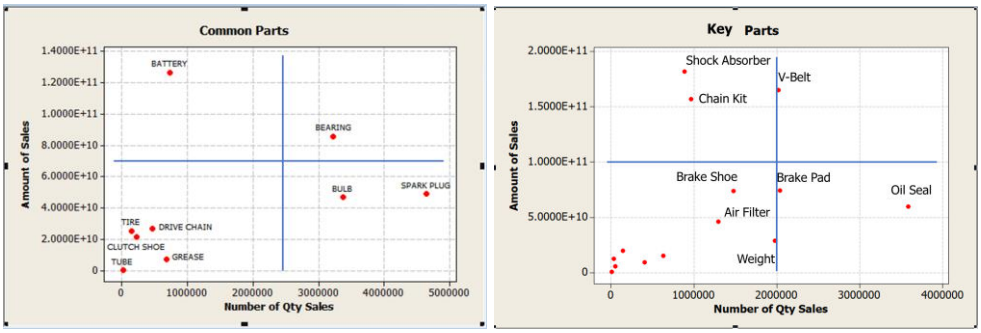

Figure 3. Market Segment – Common & Key Parts

As explained in the previous grouping step, spareparts with sales conditions that are included in the perfect competition market category are grouped into common & key parts. Due to their condition, these items are selling well because of the high demand for each motorbike. The last is captive parts or the market condition is a monopoly on the sale of the parts at this time. Or the condition is that Yamaha motorcycles can only get goods in this group through PT. YIMM.

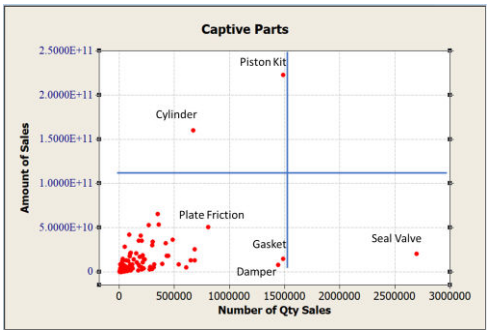

Figure 4. Market Segment – Captive Parts

Market Position Analysis

Finally, identifying the right business is key to maintaining the motorcycle parts business in Indonesia. Especially for spare parts, the availability of goods is a special concern for every motorcycle consumer who wants to have their vehicle serviced. So, by looking at the market position first, it can be the best guide or the best direction for selling spare parts.

Table 2. Priority Value Between Alternatives in Sub-criteria (Market Leader 1)

Activity	Budget 1	Budget 2	Budget 3	Stock 1	Stock 2	Delivery 1	Delivery 2	Salesman	Total	Persen	Rank
Expansion of the overall market	0.0047	0.0226	0.0134	0.0736	0.0547	0.0881	0.0326	0.1004	0.3901	39.0%	2
Expansion of the current market sahre	0.0020	0.0080	0.0049	0.2032	0.0860	0.0975	0.0074	0.0254	0.4344	43.4%	1
Guarding the existing market share	0.0010	0.0043	0.0018	0.0512	0.0232	0.0795	0.0042	0.0105	0.1755	17.6%	3

Under these conditions, the right choice of activity for segmentation A, B, and C in the market leader is to apply expansion of the current market share. Given the market conditions that are monopolized by goods belonging to PT. YIMM only, heavy advertising activities and also improving new products are needed in this segmentation.

Table 3. Priority Value Between Alternatives in Sub-criteria (Market Challenger 1)

Activity	Budget 1	Budget 2	Budget 3	Stock 1	Stock 2	Delivery 1	Delivery 2	Salesman	Total	Persen	Rank
Frontal	0.0333	0.0021	0.0043	0.1154	0.0239	0.0712	0.0143	0.0193	0.2837	28.4%	1
Flank	0.0107	0.0017	0.0057	0.0263	0.0185	0.0168	0.0049	0.0832	0.1677	16.8%	4
Encriclement	0.0203	0.0019	0.0086	0.0568	0.0343	0.0275	0.0077	0.0526	0.2098	21.0%	3
Bypass	0.0135	0.0011	0.0029	0.0168	0.0051	0.0088	0.0031	0.0227	0.0739	7.4%	5
Guerilla	0.0137	0.0047	0.0115	0.0665	0.0591	0.0754	0.0100	0.0240	0.2649	26.5%	2

In this condition, the right choice of activity for A & B segmentation in the market challenger is to apply a frontal attack to the market leader. Given the market conditions that are not monopolized by the property of PT. YIMM only, it takes big activities such as discount on purchasing goods when the network wants to develop the market. And continue to prioritize the quality of the company where the spare parts sold by PT. YIMM is definitely genuine and compatible with motorcycles in Indonesia.

6. CONCLUSIONS

Based on the research results, determine the category of spare parts PT. YIMM must first consider the competitive conditions in the market. Because of the 150 types of marketing categories owned by the company, there are several marketing categories where the type of market is not 100% monopolized by PT. YIMM. Therefore, information about what parts may be produced by competitors will be the reference for clustering category activities here.

This analysis uses total national sales data for all regions, so that the market segmentation obtained after the previous clustering is a description of the current national condition. In addition, it is necessary to in-depth research for each area to get the differences in each area.

This research is an innovation in data management, where marketing data has a major influence on sales activities, inventory management for the team concerned, and budget optimization in the business plan division. Based on these findings, by grouping the existing spare parts marketing category based on market conditions, it becomes a business road map for the company as to which parts still need to be improved again. Furthermore, what activities need to be carried out are reprocessed based on the results of interviews using the analytical hierarchy process decision-making method, so that they are in line with company expectations, namely increasing sales.

By implementing this strategy, the company becomes more focused in running its business, carrying out an activity that is right on target, and can compete with other company's spare parts brands.

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AIRCRAFT ALLOTMENT SPARE (WHEEL AND BRAKE) FULFILLMENT EVALUATION WITH A SIMULATION APPROACH

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ABSTRACT

Inventory management's role in aircraft maintenance industry is minimizing the effect of operational problem. Operational problem refers to delay and cancellation. Both problems become the outmost concern for airlines since it is related to the passenger compensantion and the brand image of the airline itself. In one of best Airline on Indonesia, it is documented during 2018, there were 354 times delays caused by technical problems and 17 times delays caused by inappropriate decision of allotments spare and most probable allotment spare is wheel and brake (4 times). This research utilized the supply chain of PT. GMF AeroAsia is a well-known company in Indonesia which provides services in aircraft maintenance and facilities. Supply chain's study is needed to gain optimal solution for allotment spare focusing on the quantity of spare part and the processing time. Simulation develop in each supply chain point (Warehouse, Central Distribution, logistic process, Production Warehouse and send back to Warehouse after being used). The novelty of this research is the amount of Warehouse that will be simulated (47 Production Warehouse). Based on analysis, scenario optimum will achieved with the process improvement on Warehouse production process, using alternating Part Number and changing on the way logistic process with Allotment Spare fulfillment.

Keywords : inventory, rotable part, processing time, discrete event simulation

1. INTRODUCTION

Inventory planning activity is one of the activities in supply chain management that plays an important role. Inaccuracy in inventory planning can lead to non-smoothness in the production process. There are differences of inventory planning in service company and manufacturing companies. In service companies, inventory is in the form of materials or supplies that are used in service to customers. Whereas in manufacturing companies, inventory is in the form of materials, work in process goods and finished goods (Zaroni, 2017). One of the objectives of inventory management planning is to assist companies in improving Service Level (SL) Agreements but at the lowest possible cost.

According to the previous similar research conducted by Eun Suk Kuh (2015) entitled "Optimization of Supply Chain Costs for Xerox Consumables", this research was aimed to investigate and estimate the most optimal inventory policy for company. The classical problem is

how much effort being needed to increase SL, how do it worth the costs incurred with increasing SL. And also how about the connection between inventory level and service level. If the increasing number of SL from 95% to 97% will create a much greater effort/cost than increasing SL from 85% to 87%. This also applies to the aircraft airline industry, where inventory is needed to minimize the impact of operational disruptions, so that aircraft can be maximally operated to transport passengers and goods with the lowest possible inventory (International Air Transport Operations, 2015).

Inventory is being managed by aircraft airlines and aircraft maintenance services industry in the form of aircraft spare parts warehouse provided in every airport that is functioned as the destination of the aircraft. This inventory is in the form of a set of spare parts needed to avoid delays or cancellations due to repairmen of aircraft that require spare parts. This set of spare parts that must be provided is called the Spare Allotment. Many aspects become parameters in determining the Allotment Spare, including data from the manufacturer, data from other airlines that operating the same type of aircraft, data from MRO (Maintenance, Repair and Overhaul) which performs aircraft maintenance both major and minor, as well as data from expert or consultant.

Research on determining the inventory management has been done in several areas of interest and by utilizing various kind of objects. However this study has its own novelty, since there are still less number of research which utilizing aircraft inventory management and involving a lot numbers of warehouse or station as the data. There are various methods developed in optimizing inventory that must be maintained in each warehouse, including using the Multi Criteria Decision Making, Inventory management of vendors or Simulation methods. In this study, a simulation approach will be used to solve Inventory problems, because it involves a fairly complex system, including one Distribution Center and several warehouses, so direct observation of the system will require a considerable time and cost. Simulation is a set of methods used to model the behavior of a real system. Currently the simulation method is widely used because the technology is able to solve even complex models (Whelar and Msefer, 1996). The first research that discusses simulations for Inventory was conducted by Suraj, et al (2016) who explained that the modeling uses two supply chain echelons and with two identical retailers with one Distribution Center/DC and one Manufacture. This study simulates Lead Time to get the most optimum inventory costs with the parameters of two echelon supply chains with two identical retailers, one distributor and one supplier. This research uses Arena software version 11 and validated with an Analytical Model.

Furthermore in the aircraft maintenance process, spare parts are divided into three types, namely expendable, repairable, and rotable. In the use of spare parts, aircraft maintenance is guided by (1) the maintenance program made by the aircraft manufacturer in which there is a replacement interval, (2) predictions from the reliability evaluation results from the Engineering unit, or (3) conditions that are no longer feasible thus requiring replacement during routine inspections.

The airplane as the mode of transportation in general has more advantages in archipelagic countries, as the Republic of Indonesia, comparing to others non-archipelagic countries. Since this mode of transportation is the most effective for transporting people or goods in terms of time and cost. In addition to the advantages that has already mentioned, there are some disadvantages, namely technical problems. As the most airlines worry about, is the occurrence of technical problems when the aircraft is at an airport that is far from the warehouse storage or other supporting modes of transportation so it can make the recovery process goes difficult. In this case,

spare part inventory planning plays an important role. Currently, the airline serves approximately 47 stations, both domestic and international, which are equipped with spare parts warehouses.

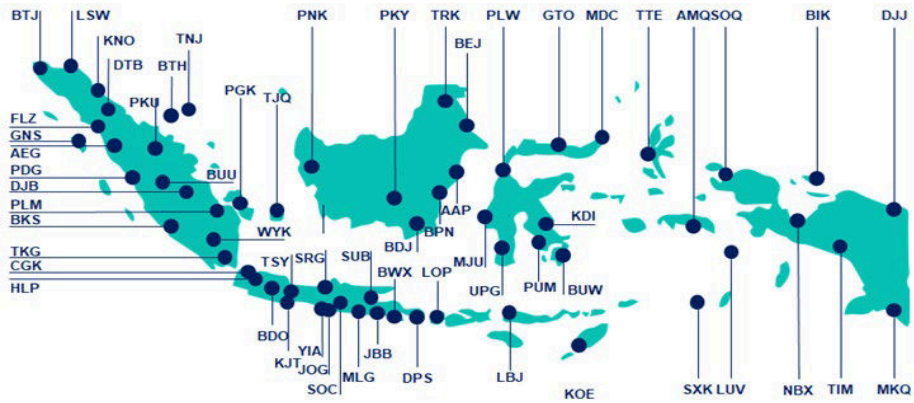

Figure 1. The Warehouses's Network of Allotment Spare Storage

In general, the Distribution Center (DC) located at the Garuda Maintenance Facility (GMF) head office in Cengkareng will serve all warehouses both domestically and internationally. GMF AeroAsia Distribution Center (GADC) obtains material supplies from the component repair process in the warehouse. If the GMF warehouse does not have the capability for repair and overhaul facilities, the supply of components will be support by the overseas pooling partners such as KLM, Air France, ST Aero, and others.

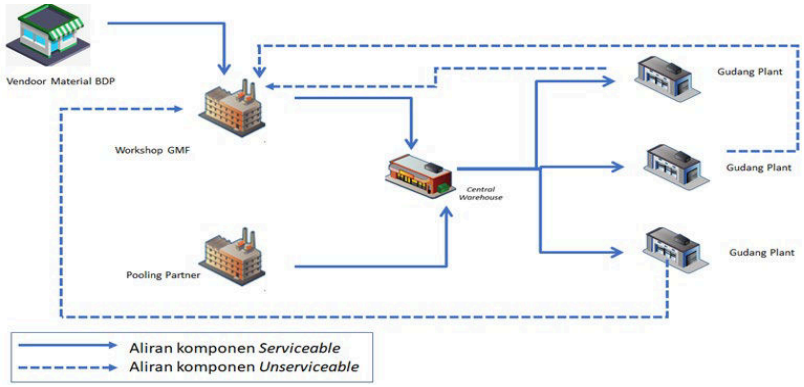

Figure 2. Material Flow in the GMF supply chain

Aircraft spare parts must be managed and controlled. Aircraft is built with an advanced technology so almost all of its spare parts are having a very high price or value. Instead of its high price, operational constraints also create higher costs of maintenance, such as delays that lead to the airline's image as well as compensation costs that must be given to passengers in accordance to the regulation of the Ministry of Transportation Number 89 in 2015. This regulation told that an airline must compensate the inconvenience caused by technical problem to passenger in form of food, beverages, or money. Or an airline also may compensate with the provision of lodging and aircraft replacement.

Aircraft as the transportation mode are closely related between one airlines to others, because the flight pattern model is sometimes the same (route, number and flight model). It makes it easier for the airline itself in terms of borrowing spare parts to minimize the impact of aircraft

disturbances. During 2018, Garuda Indonesia and Citilink Indonesia airlines experienced delays due to technical problems as many as 354 times. Delays caused by spare part problem also takes big concern, it is being ranked on fourth position by contributing 17 times (4.8%) and for Wheel Brake contributing 3 times (1%). Among all the occurrences of flight delays, the absence of material availability at the transit station, delivery problem from one station to other stations is required. This problem needs to be evaluated immediately to maintain the flight quality for the customer convenience.

As the phenomena that has been explained above, Discrete Event Simulation method is used to describe the time sequence of the process along the supply chain process in Allotment Spare. The changes that occur are at certain points in time, such as the queue of machines used, the adequacy of the number of operators, or an uncertain delivery schedule. From the simulation results, it is hoped that alternative solutions will be obtained that will allow the optimal number and location of storage in the Outstation Warehouse to be obtained. The simulation approach is used because the object of observation is quite broad, covers flight routes throughout the islands and is expected to be described by modeling to gain an optimization of cost efficiency.

However during the pandemic, all airlines keep their expense tightly in order to keep stay in the aviation business. Among all expenses of the airlines, the big three are coming from the technical issues, one of the is the cost of spare parts. The price of spare parts for a high technology airplane is very large, so it is necessary to conduct a proper study in its procurement. This includes the accuracy in determining the type, amount, and location of the spare part allocation.The choice of method in determining the Aircraft Spare Allotment is very useful for reducing the impact of aircraft operational disturbances, especially those caused by technical aspects related to all points in the supply chain in it such as warehouse capacity, delivery methods, and so on. So it can be concluded that the formulation of the problem in this study is to determine the optimization of the Spare Allotment at each airport that is the destination of Garuda Indonesia aircraft. The purpose of this research is explained as follows: (1) Creating a model of the Allotment Spare process that helps in the decision-making process to determine what components should be in it, (2) Designing alternative scenarios for improvement for the fulfillment of Allotment Spare in each Outstation Warehouse , and (3) Evaluating scenario choices to achieve the highest percentage fulfillment of existing spare allocations.

2. LITERATURE REVIEW

In the world of aviation, safety standards are absolute. To ensure flight safety, there are regulations that regulate all aspects of flight safety. One of these regulations internationally is IATA (International Air Transport Association) and the Ministry of Transportation, Directorate General of Civil Aviation at the national level. Based on IATA guideline in the revised edition at 2015, generally the objectives of inventory management in the aviation world are depicted in the hierarchical chart below,

Figure 3 : Hierarchy of Inventory Management in Aviation Industry
Sources : IATA *Handbook* (2015)

Based on the figure 3 above the first goal of inventory management is to be able to carry out the aircraft maintenance process with the highest level of safety at the lowest cost. The second objective is to anticipate flight delays and cancellations. Furthermore, the third objective is related to the availability of spare parts for aircraft maintenance functions. The supply of goods in this case is spare parts, it is closely related to the aircraft maintenance process. IATA (2015) mentioned the guidelines for aircraft repair materials and inventory management as being described in the following characteristics,

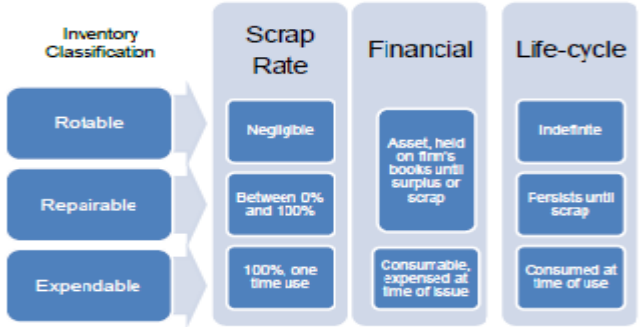

Figure 4 : Classification and Characterictics of Inventory
Source : IATA *Hand book* (2015)

The picture above illustrates that inventory is generally divided into three, namely rotable (can be used repeatedly after going through the maintenance process), repairable (can be repaired but does not increase the age of use), and expendable. In general, the three types of inventory above differ in terms of characteristics, namely scrap rate, financial value, and life cycle.

Regarding the classification of spare parts, hereinafter known the concept of Initial Provisioning. Initial Provisioning is an initial set of spare parts that must be provided by aircraft airlines to ensure that in the operation of new types of aircraft there are no problems in terms of component availability. Based on the evaluation that will be carried out from this list, it will eventually become the standard allocation for each airport. In determining what spare parts should be placed as a standard allotment, there are several data that need to be considered, including; data from aircraft manufacturers, data from similar airlines, and data from MRO (Maintenance, Repair and Overhaul).

Furthermore, research related to spare part optimization also utilizes the concept of simulation and models. Simulation is imitation of a system or process in the real world. Simulation in the form of data processing is an imitation of the input, process and results as a description of the system. A model is a simple representation of a system. The model does not have to represent all the attributes of a real system, it is simply simplified, controlled, and idealized. To be

functioned well as the real system, a model must be validated. Models can be used to investigate or predict the behavior or properties of the system to predict or provide better alternative solutions.

In addition, a system as it is a collection of objects that are connected to one another through several interactions to achieve the goal. The system is affected by changes that occur outside the system. In the modeling system, it is necessary to define the boundary between the system and its environment. The system can be studied by means of simulation, namely by providing input to a model and studying its output. The components of the system include, (a) an entity is an object in a system, for example a customer from a car repair shop, (b) an attribute is a property of an entity, such as checking the condition of a vehicle, (3) an activity is a certain system period with a certain duration, for example the replacement of car tires in August 2020, (d) events that can change the system. Examples of customer arrival hours, customer waiting time.

The output of this research is to find an optimization model. According to Sigh (2009), models can be classified into physical models, mathematical models, and computer models. Physical model is a model from an expert in the field which is a scale model of its real form. Physical model is divided into two, namely static and dynamic models. An example of a static physical model is a design drawing of a building, while an example of a dynamic physical model is a design drawing of an airplane that requires a wind tunnel for one of its tests. Moreover, a mathematical model is an imitation of a system in mathematical symbols. The difference between static and dynamic mathematical models is seen from the consideration of time in data processing. Static mathematics does not use time considerations and instead is a dynamic mathematical model. Moreover inventory data can be static or dynamic, it is static if demand and lead time are assumed to be static and it is assumed being dynamic if the demand and lead time are probabilistic. In the other hands, the computer model is an advanced form of the static and dynamic model which with the help of computers is currently a game play model that closely resembles the actual system conditions. According to Banks et al (2010), mathematical models can also be presented in simulation models. The simulation model is divided into static and dynamic simulation, deterministic and stochastic simulation, discrete and continuous simulation.

2. METHODS

This study was conducted with a qualitative research design. The data that being used are primary data and secondary data. Primary data is in the form of interviews with stakeholders related to the SCM flow which is involved starting from the Warehouse, Distribution Center (DC), Logistics to production who perform the work of replacing components on the plane. Secondary data is in the form of component movement data during 2018. Aircraft network data is also used to determine the most optimal delivery of components from DC to the Production Warehouse and the return of unserviceable components back to the Workshop. This data is in the form of Flight Route and Frequency Data in 2018. Next is the development of a conceptual model. A conceptual model is an abstraction of a simulation model that represents the real world, what should be modeled and what should not be included in the model (Robinson, 2014). The next research stage is namely the development of a conceptual model in the study. The next stage after making a conceptual model is making a simulation model. Based on the actual data in production process, it will be entered into a simulation model using software assistance (Arena version 14). The method that will be used is Discrete Event Simulation, which is a simulation method that considers a certain time unit. After making the initial model, the next step is making Scenario Design. The selected scenario that

is expected from this research is the highest fulfillment of the previously prepared Allotment Spare from all Warehouses in Outstation/Plant (% Fullfilment) with the lowest possible cost.

3. RESULTS

From the computational model that has been built, verification and validation tests are then carried out. Verification tests are carried out to ensure that the computer model is in accordance with the conceptual model which can be proven with no Syntax Errors and Semantic Errors. Validation test is carried out to ensure that the computer model that is built can accurately represent the real system. It can be tested with the Student's T Test in pairs with an error of 5% with the help of the Minitab software, the results are P-value = 0.074, greater than the error value. It can be concluded that there is not enough evidence to state that there is a difference between the simulation results and the results of real conditions.

From the simulation results on the computational model, an experimental design will be built based on the activity with the most queues, and 3 scenarios are obtained as follows:

1. Changing the pull system pattern to a push system on the component delivery model from the central warehouse to the production warehouse. From the existing computational model, it can be seen that the central warehouse will send it to the production warehouse when production places an order due to the use of the components in question. The model scenario that will be built is that when there are free components in the warehouse, it will be sent directly to the production warehouse without waiting for a request from production with data fitting the distribution of production demand following the percentage of component usage in each production warehouse in 2018 data.

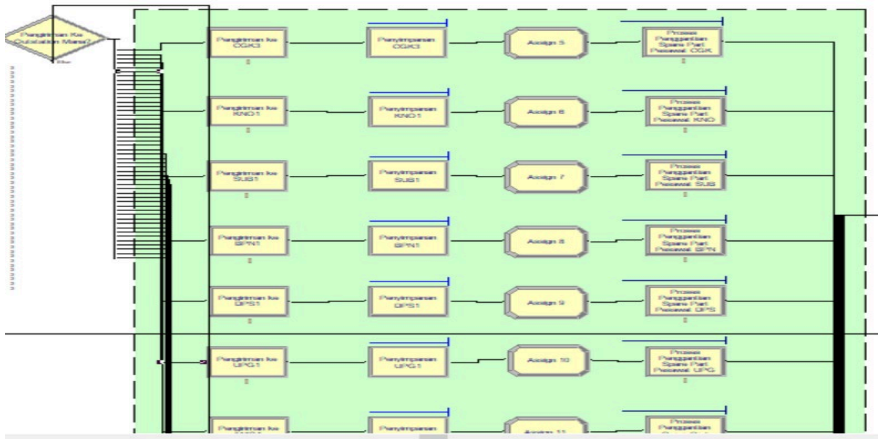

Figure 5. Delivery Queue of component from central warehouse to production Warehouse

2. Using Part Number 3-1559 as an alternate Part Number of C20637000 which will rotate in a series of production processes. It is hoped that with the increasing number of components circulating in the Demand-Supply system, it can reduce processing time in the Supply Chain.

3. Reducing the waiting document administration for components before entering the Workshop by 50%. This can be avoided due to the workmanship factor of production which is not administratively ordered so it interrupt the next process.

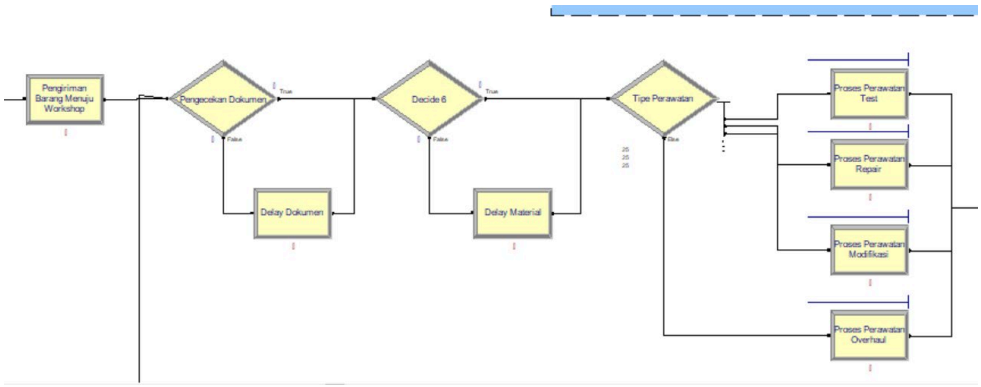

Figure 6. The Component Queueing before workshop production

4. CONLUSION

Considering the analysis process, it can be concluded that improvement of queuing process on supply chain management, related to allotment spare spesifically on wheel and brake, the simulation result shows a positive development of delivery process, the utilization of alternative spare part, and also the improvement of production behavior.

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IMPROVING SERVICE QUALITY IN HOTEL WITHOUT BUNGALOW TO INCREASE OCCUPANCY RATES DURING THE COVID-19 PANDEMIC

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ABSTRACT

According to data from the Central Statistics Agency, the hotel occupancy rate in Indonesia decreased from early March to late June 2020 because of the COVID-19 pandemic. The hotel occupancy rate in January 2020 was 49.17 percent, but it dropped from March, when the covid pandemic first emerged, to 19.7 percent in late June 2020. The goal of this research is to identify and analyze the primary causes of defects in the hotel service process, which will then be fixed to eliminate defects and improve service quality so that businesses may continue to compete in pandemic situations. The service quality gap value is calculated using Servqual based on five dimensions: tangibles, responsiveness, assurance, empathy, and reliability, which are then examined using Six Sigma Define-Measure-Analyze-Improve-Control (DMAIC). Only the phases of define, measure, analyze, and improve were performed in this study. According to a Six sigma analysis, there are 18 different categories of defects below the average sigma value. Based on the findings of the analysis, a phase of improvement was implemented, yielding four improvements: developing appropriate SOPs, conducting regular training for hotel personnel, applying for hotel service certification in pandemic situations, and procuring equipment and supplies to support services and cleaning.

Keywords: Servqual, Six Sigma, DMAIC, Improved service quality, Hotel without bungalows

1. INTRODUCTION

Today's hospitality industry is becoming more competitive, requiring business actors to be able to deliver the finest service to customers in order to survive and succeed in the face of competition. Because the hotel industry's goal is to please customers, one of the things hotel owners can do to stay ahead of the competition is to maintain and improve their quality and service. In addition to external factors such as hotel business competitiveness, the present COVID-19 pandemic has had an influence on the hotel industry. The American Hotel and Lodging Association (AHLA) published a review of the hospitality industry's economic and human problems, finding that over two-thirds (65%) of hotels had occupancy rates below 50% and were below the threshold (AHLA, 2020). However, hotels with bungalow designs, such as the Fairmont, have a 60 percent occupancy rate and offer the concept of an isolated room (Harter, 2020).

This situation is not dissimilar to what exists in Indonesia. According to statistics from the Central Statistics Agency, the hotel occupancy rate in Indonesia decreased from early January to late June 2020. The occupancy rate began to fall in March 2020, when the issue of the COVID-19 pandemic first surfaced in Indonesia. The occupancy rate dropped from 49.17 percent in January 2020 to 19.7 percent at the end of June 2020.

This situation forces hotel without bungalows to go outside the box in order to survive and compete in the face of a pandemic. Internal elements must be managed because the impact of the COVID-19 pandemic is an external factor that cannot be controlled. Sharma et al. (2020) found that manufacturing process innovation had a greater impact than other types of innovation and resulted in a high degree of confidence. Safe service delivery changes (better cleaning methods, new technologies to limit client interaction, etc.) are far more effective than organizational and marketing innovations. According to Yu, et., al. (2021), the cleanliness of the customer's room, the cleanliness of hotel workers, and the cleanliness of the workstation all have an impact on the hotel's image, word of mouth, and intent to return. Maintaining a positive brand image, according to Zhang Yi (2015), has a positive influence. Several studies have demonstrated that consumer loyalty is influenced by a variety of factors, including brand image. Several studies have also found that brand image influences consumer satisfaction, which leads to customer loyalty. According to Sharma et al. (2020), Yu et al. (2021), and Zhang (2015), there is a link between creating safe services and promoting cleanliness being a successful innovation for maintaining hotel image and increasing customer satisfaction and loyalty. Furthermore, Sun, S., et al. (2021) recommend that hotel industry participants continue to change their products and services based on information collected from client reviews in order to maintain and improve the hospitality sector's rejuvenation in the pandemic era.

Six Sigma is one way that can be utilized to improve quality management. Bill Smith created the six sigma method, which may reduce faults in goods manufactured by up to 99.99966 percent, or 3.4 potential defects per million units produced. Six sigma is a methodology that tries to increase the performance of existing processes to a six sigma level using the DMAIC technique, which consists of five phases: define, measure, analyze, improve, and control (Costa et al., 2019).

This study was conducted with the goal of determining and analyzing customer satisfaction and overall quality of hotel services that have implemented cleanliness attributes related to covid-19 and made efforts to improve services to increase customer satisfaction using the Servqual and DMAIC methods, based on the problems described above.

2. LITERATURE REVIEW

CUSTOMER SATISFACTION

According to Kotler (2014), customer satisfaction is the level of satisfaction a customer feels when comparing the performance or results they obtain to the expectations they have for that performance. If the customer's perception of performance falls short of their expectations, the performance can be described as unsatisfactory. The level of customer satisfaction can be used to assess the quality of a service.

HOTEL CLEANLINESS IN PANDEMIC CONDITIONS

To establish perceived hygiene features, Yu J., et al. (2021) utilized exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) to conduct a study on the cleanliness attributes of COVID-19. Three hygiene parameters were investigated: customer-use space hygiene, staff personal hygiene, and workstation hygiene. The empirical study of the cleanliness

characteristic having an influence on hotel image, word of mouth, and revisit intention was derived based on the research they conducted. Furthermore, according to Nilashi, M., et al. (2021), there was a strong link between service quality and satisfaction during the COVID-19 pandemic. In order to maintain and improve the resuscitation of the hospitality business in the pandemic era, Sun, S., et al. (2021) advise hotel industry participants to continue to change their products and services based on information collected from client reviews.

SIX SIGMA

Six Sigma is a way for obtaining the desired condition where the product rejected by the system has a value of less than 3.4 per million opportunities (PMO), according to Harry and Schroeder (1990), Pande et al. (2000), and the American Society of Quality cited by Allen (2006). Another definition of Six Sigma, according to Pande et al., (2001), is a target that is close to perfection in addressing customer needs. Sigma is a statistical term that refers to the standard deviation of a process in relation to its mean. 99.73% of measurements in the normal distribution process will fall on the sigma value of ± 3.0, and 99.99966% of measurements will fall on the sigma value of ± 4.5. To produce 3.4 PMO faults in a process with normal distribution and normal variation, the specification of 6 sigma values must be limited. Defects per opportunity (DPO) or defects per million opportunity (DPMO) are terms used in Six Sigma to describe the failure rate. When a process is measured and only produces 3.4 defects out of a million times, it is considered to have a sigma value of 6.

According to Pande et. al., (2001) and Andersson et. al., (2006), the use of Deming's plan-do-check-action cycle, which is carried out through five steps of the define-measure-analyze-improve cycle (DMAIC). Existing products and processes are subjected to the DMAIC technique. This approach is divided into five stages. Define, assess, evaluate, enhance, and maintain control. When the problem is still unknown or unclear, there is the possibility for cost reductions, and the project may be completed in 4-6 months, this stage is chosen (Zapartas, 2012).

According to a study by Montgomery and Woodall (2008, as cited in Ulen, 2020) the implementation of proper statistical tools is one of the keys to DMAIC's success. The information given by table 1 below relates to the tools and procedures that must be employed in six sigma for the service process.

Table 1. Six sigma tools and techniques for service process

Tools/techniques	Define	Measure	Analyze	Improve	Control
Process map (2)	Y	N	N	N	N
Brainstorming (2)	Y	N	Y	Y	N
Root cause analysis (2)	N	N	Y	Y	N
Quality costing (1)	Y	Y	N	Y	N
Hypothesis testing (2)	N	N	Y	N	N
SPC (1)	N	N	N	N	Y
SIPOC (2)	Y	N	Y	N	N
SERVQUAL (2)	N	Y	N	Y	N
GANTT charts (2)	Y	Y	Y	Y	Y
Process capability analysis (1)	N	Y	N	Y	N
Regression + correlation analysis (2)	N	N	Y	N	N
Benchmarking (1)	N	Y	N	N	N

Table 1. Six sigma tools and techniques for service process *(continued)*

Tools/techniques	Define	Measure	Analyze	Improve	Control
Control charts (2)	N	N	N	N	Y
Pareto Analysis (2)	N	N	Y	N	N
Cost-benefit analysis (2)	Y	N	N	N	N
Histograms (2)	N	Y	Y	N	N
Service FMECA (1)	N	Y	N	N	N
QFD (1)	Y	N	N	N	N
Affinity diagram (2)	N	N	Y	N	N
Project team charter (2)	Y	N	N	N	N
KANO model (2)	N	Y	N	N	N
Note: Y = applicable and N = not applicable, (1) = technique and (2) = tool					

Source: Antony, J. (2006)

SERVQUAL

Parasuraman, et al. (1985) established Servqual, which uses ten categories of perceived service quality based on the customer's perspective. Reliability, responsiveness, competence, access, courtesy, communication, credibility, security, customer understanding/knowledge, and tangibles are among the ten dimensions. Parasuraman, et al. (1988) stated that service quality is a comparison of perceived service quality (P) and customer expectations (E) based on 10 characteristics that have been simplified into 5 dimensions of service quality. Reliability, responsiveness, assurance, empathy, and tangibles are the five dimensions. According to Parasuraman, et al. (1985) research, a service's quality is judged high if E<P and less if E>P.

Servqual is one of the tools that can be utilized in six sigma, as shown in table 1. One of the rare studies that leverages the integration of the six sigma technique with servqual is done by Kumar, S., et al. (2009) to build a high quality operational process at the summer resort. As a result, in order to sustain quality, businesses must train and retain the greatest staff.

3. METHODS

SAMPLING

The type of data used in this study is the respondent's experience with hotel service quality. The questionnaire was created using Parasuraman's (1988) five dimensions for measuring service quality: Tangibles, Responsiveness, Assurance, Empathy, and Reliability. To generate representative data, this study used a non-probability sampling technique of purposive sampling using a Likert scale assessment to determine the number of samples. The following are the sample criteria that researchers must consider when using purposive sampling:

1. Those who have stayed at Briggs Inn Hotel Batu for more than or equal to one day and have used its facilities and services.
2. The Briggs Inn Hotel Batu was used for sampling.

Customers were given questionnaires, with a total of 110 being provided. 103 of the 110 questions were completely filled out, while 7 were not. The validity and reliability of the received questionnaire data were next examined. Valid results were obtained for each questionnaire item based on the results of the validity and reliability tests.

RESEARCH PROCEDURE

The integration of six sigma and servqual in the hospitality service business is examined from both an external and internal perspective. For service quality, external perception is utilized to understand client demands, expectations, and satisfaction. The servqual method is used to measure the service quality of each characteristic in order to determine the difference between the quality of service obtained and the quality of service expected by customers when measuring external perceptions. Internal perception is used to identify service quality so that defect-free service conditions can be achieved. The six sigma approach is the tool used for assessing internal perception.

Servqual is used to calculate the gap value of each dimension's attribute. At six sigma, the gap value is utilized to assess the level of satisfaction, the DPMO, and the sigma level. Once the sigma level determined, the data is utilized to determine process capability based on service quality attributes with a sigma level below the average sigma level. An analysis of root cause is conducted based on the service quality attribute defects. The defects identified from the data collected in the root cause analysis are then improved. Figure 1 shows the integration process of servqual with six sigma DMAIC.

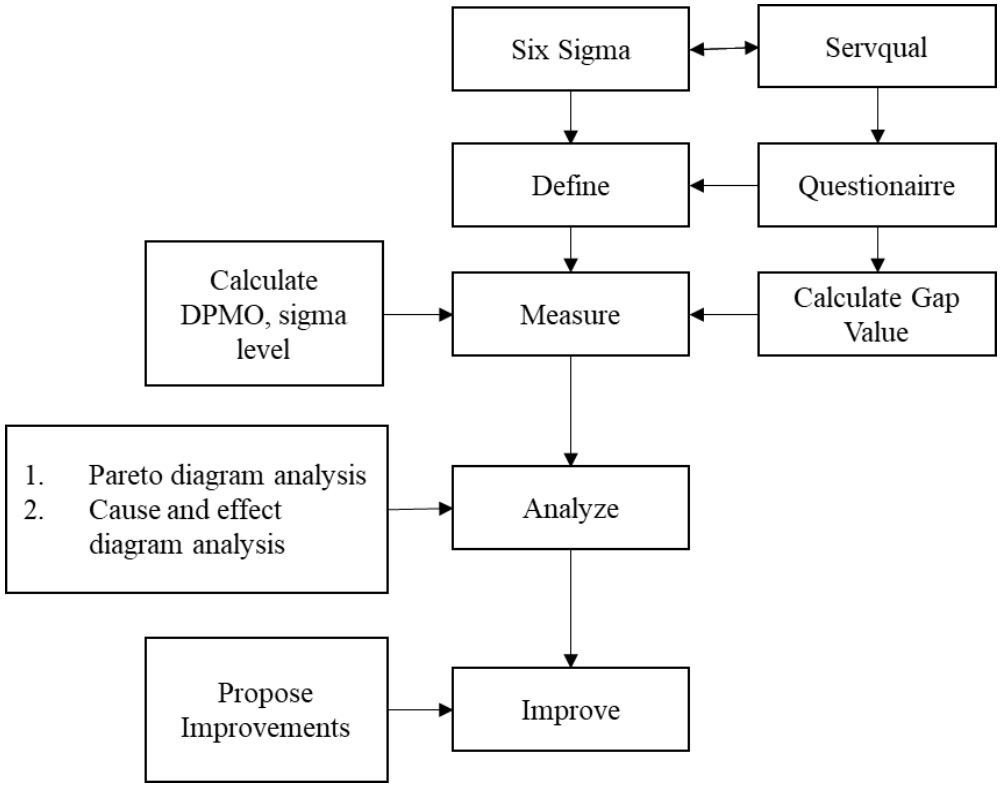

Figure 1. Integrating six sigma DMAIC and servqual

4. RESULTS

The servqual method of measurement results in a gap between the perceived and expected level of service by consumers. The gap value shows which service quality attribute has the largest negative gap. The satisfaction level, DPMO value, and sigma level may all be calculated using the gap value. The sigma level value that is lower than the average sigma level value determines the

relevance of the satisfaction attribute that needs to be corrected first. The performance of the service quality attributes described in table 2 is measured as follows.

Table 2. Measurement of service quality attributes performance

Dimension	Gap	Satisfaction Target	Satisfaction Level	DPMO	Sigma Level
Tangible 1	-0.417	5	86%	143,689	2.56
Tangible 2	-0.058	5	97%	25,243	3.46
Tangible 3	-0.369	5	89%	110,680	2.72
Tangible 4	-0.388	5	87%	126,214	2.64
Tangible 5	-0.563	5	85%	153,398	2.52
Tangible 6	-0.534	5	85%	151,456	2.53
Tangible 7	0.621	5	94%	56,311	3.09
Tangible 8	-0.243	5	93%	71,845	2.96
Tangible 9	-1.320	5	71%	285,437	2.07
Tangible 10	-1.233	5	72%	277,670	2.09
Tangible 11	-0.117	5	97%	31,068	3.37
Tangible 12	-0.049	5	98%	17,476	3.61
Tangible 13	-0.126	5	96%	42,718	3.22
Responsiveness 14	-0.165	5	96%	42,718	3.22
Responsiveness 15	-0.155	5	96%	44,660	3.20
Responsiveness 16	-0.282	5	93%	69,903	2.98
Responsiveness 17	-0.049	5	99%	13,592	3.71
Assurance 18	-0.699	5	77%	229,126	2.24
Assurance 19	-0.670	5	78%	215,534	2.29
Assurance 20	-0.786	5	74%	258,252	2.15
Assurance 21	-0.068	5	98%	23,301	3.49
Assurance 22	-0.068	5	98%	17,476	3.61
Assurance 23	-0.097	5	97%	31,068	3.37
Assurance 24	-0.359	5	91%	89,320	2.84
Assurance 25	-0.087	5	98%	23,301	3.49
Assurance 26	-0.078	5	98%	23,301	3.49
Empathy 27	-0.252	5	94%	64,078	3.02
Empathy 28	-0.107	5	97%	31,068	3.37
Reliability 29	-0.660	5	78%	22,.359	2.27
Reliability 30	-0.621	5	81%	19,233	2.37
Reliability 31	-0.709	5	75%	248,544	2.18
Reliability 32	0.184	5	88%	124,272	2.65
Reliability 33	0.427	5	91%	87,379	2.86
Reliability 34	-0.650	5	74%	260,194	2.14
Reliability 35	-0.262	5	81%	194,175	2.36
Reliability 36	-0.718	5	75%	250,485	2.17
Reliability 37	-1.340	5	70%	299,029	2.03
Average	-0.483	5	87.71%	122,907	2.82

Based on the sigma level value that is less than the average of 2.82 in table 2, the service quality qualities that need to be improved can be established. Table 3 shows the lists of the 18 service quality attributes that are below the average sigma threshold.

Table 3. Capability process of hotel service quality attributes

Dimension	DPMO	Sigma Level	Description
Tangible 1	143,689	2,56	The building is in good condition
Tangible 3	110,680	2,72	The hotel interior (rooms, lobby, and other rooms) looks neat and attractive
Tangible 4	126,214	2,64	Use of modern technology (TV, Wi-Fi, Netflix, etc.)
Tangible 5	153,398	2,52	Spacious and clean parking lot
Tangible 6	151,456	2,53	The appearance of employees is neat and attractive
Tangible 9	285,437	2,07	Lots of variety of breakfast
Tangible 10	277,670	2,09	Appealing breakfast display
Assurance 18	229,126	2,24	Linen (pillowcases, towels, bed covers, pillows) are washed using antibacterial
Assurance 19	215,534	2,29	Hotel personnel use the covid protocol (masks, facemasks, gloves)
Assurance 20	258,252	2,15	Hotel personnel practice social distancing while working
Reliability 29	221,359	2,27	The hotel cleans facilities (rooms, tables, sofas, chairs, mattresses, mirrors, and closets) using disinfectant
Reliability 30	192,233	2,37	The hotel conducts temperature checks on customers and personnel
Reliability 31	248,544	2,18	Complete and reliable service personnel
Reliability 32	124,272	2,65	Uncomplicated service procedures
Reliability 34	260,194	2,14	Dishes are served by experienced chefs
Reliability 35	194,175	2,36	Fast in serving orders
Reliability 36	250,485	2,17	The suitability of the menu ordered with the menu served
Reliability 37	299,029	2,03	Tasty breakfast

A Pareto diagram analysis is performed based on the results of the hotel service quality capability process, which has a sigma level value lower than the average, to make it easier to see which quality attribute has the highest level of defect.

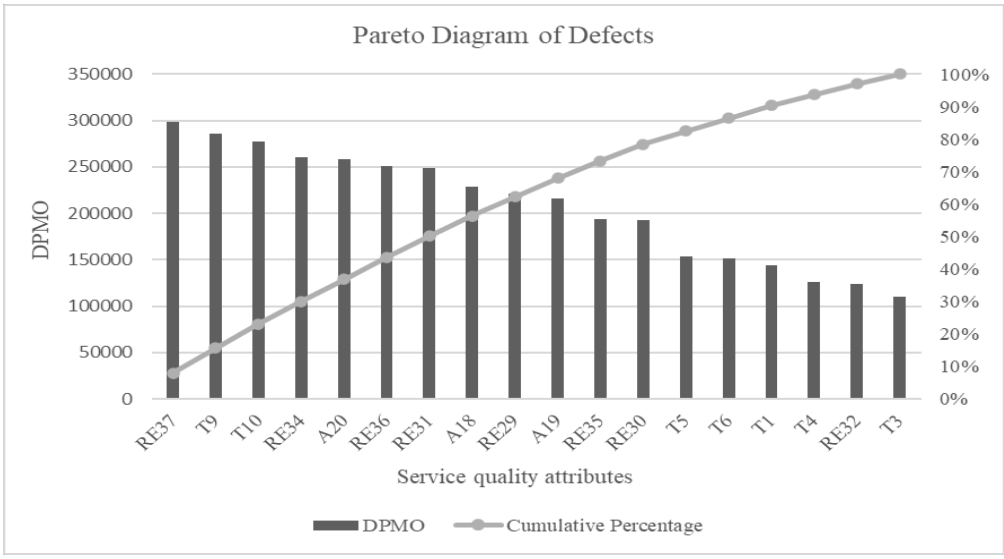

Figure 2. Pareto diagram of service quality attributes

According to the Pareto diagram in Figure 2, the Reliability 37 attribute has the biggest DPMO value of 299,029 with a sigma level of 2.03 and the Tangible 3 attribute has the least DPMO value of 110,680 with a sigma level of 2.72 among the 18 customer satisfaction characteristics with a sigma level below the average.

Then the root cause is identified using a root cause diagram in terms of 4M+1E, namely man, machine, method, material, and environment, based on process capability analysis and Pareto analysis.

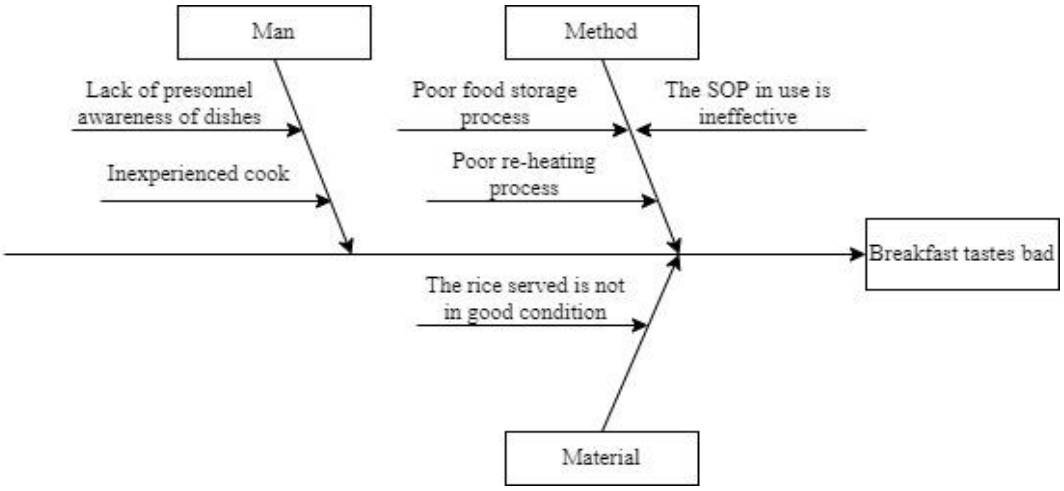

Figure 3. Cause and effect diagram of reliability 37 attribute

Figure 3 shows a root cause diagram for the service quality characteristic reliability 37 namely breakfast tastes bad, which has a sigma level of 2.03. According to the results of the brainstorming process, the causes of the defects come from the categories of man, method, and material. Lack of personnel awareness of dishes and inexperienced cook are the cause in the man category. Poor food storage process, poor re-heating process, and the Standard Operational Procedure (SOP) in use is ineffective are the cause in the method category. The rice served is not in good condition is the cause in the material category.

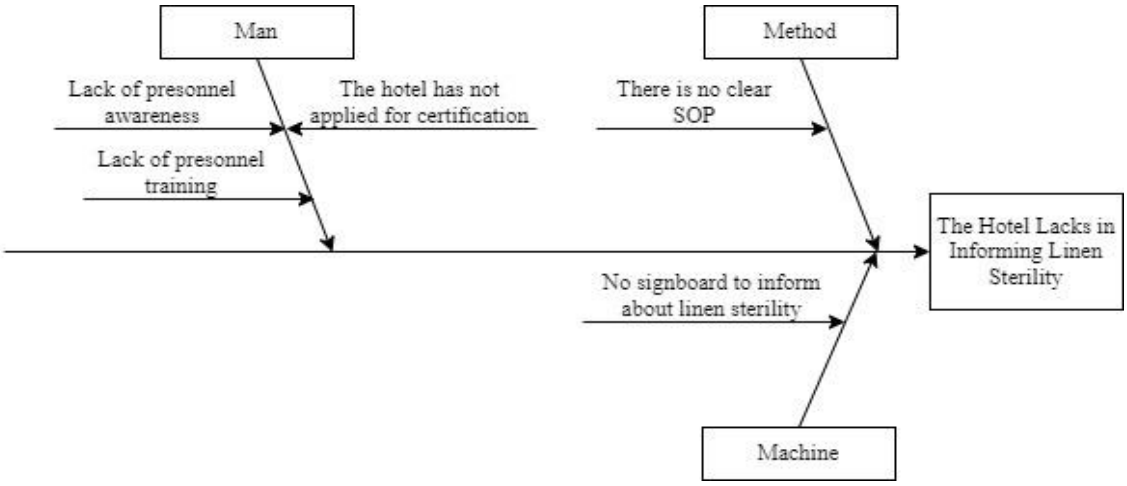

Figure 4. Cause and effect diagram of assurance 18 attribute

Figure 4 shows a root cause diagram for cleanliness for attribute assurance 18 namely the hotel lacks in informing linen sterility, which has the lowest sigma value of 2.24 when compared to other hygiene qualities. According to the results of the brainstorming process, the causes of the defects come from the categories of man, method, and machine. Lack of personnel awareness, lack of personnel training, and hotel has not applied for certification are the cause in the man category. There is no clear Standard Operational Procedure (SOP) in use is the cause in the method category. No signboard to inform about linen sterility is the cause in the machine category.

After the primary causes of defects in the quality of service at the Briggs Inn Hotel were discovered using a cause-and-effect diagram that was evaluated in the previous chapter, based on data gathering from specified defect. The following are recommendations for adjustments that should be addressed to the key sources of the problem:

1. Creating the necessary SOPs.
2. Educate hotel employees on a regular basis.
3. In pandemic situations, apply for hotel service certification.
4. Equipment and supplies procurement, as well as cleaning and support services.

5. CONCLUSION

The findings of study conducted on the object, namely hotels without bungalows, using the combined approach of servqual and six sigma DMAIC with the goal of enhancing service quality and reviving hotels during pandemic conditions, are in the form of defects that arise in services. According to the findings of a cause and effect diagram analysis of hotel service quality in terms of Man, Machine, Method, Material, and Environment, there are 18 categories of defects that occur frequently:

1. The building is in good condition.
2. The hotel interior (rooms, lobby, and other rooms) looks neat and attractive.
3. Use of modern technology (TV, Wi-Fi, Netflix, etc.).
4. Spacious and clean parking lot.
5. The appearance of employees is neat and attractive.
6. Lots of variety of breakfast.
7. Appealing breakfast display.
8. Linen (pillowcases, towels, bed covers, pillows) are washed using antibacterial.
9. Hotel personnel use the covid protocol (masks, facemasks, gloves).
10. Hotel personnel practice social distancing while working.
11. The hotel cleans facilities (rooms, tables, sofas, chairs, mattresses, mirrors, and closets) using disinfectant.
12. The hotel conducts temperature checks on customers and personnel.
13. Complete and reliable service personnel.
14. Uncomplicated service procedures.
15. Dishes are served by experienced chefs.
16. Fast in serving orders.
17. The suitability of the menu ordered with the menu served.
18. Tasty breakfast.

The following stage is improvement when the analysis stage is completed and the results are in the form of service defects that frequently occur along with the main causes of these defects. Making appropriate SOPs, performing periodic training for hotel workers, filing for hotel service

certification in pandemic conditions, and acquiring equipment and supplies supporting services and cleanliness are all adjustments that need to be addressed based on the study's findings. In the event of a covid-19 pandemic, the necessary changes are predicted to be able to preserve and improve the rejuvenation of hotels without bungalows.

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PROJECT QUALITY IMPROVEMENT BY IMPLEMENTING THE LEAN CONSTRUCTION METHOD IN OFFSHORE GAS PIPELINE FREESPAN CORRECTION PROJECT AT PT XYZ

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ABSTRACT

PT XYZ operates a 369,7 km gas transmission pipeline to deliver ± 600 MMSCFD gas to the petrochemical, power generation, and other industrial fuel industries in East Java Province. The freespan occurs in offshore pipeline is mainly caused by environmental influences. Freespan conditions can cause gas pipes leakage, therefore intervention by conducting freespan correction is needed. The 28" offshore gas pipeline freespan correction project from Pagerungan Island to Porong Sidoarjo Onshore receiving facilities (ORF) faces many problems that cause delays in project deadlines. The lean construction method is considered appropriate to solve problems by mapping the value stream, identifying waste, determining the root cause of wastes, formulating follow-up actions, then taking corrective actions. The engineering phase is carried out on time according to the plan, which is 42 working days. Procurement Phase occurred delays in procuring working vessel rentals for 28 working days. Construction Phase occurred delays due to waiting in anchorage activities for 4 days. This has an impact on overall work delays up to 185,6 working days. The chosen lean construction tool is process activity mapping (PAM). According to PAM, wastes were identified consist of waiting time in the procurement process for materials and equipment for 17 days (total) and an unplanned waiting in anhcorage at the port for 2 days. By developing risk breakdown structure model, corrective actions to be implemented are by defining minimum number of working vessel vendor candidates, making a detailed timeline for permits application, defining key performance indicators for permits agent. Therefore, the wastes are expected not to occur in next freespan correction project in PT XYZ.

Keyword : freespan correction, lean construction, waste, and non-value added activity

1. INTRODUCTION

PT XYZ is a state-owned company engaged in natural gas transmission services that distributes natural gas ± 600 MMSCFD from Pagerungan Island and Madura Sea to Gresik, Pasuruan, and Semarang City via offshore gas pipelines along 367 km and onshore gas pipelines 60 km. The offshore segment specifications are API 5L X52, schedule 80, internal diameter 28", and concrete coated. Based on a visual survey conducted with Remote

Operated Vehicle (ROV) in 2017, 181 freespan points were found. Of the 181 freespan points, 29 freespan points are above the Maximum Allowable Span (MAS) limit, thus requiring freespan correction. Freespan correction is concucted by installing a seabed groutbag under pipeline to reduce stress. The reliability of PT XYZ's offshore gas pipeline is very important (backbone) to supply gas feed for petrochemical industries, fuel for power generation, and other industries in the cities of Gresik, Surabaya, Pasuruan, and Semarang.

Since the kick-off meeting was held to start the freespan correction project on March 1st 2021, the progress of the work has not been in line with the target. The PTK-PGS consortium faced problems with the initial progress of the construction project which did not go according to plan. This is indicated by the deviation between the actual progress and the project plan as stated in the S-curve 1.63% until the 12th week. According to the lean construction point of view, delays in meeting project deadlines are considered as non value added activities (Koskela, 2002), such as: waiting due to uncertainty in working vessels selection, uncertainty on-board personnel, uncertainty in work permit from the government, and uncertainty in instructions of sailing. These activities will have an impact on delays in the freespan correction project completion.

To make a corrective plan for freespan correction project with the application of lean construction, the formulation of the problem is as follows:

1. What is the current situation and conditions that occur in offshore gas pipelines freespan correction project?
2. What are the activities that are classified as waste in this offshore gas pipeline freespan correction project?
3. What is the right method as an effort to reduce waste so that the freespan correction project runs on time?

Based on the problem formulation as mentioned above, the objectives of this study are:

1. Investigating the situation and conditions that occur in the current implementation of freespan correction of gas pipelines, starting from engineering work, procurement then the process to completion of construction work
2. Identify activities that are classified as waste in the offshore gas pipeline freespan correction project.
3. Create improvements in offshore gas pipeline freespan correction projects by applying the right Lean Construction application.

2. LITERATURE REVIEW

Freespan Correction

Subsea pipe freespan is a condition where the pipe span with a certain length has a gap to the seabed. In the subsea pipeline lying on the seabed, freespan occurs due to the uneven (uneven) seabed surface with a curvature that does not meet the natural curvature of the pipe so that the pipe span will hang. In addition, freespan can also occur if the pipeline route has a crossing with other pipelines or cables under the sea. Based on international standards DNV RP F105 (2006), the factors that cause freespan include:

1. Seabed unevenness
2. Changes in seabed conditions (due to sand waves and scouring)
3. Artificial support
4. Strudel Scours

Waste Identification

The seven types of waste identified by Taichi Ohno as part of the Toyota Production System, also known as Lean Manufacturing (1988) consist of :

1. Overproduction
2. Defect

3. Excessive Transports
4. Waiting
5. Unnecessary Inventory
6. Unnecessary Motion
7. Inappropriate Processing

Lean Construction

According to data from the Construction Industry Board, waste includes technical or non-technical errors, working out of sequence, repetitive activities and movements, delays, inputs and products or services that are not in accordance with the requirements of the project owner. In her writing, Lauren Pinch (2005) says that the focus of lean is waste elimination and adding value so that the principles of lean construction should include:

1. Establish an integrated team of owners, architects, facility users, builders, special contractors, sub-contractors and suppliers.
2. Combining project design with process design, simultaneously designing production facilities and processes.
3. Stop production instead of continuing a wrong task or product in construction
4. Centralizing decision makers, empowering project participants and making the process transparent so that the team can see the status of the project; and
5. Demands simplicity, directing handoffs between tasks in the work stream.

In The foundations of lean construction according to Lauri Koskela et al., (2002), there are differences between the traditional construction approach and the lean approach. The concept of Lean Project Delivery System (LPDS) describes lean construction implemented throughout the life cycle of a construction project from project definition, to design, supply, assembly, and use as indicated in Figure 1.

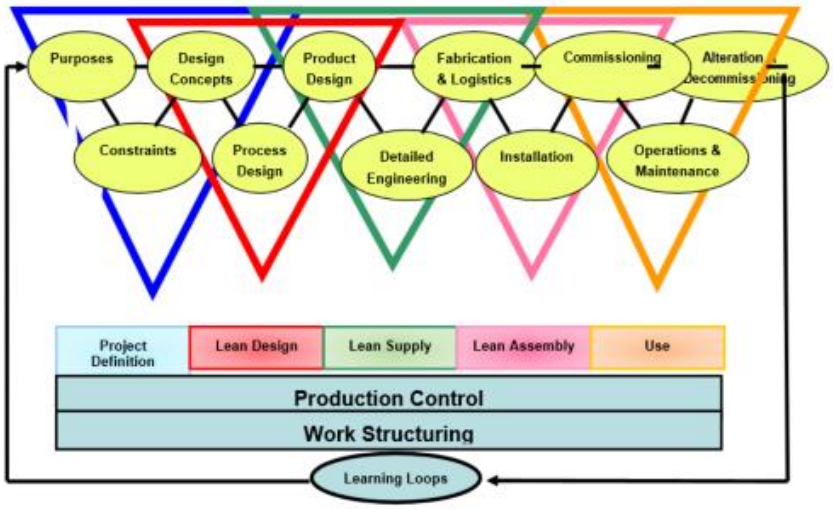

Figure 1. Lean Project Delivery System

Source : The Foundations of Lean Construction

Waste Analysis

In the lean approach, the next step is to analyze which activities add value and which do not. Hines (2000) distinguishes the types of activities in organizations into three, namely:

1. Value added activity (VA), this activity is an activity that provides added value to the process, both in the flow of information and the physical flow of the process.
2. Non-value-added activity (NVA), an activity that does not provide added value to products or services. This activity can be categorized as waste which can cause the process to not run efficiently.
3. Necessary but non-value-added activity (NNVA), activities that do not provide added value but are still needed to carry out the entire series of processes. This activity cannot be eliminated and can only be minimized.

3. METHODS

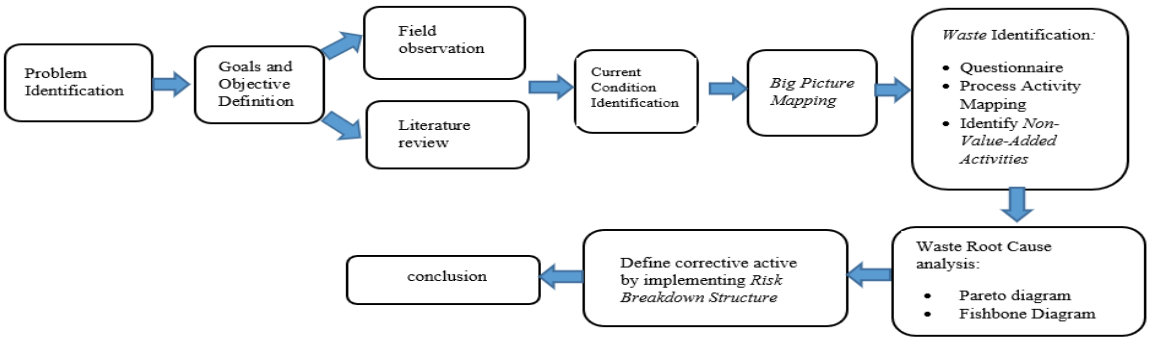

Figure 2. Research Flow Diagram

The methodology used in the study is described in detail. In general, there are 4 stages used in this research, namely the identification stage, the data collection and processing stage, the data analysis and interpretation stage, and the conclusion and suggestion stage as shown in **Figure 2**.

4. RESULTS

The initial step in this identification is to distribute questionnaires filled out by workers who are directly involved in the freespan correction construction project. The responders come from PT XYZ (project owner), PTK PGS (main contractor), and vendor (technician). In this questionnaire, the general understanding of waste was explained. The higher mean score, the more significant waste than other wastes as mentioned in **Table 1**.

Table 1. Survey Results

No	*Waste*	*Mean*
1	Defect	1,045
2	Waiting	2,631
3	Overproduction	1,455
4	Inappropriate Processing	1,273
5	Unnecessary Inventory	2,182
6	Unnecessary Motion	1,576
7	Transportation	2,000

Value Stream Mapping with the highest total score according to the VALSAT results will be used as the selected mapping to identify waste in detail. Using weighing, the highest score VALSAT is **Process Activity Mapping** as shown in **Table 2**. This selection is based that

the Value Stream Mapping with the largest value is most suitable for identifying waste in the value stream

Table 2. VALSAT Selection

No	Value Stream Mapping	Total Score
1	Process Activity Mapping	79,994
2	Supply Chain Response Matrix	44,222
3	Production Variety Funnel	11,176
4	Quality Filter Mapping	2,727
5	Demand Amplification Mapping	26,438
6	Decision Point Analysis	18,256
7	Physical Structure Mapping	4,182

Based on **Table 3**, it can be seen that operating activities including value added activities have a percentage of 36,92%, while other activities included in non-value-added activities are transportation at 7,69%, inspections at 7,69%, storage at 3,08%, and delay of 44,62%.

Table 3. Freespan Correction PAM

Activity Mapping	Activity frequency	Percentage
Operation	25	36,92%
Transportation	5	7,69%
Inspection	5	7,69%
Storage	2	3,08%
Delay	29	44,62%
TOTAL	65	100,00%

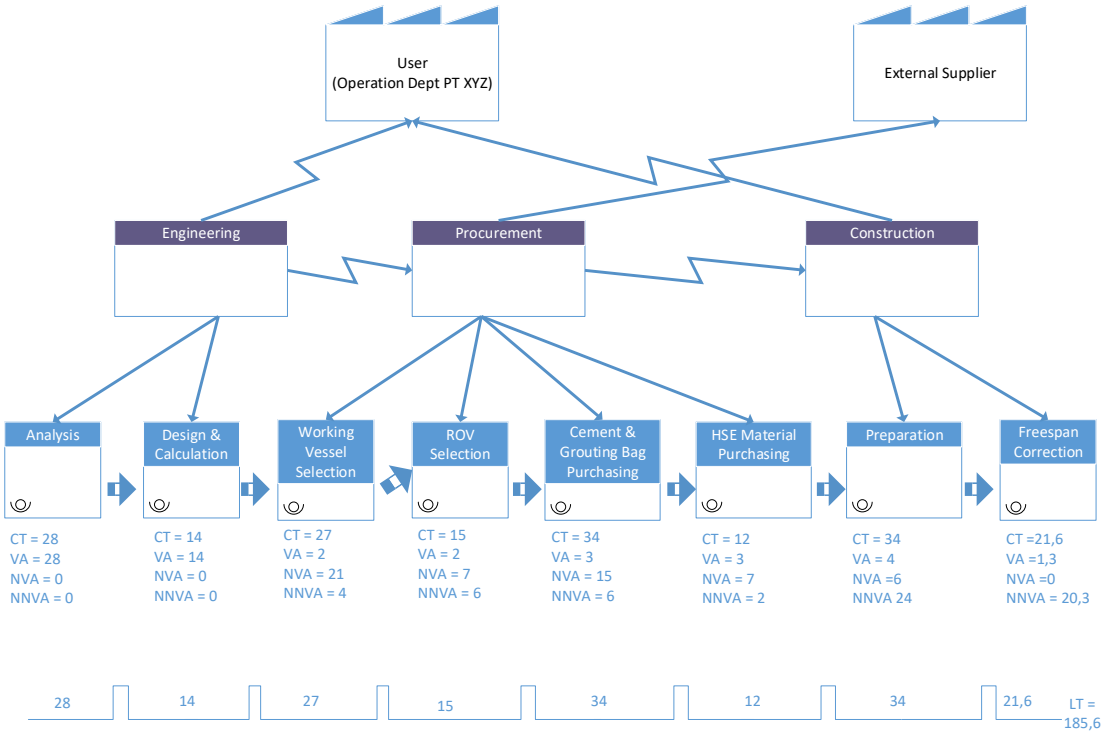

Figure 3. Big Picture Mapping Freespan Correction Project

From **Figure 3**, it can be seen that only engineering activities that are included in value added have a total time of 42 days, which is obtained from the sum of the operating time of engineering activities. Meanwhile, from the project, it is known that the total time of working days from the beginning of planning to the implementation of construction is 185,6 days. It can be said that time is not allocated for the implementation of other activities that are included in non-value added engineering activities so that the schedule is very tight and must be carried out in parallel-simultaneously as indicated in **Figure 4**.

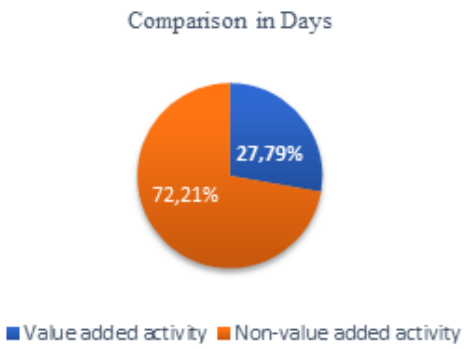

Figure 4. VA versus NVA

These activities have the potential to cause delays in the work on this freespan correction project. In the planned project work schedule, it is stated that the project will be completed on August 2nd 2021, but in reality the project schedule has been postponed and was completed on September 4th 2021. According to Wesenberg (2017), lean implementation faces the following challenges: difficulty starting to work with lean due to lack of understanding, resistance from employees, maintain a consistent focus on lean implementation, and work with units or contractors without lean experience. Therefore, the lean implementation must be developed at early stages in this project (project definition).

According to Gasperz & Fontana (2011), in terms of making quality improvements, it is necessary to collect data on the losses incurred first. In this case, the researcher uses a Pareto diagram to identify which aspects cause the greatest waste. Before making a Pareto diagram, the basis for comparing one non-value added activity with another is based on financial losses in the term of wasted costs per day. Author uses *Minitab 18* statistics software to create Pareto Diagram so that the most critical waste in this project can be identified as shown in **Figure 5**.

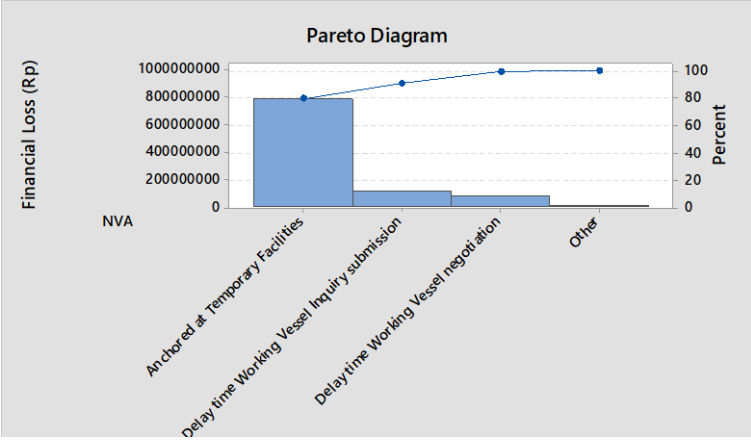

Figure 5. Pareto Diagram Freespan Correction Project

Based on the Pareto diagram above, it can be seen that the critical waste with the highest possible risk and affecting the entire project system is **Anchored at Temporary Facilities** (the period of anchoring in Probolinggo Port is too long) with a portion value of 79%. Fishbone diagrams can help to separate causes from symptoms, focus attention on relevant things, and are most practical to find out the causes of these problems (Tjiptono, 1995). For this reason, the author searches for the root cause with the fishbone diagram tool.

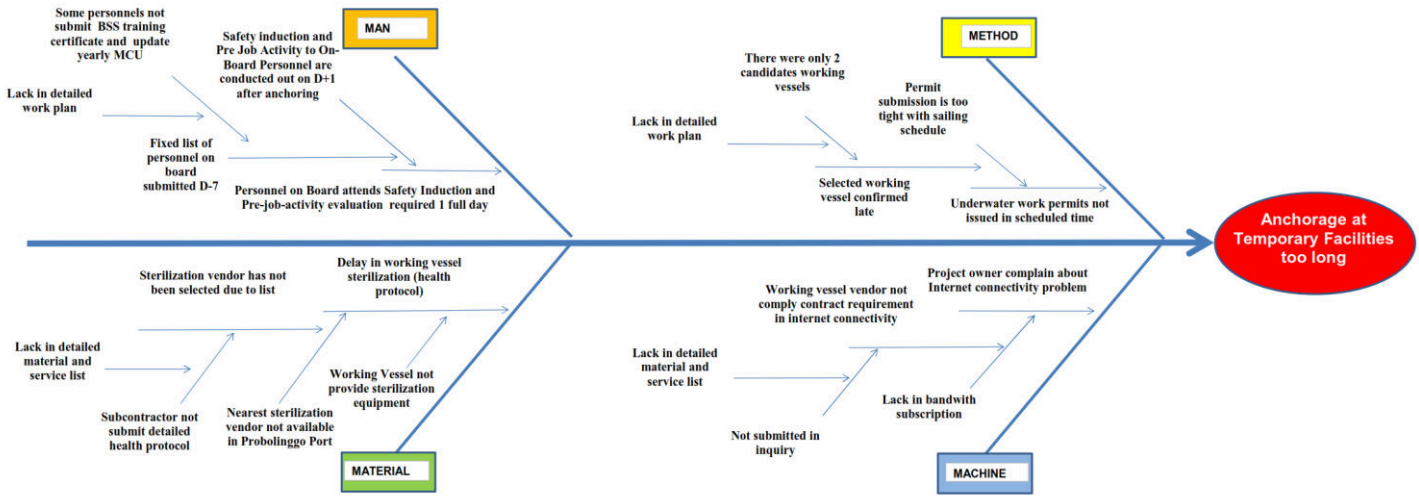

Figure 6. Fishbone Diagram

Based on **Figure 6** above, further analysis can be made of the root causes of critical non-value added activities. The root causes can be grouped based on materials, people, methods, and tools. The details are found in the following **Table 4**.

Table 4. Critical Waste Root Causes

No	Waste Aspect	Issues	Root Causes
1	Man	Personnel on Board attends safety induction and pre-job activity evaluation requires 1 full day	Lack in detailed work plan
2	Method	Underwater work permits not issued in scheduled time	Lack in detailed work plan
3	Machine	Internet connectivity problem will disturb office activity during the project	Lack in detailed material and service list
4	Material	Delay in working vessel sterilization (health protocol)	Lack in detailed material and service list

From **Table 4** above, it can be concluded that the root cause is making a work plan that is less detailed and making a list of materials and services that are less detailed. To maximize the impact of improvements, it is carried out with a comparative analysis of the alternative improvements. Alternative repair plans were consulted with the Project Manager of PT XYZ to ensure the ease and effectiveness of repairs as shown in **Table 5**.

Table 5. Decision Making Analysis

No	Alternatives	Control		Effect		Decision to Proceed
		Int.	Ext.	Sig.	Insig.	
1	Creating detailed *Risk Breakdown Structure*	v		v		Yes
2	Creating material and service list	v			v	No

The risk breakdown structure (RBS) is one of the tools used in project risk management to determine the risk of waste as **Table 6** below. According to Hilson (2003), The RBS can assist in understanding the distribution of risk on a project or across a business, aiding effective risk management. Just as the Work Breakdown Structure (WBS) is an important tool for projects because it scopes and defines the work, so the RBS can be an invaluable aid in understanding risk.

Table 6. Risk Register

No	Category	Sub-Category	Identified Risks
1	*Project Management*	*Work Breakdown Structure*	Delay in working vessel procurement
2	*Project Management*	*Work Breakdown Structure*	Delay in permit submission
3	*Construction*	*Environment*	Delay in issuing underwater work permit

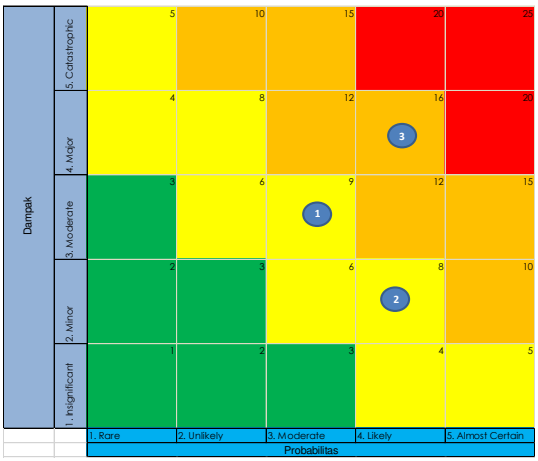

Figure 7. Risk Mapping

Source : PT XYZ Corporate Risk Matrix

From Figure 7, we can conclude the risk level of event number 1, 2, and 3. This risk levelling will be reference for prioritizing mitigation plan. In terms of reducing the waste of **Anchorage at Temporary Facilities** activity. The improvement plan that needs to be carried out by PT XYZ to prevent the recurrence of risk in the next freespan correction project is by integrating the project risk mitigation plan as mentioned in Table 7 :

Table 7. Risk Mitigation of Identified Critical Waste

No	Risks	Response	Mitigation Plan	PIC
1	Delay in working vessel procurement	Control	Create vendor list (at least 3 candidates), conduct portfolio and availability evaluation Week-5 sailing for working vessel selection	*Project Controller*
2	Delay in permit submission	Control	Create detail *timeline* for every permit, estimated time, and required documents	*Project Controller*
3	Delay in issuing underwater work permit	Transfer	Create *Key Performance Indicator* and penalty system if delay occurs in permit issuing	*Procurement*

6. CONCLUSIONS

Referring to the activity mapping process, information regarding the situation and condition of the freespan correction project is obtained as follows: engineering phase is carried out on time according to the plan, which is 42 working days\, procurement phase: experienced delays in procuring working vessel rentals for 28 working days, construction phase: experienced delays due to delays in anchorage activities for 4 days. This has an impact on overall work delays of 185,6 working days

Based on the process activity mapping, the activities classified as waste are: There are unplanned waiting times in the procurement process including: HSE Material purchasing, grouting cement purchasing, ROV rent, and working vessel rent ; There is an unplanned waiting time in the anchorage process at the port due to delays in the licensing process

This freespan correction project at PT XYZ will be periodically implemented due to environmental influence. Improvements needed in the next freespan correction project are:

1. Create a minimum 3 working vessel vendor list, then make a comparison of performance and availability on Week-5 sailing
2. Make a detailed timeline of each required permit, estimated time, and required document requirements
3. Create Key Performance Indicators for selected agents and fine mechanisms in case of delays in issuing permits

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THE ROLE OF ENTREPRISE RISK MANAGEMENT (ERM) AND SAFETY RISK MANAGEMENT (SRM) RESPONSE THE RISK OF PANDEMIC COVID-19 IN PT. XYZ

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ABSTRACT

The COVID-19 virus pandemic has caused the Indonesian aviation industry to experience a decline in the number of flights from the original 79,000 flights on international and domestic routes. Currently there are only 70 flights left. PT. XYZ is an aviation industry that provides aircraft maintenance services / Maintenance, Repair & Overhaul (MRO). The turmoil in the aviation world caused the company's revenue during the first half to fall by 35% in the same period in 2019. The purpose of the research is to discuss mitigating financial and technical risks of aircraft airworthiness during the pandemic. The research was conducted with a qualitative approach, data collection was carried out by interview (focus group discussion) and documentation. Data analysis uses Enterprise Risk Management (ERM) and Safety Risk Management (SRM) frameworks. The results of the study show that (1) Business risk mitigation (opportunity risk) because of the COVID-19 pandemic with the ERM framework approach has been well carried out with its role of 16.7% of overall risk management. (2) Mitigation of technical risk (hazard risk) because of the COVID-19 pandemic with the SRM framework approach has been well carried out with its role of 50% of overall risk management. The study also suggests several issues that need to be discussed in future research.

Keywords: COVID-19 pandemic, Enterprise Risk Management, Safety Risk Management, Opportunity risk, Hazard risk

1. INTRODUCTION

The COVID-19 virus pandemic has put the world's aviation industry under tremendous pressure. Bearing in mind, the number of flights has also decreased in line with the restrictions imposed by the government in each country that implements a lockdown policy. Based on the ICAO Uniting Aviation source "Effects of Novel Coronavirus (COVID-19) on Civil Aviation: Economic Impact Analysis", the movement of aircraft passengers in the world in 2020 decreased by -44% to -80% when compared to the previous year. This resulted in a decline in international tourism receipts of between USD 300 and 450 billion in 2020, almost a third of what was generated in 2019 of USD 1.5 trillion. And for airlines, the COVID-19 pandemic has an impact on a 48% decrease in Revenue Passenger Kilometers (RPK) in 2020 when compared to 2019 for both domestic and international flights.

In Indonesia, the graph of the number of flight passengers at five main airports in Indonesia from data from the Indonesian Central Statistics Agency (BPS) quoted from

www.bps.go.id there is a significant decline in 2020. Seen in the graph below, the decline in the number of passengers both domestic and international began in March 2020, with the peak of the decline occurring in May 2020. This was due to restrictions on human movement by the Indonesian government, both domestic and international human crossings. This decision was taken to break the chain of the spread of the Corona virus in Indonesia. The Ministry of Transportation has officially imposed a ban on domestic and foreign flights from Friday, April 24, 2020, to June 1, 2020.

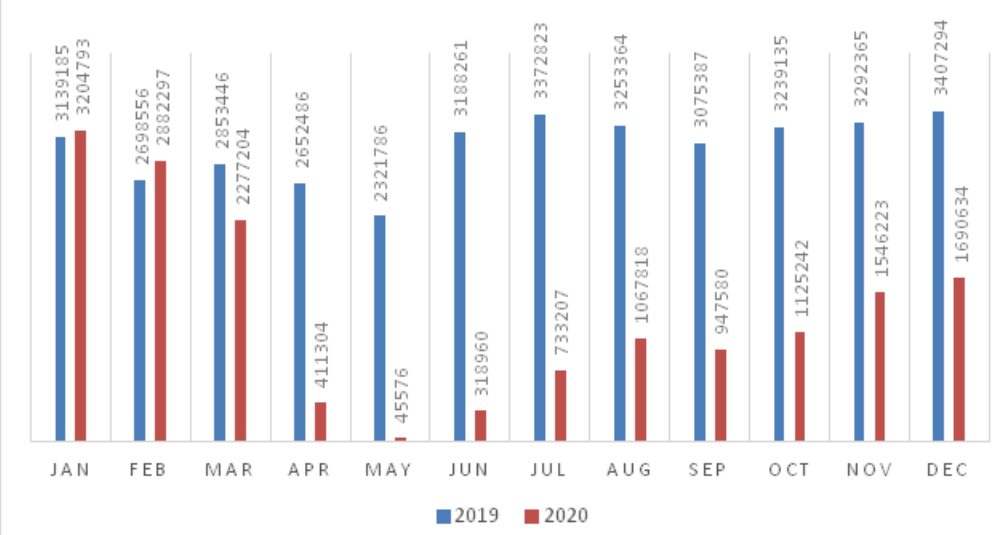

Figure 1. Number of Domestic Flight Passengers at Main Airport

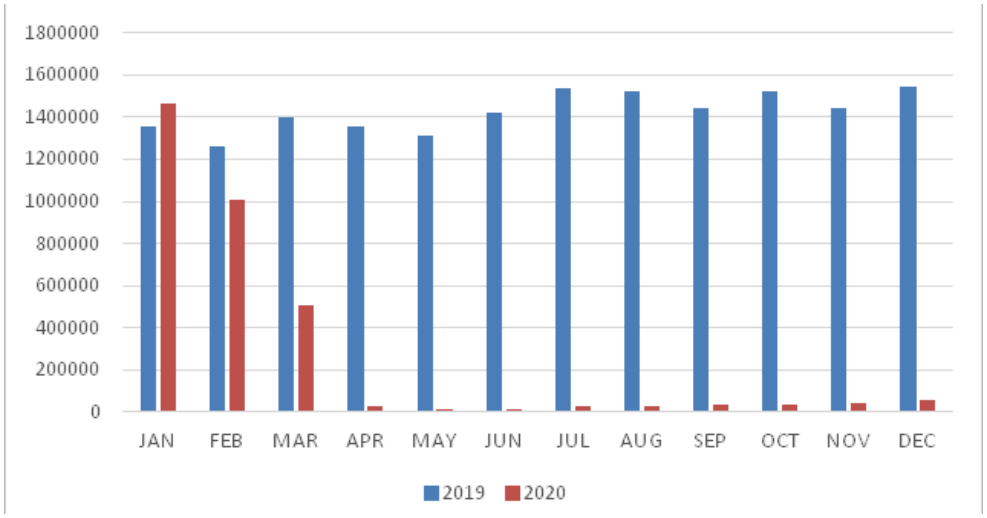

Figure 2. Number of International Flight Passengers at Main Airport

PT. XYZ is an aviation industry that focuses on aircraft maintenance services / Maintenance, Repair & Overhaul (MRO). PT. XYZ is the largest MRO in Indonesia with very rapid business development to realize its vision as a world class MRO in the world. The turmoil in the aviation world greatly affected the company's financial performance during the first semester. PT. XYZ revenue fell 35% in the same period last year. This was influenced by a decrease in income from paying aircraft maintenance fees by prime customers such as “X” Airlines and “Y” Airlines, where the payment pattern was based on the flight hours from the operation of airline

aircraft. This means that the longer the flight hours that PT. XYZ can guarantee for the aircraft it owns, the higher the amount of payment paid to PT. XYZ.

Currently PT. XYZ has carried out risk identification and risk management to address the risks that may occur within the company. As for the implementation, there are two points of view/reviews in carrying out risk management, for the business aspect it is adopted from Enterprise Risk Management (ERM) and the safety aspect is adopted from Safety Risk Management (SRM) which is aviation safety.

Based on the description above, the question is whether the application of ERM or SRM can still respond to or at least reduce the negative impacts caused by the COVID-19 pandemic by identifying, analyzing, responding, and controlling the operational risks that arise.

2. LITERATURE REVIEW

Risk management is a coordinated activity to direct and control an organization related to risk. The framework of the business risk management approach that is currently developing is enterprise-wide risk management (ERM). (Hopkin, 2010) The benefits of implementing an effective ERM in a company, among others: increasing the scope of new business opportunities, identifying, and managing risks throughout the entity, increasing positive results and profits while reducing negative surprises, reducing performance variability, and increasing company resilience. (World Economic Forum)

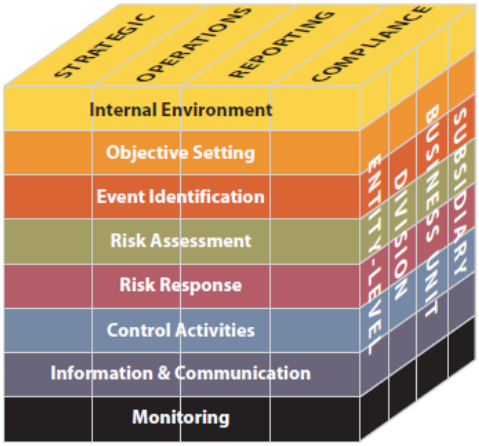

Figure 3 *Enterprise Risk Management – Integrated Framework* (COSO, 2004)

This depiction demonstrates the company's ability to focus on implementing ERM as a whole or by category, component, or unit. The effectiveness of ERM implementation can be assessed by assessing the existence and functionality of eight components in each department which will provide assurance to the board that the company's strategic, operational, reporting and compliance objectives are achieved. (COSO, 2004)

According to the Civil Aviation Safety Authority. (2012), safety risk management (SRM) is the identification, analysis, and elimination (and/or mitigation to an acceptable or tolerable level) of hazards, as well as subsequent risks, that threaten the survival of the organization. Six simple steps are suggested as an early warning safety system, including: (1) Identify security hazards, (2) Rate and rate safety hazard severity, (3) Identify existing controls/defenses to manage hazards, (4) Assess effectiveness current controls/defense, (5) Identify any further controls/defense required, and (6) Record all this information on the hazard register.

Research by Aifuwa et al (2020), Shen et al (2020), Melas and Melasová (2020), Suau-Sanchez et al (2020), and Liu et al (2020) shows that there is a negative impact of the COVID 18

pandemic on financial and non-financial performance. Corporate finances in various countries, including the negative impact on the performance of companies related to the passenger and freight aviation industry.

The research of Yang et al (2018), Alawattegama (2018), enol and Karaca (2017), Li (2018), and Callahan and Soileau (2017) shows that not always the application of an ERM framework will result in better organizational performance. However, a more mature application of ERM is needed to stimulate investors to invest, so that in the end this investment will improve business performance.

Greepherson's research (2013); Ayalew and Demissie (2020); and Halíčková et al (2016) show that employee safety and health risks are risks that need to be managed properly. Safety risk management (SRM) has a direct impact on employee satisfaction and loyalty. In addition, safety risk management (SRM) can reduce accident rates, increase employee productivity, and ultimately have a positive impact on organizational performance. This shows that occupational health and safety risk management has a positive impact on organizational performance.

While the research of Hwang et al (2020); and Viramgami et al (2020) imply that to resume the production functions of all sectors of the economy and public services, many countries have relaxed their lockdown policies, but by better managing the health and safety risks of their employees. This shows that occupational safety and health risk management plays an important role in improving the performance of organizations affected by COVID-19.

On the other hand, research by Kaliti (2015); Jaber (2020); and Kawugana et al (2020) show that risk management has a significant influence on company performance and efficiency. In other words, ERM and SRM as a form of risk management practice have a significant influence on the company's performance and efficiency.

The results of this study are expected to contribute to the application of knowledge about the application of the ERM and SRM frameworks in mitigating the risks caused by the COVID-19 pandemic in maintenance, repair, and overhaul activities at PT. XYZ.

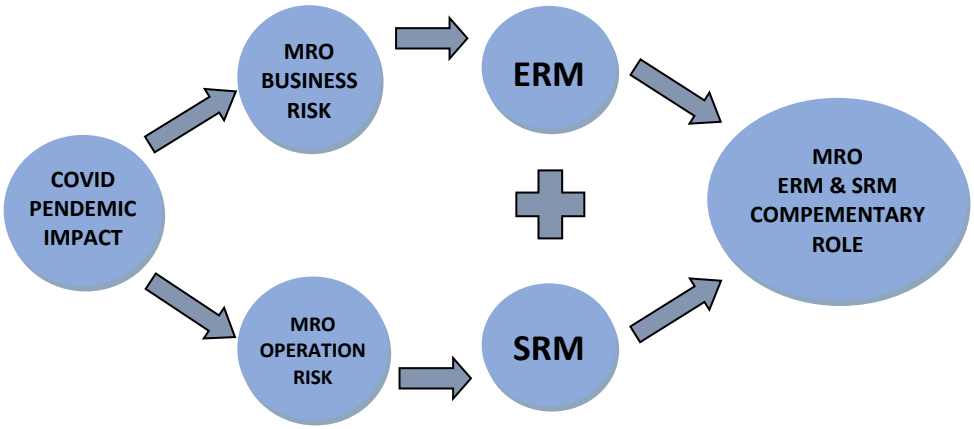

Figure 4. Complementary Roles of ERM and SRM

3. METHODS

This study uses a qualitative approach. Data was collected through interviews and focus group discussions with (1) Aircraft Maintenance Planning Engineer, (2) Aircraft Engineering, (3) Human Resources, (4) Quality Control, (5) Risk Management Office, (6) Safety Officer; discuss non-medical safety aspects related to the impact of the pandemic on employees, processes, and technical operations of MRO. Data analysis using ERM and SRM frameworks.

The COVID-19 pandemic is an unprecedented event, therefore, as with the determination of risk identification, the determination of the probability and impact of risk is determined based on PT. XYZ Safety Manual and interviews with resource persons.

Table 1. Risk Probability

Definition	Meaning	Value
Almost Certain	Will undoubtedly happen/occur, possibly frequently; Likely to occur many times (has occurred frequently); Chance ≥ 90%	5
Likely	Will probably happen/occur, but it is not a persisting issue.; Likely to occur sometimes (has occurred infrequently); Chance ≥ 65%, or < 90%	4
Possible	Might happen/occur occasionally; Unlikely to occur, but possible (has occurred rarely); Chance ≥ 30%, or < 65%	3
Unlikely	Expected to not happen /occur but it is possible it may do so; Very unlikely to occur (not known to have occurred); Chance ≥ 5%, or < 30	2
Rare	This will probably never happen; Almost inconceivable that the event will occur; Chance < 5%	1

Source: Safety Manual PT. XYZ

Table 2. Risk Severity

DEFINITION / VALUE	IMPACT TO				
	PEOPLE	OPERATIONAL	COMPLIANCE	ASSETS /FACILITIES	REPUTATIONAL
Catastrophic (A)	Multiple Fatalities	- Loss of aircraft	Loss of company approvals , permits or certificates, resulting in suspension of all operations	- Multiple A/C damage resulting in serious network disruptions - BER (Beyond Economical Repair) > 65% of asset value	- Sustained negative global (social) media coverage - Sustained long-term negative financial / revenue impact - Long term inability to attract customers & generate revenue
Hazardous (B)	- One Fatality - Serious Injury resulting in hospitalization	- Practically no operational safety margins left -Phsycal distress / high workload impairing accuracy and completion of task -Damage out of limit and not recognized before flight	Loss of company approvals , permits or certificates, resulting in suspension of part of operations	- Aircraft out of use > 24Hrs - Cost of repair >50% or <65% of asset value	- Sustained negative international (social) media coverage - Significant financial / revenue impact - Short term inability to attract customers & generate revenue
Major (C)	Injury / ill health resulting in absence not requiring hospitalization	- Large reduction in operational safety margins - Deduction in ability to cope with adverse operating conditions / increase work load - Damage within limits and not recognized before flight	- Major breach of company policy or SOPs with no direct impact on approvals, certificates, permits with significant negative effect on ability to manage operations - Attitude of regulatory authority towards company has been negatively impacted	- Aircraft out of use 2 - 24Hrs - Cost of repair >10% or <50% of asset value	- Sustained negative national (social) media coverage - Major financial / revenue impact - Inability to attract customers in specific region & generate revenue

DEFINITION / VALUE	IMPACT TO				
	PEOPLE	OPERATIONAL	COMPLIANCE	ASSETS /FACILITIES	REPUTATIONAL
Minor (D)	Minor Injury not resulting in absence	- Operating limitations - Damage timely recognized	- Breach of company policy or SOPs with no direct impact on approvals, certificates, permits with minor negative effect on ability to manage operations - Falls below expected industry 'Good Practices'	- Aircraft out of use < 2Hrs - Cost of repair 10% of asset value	- Local (social) media impact - Short - lived effects
Negligible (E)	No Injury	- No adverse effect to operational safety	- No breach of company requirements - No impact on approvals.	- No delay due to damage - No Facility damage	- No effect

Source: Safety Manual PT. XYZ

Based on the risk probability standard and the risk severity standard applicable at MRO PT. XYZ,

$$Risk\ Status = Risk\ Probability \text{ x } Risk\ Severity$$

Risk Probability : The determination of the likelihood of a risk occurring
Risk Severity : Estimate of the potential losses associated with an identified risk

4. RESULTS

Interviews and group discussions with resource persons were conducted several times on different occasions, with the results of the interviews as follows: (1)(A) The number of commercial flights decreased, (2)(B) Operational activities of the MRO base and line maintenance decreased as a whole, (3)(C) There was a change in the pattern of operational activities The MRO which was originally larger in line maintenance, during the pandemic, line maintenance activities decreased, (4)(D) There was a buildup of grounded aircraft, (5)(E) The certainty of Pandemic recovery was not clear, and (6)(F) Corporate management statements internally and through the mass media indicated that In order to increase the utilization of the MRO facilities which were overcapacity due to the COVID-19 pandemic, the corporate management decided to diversify MRO services into new businesses, namely MRO services for no commercial aircraft and industry turbines for power services. The corporate management targets the revenue contribution from new businesses to reach 10% of the overall MRO revenue.

Based on interviews and information obtained during the research, qualitatively the risk appetite of PT. XYZ is as follows:

1. Corporations have low and medium risk acceptance.
2. Corporations have no appetite for fraud/financial crime risk.
3. The corporation has zero tolerance for violation of regulations.
4. The corporation will always try to avoid negative press coverage.
5. The corporation has zero tolerance for incidents that have an impact on work safety and fatalities.
6. The corporation will not take risks that affect product quality and customer service with a tolerance of 0.2% of the Cost of Poor Quality (CoPQ) value to the value of operating revenues.

The impact of the Pandemic on MRO operations mentioned above has the following consequences of risk arising from the perspective of HR, processes, and technical operations of MRO:

Table 3. Risk Identification

Impact of the COVID-19 Pandemic		Risk Identification	
No.	**Potential Hazard**	**MRO risk**	**Risk Type**
1.	A	A1	Business
		A2	Technical
		A3	Technical
		A4	Technical
		A5	Technical
		A6	Technical
2.	B	B1	Technical
		B2	Technical
3.	C	C1	Technical
		C2	Technical
		C3	Technical
4.	D	D1	Technical
		D2	Technical
		D3	Technical
		D4	Technical
		D5	Technical
5	E	E1	Technical
		E2	Technical
		E3	Technical
6	F	F1	Business and Technical
		F2	Business and Technical
		F3	Business and Technical
		F4	Business and Technical
		F5	Business and Technical
		F6	Business and Technical
		F7	Business and Technical
		F8	Business
		F9	Business
		F10	Business
		F11	Business

Source: MRO PT. XYZ resource person

Risk analysis with the ERM and SRM frameworks is essentially the same process, namely the identification of risks, their likelihood of occurrence, the impact of the resulting risk, the expectation of the impact, and the registration (response and monitoring) of these risks. The difference is that ERM is carried out at the corporate level (PT. XYZ) because it involves corporate decisions, while SRM is carried out at the MRO operational management level because it involves operational decisions within the MRO environment. Meanwhile, business, and technical risk analysis is carried out at the corporate level, while MRO provides operational estimates in the form of technical and operational feasibility alternatives that can be used by corporate management to make decisions.

The risk status of each identified risk can be identified as follows:

Table 4. Risk Status

No.	Risk Description	Probability/ Likelihood Scale	Severity /Impact Scale	Risk Status (3 x 4)
1	**2**	**3**	**4**	**5**
1	A1	2	C	2C
2	A2	2	D	2D
16	D5	3	B	3B
17	E1	3	B	3B

3	A3	2	D	2D
4	A4	2	D	3B
5	A5	2	D	2D
6	A6	2	D	2D
7	B1	2	D	2D
8	B2	2	D	2D
9	C1	2	D	2D
10	C2	2	D	3B
11	C3	2	D	3B
12	D1	3	B	3B
13	D2	3	B	3B
14	D3	3	B	3B
15	D4	3	B	3B

18	E2	2	D	3B
19	E3	2	D	2D
20	F1	2	C	2C
21	F2	2	C	2C
22	F3	2	C	2C
23	F4	2	C	2C
24	F5	2	C	2C
25	F6	2	C	2C
26	F7	2	C	2C
27	F8	2	C	2C
28	F9	2	C	2C
29	F10	2	C	2C
30	F11	2	C	2C

Source: MRO PT. XYZ resource person

Based on Table 4 above, the 30 risks can be described on the risk status map as follows:

Probability	**Severity**				
	Negligible	Minor	Major	Hazardous	Catastrophic
Almost Certain	**5E**	**5D**	**5C**	**5B**	**5A**
Likely	**4E**	**4D**	**4C**	**4B**	**4A**
Possible	**3E**	**3D**	**3C**	**3B (A4,C2,C3,D1 ,D2,D3,D4,D5, E1,E2)**	**3A**
Unlikely	**2E**	**2D (A2,A3,A5,A6, B1,B2,C1)**	**2C (A1,E3,F1,F2, F3,F4,F5,F6, F7,F8,F9,F10, F11)**	**2B**	**2A**
Rare	**1E**	**1D**	**1C**	**1B**	**1A**

Source: Safety Manual PT. XYZ

Figure 5. Risk Status Map

A summary of the impact of the COVID-19 pandemic on the business and operations of PT. XYZ's MRO shows that:

1. The impact on the occurrence of flight safety risk (MRO) is as much as 50%.
2. The impact on the occurrence of PT. XYZ business risk is as much as 16.7%
3. The impact on the occurrence of flight safety risk and business risk simultaneously is 33.3%

5. CONCLUSIONS

Business risk mitigation (opportunity risk) because of the COVID-19 pandemic on maintenance, repair, and overhaul activities at PT. XYZ with the ERM framework approach has been well carried out with a 16.7% role portion of overall risk management.

Mitigation of operational risk (hazard risk) because of the COVID-19 pandemic on maintenance, repair, and overhaul activities at PT. XYZ with the SRM framework approach has been well carried out with a share of 50% of the overall risk management.

Overall, at the operational level of PT. XYZ's MRO, the role of SRM is more prominent than the role of ERM in responding to the impact of COVID-19. Besides that, there are also risks of pandemic impacts that need to be resolved jointly (a shared responsibility) between ERM and SRM.

The results of this study are expected to be applied to other MRO facilities besides PT. XYZ provided that the said MRO facilities use the same risk management framework, namely ERM and SRM.

Due to the importance of analyzing the impact of the COVID-19 pandemic at the corporate level of PT. XYZ, considering the magnitude of the global impact, financial impact, health impact, and operational impact as stated by CPA Australia ESG Center of Excellence (2020), it is recommended that PT. XYZ mitigate risk with an ERM approach. on: (1) Business risk related to MRO product diversification services. (2) Financial risk related to lost sales revenue, risk of supply chain disruption, risk of changing business operations, risk of impact on contractual arrangements, and risk of compliance obligations with new rules.

In addition, in line with the improving control of the COVID-19 pandemic by the Central Government and the availability of concessions granted to airlines, it is recommended for MRO management to start planning activities related to MRO business continuance.

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OPTIMIZATION MULTI-PRODUCT MULTI-BAYS FOR FUELING PROCESS USING MIXED INTEGER LINEAR PROGRAMMING (STUDY CASE: A FUEL TERMINAL)

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ABSTRACT

PT Pertamina (Persero) is a state corporation that carries out oil and gas business activities in the upstream to downstream sector. Pertamina is committed to consistently maintaining the availability of energy to all corners of the region in Indonesia. Therefore, we need the right strategy for Fuel Terminal Tuban (FTT), as one of the largest supporting terminals, to be able to fulfill the customer expectation and demand. Mixed Linear Programming Model is one method that can be used for optimization. In this research, three mathematical models will be formed to optimize storage, bays and tanker trucks available at FTT. The first mathematical model aims to maximize the volume of product to fulfill demands. The second model to minimize bays in order to know the optimal time in the refueling process through the available bays. The last model objective to maximize the tank truck so that the optimal amount of filling that the tank truck can do with the available bays are known. Furthermore, this research will also optimize FTT sales revenue. The results show that the addition of bays is worth to consider as a solution to increase service level and fulfill the demand.

Keywords: Optimization, Mixed Integer Linear Programming, Fuel Terminal.

1. INTRODUCTION

Fuel oil is the main energy for transportation sector, so that fuel is the most important requirement in supporting people's daily mobility. Based on the data number of motorized vehicles on 2017 to 2019, it can be seen that the number of motorized vehicles has increased. The data from Association of Indonesian Automotive Industries as known as GAIKINDO, nationa car sales from factories to dealers (wholesales) in the domestic market reached 523.027 units. The increasing number of motorized vehicles every year, force the industry in the oil sector to be able to serve the demands of consumers. The first priority is to fulfill the needs of customer demands. FTT has a filling shed consisting of 4 bays which is used for filling fuel tankers with a working time of 1200 minutes (20 hours) per day.

PT Pertamina (Persero) Supply and Distribution Region V Tuban Fuel Oil Terminal or which has now changed its name to Tuban Fuel Terminal (FTT) has been operating since December 2009 and carries out its role to receive, store, and distribute Oil Fuel (BBM) for Eastern Indonesia (Makassar, Wamena, Kupang and Bau-bau) as well as Tuban, Lamongan, Bojonegoro, Rembang, Gresik and Cepu.

FTT is an industrial facility owned by PT Pertamina, which functions to receive, store, and distribute oil products (distribution) to General Fuel Filling Station (SPBU) and industry. FTT has a storgae tank and is connected to a pipeline to be able to load iol inti tank cars, tank wagons, oil tankers and underground pipelines. FTT has 12 storage tanks with a capacity of 450.000 KL. All

activities for receiving, storing, and distributing oil products are carried out in a fully automatic system. For this reason, all storage tank facilities are equipped with instrumentation equipment such as Automatic Tank Gauging and other supporting accessories. To support the creation of the Terminal Automation System (TAS), whis is an automation-based Terminal opertaion, with a redundency system. All facilities are also equipped with lightning protection and fire protection, starting from PMK pumps, foam chambers, PMK pool, portable foam monitors and so on.

Data sales shown that there are two products with the largest sales, namely Solar whisch is in the first place and Pertalite in the second, while for Premium and Pertamax products, there is a sales gap that is quite far from the total sales of the other two products. Furthermore, based on the observations in the field, there is an inefficiency in the utilization of the facility, namely the distribution of Pertalite products which is not optimal because it is only operated by 2 or the 4 available bays. Thus, it is necessary to optimize the distribution of Pertalite type fuel according ti the bays and facilities available at the FTT.

Based on this description, this study aims to optimize fuel distribution planning using mixed integer linear programming method, so that the companies can obtain the maximum revenue by taking into account the existing factors and constraints. Mixed Linear Programming Model is one method that can be used for optimization. In this research, three mathematical models will be formed to optimize storage, bays and tanker trucks available at FTT. The first mathematical model aims to maximize the volume of product to fulfill demands. The second model to minimize bays in order to know the optimal time in the refueling process through the available bays. The last model objective to maximize the tank truck so that the optimal amount of filling that the tank truck can do with the available bays are known.

2. LITERATURE REVIEW

Optimization with constraints is basically a matter of determining the value of a function variable to be maximum or minimum by taking into account the existing limitations. These limitations include inputs or constraining factors such as suppliers, volume of storage space, allocation of facilities, and labor. Optimization with constraints needs to pay attetntion to the factors that become constraints on the objective function because the constraints determine the maximum and minimum values. The objective function is a mathematical statement that is used to present the criteria in evaluating the solution to a problem. The objective function in optimization techniques is an important element because it will determine the optimal condition of a situation.

One of the optimization method is the linear programming model that supported by several assumptions are used to make linear programming problem valid (Taha, 2007). There are four basic assumptions in the linear programming model, such as: (1) Divisiablitity (can be divided). Number in linear programming not have to be integers, as long as they are infinitely divisible. (2) Non-Negativity (not negative). Problem to be solved by linear programming must assume that the number in each variable is not negative or not less than zero. Rather it is greater than or equal to zero. (3) Certainty. The certainty assumption states that the case of a linear program must be in a condition of decision-making under certainty, that means all parameters or the decision variables are known beforehand. (4) Linearity. This assumption states that the objective function of the linear program and the constratont functions in it must be in linear form.

There have been many studies conducted with various optimization methods to find solution so that busniness processes run effectively and efficiently. One of the method used is Mixed Integer Linear Programming (MILP), which is an effective mathematical modeling approach for solving complex optimization tasks. The use of the MILP method can be applied to various research fields, such as chemical engineering and computer optimization of multi-

objective, multi-period renewable technology and storage systems using Evolutionary Algorithms and Mixed Integer Linear Programming (Fazlollahi et al., 2012), thermal engineering applied (Fazlollahi & Maréchal, 2013), industrial and chemical engineering (Aguirre et al., 2017), system architecture optimizing data placement and scheduling on multi-port DWM in multi-core embedded systems (Sha et al., 2021), optimization using MILP in the fields of robotics and computer-integrated manufacturing (Yin et al., 2022).

A MILP-based approach to medium term planning and scheduling in a multi-stage, multi-product sustainable plant using three new MILP models. These models combine the TSP (Traveling Salesman Problem) formulation with the main ideas of general priority and unit-specific general priority concepts to provide a hybrid discrete/ continuous time representation of the system. An efficient solution approach involves an iterative improvement algorithm to solve a medium-sized problem (Aguirre et al., 2017). The model developed by the authors Yin et al., (2022) Mixed Integer Linear Programming and Hybrid Driving Algorithm (HAD) for the problem of balancing a multi-product partial unloading line with the first multi-robot workstation to obtain the minimum unloading objectives: cycle time, consumption energy, and an improved hazard index. This research also innovatively proposes the Multi-Product Partial Disassembly Line Balancing (MPR-PDLBP) problem with multi robot work stations.

The MILP method and its realtion to the supply chain (SC) has been written by Jafarzadeh Ghoushchi et al., (2021) which provides a different point of view, namely in the context of circular economics (CE) which seeks to create new designs of closed-loop supply chain (CLSC) improvements. The objective function of maximizing the total profit of the manufacturer and customer satisfaction and minimizing the failed and reproduced parts through the network. The model provides comprehensive insight on CLSC for managers to make critical and appropriate decisions under the right conditions to reduce damage to CLSC network and get maximum revevnue simultaneously.

3. METHODS

This research was conducted to find and collect a number of data in order to obtain a clear picture of the facts about various circumstances and situations that exist in the company. In the first phase, direct observations in the field will be carried out to get an overview of the actual conditions that will be studied at the Tuban Fuel Terminal (FTT), East Java. Other forms of data collection such as descriptions of observations, document analysis and interviews were conducted to obtain more accurate and detailed data. The data obtained are in the form of literature studies, identification of observed objects and data for calculations.

In the second phase, the information and data obtained from the previous phase will be processed. At this phase a conceptual model will also be compiled, namely a diagram of a set of relationships between certain factors that will have an impact on or lead to a target condition, and also a mathematical model which is a translation of the conceptual model into mathematical symbols or in computer language or both. The mathematical model that is formed will be verified in several ways, namely by means of structured programming methods, conducting simulation model searches, testing or testing logical relations, then verifying analytical models and verifying using graphs.

The next process is the identification of parameters for the model that passes the verification test and then proceeds to the optimization process. Several variables are involves in this study, such as: (1) X_1 = Amount of Premium provided (Kilo Liters) in 1 day; (2) X_2 = Amount of Solar supplied (KL) in 1 day; (3) X_3 = Amount of Pertamax supplied (KL) in 1 day; and (4) X_4 = Amount of Pertalite supplied (KL) in 1 day. The operational definitions of these variables are as

follows: (i) The number of j products (X_j), the number of each volume of fuel products per day to meet the demand for fuel in units per kiloliter, respectively j = 1, 2, 3, 4 as Premium, Solar, Pertamax and Pertalite. (ii) The number of demands for product j on the i constratint (P_{ij}), the number of demands for each type of fuel from gas stations per day in units of per kiloliter, with j = 1, 2, 3, 4 and i = 1, 2, …, m. (iii) The selling price per unit of product j (H_j), the selling price of each type of fuel from FTT to gas stations per kiloliter in rupah, with j = 1, 2, 3, 4. (iv) Sales revenue on the i constraint (F_i), the total revenue obtained by FTT from the sale of fuel to gas stations per daya in rupiah, with i = 1, 2, …, m. (v) The working hour capacity of the fuel filling machine at filling shed is on the i (W_i) constraint, which is the total length of time the fuel filling machine operates in the bays which is obtained from the product of the multiplication of the number of arms in the filling point and the length of time the arm works in the filling point one day in minutes where i = 1, 2, …, m. (vi) The time of filling type j fuel into the compartment (section) of the tank truck (w_j), the length of time the fuel flows from the arm into the compartment (tank truck per 1 kiloliter in minutes), with j = 1, 2, 3, 4. (vii) Total tank truck capacity in the i constraint (M_i), which is the total capacity of 80 tank trucks in kiloliters, with i = 1, 2, …, m. (viii) The total number of demands for fuel in the k zone in the first constraint (B_{ik}), the number of demands for fuel from gas stations in each zone per day in units per kiloliter, with i = 1, 2, …, m and k = 1, 2, 3.

The third phase is analysis the optimization solution and numerical experimental results using Lingo software. Lingo is a windows program package that is commonly used to process linear, integer and quadratic programming cases equipped with commands that allow obtaining information, processing data or manipulating data. The calculations used in Lingo basically use the simplex method for linear programming problems, while to solve integer linear programming problems, while to solve integer linear programming and mixed integer linear progamming problems Lingo software uses the Branch and Bound method.

4. RESULTS

PT Pertamina (Persero) through FTT sells four types of fuel to gas stations which are FTT supply and distribution areas. The four products are Premium, Solar, Pertamax and Pertalite with different selling prices for each product. In carrying out its role, FTT must be able to meet every number of requests for fuel from gas stations every day. The selling price and total demand for each type of fuel are presented in Table 1.

Table 1 Selling Price and Total Demand of Product

Type of Product	Price per liter (Rp)	Price per kiloliter (Rp)	Total Demand (1 day/ KL)
Premium	6450	6450000	2032
Solar	9400	9400000	2400
Pertamax	9000	900000	1192
Pertalite	7650	7650000	3264

FTT has fuel receiving facilities from tankers (loading) through two Single Point Mooring (SPM) each 150.000 Dead Weight Tons (DWT) and 35.000 DWT which can be simultaneously operated and equipped with distribution facilities from the terminal to the tanker (back loading) capacity of 35.000 DWT. For distribution to tank trucks, FTT is equipped with 14 filling points and foyr bays. All receiving stockpiling activities and distribution is done by full automatic

systems. Filling shed as a fuel filling machine inti the tank trucks compartment with a flowrate of around 1000 liters/ minute. Inside the filling shed there are 4 bays as entry points or the tank truck area to fill fuel into the tank truck compartment. Each bay has a different type of arm, so the time it takes to fill the fuel into the tank truck compartment per 1 kiloliter is also different, there are Premium for 0.125 minutes; Solar for 0.167 minutes; Pertamax for 0.125 minutes and Pertalite for 0.167 minutes. Each arm can work for 1200 minutes per day, so that the total working hour capacity of the refueling machine based on the number of arms is 16800 minutes per day.

The distribution of fuel oil uses a tanker truck mode of transportation with a total capacity of all tank trucks used to distribute fuel amounting to 1408 KL. In distributing fuel to destination gas stations, FTT uses a distribution pattern with a zoning system because it is considered the most optimal system yo distribute the fuel. This zone system is divides into 3 zones, namely zone1 for gas stations that located in the area 0 to 30 kilometers (km) from FTT, zone 2 in the area 31 to 60 km and zone 3 in the area 61 to 185 km. the total number of requests for fuel from gas stations in each zone also varies. Number of gas stations for the purpose of distributing fuel in FTT there are 116 gas stations, while the number of tank trucks in only 80.

In the process of solving linear programming problems, the problem is identified first, then the objectives are set and sfter that a model formulation is made which is shown as a linear programming problem. In this distribution planning optimization there are 4 targets to be achieved, with the formulation of a mathematical model.

The first target, maximizing the storage volume to fulfill the total demands. The constraint function for the first objective is as follows:

$X_j + DB_{i(P_{ij})} - DA_{i(P_{ii})} = P_{ij}$, where X_j = Amount of product *j* with *j* = 1, 2, 3, 4. P_{ij} = Amount of demand for product *j* on constraint *i* with *i* = 1, 2, …, *m*. $DB_{i(P_{ij})}$ = Number of deviation value below P_{ij}. $DA_{i(P_{ii})}$ = Number of deviation value above P_{ij}. In order for the number of requests product are fulfilled, neither less nor more, the objective function of Z_1 as follows:

$$Min\ Z_1 = \sum_{i=1}^{m} \left(DB_{i(P_{ij})} + DA_{i(P_{ij})}\right)$$

So that, the mathematical models that fit the objective function are:

$X_1 + DB_1 - DA_1 = 2032$ …. (1)

$X_2 + DB_2 - DA_2 = 2400$ …. (2)

$X_3 + DB_3 - DA_3 = 1192$ …. (3)

$X_4 + DB_4 - DA_4 = 3264$ …. (4); so that the objective function become

$Min\ Z_1 = DB_1 + DA_1 + DB_2 + DA_2 + DB_3 + DA_3 + DB_4 + DA_4$ …. (5)

The second target, maximizing the working hours of the bays at the filling point. The constraint function as follows:

$\left(\sum_{i=1}^{4} W_j X_j\right) + DB_{i(W_i)} - DA_{i(W_i)} = W_i$, where X_j = Amount of product *j* with *j* = 1, 2, 3, 4. W_i = working hours capacity of bays on constraint *i* with *i* = 1, 2, …, *m*. W_j = refueling time of product *j* to tanker truck compartment. $DB_{i(W_i)}$ = Number of deviation value below W_i. $DA_{i(W_i)}$ = Number of deviation value above W_i. In order for the working hours of the bays at the filling point are maximum, the objective function of Z_2 as follows:

$$Min\ Z_2 = \sum_{i=1}^{m} \left(DB_{i(W_i)} + DA_{i(W_i)}\right)$$

So that, the mathematical models that fit the objective function are:

$0.125X_1 + 0.167X_2 + 0.125X_3 + 0.167X_4 + DB_5 - DA_5 = 16800$ …. (6);

so that the objective function become $Min\ Z_2 = DB_5 + DA_5$ …. (7).

The third target, maximizing the transportation tanker truck. The constraint function as follows:

$\left(\sum_{j=1}^{4} X_j\right) + DB_{i(M_i)} - DA_{i(M_i)} = M_i$, where X_j = Amount of product *j* with *j* = 1, 2, 3, 4. M_i = total capacity of tanker truck on constraint *i* with *i* = 1, 2, …, *m*. $DB_{i(M_i)}$ = Number of deviation value below M_i. $DA_{i(M_i)}$ = Number of deviation value above M_i. In order for the transportation tanker trucks are maximum, the objective function of Z_3 as follows:

$$Min\ Z_3 = \sum_{i=1}^{m} DB_{i(M_i)}$$

So that, the mathematical models that fit the objective function are:

$X_1 + X_2 + X_3 + X_4 + DB_6 - DA_6 = 1408$ …. (8);

so that the objective function become $Min\ Z_3 = DB_6$ .... (9).

The last target, maximizing the sales revenue of FTT. The constraint function as follows: $\left(\sum_{j=1}^{4} H_j X_j\right) + DB_{i(F_i)} = F_i$, where H_j = The selling price of product *j*. X_j = Amount of product *j* with *j* = 1, 2, 3, 4. F_i = the sales revenue on constraint *i* with *i* = 1, 2, …, *m*. $DB_{i(F_i)}$ = Number of deviation value below F_i. In order for the sales revenue are maximum, the objective function of Z_4 as follows:

$$Min\ Z_4 = \sum_{i=1}^{m} DB_{i(F_i)}$$

So that, the mathematical models that fit the objective function are:

$6450000X_1 + 9400000X_2 + 900000X_3 + 7650000X_4 + DB_7 = F$ …. (10)

so that the objective function become $Min\ Z_4 = DB_7$ .... (11).

The optimization in this research is using the LINGO software by entering an input script in the form of an objective function and a constraint function and then using the "Solve" command to optimize it. The result of this optimization can be seen on the Table 2.

Based on the result, it can be shown that: (1) Firstly, the target of maximizing the storage volume so that the demands can be fulfilled are required X_1= 2032; X_2= 2400; X_3= 1192 and X_4= 3264 and the output result are the same as the number of targets. This means that the needs of Premium value is 2032, Solar value is 2400, Pertamax value is 1192 and the Pertalite value is 3264. (2) Secondly, the target of maximizing working hours of bays. The expectation target of working hours on the bays are 16800 minutes, while the output results show that the works hour on the bays has been overused for 15451.11 minutes, this means that it is necessary to consider adding more bays or arms on the bays. (3) Thirdly, the target of maximizing transportation of tanker trucks. The target is that all the tanker trucks with total capacity of 1408 are all used, while the results show that a *DA* value of 7480 is obtained, which means that tanker trucks with a total capacity of 7480 KL is still needed to distribute the fuel to gas stations effectively. (4) Lastly, the target of maximizing of sales revenue in the FTT for the four product types of fuel per day is achieved with an income of Rp. 61,708,800,000.

Table 2 Optimization Result using Lingo Software

No	Constraint	Target	*DA*	*DB*	Result
1	Maximum volume storage	X_1= 2032 X_2= 2400 X_3= 1192 X_4= 3264	0 0 0 0	0 0 0 0	2032 2400 1192 3264
2	Maximum working hours of bays	16800	0	15451.11	32251.11
3	Maximum transportation of tanker trucks	1408	7480	0	6072
4	Maximum sales revenue of FTT	F	0	0	61,708,800,000

5. CONCLUSIONS

Based on the result and anlysis, it can be conclude that the optimization of multi-produk and multi-bays using mixed integer linear programming are: (1) maximum volume storage for each product types are 2032 KL of Premium (X_1); 2400 KL of Solar (X_2); 1192 KL of Pertamax (X_3); and 3264 KL of Pertalite (X_4). (2) maximum working hours of bays has been overused for 15451.11 minutes and consider to adding more bays or arms on the bays. (3) maximum transportation of tanker trucks are still needed to distribute the fuel to gas stations effectively with total capacity of 7480 KL. (4) maximum sales revenue of FTT in the amount of Rp 61,708,800,000.

In this study, the optimization carried out only considers ordinary constraints. For further research it is expected to consider more complex constraints by combining MILP with other optimization method, so that the result more effective and applicative for general companies.

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Technology Readiness for Commercialization of PLTS Apung Cirata Using Meter Technology Readiness Level Approach

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ABSTRACT

PLTS Apung *(Floating Solar Power Plant) development in Indonesia needs to be massively increased, to accelerate the New and Renewable Energy mix by 23% on 2025. This study aims to evaluate the level of technological readiness on the 145 MWac Floating Solar Power Plant development in Cirata (research object), so that the commercialization target can be implemented optimally. The method of measuring the technology readiness level (TRL) uses TeknoMeter V2.5. TRL is a measuring instrument with several parameter indicators according to its level, starting from scientific research, development, application and testing from laboratory analysis and its application in actual conditions in the research object. From the results of the data and analysis according to the stages in the research method at each level category, it is obtained the TRL on Level 7. This shows that the readiness of the Floating PLTS technology can already be applied. For the next level in terms of commercialization, it is still necessary to fulfill most of the indicators (Level 8 and Level 9), specifically according to the actual conditions in the research object.*

Key Words *: Floating Solar Power Plant, Technology Readiness Level (TRL), New & Renewable Energy*

1. INTRODUCTION

As part of efforts to reduce Greenhouse Gas (GHG) emissions to support the follow-up to the Paris Agreement, the Government of Indonesia is committed to reducing GHG emissions by 29% by 2030, as stated in Law No. 16 of 2016. In the Electricity Supply Business Plan (RUPTL) 2019-2028, the Government targets the New Renewable Energy (EBT) mix of power plants to reach 23.2% in 2028. On the other hand, PT PLN (Persero) is committed to supporting the government in accelerating the achievement of the national EBT mix target to 23% in 2025.

The development of Solar Power Plant technology is growing rapidly and is getting cheaper. It is also supported by the implementation of Floating Solar Power Plant, which does not require land investment costs because PT. Pembangkitan Jawa Bali (PJB) is optimizing its assets. Those mean that by utilizing the water surface above the dam that is already owned by the company (PJB), making International Partners and Lenders interested in supporting business

funding to The floating solar power plant, because this project will produce a competitive selling price that supports the feasibility level of project implementation.

Although floating solar power plant technology in the world is developing rapidly, until now Indonesia still does not have the technology so that it is still lagging behind compared to developed countries. Based on these conditions, researchers are interested in evaluating "Technology Readiness for Commercialization of Floating Solar Power Plants: A ladder Building Approach" in order to measure the maturity level of readiness of Floating Solar Power Plant technology in terms of the Level of Technology Readiness for the successful commercialization of its implementation in an effort to support the acceleration of achieving the Green vision of the Government of Indonesia.

2. LITERATURE REVIEW

2.1. Solar Power Plant

Indonesia is located on the equator, between 6° N – 11° South Latitude and 95° East Longitude – 141° East Longitude, so the sun in Indonesia shines every day throughout the year. With the development of technology, this solar radiation can be used as an energy source and becomes the most promising energy option because of the unlimited availability of sources. Based on SNI 8395:2017, solar power plant is a power generation system whose energy is sourced from solar radiation, through the conversion of photovoltaic cells. Photovoltaic cells systems convert solar radiation into electricity, as shown in Figure 1. The higher the intensity of solar radiation (irradiation) hitting the photovoltaic cell, the higher the electrical power can be produced. With the condition of solar radiation in Indonesia, which is located in the tropics and at the equator, solar power plant is one of the potential electricity supply technologies to be applied.

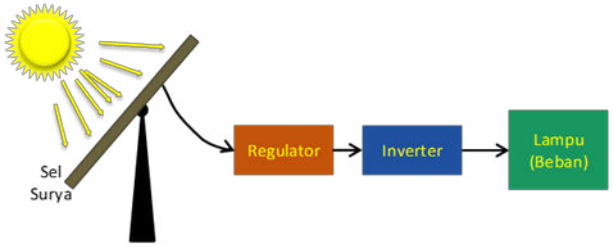

Figure 1. Illustration of a Solar Power Generation Circuit

Although the availability of solar energy is not limited, this energy source is intermittent (or not available continuously) because the electrical energy produced by solar cells is strongly influenced by the intensity of sunlight received by the system. Factors affecting the operation of solar cells to obtain the maximum value depends on :

a) Ambient air temperature
b) Solar Radiation
c) The speed of the wind blowing
d) The state of the earth's atmosphere
e) Orientation of solar cell panels or arrays
f) The position of the solar cell (array) to the sun (tilt angle)

With the existing facilities, solar power plant is one of the potential electricity supply technologies to be applied through various forms of installation. There are various types of solar power plant, when reviewed based on the system design, mode of operation and based on the installation as follows:

a) Solar power plant system design

i. Centralized solar power plant

A solar power plant system whose photovoltaic module is designed centrally (in one area) and has a distribution network system to distribute electrical power to the load.

ii. Distributed/Distributed solar power plant

Solar power plant systems whose photovoltaic modules are designed in a dispersed manner and generally do not have a distribution network system, so that each customer has their own solar power plant system.

b) Solar power plant Operation Mode

i. Solar power plant On Grid (connected to the electricity grid)

Generation of electric power whose energy is sourced from solar radiation through the conversion of photovoltaic cells where the electrical system is connected to the public electricity network. These systems are generally not equipped with batteries.

ii. Solar power plant Off Grid (not connected to the electricity grid)

Generation of electric power whose energy is sourced from solar radiation through the conversion of photovoltaic cells where the electrical system is not connected to the public electricity network. These systems are generally equipped with batteries.

c) Solar power plant installation

i. Ground Mounted Solar power plant

Photovoltaic cells are placed on a foundation installed above ground level.

ii. Rooftop Solar power plant

Photovoltaic cells are placed on a foundation mounted on the roof or can be integrated with the roof.

iii. Floating solar power plant

Photovoltaic cells are placed on the foundation, where the foundation can float on the surface of sea water, lakes or dams.

2.2. Floating Solar Power Plant

The trend of using solar cells to meet the needs of electrical energy continues to increase. In a journal that discusses Solar Power Generation Planning on the Roof of the Harry Hartanto Building at Trisakti University, Ramadhan S.G, (2016), the results of the design show that from a total area of 855 m^2, the panels used are 312 solar panels with a capacity of 300 Wp, meaning that every 1 m^2 of land will produce solar power plant output power. of 0.11kWp. In the construction of a centralized solar power plant ground, the designed power of solar power plant will certainly be large enough so that it requires an increasingly large area of land. The condition of providing land for solar power plant has the potential to be a problem that is even more difficult to solve than the technical development of solar power plant itself.

Floating solar power plant is now a trend in the development of renewable energy in the world. Quoted from the website of the Directorate General of New, Renewable Energy and Energy Conservation, the Ministry of Energy and Mineral Resources (Directorate General of EBTKE - Ministry of ESDM) Indonesia has more than 192 dams and reservoirs, with a catchment area of 86,247 hectares and the potential utilization of floating solar power plant is projected to be more than 4,300 MWp (utilization of floating solar power plants). 5% catchment area). Technically, floating solar power plant has advantages over solar power plant above ground (ground-mounted) or rooftop solar power plant, being able to optimize reservoir utilization, there are no difficulties related to large land, can be operated in a hybrid manner with hydro power plant, there is an interconnection network for reservoirs that are also available. functions as

hydropower, reduces evaporation, and increases energy yield by up to 10% due to lower ambient temperatures.

2.3. Floating Solar Power Plant Cirata

Floating Solar Power Plant Cirata was built by a consortium of PT. Java-Bali Investment Generation (PJBI), which is a subsidiary of PT PJB and an energy company from the United Arab Emirates, Masdar. The investment made in the Cirata floating solar power plant project reached a value of US $ 129 million or equivalent to Rp. 1.7 trillion, which was signed on January 12, 2020 in Abu Dhabi. PJBI owns 51% of the shares and the rest is owned by Masdar. The selling price of electricity agreed with PLN is US$ 0.0582 per kWh.

3. METHODS

3.1. Research Flow

In this research method, researchers conducted a case study of measuring TRL in the Floating Solar Power Plant unit, the developer company, namely PT Pembangkitan Jawa-Bali Masdar Solar Energy (PMSE) using a scheme that provides PPA (Power Purchase Agreement) benefits for up to 25 years and above with a capacity of 145 MWac which was carried out in 2021 with an investment of 129 million USD, and a tariff of 5.8179 cUSD/kWh.

3.2. Technology Readiness Level Measurement

Furthermore, the researchers carried out TRL measurements which included the basic principles of researched and reported technology, formulation of concepts and or application of formulations, proof of the concept of functions and or important characteristics analytically and experimentally, validating components or subsystems in a laboratory environment, validating components or subsystems in a laboratory environment. The relevant environment, demonstration of a model or prototype of a system or subsystem in a relevant environment, demonstration of a prototype system in a real environment, a complete and reliable system through testing and demonstration in a real environment, and finally ensuring the system is truly tested or proven through success operation. For more details, see the image below in Figure 2 :

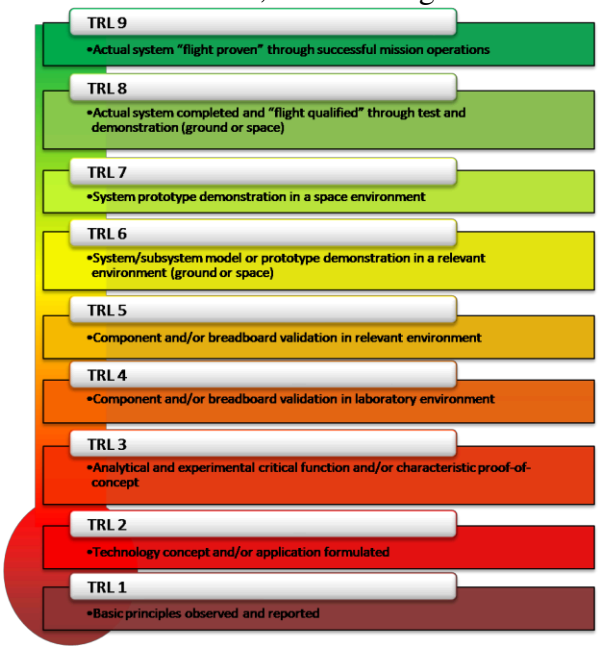

Figure 2. Levels in TRL

Next, the researchers measured the TRL using TeknoMeter_V2.5 in excel format, with the order of filling in as follows:

a) Complete the information about technology on Sheet 1

b) Determining the Limits (percentage of indicators met) for the fulfillment of the achievement of the TRL indicators at each level using the Tekno-Meter 2.5 method to measure the level of technology readiness of the flow, the percentage of indicators met is at 80.0% and the default value in % is at 100%. And can be seen based on the image below in Figure 3.

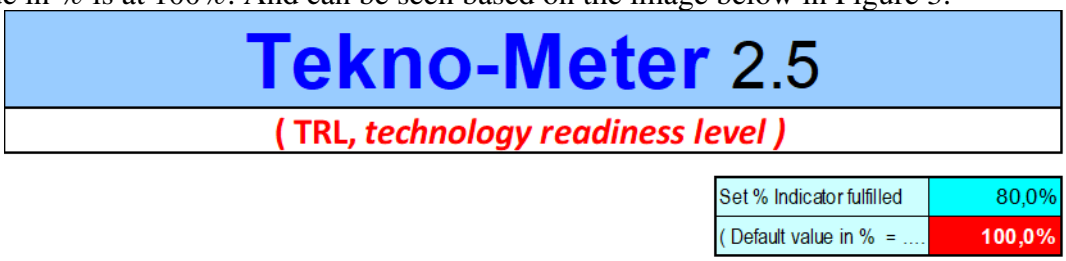

Figure 3. Version of TRL

c) The TRL measurement begins by putting a cross (X) on the TRL statement for each level

d) Filling in TRL-1 and TRL-2

Table 1. Indicator TRL Level 1 Display

	S or % fulfillment ►					Indicator TRL 1 [put a cross (X) in the appropriate column]	
					x	Indicator TRL 1 is considered to have been fulfilled	
No	0	1	2	3	4	5	(0=no fulfill; 1=20%; 2=40%; 3=60%; 4=80%; 5=100% or fulfill)
1						X	Assumptions and basic laws (ex. physics/chemistry) that will be used in (new) technology have been determined
2						X	Literature study (theoretical/empirical - previous research) on the basic principles of the technology to be developed
3						X	Research hypothesis formulation (if any)
S	0	0	0	0	0	3	
S	100,0%						
Indicator TRL 1 =						FULFILL	

From Table 1 data is obtained, that the TRL 1 indicator has been met with a value of s = 100%, which includes indicators of assumptions and basic laws (ex. physics/chemistry) that will be used in (new) technology has been determined. previous research) on the basic principles of the technology to be developed, and the formulation of research hypotheses (if any).

Table 2. Indicator TRL2 Display

	S or % fulfillment ►					Indicator TRL 2 [put a cross (X) in the appropriate column]	
						Indicator TRL 2 is considered to have been fulfilled	
No	0	1	2	3	4	5	(0=no fulfill; 1=20%; 2=40%; 3=60%; 4=80%; 5=100% or fulfill)
1						X	The equipment and systems to be used have been identified
2						X	Literature study (theoretical/empirical) the technology to be developed allows it to be applied
3						X	The theoretical and empirical designs have been identified
4						X	The basic elements of the technology to be developed are known
5						X	The characterization of the technology components to be developed has been mastered and understood
6						X	The performance of each of the constituent elements of the technology to be developed has been predicted
7						X	Preliminary analysis shows that the main functions required can work properly
8						X	Models and simulations to test the correctness of the basic principles
9						X	Analytical research to test the correctness of its basic principles
10						X	The technology components to be developed separately can work well
11						X	The equipment used must be valid and reliable
12						X	Know the stages of the experiment that will be carried out
S	0	0	0	0	0	12	
S	100,0%						
Indicator TRL 2 =						FULFILL	

From Table 2, it produces data that the TRL 2 indicator has been met with a value of s = 100%, which includes the equipment and system indicators that will be used have been

identified, a literature study (theoretical/empirical) of the technology that will be developed allows it to be applied, the theoretical design and empirical, have been identified, the basic elements of the technology to be developed are known, the characterization of the technology components to be developed has been mastered and understood, the performance of each of the constituent elements of the technology to be developed has been predicted, the initial analysis shows that the main functions required can work well, models and simulations to test the correctness of the basic principles, analytical research to test the correctness of the basic principles, the components of technology that will be developed separately can work well, the equipment used must be valid and reliable and the last known stage of the experiment to be carried out.

e) Filling in TRL Level 3

Table 3 shows that the TRL 3 indicator has been met with a value of s = 88.9% , which includes analytical studies supporting the prediction of the performance of technological elements, the characteristics / properties and performance capacity of the basic system have been identified and predicted, experiments have been carried out laboratories to test the feasibility of applying these technologies, models and simulations support predictions, the ability of technological elements, the development of these technologies with the initial steps using mathematical models is very possible and can be simulated, laboratory research to predict the performance of each element of technology, theoretically, empirically and experimentally it is known that the components of the technology system can work well, research has been carried out in the laboratory using dummy data, and the technology is scientifically feasible (analytical studies, models/simulations, experiments).

Table 3. Indicator TRL Level 3 Display

	S or % fulfillment ▶					Indicator TRL 3 [put a cross (X) in the appropriate column]	
						Indicator TRL 3 is considered to have been fulfilled	
No	0	1	2	3	4	5	(0=no fulfill; 1=20%; 2=40%; 3=60%; 4=80%; 5=100% or fulfill)
1						X	Analytical studies support the prediction of the performance of technology elements
2						X	The characteristics/properties and performance capacities of the basic systems have been identified and predicted
3					X		Laboratory experiments have been carried out to test the feasibility of applying the technology
4					X		Models and simulations support predictive capabilities of technology elements
5						X	The development of the technology with the initial steps using a mathematical model is very possible and can be s
6					X		Laboratory research to predict the performance of each element of technology
7					X		Theoretically, empirically and experimentally, it is known that the components of the technology system can work
8					X		Research has been carried out in the laboratory using dummy data
9						X	Scientifically feasible technology (analytical studies, models/simulations, experiments)
S	0	0	0	0	5	4	
S	88,9%						
Indicator TRL 3 =	FULFILL						

f) Filling in TRL Level 4

Based on the data from Table 4, the value of s = 82.5%, which means the TRL 4 indicator has been met, which includes separate laboratory tests of the components have been carried out, the system requirements for the application according to the user have been known (adopter's desire), the results of laboratory experiments of the component demonstrates that it is operational, testing of key technology functions in the relevant environment, lab-scale technology prototypes have been created, component integration research has started, key processes for its manufacturing have been identified and reviewed in the lab, and technology systems integration and scale design lab has been completed (low fidelity).

Table 4. Indicator TRL 4 Display

	S or % fulfillment ►						Indicator TRL 4 [put a cross (X) in the appropriate column]
	Indicator TRL 4 is considered to have been fulfilled						
No	0	1	2	3	4	5	(0=no fulfill; 1=20%; 2=40%; 3=60%; 4=80%; 5=100% or fulfill)
1					X		Separate laboratory tests of components have been carried out
2						X	The system requirements for the application according to the user are known (adopter wishes).
3					X		The results of laboratory experiments on components show that these components can operate
4					X		Experiment the main functions of the technology in the relevant environment
5					X		Lab-scale technology prototype has been created
6					X		Component integration research has started
7					X		The 'key' processes for its manufacture have been identified and reviewed in the lab.
8					X		Technology system integration and lab scale design have been completed (low fidelity)
S	0	0	0	0	7	1	
S	82,5%						
Indicator TRL 4 =	FULFILL						

g) Filling in TRL Level 5

Based on Table 5, it shows that the TRL 5 indicator has been met with a value of s = 80.0% which includes indicators that hardware production preparation has been carried out, market research (marketing research) and laboratory research to select the fabrication process and prototypes have been made, equipment and supporting machines has been tested in the laboratory, the system integration is completed with high fidelity ready to be tested in a real/simulation environment, the accuracy/fidelity of the prototype system is increased, laboratory conditions are modified, so that it is similar to the real environment, and the production process has been reviewed by the manufacturing department.

Table 5. Indicator TRL Level 5 Display

	S or % fulfillment ►						Indicator TRL 5 [put a cross (X) in the appropriate column]
	Indicator TRL 5 is considered to have been fulfilled						
No	0	1	2	3	4	5	(0=tidak terpenuhi; 1=20%; 2=40%; 3=60%; 4=80%; 5=100% atau terpenuhi)
1					X		Preparation for hardware production has been carried out
2					X		Market research (marketing research) and laboratory research to select the fabrication process
3					X		The prototype has been created
4					X		Supporting equipment and machines have been tested in the laboratory
5					X		System integration is complete with high fidelity, ready to be tested in a real/simulated environment.
6					X		Improved prototype system accuracy/fidelity.
7					X		Laboratory conditions are modified so that they are similar to the real environment
8					X		The production process has been reviewed by the manufacturing department.
S	0	0	0	0	8	0	
S	80,0%						
Indicator TRL 5 =	FULFILL						

h) Filling TRL Level 6

Based on the Table 6, the value of s = 86.7% means that the TRL 6 indicator has been met, including 2 indicators that are in category 5 (100%) such as indicators of the actual operating environment conditions that have been identified and investment needs for equipment and manufacturing processes have been identified. Furthermore, the 4 indicators are in category 5 (80%) such as machinery and system indicators for the performance of technology systems in the operating environment, the manufacturing/fabrication department approves and accepts the results of lab testing, the prototype has been tested with high accuracy/lab fidelity in a simulated operational environment. (which is actually outside the lab), and the test results prove technically feasible (Engineering Feasibility)

Table 6. Indicator Level 6 Display

	S or % fulfillment ►						Indicator TRL 6 [put a cross (X) in the appropriate column]
	Indicator TRL 6 is considered to have been fulfilled						
No	0	1	2	3	4	5	(0=fulfill; 1=20%; 2=40%; 3=60%; 4=80%; 5=100% or fulfill)
1						X	The actual operating environment conditions are known
2						X	Investment needs for equipment and manufacturing processes are identified.
3					X		Machinery & System for the performance of technological systems in the operating environment.
4					X		Manufacturing/manufacturing department approves and accepts lab test results.
5					X		The prototype has been tested with high lab accuracy/fidelity in a simulated operational environment (which is actu
6					X		Test results prove technically feasible (engineering feasibility)
S	0	0	0	0	4	2	
S	86,7%						
Indicator TRL 6 =	FULFILL						

i) Filling TRL Level 7

Based on Table 7, it shows that the TRL 7 indicators have been met with a value of s = 83.6% which includes indicators of equipment, processes, methods and engineering designs that have been identified which are in the value category 4 (80%), and 6 indicators are in the value category 5 (100%) which includes the process and procedure of equipment fabrication starting to be tested, process equipment and test/inspection equipment being tested in a production environment, the draft design drawing is complete. Equipment, processes, methods and engineering designs have been developed and started to be tested, the calculation of cost estimates has been validated (design to coast), the general fabrication process has been well understood, and 4 indicators are in category 3 (60%) which covers almost all the function can run in the operating environment/condition, the complete prototype has been demonstrated in an operational environment simulation, the system prototype has been tested in field trials, and is ready for initial production (Low Rate Initial Production- LRIP).

Table 7. Indicator TRL Level 7 Display

	S or % fulfillment ►						Indicator TRL 7 [put a cross (X) in the appropriate column]
	Indicator TRL 7 is considered to have been fulfilled						
No	0	1	2	3	4	5	(0=tidak terpenuhi; 1=20%; 2=40%; 3=60%; 4=80%; 5=100% atau terpenuhi)
1					X		Equipment, processes, methods and engineering designs have been identified
2						X	Equipment fabrication processes and procedures are being piloted
3						X	Process equipment and test/inspection equipment are piloted in a production environment
4						X	The design drawing draft is complete
5						X	Equipment, processes, methods and engineering designs have been developed and are being piloted.
6						X	The cost estimate calculation has been validated (design to cost)
7						X	The general fabrication process is well understood
8					X		Almost all functions can run in the operating environment/condition
9					X		The complete prototype has been demonstrated in a simulated operational environment
10					X		The system prototype has been tested in field trials
11					X		Ready for initial production (Low Rate Initial Production- LRIP)
S	0	0	0	4	1	6	
S	83,6%						
Indicator TRL 7 =	FULFILL						

4. RESULTS

Based on the results of TRL measurements using TeknoMeter_V2.5 in excel format, the results can be summarized as follows in Figure 4:

RESULTS SUMMARY

TRL

MEASUREMENT OF TECHNOLOGY READINESS LEVELS

		No. 20210929 -001
Technology Name/Title	:	**Application of 145 MWac Floating PV Technology at PLTA Cirata**
Technology Field	:	**Electric Power**
Team Leader / Activity Executor	:	**Mr. A**
Program Manager	:	**Mr. B**
Implementing Institution/Unit	:	**PT Pembangkitan Jawa-Bali**
Address / Contact	:	**Jl. Ketintang Baru No. 11 Surabaya**
		Telp/Fax

TRL Assessment Date	:	**29-Sep-21**

Level TRL	**7**	***(of 9 levels)***	***Fulfillment Indicator*** **80%**

Figure 4. TRL measurement result

Based on the TRL measurement of the 9 levels, there are 2 levels that are not fulfilled, namely at level 8 which produces data with the result of s = 73.3%, which means it is not fulfilled. Floating solar power plant technology in Cirata is currently entering the installation stage, so there are several indicators in TRL-8 that have not been met, i.e. The form of conformity and function of components compatible with the operating system, machines and equipment have been tested in a production environment, the fabrication process is being tested on a pilot scale (pilot-line or LRIP), fabrication process tests show acceptable results and productivity levels, all function tests are performed in a simulated operating environment, and the system meets qualifications through tests and evaluations (DT&E completed). Furthermore, at level 9 measurements obtained a value of s = 47.5% which means it is not fulfilled. At level 9, there are 3 indicators that are at a value of 0, i.e. : the technology indicator has been tested in actual conditions, productivity is at a stable level, and all documentation is complete. This means that the readiness for commercialization of floating solar power plants has not been maximized, so some of these indicators need to be considered in operating floating solar power plants, especially the TRL indicators 8 to 9 which are sufficient to determine the smoothness and readiness of commercialization of floating solar power plants.

5. CONCLUSIONS

The results of this research get the following conclusions:

a) According to the results of the TRL assessment that was carried out on September 29, 2021, the level of readiness of the Floating Solar Power Plant Cirata project is at level 7.

b) By using the Indicator Limits met by 80% and based on the results of the TRL assessment that has reached level 7 out of 9 levels, the maturity level of readiness of the Floating Solar Power Plant technology has actually been tested but is only limited to the prototype level and project based. However, to achieve commercialization, improvements must be made to level 8 TRL indicators which have not yet reached level 5, as mention below:

   i. The form, fit and function of components compatible with the operating system are still at level 3 out of 5 levels

ii. Machines and equipment have been tested in a production environment still at level 3 of 5 level
iii. The fabrication process is piloted on a pilot scale (pilot-line or LRIP) still at level 3 out of 5
iv. The test of the fabrication process shows the results and the acceptable level of productivity is still at level 3 of 5 levels
v. The entire function test is carried out in a simulated operating environment still at level 3 of 5 levels
vi. The system meets the qualifications through test and evaluation (DT&E completed) is still at level 3 of 5 levels

Almost all of the indicators at level 9 have not been met.

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PROJECT SCHEDULING OF THE FEED FACTORY EXTEND MACHINE TOWER DEVELOPMENT PROJECT

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ABSTRACT

The project requires not only reliable human resources, but also must be supported by good management. Good management is reflected by adequate planning project activities to achieve project completion. Program Evaluation and Review Technique (PERT) method is one of scheduling supporting tools which focuses on probabilistic scheduling. This method can be applied in carrying out projects, so that all work can go according to plan and provide more satisfactory results.

The purpose of this study was to evaluate the schedule of the development project for the development of the animal feed production area owned by PT Suri Tani Pamuka in the city of Lampung, South Sumatra which was carried out by the PT HIJ contractor. In looking for the possibility of achieving the planned project time in the time schedule with analysis using the PERT method, analyzing the time to reschedule probabilistic activities using PERT and modeled with Monte carlo simulation. The data used is the project data for the development of PT XYZ's animal feed production area. The result of this research is that the project target duration is 137-145 with a probability of 90% but the implementation reaches 161 days, so the probability obtained is 95%.

Keywords: Planning, Time Schedule, Probabilistic, PERT & Monte carlo simulation method

1. INTRODUCTION

The market needs to generate entrepreneurs in consumer goods Expansion of the development of its production capacity. Production capacity is increased by adding land/buildings for processing raw materials into materials that can be processed. One of them is the building capacity at the Lampung Machine Tower owned by PT XYZ which will be needed. The expansion. The expansion of the building was carried out by PT HIJ as a construction service provider appointed by PT XYZ. (Kusjadmikahadi, 1999) The existence of a project in a factory that has been established also creates obstacles that cause the project to be delayed in completing work. (Latham, 1994) Project delays mean obstacles to achieving a project goal, which suggests ensuring timely work and is one of the important needs of clients and the construction industry.

The project for making this extending machine tower building was carried out by PT HIJ which is located in Lampung, South Sumatra. The project is an expansion project for the engine tower building which has already been established and its area has been added to be used as a place for new machines that process animal feed. This raises various risks such as time, cost, and choosing the right work method. The effectiveness of the project implementation schedule and the supervision that can be applied is an indicator of the success of a construction project, therefore scheduling is a very important project in a construction process, where weak project scheduling can lead to completion of projects that occur in waste. cost. In an activity or project process, you must first make a time plan or often called a project time schedule (Time Schedule). Time Schedule is the division of time in detail for each activity or type of activity on a construction project, starting at the beginning of the work until the end of project implementation. (Dipohusodo, 1996) The project time schedule is a tool that can show when each activity starts, so it can be used to control the overall project implementation.

Program Evaluation and Review Technique can be abbreviated as PERT which is a management tool related to time planning on a project. The method can be applied in carrying out, reducing delays, and production interruptions, as well as various parts of the job as a whole and completing projects. This technique supports work that is not controlled and orderly, because the schedule and budget of a job have been determined before it is carried out. The purpose of PERT is a certain achievement where time is the basis of PERT in completing activities for a project. Added by simulating using the Monte Carlo method can also calculate the factors that cause delays in a project.

2. LITERATURE REVIEW

Darmawan (2011) has planned operational risk measurements in finance companies. The risk management method used is the Risk Breakdown Structure (RBS) and the Analytic Network Process (ANP).

Andi (2015) in his title Analysis of Cost and Time Optimization with the TCTO (Time Cost Trade Off) Method on the Pasar Peting Serang Banten development project got the results of project acceleration up to a maximum of 159 days or without any delays, spending less, which was Rp. 6,727. 075,874,40 than your optimal acceleration of 182 days with a delay of 23 days of Rp. 6,848,751,591.98.

M. Arsyanshah Alwi (2016), in his research entitled Analysis of the Application of CPM, PERT, and LOB Scheduling Systems in Scheduling Projects for the Construction of the Office of PT. Jasa Asuransi Indonesia obtained the results of calculations using the CPM method, the overall duration of project activities was 182 days and with the PERT method, the probability of successful completion of the project with a duration of 182 days was only 25.46%.

Literature review of this research to ensure this research finds new inspiration for further research that previous studies help this research position the research and show the capacity of the research.

Tabel 2.1 previous research

Nama	Judul	Tahun	Metode
Shaulaafifa	Planning Risk Management SDM PT X	2007	Monte carlo
Darmawan	Operational Risk Measurement Planning in Financing Companies	2011	RBS & AHP
Andi	Cost and Time Optimization Analysis with the TCTO (Time Cost Trade Off) Method on the Peting Market Serang Banten development project	2015	TCTO
Maulidia Octaviani Bustamin	Study On Development of Scheduling Acceleration Landing Craft Utility (LCU) With Monte Carlo	2015	Monte Carlo
M. Arsyanshah Alwi	Analysis of the Application of the CPM, PERT, and LOB Scheduling System on the Project Scheduling for the Office Development of PT. Jasa Asuransi Indonesia	2017	CPM & PERT
Farhannov Mufty	Risk Mitigation in Scheduling Work Projects Network Improement Quality Equipment (NIQE) Fiber Optic	2018	FGD
Wahyu Rifai	Risk Analysis of Construction Delays in Spazio Tower 2 Surabaya Project Implementation	2018	RBS & ANP
Gde Ngurah Anindita	Risk Analysis of Delays in the Implementation of Bali Hotel Construction Projects	2019	Purposive Sampling
Mujahidin Prasetyo Utomo	Scheduling Analysis of The Implementation of The Feed Factory Extend Machine Tower Development Project	2021	WBS & Monte carlo

3. METHODS

This type of project research is a descriptive type of research, where this research aims to collect actual information in detail that describes existing events, identify problems or examine conditions and applicable applications. This research was carried out in the implementation of the Lampung machine tower project, by identifying the factors causing delays, and the impacts that would occur due to delays in project development.

The method used in this survey uses questionnaires and interviews with experts/experts involved in a project. Supervision is carried out to owners & contractors who carry out construction on the Lampung machine tower.

Determination of the sample using confirmation / Judgment Sampling which is a non-probability sampling, the sample in this study was determined by the researcher with the

consideration that the sample can provide accurate and precise information. Limitations in this sample are personnel who are directly involved in the Lampung machine tower project

3.1 Research Concept

This literature study to assist in writing this thesis requires a lot of supporting literature, which serves as the development of insight and analysis. The required literature studies include: • Study of the construction process of the machine tower project in Lampung. Study on the project schedule according to the contract

a. Studies project management and risk reporting
b. Study of risk factors from previous research that
c. approximates what happened to a project.

3.2 Data collection techniques

1. Project studies for data collection in field studies are needed as material to support the hypothesis of the research conducted. The data to be processed is related to the evaluation of project performance material for analysis and the existing conditions of the machine tower project organization. Required data include:
   a) Initial schedule data and project development targets.
   b) Data report – monthly project to find out the events on the project.
   c) Data on the distribution of questionnaires to stakeholders involved in project development, namely Engineering drawing, civil, PPIC, and other divisions involved in the construction of a tower extension project belonging to an animal feed company.
   d) With the aim of obtaining the duration & scheduling probability for each activity in the project. Then interviewed the respondents, experts/experts related to project development to obtain the dominant risk indicators that will be analyzed, then interviewed with depth interviews to get their opinions
   e) For the management of questionnaire data which is a scheduling confirmation interview scale and with the interview, the results obtained are Pessimistic, Most Like and Optimistic, so the interview is very appropriate to be used for questionnaire data analysis in this study.
2. Work Breakdown structure, WBS is used to define and group the tasks of a project into small parts, so that they are easier to organize and know.

Figure 3.1 previous research

3. Identification of Activity Completion Time, Identification of activity completion time using a Triple duration estimate, which is a method of estimating time based on three types of duration as follows:
   a) Optimistic duration
   b) Most likely duration
   c) Pesimistic duration

   The type of duration above can be identified through the interview process and processed into such data.

Tabel 3.1 Sample

Subject	Function	Total Sample
Contractor	Project Manager	3
	Site Engineer	2
	Supervisor	1
	QC Engineer	2
	PPIC	1
	Supervisor Drawing	1
	Checker	2
	Drafter	4
Total Sampel		16

4. Modeling Program Evaluation and Review (PERT) is a network model capable of mapping random activity completion times. (PERT) was developed in order to create the space / potential for reducing the time and cost required to complete the project. Core modeling to add the following information
   a) Project completion period
   b) Possibility of project completion before the specified date,
   c) Critical activity stages, which can have a direct impact on project completion time,
   d) Activities that have relatively loose deadlines that should be managed as additional time for critical activity stages,
   e) Activity start date and activity end date (program period).

5. Research Simulation Model Development, data that has been obtained is then identified and translated. This research focuses on the identification of delay factors in the development process. Starting with creating a network on the implementation of the extension machine tower construction project, then analyzing the causes of the delay.

   The next step is to carry out a simulation that is being implemented by the existing condition company and continue with testing whether the simulation model is in accordance with the real conditions or not. if so, run the simulation for several times

until the results are valid. using a method of removing random numbers and then pairing the values in the parameters or data that have been compiled with existing random numbers. For practical reasons, the method that is often used to generate random numbers between 0 and 1 in simulations is called the multiplicative congruental method (Taha, 1997).

6. Monte Carlo simulation, calculating the distribution value of the impact. consists of the equation of a normal/abnormal distribution, namely the trend of the possible impact using the average value and standard deviation. after knowing the risk category the next step is to use quantitative analysis methods to compile the level of risk importance (importance level).
   In processing this data, 3 types of distribution are used based on fitting distribution data from the risk of delay. Here is the formula for the distribution used in @risk:
   • Triangular distribution = RiskTriang(min;likely;max)
   • Lognormal distribution = RiskLognorm(mean;stand.dev)
   • Exponential Distribution = RiskExpon(mean)

4. RESULTS AND DISCUSSION

This section encompassed compiling the work breakdown structure of the project, identifying the project execution time, PERT modeling, sample and research population, development of the monte carlo model, running model and project completion time.

4.1 Data Collection, using qualitative data collection methods. This data collection was carried out by conducting a Forum Group Discussion, which means that researchers hold joint discussions with expert judges to provide questions related to the completion of work items on the Lampung extend machine tower project.

4.2 Identification of Activity Schedule, the identified activities will then be clarified with timeline of each activity.
   a) Start, the date and day on which the activity in question begins.
   b) Finish, the date and day on which the activity in question is completed.
   identification of project completion time, namely
   a) Ideal Time Condition Data: is a single time data (single value) which implies the standard time of completion of work components in a project.
   b) Time Condition Data with Uncertainty: is time data that accommodates uncertainty based on certain distribution parameters.

4.2.1 Preparation of Work Breakdown Structure, to identify the type of work to be carried out. The first stage is to collect actual detailed information.

4.2.2 Identification of the Ideal Time (deterministic scheduling), The results of collecting the ideal time The identification of the thesis directs expert judgment to the parameter of duration and interviews are conducted with
   a. Interviews with several employees of PT HIJ who often work on similar projects/field people such as the job of extending the Lampung engine tower.

b. Interview with the Engineering/drawing team in terms of design planning, distribution of drawings and implementation for fabrication.
c. Interview with the workshop team in the half-fabrication of steel and ordering the required materials.

4.2.3 Identification of Project Work Sequences, carried out on the sequence of project work (sequence) through the mapping of predecessor activities, meaning activities that refer specifically to work schedule activities that are part of the project that determine or determine when the activities are determined by the project management team and or the management team leader project into logical successor activities can be started or terminated.

4.2.4 Project Network development, based on PERT principles, to map all components of project work. It is also used as a conceptual model base for the development of a simulation model on the aspect of time uncertainty.

4.3 Time identification with uncertainty (probabilistic scheduling), modeled as a probability distribution with certain parameters.

a) The Triangular distribution uses 3 parameters, namely A (the fastest time to complete the work), B (the most likely time to complete the work), and C (the longest time to complete the work).

4.4 Simulation Model Development for Time Uncertainty, developed based on the conceptual model and the data parameters obtained

$$X = \begin{cases} a + \sqrt{R\,(c-a)(b-a)}, for\ R \leq \dfrac{b-a}{c-a} \\ c - \sqrt{(1-R)(c-a)(-b+c)} \end{cases}$$

Dimana:

a = minimum value

b = most likely value

c = maximum value

R = random number (LCG)

4.4.1 Running the Monte Carlo Simulation Model, generates values for the variables in the model being tested. The simulation is then run with a number of replications of 10,000 and will be selected with the consideration that the number of replications is very representative of the simulation results.

4.5 Discussion, an experiment on the probability (or probabilistic) element using random sampling.

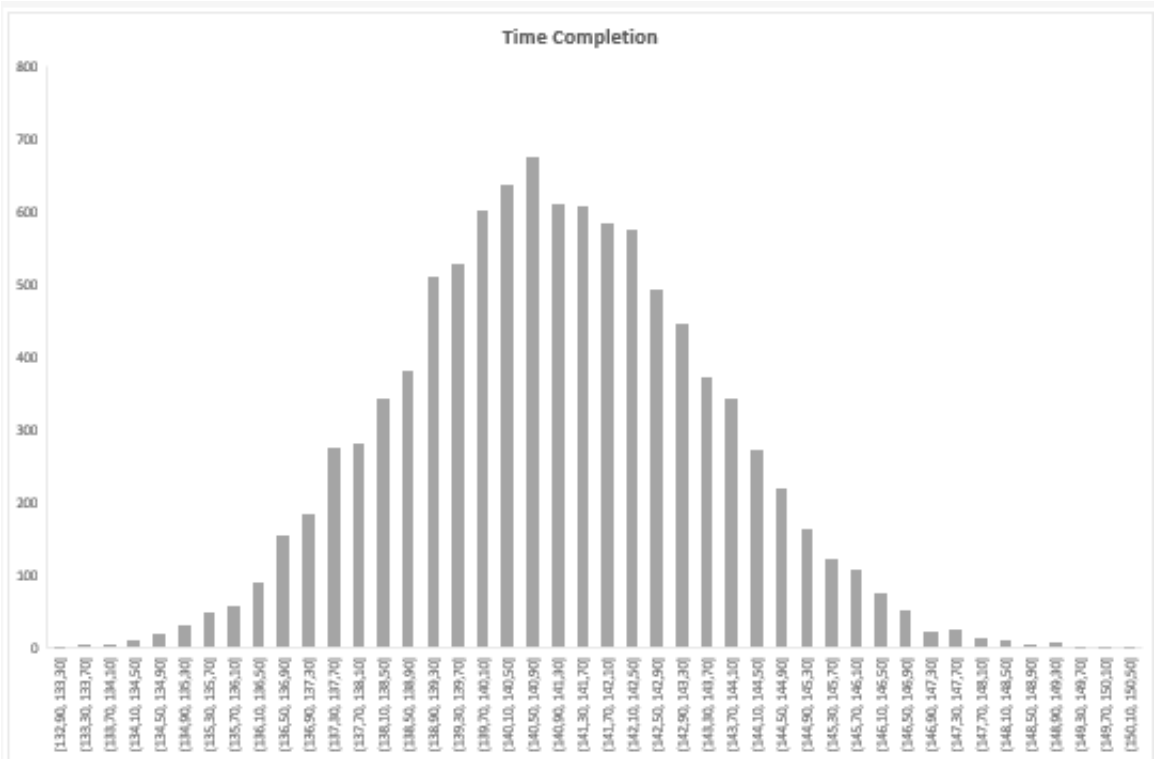

Figure 4.3 Simulation graph using the Monte Carlo method

Shows the output of running simulations that form a comparison curve between the time of project activities and the number of simulations that are run. from the more shapes to the experimental time curve, the more simulation experiments are carried out, which means the most probable time probability is applied to the project under study.

Table 4.5 Simulation result

Output Parameter	Time Completion
90% Probability Range	
Lower	137,04
Upper	145,16
5% Probability	< 137.04
5% Probability	> 145.16

Simulation results are obtained for the uncertainty of the project completion time, which is between 137 to 145 days with a probability of 90%. This probability allows the project lead time that could occur if applied successfully.

The probability of 5% is that the project is likely to be completed in less than 137 days or even the project execution time is slower or not in accordance with the simulation conditions. In this case, the project experienced a time delay.

The results of the analysis of the discussion of the Project Schedule that has been done by PT HIJ.

5. CONCLUSIONS AND SUGGESTIONS

5.1 Conclusion

Based on the results of simulations and analysis of existing models and scenarios that have been carried out by researchers, the following conclusions can be drawn, including the following:

1. Based on the results of the research, the optimistic duration of activity is 310 days, the most likely duration of activity is 405 days, and the optimistic duration is 461 days
2. work similar to the construction of the Lampung extend machine tower. The table above shows that if the completion target is longer than the range, then the probability is > 95%. Conversely, if < range, then the probability is 5%. The target of the project exceeds the specified range of 137-145 so the probability is 95%
3. In actual conditions, this machine tower building project is carried out by PT HIJ which is located in Lampung, South Sumatra, namely the completion time is more than the 90% probability requirement, which is 137-145 days.

5.2 Suggestions

The following is an explanation of suggestions for evaluation and recommendations at the company and for the academic level to assist further research, namely.

1. For further research, it is possible to expand the model limits to be more detailed in any conditions that result in project delays or other obstacles.

2. Added costs due to delays, costs if there is acceleration, costs if they are on target that need to be analyzed by further researchers.

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RISK ANALYSIS DUE TO DELAY IN MEZZANINE INSTALLATION AT PT. XYZ COMPANY USING THE MONTE CARLO METHOD SIMULATION

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I. INTRODUCTION

In the implementation of a project, it must be able to run well according to the plan, both in terms of specifications, design, funds, and time. Therefore, it is necessary to analyze the risk factors that may arise when project implementation is carried out. The most common thing is the problem of Time. In the machine mezzanine project at the company PT. XYZ is very important to be carried out according to the planned time because in this project a third party is involved, namely factory consumers and machine suppliers. Schedule arrival and installation must be on time Problems that arise can cause costs and production time to exceed planning and result in delayed fulfillment of orders to factory consumers. Therefore, a delay risk analysis needs to be done and one of them is using the Monte Carlo method. The purpose of this research is to find out the risks and find out how to avoid the risks that may occur so that the implementation of the project can go according to plan. The project is located at the Glue Factory in the Sidoarjo area. The analysis carried out by the Monte Carlo method includes Time Scheduling, and Technical / Work Methods in its implementation, including Human Resources to be assigned and the tools needed so that project activities go according to plan. The data used is the Mezzanine Machine Development Project Data at the Glue Factory in East Lingkar, Sidoarjo City, East Java. The expected result of this research is to know the factors causing the risk and be able to prepare the mitigation to be implemented in future projects so that it runs smoothly according to the plan.

Keywords: risk mitigation, Monte Carlo Method, Mezzanine Development Project.

2. LITERATURE REVIEW

2.1 Risk

A project both abroad and in Indonesia, both in government agencies and in the private sector, there must be a risk that occurs. Whether it's a risk that causes profit or loss. In this paper, what we want to examine is the risk that causes losses. Risk is a variation in many things that occur naturally in a situation (Fisk, 1997), in another theory it is said that risk is a threat to life, property or financial gain due to the danger that occurs (Duffied & Trigunarsyah, 1999). Or in general, risk is associated with the probability (probability) of the occurrence of events outside the expected (Soeharto, 1995). So it can be concluded here that risk is a variation in many things that may occur naturally or the possibility of an unexpected event occurring which is a threat to a project, property and financial benefits due to the hazard that occurs.

In general, risk can be classified according to various points of view depending on the needs in handling it (Rahayu, 2001).

3. METHOD

3.1 Research Procedure

This study aims to evaluate the aspects of uncertainty in the completion of the project which includes the uncertainty of cost and time. In the flow chart below, it is explained that the research begins with a study of the existing literature, then continues with the collection of a number of project data, from the project data identification is carried out with WBS (Work Breakdown Structure) with a focus on cost and time identification. After that proceed with making a model for simulation.

In simulation modeling, uncertainty modeling and simulation model development are made. The results can be analyzed from the modeling results and the data obtained so that the interpretation of the results can be made to draw conclusions from this research.

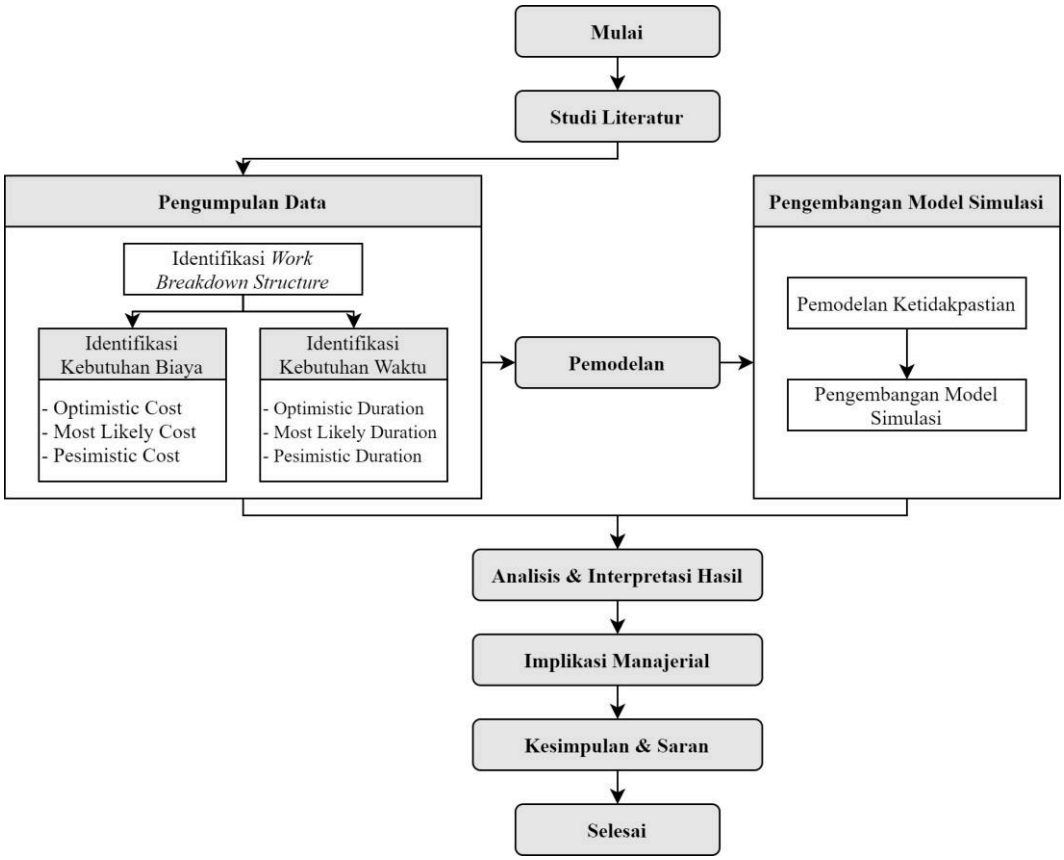

Figure 3.1 Research diagram

4. Result

4.1 Evaluasion *Work Breakdown Structure* project

4.2 Development of Project Completion Time Simulation Model

In the context of making probability distributions of parameters, triangular distribution is used in this study to accommodate the uncertainty aspect of completion time of each work component with optimistic, most likely, and pessimistic time parameters. While the random number used is a random number that is uniformly distributed between 1 to 0 which is generated through Microsoft Excel software. The following are the equations used in the simulation model to produce the triangular distribution.

Tabel 4.2 Simulation Model *Spreadsheet*

No	Activity	No	Name	Kebutuhan Waktu Kerja Satuan (Days)			Generated Time Completion
				A	B	C	
				Optimistic (Waktu Tercepat)	Most Likely (Waktu Paling Mungkin)	Pessimistic (Waktu Terlama)	
A	**Preleminary Work**	A-1	Cleanng area	2	3	4	3.71
		A-2	Prepare fasilities and infrastructrure	1	2	3	1.92
		A-3	Build Direksi Kit	2	3	4	3.50
		A-4	Mob-Demob equipment	2	3	4	3.81
		A-5	Install Uitset and bowplank	1	2	3	1.72
		A-6	Sewa Genset dan Molen serta Crane	1	2	3	1.70
B	**Excavation work**	B-1	Excavation Land	2	3	4	2.81
		B-2	Boor Pile	5	6	7	6.13
		B-3	Work floor	2	3	4	3.30
C	**Iron work**	C-1	Iron for Pile	3	4	5	3.69
		C-2	Iron for Pile cap	3	4	5	3.91
		C-3	Iron Sloof	3	4	5	4.33
		C-4	Install Wire Mesh	2	3	4	3.03

No	Activity	No	Name	Kebutuhan Waktu Kerja Satuan (Days)			Generated Time Completion
				A	B	C	
				Optimistic (Waktu Tercepat)	Most Likely (Waktu Paling Mungkin)	Pessimistic (Waktu Terlama)	
		C-5	Install Anchor	2	3	4	2.30
		C-6	Connector	2	3	4	2.60
D	**Concrete Work**	D-1	Concrete Strouss	1	2	3	1.76
		D-2	Concrete Sloof	1	2	3	2.16
		D-3	Floor Concrete	1	2	3	2.30
E	**Landfill**	E-1	Landfill after excavation work	1	2	3	2.71
F	**Steel Work**	F-1	Install Column - A	5	7	8	5.84
		F-2	Install Column - B	5	7	8	7.43
		F-3	Install Ring Bar / balok - A	4	6	8	5.68
		F-4	Install Ring Bar / balok - B	4	6	8	6.51
		F-5	Install Ring Bar / balok - C	4	6	8	4.58
		F-6	Install Ring Bar / balok - D	4	6	8	5.75
		F-7	Steel Plate	3	4	5	4.97
		F-8	Steel Plate	3	4	5	4.06
		F-9	Bondex Plate	2	3	4	2.99
		F-10	Install bolt	2	3	5	2.97
G	**Painting**	G-1	Base coat Steel	3	4	5	4.44
		G-2	Finishing coat	3	4	5	3.92
H	**Fence**	H-1	Access Fence	6	8	10	8.00
		H-2	Foot Plate	1	2	3	2.41
I	**Finishing**	I-1	Install Floor Ceramic	7	8	10	7.18
J	**Cleaning**	J-1	Cleaning	3	5	7	4.58

Tabel 4.3 Model Simulasi *Spreadsheet* Cost fungsion

No	Activity	No	Name	Kebutuhan Biaya (Rp)						Generated Cost Function	
				A		B		C			
				Kebutuhan Biaya paling Minimum		Kebutuhan Biaya paling Mungkin		Kebutuhan Biaya paling Maksimum			
A	**Preleminary Work**	A-1	Cleanng area	IDR	1,500,000.00	IDR	2,000,000.00	IDR	3,000,000.00	IDR	2,283,300.14
		A-2	Prepare fasilities and infrastructrure	IDR	5,000,000.00	IDR	7,500,000.00	IDR	10,000,000.00	IDR	8,199,725.64
		A-3	Build Direksi Kit	IDR	10,000,000.00	IDR	15,000,000.00	IDR	17,500,000.00	IDR	15,459,237.48
		A-4	Mob-Demob equipment	IDR	2,500,000.00	IDR	3,000,000.00	IDR	5,000,000.00	IDR	3,557,379.21
		A-5	Install Uitset and bowplank	IDR	3,000,000.00	IDR	5,000,000.00	IDR	7,500,000.00	IDR	5,954,035.89
		A-6	Sewa Genset dan Molen serta Crane	IDR	90,000,000.00	IDR	125,000,000.00	IDR	150,000,000.00	IDR	94,580,473.09
B	**Excavation work**	B-1	Excavation Land	IDR	12,000,000.00	IDR	15,000,000.00	IDR	20,000,000.00	IDR	13,421,698.14
		B-2	Boor Pile	IDR	24,000,000.00	IDR	36,000,000.00	IDR	40,000,000.00	IDR	35,592,152.69
		B-3	Work floor	IDR	7,200,000.00	IDR	10,800,000.00	IDR	14,400,000.00	IDR	9,465,565.46
C	**Iron work**	C-1	Iron for Pile	IDR	5,400,000.00	IDR	6,000,000.00	IDR	7,500,000.00	IDR	5,671,461.69
		C-2	Iron for Pile cap	IDR	7,500,000.00	IDR	10,000,000.00	IDR	12,500,000.00	IDR	10,809,093.72
		C-3	Iron Sloof	IDR	50,000,000.00	IDR	65,000,000.00	IDR	70,000,000.00	IDR	57,193,569.87
		C-4	Install Wire Mesh	IDR	60,000,000.00	IDR	90,000,000.00	IDR	120,000,000.00	IDR	83,698,648.20
		C-5	Install Anchor	IDR	12,000,000.00	IDR	15,000,000.00	IDR	17,000,000.00	IDR	15,443,491.90
		C-6	Connector	IDR	15,000,000.00	IDR	25,000,000.00	IDR	30,000,000.00	IDR	23,401,921.77
D	**Concrete Work**	D-1	Concrete Strouss	IDR	24,000,000.00	IDR	36,000,000.00	IDR	48,000,000.00	IDR	44,534,111.74
		D-2	Concrete Sloof	IDR	36,000,000.00	IDR	48,000,000.00	IDR	56,000,000.00	IDR	45,889,638.02
		D-3	Floor Concrete	IDR	50,000,000.00	IDR	60,000,000.00	IDR	70,000,000.00	IDR	66,949,158.35
E	**Landfill**	E-1	Landfill after excavation work	IDR	6,000,000.00	IDR	7,500,000.00	IDR	10,000,000.00	IDR	8,497,730.81
F	**Steel Work**	F-1	Install Column - A	IDR	90,000,000.00	IDR	96,000,000.00	IDR	102,000,000.00	IDR	92,084,099.97
		F-2	Install Column - B	IDR	96,000,000.00	IDR	100,000,000.00	IDR	110,000,000.00	IDR	100,898,521.04
		F-3	Install Ring Bar / balok - A	IDR	100,000,000.00	IDR	110,000,000.00	IDR	120,000,000.00	IDR	107,516,703.96
		F-4	Install Ring Bar / balok - B	IDR	120,000,000.00	IDR	130,000,000.00	IDR	135,000,000.00	IDR	124,428,560.72
		F-5	Install Ring Bar / balok - C	IDR	115,000,000.00	IDR	120,000,000.00	IDR	130,000,000.00	IDR	125,217,782.83

No	Activity	No	Name	Kebutuhan Biaya (Rp)						Generated Cost Function	
				A		B		C			
				Kebutuhan Biaya paling Minimum		Kebutuhan Biaya paling Mungkin		Kebutuhan Biaya paling Maksimum			
		F-6	Install Ring Bar / balok - D	IDR	110,000,000.00	IDR	120,000,000.00	IDR	125,000,000.00	IDR	115,812,625.29
		F-7	Steel Plate	IDR	30,000,000.00	IDR	40,000,000.00	IDR	50,000,000.00	IDR	39,753,539.21
		F-8	Steel Plate	IDR	25,000,000.00	IDR	30,000,000.00	IDR	35,000,000.00	IDR	28,995,771.06
		F-9	Bondex Plate	IDR	27,000,000.00	IDR	33,000,000.00	IDR	40,000,000.00	IDR	29,571,226.39
		F-10	Install bolt	IDR	5,000,000.00	IDR	7,500,000.00	IDR	10,000,000.00	IDR	6,576,857.42
G	**Painting**	G-1	Base coat Steel	IDR	3,500,000.00	IDR	5,000,000.00	IDR	8,000,000.00	IDR	6,059,331.46
		G-2	Finishing coat	IDR	10,000,000.00	IDR	12,000,000.00	IDR	15,000,000.00	IDR	12,493,809.28
H	**Fence**	H-1	Access Fence	IDR	30,000,000.00	IDR	35,000,000.00	IDR	37,000,000.00	IDR	31,568,637.51
		H-2	Foot Plate	IDR	4,000,000.00	IDR	5,000,000.00	IDR	6,000,000.00	IDR	4,739,804.54
I	**Finishing**	I-1	Install Floor Ceramic	IDR	18,000,000.00	IDR	20,000,000.00	IDR	22,000,000.00	IDR	20,938,472.53
J	**Cleaning**	J-1	Cleaning	IDR	8,000,000.00	IDR	10,000,000.00	IDR	12,000,000.00	IDR	9,443,891.38

Tabel 4 Simulation Model Output Recapitulation

Output Parameter	Time Completion (Days)
90% Probability Range	
Lower	71.64
Upper	79.53
5% Probability	< 71.64
5% Probability	> 79.53

Tabel 5 Rekapitulation Output Model Simulasi Cost fungsion

Output Parameter	Cost (IDR)
90% Probability Range	
Lower	IDR 1,406,458,344.69
Upper	IDR 1,481,009,591.30
5% Probability Range	< IDR 1,406,458,344.69
5% Probability Range	> IDR 1,481,009,591.30

$$X = \begin{cases} a + \sqrt{R\,(c-a)(b-a)}, for\ R \leq \dfrac{b-a}{c-a} \\ c - \sqrt{(1-R)(c-a)(-b+c)} \end{cases}$$

a = *minimum value* (*optimistic duration*)

b = *most likely value (most likely duration)*

c = *maximum value* (*pessimistic duration)*

R = *random number* (Uniform – 0,1)

6. CONCLUTION

The simulation was carried out with 1000 replications and the project completion time profile was obtained as follows:

• 90% chance that the project can be completed within 71.64 to 79.53 days.

• 5% chance that the project can be completed in less than 71.64 days.

• 5% chance that the project can be completed in more than 79.53 days.

Meanwhile, the following results are obtained related to the profile of project completion costs.

• 90% probability that the project can be completed with a cost of between Rp. 1,406,458,344.69 to Rp. 1,481,009,591.30.

• 5% probability that the project can be completed with a cost requirement of less than Rp. 1,406,458,344.69.

• 5% probability that the project can be completed with a cost of more than Rp 1,481,009,591.30.

The project completion time profile obtained from the simulation results shows that the probability distribution of the dominant project completion time is less than 3 months effective. There is only a 5% possibility where the project completion time is more than 79.53 days. In principle, the need for a project completion time of 3 months has also taken into account the aspect of tolerance for uncertainty. However, this value only implies a single value and does not provide a comprehensive profile or description of the probability distribution. Meanwhile, the profile of the total project cost requirement shows that the total cost requirement may exceed the reference base of Rp 1,455,300,000. There is a possibility of about 30% where the project cost requirement will exceed the reference cost and there is a 5% possibility where the project cost requirement may exceed Rp 1,481,009,591.30.

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ANALYSIS OF COMMUNITY SATISFACTION MEASUREMENT INSTRUMENTS OF SERVICE UNIT USERS IN XYZ UNIVERSITY ENVIRONMENT

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ABSTRACT

Public services carried out by XYZ university service unit are currently felt to have not met community expectations. If not handled, the complaint has a destructive impact on XYZ university. The Community Satisfaction Index (IKM), using the material of permen PANRB survey material no. 14 of 2017, is one of the methods used to determine the quality of public services through public perception. This type of research is observational research with data retrieval methods using cross-sectional approaches and probability random sampling techniques. The study population consisted of 111 respondents from the Academic Community of XYZ University. Surveys are circulated online at service units within XYZ University. Multiple linear regression analysis is used to analyze the collected data. The findings revealed that system variables, mechanisms, and procedures had a positive and significant effect on service satisfaction; variable facilities and infrastructure, costs/tariffs, the competence of implementers, product specifications of service types, completion time has a positive and insignificant effect on service satisfaction; varying requirements, the conduct of implementers and complaint handling, suggestions and inputs have a negative and little impact on service satisfaction; varying needs, the behaviour of implementers and complaint handling, suggestions and inputs have an adverse and negligible effects on service satisfaction; This demonstrates that data and information obtained from respondents about the level of community satisfaction can be used as an instrument of assessment and evaluation of public service performance in the XYZ university environment in order to improve the quality of public services based on the needs and expectations of public service recipients.

Keywords: *IKM, Questionnaire, Permen PANRB, Service Unit*

1. INTRODUCTION

The public service organizing unit is a work unit in a government agency that directly provides services to public service recipients (Menpan No.63 / KEP / M.PAN / 7/2003). As public service providers, Government Agencies are responsible and continue to strive to provide the best service to the community (Widyanti, 2014). To date, public services to students, stakeholders, and the general public service users at XYZ University have been running smoothly but still do not fully meet the quality or satisfaction expected by service users. Therefore, it is necessary to measure the success rate of services in a community satisfaction index survey (IKM) / Evaluation of service user satisfaction. In 2019, XYZ University conducted a service user satisfaction survey adjusted to the latest regulations, namely PERMENPANRB No: 14 of 2017 on Guidelines for The Preparation of Public Service Organizing Unit Community Satisfaction Survey. The method of processing the value of IKM is guided by how the value of IKM is calculated under the regulation. IKM survey results have decreased, as shown in the table below:

Table 1. Community Satisfaction Index (IKM) survey per Faculty 2019

No	Faculty	IKM Value	Quality of Service
1	Medicine	67.53	**C**
2	Dentistry	70.76	**C**
3	Law	60.59	**D**
4	Economics & Business	73.26	**C**
5	Pharmacy	68.54	**C**
6	Veterinary Medicine	62.25	**D**
7	Social Sciences & Political	73.08	**C**
8	Science & Technology	67.25	**C**
9	Public Health	69.56	**C**
10	Psychology	71.87	**C**
11	Cultural Science	62.62	**D**
12	Nursing	67.62	**C**
13	Fisheries & Marine	66.23	**C**
14	Vocational	64.01	**D**

Good quality of service is not based on the point of view or perception of service providers and/or services but on consumer perceptions and rules or regulations about the quality of service. (Gómez-Cruz, et al, 2020). If the service provided is in accordance with what is expected by service users, then it can be said that the service is a quality service. Conversely, if the service provided is not in accordance with the expectations of service users, then it can be said that the service is not qualified. The need for a survey measuring community satisfaction with higher education services is critical in this study because a community service unit is the spearhead of service (street level bureaucracy), which is owned by each work unit in bringing its services closer to students / communities that are widespread in their work area. (Bauer, M., et al, 2020). Furthermore, this study is intended as part of the evaluation that XYZ University must know about the effective and efficient community service currently run. Recommendations from the survey are expected to provide an overview and then be implemented to improve the quality and quantity of community services.

2. LITERATURE REVIEW

2. 1. Public Service Theory.

According to Law No. 25/2009, Chapter I, Article 1, paragraph (1), the understanding of public service is an activity or series of activities to meet the needs of services following the laws and regulations for every citizen and resident of goods, services, and/or administrative services provided by public service providers. In customer-oriented public servants(Chen, C.-K., et al,2006), this study proposes an organizational change model to address performance gaps using a three-phase approach: evaluation, reevaluation and action.

2. 2. Customer Satisfaction Theory.

Customer satisfaction is described "as a subjective assessment of the customer" of the consumption experience, based on the relationship between customer perception and objective characteristics of the product" (Pizam A et al., 2016). According to Kotler and Armstrong (2015) customer satisfaction refers to a person's feeling of pleasure or disappointment as a result of comparing the performance of the perceived product to the expected performance (or results). Instead of exploring cognitive outcomes, customer satisfaction is considered an adequate measure of the usefulness of a product or service provided by a customer (Berezina et al., 2012). According to Permen PanRB number 14 of 2017, Service Satisfaction is the result

of public opinion or assessment of the performance of services that the public service organizing apparatus will provide.

2. 3. Relationship of Quality of Service with Customer Satisfaction

There are indicators of consumer satisfaction measures that lie in the five dimensions of service quality based on what consumers say to determine the quality of service that consumers feel (Parasuraman et al., 1988; Shokouhyar, S, et al., 2020) Tangibles, Reliability, Responsiveness, Assurance and Empathy. According to Kotler, P., (2019) defines the quality of service is a form of consumer assessment of the level of service received with the level of service expected. If the service is received or felt as expected, the service quality is regarded as excellent and satisfactory.

2. 4. Research Framework

Referring to Permenpan RB number 14 of 2017 9 independent variables will be studied significantly. While the performance of public services is a dependent variable or variable that is affected. Independent variables or free variables are variables that affect the cause of changes in the emergence of dependent variables (Y), Sugiyono (2011:64); this research framework can be seen in Figure 1 below :

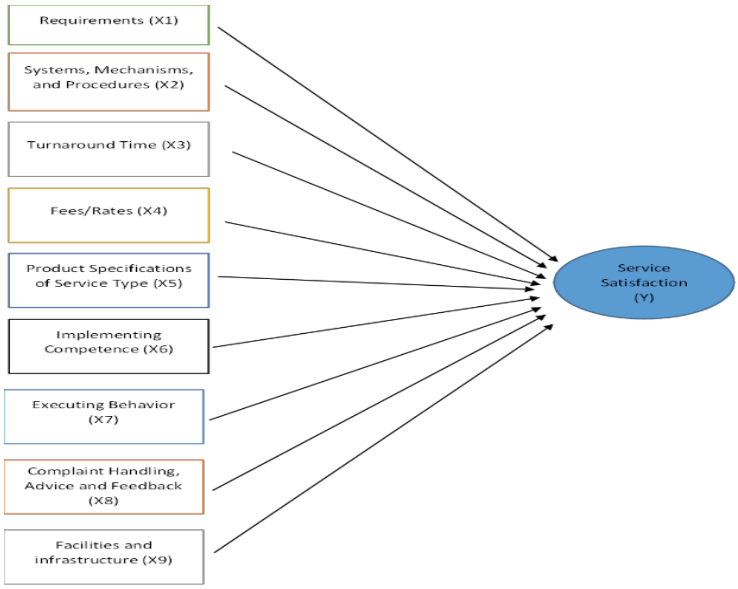

Figure 1 Research Framework

2. 5. Hypothesis

The study developed 9 (nine) hypotheses based on the framework and description of previous research:

a. Does the requirement element (X1) positively and significantly impact service satisfaction?
b. Does elements of Systems, mechanisms, and Procedures (X2) positively and significantly impact service satisfaction?
c. Does the Completion Time (X3) element positively and significantly impact service satisfaction?
d. Does the cost/Tariff Element (X4) positively and significantly impact service satisfaction?
e. Does Product Element Service Type Specification (X5) positively and significantly impact service satisfaction?
f. Does implementing Competency Element (X6) positively and significantly impacts service satisfaction?

g. Does implementing Behavior Element (X7) positively and significantly impacts service satisfaction?
h. Complaint Handling, Advice and Input (X8) element has a positive and significant impact on service satisfaction?
i. Does the Facilities and Infrastructure Element (X9) positively and significantly impact service satisfaction?
j. How far does independent variable (X) influence simultaneously affect dependent variables (Y)?

3. METHODS

The study was quantitative and used primary data collected through online surveys with causal relationships between variables.

A. Population and Sample

The population of this study is the Academic Community of service users who are located in 5 Service Units in XYZ University environment. This type of research is an observational study with data retrieval methods using a cross-sectional approach and probability random sampling techniques. The number of samples is determined using the formula Kep/25/M.PAN/2/2004 and involves 111 samples.

B. Data Collection Methods

The data used as the basis for hypothesis testing is primary data collected from XYZ university's Academic Community of service users. The data was collected through online questionnaires. In this study, researchers received recommendations from institutions where the health research ethics commission with information passed the ethics review no. 2381-KEPK. The study has fulfilled the ethical principle of human beings as a subject of research (KEPPKN Guidelines 2017: 68). The likert scale, in which respondents expressed a degree of agree or disapproval (good or bad) about various statements about behavior, objects, people, or events (Cheng, C., et al.2021).

C. Data Analysis Methods

The data analysis includes test research instruments, classical assumption tests, multiple regression analysis, and hypothesis tests. The data is processed using the Windows version of the statistical application.

4. RESULTS

4.1 Test Results validity and reliability

Table 2. Variable Item Validity Test Results

Indicator	r count	r table	Information
X1	0,690	0,1865	Valid
X2	0,951	0,1865	Valid
X3	0,866	0,1865	Valid
X4	0,561	0,1865	Valid
X5	0,813	0,1865	Valid
X6	0,766	0,1865	Valid
X7	0,814	0,1865	Valid
X8	0,850	0,1865	Valid
X9	0,750	0,1865	Valid
Y	0,752	0,1865	Valid

Source: SPSS Primary Data 25 (2021)

From the results of the validity test in the table above, the questionnaire containing 10 variables can be seen that $r_{count} > r_{table}$ so that it can be stated all variable items are valid.

Table 3 Reliability test results against Independent variables (X)

Total Reliabel Independent

Cronbach's Alpha	N of Item
.898	9

Source: SPSS Primary Data 25 (2021)

The reliability test results on variable (X) can be seen that Cronbach's alpha in this variable is higher than the standard value of 0.898 > 0.60. The results prove that all statements in the variable questionnaire (X) are declared reliable.

Table 4 Reliability test results against dependent variables (Y)

Item Dependent variables (Y)	
Cronbach's Alpha	N of Items
.623	3

Source: SPSS Primary Data 25 (2021)

Table 4 shows the result of the reliability test on the second variable or dependent variable (Y). The resulting value of this variable is 0.623, indicating that cronbach's alpha 0.623 > 0.60. Based on these findings, it is possible to conclude that all statements about this variable are reliable or trustworthy.

4.2. Classic Assumption Test

4.2.1. Normality Test

Table 5 One-Sample Data Normality Test Kolmogorov-Smirnov Test

		Unstandardized Residual
N		111
Normal Parameters[a,b]	Mean	0.1944409
	Std. Deviation	2.01769778
Most Extreme Differences	Absolute	0.069
	Positive	0.053
	Negative	-0.069
Test Statistic		0.069
Asymp. Sig. (2-tailed)		.200[c,d]

Source: SPSS Primary Data 25 (2021)

Based on the results in Table 5, the significance level above 0.05 is 0.200. This means that the residual data follows a normal distribution. It can also be explained by the following graphical results, namely the Normal Probability plot graph :

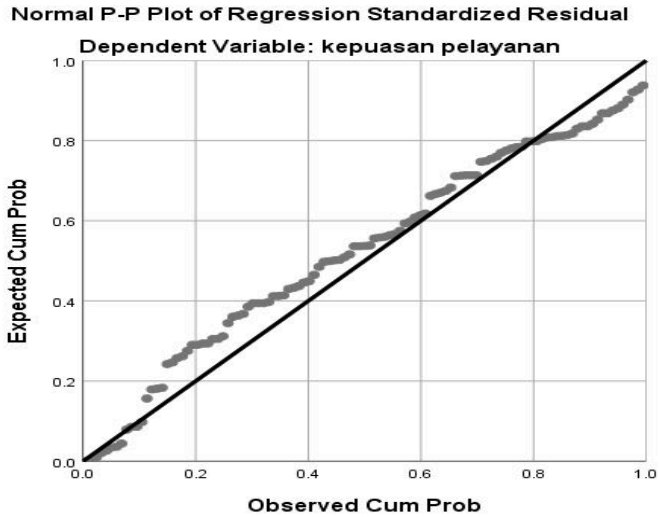

Figure 2. Normal Probability Plot Graphic

The basis for decision-making from normal probability plot analysis is as follows: if the data spread around the diagonal line and follows the direction of the diagonal line indicating a normal distribution pattern, then regression meets the assumption of normality.

4.2.2 Heteroskedasticity Test

A good regression model does not occur heteroskedasticity (Ghozali, 2016).

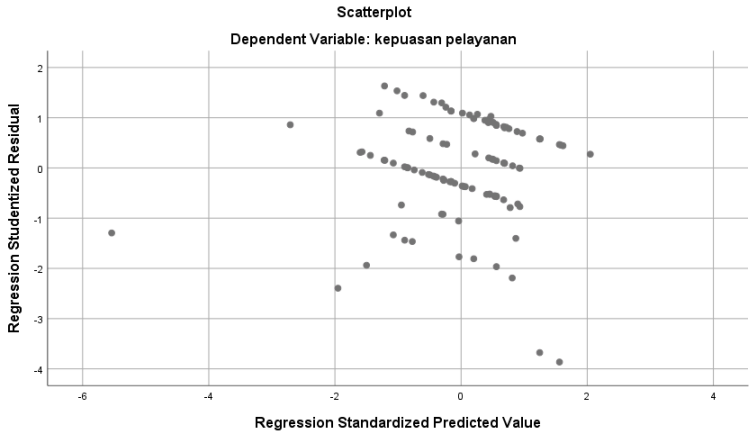

Figure 3 Results of Heteroskedasticity Test Scatterplot Graph

The scatterplot graph above shows that the points are randomly distributed and spread above and below the number 0 (zero) on the Y axis. It can be concluded that the regression model used exhibits no signs of heteroskedasticity.

4.2.3 Multicollinearity Test

Table 6 Multicollinearity Test Results

Model	Collinearity Statistics	
	Tolerance	VIF
(Constant)		
Requirement	0.555	1.801
Systems, mechanisms, and procedures	0.155	6.469
Turnaround Time	0.285	3.51
Fees/Rates	0.696	1.438

Product Specifications of Service Type	0.385	2.594
Implementing Competence	0.415	2.407
Executor Behavior	0.324	3.085
Complaint Handling, Suggestions and Feedback	0.29	3.446
Facilities and Infrastructure	0.464	2.153

Source: SPSS Primary Data 25 (2021)

Table 6 above are all free variables with a VIF value of < 10 and a tolerance > 0.10. So it can be concluded that there is no deviation of the classic assumption of multicollinearity between free/independent variables in the model. This result means that the data can be further analyzed using multiple linear regression analysis.

4.3. Data Analysis Methods

This test is performed to find out whether all independent variables either simultaneously or partially affect dependent variables with the Multiple Linear Regression test and the Coefficient of Determination (R^2) Test (Stockemer D., 2019).

4.3.1. Multiple Linear Regression Test

Table 7 Partial Test Results

Model	Unstandardized Coefficients	
	B	Std. Error
(Constant)	11.210	1.039
Requirement	-0.130	0.233
Systems, mechanisms, and procedures	0.518	0.152
Turnaround Time	-0.323	0.174
Fees/Rates	0.341	0.169
Product Specifications of Service Type	0.300	0.304
Implementing Competence	0.092	0.291
Executor Behavior	0.467	0.371
Complaint Handling, Suggestions and Feedback	0.200	0.208
Facilities and Infrastructure	0.214	0.139

Source: SPSS Primary Data 25 (2021)

Based on the results of the multiple linear regression test in Table 7 above, the regression equation is obtained as follows:

$\hat{Y}= 11.210 - 0.13X_1+0.518X_2 - 0.323X_3 + 0.341X_4 + 0.300X_5 + 0.092X_6 + 0.467X_7 + 0.200X_8 + 0.214X_9$

The above formula can be explained as follows:

a. **The constant value** of 11,210 indicates that variables $X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8., X_9$ if the value is 0, then service satisfaction (Y) has a performance level of 11,210
b. **Elements that positively** affect variable Y are Facilities and Infrastructure, Costs / Tariffs, Implementing Competencies, Service Type Specification Products, Implementing Behavior, Complaint Handling, Advice and Input, Systems, Mechanisms, and Procedures
c. **The negatively** influential elements are the Terms and Time of completion.

4.3.2. Coefficient of Determination (R^2)

Table 8 Partial Test Results

Summary Coefficient DeterminationTest				
Model	R	R Square[b]	Adjusted R Square	Std. Error of the Estimate
1	.989[a]	0.978	0.976	2.105

Source: SPSS Primary Data 25 (2021)

The table above shows that the magnitude of the coefficient of determination (Adj. R^2) is 0.976. This means that the contribution of Facilities and Infrastructure, Costs / Tariffs, Requirements, Implementing Competencies, Service Type Specification Products, Turnaround Time, Implementation Behavior, Complaint Handling, Advice and Input, Systems, mechanisms, and procedures to Service Satisfaction is 97.6%. In comparison, the remaining 0.4% is not disclosed in this study.

4.4. Hypothesis Test

The analysis technique is carried out using the statistics app for windows with a T (t-test), F test (F-test) with a signification rate (α) of 5%.

4.4.1. Individual Parameter Significance Test (Test t)

Table 9 Partial Test Results

Model	t	Sig.
Requirement	-0.383	0.702
Systems, mechanisms, and procedures	2.383	0.019
Turnaround Time	-1.288	0.201
Fees/Rates	1.385	0.169
Product Specifications of Service Type	0.677	0.500
Implementing Competence	0.216	0.830
Executor Behavior	0.874	0.384
Complaint Handling, Suggestions and Feedback	0.670	0.504
Facilities and Infrastructure	1.063	0.290

Source: SPSS Primary Data 25 (2021)

From sig table. The above can be interpreted as follows:

a. The requirements have no effect on service satisfaction with sig. (0.702) > to a α = 5%
b. Systems, mechanisms, and procedures significantly affect service satisfaction with sig. (0.019) < to an α = 5%, the quality of systems and services significantly affects the perception of ease of use (Xu, F. and J.T. Du, 2018)

c. Completion time has no effect on service satisfaction with sig. (0.201) > to α = 5%
d. Cost/rate does not affect the satisfaction of service with sig. (0.169) > to a rate of α = 5%, it is necessary to understand the importance of cost perception and customer response to service costs as relevant factors that influence their reaction to service use (Dominique-Ferreira et al. 2016, p. 328)
e. Product Specification Type of Service does not affect service satisfaction with sig. (0.500) > to a α = 5%
f. The competence of the Executor has no effect on the satisfaction of service with sig. (0.830) > to a α = 5%
g. The behaviour of the Executor has no effect on service satisfaction with sig. (0.384) > to a α = 5%
h. Handling complaints, suggestions and inputs have no effect on service satisfaction with sig. (0.504) > to a α = 5%
i. Facilities and infrastructure have no effect on service satisfaction with sig. (0.290) > to α = 5%

4.4.2. Test Results F (Simultaneous)

Table 10 Simultaneous Tests

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	19955.982	9	2217.331	500.351	.000[c]
Residual	452.018	102	4.432		
Total	20408.000[d]	111			

Source: SPSS Primary Data 25 (2021)

Table 10 shows that the independent variable has a P-Value of 0.000, indicating that the probability value is less than 0.05. As a result, it is possible to conclude that the variables Facilities and Infrastructure, Costs / Tariffs, Requirements, Implementing Competencies, Product Specifications of Service Types, Turnaround Times, Executing Behaviors, Complaint Handling, Advice and Inputs, Systems, Mechanisms, and Procedures all have an impact on service satisfaction.

4.5. Results of Preparing a Community Satisfaction Index

Table 11 Quality of Service Categorization (Permen PANRB 14 of 2017)

Perception Values	Interval Value	Conversion Interval Value	Quality of Service (x)	Service Unit Performance (y)
1	1,00-2,59	25,00-64,99	D	Bad
2	2,60-3,06	65,00-76,60	C	Less Good
3	3,07-3,53	76,61-88,30	B	Good
4	3,54-4,00	88,31-100,00	A	Excellent

Table 12 Processing data of Community Satisfaction Survey (Permen PANRB 14 of 2017)

PROCESSING SURVEY DATA ON COMMUNITY SATISFACTION OF EACH RESPONDEN AND EVERY ELEMENT OF SERVICE

NO. RESP	SERVICE ELEMENT VALUE														
	U1	U2				U3		U4	U5	U6	U7	U8		U9	
(0)	(1)	(2)	(13)	(14)	(15)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1	3	3	4	3	3	2	3	3	3	3	3	3	3	4	3
2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
3	4	4	4	4	4	4	3	3	4	4	4	4	4	3	4
4	4	3	3	3	4	3	3	5	3	3	3	3	4	4	3
5	3	3	3	3	4	3	3	3	3	3	3	3	4	3	3
6	5	4	4	4	4	4	4	5	4	4	4	4	4	3	3
7	3	3	4	4	4	4	4	5	4	4	4	4	4	4	4
8	3	3	4	4	4	4	3	3	4	3	3	3	4	4	4
9	4	4	4	4	4	4	4	5	4	5	4	4	4	5	5
10	5	4	3	4	4	4	3	3	5	5	4	4	4	3	3
11	4	4	4	4	4	4	4	5	4	4	4	4	4	3	4
12	3	4	4	4	4	3	3	3	4	4	4	4	4	4	4
13	4	3	4	5	4	4	3	5	4	5	5	5	4	3	3
14	3	3	3	4	4	3	3	3	3	3	4	3	4	3	4
15	3	3	3	4	4	3	3	3	3	3	3	3	4	3	4
16	3	4	4	3	3	3	4	5	3	4	4	3	4	3	4
17	5	4	4	4	4	4	4	3	4	4	4	4	4	4	4
18	3	4	5	5	5	5	5	3	4	3	5	5	5	3	5
19	3	3	4	3	4	3	4	3	3	4	4	3	4	5	4
20	4	4	4	4	4	4	4	4	4	5	5	5	5	4	4
21	5	5	4	5	5	4	4	4	4	5	5	4	4	5	5
22	3	4	4	4	4	4	4	3	4	4	4	4	4	4	4
23	4	4	4	4	4	4	4	4	5	4	4	5	4	4	4

NRR/unsur (tambahan sub unsur)	3.740	3.900	3.750	3.880	3.800	4.000	3.980	3.920	3.870	
NRR tertbg/ unsur	0.415	0.433	0.416	0.431	0.422	0.444	0.442	0.435	0.430	*) 3.867
Service unit IKM Conversion Results										**) **96.681**

Information :
- U1 s.d. U14 = Service elements
- NRR = Average value
- IKM = Community Satisfaction Index
- *) = Number of IKM-weighted NRR
- -**) = Weighted NRR Number x 25

NRR Element = Number of values per element divided Number of questionnaires filled

NRR tertimbang Element = NRR per element x 0,111

No.	SERVICE ELEMENTS	VALUE
U1	Requirement	3.740
U2	Procedure	3.900
U3	Service time	3.750
U4	Fees/rates	3.880
U5	Service products	3.800
U6	Implementing competence	4.000
U7	Executor behavior	3.980
U8	Service Information	3.920
U9	Complaint Handling	3.870

SERVICE UNIT IKM (conversion results) : 96.681

Mutu Pelayanan :
A (Very Good) : 88,31 - 100,00
B (Good) : 76,61 - 88,30
C (Less Good) : 65,00 - 76,60
D (Bad) : 25,00 - 64,99

From Table 12 it can be seen that the element that has the highest Average Value (NRR) is the competency element implementing an average value of 4.0 with conversion of service quality value A such as table.11,while the element with the lowest Average Value(NRR) is the element requirement of average value 3.74 with conversion of service quality value A . Service elements that have received an average Community Satisfaction Index value of 96.68 (Very Good) illustrates that the public's assessment of these services is generally very good with these service elements. This figure shows that the highest level of service satisfaction is obtained from the competence of implementers where the service is provided and received in accordance with the provisions that have been established and managed properly.

5. CONCLUSIONS AND SUGGESTIONS

5.1 Conclusions

a. In general, the quality of public services in the archival service unit at XYZ university is perceived very well by public service applicants. This is seen from the Community Satisfaction Index (IKM) obtained which ranges from 88.31-100.00. IKM value obtained in 9 service elements is 96.68 (Very Good)
b. System variables, mechanisms, and procedures have a positive and significant effect on service satisfaction while the variables of facilities and infrastructure, cost / tariff, competence of implementers, product specifications of service types, completion time have a positive and insignificant effect on service satisfaction; variable requirements, conduct of implementers and complaint handling, suggestions and inputs negatively and insignificantly affect service satisfaction.
c. Contribution coefficient of determination of Facilities and Infrastructure, Cost / Tariff, Requirements, Competence of Implementers, Product Specifications of Service Type, Completion Time, Implementation Behavior, Complaint Handling, Advice and Input, Systems, mechanisms, and procedures to Service Satisfaction is 97.6%, while the remaining 0.4% is not disclosed in this study.

5.2 Suggestions

a. Further research is expected to expand the scope of service units at XYZ university used as research samples and increase the research period so that the research sample is more extensive and gets better research results.
b. After obtaining the results of SKM data processing, it is necessary to analyze the elements surveyed, both technical and non-technical as a whole, to describe the objective consequences of the SKM itself.

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MAPPING THE MATURITY OF THE PROCUREMENT OF GOODS/SERVICES WORK UNIT (UKPBJ) (CASE STUDY: UKPBJ REGION OF RIAU ISLANDS PROVINCE)

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ABSTRACT

Procurement aims to achieve economic benefits, not only for regional officials as users but also for the community, as well as reducing negative impacts on the environment. The Procurement Unit (UKPBJ) is needed to serve and handle the procurement process. Various procurement problems in the regions, such as ineffective and efficient procurement, low quality of procurement have the potential to reduce UKPBJ performance. On the other hand, the condition of resources, management, and infrastructure causes the maturity level of UKPBJ to be different from one another. UKPBJ Maturity Level measurement will be carried out using the UKPBJ maturity instrument. A total of 8 UKPBJs located in the Riau Islands Province were used as research objects. The results are then mapped graphically to see the maturity level of UKPBJ. UKPBJ which is included in the proactive level is UKPBJ Batam, it has carried out the procurement function oriented to meeting customer needs through collaboration. UKPBJ at the essential level, namely UKPBJ Riau Islands Province, Bintan, Anambas Islands, Lingga, and Tanjung Pinang means that UKPBJ focuses on basic functions in the election process. There are two UKPBJs that are at the initiation level, namely UKPBJ Karimun and Natuna Regency.

Keywords: Procurement, UKPBJ, Maturity Level, Mapped

1. INTRODUCTION

Government procurement has an important role in the implementation of national development to improve public services and develop the national and regional economy. Currently, procurement has a trend of being carried out in a sustainable manner that can provide the maximum value of benefits. Sustainable procurement is a procurement that aims to achieve a beneficial value that is economically beneficial not only for Ministries/Institutions/Regional Apparatuses as users but also for the community, as well as significantly reducing negative impacts on the environment in its entire use cycle. Optimum procurement has a positive effect on the implementation of government duties and functions. The procurement function plays an important role in the process of providing facilities and infrastructure. Therefore, there will be a need to improve the quality and quantity in the procurement of government goods/services.

The government through Presidential Regulation Number 16 of 2018 concerning the Procurement of Goods/Services The government has regulated and formed a special organization that handles the process of procuring government goods/services in the form of the Goods/Services Procurement Work Unit (UKPBJ). UKPBJ is a unit that functions to carry out the Procurement of Goods/Services in K/L/PD which is permanent. UKPBJ can stand alone or be attached to an existing unit. UKPBJ conditions vary from one agency to another. This diversity can be seen from

the institutional or organizational side. Some UKPBJs have been formed as their own structural unit and some are attached to existing structural units or called ex-officio. Likewise, some working group members have permanent status, but on the other hand, there are still working group members who serve as employees in other units/work units.

The Goods/Services Procurement Unit (UKPBJ) is a work unit in the Ministry/Institution/Local Government which is the center of excellence for the Procurement of Goods/Services (Perpres No. 16 of 2018). UKPBJ as a center for procurement excellence has characteristics such as strategic, collaborative, performance-oriented, proactive and able to make continuous improvements. The way to ensure continuous improvement is to apply a maturity level model which is a measure of improvement. Problems often occur in the procurement of goods/services such as procurement that is not effective and efficient, the weakness of the supervisory function which results in the low quality of procurement of goods/services in government institutions, including UKPBJ in the Riau Islands Province. The procurement function plays an important role in the process of providing facilities and infrastructure to government agencies. An established organization with the right processes and strategies as well as the use of information technology are key factors for improving this performance (Suliantoro, Nadiya, et al. 2020).

The diversity of problems in UKPBJ has the potential to reduce organizational performance, especially UKPBJ located in the Riau Islands Province, this needs to be minimized so it is necessary to map UKPBJ to see the condition of UKPBJ in the province. Mapping can be done through performance measurement. Performance measurement is carried out to find out performance indicators that are still considered low so that they can be improved to improve public services. LKPP as a supervisory agency has compiled a study on measuring the level of organizational maturity. Through this maturity measurement activity, an existing condition of the UKPBJ organizational capacity can be mapped. Furthermore, based on the results of the mapping, a road map for UKPBJ capacity development can be drawn up for each K/L/PD.

Organizational maturity is a management process carried out in order to produce a high-quality product. In organizational maturity there are levels that are arranged sequentially or sequentially. Each maturity level is characterized by a characteristic that occurs in the organization. The process to achieve each level is carried out in stages, meaning that each level to be achieved must pass through the characteristics of the organizational processes below it. The variable measured in organizational maturity is the area of the management process that is the activity of the organization. In the UKPBJ organization there are 4 (four) process areas or variables in carrying out their duties and authorities. Furthermore, each variable is broken down into several sub-variables. Each sub variable is described into several indicators that show the level of organizational maturity. The process of measuring the maturity level in UKPBJ is done by assessing the condition of each sub-variable based on indicators.

Seeing the development of the procurement of goods/services in the future which is increasingly complex as well as very important roles and functions in implementing good governance, professionalism in increasing the organizational capacity of UKPBJ is something that must be implemented. Therefore, in order to develop the capacity and professionalism of UKPBJ towards ideal conditions, it is necessary to measure and map the level of maturity of the UKPBJ organization. By knowing the maturity level of UKPBJ, strategies and steps to be taken to increase UKPBJ capacity can be prepared and mapped appropriately.

This study aims to map UKPBJ in the Riau Islands Province based on the maturity level of UKPBJ. Based on this mapping, it is hoped that UKPBJ in the Riau Islands Province can improve

its performance to provide better services in the procurement of government goods and services, especially in the Riau Islands Province. Based on the background that has been described, the formulation of the problem in this study is:

1. What is the maturity condition map for the Goods/Services Procurement Unit (UKPBJ) based on the UKPBJ Maturity Level Measurement Model?
2. What should be done to improve the maturity and performance of UKPBJ in the Riau Islands Province, in order to provide optimal services to the government and the community and how to evaluate the maturity level measurement model?

The objectives of this research are:

1. Mapping the maturity condition of the Goods/Services Procurement Unit (UKPBJ) using the UKPBJ maturity level measurement model.
2. Provide input on steps, strategies for improving UKPBJ, in order to increase the maturity and performance of UKPBJ, in order to provide optimal services to the government and the community as well as evaluate the UKPBJ maturity level measurement model.

2. LITERATURE REVIEW

Project management is the application of knowledge, skills, tools and techniques to project activities to meet project requirements. There are 10 areas of knowledge from project management, one of which is project procurement management, namely the management of procurement on projects that involves the process of acquiring or purchasing goods and services for projects from the organizations that provide them (Schwalbe 2012). Van (2009) explains that procurement is a process to seek, approve, and obtain goods or services from providers through tenders or through a bargaining process. The process carried out has the aim of ensuring that buyers get goods or services at the best price by considering quality, quantity, time, and location. Procurement is a process to obtain the right quality of material, at the right time and quantity, and from the right source at the right price (Bailey et. al., 2015).

Procurement is one of the activities in project management. Project management is the application of processes, methods, knowledge or knowledge, expertise, and experience to achieve the objectives of a project (Mateen 2015). According to Pratami et al., (2015) also stated that procurement projects are included in 10 knowledge areas. Project procurement management is the part of the project management process in which products or services are procured or purchased outside the organization or company in order to complete a task or project. Presidential Regulation Number 16 of 2018 concerning the Procurement of Goods/Services mandates that UKPBJ in a structural form function to manage the procurement of goods/services, manage electronic information systems, foster institutional and procurement human resources, provide technical guidance, and advocate for the procurement of goods/services as well as other tasks. such as procurement agents and implementation of procurement strategy preparation and others.

One way to see if there are improvements is to apply a maturity level model which is an instrument to measure improvements made as well as a guide for UKPBJ in seeking further improvements. A mature procurement organization is an indicator of success in developing a more efficient and corruption-free government procurement system for goods/services. With the change in the duties and functions of UKPBJ, LKPP has conducted a study of the UKPBJ maturity level model including determining the maturity level in line with Presidential Regulation 16 of 2018. The UKPBJ maturity level measurement model is defined as a measurement instrument in implementing UKPBJ institutional management that describes UKPBJ capabilities and becomes a

reference for UKPBJ in efforts to develop/strengthen UKPBJ institutions towards a center of excellence for the Procurement of Goods/Services (LKPP Regulation, 2019).

UKPBJ maturity level according to LKPP there are 5 (five) levels of maturity, namely:

1. Initiation is UKPBJ which is passive in responding to every request in an ad-hoc form and has not utilized the integrity of the expansion of functions in the goods/services procurement organization (UKPBJ);
2. The essence is UKPBJ which focuses on the basic functions of UKPBJ in the selection process, has a segmented work pattern and has not yet formed collaboration between active PBJ process actors;
3. Proactive is UKPBJ that carries out PBJ functions oriented to meeting customer needs through collaboration, strengthening the planning function with internal and external customers;
4. Strategic means UKPBJ that carries out innovative, integrated and strategic procurement management to support the achievement of organizational performance;
5. Superior is UKPBJ which always creates added value and implements sustainable best practices for PBJ so that it becomes a role model and mentor for other UKPBJs.

UKPBJ maturity level measurement based on this model consists of 4 (four) domains and 9 (nine) variables which include:

1. The process domain includes the variables of procurement management, provider management, performance management, and risk management;
2. Institutional domain includes organizational variables and tasks/functions;
3. The domain of human resources includes planning and development variables;
4. The information system domain includes information system variables.

3. METHODS

This research is an exploratory descriptive study which aims to provide an overview and interpretation of the population being studied. The variables used in the maturity level measurement model are characterized by Key Drivers which have different characters at each maturity level. The organization will reach a certain level on each variable which is comprehensive, which means that if there is a key driver that has not been met, it cannot be recognized as being at that level.

Table 1. Domain, Variable, and Key Drivers

Domain	**Variable**	**Key Drivers**
Process	Procurement Management	UKPBJ's focus on managing the supply chain of goods and services
		Availability of procedures that support the role of UKPBJ
	Provider Management	Interaction and coaching to providers
		Provider performance data analysis
	Work management	Scope of application of performance management
		Utilization of performance management results for the benefit of the organization
	Risk management	Scope of application of risk management in the supply chain of goods/services

Institutional	Organizing	Utilization of the results obtained by the organization from the implementation of risk management Ability to support organizational vision and strategy
		UKPBJ organizational position
	Job and function	The scope of services provided, both to internal and external parties
		Synergy between internal functions that can create value for the organization
Human Resources	HR Planning	Analysis of needs and fulfillment of HR needs
		HR recruitment procurement
	HR Development	Development of HR competencies for procurement of goods and services
		Procurement HR performance management
Information Systems	Information Systems	The scope of automation of the procurement of goods/services
		Availability of procurement data and information for stakeholders

(Source : LKPP)

The population in this study is UKPBJ located in the Riau Islands Province. The target population is UKPBJ leaders or staff. The UKPBJs are UKPBJ Riau Islands Province, Bintan Regency, Karimun Regency, Anambas Islands Regency, Lingga Regency, Natuna Regency, Batam City, and Tanjungpinang City.

4. RESULTS

The results of the questionnaire obtained from respondents in each UKPBJ that have been verified are then displayed in the data tabulation as shown in Table 2.

Table 2. Data Tabulation

NAME	UKPBJ							
	Riau Islands Regency	**Bintan Regency**	**Karimun Regency**	**Anambas Islands Regency**	**Lingga Regency**	**Natuna Regency**	**Batam City**	**Tanjung Pinang City**
Procurement Management	2	2	0	2	2	1	3	2
Provider Management	3	3	3	3	2	1	3	2
Work management	3	3	3	2	2	2	3	2
Risk Management	3	3	3	3	2	2	3	3
Organizing	3	3	3	3	3	2	3	3
Tasks & Functions	3	3	3	3	3	3	3	4

NAME	UKPBJ							
	Riau Islands Regency	**Bintan Regency**	**Karimun Regency**	**Anambas Islands Regency**	**Lingga Regency**	**Natuna Regency**	**Batam City**	**Tanjung Pinang City**
HR Planning & Procurement	3	3	0	3	2	1	3	2
Procurement HR Development	3	3	0	0	2	1	3	2
Information Systems	2	2	0	2	3	2	3	2
Percentage of Achieved Target	78%	78%	56%	56%	44%	11%	100%	33%

In the tabulation of the data above, the maturity level of each UKPBJ is generated. In the task & function variables, all UKPBJs have reached maturity level 3 or proactive. This means that all UKPBJ's task and institutional function variables in carrying out PBJ management functions, electronic procurement service management functions as well as PBJ guidance and advocacy functions in meeting the needs of goods/services have been well fulfilled. On the other hand, in the procurement management variable, not all UKPBJs can meet this proactive level, it shows that the management of the PBJ process has not been integrated in all links in the procurement process from planning to contract implementation and there is no collaboration between related parties, in this case procurement actors and/or business actors. The tabulation of this data also shows the percentage of each UKPBJ in achieving the target as a center of excellence for the procurement of goods/services, which must be at a proactive level. Figure 1 shows a radar/spiderchart to show the results of the regional UKPBJ mapping in the Riau Islands Province. It can be seen that UKPBJ has reached the ideal condition and UKPBJ has not yet reached the ideal condition which requires improvement and improvement to achieve the ideal condition.

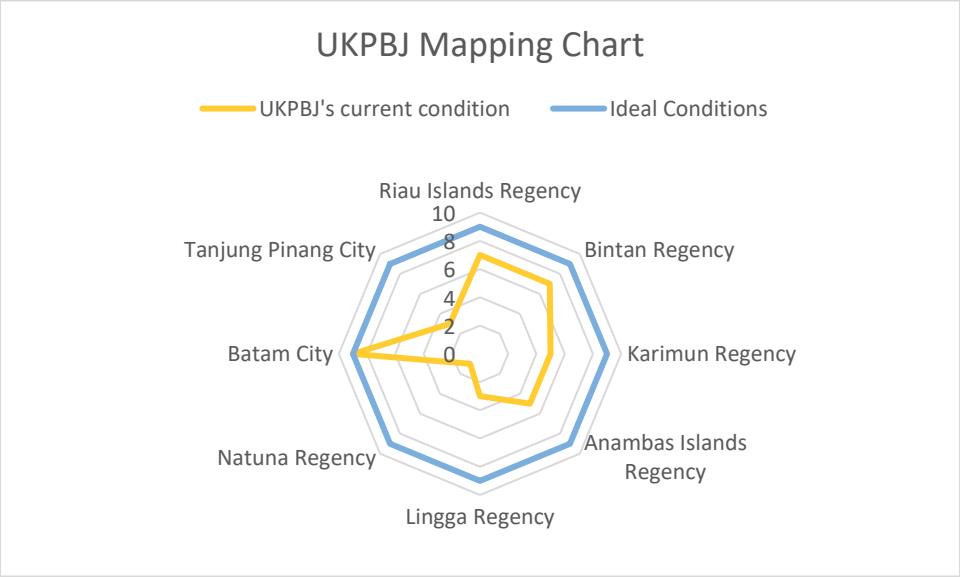

Figure 1. Regional UKPBJ Radar/Spiderchart Graph

From the picture above shows the spiderchart of each area. This shows the mapping of regional UKPBJ maturity conditions. There is an imbalance in the condition of maturity of one region with another. From the figure, it can be seen that UKPBJ Batam City has the highest maturity score, namely with a maturity scale of 3 or proactive and is already in ideal conditions. While UKPBJ Riau Islands Province, Bintan Regency, Anambas Island Regency, and Karimun Regency is nearing the ideal condition while Natuna Regency, Lingga Regency, and Tanjungpinang City need more efforts to achieve ideal conditions.

5. CONCLUSIONS

Based on the results of measurements and discussions that have been carried out, the following conclusions can be drawn:

1. A map of the maturity condition of the Goods/Services Procurement Unit (UKPBJ) based on the UKPBJ Maturity Level Measurement Model at the regional UKPBJ in the Riau Islands Province. almost close to ideal conditions, namely UKPBJ Riau Islands Province and UKPBJ Bintan Regency, while UKPBJ Karimun Regency and Anambas Islands with sufficient maturity conditions while UKPBJ Lingga Regency, UKPBJ Tanjungpinang City, and UKPBJ Natuna Regency are still in a condition of less maturity;
2. To be able to improve the maturity and performance of regional UKPBJs in the Riau Islands Province for UKPBJs that have not yet reached the proactive level, namely by increasing leadership commitment, division of tasks, setting targets, collaboration, cooperation or coordination among stakeholders, monitoring and evaluation as well as carrying out transformations and strategies.
3. Several things that have become researchers' notes on this maturity level measurement model, namely the UKPBJ maturity level model developed by LKPP is sufficient to provide an overview of the UKPBJ maturity level condition in the area, several evaluations need to be carried out so that this model can be more sustained or sustainable, including the need for standard guidelines, socialization and coaching as well as the need for supervision.

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A SIMULATION STUDY OF IMPROVING LOADING PERFORMANCE OF LIQUID AMMONIA IN A FERTILIZER COMPANY IN INDONESIA

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ABSTRACT

This study explores how to improve the loading performance of liquid ammonia in Petrokimia Gresik. Liquid ammonia is considered in this work as the product has an immense opportunity in the market to improve the company's profitability. However, the firm is facing difficulties to increase liquid ammonia sales due to technical problems related to the low loading rate of liquid ammonia. This study uses a simulation approach with discrete events to model the loading process for liquid ammonia products in the loading station. The simulation model is used to understand the complexity and the uncertainties that are hard to observe in the real world. Then, using the Pareto approach, it can be seen the important or dominant factors that cause a decrease in the speed of the liquid ammonia loading process. Seven alternatives of improvement are suggested, and the best scenario is to add one loading operator at each shift and one loading arm, which can increase the loading speed to be 7% from the existing condition. Investment analysis obtained Return of Investment (ROI) of 263% and the Payback Period (PP) of 0,275 years. This study is expected to provide practical solutions to the company used in the case study while enriching the literature in the context of discrete-event simulation applications.

Keywords: Loading performance, Liquid Ammonia, Discrete-event simulation

1. INTRODUCTION

PT. Petrokimia Gresik is the complete fertilizer producer located in Gresik, East Java, Indonesia, producing various fertilizers and chemicals for agricultural industry solutions. It provides liquid ammonia sales services to consumers, especially in the East Java area. The customer's tank truck comes to the Loading Station to load the liquid ammonia from the loading arm which is connected by piping to the ammonia tank carried by truck. The loading speed will affect the length of service time for the tank truck, the faster the tank truck service, the faster the truck will be in the Loading Station area. This will increase the number of tank trucks that come to the Loading Station and the tonnage of liquid ammonia that can be sold so that it will increase revenue.

The firm has been able to fulfill the market with sales of around 75.000 tons per year. It can be seen from Figure 1 that between 2016 and 2020, the average ammonia sales could not reach the target that had been set, only in 2019 and 2020 does it exceed the target. The market for ammonia sales in East Java reaches 150.000 tons per year, while the firm has only been able to fulfill the market with sales of around 75.000 tons per year. The Loading Station cannot reach the

target of 300 tons/day due to the low loading speed of liquid ammonia KPI targets that are set by the company through an evaluation based on the utility of equipment and manpower at the Loading Station. Figure 2 shows that the loading rate of liquid ammonia in 2020 has never reached the target that has been set.

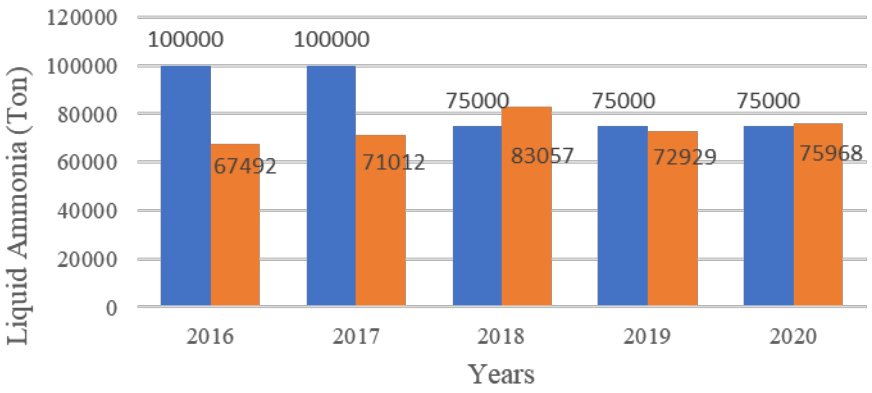

Figure 1. Liquid Ammonia Sales 2016 – 2020

Figure 2. Loading Speed in 2020

Activities that occur in the loading process are declared as dynamic systems because the problems that arise inside in the loading system are complicated and have high uncertainty. Likewise, it takes a high cost and a long time to identify and analyze the loading system. We need a system model that represents and describes the loading system to make it easier to analyze the loading system. The description of the model is carried out using the simulation method to analyze the behavior and traits of the loading system and its performance.

From this research, the discrete event simulation method may be utilized in research to conquer the problem of the slow loading speed of liquid ammonia. From this research, it is expected to be able to develop alternative scenarios to improve current conditions, then model these alternative scenarios in simulations to obtain the best speed for loading liquid ammonia. Furthermore, the best alternative can be determined from the comparison of return on investment (ROI) and payback period from the alternative scenario with the potential for increased sales that occur.

2. LITERATURE REVIEW

2.1 Loading Station

Loading Station is an area in warehousing that is used for loading a product into a container (truck, ship, or train) to be sent to the intended location (customer/end-user). Companies that have a good loading system are companies that can provide maximum service to customers so that company goals are achieved (Orban and Varki, 2009). A good relationship between demand and the loading system will cause the service system in the company to be more effective and efficient.

2.2 System

A system can be categorized into two types, namely discrete systems, and continuous systems (Kelton, Sadowski, & Zu pick, 2015). Discrete systems are systems in which changes occur at several points over time. An example of a discrete system is the cashier service activity in a supermarket, by considering the number of buyers at the cashier which only changes when the buyer arrives or when the buyer leaves after being served. A continuous system is a system in which changes can occur continuously over time. An example of a continuous system such as an airplane flying in the air, this is because the position and speed of the aircraft can change continuously. In the real world, systems are rarely discrete or continuous. However, because one of them is more dominant than the other, it is possible to classify the system (Law and Kelton, 2000).

2.3 Model

A model is defined as a representation of the system both qualitatively and quantitatively representing a process or event, which can clearly describe the interaction relationship between various important factors to be observed. Observations in a system can be the basis for the formation of a model (Law and Kelton, 2000)

The characteristics of a good model according to (Stewart et al, 2015) are:

- Including all components that have a significant relationship and influence on the system being studied, namely by paying attention to the boundaries so that the analysis process of a system 2.
- There is efficiency in cost and time utilization.

2.4 Simulation

Simulation is a method to mimic operations or processes that occur in a system using the help of computer devices and based on certain assumptions so that the system can be studied scientifically (Sadowski & Kelton, 2003). The cause of the simulation method is to make observations using information from the behavior and performance of the real system (Banks., Carson, Nelson, & Nicol, 2004).

A discrete event simulation is an important tool that can assist to recognize and manage complex manufacturing systems, which are common in today's industry (Law and Kelton, 2000). Discrete event simulation focuses on the modeling of a system that accounts for changes in time by depicting where state variables change at separate points in time. The point in time is the time at which the event occurs, and the model will experience a state change if an event changes.

3. METHODS

The research method was carried out to increase the loading rate of liquid ammonia in tank trucks by simulating the liquid ammonia loading process. The first step begins with identifying the

system to know the description of the loading service system. Data is collected from the operational log sheet of loading liquid ammonia. The data in the loading process is processed by finding the average value, standard deviation, and distribution. The data that has been collected will be known by the characteristics of the distribution equation. The next step is to construct a model that represents the real situation related to liquid ammonia loading activities. The output of this stage is a computerized model that will be read by discrete system simulation software. The simulation is run by starting with inputting the simulation data on the Arena 14.0 software. The simulation running process is carried out from the existing conditions that have been created. Furthermore, the simulation model is carried out with a verification and simulation validation process.

The simulation results from the initial conditions are used to find the problem of low loading speed. Based on these results, identification was carried out using Pareto to determine the dominant factors of loading speed that did not reach the target. Root cause analysis is carried out based on the identification of the most influential factors that have been obtained at the analysis stage using Pareto. The tools that will be used in the root cause analysis of this problem are the 5 Why's Tool. The next step is to make Failure Mode and Effect Analysis (FMEA) determine the priority of repairs that can be done by looking at the risk priority number. From the repair priorities, alternative repair scenarios are developed, and simulations were carried out to compare the results with current conditions. At this stage, the best alternative scenario is obtained that can provide the potential for increasing liquid ammonia sales with a feasible repair cost to be carried out based on investment analysis in scenarios to compare the profits in the form of net profit generated with the repair costs or investments incurred.

4. MODULE DEVELOPMENT

4.1 Data Distribution

Secondary data on the Loading Station is used as data in this simulation-based research. The data used is data on the arrival of tank trucks on December 1 to 16, 2020 with a total of 250 tank trucks arriving. In the discrete event simulation method, it is necessary to approach to obtain characteristics of data describing the loading of liquid ammonia. The characteristics of these data will be known by the distribution equation in Table 1.

Table 1. Determination of Data Distribution

No	Type of Data	Type of Distribution	Distribution
1	Tank Truck Inter-Arrival Time Data	Gamma	GAMM (0.612, 2.53)
2	Total Tonnage Data for Each Tank Truck	Normal	NORM (17.6, 6.81)
3	Data Waiting Time Weighing Before Loading	Triangular	TRIA (0, 0.146, 1.46)
4	Weighing Time and Document Inspection Data Before Loading	Normal	NORM (0.12, 0.0155)
5	Truck and Tank Inspection Time Data Before Loading	Lognormal	0.08 + LOGN (0.153, 0.0782)

6	Waiting Time Load Preparation Data	Triangular	TRIA (-0.001, 0.269, 2.7)
7	Loading Preparation Time Data	Triangular	TRIA (0.24, 0.396, 0.91)
8	Loading Time Data	Normal	NORM (1.04, 0.446)
9	Weighing Waiting Time Data After Loading	Lognormal	LOGN (0.321, 0.248)
10	Weighing Time Data after Loading	Normal	NORM (0.12, 0.0155)
11	Truck and Tank Inspection Time Data After Loading	Lognormal	0.04 + LOGN (0.177, 0.0685)
12	Document Check Time Data After Loading	Erlang	0.04 + ERLA (0.026, 7)

4.2 Existing Model

Conceptual modeling is done before starting to design a simulation model. The conceptual model created serves to facilitate the translation of the loading process into a simulation model. Figure 3 shows the conceptual model for the loading process at PT Petrokimia Gresik Loading Station.

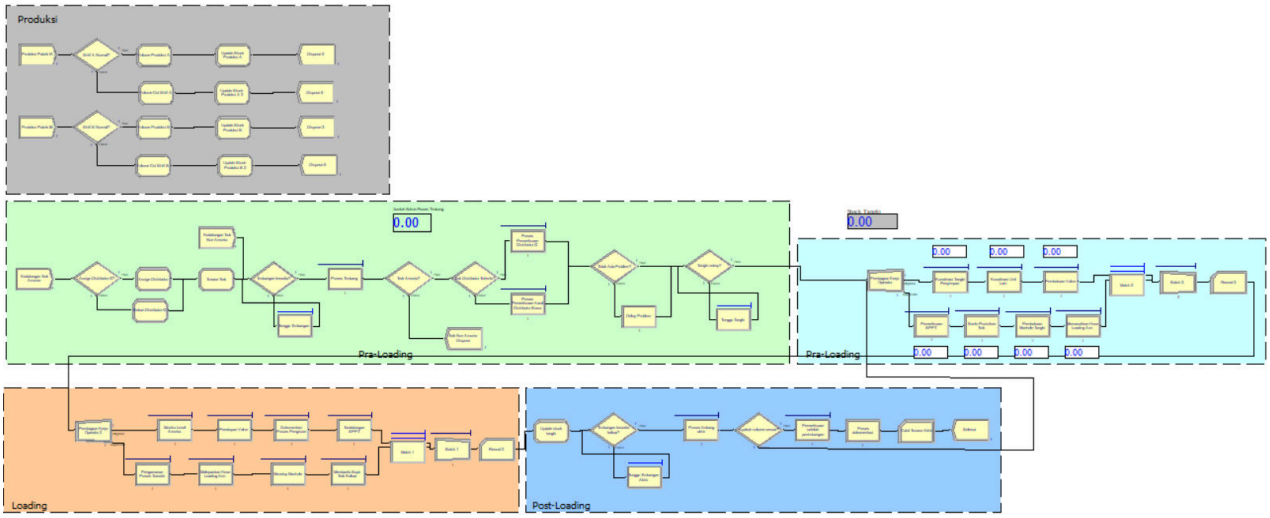

Figure 3. Existing Model of Simulation

4.3 Model Verification and Validation

This verification stage is carried out by looking at the behavior of the queue in the simulation model where the longest queue time occurs in the loading preparation process. This condition is also seen in the actual conditions in the field where according to observations in the loading preparation process, tank truck queues often occur. In the simulation model, the verification stage is carried out by testing the model and ensuring there are no errors. After the existing liquid ammonia loading process from the loading station to the tank truck is simulated, the verification process is carried out first. Verification is done by "checking the model" on the software so that from that it can be seen errors in the design of the model. The indication of the simulation software is "No Error or Warning in Model". It can be concluded from these results that the model made passes verification and there are no errors in the model.

Validation is carried out to determine whether the model made is by the actual conditions of the system. Validation is achieved through evaluating the simulation result with primary statistics within the existing requirements for the favored parameters. Validation is performed by comparing the simulation consequences with the precise cost the usage of a one-sample t-test. The simulation data is said to be valid if the P-value of the t-test result is> 0.05. The simulation information is said to be valid if the P-value of the t-check result is> 0.05. before the only-sample t-test, first, search for the ideal wide variety of replications with an initial trial of n = 30 replicas. Simulation errors (2,25%) relative error (five%), then the quantity of replications has met the validation requirements. So, the quantity of replicas used is 30 times.

The next stage is to test the hypothesis with a one-sample t-test. The significance level used is a = 0.05. Determine H0 and H1 with H0: $\mu 0 = 218,56$ and H1: $\mu 1 \neq 218,56$. By using a one-sample t-test in Microsoft Excel, as shown in Table 2 below.

Table 2. Validation Result of One-Sample T-Test

	Real System	*Model Simulation*
Mean	218	218,56
Observations	1	30
Pooled Variance	1250,736	
Hypothesized Mean Difference	0	
df	29	
t Stat	-0,015762	
P(T<=t) one-tail	0,5	
t Critical one-tail	1,6991270265	
P(T<=t) two-tail	0,9875318285	
t Critical two-tail	2,045229642	

From the above calculation, a P value of 0.5 can be obtained, where P value > 0.05 then the hypothesis can be said that it failed to reject H0 or in other words, there's no sizable distinction among the real system and the simulation and the simulation so that the model is said to be valid. So, from these results, it can be concluded that there is no distinction between the simulation outcomes and the real conditions so that the simulation can be said to have passed the validation test.

5. RESULT AND DISCUSSION

5.1 Identification of Factors Causing Low-Speed Loading of Ammonia Liquid

The results of the simulation of the current condition obtained output data of loading speed and queue time for each loading process based on the data that has been collected. Based on the simulation results, it was found that the longest waiting time occurred in loading preparation process and loading process. The two main problems that have been discussed are further analyzed using 5 why’re tools to find out the root cause of the low loading speed. Identification of the root causes is carried out by conducting interviews, discussions with various parties who understand

and direct observation of the process of loading liquid ammonia, each of the results obtained by the following Table 3.

Table 3. 5 (Five) Whys Analysis

No.	Problem	*Why 1*	*Why 2*	*Why 3*	*Why 4*	*Why 5*
1	Loading Preparation takes a long time	Truck queue	Operators need to coordinate with other units regarding the availability	Liquid ammonia needs from storage tanks are not only for Loading Stations	The transfer process from the storage tank is only one pipe to Loading and other units	There is no independent pipe specifically for Loading Station
2			Truck do not move directly to the loading point while the queue is over	Drivers often leave trucks while waiting inline	There is no operator/supervisor to make sure the driver must be in the truck	The number of operators is less under supervision
3		The process of opening the tank manhole and inserting the loading arm takes a long time	The operator is not ready when the truck is in the loading position	Operators are still coordinating regarding the availability	Operators cannot perform activities simultaneously	The number of operators is lacking in preparation
4				The operator needs to go up by ladder for setting the Loading arm	Setting loading using the type of top-loading arm	Adapting the type of customer's tank truck, all which manholes are above the tank
5	Loading takes a long time	The loading method is not effective	Tank trucks cannot be in the filling area at the same time	Tanker trucks must wait for other tanker trucks to finish loading	Tank trucks are serviced by only one liquid ammonia output source	The number of loading arms is less in loading
6		Ammonia that is filled into the tank is vaporized	Filling to the truck tank is not pure liquid ammonia	Ammonia going to the loading station is mixed with ammonia vapor	The operating temperature of the ammonia in the loading station is too hot so liquid ammonia transforms to be vapor.	Insulation The transfer pipe from the storage tank to the loading station is damaged a

						lot

After analyzing the causal factors using the root causes of the problem successfully traced, the next step is to make an FMEA determine the priority of improvements that can be made by looking at the risk priority number. In making a risk priority number, what must be done is to determine the criteria for Severity, Occurrence, and Detection. FMEA analysis is developed in Table 4 below

Tabel 4. FMEA Analysis

No.	Problem	Root Cause	(S)	(O)	(D)	RPN
1	Loading Preparation takes a long time	There is no independent pipe specifically for Loading Station	4.00	10	2.50	100
2, 4	Loading Preparation takes a long time	The number of operators is lacking in preparation and supervision	3.33	10	7.17	238.89
3	Loading Preparation takes a long time	Adapting the type of customer's tank truck, all which manholes are above the tank	3.50	7.67	2.33	62.61
5,6	Loading takes a long time	The number of loading arms is less in loading	3.17	10	7	221.67
		Insulation The transfer pipe from the storage tank to the loading station is damaged a lot	3.83	10	1.67	63.89
Total RPN						687.06
Rata-rata RPN						137.12

From the outcomes, it changed into discovered that 2 (two) dominant root reasons have been the wide variety of personnel missing in preparation & supervision, and the number of loading arms missing in loading.

5.2 Scenario Development

Alternative repair scenarios are solutions to the root causes causing the low loading speed. Scenarios need to be accomplished to increase the loading rate of liquid ammonia at the Petrokimia Gresik Loading Station. The root cause of the underlying low loading speed in developing alternative repair scenarios.

Tabel 5. Alternative Scenarios

Scenarios	Repair Scenarios	Scenarios	Repair Scenarios
0	Existing Condition	4	Addition of 1 operator and 1 loading arm
1	Addition of 1 operator	5	Addition of 1 operator and 2 loading arms
2	Addition of 2 operator	6	Addition of 2 operators and 1 loading arm
3	Addition of 1 loading arm	7	Addition of 2 operators and 2 loading

			arms

5.3 Cost and Benefit Analysis

For each improvement scenario, sales potential will be calculated based on the output of the simulation results for each scenario, namely the loading speed of liquid ammonia which has units of tons/day. Liquid ammonia sales at Petrokimia Gresik are carried out for 1 full year or 360 days. Assumed liquid ammonia sales margin profit per ton is Rp 659,473. Each scenario also has its investment costs that need to be considered to determine the best alternative scenario. The next stage is to calculate the ROI and PP of the repair costs of each alternative scenario.

Table 6. Comparison of Investment Analysis between Scenarios

Scenarios	Loading Speed (ton/day)	Sales Increase Profit (Rp)	Repair Cost (Rp)	ROI	PP
0					
1	219	0	286.000.000	-1%	-
2	219	0	572.000.000	-1%	-
3	227	1.925.661.160	708.000.000	171%	0,367
4	234	3.610.616.675	994.000.000	263%	0,275
5	239	4.814.152.900	1.702.000.000	182%	0,353
6	236	4.092.029.965	1.280.000.000	219%	0,312
7	244	6.017.691.125	1.988.000.000	202%	0,330

From Table 7, it is found that scenario 4 is the best result with an ROI of 263% in 1 year and a PP of 0.275 years. The same thing also exists in scenario 6 which has a smaller ROI value of 219% and the PP value reaches 0.312 years. These 2 (two) alternatives can be said to be good because they have higher ROI values when compared to another scenario.

6. CONCLUSIONS

The factors that cause the low loading speed of liquid ammonia are the high loading preparation time at the Loading Station which reaches 58,28% of all loading activities, and the high loading time at the Loading Station which reaches 39,08% of all loading activities. There are 7 alternative scenarios for improvement that have been developed with 2 main alternative scenarios which includes the addition of employees for supervision and preparation in every shift and the addition of Loading Arm as well as 5 alternative scenarios from the combination of the main scenarios. From the result, it can be concluded that adding 1 operator in each shift and adding 1 Loading Arm during liquid ammonia loading is the best alternative. By means of implementing this alternative, the loading price may be increased to 234 tons/day or a growth of 7% from the initial (current) situation. From the calculation of the feasibility of investment costs, the ROI value is 263% and the PP value is 0.275 years. This research has included descriptive and predictive stages and can be developed in further research by continuing at the prescriptive stage through optimizing the improvement of all significant variables and increasing the analysis period for one year with real-time data.

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ALTERNATIVE ANALYSIS OF OPERATION FINANCING & MAINTENANCE OF SURAMADU BRIDGE

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ABSTRACT

Suramadu Bridge is currently the status as the largest and longest special bridge in Indonesia. A special bridge is a category of physical infrastructure that is built with high technology, has a long span, and costs a very large investment. Therefore, the management of special bridges needs specific handling and is not confused with bridges in general. However, with the change in the status of the Suramadu bridge to a public road and the end of management by the Toll Road Business Entity, problems emerged related to indications of reduced performance in its operational and preservation (OP) aspects. An important and urgent strategy to be carried out is to try again for the participation of non-government parties in supporting the management of the Suramadu bridge.

The purpose of this study is to examine the Suramadu bridge management scheme through the analysis of the most appropriate financing scheme for the operation and maintenance of the Suramadu bridge, preceded by cost identification. This study shows that the characteristics of a cost are very important for infrastructure development projects so that they can be considered more efficient and optimal in the management of APBN funds each year without having to reduce the portion of state spending (mandatory spending).

The analytical methods used include process management analysis and workflow schematic, and Life Cycle Cost Analysis (LCCA), and cash flow modeling. The analysis formula is in the form of estimated operational and maintenance costs on the Suramadu bridge and alternative management schemes.

Key words : *Present Value, Bridge Life Cycle Cost Analysis, Suramadu bridge, Alternative Financing Schemes, operations and preservation, management strategies.*

1. INTRODUCTION

Road and bridge infrastructure are basic transportation infrastructure that are important in increasing accessibility, connectivity and mobility to support regional development (transport promote development). One of the crucial infrastructures is special bridges which generally have very long spans, are built with advanced technology, and are worth a very large investment. Therefore, the post-construction management of this special bridge also needs special attention.

The Suramadu Bridge is currently the largest and longest special bridge ever built in Indonesia. Since 2008, this bridge has been operationalized and managed by BUJT (Toll Road Business Entity), until it ended in 2018 with the issuance of Presidential Decree 98/2018 regarding the change in the status of the Suramadu Bridge to a non-toll public road.

In an effort to overcome these problems, there was an initiative to develop an Operational & Maintenance management project on a special bridge through the participation of a 3rd party. One very actual idea is to analyze the most appropriate

financing scheme for the operation and maintenance of the Suramadu Bridge, which is preceded by cost identification, which will be used as a funding concept for the Operation and Maintenance of the Suramadu Bridge.

In the context of financing the operation and preservation of the Suramadu Bridge infrastructure, something new is needed that has never been realized in special bridge infrastructure, so it is urgent to study it. Even in the 2020-2024 budget year, the Ministry of Public Works and Public Housing has opened funding options through investment in the scope of bridge infrastructure implementation. This is done as a step to cover the non-APBN funding gap of 70 percent or Rp. 1,435 trillion. The projected capacity of the 2020-2024 APBN is estimated to only be able to meet 30 percent or around Rp. 623 trillion of the total budget requirement for infrastructure provision.

From the description of the background described above, the study of Operations & Maintenance Management of the Suramadu Bridge through the determination of the Life Cycle Cost Analysis (LLCA) calculation between the two alternative contracts as material for the consideration of the Suramadu Bridge funding concept. In addition, it will have a novelty value considering that it has never been applied to a special bridge infrastructure. Therefore, the results of the study besides being useful for improving management management at the Suramadu Bridge, can also be enriched material for the development of studies on the management of other special bridges in Indonesia.

1.1 Research Objectives

The aims of this research include:

1. Analyzing the operational & maintenance costs of Suramadu?
2. Identify possible alternative financing schemes for the operation and maintenance of the Griramadu bridge
3. Analyzing and selecting the best financial alternative for the operation & maintenance of the Suramadu Bridge?

2. LITERATURE REVIEW

According to Mochamad Faisal Syarifuddin (2020), entitled "The Effectiveness of Performance-Based Contracts in Implementing Road Maintenance Handling". This research is a special strategy in national road maintenance. Functional and structural conditions of roads that are damaged before the design of the road design life are the main problems related to handling road maintenance in Indonesia. The damage was caused by several factors, including inappropriate planning and design, errors during the construction period, lack of supervision of vehicle loads during road operation and inaccurate road maintenance strategies. This study uses a qualitative analysis method.

Indra Wijaya (2014) entitled "Analysis of Performance Based Contracts (KBK) and Conventional Contracts Case Study: Semarang - Bawen KBK Road Construction Project and Semarang - Solo Toll Road Development Project". This study will analyze the differences between the KBK system and the conventional contract system by comparing the project life cycle, project coordination line, construction period, maintenance period, and budget plan between the KBK system and the conventional contract system. The research method used is descriptive analytical method and data collection through direct field observations and interviews with case studies of the Semarang-Bawen KBK Road Development Project and the Semarang-Solo Toll Road Development Project.

Arief Darmawan (2018), entitled "Promoting PPP Schemes with Availability Payment Mechanisms as an Alternative for Financing the Development of Regional Public Facilities (Infrastructure). This research is descriptive analytic using library research methods, the main objects are books, laws and regulations, academic manuscripts, journal articles, project reports, or other literature sources, or the results of previous research thesis/dissertation studies. Data were searched and found through a literature review relevant to the discussion. The research method is a mixed category research method with procedures for data collection activities and descriptive final presentation techniques.

Eko Nur Surachman (2017), entitled "The Application Of Availability Payment In Indonesia Case Study: On Palapa Ring Project". This study Using and linking different methodological aspects in an integrated research design will contribute to overcoming the expected and subtle difficulties in conducting valid research (Panas & Pantouvakis, 2010). Moreover, the authors point out that it will result in greater acceptance of the research results of both academics and industrialists. Based on this, a triangulation research strategy that combines literature review, FGD, and financial modeling was adopted for this study. This approach combines both qualitative and quantitative methods.

Wahyu Prasetyo Nugroho's research (2018), entitled "Cost Analysis on Alternative Selection of Road Maintenance Equipment at BBPJN V SURABAYA with the Life Cycle Cost Method". This study uses a research method using Life Cycle Cost (LCC) which is used to assess alternative equipment by identifying the costs that arise in the use of routine road maintenance equipment in SKPD Jatim. Data were collected by means of structured interviews to determine the priority of the work and the equipment used. Costs incurred on equipment are identified over an interval of 10 years from purchase value to write-off.

3. METHODS

The study will be conducted with a qualitative approach supported by quantitative. A quantitative approach as a support is applied to the analysis of calculations in each item of operational services and bridge preservation, as well as determining the cash flow until the end of the planned service life of the Suramadu bridge. This cashflow model shows the present value of the annual payment that will be paid as the life cycle cost of infrastructure for operational activities and bridge preservation that are collaborated through the selection of a contract system.

3.1 Data Collection

This data collection is obtained from the results of secondary data collection from Operational and Maintenance Activity data as shown below:

1. Secondary data needed to obtain bridge maintenance variables are as follows:
   - Bridge Operation is a variable obtained from daily transportation in the form of MST (Heaviest Axis Load) data and bridge security in case of force majeure.
   - Bridge Preservation is a Work Unit that has the authority to keep all bridge works in good serviceability condition after construction

2. While the Primary Data, obtained from interviews with stakeholders involved in the operational and maintenance activities of the Suramadu bridge.

3.2 Data Analysis Method

The following describes several analytical methods that will be used in answering the study problems, including:

1) How much is the operation & maintenance cost of the Suramadu bridge?
   a) Analisis Manajemen Proses
      Used to identify and develop the concept of stages of activities that will appear in the implementation of the Contract, which includes input (required resources), process (activities carried out), output (results/products resulting from activities);
   b) Diagram *Skematic Workflow Analysis*
      Used to describe the process stages of Contract activities resulting from process management analysis in the form of a schematic diagram so that it is easier to understand the workflow.
2) How to finance the operation & maintenance of Suramadu?
   a) Cash Flow Modelling
      Used to describe the details of costs in the form of a cash flow model so that it is easier to understand and interpret the results of the analysis.3) Analyze and choose the best financial alternative for the operation & maintenance of the Suramadu Bridge?
   a) LCCA (*Life Cycle Cost Analysis*)
      Digunakan untuk menganalisa estimasi biaya yang diperlukan dalam kegiatan operasional dan preservasi jembatan Suramadu selama periode umur layanan yang telah direncanakan (*infrastructure life cycle cost*). Kemudian hasil LCCA tersebut akan ditambahkan dengan item biaya lain (seperti profit pihak ketiga dan alokasi *interest*) sebagai dasar perhitungan nilai kontrak;

4. RESULTS

The management technique used to identify and monitor costs is Life Cycle Costing. There are 2 types of payment schemes for comparison which will later be used as an alternative to financing the Suramadu Bridge (JS).

4.1 Traditional Contract Financing Scheme (APBN Subsidy)

Determination of the selection for alternative financing for the operation and maintenance of the Suramadu Bridge, using the funding source from the State Budget of the Ministry of Works and Public Housing which is specialized in the Suramadu road and bridge sector with a funding source of Rp.73,949,440,000. So, it will be a major requirement in the application of this type of contract in planning that is really appropriate so that the government (owner) can estimate the quantity accurately, as will be done as follows:

Assumptions for calculating the budget for the next 25 years are prepared from the 2021 macroeconomic framework, prepared with a high risk of uncertainty, so that there is a possibility of divergence in global projections. The Outlook for Basic Macroeconomic Assumptions for 2018 - 2021 is as follows:

Tabel 4.1 Basic Macroeconomic Assumptions 2018 - 2021

Indikator	2018	2019	2020	2021
Economic Growth (%,yoy)	5,2	5,0	(1,1) – 0,2	4,5 – 5,5
Inflation (%,yoy)	3,1	2,7	3,5	3,0
Interest rate (%)*	5,0	5,6	3,8	7,29
Rupiah exchange rate (Rp/US$)	13.384	14.146	14.400	14.600
Indonesian Crude Oil Price (US$/barrel)	51	67	38	45
Oil Lifting (thousand barrels per day)	804	746	705	705
Lifting Gas (thousand barrels of oil equivalent per day)	1,142	1,057	992	1,007

Source: Ministry of Finance, Ministry of Energy and Mineral Resources, BI, SKK Migas

Referring to the 2018-2021 macroeconomic framework, the inflation rate and Indonesian interest rates are used as a reference for the operational cashflow and maintenance of the Suramadu Bridge (JS). The calculation is pulled backwards to get the inflation rate for the next 25 years using the BBM Consumer Price Index (CPI) as follows:

IHK BBM 1996 = Rp. 1200

IHK BBM 2021 = Rp. 7650

$$= \frac{(\text{Rp.7650} - \text{Rp.1200})}{7650} x100$$

= 0,843 x 100

= 84,3 %

$$= \frac{84{,}3\ \%}{25\ \text{tahun}}$$

= 3,37 %

So, it is found that for the next 25 years the inflation rate is assumed to be around = 3.37%. To achieve stability, the government must maintain a stable inflation rate at 3.37% through fiscal policy, monetary policy, and other policies.

Known :
Present value is the amount of the 2021 APBN for roads and bridges of Rp. 73.949.440.000 and will be calculated using Future Value to find out the following year's budget:

Future Value : PV x (1 + I) n
PV : Present Value
I : Inflation
N : periode

Future Value = PV x (1 + I) n
= Rp73.949.440.000 x (1 + 3,37 %) 1
= Rp73.949.440.000 x [1 +(0,037 x 1)]
= Rp76.441.536.128

From these calculations, the APBN budget costs for the following year are obtained and are valid for the next 25 years which can be seen in the table:

Tabel 4.2 Fiscal Year Fees:

Year	**Budget APBN PUPR (FV = PV x (1,0337)*Tahun**
2021	Rp73.949.440,000
2022	Rp79.340.354,176
2023	Rp85.124.265,995
2024	Rp91.329.824,986
2025	Rp97.987.769,228
2026	Rp105.131.077,605
2027	Rp112.795.133,162
2028	Rp121.017.898,370
2029	Rp129.840.103,161
2030	Rp139.305.446,681
2031	Rp149.460.813,744
2032	Rp160.356.507,066
2033	Rp172.046.496,431
2034	Rp184.588.686,021
2035	Rp198.045.201,232
2036	Rp212.482.696,402
2037	Rp227.972.684,970
2038	Rp244.591.893,704
2039	Rp262.422.642,755
2040	Rp281.553.253,412
2041	Rp302.078.485,586
2042	Rp324.100.007,185
2043	Rp347.726.897,708
2044	Rp373.076.188,551
2045	Rp400.273.442,697

Tabel 4.3 Cashflow Alternative Traditional Contracts.

DISCOUNT FACTOR 7,29%	YEAR PERIOD				
	1	2	3	4	5
- Bridge Operation					
- Bridge SMKS Operation	-Rp6.389.157.996,000	-Rp6.398.476.783,819	-Rp6.412.480.456,263	-Rp6.431.199.706,342	-Rp6.454.675.632,229
MAINTENANCE COST	-Rp2.920.972.000,000	-Rp2.925.232.329,500	-Rp2.931.634.477,503	-Rp2.940.192.476,128	-Rp2.950.925.114,487
- Causeway					
- Approach Bridge	-Rp10.528.056.149,000	-Rp10.543.411.649,906	-Rp10.566.486.904,873	-Rp10.597.332.489,851	-Rp10.636.016.126,418
- Main Bridge	-Rp10.002.563.575,000	-Rp10.017.152.628,465	-Rp10.039.076.115,721	-Rp10.068.382.088,294	-Rp10.105.134.887,538
- Access Road	-Rp11.145.373.488,000	-Rp11.161.629.365,654	-Rp11.186.057.648,643	-Rp11.218.711.878,463	-Rp11.259.663.747,574
- Bridge Vocational High School Equipment	-Rp5.154.812.961,000	-Rp5.162.331.417,776	-Rp5.173.629.669,010	-Rp5.188.732.478,018	-Rp5.207.673.003,061
- Peralatan SMKS Jembatan	-Rp248.033.678.200	-Rp248.395.443.118	-Rp248.939.080.071	-Rp249.665.780.593	-Rp250.577.140.157
CASHFLOW					
- Net Cash Flow	-Rp294.174.614.369,000	-Rp294.603.677.293,201	-Rp295.248.445.342,996	-Rp296.110.331.710,015	-Rp297.191.228.668,416
- Subsidi APBN	Rp73.949.440.000,000	Rp76.441.536.128,000	Rp79.017.615.895,514	Rp81.680.509.551,192	Rp84.433.142.723,068
- Discount Factor	1,073	1,151	1,235	1,325	1,422
- Discount Cash Flow	-Rp205.261.603.475,627	-Rp189.522.552.467,397	-Rp175.081.346.654,731	-Rp161.825.964.534,881	-Rp149.654.523.377,793

DISCOUNT FACTOR 7,29%	YEAR PERIOD				
	6	7	8	9	10
- Bridge Operation					
- Bridge SMKS Operation	-Rp6.482.959.887,674	-Rp6.516.114.871,476	-Rp6.554.213.956,963	-Rp6.597.341.762,673	-Rp6.645.594.465,634
MAINTENANCE COST	-Rp2.963.856.007,454	-Rp2.979.013.682,285	-Rp2.996.431.683,531	-Rp3.016.148.696,787	-Rp3.038.208.691,916
- Causeway					
- Approach Bridge	-Rp10.682.622.929,638	-Rp10.737.255.720,267	-Rp10.800.035.402,892	-Rp10.871.101.411,962	-Rp10.950.612.228,008
- Main Bridge	-Rp10.149.415.380,122	-Rp10.201.321.254,655	-Rp10.260.967.380,948	-Rp10.328.486.233,781	-Rp10.404.028.383,362
- Access Road	-Rp11.309.003.361,802	-Rp11.366.839.570,845	-Rp11.433.300.368,586	-Rp11.508.533.365,274	-Rp11.592.706.334,018
- Bridge Vocational High School Equipment	-Rp5.230.492.918,714	-Rp5.257.242.568,720	-Rp5.287.981.151,143	-Rp5.322.776.936,752	-Rp5.361.707.521,781
- Peralatan SMKS Jembatan	-Rp251.675.164.015	-Rp252.962.274.553	-Rp254.441.320.198	-Rp256.115.585.929	-Rp257.988.805.437
CASHFLOW					
- Net Cash Flow	-Rp298.493.514.500,687	-Rp300.020.062.221,152	-Rp301.774.250.141,993	-Rp303.759.974.336,191	-Rp305.981.663.061,778
- Subsidi APBN	Rp87.278.539.632,835	Rp90.219.826.418,462	Rp93.260.234.568,764	Rp96.403.104.473,731	Rp99.651.889.094,496
- Discount Factor	1,525	1,636	1,756	1,884	2,021
- Discount Cash Flow	-Rp138.474.317.758,393	-Rp128.200.953.400,206	-Rp118.757.566.486,967	-Rp110.074.119.654,293	-Rp102.086.766.811,762

DISCOUNT FACTOR 7,29%	YEAR PERIOD				
	11	12	13	14	15
- Bridge Operation					
- Bridge SMKS Operation	-Rp6.699.080.158,864	-Rp6.757.919.254,958	-Rp6.822.244.937,855	-Rp6.892.203.665,183	-Rp6.967.955.723,815
MAINTENANCE COST	-Rp3.062.661.086,492	-Rp3.089.560.930,306	-Rp3.118.969.111,907	-Rp3.150.952.588,260	-Rp3.185.584.638,734
- Causeway					
- Approach Bridge	-Rp11.038.745.966,735	-Rp11.135.701.044,042	-Rp11.241.696.920,460	-Rp11.356.974.928,907	-Rp11.481.799.190,127
- Main Bridge	-Rp10.487.763.055,009	-Rp10.579.878.760,981	-Rp10.680.584.007,758	-Rp10.790.108.082,475	-Rp10.908.701.922,675
- Access Road	-Rp11.686.007.834,419	-Rp11.788.647.916,581	-Rp11.900.858.909,204	-Rp12.022.896.295,869	-Rp12.155.039.684,162
- Bridge Vocational High School Equipment	-Rp5.404.860.116,358	-Rp5.452.331.870,124	-Rp5.504.230.236,721	-Rp5.560.673.379,087	-Rp5.621.790.617,681
- Peralatan SMKS Jembatan	-Rp260.065.175.004	-Rp262.349.369.171	-Rp264.846.558.275	-Rp267.562.427.952	-Rp270.503.200.703
CASHFLOW					
- Net Cash Flow	-Rp308.444.293.222,161	-Rp311.153.408.948,201	-Rp314.115.142.399,166	-Rp317.336.236.891,827	-Rp320.824.072.479,781
- Subsidi APBN	Rp103.010.157.756,980	Rp106.481.600.073,391	Rp110.070.029.995,864	Rp113.779.390.006,724	Rp117.613.755.449,951
- Discount Factor	2,168	2,327	2,496	2,678	2,873
- Discount Cash Flow	-Rp94.737.279.780,361	-Rp87.972.530.472,996	-Rp81.744.023.007,069	-Rp76.007.470.727,223	-Rp70.722.413.641,393

DISCOUNT FACTOR 7,29%	YEAR PERIOD				
	16	17	18	19	20
- Bridge Operation					
- Bridge SMKS Operation	-Rp7.049.675.841,584	-Rp7.137.553.858,447	-Rp7.231.795.460,671	-Rp7.332.622.982,038	-Rp7.440.276.276,428
MAINTENANCE COST	-Rp3.222.945.144,765	-Rp3.263.120.896,692	-Rp3.306.205.929,415	-Rp3.352.301.888,684	-Rp3.401.518.430,021
- Causeway					
- Approach Bridge	-Rp11.616.457.620,694	-Rp11.761.263.038,931	-Rp11.916.554.374,722	-Rp12.082.697.989,732	-Rp12.260.089.115,241
- Main Bridge	-Rp11.036.639.073,996	-Rp11.174.216.740,892	-Rp11.321.756.936,053	-Rp11.479.607.734,738	-Rp11.648.144.640,833
- Access Road	-Rp12.297.593.872,773	-Rp12.450.890.022,271	-Rp12.615.286.935,846	-Rp12.791.172.456,946	-Rp12.978.964.991,415
- Bridge Vocational High School Equipment	-Rp5.687.722.924,022	-Rp5.758.623.462,183	-Rp5.834.658.181,141	-Rp5.916.006.461,196	-Rp6.002.861.817,968
- Peralatan SMKS Jembatan	-Rp273.675.659.641	-Rp277.087.174.549	-Rp280.745.730.380	-Rp284.659.958.359	-Rp288.839.169.860
CASHFLOW					
- Net Cash Flow	-Rp324.586.694.118,831	-Rp328.632.842.568,800	-Rp332.971.988.197,840	-Rp337.614.367.872,086	-Rp342.571.025.131,550
- Subsidi APBN	Rp121.577.339.008,614	Rp125.674.495.333,205	Rp129.909.725.825,934	Rp134.287.683.586,268	Rp138.813.178.523,125
- Discount Factor	3,083	3,308	3,549	3,807	4,085
- Discount Cash Flow	-Rp65.851.872.241,445	-Rp61.362.034.097,351	-Rp57.221.969.986,623	-Rp53.403.376.653,584	-Rp49.880.343.590,482

DISCOUNT FACTOR 7,29%	YEAR PERIOD				
	21	22	23	24	25
- Bridge Operation					
- Bridge SMKS Operation	-Rp7.555.013.666,549	-Rp7.677.112.974,080	-Rp7.806.872.636,950	-Rp7.944.612.920,025	-Rp8.090.677.226,058
MAINTENANCE COST	-Rp3.453.973.652,463	-Rp3.509.794.569,514	-Rp3.569.117.619,939	-Rp3.632.089.221,265	-Rp3.698.866.369,113
- Causeway					
- Approach Bridge	-Rp12.449.153.415,472	-Rp12.650.348.685,059	-Rp12.864.166.690,096	-Rp13.091.135.163,110	-Rp13.331.819.963,241
- Main Bridge	-Rp11.827.772.072,152	-Rp12.018.924.973,177	-Rp12.222.070.564,214	-Rp12.437.710.236,791	-Rp12.666.381.606,014
- Access Road	-Rp13.179.115.162,491	-Rp13.392.107.607,804	-Rp13.618.462.928,375	-Rp13.858.739.800,567	-Rp14.113.537.262,927
- Bridge Vocational High School Equipment	-Rp6.095.432.667,848	-Rp6.193.943.159,118	-Rp6.298.634.073,382	-Rp6.409.763.802,353	-Rp6.527.609.405,537
- Peralatan SMKS Jembatan	-Rp293.293.393.236	-Rp298.033.413.810	-Rp303.070.817.249	-Rp308.418.036.565	-Rp314.088.403.005
CASHFLOW					
- Net Cash Flow	-Rp347.853.853.872,619	-Rp353.475.645.778,558	-Rp359.450.141.762,119	-Rp365.792.087.708,996	-Rp372.517.294.837,550
- Subsidi APBN	Rp143.491.182.639,354	Rp148.326.835.494,300	Rp153.325.449.850,458	Rp158.492.517.510,419	Rp163.833.715.350,520
- Discount Factor	4,383	4,702	5,045	5,413	5,807
- Discount Cash Flow	-Rp46.629.141.498,262	-Rp43.628.030.322,536	-Rp40.857.084.972,976	-Rp38.298.037.024,745	-Rp35.934.130.871,068
- Net Present Value	-Rp2.383.189.453.510,160				

The Npv value obtained is -Rp2,383,189,453,510,160 or less than zero with an interest rate of 7.29% per year. This means that the alternative Traditional Contract financing scheme cannot be used in handling the operational and maintenance funding of the Suramadu Bridge (JS).

4.2 Availability Payment Scheme

This availability payment is an alternative for the government in order to ease the burden of financing infrastructure development, whereby investors finance all the costs of the work with their own capital. contractors are given the right to manage (operate) and maintenance (maintenance). After the contract period is over, the government pays the construction costs in installments according to the time of the agreement. For the availability payment budget, the calculation is taken from the Regulation of the Government Goods/Services Procurement Policy Agency Number 9 of 2018 of 2017 concerning Guidelines for the Implementation of the Procurement of Goods/Services Through Providers, namely with a profit of 15% (fifteen percent). Then the data is multiplied by 15% of the total investor fees as below:

Table 4.4 Investor CashFlow

Year	Total cost	Budgeting Availability payment
1	Rp294.174.614.369,000	Rp338.300.806.524,350
2	Rp294.603.677.293,201	Rp338.794.228.887,182
3	Rp295.248.445.342,996	Rp339.535.712.144,445
4	Rp296.110.331.710,015	Rp340.526.881.466,517
5	Rp297.191.228.668,416	Rp341.769.912.968,678
6	Rp298.493.514.500,687	Rp343.267.541.675,790
7	Rp300.020.062.221,152	Rp345.023.071.554,325
8	Rp301.774.250.141,993	Rp347.040.387.663,292
9	Rp303.759.974.336,191	Rp349.323.970.486,620
10	Rp305.981.663.061,778	Rp351.878.912.521,045
11	Rp308.444.293.222,161	Rp354.710.937.205,485
12	Rp311.153.408.948,201	Rp357.826.420.290,431
13	Rp314.115.142.399,166	Rp361.232.413.759,041
14	Rp317.336.236.891,827	Rp364.936.672.425,601
15	Rp320.824.072.479,781	Rp368.947.683.351,748
16	Rp324.586.694.118,831	Rp373.274.698.236,656
17	Rp328.632.842.568,800	Rp377.927.768.954,120
18	Rp332.971.988.197,840	Rp382.917.786.427,516
19	Rp337.614.367.872,086	Rp388.256.523.052,899
20	Rp342.571.025.131,550	Rp393.956.678.901,283
21	Rp347.853.853.872,619	Rp400.031.931.953,512

Year	Total cost	Budgeting Availability payment
22	Rp353.475.645.778,558	Rp406.496.992.645,342
23	Rp359.450.141.762,119	Rp413.367.663.026,437
24	Rp365.792.087.708,996	Rp420.660.900.865,345
25	Rp372.517.294.837,550	Rp428.394.889.063,183

The calculation assumptions above are budget funds for Availability Payment contract funding for the next 25 years. If there are excess budget funds, the budget will be returned to the state treasury and become a State Budget Surplus.

Tabel 4.4 Cashflow Alternatif Availability Payment

DISCOUNT FACTOR 7,29%	YEAR PERIOD				
	1	2	3	4	5
OPERATING COSTS					
- Bridge Operation	-Rp6.389.157.996,000	-Rp6.398.476.783,819	-Rp6.412.480.456,263	-Rp6.431.199.706,342	-Rp6.454.675.632,229
- Bridge SMKS Operation	-Rp2.920.972.000,000	-Rp2.925.232.329,500	-Rp2.931.634.477,503	-Rp2.940.192.476,128	-Rp2.950.925.114,487
MAINTENANCE COST					
- Causeway	-Rp10.528.056.149,000	-Rp10.543.411.649,906	-Rp10.566.486.904,873	-Rp10.597.332.489,851	-Rp10.636.016.126,418
- Approach Bridge	-Rp10.002.563.575,000	-Rp10.017.152.628,465	-Rp10.039.076.115,721	-Rp10.068.382.088,294	-Rp10.105.134.887,538
- Main Bridge	-Rp11.145.373.488,000	-Rp11.161.629.365,654	-Rp11.186.057.648,643	-Rp11.218.711.878,463	-Rp11.259.663.747,574
- Access Road	-Rp5.154.812.961,000	-Rp5.162.331.417,776	-Rp5.173.629.669,010	-Rp5.188.732.478,018	-Rp5.207.673.003,061
- Bridge Vocational High School Equipment	-Rp248.033.678.200	-Rp248.395.443.118	-Rp248.939.080.071	-Rp249.665.780.593	-Rp250.577.140.157
CASHFLOW					
- Net Cash Flow	-Rp294.174.614.369,000	-Rp294.603.677.293,201	-Rp295.248.445.342,996	-Rp296.110.331.710,015	-Rp297.191.228.668,416
- Availability Payment	Rp338.300.806.524,350	Rp338.794.228.887,182	Rp339.535.712.144,445	Rp340.526.881.466,517	Rp341.769.912.968,678
- Discount Factor	1,073	1,151	1,235	1,325	1,422
- Discount Cash Flow	Rp41.127.963.608,305	Rp38.389.365.305,557	Rp35.859.245.099,637	Rp33.520.295.513,437	Rp31.356.748.309,338

DISCOUNT FACTOR 7,29%	YEAR PERIOD				
	6	7	8	9	10
OPERATING COSTS					
- Bridge Operation	-Rp6.482.959.887,674	-Rp6.516.114.871,476	-Rp6.554.213.956,963	-Rp6.597.341.762,673	-Rp6.645.594.465,634
- Bridge SMKS Operation	-Rp2.963.856.007,454	-Rp2.979.013.682,285	-Rp2.996.431.683,531	-Rp3.016.148.696,787	-Rp3.038.208.691,916
MAINTENANCE COST					
- Causeway	-Rp10.682.622.929,638	-Rp10.737.255.720,267	-Rp10.800.035.402,892	-Rp10.871.101.411,962	-Rp10.950.612.228,008
- Approach Bridge	-Rp10.149.415.380,122	-Rp10.201.321.254,655	-Rp10.260.967.380,948	-Rp10.328.486.233,781	-Rp10.404.028.383,362
- Main Bridge	-Rp11.309.003.361,802	-Rp11.366.839.570,845	-Rp11.433.300.368,586	-Rp11.508.533.365,274	-Rp11.592.706.334,018
- Access Road	-Rp5.230.492.918,714	-Rp5.257.242.568,720	-Rp5.287.981.151,143	-Rp5.322.776.936,752	-Rp5.361.707.521,781
- Bridge Vocational High School Equipment	-Rp251.675.164.015	-Rp252.962.274.553	-Rp254.441.320.198	-Rp256.115.585.929	-Rp257.988.805.437
CASHFLOW					
- Net Cash Flow	-Rp298.493.514.500,687	-Rp300.020.062.221,152	-Rp301.774.250.141,993	-Rp303.759.974.336,191	-Rp305.981.663.061,778
- Availability Payment	Rp343.267.541.675,790	Rp345.023.071.554,325	Rp347.040.387.663,292	Rp349.323.970.486,620	Rp351.878.912.521,045
- Discount Factor	1,525	1,636	1,756	1,884	2,021
- Discount Cash Flow	Rp29.354.229.595,924	Rp27.499.629.255,980	Rp25.780.983.218,396	Rp24.187.367.254,901	Rp22.708.801.123,353

DISCOUNT FACTOR 7,29%	YEAR PERIOD				
	11	12	13	14	15
OPERATING COSTS					
- Bridge Operation	-Rp6.699.080.158,864	-Rp6.757.919.254,958	-Rp6.822.244.937,855	-Rp6.892.203.665,183	-Rp6.967.955.723,815
- Bridge SMKS Operation	-Rp3.062.661.086,492	-Rp3.089.560.930,306	-Rp3.118.969.111,907	-Rp3.150.952.588,260	-Rp3.185.584.638,734
MAINTENANCE COST					
- Causeway	-Rp11.038.745.966,735	-Rp11.135.701.044,042	-Rp11.241.696.920,460	-Rp11.356.974.928,907	-Rp11.481.799.190,127
- Approach Bridge	-Rp10.487.763.055,009	-Rp10.579.878.760,981	-Rp10.680.584.007,758	-Rp10.790.108.082,475	-Rp10.908.701.922,675
- Main Bridge	-Rp11.686.007.834,419	-Rp11.788.647.916,581	-Rp11.900.858.909,204	-Rp12.022.896.295,869	-Rp12.155.039.684,162
- Access Road	-Rp5.404.860.116,358	-Rp5.452.331.870,124	-Rp5.504.230.236,721	-Rp5.560.673.379,087	-Rp5.621.790.617,681
- Bridge Vocational High School Equipment	-Rp260.065.175.004	-Rp262.349.369.171	-Rp264.846.558.275	-Rp267.562.427.952	-Rp270.503.200.703
CASHFLOW					
- Net Cash Flow	-Rp308.444.293.222,161	-Rp311.153.408.948,201	-Rp314.115.142.399,166	-Rp317.336.236.891,827	-Rp320.824.072.479,781
- Availability Payment	Rp354.710.937.205,485	Rp357.826.420.290,431	Rp361.232.413.759,041	Rp364.936.672.425,601	Rp368.947.683.351,748
- Discount Factor	2,168	2,327	2,496	2,678	2,873
- Discount Cash Flow	Rp21.336.162.004,534	Rp20.061.106.290,814	Rp18.875.998.884,302	Rp17.773.849.250,468	Rp16.748.253.552,034

DISCOUNT FACTOR 7,29%	YEAR PERIOD				
	16	17	18	19	20
OPERATING COSTS					
- Bridge Operation	-Rp7.049.675.841,584	-Rp7.137.553.858,447	-Rp7.231.795.460,671	-Rp7.332.622.982,038	-Rp7.440.276.276,428
- Bridge SMKS Operation	-Rp3.222.945.144,765	-Rp3.263.120.896,692	-Rp3.306.205.929,415	-Rp3.352.301.888,684	-Rp3.401.518.430,021
MAINTENANCE COST					
- Causeway	-Rp11.616.457.620,694	-Rp11.761.263.038,931	-Rp11.916.554.374,722	-Rp12.082.697.989,732	-Rp12.260.089.115,241
- Approach Bridge	-Rp11.036.639.073,996	-Rp11.174.216.740,892	-Rp11.321.756.936,053	-Rp11.479.607.734,738	-Rp11.648.144.640,833
- Main Bridge	-Rp12.297.593.872,773	-Rp12.450.890.022,271	-Rp12.615.286.935,846	-Rp12.791.172.456,946	-Rp12.978.964.991,415
- Access Road	-Rp5.687.722.924,022	-Rp5.758.623.462,183	-Rp5.834.658.181,141	-Rp5.916.006.461,196	-Rp6.002.861.817,968
- Bridge Vocational High School Equipment	-Rp273.675.659.641	-Rp277.087.174.549	-Rp280.745.730.380	-Rp284.659.958.359	-Rp288.839.169.860
CASHFLOW					
- Net Cash Flow	-Rp324.586.694.118,831	-Rp328.632.842.568,800	-Rp332.971.988.197,840	-Rp337.614.367.872,086	-Rp342.571.025.131,550
- Availability Payment	Rp373.274.698.236,656	Rp377.927.768.954,120	Rp382.917.786.427,516	Rp388.256.523.052,899	Rp393.956.678.901,283
- Discount Factor	3,083	3,308	3,549	3,807	4,085
- Discount Cash Flow	Rp15.793.342.258,130	Rp14.903.732.686,447	Rp14.074.485.991,996	Rp13.301.068.166,087	Rp12.579.314.653,740

DISCOUNT FACTOR 7,29%	YEAR PERIOD				
	21	22	23	24	25
OPERATING COSTS					
- Bridge Operation	-Rp7.555.013.666,549	-Rp7.677.112.974,080	-Rp7.806.872.636,950	-Rp7.944.612.920,025	-Rp8.090.677.226,058
- Bridge SMKS Operation	-Rp3.453.973.652,463	-Rp3.509.794.569,514	-Rp3.569.117.619,939	-Rp3.632.089.221,265	-Rp3.698.866.369,113
MAINTENANCE COST					
- Causeway	-Rp12.449.153.415,472	-Rp12.650.348.685,059	-Rp12.864.166.690,096	-Rp13.091.135.163,110	-Rp13.331.819.963,241
- Approach Bridge	-Rp11.827.772.072,152	-Rp12.018.924.973,177	-Rp12.222.070.564,214	-Rp12.437.710.236,791	-Rp12.666.381.606,014
- Main Bridge	-Rp13.179.115.162,491	-Rp13.392.107.607,804	-Rp13.618.462.928,375	-Rp13.858.739.800,567	-Rp14.113.537.262,927
- Access Road	-Rp6.095.432.667,848	-Rp6.193.943.159,118	-Rp6.298.634.073,382	-Rp6.409.763.802,353	-Rp6.527.609.405,537
- Bridge Vocational High School Equipment	-Rp293.293.393.236	-Rp298.033.413.810	-Rp303.070.817.249	-Rp308.418.036.565	-Rp314.088.403.005
CASHFLOW					
- Net Cash Flow	-Rp347.853.853.872,619	-Rp353.475.645.778,558	-Rp359.450.141.762,119	-Rp365.792.087.708,996	-Rp372.517.294.837,550
- Availability Payment	Rp400.031.931.953,512	Rp406.496.992.645,342	Rp413.367.663.026,437	Rp420.660.900.865,345	Rp428.394.889.063,183
- Discount Factor	4,383	4,702	5,045	5,413	5,807
- Discount Cash Flow	Rp11.905.398.237,647	Rp11.275.799.872,495	Rp10.687.282.185,351	Rp10.136.865.386,420	Rp9.621.805.360,058
- Net Present Value	Rp528.859.093.065,349				

The NPV value obtained is +Rp528,859.093,065,349 or greater than zero with an interest rate of 7.29% per year. This means that the use of the Availability payment Scheme can complete contract work. The funding implementation method uses three pillars, namely PUPR, PJPK, and PII where payments are made by PJPK as BBPJN EAST JAVA - BALI, it can be seen that in the next 1 to 25 years the Ceiling funds and total annual costs can be offset without any compensable days. So, an alternative to using Availability Payment can be to carry out Operational & Maintenance work for the Suramadu Bridge (JS)

4.5 Cost Sensitivity Analysis Availability Payment

After conducting the analysis, it can be seen how far the impact of these changes on the feasibility of the project. Sensitivity analysis is carried out by calculating the NPV in several scenarios of changes that may occur.
Sensitivity analysis on AP contract costs for the Suramadu Bridge:

Tabel 4.5 Recapitulation of the increase in availability Payment costs

YEAR	DISCOUNT CASH FLOW CONTRACT AP INCREASE 10 %	DISCOUNT CASH FLOW CONTRACT AP INCREASE 15 %	DISCOUNT CASH FLOW CONTRACT AP INCREASE 20 %	DISCOUNT CASH FLOW CONTRACT AP INCREASE 25%
1	Rp41.127.963.608,305	Rp41.127.963.608,305	Rp41.127.963.608,305	Rp41.127.963.608,305
2	Rp38.250.734.012,468	Rp37.994.858.201,968	Rp37.738.854.613,286	Rp37.482.723.246,421
3	Rp35.535.377.196,398	Rp34.936.913.740,504	Rp34.337.253.956,310	Rp33.736.396.051,118
4	Rp32.975.062.217,288	Rp31.965.992.411,929	Rp30.952.884.314,084	Rp29.935.723.789,745
5	Rp30.562.812.830,396	Rp29.090.633.931,674	Rp27.608.869.130,675	Rp26.117.460.840,198
6	Rp28.291.604.952,006	Rp26.316.640.344,932	Rp24.322.852.546,731	Rp22.310.071.682,788
7	Rp26.154.444.883,919	Rp23.647.568.414,654	Rp21.107.939.264,814	Rp18.535.146.180,997
8	Rp24.144.431.413,762	Rp21.085.143.637,427	Rp17.973.482.650,712	Rp14.808.578.662,843
9	Rp22.254.804.434,561	Rp18.629.607.811,840	Rp14.925.744.891,299	Rp11.141.549.162,658
10	Rp20.478.982.325,529	Rp16.280.010.286,947	Rp11.968.449.267,111	Rp7.541.338.820,184
11	Rp18.810.589.993,739	Rp14.034.451.492,997	Rp9.103.241.435,369	Rp4.012.006.136,787
12	Rp17.243.479.184,633	Rp11.890.286.061,235	Rp6.330.073.959,030	Rp554.946.373,602
13	Rp15.771.742.420,730	Rp9.844.291.739,190	Rp3.647.526.078,371	-Rp2.830.647.307,941
14	Rp14.389.721.716,253	Rp7.892.809.372,833	Rp1.053.068.835,476	-Rp6.147.405.441,516
15	Rp13.092.013.035,119	Rp6.031.858.432,244	-Rp1.456.715.927,842	-Rp9.399.473.641,924
16	Rp11.873.467.306,420	Rp4.257.231.881,714	-Rp3.885.955.519,356	-Rp12.592.262.996,185
17	Rp10.729.188.681,117	Rp2.564.573.620,584	-Rp6.239.339.245,867	-Rp15.732.250.487,974
18	Rp9.654.530.602,832	Rp949.441.232,323	-Rp8.521.999.072,391	-Rp18.826.822.010,625
19	Rp8.645.090.171,526	-Rp592.643.636,495	-Rp10.739.413.809,803	-Rp21.884.151.813,052
20	Rp7.696.701.198,997	-Rp2.066.155.299,545	-Rp12.897.333.234,642	-Rp24.913.113.315,007
21	Rp6.805.426.287,457	-Rp3.475.532.789,862	-Rp15.001.719.125,507	-Rp27.923.217.157,547
22	Rp5.967.548.205,141	-Rp4.825.155.944,528	-Rp17.058.700.693,386	-Rp30.924.573.150,018
23	Rp5.179.560.784,430	-Rp6.119.327.623,072	-Rp19.074.542.302,562	-Rp33.927.873.460,661
24	Rp4.438.159.527,059	-Rp7.362.261.053,645	-Rp21.055.621.736,109	-Rp36.944.394.994,614
25	Rp3.740.232.066,458	-Rp8.558.071.459,372	-Rp23.008.417.565,535	-Rp39.986.019.428,401
NPV	Rp453.813.669.056,541	Rp305.541.128.416,781	Rp143.258.446.318,572	-Rp34.728.300.649,820

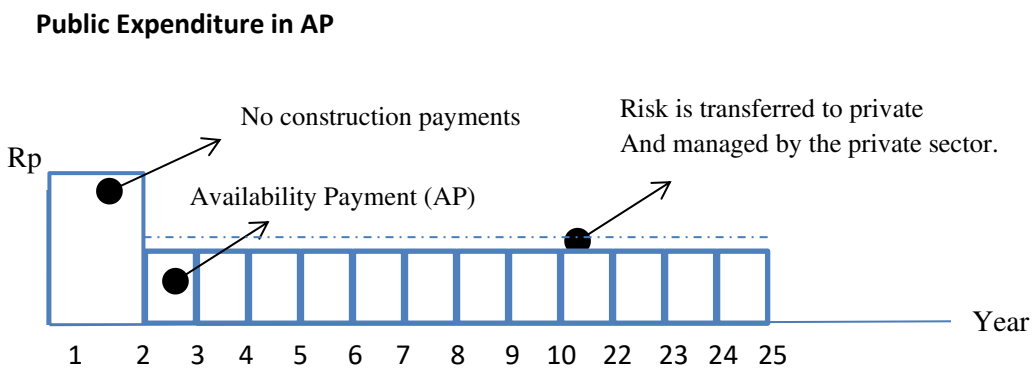
Cost increase limit is up to 25%, If the cost increase rate > 25% NPV becomes negative

5. CONCLUSIONS

For the selection of the best Scheme, it can be said that the use of the Availability Payment Scheme is the best because basically the AP Scheme always pays attention to the following aspects:

- state financial capacity;
- fiscal sustainability; and
- fiscal risk management,

Flow of spending system against Service Availability Scheme (AP Scheme)



The advantage of this scheme lies not only in the benefits obtained by the Government and Business Entities, but also benefits for the community as users, because the community will get better quality services that emphasize their needs. The overall project life cycle cost is also lower by implementing AP as a return on investment scheme, compared to the conventional pattern so that infrastructure provision becomes more efficient in the long term.

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GUIDELINES: Implementation of PPP with Availability Payment Mechanism

Presidential Regulation No. 38 Year 2015

Presidential Regulation of the Republic of Indonesia Number 98 of 2018 concerning the Surabaya – Madura Bridge

PUPR Ministerial Regulation 41/2015 concerning the Implementation of Road Bridge and Tunnel Security.

ANALYZING THE INFLUENCE OF LEADERSHIP STYLE ON EMPLOYEE PERFORMANCE AND JOB SATISFACTION AT PT PLN (PERSERO) UIW SULUTTENGGO

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ABSTRACT

The leadership style in the company can affect job satisfaction and employee performance in the company, as well as at PT PLN (Persero) UIW Suluttenggo. The unsuitable leadership style of superiors can cause problems that can hinder performance targets. This study aims to examine and analyze the influence of leadership style on the performance and job satisfaction of employees of PT PLN (Persero) UIW Suluttenggo. This research is a descriptive quantitative research based on the study of empirical rational principles. The data was collected using a questionnaire, and the population was employees of PT PLN (Persero) UIW Suluttenggo with the number of samples, namely: 125 respondents. Data were analyzed using SEM-PLS. The results showed that different leadership styles had a positive relationship on employee performance and satisfaction. Job satisfaction has a positive relationship on employee performance. Therefore, when an employee's job satisfaction increases, it will have a positive impact on his performance.

Keywords: leadership style, employee performance, SEM-PLS, job satisfaction

1. INTRODUCTION

Employees of PT PLN (Persero) UIW Suluttenggo always try to meet consumer expectations and work as much as possible, as evidenced by the NKO unit value obtained by PT PLN (Persero) UIW Suluttenggo in first semester 2021 is 99.64% where almost reached the 100% performance target. In addition to maintaining customer satisfaction, maintaining employee job satisfaction is very important for a company. Maintaining employee job satisfaction can improve employee performance, because when employees are satisfied, they will work more optimally. Job satisfaction itself has a definition of the level of employee satisfaction with their work related to the nature and tasks of the work.

Job satisfaction and employee performance in the company are also unavoidable from the touch of the leadership style in the company. PT PLN (Persero) UIW Suluttenggo itself has not only changed leadership once, or even in each department it is not uncommon to change leadership. In fact, sometimes there are employees who experience incompatibility with the new leader, so that this incompatibility can cause problems that can hinder efforts to achieve predetermined goals. Of course, with a new leader, leadership styles can be different.

Based on different leadership styles, further analysis is needed on the influence of servant leadership, authoritarian leadership and participatory leadership on employee satisfaction and performance, as well as how job satisfaction affects employee performance. In this study, the

analytical method used is Partial Least Square (PLS) where PLS predicts the relationship between constructs. PLS can be used to identify the main variables and does not require a large sample size to be able to test a model. In addition, PLS can be used as confirmation of theory testing (confirmation of theory), recommending relationships that do not yet have a theory (exploratory) and developing theory. In this study, the analytical method used is Partial Least Square (PLS) where PLS predicted relationships between constructs. PLS can be used to identify the main variables and it does not need a large sample size to be able to test a model. In addition, PLS can be used as confirmation of theoretical testing (confirmation of theory), recommending relationships that do not yet have a theory (exploratory) and developing theories.

The relationship modeling factor is based on the results of the leadership style analysis. Modeling the relationship between factors based on substance theory. The expected result of this study is to analyze the leadership style that affects job satisfaction so as to improve employee performance. Based on the problems mentioned above, the objectives of this research are:

- To analyze the relationship between servant leadership and authoritarian leadership style and participatory leadership style on employee performance and job satisfaction.
- To analyze the relationship between servant leadership and authoritarian leadership style and participatory leadership style on employee performance by mediating job satisfaction.
- To analyze the effect of job satisfaction on employee performance.

2. RESEARCH FRAMEWORK

2.1. Servant Leadership

This leadership prioritizes service, beginning with a sense that naturally exists in an individual to provide service and prioritize service. Only then form an awareness to be able to accommodate aspirations and provide encouragement to the leader in leading the people he leads. The function of the leadership is not only to influence employees to be able to work optimally and loyally, but a manager is also required to be able and have mastery over management, where this is very necessary in solving all complexities through making rules, preparing formal plans, creating organizational structures. and then monitor what has been done through comparison to planning.

2.2. Authoritarian Leadership

Leaders who carry out their leadership by using an authoritarian style make decisions without considering the people (employees), all decisions are taken by themselves. However, after making a decision the leader will communicate it to employees so that they can then proceed according to instructions quickly (Boone & Kurtz, 2007). With this style, it focuses all decision-making and makes policies on itself, so that the entire distribution of work and responsibility lies with the leader, employees are limited to carrying out their work.

2.3. Participatory Leadership

Mangkunegara (2017) explains that participatory leadership style is a type of consultative leadership by encouraging other individuals to participate. Decision making is done based on the results of the process of the participation of all parties. Someone who uses this leadership style is fatherly, has the assumption that in carrying out his work employees cannot be independent and need encouragement. Have a tendency to always provide protection for employees.

2.4. Job Satisfaction

Job satisfaction, is the level of feeling satisfied by employees with their work related to the nature and tasks of the work, achievement of work, supervision obtained or feeling relieved and liking for their work so that they can then be pursued. This feeling of satisfaction shows how employees feel about the work they do, this can be seen from positive behavior for the work they do and all the things they face in the work environment. This satisfaction can be seen and formed when the employee's expectations can be achieved and the rewards received for their work are appropriate. (Wibowo and Bhinekawati, 2021).

2.5. Employee Performance

Employee performance, namely the acquisition of an individual that can be produced on a job given to him. Mangkunegara (2017) provides an explanation of employee performance, namely the acquisition of results for a job carried out by employees in quantity or quality. Meanwhile, Sedarmayanti (2017) defines performance as the use of ability & motivation interaction. According to Wibowo (2010) performance is an employee who works and can get a result for his work. From the many explanations of these experts as a whole, they focus on the acquisition of employees when carrying out the work that has been given to them.

2.6. Validity Test

The validity test is carried out on the content of an instrument, with the aim of measuring the accuracy of the instrument used in a study (Sugiyono, 2010). Validity can be measured by composite reliability (CR), average variance extracted (AVE), or using table r (Persada, et al., 2015).

2.7. Reliability Test

Reliability is an index that shows the extent to which a measuring instrument has consistent results when used repeatedly. Instrument reliability is done by testing the scores between items using Cronbach's alpha technique calculations so that the level of reliability of r alpha can be seen compared to r table.

Reliability testing is done by calculating the Cronbach Alpha value (α), if the Cronbach Alpha (α) value is greater than 0.60 then the research data is considered good and reliable enough to be used as input in the data analysis process.

2.8. Structural Equation Modelling (SEM)

The Structural Equation Modeling (SEM) method is a continuation of path analysis and multiple regression, both of which are forms of multivariate analysis. When compared to path analysis or multiple regression, the SEM method is superior because it is able to analyze data more comprehensively. In path analysis and multiple regression, data analysis is carried out on interval data from the total variable score which is the sum of the scores of the dimensions or items of the research instrument (Haryono, 2016).

3. RESEARCH METHODOLOGY

3.1. Data Collection Methodology

This study uses several tests and methods to determine the effect of leadership style on employee job satisfaction and employee performance. The tests used are Validity Test, Reliability Test, and Frequency Analysis. The methodology used is Partial least square.

In obtaining the main data, this research used a questionnaire survey method. Survey research is research that takes a sample from one population and uses a questionnaire as the main

data collection tool. Data obtained from the distribution of questionnaires. Questionnaires are used to collect data from research respondents, where the questionnaire itself contains questions or statements related to the research objectives.

Questionnaire data will be used as a measure of whether it is reliable. The measuring instrument is said to be reliable if the measuring instrument produces the same data on several tests carried out on the same object (Sugiyono, 2006). In Kuncoro (2019), reliability shows the consistency and stability of a score (in the measurement scale).

In this study, a questionnaire will be given to employees of the PLN Suluttenggo regional office to obtain primary data on leadership styles.

3.2. Data Analysis Method

Quantitative analysis is data analysis that is done by classifying, comparing, and calculating numbers with relevant formulas. For data analysis, Partial Least Square will be used, which aims to determine the factors.

At this stage, tests are carried out regarding the suitability of the model with several goodness of fit criteria. Evaluation of the PLS model is carried out through evaluation of the outer and inner models. PLS is commonly known as the outer model, in PLS, the relationship between indicators and variables is only reflexive, while in PLS it can be reflexive or formative. Determining indicators can be based on theory or adapting indicators that have been used by previous researchers. Assumptions about distribution are also an important requirement in PLS. The data in the modeling must meet the multinormal distribution, if this condition is not met then the estimate will be shifted to resampling or bootstrapping approaches. In PLS, the assumption of a multinormal distribution is not needed because the direct estimation uses a bootstrapping technique. with the following steps (Ghozali, 2006):

1. Model Design.
2. Convert Path Diagram to System of Equations.
3. Estimation: Weight, Path Coefficient and Loading.
4. Evaluation of Goodness of Fit.
5. Hypothesis Testing.

The statistic used is t statistic or t test. The application of the resampling method allows the application of freely distributed data and small data. The following is the Path Model Model in SEM with partial least square PLS in this study as follows:

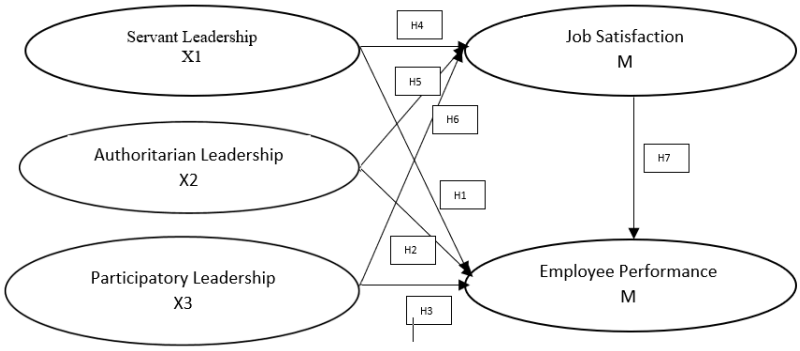

Figure 1. Theoretical framework

The number of research samples in this case the number of indicators is the indicator variable X1 as much as 5, variable X2 as much as 5, variable X3 as much as 4, Variable M as much as 5 and variable Y as much as 6, so the overall indicator = 25.

4. RESULTS AND DISCUSSION

4.1. Analysis of the Positve Relationship between Servant Leadership, Authoritarian Leadership, Participatory Leadership, Employee Satisfaction and Employee Performance

Partial Least Square (PLS) analysis is used to test the predictive model and the relationship between the factors that have been developed. The evaluation of the prediction model in PLS is divided into two: evaluation of the inner model and the outer model.

Evaluation of the outer model is carried out to ensure that the measurements used are feasible to be used as valid and reliable measurements. While the evaluation of the interior of the model is carried out to ensure that the structural model built is accurate. Figure 2 shows the output display of the measurement model which will then be used as data for validity testing, reliability testing, coefficient of determination, predictive relevance, goodness of fit and path coefficients.

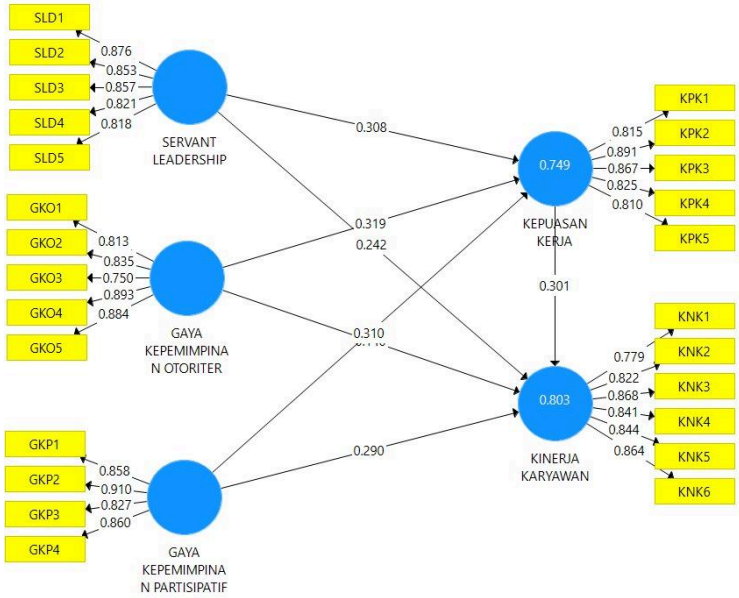

Figure 2. Outer Model Evaluation

4.2. Variable Validity Test

The construct validity test used in this study is convergent validity and discriminant validity. The first evaluation conducted on the outer model is a test of convergent validity. Convergent validity occurs if the scores obtained from two or more different instruments that have the same construct have a high correlation. In the SEM/PLS approach, a measurement has met convergent validity if it meets several conditions, one of which is to have a loading factor value with a value of > 0.7.

Table 1. Mean Value and Loading Factor

No	Code	Indicator	Mean Value	Loading Factor Value	Result
1	SLD1	Love	3.936	0.876	RELEVANT
2	SLD2	Empowerment	3.584	0.853	RELEVANT
3	SLD3	Vision	3.816	0.857	RELEVANT
4	SLD4	Humility	3.568	0.821	RELEVANT
5	SLD5	Trust	3.520	0.818	RELEVANT
6	GKO1	Based on power and coercive actions that absolutely must be obeyed.	3.616	0.813	RELEVANT
7	GKO2	Have the ambition to be king over all conditions	3.656	0.835	RELEVANT
8	GKO3	All orders and policies are determined by themselves, without a discussion process with other parties	3.424	0.750	RELEVANT
9	GKO4	Employees are not given clear information related to planning and various actions that must be carried out	3.992	0.893	RELEVANT
10	GKO5	Appreciation & criticism to employees is done subjectively	3.952	0.884	RELEVANT
11	GKP1	The authority of the leader is not absolute	3.824	0.858	RELEVANT
12	GKP2	Decision making and policy making are done together	3.888	0.910	RELEVANT
13	GKP3	Control of behavior	3.688	0.827	RELEVANT
14	GKP4	Active	3.912	0.860	RELEVANT
15	KPK1	Have a sense of satisfaction with the boss	3.752	0.815	RELEVANT
16	KPK2	Have a sense of satisfaction with coworkers	3.944	0.891	RELEVANT
17	KPK3	Have a sense of satisfaction at work	3.832	0.867	RELEVANT
18	KPK4	Have a sense of satisfaction with the promotion opportunity	3.688	0.825	RELEVANT
19	KPK5	Have a sense of satisfaction with his income	3.736	0.810	RELEVANT
20	KNK1	Quality of Work	3.720	0.779	RELEVANT
21	KNK2	Work Quantity	3.688	0.822	RELEVANT
22	KNK3	On Time	3.792	0.868	RELEVANT
23	KNK4	Effectiveness	3.672	0.841	RELEVANT
24	KNK5	Independence	3.712	0.844	RELEVANT
25	KNK6	Work Commitment	3.664	0.864	RELEVANT

4.3. Reability Test

Reliability test is used to measure the extent to which the measurement of a test remains consistent after repeated tests on the subject and under the same conditions. In this study using composite reliability. Composite reliability is used because it can measure and test the reliability value of indicators on a variable. A variable can be said to meet the reliability if it has a composite reliability value > 0.70.

Table 4. *Reliability* Test

Variabel	Cronbach's Alpha	Keterangan
Servant Leadership	0,900	Reliabel
Authoritian Leadership	0,893	Reliabel
Participatory Leadership	0,887	Reliabel
Employee Satisfaction	0,897	Reliabel
Employee Performance	0,914	Reliabel

Table 4 Based on the actual test results in the table above, it shows that all variables have Cronbach's Alpha values> 0.7. It can be concluded that all variables used in this study are reliable.

4.4. Inner Model Evaluation of Research dan Research Hypothesis

Evaluation inner structural research model or models in PLS using R-square values for the dependent variable and the value of the path coefficient (ß) for the independent variables were then assessed the significance based on the T-statisitc each path. The R-Square value is used to show the proportion of the effect of the exogenous (dependent) variable on the endogenous (independent) variable.

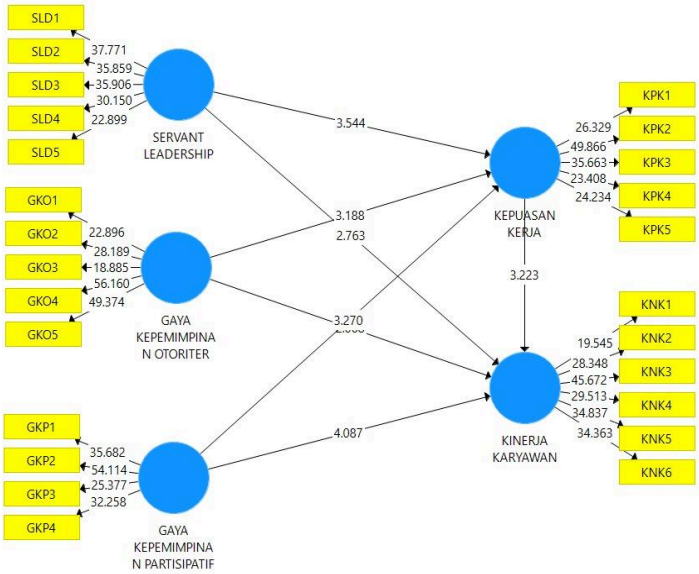

Figure 3. Inner Model Evaluation

The results of the PLS R-Squares represent the total variance of the construct described by the model. The following is the result of calculating the R-Squares value:

Table 5. R-Square Value

	R Square	R Square Adjusted
Kepuasan Kerja	0,749	0,742
Kinerja Karyawan	0,803	0,796

Table 5 shows the value of R square for the variable job satisfaction 0.749 and employee performance 0.803. These results indicate that 74.9% of Employee Performance variables are influenced by X1, X2, X3. Meanwhile, Employee Satisfaction shows that 80.3% of this variable is influenced by Employee Performance.

4.5. Hypothesis Test

The path coefficient value (original sample estimate) shows the level of significance in hypothesis testing. Research hypothesis testing is acceptable if the value of t> 1.96 for a two-tailed hypothesis and> 1.64 for the hypothesis of the tail (Hair et al, 2010). Table 4 shows the results of path coefficient and the t-statistic.

Table 6. Coefficient Path and T-Statistic Result

Hipotesis	***Path Coefficients***	***t-statistic***	***P Value***	Result
H1: Servant leadership has a positive relationship on employee performance	0.242	2,763	0,006	RELEVANT
H2: Authoritarian leadership style has a positive relationship on employee performance	0.140	2,608	0,039	RELEVANT
H3: Participative leadership style has a positive relationship on employee performance	0.290	4,087	0,000	RELEVANT
H4: Servant leadership has a positive relationship on employee satisfaction	0.308	3,544	0,000	RELEVANT
H5: Authoritarian leadership style has a positive relationship on job satisfaction	0.319	3,188	0,002	RELEVANT
H6: Participative leadership style has a positive relationship on job satisfaction	0.310	3,270	0,001	RELEVANT
H7: Job satisfaction has a positive relationship on employee performance	0,301	3,223	0,001	RELEVANT

Table 6 shows the results of the bootstrapping test using the Smart-PLS software with a sub sample of 125 samples. From the results of the bootstrapping test, the beta coefficient values, mean values, standard deviations, t-count (1 tail) and P Values were obtained. To test the research hypothesis, the terms t-count > t-table are used. In this study, the t-Table value for 1 tail was 1.64. Based on the results of the bootstrapping test, it was found that 7 hypotheses were accepted. This will change the predictive modeling previously carried out by researchers in the evaluation of the outer and inner models.

5. CONCLUSIONS

Based on the model of the relationship between factors, there is a positive influence between servant leadership, authoritarian leadership, and participatory leadership on employee job satisfaction and employee performance and a positive influence between job satisfaction and employee performance at the regional office of PT PLN (Persero) Suluttenggo.

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SERVICE QUALITY ASSESSMENT PT. DISTRIBUTOR REAGENT: COMBINATION OF SERVICE QUALITY AND IMPORTANCE-PERFORMANCE ANALYSIS METHODS

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ABSTRACT

The need for laboratory reagents is currently an essential need, this condition is due to the growing development of research in the field of science and the increase in health checks in the community, especially due to pandemic conditions. The need for these reagents is also met by imports through designated distributors in Indonesia. PT. Distributor of Reagents is one of the importing companies for Laboratory reagent products in Indonesia. One of the main products that are needed a lot at this time is the Genomics product which is a product for the completeness of the Covid-19 examination using the PCR technique. However, customer demand did not increase in line with the increase in cases. The number of new competitors selling this product is one of the causes, the reduced demand for reagents. In addition, several complaints about the quality of service were also complained by customers. One of the company's efforts in facing competition is to improve the quality of service to customers to differentiate themselves from competitors of other reagent distributor companies. The purpose of this study is to assess the quality of service to customers that have been carried out at PT. Distributor Reagents use the service quality (SERVQUAL) method and identify elements of service quality that are considered important for customers with the Importance Performance Analysis (IPA) technique. Data were obtained by quota sampling as many as 42 customers who were selected based on the purchase value of genomic products and did not make purchases again at a certain time. The results showed the average value of the gap analysis of the SERVQUAL method at PT. Distributor Reagent is -0.27 with a suitability level of 92.94% so the quality of service is still relatively good. Furthermore, there are 3 attributes with high importance and performance in Quadrant I, then 6 attributes with high importance and low performance which should be the main priority to be improved in Quadrant II. Based on these results, the recommendation for management is to improve its analysis by examining the performance level of competitors on each attribute used to determine the performance of the services provided.

Keywords: *reagents, distributors, Service quality (SERQUAL), Importance Performance Analysis*

1. INTRODUCTION

The need for laboratory reagents is now an essential need, this condition is due to the development of research in the field of science and the increasing number of health checks in the

community. In addition, Laboratory reagents are also still dependent on products from abroad. The fulfillment of their needs is carried out by importing through a designated distributor, PT. Reagent Distributor is one of the importing companies for Laboratory reagent products in Indonesia. PT. Reagent distributors classify these products into 3 major groups, namely Genomics, Proteomics, and Culture products. From the three product groups, the author will choose one of the products to be discussed, namely Genomic products. This is because the most needed Genomic products are related to Covid-19 examinations, especially for PCR examinations. In addition, there are many competitors who sell Genomic products due to the increasing need for examinations in the community to deal with Covid-19 cases, this condition will also be a challenge for the company to continue to exist among competitors. This competition is very much felt by the addition of new distributors from various producing countries, this can also be seen from the increase in recommendation kits used for inspection, from the initial dozens to hundreds.

This concern is reinforced by the latest sales data for several major Genomics products which decreased significantly in demand when compared to the demand in the previous year. In addition to these conditions, some customers also complained about the services that occurred at PT. Distributor of Reagents, such as:

1. Late arrival of goods, not according to the promised time
2. Administrations that are too rigid cannot revise the invoicing if there is a change in customer administration data or something else
3. Too focused on reagents for pandemic needs, neglected reagent needs for other research
4. The product maintenance team cannot conduct training and consultation directly with customers, especially those located outside the city (head office)
5. Limited technicians and resolving customer complaints are usually done with a queuing system

Some of the reasons that have been described previously, one of the company's efforts in facing competition is the need to improve the quality of service to customers to differentiate themselves from competitors of other reagent distributor companies. The purpose of this study is to identify elements of service quality that are considered important for customers of PT. Distributor of Reagents and assessing the quality of service to customers that have been carried out at PT. Reagent Distributors. The model for measuring service quality used is the SERVQUAL model. The results from SERVQUAL are analyzed using the IPA (Importance Performance Analysis) technique, the aim is to identify what dimensions must be considered or become priorities in an effort to improve service quality.

2. LITERATURE REVIEW

The business process carried out as a distributor begins with registering the company as an importer with a business license in the form of a distributor of chemicals/medical devices and laboratory equipment. To support the formation of this business process, there are at least seven components, including outcome (output), customer (customer), actor (process actor), object (process object), event (event), and decision point (point of decision making). According to Dumas (2013), the result of a business process is an output that can be positive or negative, which provides value to customers who are actors in the business process.

Imported products are reagents, which are substances added to a system to carry out a chemical reaction or in other words added to see the occurrence of a certain reaction. Reagents can be found in solid (solid) form, or in liquid form. Some reagents are used as basic components in specific biomolecules and some serve as kits and tests used to detect organisms that are difficult to

find under conventional imaging devices. Usually, reagents are used for research purposes such as raw materials in molecular biology, forensic use, blood or serology tests, immunology, gram testing, and pharmaceutical processes (Lattanzi,2012). This reagent will be supplied, to several customers to meet the needs of the Laboratory.

One of the measurements used to assess the quality of service to customers is the service quality model (SERVQUAL). SERVQUAL provides techniques for assessing and managing service quality. As stated by Adil (2013), many studies have used the SERVQUAL dimension as the basis of their research, so that it has a great impact on business and the academic community so that it can be said as a practical framework used in service quality management. The service quality scale operationalizes service quality by calculating the difference between expectations and perceptions, evaluating them in relation to 22 questions that represent the five dimensions of service quality (Kotler & Keller, 2016), as explained in the following table below:

Table 1. The five dimensions of service quality

Tangibles	The appearance of physical facilities, equipment, staff, and communication materials.
Reliability	The ability to perform the promised service dependably and accurately
Responsiveness	The willingness to help customers and provide prompt service
Assurance	The knowledge and courtesy of employees and their ability to convey trust and confidence.
Empathy	The provision of caring, individualized attention to customers.

Each item is measured based on responses from two statements, namely measuring customer expectations regarding services (E) and perceptions of actual services provided by companies in the service sector (P). The gap for each item was calculated as the perception score minus the expectation score (P-E). According to Yousapronpaiboon (2014), the results of these calculations can be concluded as follows:

1. A positive gap score implies that expectations have been met or exceeded, service quality is considered satisfied.
2. Negative gap score implies that expectations have not been met, quality is considered unsatisfactory

Furthermore, Importance-Performance Analysis (IPA) has become a popular tool for understanding customer satisfaction and prioritizing service quality improvement since Martilla and James in 1977, first demonstrated this technique. IPA has been used as a tool to understand customer needs and wants so as to develop marketing strategies to respond to them. IPA is widely used in many fields where customer satisfaction is key to a thriving business including higher education, tourism, government services, convenience stores, and banking services.

This customer satisfaction is a function of customer perception, which involves the quality of the organization's products or services and customer expectations. Therefore, as stated by Kwon & Chung (2018), IPA measures satisfaction from customer satisfaction surveys based on two components of product or service attributes, namely the importance of the product or service for customers and the performance of the organization in providing the product or service. Furthermore, according to Kotler & Keller (2016), the ranking of elements in the IPA is divided into four quadrants according to in the picture below:

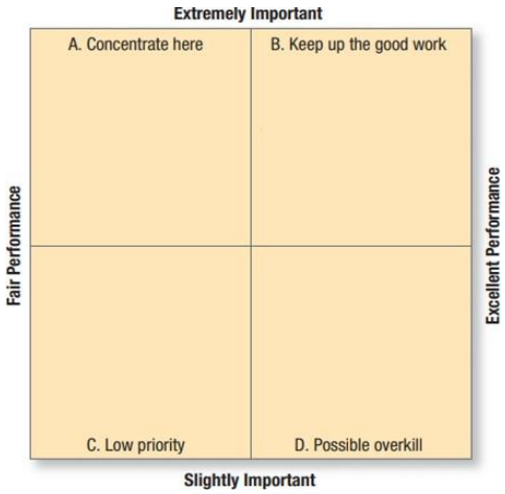

Figure 1. Importance Performance Analysis

1. Quadrant A in the figure shows important service elements that are not being performed at the desired level.
2. Quadrant B shows important service elements that are being performed well; the company needs to maintain this high performance.
3. Quadrant C shows minor service elements that are being delivered in a mediocre way but do not need any attention
4. Quadrant D shows that a minor service element, "Send out maintenance notices," is being performed in an excellent manner.

3. METHODS

The sampling technique used is quota sampling which is a non-probability sampling technique by selecting samples that have certain characteristics in the amount of quota determined by the number of respondents as many as 42 customers who make purchases of Genomic products (March-July 2020) and do not make purchases again (January-May 2021). The SERVQUAL attribute was compiled based on interviews with the management team, a database of customer complaints, and previous research literature. The data from the questionnaire were tested for validity with Pearson's Product Moment and for reliability using Cronbach's Alpha. Valid results will be analyzed using SERVQUAL and IPA, if not valid, they will not be included in the analysis calculation. Before filling out the questionnaire, the customer will fill in the demographic data form, such as education, position, the purpose of the purchase, length of time being a customer at PT. Reagent Distributors. This is done to find out the customers who fill out the questionnaire according to the appointed respondents.

4. RESULTS

4.1 SERVQUAL Attributes

Table 2. Respondent demographic data

Demographic Variables		Total
Education	S2	20
	S1	15
	S3	5

Table 2. Respondent demographic data

Demographic Variables		Total
Education	D3	2
Position	Researcher	11
	Unit Head	9
	Laboratory Staff	7
	Laboratory Coordinator	7
	Analyze	6
Purchase purpose	Government project	18
	Private Company Project	13
	Personal Project	11
Time for being customer	More than 2 years	31
	Between 1-2 years	8
	Less than 1 years	3

The demographic data information can be accordance with the selection of sample data, namely quota sampling which represents sampling based on certain characteristics. In this case, the respondents who were appointed were those with the purchase of genomic products and demographically, based on the level of education, position, the purpose of purchasing the product, and length of time being a customer of PT. Distributors Reagent. This data will help researchers to know the characteristics of respondents, especially in deciding to purchase products offered by PT. Distributor Reagent.

4.2 SERVQUAL Attributes

Table 3. SERVQUAL Attributes

Variable	SERVQUAL Attributes	
Tangible	Q1	The quality of the products offered
	Q2	Warehouse stock update information
	Q3	Promo and product information (brochures, journals, flyers)
	Q4	The storage, packing and shipping
Reliability	Q5	Provide after-sales service or maintenance
	Q6	The ability of employees to answer customer questions
	Q7	Provide solutions to help customer difficulties
	Q8	The employee communication skills to customers
	Q9	Provide timely delivery service as promised
Responsiveness	Q10	Perform function tests and presentations to customers
	Q11	Willingness to help customers anytime
	Q12	Speed and accuracy in responding to customers
	Q13	Willingness to accept complaints and resolve them
Assurance	Q14	Customer support facilities
	Q15	Customer payment time options
	Q16	Security, comfort and convenience in transactions
	Q17	Product guarantee received in good condition
	Q18	Guarantee if there is a delay in the order
Empathy	Q19	Company participation in providing support (sponsorship)
	Q22	Participate in social and humanitarian activities

The attributes in the SERVQUAL questionnaire were obtained from interviews with the management team in this case the marketing manager, field observations when meeting customers, a database of customer complaints that had been submitted to the sales team, and literature obtained from previous research.

4.3 Validity & Reliability Test Results

Table 4. Validity Test Results

Variable	R-Count	R-Table	Results
Form expectation	0.778	0.3044	Valid
Form performance	0.729	0.3044	Valid
Form Importance	0.703	0.3044	Valid

The calculation results are expressed by this Pearson correlation, where the correlation measures the existence of a linear relationship between attributes. If the attribute is not valid, r count is smaller than the r table, then it is not included in the next analysis. With the number of respondents as many as 42, then obtained df = 42-2 = 40. with a significant level of 5%, then the results of the validity of each variable on the reality, expectations, and interests form are obtained as the Table. 4. Validity Test Results. The results of the calculation of the validity test above obtained valid results, namely the r-count are greater than the r-table so that the statement can be used as an instrument for the questionnaire.

Table 5. Reliability Test Results

Variable	Cronbach's Alpha Coefficient Value	Results
Form expectation	0.951	very good
Form performance	0.949	very good
Form importance	0.828	good

The results of the reliability test from Alpha's Cronbach for the form of statements of hope, reality, and interests have an average value of > 0.9 which means that the questionnaire used is reliable, as shown in Table 3. The results of the reliability test of each statement.

4.4 SERVQUAL Results

Table 6. Calculation of the Average Level of Compliance Dimensions of Service Quality

SERVQUAL Dimension	Average Important	Average Performance	Service Quality Performance (%)
Tangibles	4.20	3.91	93.09
Reliability	4.14	3.87	93.47
Responsiveness	4.14	3.96	95.65
Assurance	4.10	3.85	93.90
Empathy	3.86	3.42	88.60
Averages	**4.08**	**3.80**	**92.94**

The Calculation of the average level of suitability for service quality dimensions shows that the average SERVQUAL dimension for service quality is 92.94% with each dimension such as tangible 93.09%, reliability 93.47%, responsiveness 95.65%, assurance 93.90%, and empathy by 88.60%. Based on the results of this research data, overall service quality as seen from the percentage value of the five dimensions of SERVQUAL has a very good suitability value according to customer. This is based on research conducted by Ansari et al., (2019), The results of the service quality research data are seen from the five dimensions of SERVQUAL at Commercial Banks in Indonesia with an average level of conformity of 80.40% having a very good suitability value according to customers.

The gap between expectations and customer perceptions in Gap 5 is measured by subtracting the total average value of the statement of reality (perception) items with the total average value of expectations (expectations) on each attribute. From the calculation data, the results are obtained in accordance with Table 7. The results of the gap score of expectations and reality are below:

Table 7. The Results of the gap score of expectations and reality

Variable		Importance (I)	Performance (P)	GAP (P-I)
Tangible	Q1	4.29	4.10	-0.19
	Q2	4.21	3.71	-0.50
	Q3	4.00	3.69	-0.31
	Q4	4.31	4.14	-0.17
Reliability	Q5	4.00	3.71	-0.29
	Q6	4.17	3.79	-0.38
	Q7	4.12	3.79	-0.33
	Q8	4.26	4.14	-0.12
	Q9	4.17	3.93	-0.24
Responsiveness	Q10	4.07	3.74	-0.33
	Q11	4.19	3.98	-0.21
	Q12	4.17	4.12	-0.05
	Q13	4.14	4.02	-0.12
Assurance	Q14	4.10	3.57	-0.52
	Q15	4.10	3.95	-0.14
	Q16	4.19	4.05	-0.14
	Q17	4.21	4.07	-0.14
	Q18	3.90	3.60	-0.31
Empathy	Q19	3.90	4.36	-0.40
	Q22	3.81	3.33	-0.48
		4.12	**3.85**	**-0.27**

From the results of the calculation of the gap obtained, all indicators obtained negative results, meaning that the company's perception was still unable to satisfy customer expectations (Sianturi & Singgih, 2011). Even though, this gap analysis shows the average level of service quality at PT. Distributor Reagent of -0.27 which means it is still quite good. According to Parasuraman in Ansari et al., (2019) if the result of the gap <-1 means good, and the result >-1 means the quality of service provided is not good.

4.5 IPA Results

Importance Performance Analysis (IPA) in this study was conducted on all respondents using a comparison between surveys the level of importance to customers with the performance given by the company can be seen in Table 8. The results of the average score for calculating the level of customer interest with the performance of the services provided by the company are as follows:

Table 8. The results of the average score for calculating the level of customer interest with the performance of the services provided by the company

SERVQUAL Attributes		Importance	Performance
Q13	Willingness to accept complaints and resolve them	5.19	4.02
Q5	Provide after-sales service or maintenance	4.45	3.71
Q17	Product guarantee received in good condition	4.29	4.07
Q1	The quality of the products offered	4.21	4.10
Q4	The storage, packing and shipping	4.21	4.14
Q9	Provide timely delivery service as promised	4.21	3.93
Q2	Warehouse stock update information	4.17	3.71
Q7	Provide solutions to help customer difficulties	4.14	3.79
Q16	Security, comfort and convenience in transactions	4.12	4.05
Q12	Speed and accuracy in responding to customers	4.10	4.12
Q15	Customer payment time options	4.05	3.95
Q6	The ability of employees to answer customer questions	4.02	3.79
Q14	Customer support facilities	4.02	3.57
Q11	Willingness to help customers anytime	4.00	3.98
Q18	Guarantee if there is a delay in the order	4.00	3.60
Q8	The employee communication skills to customers	3.98	4.14
Q10	Perform function tests and presentations to customers	3.93	3.74
Q3	Promo and product information (brochures, journals, flyers	3.83	3.69
Q19	Company participation in providing support (sponsorship)	3.67	3.50
Q22	Participate in social and humanitarian activities	3.67	3.33

The analysis of interests and performance seen from the average score of the above calculation will assess various attributes of the service variable and identify the actions required by the company. The results of the analysis of the average score of the calculation of customer interests and company performance, from the order of the highest importance value to the lowest are the attributes Q13, Q5, Q17, Q1, Q4, Q9, Q2, Q7, Q16, Q12, Q15, Q6, Q14, Q11, Q18, Q8, Q10, Q3, Q19, and Q22. Most of the average scores of this attribute have a performance value smaller than the level of customer importance. This shows that customers feel these attributes are very important but are not done well by the company.

The results of decision-making with the IPA method are in accordance with Figure. 2 The results of the IPA analysis based on the Quadrant above show that the service quality in Quadrant I (high interest or low performance) is also called (concentrate here), including attributes that require immediate corrective action. There are 3 attributes including Q5, Q2, and Q7. This statement is also supported by the result that the average score of importance is quite high but the average score of performance is low. Then, Quadrant II (interest and high performance) is referred to as (keep up the good work) which represents the strong side and competitive advantage of the company, its task is to continue to maintain the quality of the attributes in it. There are 6 attributes in this quadrant, namely attributes Q1, Q4, Q9, Q13, Q16, and Q17. These results can be concluded that customers are very

satisfied with the services provided by the company. This attribute also has a high average score of importance, so the company must maintain this service quality attribute.

Seven attributes in Quadrant III (Low priority) are Q3, Q6, Q10, Q14, Q18, Q19, and Q22. This attribute is considered to have low importance and performance, this condition does not represent any threat to the company, but managers should think about options to transfer resources from these attributes to attributes that require immediate action (Ormanovic and Ciric, 2017). This quadrant also has the most attributes among the other quadrants.

There are 4 attributes in Quadrant IV (Possible Overkill), namely Q8, Q11, Q12, and Q15. This quadrant has low importance and high performance. The customers are satisfied with the company's performance. However, this attribute is actually not very important but its performance is relatively high. Respondents are satisfied with organizational performance, but managers should consider efforts on this Quadrant attribute as excessive or unnecessary.

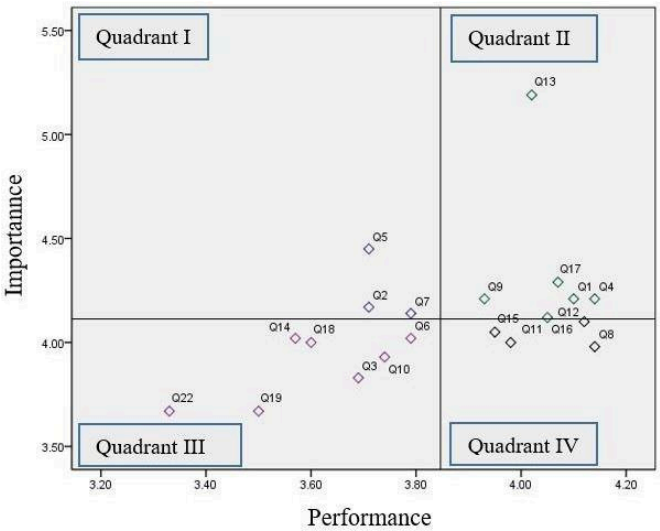

Figure 2. The Cartesian Diagram of Science Analysis Results

6. CONCLUSIONS

The quality of service to customers has been passed by PT. Distributor Reagents are classified as good, the value of gap analysis using the SERVQUAL method shows the average level of service quality at PT. Distributor Reagents of -0.27, as well as the value of the level of conformity of 92.94% which means good according to customers. There are 3 attributes with high importance and performance in Quadrant I, then 6 attributes with high importance and low performance which should be the main priority to be improved in Quadrant II. Based on these results, the recommendation for management is to improve its analysis by examining the performance level of competitors on each attribute used to determine the performance of the services provided.

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RISK ANALYSIS AND MITIGATION OF HIGH VOLTAGE AIR TRANSMISSION LINE (SUTT) PROJECT

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ABSTRACT

PT. Perusahaan Listrik Negara (PLN) as a state electricity service provider company meets the growing needs of customers by implementing electricity projects such as the High Voltage Air Transmission Line (SUTT). SUTT project is complex and carries a high risk in its implementation, so a comprehensive risk management implementation is needed to be able to identify, analyze, evaluate, and mitigation to these risks so that the construction work of the SUTT Transmission can be completed properly. In this research, a case study of the SUTT 150 kV KIS – Bangil Project was selected, which is the scope of work of PT. PLN (Persero) UIP JBTB. This project is one that is ongoing projects in 2021 and is one of the priorities because it aims to anticipate the need for electrical energy around the Sidoarjo area and its surroundings at this time and in the next few years and improve the quality and view of electric power to customers. This paper aims to provide a method for risk analysis and mitigation of the SUTT project that minimizes subjectivity, conduct analysis and evaluation of - the results of the SUTT that have been identified, find out the causes and impacts on the dominant/ekstrem risks on project completion. The method used to carry out risk management in this project is Delphi Technique to overcome the problem of subjectivity during the risk identification, Consequence/Probability Matrix method to analyze and evaluate the risks, and use Bow Tie Analysis to plan mitigation of extreme levels of risk. The results obtained from the study are that there are 24 identified and consensus risks. From the identification it is obtained 7 risks with extreme levels. Based on the 7 Extreme risks, prevention controls and recovery controls are prepared to avoid or recover risks that can disrupt the sustainability of the project as outlined in the Bow Tie Analysis Diagram.

Keywords: Risk management, Delphi Technique, Consequence / Probability Matrix, Bow Tie Analysis

1. INTRODUCTION

PT. Perusahaan Listrik Negara (Persero) As a state electricity service provider company, it is expected to continue to increase the electrification ratio so that it can meet the needs of new and existing customers throughout Indonesia. With high demand growth, PT. PLN is required to increase its production capacity. To answer this need, PT. PLN continues to improve its services by implementing electricity projects.

In this research, a case study of the 150 kV KIS – Bangil SUTT Development Project was selected, which is the scope of work of PT. PLN (Persero) Unit Induk Pembangunan Jawa Bagian Timur dan Bali (UIP JBTB). This project is an ongoing project in 2021 and is one of the priorities for project completion by PLN UIP JBTB because it aims to anticipate the increasing demand for

electricity around the Sidoarjo area and its surroundings at this time and in the next few years as well as improving the quality and reliability of electricity distribution to the customer.

In this project implementation in order to complete the appropriate cost, quality, and time, it is necessary to implement risk management. Any project risk management process must be tailored to the particular circumstances of the project and of the organization undertaking it (Del Cañ et al., n.d.).So, the project risk management process in this study is viewed from project owner's point of view. Several problems that often arise in the preparation of management studies, especially at PT PLN (Persero) UIP JBTB, are the subjectivity of risk assessment which is still very high, In ISO-31010 Risk Management - Risk Assessment Techniques 31 methods that can be applied in risk assessment. One of them is the Delphi Technique. In the implementation of the Delphi Technique, there is a weakness that it can only be implemented until the risk identification stage, so that other methods are needed that can continue the risk management process to the analysis, evaluation, and mitigation to risk stages. Then in analyzing and evaluating the Consequence / Probability Matrix and using Bow Tie Analysis in responding to risk.

2. LITERATURE REVIEW

This literature study was conducted by looking for theories relevant to the problem under study. After collecting related theories and research, the authors make comparisons with previous studies. This stage produces a theoretical framework that forms the basis of the research. The difference between this thesis and the results of previous studies is that this research has a different case study. In this study, the application of risk management was carried out on the High Voltage Air Transmission line (SUTT) project by identifying risks using the Delphi Technique, analysis and evaluation using a Consequence / Probability Matrix, then risk mitigation with a Bow Tie Analysis.

3. METHODS

The application of risk management in this study uses the Delphi Technique for identifying risks, analysis and evaluation using a Consequence / Probability Matrix, then risk mitigation with a Bow Tie Analysis.

Delphi Technique is a research approach that is used to obtain a reliable consensus of opinion from a group of experts through a series of questionnaires interspersed with controlled feedback, the opportunity for experts to reconsider their answers, and anonymity between respondents (Chalmers & Armour, 2019)The following are the steps for Risk Identification using the Delphi technique:

a) Selecting Expert Resource Persons who are experienced in the Construction of the SUTT Transmission Project as respondents
b) Prepare similar risk variables based on literature study.
c) Filling out the first questionnaire related to the risk of the SUTT development project by conducting interviews with respondents
d) Filling out a questionnaire from each respondent regarding the proposed risk objective along with the estimated level of Impact and Probability
e) The results of the first questionnaire are said to be consensus if more than 70% of the average value of each item on the questionnaire is three or four Likert scales and has a median value of at least 3.25.
f) Filling in the second round of Delphi questionnaires where all of the respondent's suggestions are included in the questionnaire.

g) Then it is repeated until a consensus is reached

Consequence / Probability Matrix is a method that combines qualitative and/or semi-quantitative assessments of the impact scale and likelihood level to produce a level or risk assessment. The format and definition of the compiled matrix depends on the context in which it is used and what needs to be noted is that the design used must be adapted to the conditions or circumstances, to implementing this method, it is necessary to have criteria for impact scale **Table.1**, likelihood scale **Table. 2**, and a risk level matrix **Figure. 1** that are in accordance with project conditions.

Table 1. Impact Scale

Factor	**IMPACT SCALE**				
	Not Significant	**Minor**	**Medium**	**Significant**	**Very Significant**
Cost	Almost no increase in project costs (Cost Increase ≤ 2%)	The increase in project costs is not significant (2% < Cost Increase ≤ 5%)	The increase in project costs is quite significant (5% < Cost Increase ≤ 10%)	Significant increase in project costs (10% < Cost Increase ≤ 15%)	The increase in project costs is very significant (15% < Cost Increase)
Time	Project completion on time (Progress Delay < 5%)	Completion of the project a little late but does not affect the operation of the system (5% < Progress Delay ≤ 15%)	Project completion is late so it starts to affect system operations operasional (15% < Progress Delay ≤ 35%)	Project completion is so late that it interferes with system operations (35% < Progress Delay ≤ 50%)	Project completion is very late and there is a potential for the project to fail or be delayed (50% < Progress Delay)
Quality	Project or equipment performance targets are met (performance drop ≤ 5%)	Project or equipment performance is down but still on target (5% < performance drop ≤ 10 %)	A decline in project or equipment performance begins to affect system operations (10% < performance drop ≤ 20%)	Low project or equipment performance that interferes with system operations (20% < performance drop ≤ 30%)	Project or equipment performance is so poor that it jeopardizes system operations (30% < performance drop)

Table 2. Likelihood Scale

		Probability	Qualitative Description	Previous Incident
E	**Almost Certain**	> 90%	almost certainly will happen	happened more than once in the last 6 months
D	**Likely**	70% - 90%	most likely will happen	Happened once in the last 6 months
C	**Possible**	>30% - < 70%	the probability is the same between it will happen and not happen	happened 1 time in the last 1 time span
B	**Unlikely**	10% - 30%	unlikely to happen	didn't happen 1 time in the last 1 time span
A	**Rare**	< 10%	almost certainly won't happen	never happened in a span of more than 1 year

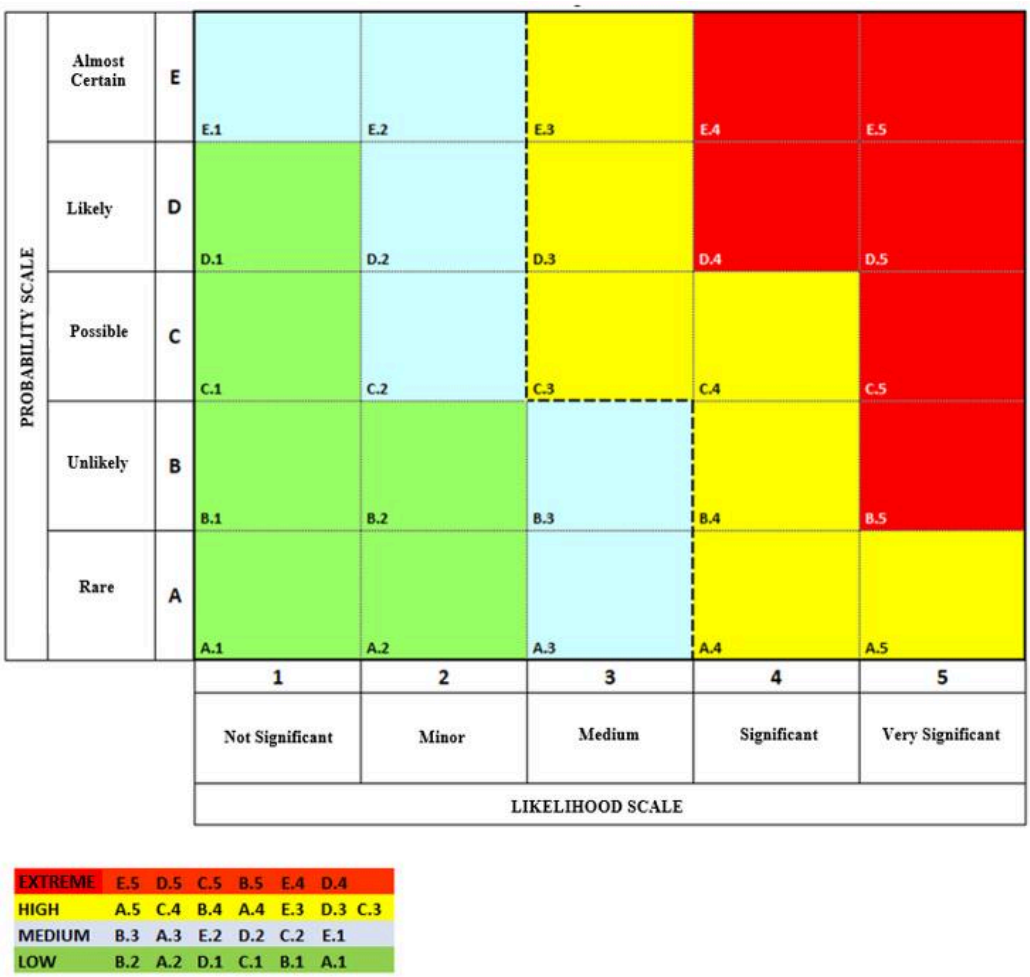

Figure 1. Risk Level Matrix

Bowtie is a diagrammatic method used to describe and analyze the path of a risk from the factors causing the failure to its impact. This method is called Bowtie because the resulting diagram resembles a bow tie with the causes and effects of each being two left and right wings flanking the risk event in the middle. An example of a simple representation of the Bowtie method can be seen in **Figure. 2** below.

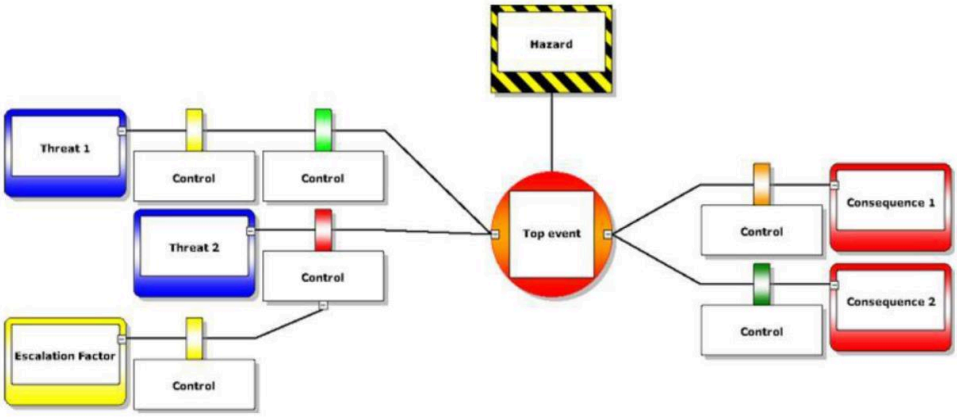

Figure 2. An example of a simple representation of the Bowtie method

4. RESULTS

The implementation of the process is carried out by 5 experts who are experienced in the implementation of electricity projects, the results of the risk identification carried out with Delphi Tecnique reached an agreement after two survey rounds were carried out. The results of risk identification obtained 24 risks then carried out risk analysis and evaluation using the Consequence / Probability Matrix method. The results of the identification, analysis, and evaluation are listed in table 3 below.

Table 3. Risk Identification, Analysis, and Evaluation Results

No.	Category	Risk	Likelihood Scale	Impact Scale	Risk Level
1	Human Resources	Insufficient number of Field Supervisors (PT. PLN)	Possible	Medium	High
2		Work accident	Possible	Significant	**Extreme**
3		Contractors Strike	Unlikely	Significant	High
4		Contractor's Manpower Limitations	Possible	Significant	High
5	Equipment, Facilities, and Infrastructure	Insufficient amount of equipment, facilities and infrastructure	Possible	Significant	**Extreme**
6		Equipment, facilities and infrastructure are not reliable	Possible	Medium	High
7		Damage or loss of equipment	Possible	Medium	High
8	Data and Information	Improper use of technology	Possible	Medium	High
9		Inaccurate planning survey data	Possible	Medium	High
10		Inaccurate reporting of work progress	Possible	Medium	High
11	Construction execution	Non-compliance with Standards and Job Specifications	Possible	Significant	**Extreme**
12		Late Arrival of Materials	Likely	Significant	**Extreme**
13		Delay in Submission and Revision of Approval Drawings	Possible	Medium	High
14		Contractor Performance Less Optimal	Possible	Significant	**Extreme**

No.	Category	Risk	Likelihood Scale	Impact Scale	Risk Level
15		Brand / Design Change	Possible	Medium	High
16		Difficulty in providing access to land	Possible	Medium	High
17		Difficulty in Land Provision and Compensation	Likely	Significant	**Extreme**
18		Natural disasters / extreme weather	Possible	Significant	**Extreme**
19		The commissioning test process is late	Possible	Medium	High
20		The length of the variation order amendment process	Possible	Medium	High
21		Social disturbance at the construction stage	Possible	Medium	High
22	Law	Violation of contract documents	Unlikely	Medium	Medium
23		Delays in resolving legal issues	Possible	Medium	High
24		Asset ownership issues	Possible	Medium	High

From the results of the Risk Level Evaluation according to Table 3 above, it was obtained 1 Risk with a "Moderate" risk level category, 16 Risks with a "High" risk level category, and 7 Risks with an "Extreme" risk level category. Then the Extreme risk mitigation is carried out using Bow Tie Analysis. Based on Astuti (2017) the bowtie method used to analyze the controls for each cause and the controls for each impact on extreme risks. Then mitigation is carried out using Bow Tie Analysis for extreme risk levels.

Bow Tie Analysis method, is a technique that refers to a diagram that describes or visualizes risk events in a simple way. The left side diagram visualization depicts proactive risk management while the right side depicts protective risks. The Bow Tie diagram in this study was initiated or built through a risk response process, brainstorming activities were carried out with the respondents at PT. PLN UIP JBTB in order to obtain causes, impacts and controls to respond to dominant/extreme risks. The preparation of the Bow Tie diagram begins with the purpose of the technique being structured to provide an overall picture of the logic of the risk event scenario and help provide a simple visual explanation of the risk event, its causes and consequences. The next step is to link risk events that can be handled using various technical sections such as the hazard section, peak events, causes and consequences. The last analysis relates to determining the distribution of weaknesses and strengths in the analyzed risks to find impacts and mitigation. Strength analysis describes controls that reduce the likelihood of a peak event occurring and controls that reduce the level of consequences that will be accepted/borne. This analysis ensures that peak events have been managed through the various controls in place. Structured and comprehensive risk analysis in risk assessment so it is very useful for sharing knowledge related to peak events. This method also provides output in the form of a diagram that gives a good picture of a problem, so it is very useful for risk owners in sharing knowledge related to extreme risks to the team in their respective business processes.

From **Table 3** there are 7 risks that have an extreme level of risk. In this research, mitigation is planned using bow tie analysis.

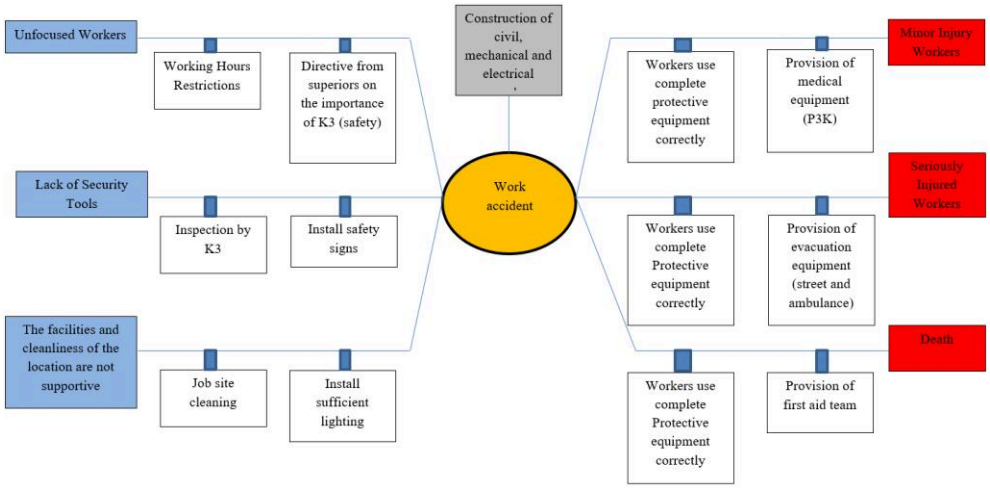

Figure 3. Mitigation of Risk Work accident

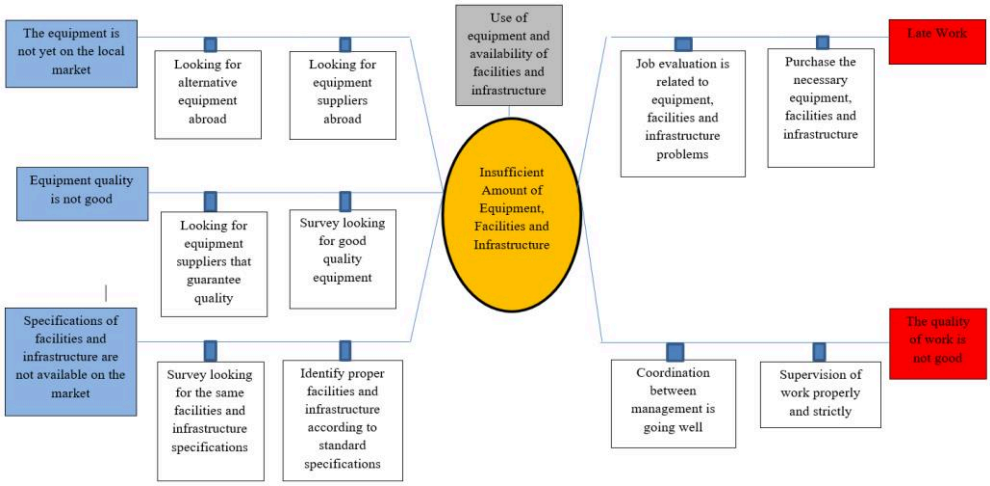

Figure 4. Mitigation of Risk Insufficient amount of equipment, facilities and infrastructure

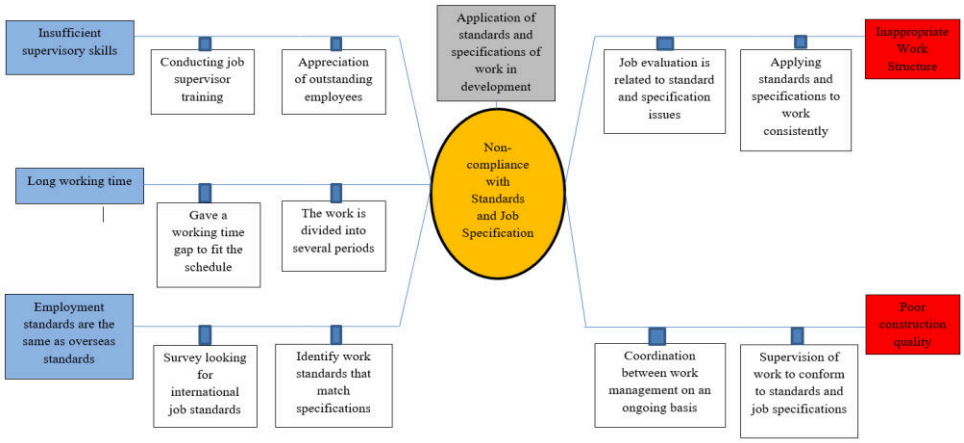

Figure 5. Mitigation of Risk Non-compliance with Standards and Job Specifications

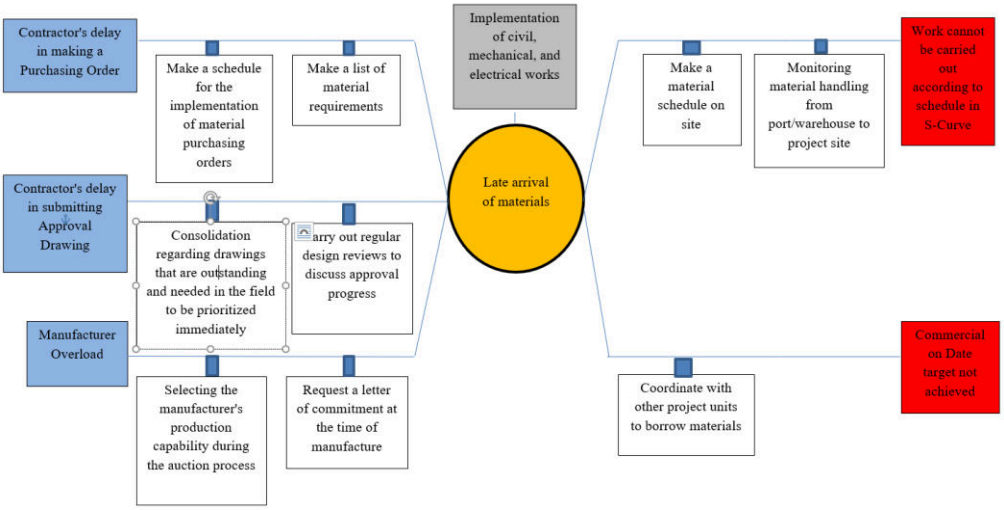

Figure 6. Mitigation of Risk Late Arrival of Materials

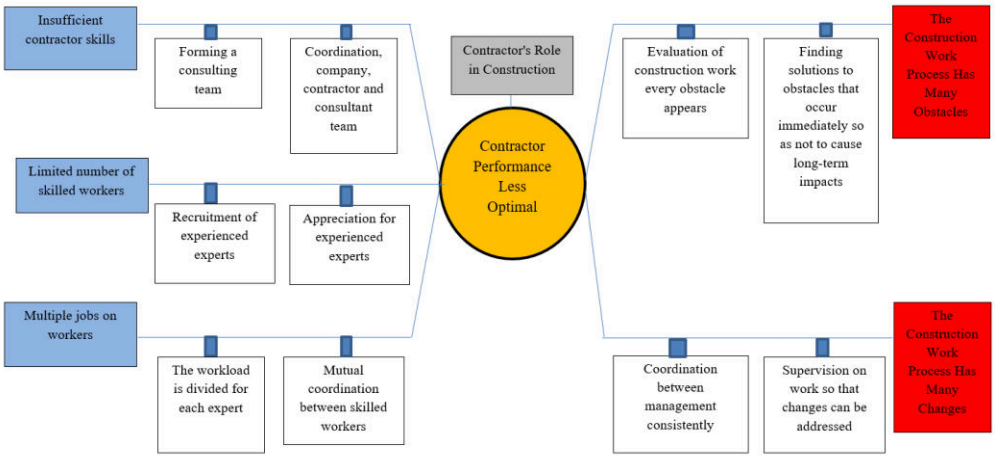

Figure 7. Mitigation of Risk Contractor Performance Less Optimal

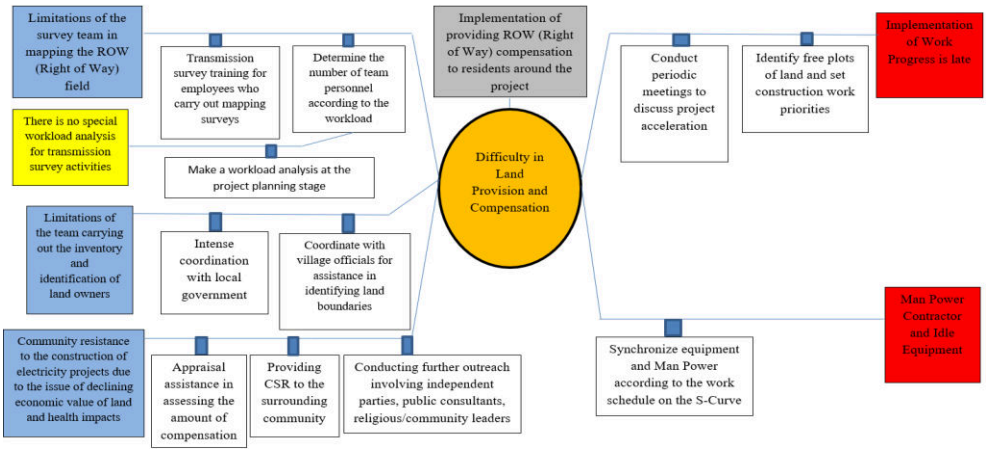

Figure 8. Mitigation of Risk Difficulty in Land Provision and Compensation

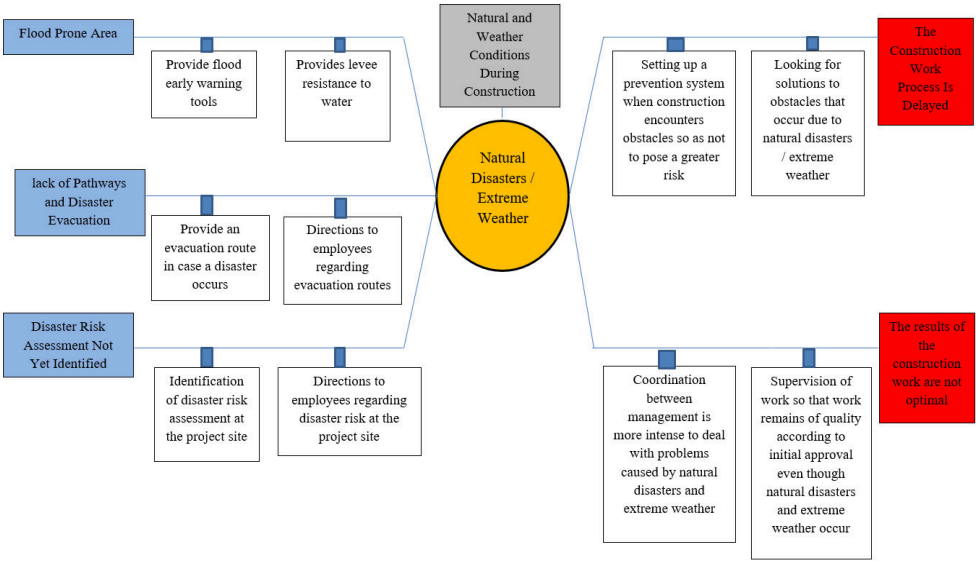

Figure 9. Mitigation of Risk Natural disasters / extreme weather

5. CONCLUSIONS

After identification, analysis, and risk evaluation, it can be concluded that:

1. Risk identification using the Delphi Technique can provide risk identification results that minimize subjectivity, from this study obtained 24 risks that have been consensus from the respondents in the survey.
2. The results of the analysis and evaluation using the Consequence / Probability Matrix on the 24 identified risks resulted in:
   a) 7 Extreme Risks
   b) 16 High-Level Risk
   c) 1 Moderate Risk
3. The causes and impacts on the extreme risks as well as the mitigation controls for the construction of this SUTT transmission network project can be identified through the implementation results in the Bow Tie Analysis diagram.

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OPTIMIZATION OF RAW MATERIALS INVENTORY BY IMPLEMENTING TIME-PHASED ORDER POINT SYSTEM (TPOP) TO REDUCE INVENTORY COST IN THE LUBRICANT INDUSTRY

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ABSTRACT

PT XYZ is a company that produces, distributes, and markets lubricants, greases, and specialty products for national and international market consumers. In conducting its production planning, PT XYZ uses product sales forecasting in a year as a guideline for making material requirements plan that will be used in production activities in the same year. However, in the management of the existing material inventory, some materials were found to be overstocked and/or understocked. The time-phased order point (TPOP) will be applied in the company's inventory management planning with the help of data processing using LINGO software which will provide output in the form of simulation results from the total inventory cost model as well as the schedule and number of orders for each material that became the object of this research. Based on the simulation results of the TPOP application using LINGO software, it was found that the company's inventory cost savings could reach 27 percent of the current actual inventory costs.

Keywords: Inventory management, time-phased order point, material requirements planning.

1. INTRODUCTION

In the manufacturing industry, supply chain management is one of the most important activities in operations and has a direct impact on company performance. Supply chain management is the activity of managing various activities to get raw materials into semi-finished goods and finished goods, then sending these products to consumers through the distribution system (Heizer & Render, 2011). The purpose of supply chain management is to align demand and supply effectively and efficiently. Some of the main problems that exist in the supply chain relate to determining the right level of outsourcing, procurement management, supplier management, managing customer relationships, identifying problems, and responding to these problems, and risk management (Stevenson, 2005).

One way to improve company performance is to reduce expenses to increase profits. There are differences from which side the improvement implementation should be carried out. For companies that implement make to order, improvements can be made from the external side of the company such as logistics integration with suppliers. Meanwhile, for companies that implement make to stock, improvements should be made from the internal side of the company (Olhager & Prajogo, 2012).

The lubricant company in this research is Production Unit Gresik (PUG) of PT XYZ. PT XYZ's line of business is to produce, distribute and market lubricants, greases, and specialty products. The total production capacity of PT XYZ is 540,000 KL/year, with a total domestic production capacity of 480,000 KL/year and overseas production capacity of 60,000 KL/year. However, the availability of additive material stock in the Gresik Production Unit does not always meet the planned minimum stock level and sometimes also exceeds the maximum stock level. The phenomenon of this inventory level discrepancy can be influenced by several factors, one of which is the result of floating demand for finished products which has an impact on fluctuations in material needs. Overstock inventory conditions will have a negative impact on company finances. This is because inventory is part of the company's assets. Therefore, efforts are needed to optimize existing inventory methods so that inventory cost savings can be achieved.

2. LITERATURE REVIEW

Inventories are goods that must be stored for use or sale in the future (Ristono, 2009). With this description, inventory also means company assets and must be managed properly so that it can be utilized immediately to provide added value for the company. Therefore, material inventory must be carried out selectively and pay attention to aspects such as criticality level, length of procurement time and usage value so as not to cause material accumulation that causes inefficiency. In general, inventory serves to provide a continuous supply of materials for the company's operational activities. According to Buchan and Koenigsberg (1977), there are three motives for companies to carry out inventories, namely transaction motives, precautionary motives, and speculative motives. The transaction motive is that inventory exists to meet the demand for goods. While the precautionary motive is intended if inventory exists as an anticipation of uncertainty. The speculative motive is that inventory exists with the aim of gaining more profit from rising prices of goods later.

There are two common problems encountered in inventory problems, namely when and how many orders must be made to meet the production plan that has been set. The first problem can be solved if we know when the need must be met according to the master production schedule (MPS) and lead time. While the second problem can be solved by lot-sizing technique, which is a technique to determine the optimal lot size to meet certain demands. Material Requirements Planning (MRP) was developed to assist the processing of inventory of dependent goods. Herjanto (1997) argues that MRP is a concept in production management, so that the required goods can be available according to the plan. Material Requirement Planning (MRP) identifies how much and when a component is needed according to the master production schedule (Master Production Schedule). By using this method, the procurement (purchase) of the components required for a production plan can be carried out to the extent necessary so as to minimize inventory costs.

Inventory management policies in companies with randomly fluctuating demand are divided into two categories, namely continuous inventory review (continuous review policy) and periodic inventory review (periodic review policy). A continuous inventory review policy is more expensive in terms of costs than a periodic policy, but continuous inspection is very useful to achieve and maintain the desired service level of slow moving materials (Cardos et. al., 2009).

The time-phased order point (TPOP) is a different concept from the usual reorder point concept, where the system is based on the amount of stock or can also be called a quantity-based order point. Time phasing is the range of exposure of goods based on future needs. This method is focused on managing inventory flows within a certain period of time (Erlina, 2011).

Linear programming (LP) is used to optimize models where the objective and constraint functions are linear. This technique can also be used in many fields such as agriculture, industry,

transportation, economics, health systems and social sciences. Linear programming is also very efficient in calculating algorithms for thousands of constraints and variable problems.

Therefore, linear programming with outstanding computational efficiency forms the backbone of algorithmic solutions and operations research models such as integer programming, stochastic programming, and linear programming.

Linear programming has three elements. The decision variable is the solution sought by the model and satisfies all the existing constraints. Decision variables are generally in the form of:

X1, X2, X3, ..., Xn

The objective function is the objective function that you want to optimize in finding a solution. Solution optimization can be done by maximizing or minimizing. The objective function can be:

$$Minimize: \ z(x) = \sum_{i=1}^{n} c_i x_i$$

Or

$$Maximize: z(x) = \sum_{i=1}^{n} c_i x_i$$

The limiting function is an equation or inequality that limits the value of the variable. The form of the limiting function can be:

$$g_i(x)=b_i$$
$$g_i(x)\geq b_i$$
$$g_i(x)\leq b_i$$

Where $g_i(x)$ is a constraint function containing a decision variable and bi is a right-hand side constant.

3. METHODS

The research method in this research is a case study at the Gresik Production Unit PT XYZ. At this stage, literature studies and field studies will be carried out. This research is quantitative in nature where the researcher wants to explore a particular case in depth which involves the collection of various data and information. The literature study was conducted by searching for literature related to this research, either through books, company policy decisions, journals, and previous theses regarding inventory policies and inventory management with unstable demand. The field study was conducted to find out in depth the existing condition of the inventory policy that has been carried out by the company.

After identifying the problem, the next step is to collect the data needed during the research. All data used were taken from the Gresik Production Unit of PT XYZ for a year, namely in 2020. The data needed in this study are:

1. Additive stock data in a year;
2. Data on additive needs in a year;
3. Additive lead time data;
4. Additive inventory cost data;
5. Additive ordering cost data; and
6. Initial inventory level.

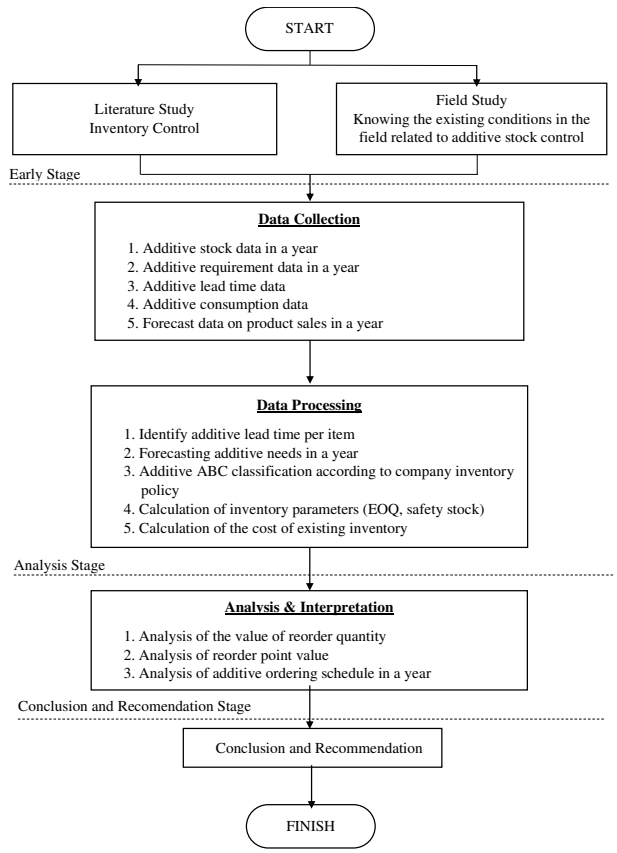

Figure 1. Research Methodology

The Time-Phased Order Point (TPOP) system is a system that resembles MRP with a time-based planning logic for requests for each material item, where the gross requirements are obtained from forecasting not from explosions. Therefore, the calculation of inventory parameters is obtained from forecasting data for additive needs in one year which is derived from forecasting sales of finished products in one year. This demand forecasting data is combined with total material lead time data both in terms of ordering, shipping, and customs clearance. Furthermore, on-hand inventory data is taken from material stock report data from the Gresik Production Unit (PUG) in the same period. Inventory management modeling using linear programming uses calculation elements which can be seen in the following. The following model applies to each type of raw material to be analyzed.

Decision Variables

The decision variable in this optimization model is the amount of material ordered in a certain period. If the variable c_i is the cost of ordering material i, x_{ij} is the amount of material i ordered in period j, n_{ij} is the amount of material inventory i in period j, bi is the average storage cost of material i. For more details, please refer to the following table.

Table 1. Model Decision Variables

Variable	Definition
c_i	the cost of ordering materials i
x_{ij}	quantity of material i ordered in period j
n_{ij}	stock level of material i in period j

Variable	Definition
b_i	average holding cost of material i

Where i = 1..8, with the following details: 1 = item A010101485; 2 = item A011004384; 3 = item A011009355; 4 = item A010153156; 5 = item A010160311; 6 = item A010163181; 7 = item A010180671; and 8 = item A010190448. Meanwhile j = 1..48, with the following example: 1 = order placed on week 1; 2 = the order is placed in week 2; and so on until week 48.

Objective Function

The objective of this optimization model for raw material inventory costs is to minimize the total required costs such as ordering costs and raw material storage costs. Thus, it can be formulated as follows:

$$Minimize\ Z = \sum_{i=1}^{l}\sum_{j=1}^{m} c_i x_{ij} + \sum_{i}\sum_{j} n_{ij}\, b_i$$

Where:
c_i = Cost of ordering material i;
x_{ij} = The number of orders for material i in period j;
n_{ij} = Total inventory of material i in period j; and
b_i = Average storage cost of material i.

Constraint Function

Next, we will discuss the constraint function in this model. There are two types of limiting functions that will be used in this model, namely the amount of beginning and ending inventory for each period, as well as non-negativity which prevents the purchase value and inventory value from being negative. Here are the details:

- Beginning and ending inventory for each period
  Beginning inventory + materials to be purchased - demand = ending inventory

$$n_{ij} + x_{ij} - r_{ij} = n_{i(j+1)} \qquad \forall\, i,\ j$$

- Non-negativity

$$x_{ij} \geq 0 \qquad \forall\, i,\ j$$

$$n_{ij} \geq 0 \qquad \forall\, i,\ j$$

Model Verification and Validation

At this verification stage, running on the model with data on costs, inventories, and material requirements 1 is carried out, namely A010101485. The mathematical model is translated into LINGO and then an experiment is carried out to verify the model and pay attention to the suitability of the solution not violating the constraints of the model. The model has been successfully run on the LINGO software so that the model can be said to have been verified. In Figure 2 a snippet of the results of the running model can be seen.

Furthermore, an analysis of several parameters is carried out for validation. The value that will be seen for conformity is the value of material requirements for each period (r_{ij}), the number of material orders in each period (x_{ij}), and the amount of material inventory in each period (n_{ij}).

The suitability of the need value printed on LINGO will be matched with the need value in the weekly material demand data. It was found that there was a match between the needs printed in LINGO and the weekly material demand data.

Furthermore, the two variables of the number of material orders in each period (x_{ij}), as well as the amount of material inventory in each period (n_{ij}) will be observed. These two variables are variables that cannot be negative in accordance with the limiting function. From the LINGO output, it can be concluded that all the values of the two variables do not violate the constraints, that is, they are not negative. From all these checks, it was found that the model has found the optimal solution without violating the specified constraints.

Furthermore, model validation is carried out by testing the model with extreme parameters. The test variable that will be used to validate this model is the storage cost variable (b_i). To carry out validation, the amount of material storage costs A010101485 will be reduced to 20 percent of the original storage. In theory, the lower the storage cost, the larger the lot of purchases that will be made, and vice versa.

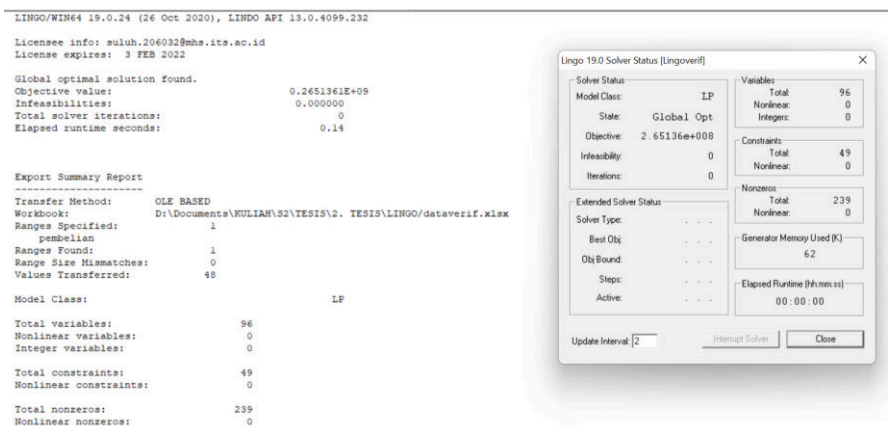

Figure 2. Snippet of Running Model Verification Results in LINGO

X(1, 1)	125.3921	0.000000
X(1, 2)	0.000000	66127.65
X(1, 3)	0.000000	65120.86
X(1, 4)	0.000000	64114.08
X(1, 5)	0.000000	63107.29
X(1, 6)	0.000000	62100.51
X(1, 7)	0.000000	61093.73
X(1, 8)	0.000000	60086.94
X(1, 9)	0.000000	59080.16
X(1, 10)	0.000000	58073.37
X(1, 11)	0.000000	57066.59
X(1, 12)	0.000000	56059.80
X(1, 13)	0.000000	55053.02
X(1, 14)	0.000000	54046.24
X(1, 15)	0.000000	53039.45
X(1, 16)	0.000000	52032.67
X(1, 17)	0.000000	51025.88
X(1, 18)	0.000000	50019.10
X(1, 19)	0.000000	49012.32
X(1, 20)	0.000000	48005.53
X(1, 21)	0.000000	46998.75
X(1, 22)	0.000000	45991.96
X(1, 23)	0.000000	44985.18
X(1, 24)	0.000000	43978.40

Figure 3. Amount of Material Purchase Lot After Storage Cost Decrease

It can be seen in the Figure 3 that the calculation results show a large number of lot purchase in Period 1. This phenomenon is in line with the theory that the smaller the storage cost, the larger the lot of purchases that will be made. The purchase period is also carried out in advance because the storage cost is much smaller, so stacking inventory for a long time is not a problem.

This shows that the designed model is valid and can be applied to the full modeling that will be carried out in this study.

4. RESULTS

4.1. Purchasing VS Demand

Material purchase analysis begins by extracting the material purchase schedule calculated by LINGO and pouring it into a graph to make it easier to understand and compare it with the level of material needs per period. The first curve in blue is the total Purchase Curve of the eight materials. While the second curve in orange is the total Order Curve of the eight materials. The two curves are then poured into the same graph area, resulting in a graph of purchases vs material requirements as shown in Figure 4. It can be seen in the graph that there was a high order value (spike) in the first week. This is because there is a large difference in the level of the existing inventory stock from the previous period compared to the desired stock level to meet material demand in a timely manner, so that orders in high quantities are made to catch up with the desired stock level to achieve a stock level that can meet needs. at the appropriate time. This phenomenon is the goal of implementing the time-phased order point (TPOP) system, namely the fulfillment of the inventory level with the right amount, at the right time by considering the lead time of each material. In addition, it can be seen on the graph that there is a purchasing curve that resembles a shadow with a demand curve that starts at the meeting point of the two curves, which is the 20th week period. overall, because the existing stock of each material has been consumed by the need to reach a balanced inventory level, where later if there is an additional material stock level, the additional inventory level of each material will be in line with the number of orders.

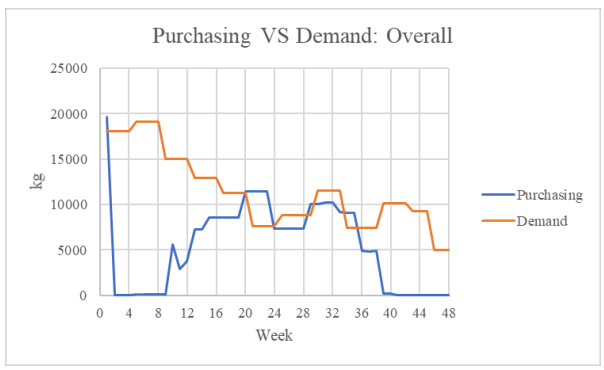

Figure 4. Purchasing VS Demand: Overall

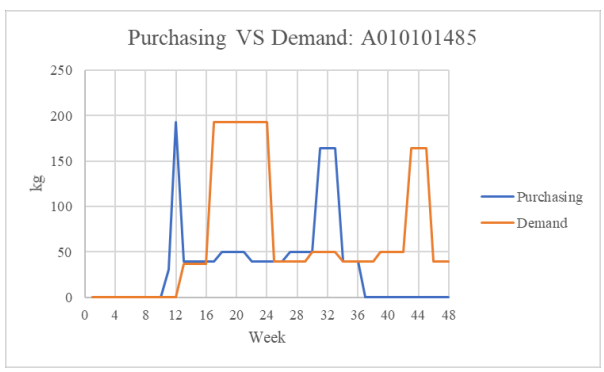

Figure 5. Purchasing VS Demand: A010101485

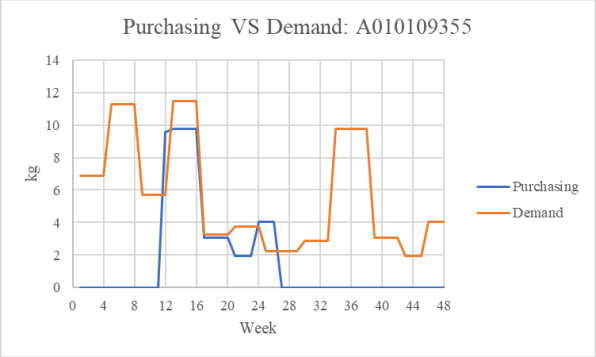

Figure 6. Purchasing VS Demand: A010109355

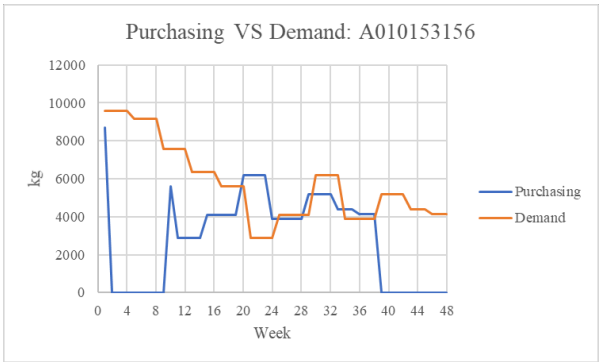

Figure 7. Purchasing VS Demand: A010153156

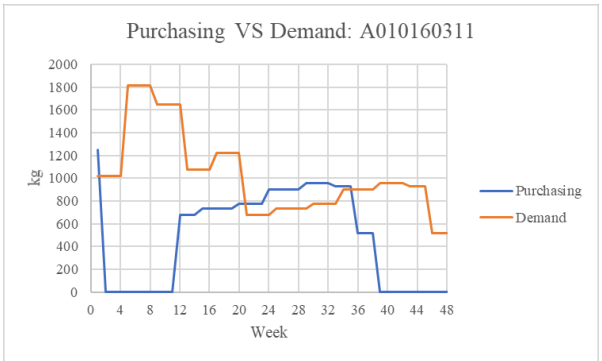

Figure 8. Purchasing VS Demand: A010160311

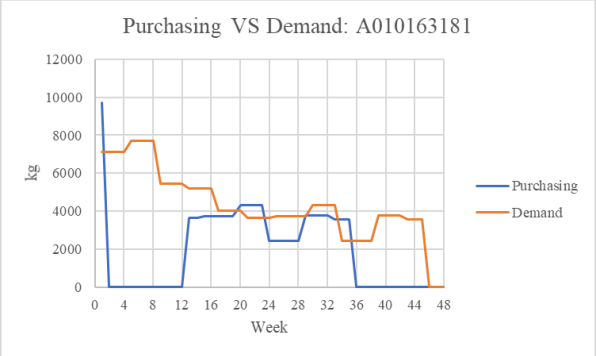

Figure 9. Purchasing VS Demand: A010163181

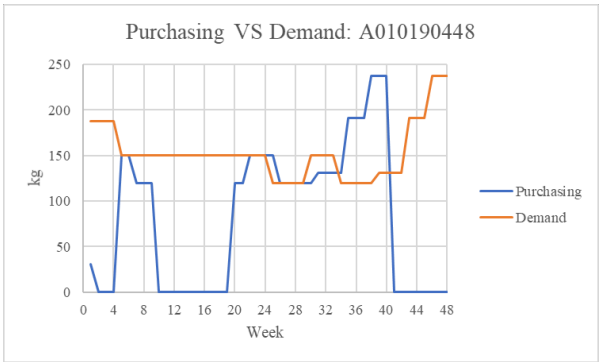

Figure 10. Purchasing VS Demand: A010190448

4.2. Total Inventory Cost

In addition to output analysis in the form of schedules and the amount of material ordered, the model processed using the LINGO program also produces output in the form of a simulation of the total cost of the Gresik Production Unit (PUG) inventory in the analyzed period. The total output of PUG inventory costs for one year resulting from the simulation is Rp. 34,998,350,000.00. The value of this inventory is less than the value of the actual inventory issued by the company in the same period for the same group of materials. The comparison can be observed on the following table.

From Table 2, it can be concluded that there is a potential savings of 27%, or Rp. 12,848,198,309.00 if the company applies the Time-Phased Order Point (TPOP) method in its inventory management, compared to the actual total cost of inventory in 2020, which is Rp. 47,846,548,309.00. This shows that the application of the TPOP method in the company's inventory management can be a recommendation for improving inventory management of existing companies and can provide added value in the form of saving inventory costs so that it has the potential to increase profits and allocate more capital for other operations for the company.

Table 2. Comparison of Total Actual Inventory Cost with TPOP Metode Method

Total Actual PUG Inventory Cost Class A Materials 2020	Total Cost of PUG Inventory Class A Materials with TPOP Method	**Savings**	Savings Percentage
Rp 47,846,548,309.00	Rp 34,998,350,000.00	**Rp 12,848,198,309.00**	27%

5. CONCLUSIONS

Based on the results of research that has been carried out by the author, several conclusions can be drawn as follows:

1. The optimization model that has been made based on the TPOP (Time-Phased Order Point) method can be applied to the additive inventory management case of PT XYZ company to determine the reorder point for each additive material and shows the potential for inventory cost savings, which is Rp. 12,848,198,309.00 or 27% of actual inventory cost in the same period, which is Rp 47,846,548,309.00.
2. Recommendations for improving inventory management for companies are to adapt the optimization model based on TPOP (Time-Phased Order Point) in stages, starting with

Class A Additive Material which is 20% of the core additive material group which has 80% (critical) share in operations. production.

3. For overstocked and understocked material, the company may consider sending the excess material stock to another Production Unit that has a greater need for overstocked material at the Production Unit Gresik. And also sending the excess material stock from other Production Units to the Production Unit experiencing understock (in this case the Gresik Production Unit or PUG). So that in addition to reducing inventory costs, ordering costs can also be reduced because the shortage of materials in the Production Unit that requires more can be fulfilled without placing an order with the vendor of the material concerned.
4. The delivery scheme between Production Units can be carried out not limited to one type of material in one shipment, but it can be done by mixing the types of materials with each other so that material delivery between Production Units can be more efficient. This is because the mixing of material types can minimize the possibility of empty space in the transporter fleet so that shipping costs per unit weight of material can be reduced.

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SUSTAINABILITY ASSESSMENT OF NON-METAL AND ROCK MINERALS MINING PROJECT USING FUZZY COMPREHENSIVE ASSESSMENT METHOD

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ABSTRACT

Mining Projects extract rock and non-metal minerals as one of the abundant commodities that are non-renewable. Mining sustainability assessment conducts to measure the implementation of weak sustainability concepts on mineral resources exploitation. Assessment framework discovers experts' ideas to depict a better definition of mining sustainability. Exploiting humans though to make the concept representable Analytic Hierarchy Process (AHP) is better than Multi-Criteria Decision Analysis (MCDA). The AHP structures create a sustainability assessment framework that interconnects a set of indicators. The fuzzy set theory adds to AHP to handle human preferences that contain subjectivity. Fuzzy Comprehensive Assessment (FCA) was employed to combine both methods to minimize the weakness. The results indicate that the FCA method is appropriate to evaluate mining sustainability because it has fairly high reliability. Sensitivity analysis points out the assessment system developed is reliable in value and weight fluctuations of ±10%. The reliability of FCA is good considering the uncertainty in collecting data and defining the weight of indicators.

Keywords: Mining sustainability assessment, Fuzzy Comprehensive Assessment, Sustainable Development, Analytic Hierarchy Process.

1. INTRODUCTION

Indonesia occupies the top position as the world's leading producer of metallic minerals and coal according to data from World Mineral Production 2014-2018 published by the British Geological Survey (2020). In addition, non-metallic minerals and rocks abundance much higher concentrations in Indonesia, including East Java. The concentration of mineral deposits is influenced by regional geological processes in producing mineral resources that are economical to mine.

The abundance of mineral resources needs to be well-managed considering that mineral resources are non-renewable. Therefore, it is necessary to adopt the concept of weak sustainability to define mining sustainability by applying HPHS rules (Hartwick (1977) on Kommadath et al.,

2012). It solves the multi-generation ethical problems by avoiding the over-consumption of mineral resources (Kommadath et al., 2012). That concept needs implementation because the depletion of mineral reserves can't be avoided.

2. LITERATURE REVIEW

In line with the concept, *World Commission on Environment and Development* (WCED) United Nations (1987) introduced sustainable development principles which define fulfilling present demand without sacrificing future generations to fulfill their needs (Asr et al.,2018). Sustainable development become a world consideration because of some researcher concerns (Que,2018), among others: the environmental impact of metal distribution in the Congo (Pourret, 2016), metal rate of depletion (Arndt, 2017), the sustainability of mineral extraction at the local level in Russia (Suutarinen,2015), stakeholders recommendations for mining sustainability in Colombia (Franco, 2018), good mining practices and community development in Poland (Wozniak, 2018), and development of the integrated model for assessing the level of sustainable development in coal mining (Kopacz, 2017).

This consideration needs multi-criteria evaluation as an input of the decision-making process to engage sustainability assessment on the mining sector (Boggia & Cortina, 2010). Mining sustainability assessment requires a set of mining sustainability indicators to break the assessment objectives (Azapagic, 2004). This indicator framework serves the assessment framework that constructs by selecting an appropriate methodology (Krajnc and Glavic, 2005). More research is required to make the aggregation methodologies credible by creating primary data more relevant and comprehensive(Statistics Finland (2003) on Krajnc and Glavic, 2005).

Multi-Criteria Decision Analysis (MCDA) seems straightforward but unrepresentative to the weak concept of sustainability understanding from Arrow's Theorem point of view (Bai et al., 2019). Analytic Hierarchy Process (AHP) that still tolerates the subjectivity coming from human preference is more suitable better than MCDA (Nuong et al.,2011). Adding fuzzy concepts is required because human thought always contains uncertainty nearing preferences (Nuong et al.,2017). To combine the two powerful methods, a Fuzzy comprehensive assessment can be a good choice for assessing mining sustainability (Bai et al.,2019).

3. METHODS

Identification of a set sustainability indicator to represent sector-specific analysis is conducted to provide a credible methodology. An appropriate method must be applied to build an interconnection between indicators in sustainability assessment frameworks (**Figure 1**). A group of mining experts is involved to point out a minimum representation of how sustainability assessment should be defined. Experts justify the relevancy of indicators by giving a score on a questioner scale given.

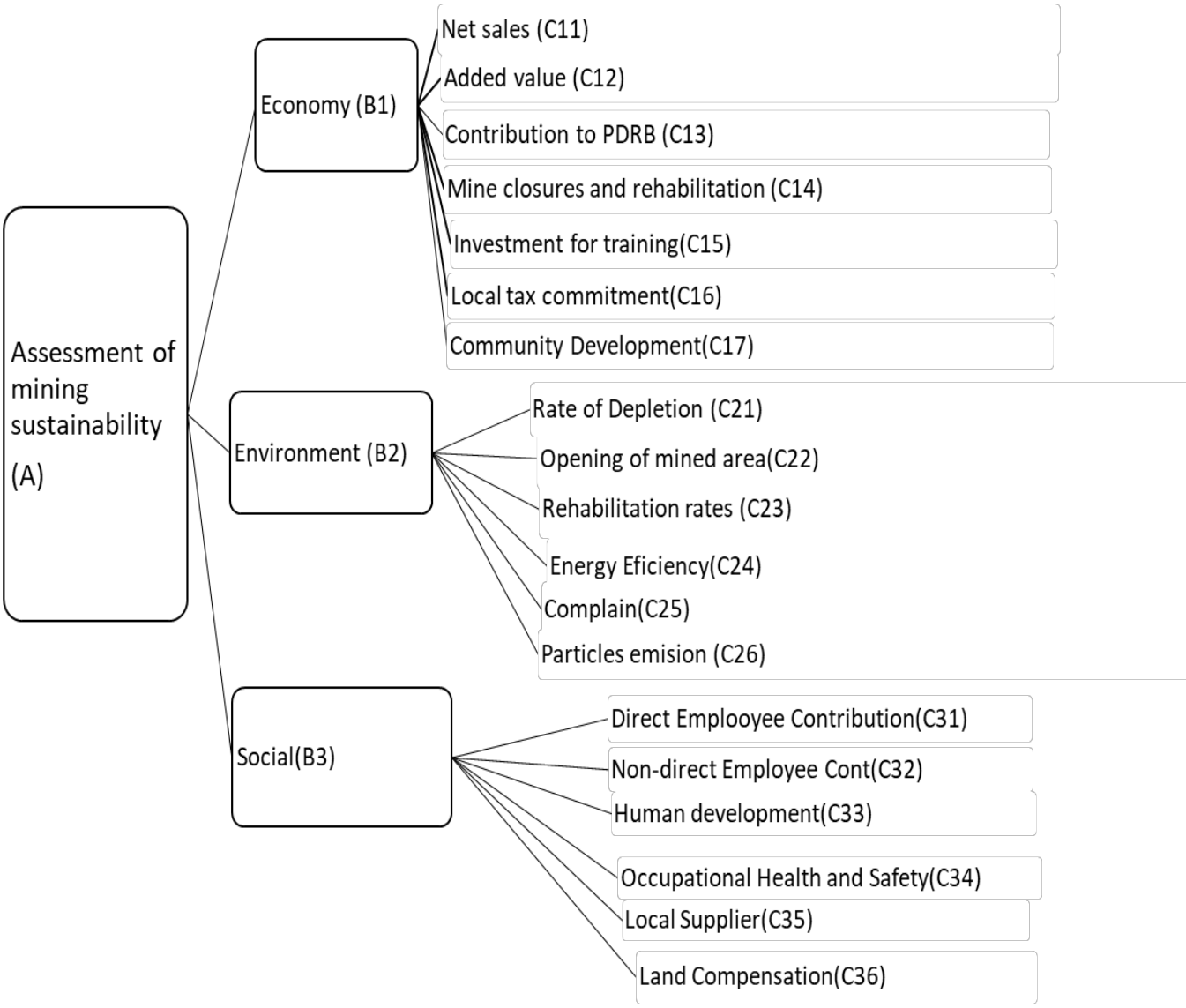

Figure1. The framework of mining sustainability indicators

Figure1. show the number of indicators declared as relevant that shall be occupied for the next step in developing an assessment system. The framework of sustainability indicators consists of the attribute of the economy aspect (B1), attribute of the environment aspect (B2), and attribute of social aspect (B3). Seven indicators declared relevant as an attribute of the economy (B1), among others: Net sales (C11), Added value (C12), Contribution to PDRB (C13), Mine Closures and Rehabilitation (C14), Investment for training (C15), Local tax commitment (C16) and Community Development (C17). Six indicators were declared relevant as an attribute of the environment (B2), such as Rate of depletion (C21), Opening of mined area (C22), Rehabilitation rates (C23), Energy Efficiency (C24), Complain (C25), and Particle emission (C26). Six indicators declared relevant as an attribute of social (B3) such as Direct employee contribution to local economy (C31), Non-direct employee contribution to the local economy (C32), Human Development(C33), Occupational Health and Safety(C34), Local supplier (C35) and Land Compensation(C36).

A suitable method sets the framework of mining sustainability indicators mentioned in **Figure1**. into the framework of sustainability assessment in the mining sector (Boggia and Cortina, 2010). The utilization of FCA method adopted from Bai et.al (2019) can be described in **Figure 2**.

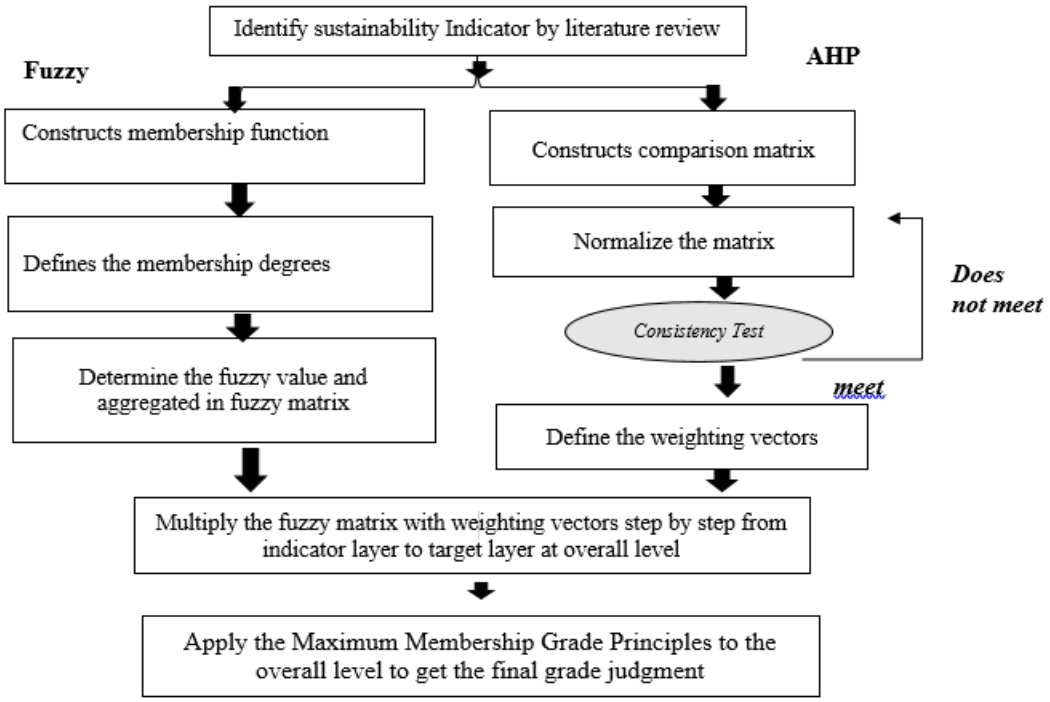

Figure 2. FCA in mining sustainability assessment

Figure 2 describes that data collection and processing consist of two main processes (AHP and fuzzy). AHP was applied to bring prioritization by using AHP fundamental scale. This prioritization generates a comparison matrix that is normalized to check the consistency. If the consistency test does not meet, the prioritization must be repeated. But if the consistency test passes, the eigenvectors are performed by squaring the matrix.

On the other hand, a fuzzy process needs input data for quantitative and qualitative indicators. The data can be obtained by extracting numbers and functionally defining the grade of indicators based on evaluation document standards. Both of them are requested the expert justification gained from a structured interview. The interview results were aggregated to define baselines of each assessment grade that construct the membership function.

The membership function maps the measurement result into membership degrees of each assessment grades on the indicator layer. Grades of the attribute layer proceed by augmenting that membership degree and weight on the indicator layer. This process leads to the overall level by contributing membership degrees and weight at the attribute layer. In the end, the principle of maximum membership degree applied to the membership degrees of overall level to determine the final grade judgment (Bai et al.,2019).

4. RESULTS

A case study on a mining project on East Java conducts to test the developed assessment system. Some questions are arranged to get a measurement of the sustainability performance of a non-metal and rock mining project **(Table 1.).**

Table1. The assessment result of mining project sustainability performance

Attribute index	Indicator Index	Unit	Hasil Pengukuran	Membership of indicator index (C-layer)			Membership of attribute index (B-layer)		
				L1	L2	L3	L1	L2	L3
B1	C11	%	100	1.000	0.000	0.000	0.864	0.136	0.000
	C12	%	100	1.000	0.000	0.000			
	C13	%	15	0.012	0.988	0.000			
	C14	-	4	1.000	0.000	0.000			
	C15	%	3	0.000	1.000	0.000			
	C16	-	3	1.000	0.000	0.000			
	C17	-	3	1.000	0.000	0.000			
B2	C21	%	3	0.885	0.115	0.000	0.510	0.215	0.275
	C22	%	70	0.000	0.400	0.600			
	C23	%	15	0.000	0.375	0.625			
	C24	%	3	1.000	0.000	0.000			
	C25	-	2	1.000	0.000	0.000			
	C26	-	3	1.000	0.000	0.000			
B3	C31	%	15	0.000	0.001	0.999	0.401	0.167	0.431
	C32	%	85	0.769	0.231	0.000			
	C33	-	3	1.000	0.000	0.000			
	C34	-	3	1.000	0.000	0.000			
	C35	%	60	0.259	0.741	0.000			
	C36	-	2	0.000	1.000	0.000			
Overal Level							0.669	0.171	0.160

The measurement result on the fourth column in **Table 1** maps into membership degree using half-trapezoidal membership function and triangular membership function on indicator layer. Membership degree on three assessment grades (L1=Strong sustainability/Optimum Level, L2 =Weak sustainability, and L3=Almost unsustainability) bring up from indicator layer to target layer using weight vectors. The overall level score is a membership degree resulting on the target layer where the maximum membership grade can apply to gain the final grade judgment. Therefore, L1 grades were declared as the result of FCA with a score of membership degrees on an overall level of 0.669.

Sensitivity analysis shows that membership degrees at the overall level in the fluctuation range of ± 10% are not sensitive to changes in weights and values, although it is less sensitive at the indicator layer. The reliability of FCA is good considering the uncertainty in collecting data and defining the weight of indicators.

6. CONCLUSIONS

Implementation of mining sustainability can be assessed by employing a set of indicators relevant to the sector. A set of indicators stated as relevant by some experts who has a proper qualification in managing non-metal and rock mining commodities. The method applied for sustainability assessment should represent the problem definition of weak sustainability concept and changes the indicator framework into a reasonable assessment result. The conclusion is FCA has quite good result to be implemented and has good reliability to produce a reasonable assessment result on mining sustainability assessment.

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PRIORITIZING OF REPAIR WORKS IN PIPELINE AND GAS DISTRIBUTION FACILITY USING AHP-TOPSIS

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ABSTRACT

Gas distribution company in Indonesia PT. PXY performs annual repairs to protect the integrity of the gas pipeline system from failure. The problem faced is that the budget has decreased significantly and the number of works submitted by the O&M division is numerous, so it is necessary to make a priority. It is hoped that priority setting can be carried out objectively and measurably. The AHP method is very suitable to determine the weight of the criteria objectively, then proceed with the TOPSIS method in prioritizing alternatives based on the ideal solution distance. A combination of these two methods is used to minimize weaknesses. The results showed that the combination of AHP-TOPSIS is appropriate to use in prioritizing of repair works in pipeline and gas distribution facility because it has a consistency value of <0.1 and the alternative is as expected. Obtained 6 important criteria in determining priorities, namely Asset Performance, then followed by Maintenance Level, Safety, Asset Condition, Environment and Operating Life. Eventually, repair works are prioritized that have a bad history during operation, lack of routine maintenance and have the potential to impact the safety of employees or local residents.

Keywords: Pipeline & Facility, Gas Distribution, Prioritization, AHP, TOPSIS.

1. INTRODUCTION

Natural gas is one of the alternative energy sources that is worth considering, it is common knowledge that oil reserves in the world are currently running low. Pipeline is a technology in flowing fluids such as oil, gas or water in very large quantities and long distances through the sea or certain areas. Aging of distribution pipelines is the cause of leakage and also has an impact on social and economic damage (Shin et al., 2016). With the passage of time, the distribution pipeline or gas facility will experience fatigue and decrease in function, to maintain the integrity of these assets, repair work is carried out every year. Due to limited resources and time, prioritization is needed. The decision-making method that will be used to determine the influential criteria in repair work is AHP, while evaluating alternatives is TOPSIS. These two methods include MCDM (Multi-Criteria Decision Making) which is able to choose the best criteria from a number of predetermined criteria. The advantage of the AHP method is the pairwise comparison process (comparing the criteria in pairs) so that an accurate weight value is obtained from the importance of each of the existing criteria. The results of the application of AHP combined with TOPSIS can sort the best alternative based on the ideal solution distance. Wijonarko (2017) and Wang & Duan (2019) also uses a combination of these two methods in prioritization and risk evaluation.

2. LITERATURE REVIEW

Pipelines is one of the structures that acts as a means of fluid transportation, generally it can be divided into 2, namely offshore pipelines which functions to distribute sour gas from one platform to another (upstream business) and onshore pipelines which functions to distribute sweet gas that has gone through several processes to the customer (downstream business). The advantage of this pipeline is that it can meet the transportation needs of production products more quickly than using a temporary form of oil or gas storage unit. A regulator is required in each pipeline in a high-pressure distribution system to manage the pressure provided to the customer.(ASME B31.8, 2012). Through the regulation of pressure and flow rate at the Offtake Station, Meter Regulating System (MRS) and a series of various valves, finally gas can flow through various diameters and pressures according to the needs and business characteristics of each customer. The challenges in managing the gas distribution system are the installation of underground pipelines in densely populated areas and pipeline failures due to time-dependent mechanisms such as corrosion as well as time-independent mechanisms such as geohazards (Bianchini et al., 2018).

Prastiawan (2019) conducted research using the Analytical Hierarchy Process (AHP) method combined with the cluster technique. According to Prastiawan, the combination of the AHP and cluster methods can determine priority rehabilitation programs and the criteria for the causes of leaks that have the most influence on the drinking water distribution pipeline. Wang & Duan (2019) used the integration of the AHP Method and the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) to evaluate risks in oil and gas pipelines. AHP analysis was carried out to obtain the weight of each criterion. Then, TOPSIS is used to determine the level of risk of each alternative, the level of risk obtained from the integration of the AHP-TOPSIS method is compared with empirical analysis of the Adjustment Factors method. The results show that the evaluation of the oil and gas pipeline model uses the AHP-TOPSIS assessment is feasible.

The AHP analysis began with each variable being assigned a priority value, followed by pairwise comparisons of the current variables and alternatives (Nur et al., 2016). This method also combines the strength of sentiments and logic in many difficulties, then synthesizes a variety of considerations into results that intuitively match our estimates as provided in the considerations that have been made (Saaty, 2008).The alternative selection using TOPSIS is chosen by taking into account the shortest distance from the positive ideal solution and the farthest distance from the negative ideal solution (Jozaghi et al., 2018). This approach was chosen because it provides a scalar number that describes both the best and worst alternative choices at the same time, as well as a straightforward computational procedure that can be simply written into a spreadsheet (Pelorus & Karahalios, 2017). The combination of AHP & TOPSIS is a methodology that allows us to reduce uncertainty and information loss in group decision making, so this combination guarantees a robust solution for the company (Efe, 2015).

3. METHODS

To determine the priority of repair works in pipeline and gas distribution facility objectively and measurably, this study is based on a literature review to identify criteria and alternatives, an AHP analysis to weight criteria and sub-criteria, and a TOPSIS analysis to evaluate the priority of alternative. The AHP approach has been widely used to address complicated problems, however its weakness in analyzing only one-sided solutions necessitates combining it with other MCDM in some circumstances. Similarly, the TOPSIS technique is frequently chastised for its failure to deal with ambiguity and imprecision in the process of mapping decision makers' perceptions, despite its widespread use and conceptual simplicity (Krohling & Campanharo, 2011). Therefore, in this study, a combination of AHP-TOPSIS will be

used which can complement each other and cover the shortcomings with their respective advantages. According to a literature review, the following factors are deemed relevant for assessing the priority of repair work (**Figure 1**).

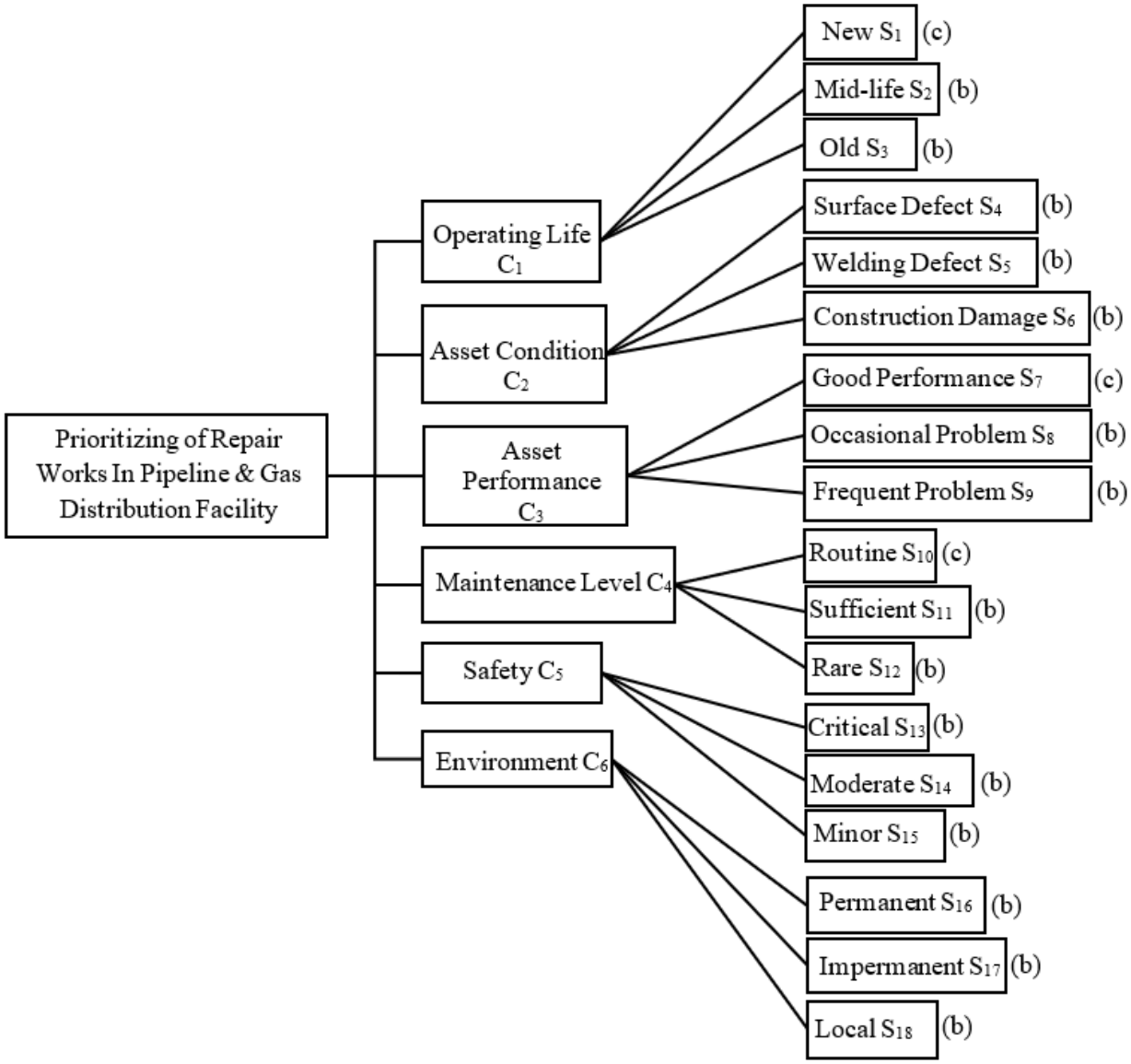

Figure 1. Index System of Priority Repair Works

Figure 1 shows all the factors that are important in determining the priority of repair works in pipeline and gas distribution facility obtained from the literature study. According to Prastiawan (2019) and the Assets Health Index (AHI) of PT. PXY, operating life has an influence in the selection of distribution pipeline replacement work. In addition, AHI also mentions that Asset Condition, Asset Performance and Level of Maintenance have an important role in assessing the health of these assets. The impact on safety and the environment is also a consideration in choosing priorities for repairing oil and gas pipelines (Wijonarko, 2017). The symbol (c) in **Figure 1** means that the factor is included in the cost sub-criteria (the preferred sub-criteria if it has a low value), while the symbol (b) for the benefit sub-criteria (the preferred sub-criteria if it has a high value), this provision needs to be considered when conducting a TOPSIS analysis.

Table 1. Alternatives

Alternatives	Code	Type of Asset
Sacrificial Anode Replacement Work 15 Locations	A-1	Pipeline
Gunung Sari Indah Pipeline Looping Work in 2 Locations	A-2	Pipeline
Revocation of MRS Ex-Customer PT Duta Cipta 2 (G160)	A-3	Facility
Fire Suppression System Repair Work in Tandes Offtake Station	A-4	Facility
Valve Block Repair and Elevation Works	A-5	Pipeline
Gas Stake and Marker Post Manufacturing and Installation Works	A-6	Pipeline
MR/S Check Valve Addition Work in 8 Locations	A-7	Facility
OSH Support System Repair Work at Ofttake Station Pasuruan	A-8	Facility
Replacement Valve Passing in Kalisogo & Semare Offtake Station	A-9	Facility
Overhaul Orifice Works in Kalisogo Offtake Station	A-10	Facility

Table 1 shows the 10 alternatives to be studied, the selection based on the results of the company's risk assessment is used as one of the considerations, then proceeds to eliminate alternatives for similar repair work.

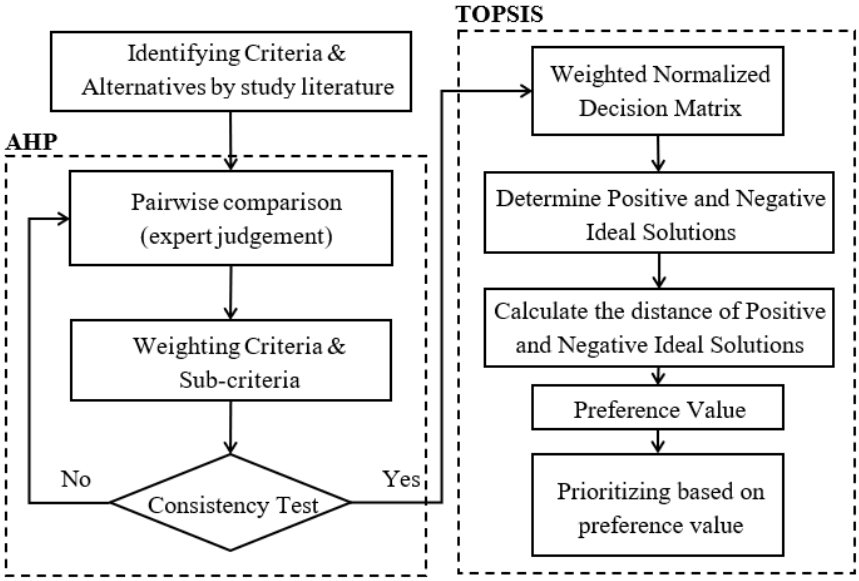

Figure 2. AHP-TOPSIS In Prioritizing Of Repair Works

Figure 2 explains the process flow of this research that data collection and processing consists of two main methods, namely AHP and TOPSIS. the first step is to identify important factors and alternatives to be researched based on literature study. The AHP process begins by conducting pairwise comparisons with the Saaty rating scale (expert judgment), weighting the criteria and sub-criteria and conducting a consistency test with the AHP rules (Harianti & Purnomo, 2019). If the Consistency test does not meet, then the pairwise comparison will be repeated. But if the consistency test meets the requirements, the process will proceed to the TOPSIS analysis.

The next method is TOPSIS analysis, according to Roszkowska (2011) this method begins with making a normalized decision matrix and multiplied by the weights that have been obtained previously, determining positive and negative ideal solutions, calculating the distance of positive (Si+) and negative ideal solutions (Si-) and finally calculating preference value.

The results from the combination of the two main methods will be used to prioritize the repair works in pipeline and gas distribution facility. From 10 alternatives, the one with the highest priority will be searched, the one with a greater preference value than the others will be selected.

4. RESULTS

The results of expert judgment from six respondents are merged in the first phase to create a comparison matrix between criteria and sub-criteria, which will subsequently be utilized to calculate weights.

Table 2. Pairwise Comparison Between Criteria

Pairwise Comparison	C_1	C_2	C_3	C_4	C_5	C_6
C_1	1	0.389	0.188	0.501	0.520	0.907
C_2	2.572	1	0.417	0.723	0.585	0.767
C_3	5.320	2.396	1	3.689	1.054	1.442
C_4	1.995	1.383	0.271	1	1.182	3.249
C_5	1.923	1.710	0.949	0.846	1	1.337
C_6	1.103	1.303	0.693	0.308	0.748	1

Table 2 presents pairwise comparisons between criteria that have their respective levels of importance, the results of the assessment have been simplified to be used as the basis for calculating the weight of each criterion. For sub-criteria, the same steps are also carried out.

The second phase, the stage of weighting the criteria, is to add up the comparison matrix by dividing the value of the importance of each row by the number per column, then dividing by the number of criteria, as well as the sub-criteria.

Table 3. The Important Factor Weights

Criteria (1st-index)	First Weight	Sub-criteria (2nd-index)	Second Local Weight	Second Global Weight
Operating Life C_1	0.074	New S_1	0.069	0.005
		Mid-life S_2	0.230	0.017
		Old S_3	0.701	0.052
Asset Condition C_2	0.121	Surface defect S_4	0.123	0.015
		Welding defect S_5	0.511	0.062
		Construction damage S_6	0.366	0.044
Asset Performance C_3	0.320	Good Performance S_7	0.057	0.018
		Occasional Problem S_8	0.259	0.083
		Frequent Problem S_9	0.685	0.219
Maintenance Level C_4	0.185	Routine S_{10}	0.064	0.012
		Sufficient S_{11}	0.208	0.039
		Rare S_{12}	0.728	0.135
Safety C_5	0.179	Critical S_{13}	0.757	0.136
		Moderate S_{14}	0.191	0.034
		Minor S_{15}	0.052	0.009
Environment C_6	0.120	Permanent S_{16}	0.769	0.093
		Impermanent S_{17}	0.130	0.016
		Local S_{18}	0.101	0.012
Consistency Ratio Criteria = 0.07 Consistency Ratio Sub-Criteria = 0.09				

Table 3 illustrates the results of utilizing the AHP approach to weight criteria and sub-criteria. The consistency ratio derived using Eqs. (1) and (2) is 0.07 for the weighing of criteria and 0.09 for the weighting of sub-criteria. When the consistency ratio is less than 0.1, it signifies that the weights were determined in a consistent and valid manner. The highest criterion weight is

Asset Performance C_3 (0.320) compared to other criteria, proving that the respondents have satisfaction and focus on customer satisfaction because the performance of problematic assets, continuity of gas supply to customers will be disrupted. The results of the weighting of asset performance criteria are also in line with one of the corporate cultures of PT. PXY stands for Excellent Service, putting the needs of both internal and external customers first and offering the best service possible. Then, for the 2nd highest criterion, namely Maintenance Level C_4 (0.185) is also considered in choosing repair work for pipelines and gas distribution facilities, the level of maintenance that is rarely carried out is generally because it is in a remote area or there is no direct care from the party company, so that alternatives with these conditions will be added value in front of priorities. C_4 Maintenance Level Criteria that work with the integrity of the pipelines and facilities are the same as one of the Integrity corporate cultures. The 3rd highest criterion is Security C_5 (0.179) which means safety for employees or the surrounding environment, one of the company's culture is also like this criterion, namely Safety, ensuring occupational safety and health both for yourself and the surroundings. Wijonarko (2017) also stated that the higher criteria found in prioritizing gas pipeline repair projects are safety and assets over the environment, because safety and assets are sources of income/profits for the company. Function & Operation in this study is that asset performance is the main triggering factor that causes pipe accidents (Wang & Duan, 2019). From the analysis above, it does not mean that other criteria, namely Asset Condition C_2 (0.121), Environment C_6 (0.120) and Operating Life C_1 (0.074) are not considered, but the results of the weighting of the criteria from this study help in determining the order of priority of the six criteria that are considered important.

The findings of the two weighting criteria and sub-criteria will be utilized to calculate alternative priorities in the TOPSIS technique, while the alternative conditions for the criteria generated through the interpretation of secondary data will be used to determine the decision matrix.

Table 4. The Priority Results

Alternative	Si+	Si-	C_i	Ranking
A-1	0.058179	0.040475	0.410	9
A-2	0.052020	0.058779	0.531	1
A-3	0.062820	0.057998	0.480	2
A-4	0.064254	0.045955	0.417	8
A-5	0.051121	0.043895	0.462	5
A-6	0.075262	0.026628	0.261	10
A-7	0.063994	0.057013	0.471	4
A-8	0.061815	0.052471	0.459	7
A-9	0.063807	0.057820	0.475	3
A-10	0.061727	0.052574	0.460	6

As shown in **Table 4**, Si+ and Si- of each alternative, to find out the closest to Si+ and the farthest to Si-, the preference value calculation is carried out, the alternative that has a preference value greater than the other alternatives is the alternative that is prioritized or better to be chosen.

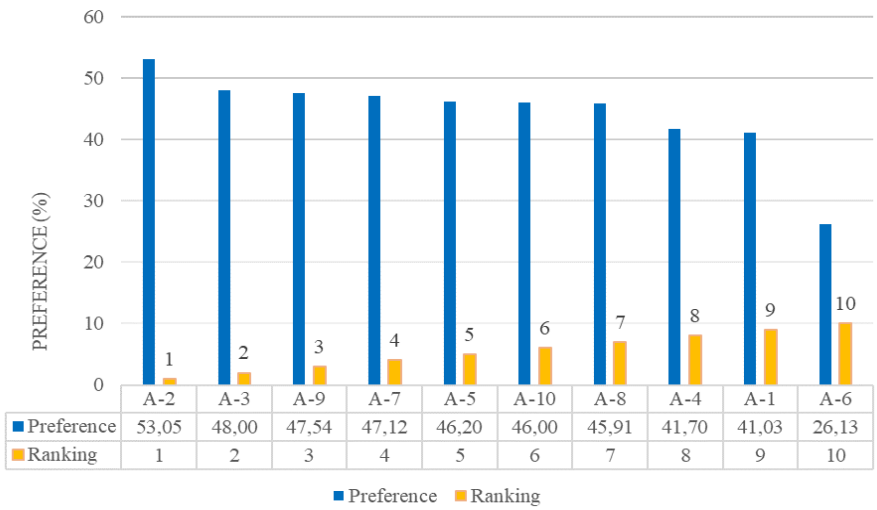

Figure 3. Results of Priority Ranking for Repair of Pipeline and Gas Distribution Facilities

Figure 3 shows that the alternative that ranks first is Alternative A-2, namely "Gunung Sari Indah Pipeline Looping Work in 2 locations". Alternative A-2 is a distribution pipeline that is located close to gas customers, the level of maintenance is in the "Sufficient" category because pipeline patrols are carried out every three months, asset performance is in the "Frequent Problem" category, supported by data on customer complaints that gas stops flowing when in the morning and the gas pressure fluctuates/unstable, in terms of safety it is in the "Moderate" category because low pressure distribution pipeline and the pipe depth is not too deep, the operating life of this pipeline network is 5-15 years so it is in the "Mid-Life" category and from the standpoint of the environment, it is in the "Impermanent" pollution category. It can be concluded that alternative A-2 is indeed worthy of being the first priority because it has a fairly large value on the high-weighted criteria and has a fairly small value on the low-weighted criteria.

While the alternative that ranks last is Alternative A-6, namely "Gas Stake and Marker Post Manufacturing and Installation Work" is an improvement in the utility of the pipeline which is a sign to indicate the presence of a gas pipeline. In terms of asset performance, it is in the "Good Performance" category because the function of the pipeline is in good condition, only the signs above it are damaged. The condition of the assets in the category of "Surface Defects & Construction Damage" is generally caused by the work of third parties. For safety, it is in the "Minor" category because the work to be carried out does not interact directly with the gas pipeline, only above ground level. As a result, alternative A-6 deserves to be ranked last because has a fairly small value on the high-weighted criteria.

5. CONCLUSIONS

It can be inferred, based on the findings and discussion, the criteria that are important in determining the priority of repair work in pipeline and gas distribution facility are Asset Performance, Maintenance Level, Safety, Asset Condition, Environment and Operating Life. Referring to the results of the study, namely the calculation of the AHP-TOPSIS method, the proposed work on repairing pipelines and gas distribution facilities that are prioritized are works that are directly related to assets, have a bad history during operation, lack of routine maintenance and have the potential to impact on safety of employees or local residents. Thus, the proposed repair work that has these characteristics will be a top priority to be implemented immediately.

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ANALYSIS OF EFFECTIVENESS OF PRODUCTION MACHINES USING OVERALL EQUIPMENT EFFECTIVENESS APPROACH TO REDUCE SIX BIG LOSSES

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ABSTRACT

PT. Intera Indonesia is one of the factories engaged in the wood processing industry under the auspices of the Integra Group. In carrying out the production process the company experienced obstacles in the form of engine damage, replacement of spare parts, and a decrease in engine speed. These obstacles will reduce the effectiveness of the company's equipment. This research was conducted to measure the effectiveness of the machine in the S4S production process based on Overall Equipment Effectiveness (OEE). Furthermore, an analysis of the OEE parameters is carried out using Six Big Losses. From the analysis of the Six Big Losses measurement. Then identified by using Fishbone Diagram. The results of this study found that the OEE value of 68.38% which is still below world standards and the calculation of the six big losses that affect the effectiveness of the machine produces six loss factors, and the biggest losses are Reduced speed losses of 27.01% and Idling and minor stoppage losses of 47.58%. Alternative improvements to the Fishbone diagram are implementing preventive maintenance before and after using the machine, making a checksheet for checking the machine, briefing the helper so as not to be late, and checking spare parts optimally. The improvement alternatives are expected to reduce the Six Big Losses that occur and increase the effectiveness of the equipment used.

Keywords: ***Fishbone Diagram*, Maintenance Managemement, OEE, *Six Big Losses***

1 INTRODUCTION

In the current era of globalization, every company is required to always advance and develop. The effect of the globalization era is the increasingly competitive world trade, this encourages industry, especially the manufacturing industry to increase competitiveness to enter the global market. According to Cahyono (2020) the main goal of every industry is to obtain maximum profit by utilizing its resources efficiently. One of the problems faced by the company in carrying out the production process is the occurrence of engine damage, which results in the cessation of the production process. In general, the causes of disturbances in the production process can be categorized into three, namely human, machine, and environmental factors. The object of this research focuses on one of the subsidiaries of the Integra Group, namely PT. Intera Indonesia in the Gesso division. PT. Intera Indonesia is a company that produces bare core and door frame (jamb) products based on the order. This production division currently has two types of products, namely S4S (Smooth Four Surface) and SJ (Super Jamb). All products from the Gesso Division of PT. Intera Indonesia is exported to China, America, and Europe. In the Gesso Division, there are 4 production processes from raw materials to finished goods. The 4 phases are bare core, preparation, gesso, and packing. Gesso is a component in the form of a paste and functions as an outer layer that closes the pores of the

wood and as a base layer so that water does not easily penetrate the wood, thus making the wood more durable. While the machine used to process gesso coating is called a gesso machine. Based on initial observations in the production department, machine breakdowns can occur every day during the production process which causes the machine to stop working and require replacement of spare parts, otherwise, the machine must be turned off. Several types of damage are usually caused by damaged spare parts such as broken fan belt rubber, pneumatic errors, rollers that cannot rotate, and other spare parts.

Based on the explanation that has been mentioned that machine damage can cause losses that harm the company. To prevent this problem, it is necessary to take appropriate steps in maintaining the machine or equipment, one of which is by using the Overall Equipment Effectiveness (OEE) approach as an indicator and looking for the cause of the machine's ineffectiveness with the parameters of availability rate, performance rate, and quality rate. The OEE parameters will be broken down into Six Big Losses, including breakdown time, setup and adjustment time, idling and minor stoppage, reduced speed, defect or rework losses, and reduced yields to determine the percentage of each loss factor that occurs. After knowing the biggest factor influencing the low effectiveness of the machine, the next step is identification using the Fishbone Diagram.

2 LITERATURE REVIEW

Maintenance

Fardani (2017) stated that maintenance is a combination of several actions taken to maintain an item or bring it to an acceptable condition. A clearer understanding of maintenance is carrying out maintenance on machines or operating equipment intending to prolong its service life and minimize machine failure or damage. Basically, machine maintenance activities are also related to preventive maintenance known as preventive maintenance, which is a plan that requires regular inspections, maintenance, and maintaining facilities in good condition so that damage does not occur in the future. Kurniawan, (2013) stated that maintenance is carried out to minimize downtime so that activities run smoothly according to the previously made plan. Hapsari (2012) states that maintenance is all activities related to maintaining system availability and reliability, as well as maintaining component functionality in accordance with established quality standards.

Overall Equipment Effectiveness

Chikwendu (2020) define OEE as a measure of the performance and productivity of manufacturing activities, expressed as a percentage, which indicates the extent to which the manufacturing process is truly productive and serves as a general and comprehensive measure of performance. Hapsari (2012) explained that OEE is a critical measurement used in the application of TPM to assess the capacity of equipment in a production system. OEE consists of three main components, namely availability, performance, and quality. OEE can be calculated by the following formula

OEE (%) = *Availability* (%) x *Performance Rate* (%) x *Quality of Rate* (%)

1. Availability

Availability is the operating time or the time the equipment actually works. Availability rate can be calculated by the following formula:

$$Availability = \frac{Loading\ Time - Downtime}{Loading\ Time}$$

2. Performance Rate

Performance rate is the ratio of the actual production level with the expected. This measurement shows how well the equipment is able to do its job. Performance rate can be calculated by the following formula:

$$Performance\ Rate = \frac{Processed\ Amount\ x\ Ideal\ Cycle\ Time}{Operation\ Time}$$

3. Quality rate

Quality rate is a measurement that shows the ability of equipment to produce products that meet standards. Quality rate can be calculated by the following formula:

$$Quality\ Rate = \frac{Total\ Production - Defect\ Amount}{Total\ Production}$$

Chikwendu (2020) explained that if the calculated OEE is the same as world-class OEE, it can be interpreted that the manufacturing organization is in good condition, but if OEE is lacking, then it means that maintenance policies and strategies need to be improved immediately.

No	OEE Factor	OEE World Class Rate %
1	Availability	90%
2	Performance	95%
3	Quality	99%
4	OEE	85%

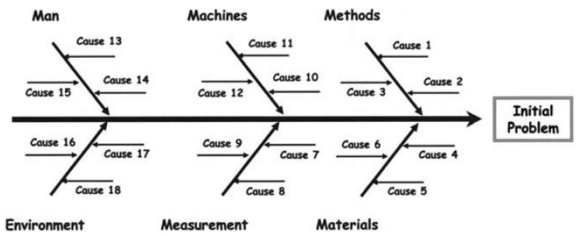
Source: Okpala (2020).

Six Big Losses

Six Big Losses were introduced to the concept of Total Productive Maintenance (TPM) as losses that must be eliminated. There are three main categories based on the aspect of losses, namely downtime losses, speed losses and defect losses. Downtime losses include equipment failure (breakdown), Speed Losses include setup and adjustment, idling and minor stoppages and defect losses include reduced speed, quality defects, and startup losses (reduced yield losses). Hasanudin (2020) argues that measuring the productivity of six big losses is an activity and action that is not only aimed at preventing machine/equipment damage and minimizing machine/equipment downtime.

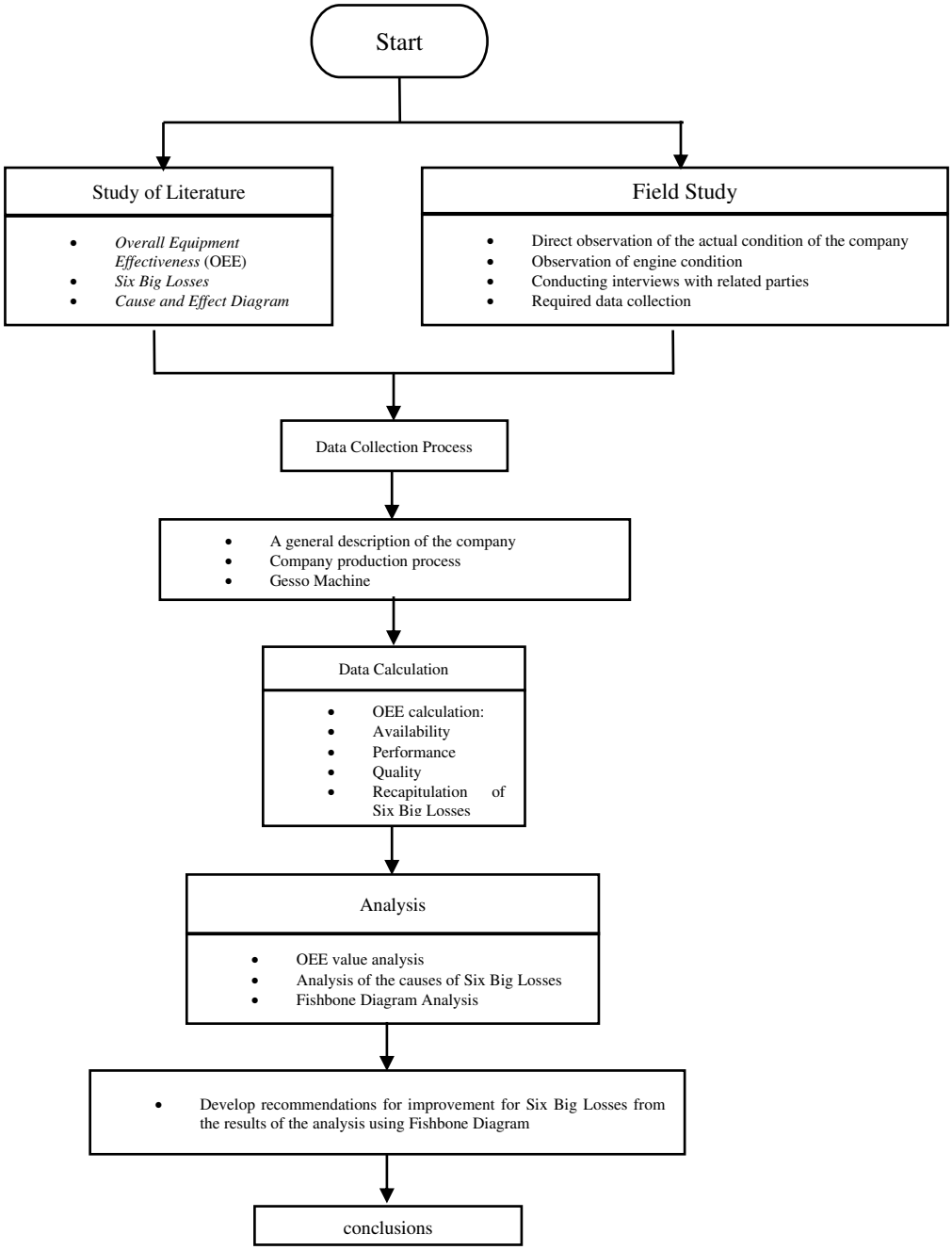
Fishbone Diagram

According to Hasanudin (2020) fishbone diagram is a tool to organize and show everything related to these problems. Meanwhile, according to Soemohadiwidjojo (2017) fishbone diagrams are used for product design and defect prevention, analyze and determine the causal factors that most influence the occurrence of problems. According to Ridwansyah (2017) Fishbone diagrams are used to identify and describe the causes of problems. The cause-and-effect diagram developed by Dr. Kaoru Ishikawa in 1943, widely known as the Ishikawa diagram or fishbone diagram, is also a modification of lines and symbols designed to represent the relationship between effect and cause.



Source: Borris (2008).

3 METHODS



First

Data collection was carried out to obtain the data needed in the implementation of the research. The data used in this study include:

• Production process for S4S products

• Gesso engine performance data which includes downtime data, number of defective products, speed rate, and others

Measurement

At this stage, measurements are taken which form the basis of this research and make recommendations for improvement consisting of:

• Calculation of Availability, Performance Rate, and Quality Rate to determine the value of each OEE parameter of the Gesso engine. Each parameter is detailed to determine the value of Six Big Losses
• Calculation of the OEE value to determine the level of effectiveness of the Gesso machine
• Identify the Six Big Losses and the types of failures that occur

Analysis
At this stage, an analysis of the results of data collection and processing is carried out which consists of:
• Analyze the OEE value to determine the level of effectiveness of the Gesso. machine
• Analysis of the causes of Six Big Losses to find out the biggest factor causing the low effectiveness of the Gesso machine
• Analysis using Fishbone Diagram based on the biggest causes of Six Big losses

Analysis Results
At this stage, improvements are made in the form of
Develop recommendations for improvement for Six Big Losses from the results of the analysis using Fishbone diagrams

Conclusion
At this stage, conclusions are drawn from the research. Furthermore, suggestions are proposed to improve the research that will be carried out in the future.

4 RESULTS

In measuring the OEE value, it consists of three parameters of availability, performance rate, and quality rate. Furthermore, the measurement of Six Big Losses is carried out based on the measurement of the value of the OEE that has been carried out in the previous stage. The data used for measuring the OEE value is data for the period September 2020 to May 2021.

Table 1 Table Data

Data Loading Time				
Month	Total Time	Planned Maintenance	Breakdown Time	Setup
September 2020	520	52	30	10
Oktober 2020	540	54	22	25
November 2020	500	50	30	12
Desember 2020	540	54	20	22
Januari 2021	520	52	26	30
Februari 2021	480	48	30	15
Maret 2021	540	54	30	14
April 2021	520	52	33	15
Mei 2021	520	52	30	22

1. Availability

$$Availability = \frac{Loading\ Time - Downtime}{Loading\ Time}$$

$$Availability\ September = \frac{468\ jam\ -\ 40jam}{468\ jam} = 91{,}45\%$$

Table 2 Table Availability Gesso Machine

Availability Gesso Machine							
Month	Total time (Hours)	Planned Maintenance (Hours)	Loading Time (Hours)	Breakdown Time (Hours)	Setup (Hours)	Operation Time (Hours)	Availability (%)
Sep-20	520	52	468	30	10	428	91,45%
Oct-20	540	54	486	22	25	439	90,33%
Nov-20	500	50	450	30	12	408	90,67%
Dec-20	540	54	486	20	22	444	91,36%
Jan-21	520	52	468	26	30	412	88,03%
Feb-21	480	48	432	30	15	387	89,58%
Mar-21	540	54	486	30	14	442	90,95%
Apr-21	520	52	468	33	15	420	89,74%
May-21	520	52	468	30	22	416	88,89%
Average							90,11%

Based on Table 2, it can be seen that the highest equipment availability was in September 2020 which reached 91.45% and the lowest level of equipment availability was in January 2020 with a value of 88.03%. while for the period September 2020 – May 2021, the average value of the availability rate on the Gesso machine is 90.11%.

2. Performance

$$Performance\ Rate = \frac{Processed\ Amount\ x\ Ideal\ Cycle\ Time}{Operation\ Time}$$

$$Performance\ Rate = \frac{595175\ x\ 0{,}00061}{428} = 84{,}83\%$$

Table 3 Table Performance Gesso Machine

Performance Gesso Engine				
Month	Produksi (Units)	Ideal Cycle Time (Hours)	Operating time (Hours)	Performance (%)
Sep-20	595175	0,00061	428	84,83%
Oct-20	420417	0,00061	439	58,42%
Nov-20	560553	0,00061	408	83,81%
Dec-20	624600	0,00061	444	85,81%
Jan-21	447895	0,00061	412	66,31%
Feb-21	384273	0,00061	387	60,57%
Mar-21	601534	0,00061	442	83,02%
Apr-21	585899	0,00061	420	85,09%
May-21	563752	0,00061	416	82,67%
Averag				76,73%

Based on Table 3, it can be seen that the highest tool performance rate in December 2020 reached 85.81%, and the lowest tool performance rate in October 2020 at 58.42%. For the period September 2020 – May 2021, the average performance rate for the Gesso engine is 76.73%.

3. Quality

$$Quality\ Rate = \frac{Total\ Production - Defect\ Amount}{Total\ Production}\ x\ 100\%$$

$$Quality\ Rate = \frac{595175 - 5128}{595175}\ x\ 100\% = 99{,}14\%$$

Table 4 Table Quality Gesso Machine

Quality Gesso Machine					
Month	Production	Reduced Yield	Defect/Rework	Good Product	Quality
Sept-20	595175	0	5128	590047	99,14%
Oct-20	420417	0	4297	416120	98,98%
Nov-20	560553	0	7249	553304	98,71%
Dec-20	624600	0	8342	616258	98,66%
Jan-21	447895	0	5165	442730	98,85%
Feb-21	384273	0	7781	378492	99,02%
Mar-21	601534	0	5569	595965	99,34%
Apr-21	585899	0	6325	579574	99,01%
May-21	563752	0	7981	555771	98,58%
Average					98,82%

Based on Table 4, it can be seen that the highest quality rate was in March 2021 which reached 99.34% and the lowest quality rate was in May 2021 with a value of 98.58%. while for the period September 2020 – May 2021, the average quality rate value on the Gesso engine is 98.82%.

4. OEE

$$OEE = Availability\ x\ Performance\ Rate\ x\ Quality\ Rate$$
$$OEE = 91{,}45\%\ x\ 84{,}83\%\ x\ 99{,}14\% = 76{,}91\%$$

Table 5 Table OEE

OEE Gesso Machine				
Month	Availability	Performance	Quality	OEE (%)
Sep-20	91,45%	84,83%	99,14%	76,91%
Oct-20	90,33%	58,42%	98,98%	52,23%
Nov-20	90,67%	83,81%	98,71%	75,00%
Dec-20	91,36%	85,81%	98,66%	77,35%
Jan-21	88,03%	66,31%	98,85%	57,71%
Feb-21	89,58%	60,57%	99,02%	53,73%
Mar-21	90,95%	83,02%	99,34%	75,00%
Apr-21	89,74%	85,09%	99,01%	75,61%
May-21	88,89%	82,67%	98,58%	72,44%
Average				68,38%

After the calculation, it can be seen at the Table 5, that the OEE value of the Gesso engine is 68.38% but the OEE value is still below the world-class standard, which is 85%.

5. Six Big Losses

After calculating the OEE value, then calculating the value of Six Big Losses which includes:

- Breakdown Time Losses
- Setup and adjustment losses
- Idling and stoppage Minor losses
- Reduced Speed Losses
- Defect/Rework Losses

Table 6 Table Six Big Losses

Tabel Six Big Losses		
Six Big Losses	Total Time Losses	Presentase
Breakdown Losses	251,00	14,19%
Setup & Adjusment Time Losses	165,00	9,32%
idling & minor Stoppage losses	842,85	47,58%
Reduce Speed Losses	478,4	27,01%
Defect / rework losses	34,06	1,92%
Reduce yield losses	0	0,00%
Total	1771,32	100,00%

Table 6 is a recapitulation of the calculation of the six big losses along with the total percentage of each loss that occurs in the Gesso Machine. Losses with the largest percentage are reduced speed losses and idling and minor stoppage losses. Idling and minor stoppage losses with a percentage of 47.58% and total time losses of 842.85 hours and reduced speed losses, with a percentage of 27.01% and total time losses of 487.4 hours

6. Fishbone Diagram

Based on the Pareto diagram in Figure XX, the factors causing the six big losses with a high percentage value are Idling and Minor Stoppages Loss and Reduced Speed Losses. It also shows the priority of the problem which is further analyzed using a cause-and-effect diagram. The analysis is carried out only on the priority six big losses factors, namely Idling and Minor Stoppages Loss and Reduced Speed Losses. This is intended so that the analysis carried out is more efficient and focused on the factors that have the greatest influence that cause the low productivity of the Gesso machine.

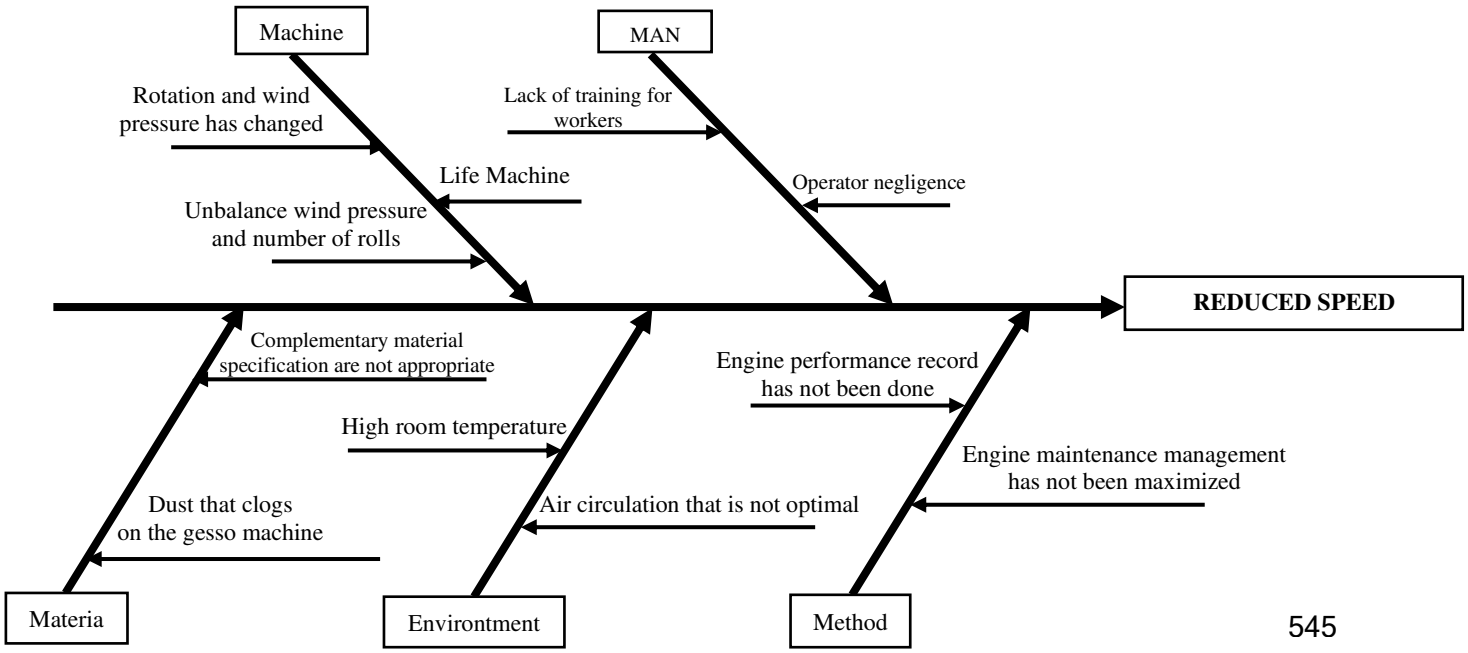


Figure 1 Fishbone Diagram Reduced Speed Losses

• Man

Operator negligence, operators often experience negligence in operating the Gesso machine so they do not realize that the machine is experiencing a decrease in speed and continue to force the machine to operate.

• Machine

Changes and wind pressure on the engine cause the engine to experience a decrease in speed so it doesn't work optimally

• Materials

The amount of dust that gets into the Gesso engine makes the engine performance not optimal and affects the speed of the Gesso engine.

• Method

Records from the machine must also be recorded to make it easier to carry out maintenance by looking at historical data.

• Environment

the temperature in the working room is hot enough to increase the engine temperature which can make the engine overheat. The lack of air circulation also causes the engine to get less air intake to fill the air pressure, thus making the engine experience a decrease in speed.

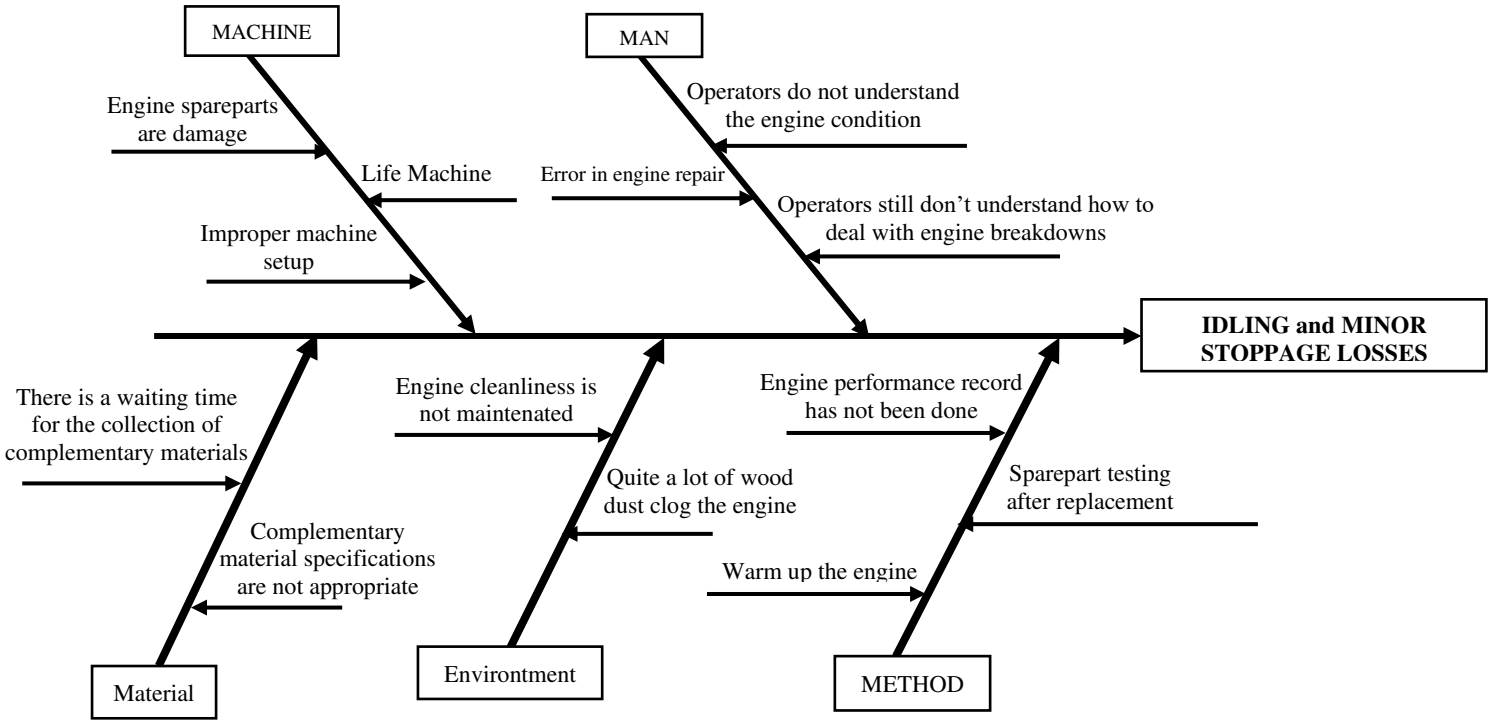


Figure 2 Fishbone Diagram Idling and Minor Stoppage Losses

• Man

Operators are not very careful in supervising the production process and are in a hurry in setting up the Gesso machine.

• Machine

The machine has a breakdown because the machine is often still operated even though the operator knows that the machine has been damaged, there are some components of the Gesso machine that wear out easily or have a short life due to wear and tear

• Method

After replacing the engine spare parts, a trial of the new spare art is carried out, this causes the engine to become idle and waste time. In addition, the schedule for replacing components has not been effective, usually the replacement of engine components is carried out when only the engine components are damaged.

• Materials

Stocks of gesso mixtures that do not meet specifications can cause delays in the manufacture and production process. Too long in processing the gesso mixture also results in wasted time and makes the engine wait for idle.

• Environment

The cleanliness of the engine is less visible in the template and channel components of the calcium gesso, for example, you can see the remnants of the mixed material that has stuck and dried on the components of the gesso engine.

5 CONCLUSIONS

From the results of the study, it can be seen that the level of effectiveness of the gesso machine is reviewed based on the OEE value at the PT. Intera Indonesia is 68.38% the OEE value is still below the world class standard of 85%. In addition to the three parameters mentioned, things that affect OEE are the Six Big Losses. In this study, it is known that the biggest causes of Six Big Losses are Idling and Stoppage Minor Losses and Reduced Speed Losses.

Given these problems, the researchers provide suggestions for improving managerial implications to reduce Six Big Losses Idling and Stoppage Minor Losses and Reduced Speed Losses based on identification of failures using Fishbone Diagrams, including providing briefings before work to avoid missed communication between employees, implementing preventive maintenance so that the engine does not experience a decrease in performance when used, always checks engine parts before and after use, and applies a checksheet to be filled out before use and given to the department so that the engine condition is always monitored and is useful for historical data in engine maintenance. It is hoped that the proposed solution of managerial implications given to the company is able to reduce the six big losses and improve the performance of the gesso machine.

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Quality Improvement of Corrugating Medium Paper Using Six Sigma in Paper Manufacturing Company

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ABSTRACT

Paper Company (PC, is a nickname) is a company which produces brown paper, mainly test liner and medium corrugating paper 10.000 MT/month and integrated with paper board company. The production process in the paper industry is continuing process. The quality report in paper mill unit 2 has a defect over the percentage that exceeds company standards. The lowest percentage of defects is in September 2021, which is 2.94%, while the company's target is 1%. DPMO is 45.600 it is equal with 3,35 sigma. To achieve this target, research was carried out to improve the quality of PM 2 papers using the six sigma method. Six sigma begins with the DMAIC stage (Define, Measure, Analyze, Improve, and Control). Define stage by making a flow diagram of the production process by making a SIPOC diagram. Measure stage, quality identification is carried out by describing the analysis of the data and measuring the work baseline. The analysis stage will be a capability analysis and finding the root of the problem using an Ishikawa diagram. The improvement stage, which contains proposed improvements, and the control stage will be carried out by comparing the results before and after the improvement. Based on the analysis, the analysis obtained three recommendations for improvement: making SOP for setting basic weight, refresh SOP for checking and sampling basic weight, and modification headboxes in the QCS system Result has been taken in January week 3, the DPMO is 25.566 it is equal to 3,68 sigma.

Keywords: quality improvement, six sigma, DMAIC, and Ishikawa diagram

1. INTRODUCTION

Quality control in the manufacturing industry is very important. Quality control can be carried out by determining incoming raw material standards, incoming supporting material standards, production process standards, and finished goods standards. Standards of finished goods that are set must meet the standards of customer desires. Finished goods whose quality is below specifications will require rework. The rework process will increase production costs which are detrimental to the company. The choice that will be chosen by the company is to carry out a rework process or sell products at special prices, where both of these options will harm the company so that quality control is important to minimize product failures, reduce production costs and increase company profits.

Inappropriate quality can be caused by several factors, namely machine, method, material, human, and environmental factors (Socovic, 2005). The machine factor is a disturbance from the

machine such as equipment damage and instrumentation disturbances from the machine which can be overcome by making a machine repair schedule. The method factor is operational standard errors such as setting point errors, so that it can be overcome by making SOPs properly and clearly. Material factors are errors in the characteristics of raw materials, auxiliary materials, and errors in the preparation of a production process. The human factor is the error in running the SOP. Environmental factors are factors in the production environment that can affect production results such as humidity in the production room, etc.

Paper Company (PC) is a paper manufacturing company that produces brown paper, cardboard boxes, and strapping bands. The paper produced is a recycle test liner and corrugating medium with a basic weight of 90 - 350gsm. PC also produces corrugated cardboard which is integrated with paper units and marketed to end user customers. Research will be conducted to improve the quality of corrugating medium paper in paper mill (PM) unit 2 because paper mill unit 2 has a production efficiency of more than 80% and this type of paper is more in demand by customers. **Table 1** describes the percentage of defect products that occurred in PM 2.

Tabel 1. Percentage defect product

Month	Defect (Ton)	% Defect
April	183,000	8,38
May	335,124	14,30
June	166,028	6,38
July	181,466	7,62
August	149,506	6,03
September	73.484	2,94

The company's target for the percentage of defect products is a maximum 1% from total production output. In April to September the company's target was not achieved so it is necessary to evaluate and improve the process to achieve the target. In this study, the six sigma method will be used to reduce process variance so that the process can be more consistent. The use of the six sigma method is a method to achieve good operating performance, which is up to 3.4 defects for one million results so that the percentage of production according to standards is 99.99996%.

2. LITERATURE REVIEW

2.1 Quality

Quality is a feature that meets customer needs, quality can provide greater customer satisfaction to increase revenue, but in real conditions improving quality requires investment and increasing costs so that quality improvements require increased costs. The word quality is defined on several criteria including product, product specification, customer, customer satisfaction, deficiency, and customer dissatisfaction. Products are generally defined as goods produced. Product specifications are the criteria for a product that will meet with customers. Customer dissatisfaction is a situation where a product error/defect is considered disturbing so that claims, complaints, and so on (Juran, 1999) (Chen, 2016).

2.2 Six Sigma

Six sigma is a quality improvement method that aims to reduce defective products to 3.4 DPMO (defects per million opportunity) by using a normal distribution and a strong relationship between defective products, production yield, reliability, cycle time, etc. (Socovic, 2005) There are 2 perspectives on six sigma are statistical and methodological perspectives.

- Statistical perspectives
  Sigma is the standard deviation or deviation from mean. A process is said to be good if it is still in the range of the upper and lower limits of the deviation, while the value outside the deviation can be declared as a defect. **Tabel 2** is the colleration between defect per million opportunity (DPMO) with sigma (Wijaya, 2010).

Tabel 2. Colleration DPMO and Sigma

Sigma Score	DPMO	%Good
0	933,193	0,067
1	691,462	30,85
2	308,538	69,15
3	66,807	93,32
4	6,210	99,38
5	233	99,98
6	3,4	99,9997

Defect per unit (DPU):
DPU = Total defect product
DPU = Total Defect Product / Total Production Result (1)
Defect per million opportunities (DPMO)
DPMO = DPU × 1.000.000 / Defect Probability (2)

- Methodological Perspectives
  Six sigma is a strategy implemented by all members of the company in accordance with the company's vision and mission which aims to increase productivity and fulfill customer desires thereby increasing company value. There are five stages in implementing the six sigma strategy, namely Define-Measure-Analyze-Improvement-Control (DMAIC). DMAIC is the key to six sigma analysis to achieve customer satisfaction by minimizing product defects (Mehrjerdi, 2011).
  - Define is the main problem to be discussed (Critical to Quality)
  - Measure is a phase to measure the current situation by collecting data and identifying problems
  - Analyze is a phase to identify the root of the problem
  - Improvement is a phase to implement solutions to solve problems that have been identified in the analyze phase
  - Control is the phase of evaluating the improvement carried out whether it is appropriate or not, if it is not appropriate, it is necessary to repeat the cycle

2.3 Root Cause Analysis (RCA)

Root Cause Analysis is a method of solving problems by identifying a problem to the root of the problem. Factor is the root of the problem if when the factor is removed it can reduce or prevent failure. RCA is often used to analyze a problem. Making a good RCA is a systematic RCA that starts from identification to conclusions accompanied by evidence. In the manufacturing process, causal relationships and 5 whys can be used. Ishikawa developed the process of making a cause-effect diagram with the following stages (Montogmery, 2003):

1. Determine a problem to be analyzed
2. Draw arrows from left to right and place the problem on the right arrow and become the main arrow
3. Determine the possible cause and place it with another arrow and connect it to the main arrow
4. Determine other causes that may occur as a branch of step number 3

3. METHODS

The data is taken based on the company's internal data and data from interviews in the company. The data that has been collected then be processed and analyzed using DMAIC method.

3.1 Define

The process flow mapping is taken from the 125 gsm corrugating medium paper production diagram from a documented process flow chart. The process flow chart is detailed to support the improvement phase. Determination of the focus improvement is carried out to improve quality and reduce the number of products that are not up to standard. The determination is taken based on the most frequent defects.

3.2 Measure

The focus of improvement is taken from the list of the highest percentage of defective items that need improvement. From the percentage of product defects then made a Pareto diagram. The measurement of the work baseline uses the six sigma method with the unit of measurement for DPMO (Defect Per Million Opportunity) and also the level of sigma capability for conditions prior to improvement.

3.3 Analyze

Capability analysis is carried out to find out whether the current process is able to meet the required standards. The RCA analysis was made ishikawa diagram to find the root cause of the product defect. The results of the analysis are found the most basic factors that can lead to defective products.

3.4 Improvement

Improvements are made to reduce the number of items that are not up to standard by making suggestions for improvement according to the root cause of each type of defect so that it reaches the desired sigma value.

4. RESULTS

4.1 Define

Define is the initial stage of DMAIC which contains a description of the paper production process using supplier, input, process, output, and customer (SIPOC) diagrams and is carried out to find out the number of defective products per month in 2021. **Tabel 3** is production data in Agust and September 2021

Table 3. Production Data in August and September

Month	Total Production (Roll)	Defect (Roll)
August	1478	83
September	1568	56

From **Table 3** the defect that occurs exceeds the company's standard where the company's standard is a maximum of 1%. The defects that occur are non-standard basic weight, excessive cobb size, non-standard moisture, less neat paper cuts, more joints, uneven basic weight, and loose rolls. SIPOC diagram shows the activities of corrugating medium paper production starting from the supply of raw and auxiliary goods that are processed into products that will be sold to customers. The SIPOC diagram was created by conducting interviews with various parties from PPIC and production. Here is a SIPOC diagram in **Figure 1**.

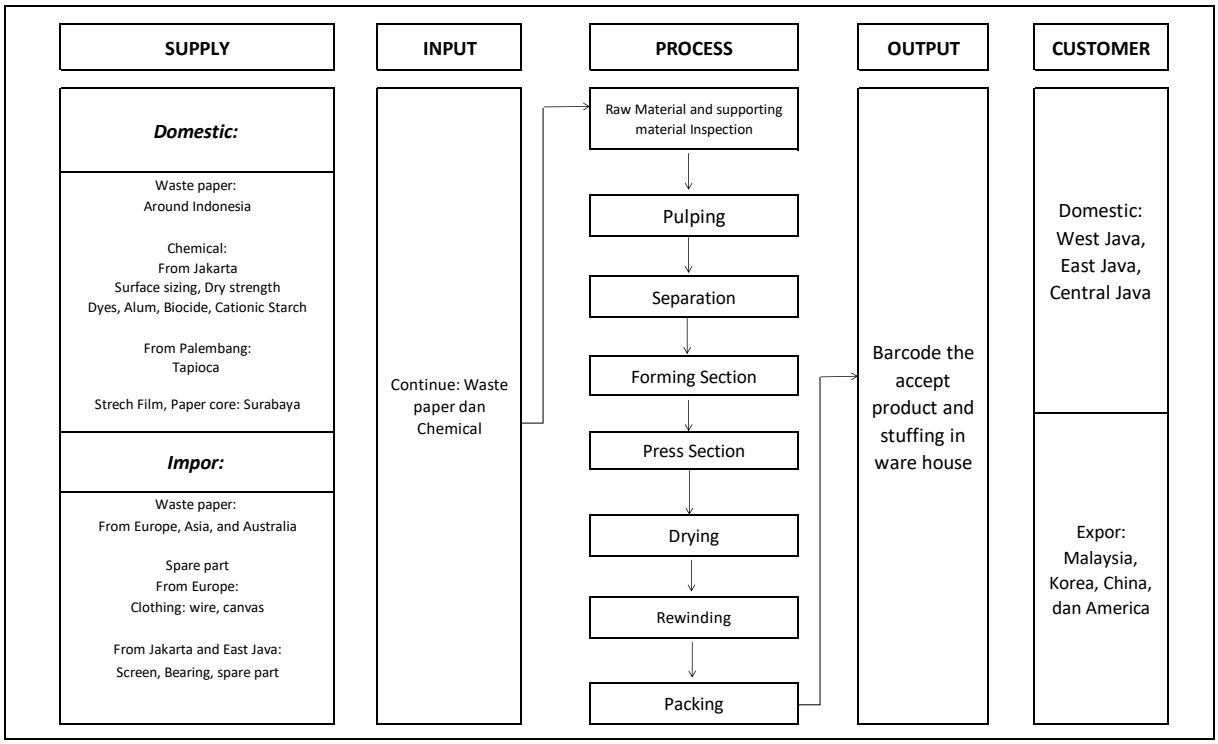

Figure 1. SIPOC Diagram

4.2 Measure

At the measure stage is an advanced stage which aims to perform data processing. The steps are taken to determine the critical to quality and making control maps. At this stage, identification of defects that occur in August and September 2021 is carried out in pareto diagram **figure 2** and the calculation in **tabel 4**. Using equation 1 and 2 the result of DPMO is 45,600 it is equal with 3.35 sigma.

Tabel 4. Calculation for Pareto Diagram

Defect	**Quantity**	**Persentage**	**Accumulation**
Unstable Basic Weight (BTS)	47	33.8%	33.8%
Over cobb size (CBL)	39	28.1%	61.9%
Over moisture (MTS)	24	17.3%	79.1%
Over joint (SLB)	12	8.6%	87.8%
Uneat cutting (PKR)	11	7.9%	95.7%
Under Hardness Standard (GBS)	6	4.3%	100%
Total	**139**	**100%**	

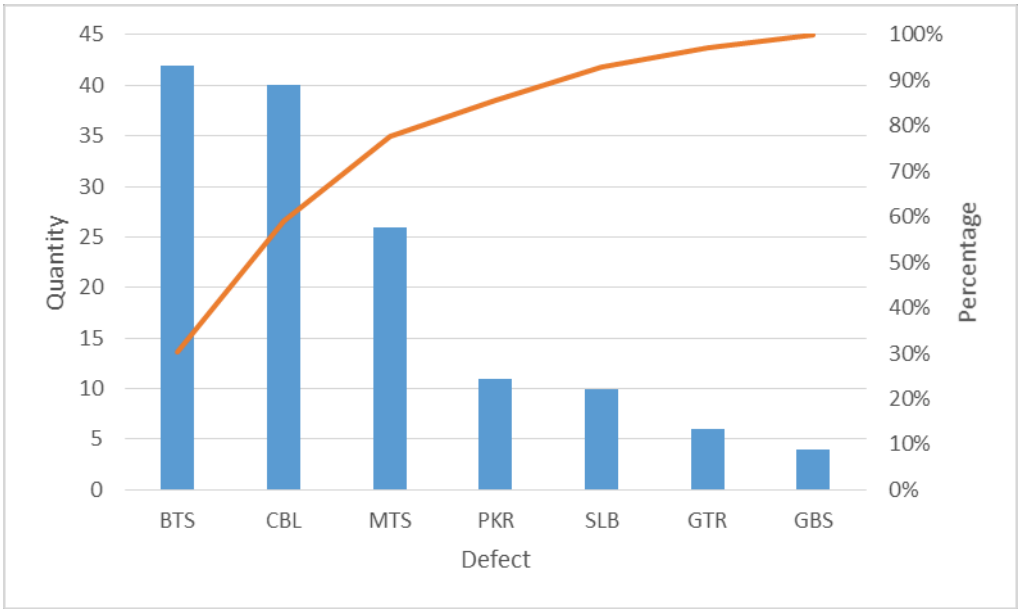

Figure 2. Pareto Diagram of Product Defect

4.3 Analyze

Improvement is focussed in unstable basic weight. Factors causing defects are made by brainstorming and interviews with the production department. The results of the brainstorming and interviews are depicted on a ishikawa diagram in **Figure 3.**

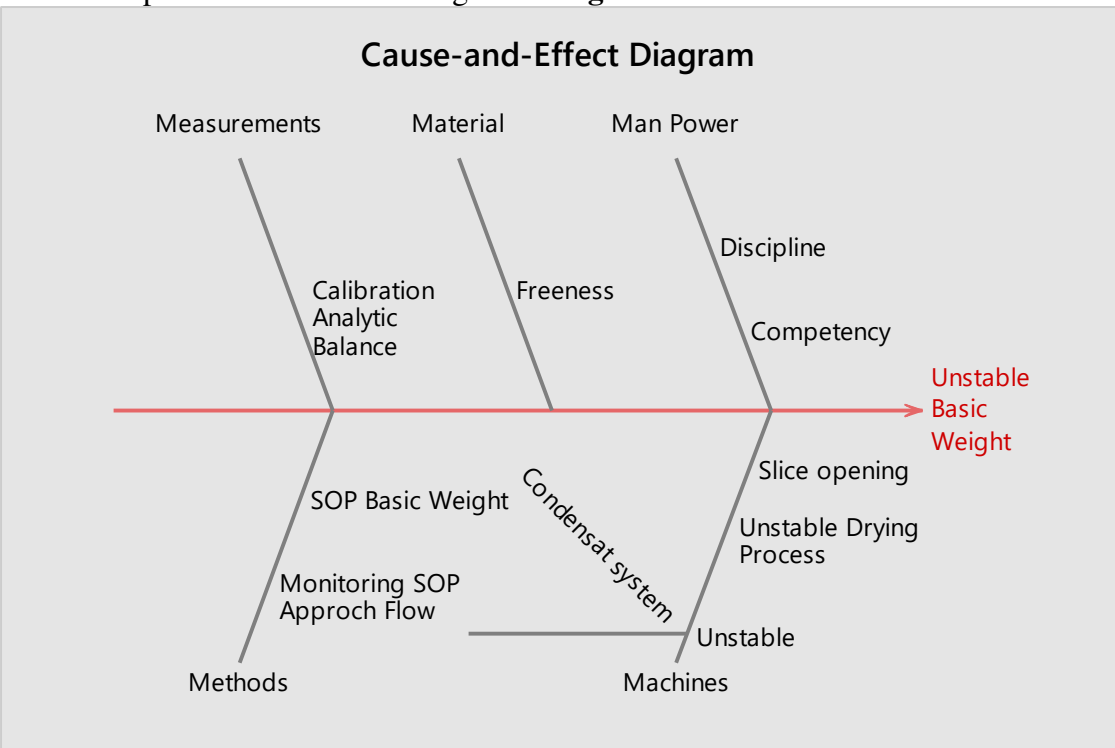

Figure 3. Ishikawa Diagram

The root factor is SOP in monitoring approach flow, instal DCS system, and calibrate the analitic balance.

4.4 Improve

At the end of 2021, a quality improvement program is refresh SOP in approach flow, calibrate analitic balance and instal DCS. The SOP refresh trial in December 2021 was carried out on one operator team. The SOP refresh was carried out by updating the SOP and applying punishment. There are 2 hypotheses:

H0 = there is no difference in work results after SOP refresh

H1 = there is a difference in work results after refreshing the SOP

Data is used in December the 3rd week with the same operator team taken on 6 working days. **Table 4** is the result of comparison before and after SOP refresh.

Tabel 5. Result of Refresh SOP

Before Refresh SOP	After Refresh SOP
5	0
2	3
3	1
1	0
2	0
2	2

Using t-test hypothesis in minitab 17 the result is:

	N	Mean	StDev	SE Mean
Before training	6	3,17	1,47	0,60
After training	6	1,00	1,26	0,52

Difference = μ (before training) - μ (after training)

Estimate for difference: 2,167

95% CI for difference: (0,374; 3,959)

T-Test of difference = 0 (vs ≠): T-Value = 2,73 P-Value = 0,023 DF = 9

p-value = 0.023 with p-value less than 0.05 then H0 is rejected and H1 is accepted. It can be concluded that there are differences in work results after the SOP refresh is carried out. In January 2022 the improvements that have been made are to refresh the SOP in all team member.

4.5 Control

Result has been taken in January week 3, the DPMO is 25,566 it is equal to 3.68 sigma. The improvement was made correctly.

5. CONCLUSIONS

The critical factor in quality is unstable basic weight, over moisture content, and over cobb size. The root factor is SOP in monitoring approach flow and there is no DCS system. improvement can be done by refreshing the SOP and procuring the DCS system so that the system can be monitored in real time and reduce the human error factor. Refresh SOP to dicipline operator has been done in January week 1, the result is the DPMO is decreasing from 45,600 to 25,566 dan sigma is increasing from 3.35 to 3.68.

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INFLUENCE OF INSTAGRAM INFLUENCER'S CREDIBILITY AND ATTRACTION ON SKINCARE INDUSTRY SOCIAL MEDIA MARKETING

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ABSTRACT

The beauty industry in Indonesia is growing positively due to the growth of local beauty products. Transactions in the beauty category in e-commerce in 2020 doubled compared to the previous year, with the most popular types of products in the skincare category. The skincare category is one of the most important factors in the growth of the beauty industry in Indonesia. At the Sociolla Award 2020, in 9 categories of best skincare, skincare from Indonesia (local skincare) won 4 categories. There are 760 local companies, of which 95 percent are Small and Medium Industries, which have limited budgets. The budget must be used wisely according to needs but must get optimal results. Marketing using influencers on Instagram social media is considered one of the effective and efficient strategies to do. This study aims to determine the influence of sources of credibility and sources of attractiveness on the trust of influencer followers on the Instagram platform, which will affect follower loyalty and brand marketing objectives. This study uses descriptive multiple cross-sectional conclusive designs. Data were collected using an online questionnaires to 173 samples who followed Indonesian beauty influencers. Then, the data were analyzed using Structural Equation Modeling (SEM). The results show that authenticity, physical attractiveness, and social attractiveness positively affect follower trust, and follower trust affects their attitude toward the products promoted by SMI.

Keywords: ***Social Media Influencer (SMI), Attractive Source, Credibility Source, Purchase Intention, Trust, SEM***

1. INTRODUCTION

The beauty industry in Indonesia is growing positively in line with the growth of Indonesian people's income and changes in people's lifestyles. This indicates that the Indonesian people are increasingly concerned about taking care of themselves. Based on data from the Central Statistics Agency (BPS), the beauty industry's revenue was 99.33 trillion rupiahs in 2020, this figure increased by 2.84 percent from 2019 (Republika, 2021). According to the Ministry of Industry, the total beauty industry is 760 companies, of which 95 percent are Small and Medium Enterprises (SMEs) and only 5 percent are large-scale industries (Ekonomi Bisnis, 2021). Small and medium enterprises with limited funds must spend their budget wisely according to their needs, but must obtain optimal results. Thus, SMEs must be selective in choosing the marketing

strategy used. Of the many marketing techniques that already exist, marketing through social media is one strategy that is considered effective and efficient for SMEs.

According to getting Craft (2017), social media tops the list of the most effective digital marketing channels in Indonesia. The social media that has the most active users is Instagram, it is recorded that Instagram has more than one billion global active users (Katadata, 2020). Currently, Instagram has a special feature for shopping, wherein the seller or brand profile section, other users can open the link and go directly to the related site or e-commerce. Instagram also has a feature audience insight, where marketers can find out their consumer profiles, such as demographics, age, and consumer interest in their business (Kompas, 2018). It can be used by marketers to maximize their business. Instagram also has an Instagram Shopping feature, this feature is like providing a digital storefront for marketers, where consumers can see detailed information about a product by using a tag special view product in a photo or video. In addition to having many features that marketers can take advantage of, Instagram is a visual-based social media (photos and videos) so that it is easier for marketers to introduce their products. Many local skincare marketers Instagram as their main means of marketing, because with a visual basis, it is easier for marketers to provide related information, product form, how to use the product, the benefits of the product with before and after photos.

According to the results of a survey conducted by Instagram and the business consulting firm IPSOS, 81 percent of Instagram users in Indonesia use Instagram to find information when interested in a product or brand (Kompas, 2018). Online recommendations given by fellow social media users can positively influence consumers' perceived usefulness and trust, which is likely to increase their intention to make purchases on social media (Ryu & Park, 2020). By using social media, celebrities or ordinary people can share their thoughts and feelings, create all kinds of content online, and thus develop their unique persona on social media (Labrecque, 2014). Certain social media personas are well-liked by others, which has allowed them to amass millions of followers. Those who have built a sizeable network of social media followers and thus have acquired the potential to exert influence over their followers are usually described as Social Media Influencers (SMI) (Wha & Kyung, 2019). Influencers convey the message of the brand to followers by leveraging the relationships and trust that have been built. Therefore, it is very important to build a relationship of trust between influencers and their followers. According to Eyal (2018), trust marketing influencer is very important, research found that 92 percent of social media users trust influencers more than marketing using television channels. In a global consumer survey, 46 percent of respondents distrust newspapers, magazines, TV, and radio (IPSOS, 2019).

Even though social media is a channel of effective marketing, there are still knowledge gaps among marketers in Indonesia in understanding the right digital marketing measurements and do not yet fully understand how their digital campaigns contribute to business goals (Get Craft, 2017). In marketing with influencers, choosing the right SMI is one of the important success factors in digital marketing (Chuang et al., 2020). According to De Veirma et al. (2017), The number of followers that SMI has is a determining factor influencing the choice of SMI for marketers, but according to Wha & Kyung (2019) what is more important is understanding how SMI can gather their number of followers and gain the potential to influence them. A strong relationship with a foundation of trust and loyalty that has been built is very important in marketing influencers. Because it's important to know how influencers can increase the trust level of their followers. This study discusses the influence of credibility and attractiveness of influencers on the level of trust of followers. Furthermore, whether the level of follower trust affects loyalty, purchase intention, and the image of the product.

2. LITERATURE REVIEW

2.1 Social Media Influencer (SMI)

Social Media Influencers or SMIs are those who have built a sizable network of social media followers and thus have acquired the potential to exert influence over their followers (Wha & Kyung, 2019). According to the Interactive Advertising Bureau (2018) Influencer, social media is defined as a user who has the potential to create engagement, encourage conversation, and or sell products/services to target the intended audience.

2.2 The Source of Credibility Model: Expertise and Authenticity

Source credibility is defined as the image of a speaker who can be trusted by listeners at any given time (Andersen & Clevenger, 1963). The dimensions of source credibility are mostly grouped into two categories, namely the expertise and intentions of the speakers (Hovland & Janis, 1953). Expertise describes the extent to which the speaker is considered a valid source of revelation. The speaker's intention is defined as, the degree of confidence in the communicator's intention to communicate the statement he or she considers the most valid. The intention felt by the listener of a message can be influenced by the speaker's efforts to persuade and manipulate it.

2.3 The Source of Attraction Model: Physical Attractiveness, Social Attractiveness, Similarity of Attraction

According to (McGuire, 1968) the attractiveness model considers characteristics such as familiarity, similarity, liking, and attractiveness. In the context of influencer marketing, physical attractiveness, social attractiveness, and similarity of attraction are adopted as three dimensions of attractiveness. The physical attractiveness of an influencer can influence his followers to agree on the opinions expressed. Physically attractive individuals tend to be considered kind, attractive, sociable, modest, and responsive (Dion et al., 1972). Social attractiveness refers to a speaker's liking (Sokolova & Kefi, 2020). Social appeal gives the impression that followers can get closer and become friends with influencers. Interest similarity refers to the perceived similarity in the communicator's beliefs, values, experiences, and lifestyle by the recipient (Gilly et al., 1998). Communicators who are related and similar tend to be influential and can greatly influence recommendations (v. Wangenheim & Bay´on, 2004).

2.4 Trust

Trust is an individual's belief and willingness to act on the words, actions, and decisions of others. Trust is defined as, confidence in the integrity and reliability of partners (Morgan & Hunt, 1994). In communication, trusting the speaker reflects the listener's belief and willingness to believe and agree with the message conveyed, therefore trust represents the extent to which consumers believe that the words or claims of an influencer are valid or trustworthy.

2.5 Marketing Objectives: Product Image, Purchase Intention

Marketing objectives are the goals that brands expect their products to have after marketing. In general, marketing objectives are divided into two, namely product image and purchase intention. Product image is a perception given to a product (Biel, 1992). According to Bosnjak et al (2006) purchase intention is a tendency and desire that strongly encourages an individual to buy a product or service.

2.6 Hypothesis

Several previous studies have discussed that the credibility and attractiveness of an influencer can increase followers' trust in influencers (Masuda et al., 2021; Youn & Young, 2021). An influencer who demonstrates his expertise in a particular topic can receive approval from his followers. Authenticity, which is also one of the dimensions of credibility, also greatly influences followers' trust. Social media users are aware of sponsors and may be skeptical of the reasons the influencers' for promoting products/services. As such, authenticity allows followers to believe that

an influencer's posts are based own genuine opinions. The perceived intention of the influencer determines dependability, consistency, and predictability (Giffin, 1967). According to Youn & Young (2021), the expertise and authenticity of an influencer have a significant positive effect on followers' trust

H1: The expertise of an influencer has a positive effect on follower trust.

H2: The authenticity of the influencer has a positive effect on follower trust.

Sources of attractiveness consider characteristics such as familiarity, similarity, liking, and attractiveness. In the context of influencer marketing, physical attractiveness, social attractiveness, and similarity of attraction are adopted as three dimensions of attractiveness. The physical attractiveness of an influencer seen by a follower can influence a follower's initial judgment (Baker & Churchill, 1977). This influence can increase the level of approval of the opinion given (Chaiken, 1979). Social attractiveness refers to the tendency of influencers to increase the emotional liking of their followers beyond simply gathering likes on social media platforms. Interest similarity refers to the perceived similarity in the beliefs, values, experiences, and lifestyles of influencers and followers (Gilly el al., 1998). Influencers who have a more likely relationship can influence recommendations (v. Wangenheim & Bay´on, 2004). Therefore, the hypothesis of physical attractiveness, social attractiveness, and similarity of attraction of influencers has a significant positive effect on follower trust (Youn & Young 2021; Masunda H et al. 2021).

H3: The physical attractiveness of the influencer has a positive effect on follower trust.

H4: Social attractiveness of influencers has a positive effect on follower trust.

H5: Homophily of influencers has a positive effect on follower trust.

Trust in influencers makes followers find the relationship built useful and increases the effectiveness of the message. Since followers believe that a message from an influencer will lead to positive results, they expect the support to be influencer's beneficial. For example, about product purchases, trust-based on prior experience reduces follower doubt (Zeithaml, 1981) and increases sales effectiveness (Crosby, 1990). Thus, followers have a positive attitude towards the product and high purchase intention towards the product recommended by the influencer. Therefore, the hypothesis is formulated that follower trust has a significant positive effect on the product image, and follower trust has a significant positive effect on purchase intention (Youn & Young 2021; Masunda H et al. 2021).

H6: Follower trust has a positive effect on the product attitude.

H7: Follower trust has a positive effect on purchase intention.

3. METHODS

3.1. Sample and Data Collection

The sample characteristics are women or men, 18 years old or above, Instagram users and followed one or more Indonesian beauty influencers on Instagram (@tasyafarasya, @rachgoddard, @abelyc). These three Instagram beauty influencers were chosen as research objects because they have more than one million followers and concerned about skincare. Data were collected from a sample of 173 beauty influencers followers, but there are only 169 valid responses to be analyzed on the next stage. This study designed online questionnaire using Google Forms for the data collection. The online questionnaire (Google Forms) distributed to respondents by posting the questionnaire poster with the link on author’s social media account and sharing to group chats. Respondents consist of 150 women and 19 men, with age varies from 18 until above 45 years old. Most respondents are 18-25 years old and workers from various fields. The respondents also well educated with approximately 54% holding bachelor degree.

3.2 Instrument and Measures

The scales of the research constructs were adopted, revised, and translated from English to Indonesian as the survey was administered in Indonesia. Responses were recorded using a 5-point agreement scale, from 1 strongly disagree to 5 strongly agree. Measures of source credibility were adopted from Youn & Young (2021). Measures of source of attractiveness were adopted from Masunda H et al. (2021). Measures of trust were adopted from Youn & Young (2021). Marketing outcome were adopted from Youn & Young (2021) and Masunda H et al. (2021).

3.3. Analytical Technique

After data were collected, the author tested the proposed research model using structural equation modeling to analyze the causal relationship among latent construct. All analytical techniques used IBM SPSS 25 and IBM AMOS 26.

4. RESULTS

4.1 Normality and Linearity

In the first stage, an analysis was carried out using IBM SPSS 25. First, missing data were checked and there were no missing values. Second, outlier test was conducted using Z-score. The Z-score value for each indicator is -4.48 to 1.56, so there are three responses that are deleted to meet the cut-off value range (Hair et al., 2010). Third, a normality test was carried out on the data. The data has a skewness value and a kurtosis value in the normal range. So, it can be stated that the data is normally distributed This study uses a scatter plot to test linearity with results showing that the relationship between variables is linear, which can be seen from the distribution of points on the scatter plot and does not form a certain pattern.

4.2 Measurement Model

Table 1 Measurement Model

	Mean	Std. Deviation	Factor Loading	AVE	Cronbach's Alpha	Composite Reliability
Cut-off Value			**0,5**	**0,5**	**0,7**	**0,6**
Expertise (E)				0,723	0,82	0.912
E1	4,54	0,56	0.771			
E2	4,37	0,62	0.775			
E3	4,10	0,83	0.676			
E4	4,39	0,62	0.754			
Authenticity (A)				0.688	0,77	0.867
A1	4,30	0,67	0.600			
A2	4,04	0,83	0.832			
A3	4,14	0,73	0.753			
Physical Attractiveness (PA)				0.609	0,74	0.859
PA1	4,61	0,57	0.735			
PA2	4,64	0,53	0.806			
PA3	3,80	0,97	0.531			
PA4	4,41	0,72	0.652			
Social Attractiveness (SA)				0.601	0,84	0.855
SA1	3,42	1,09	0.851			
SA2	3,90	1,06	0.754			
SA3	3,44	1,13	0.835			
SA4	4,30	0,71	0.563			
Homophily (H)				0.549	0,83	0.827
H1	3,30	1,09	0,741			
H2	3,18	1,27	0,741			
H3	3,48	1,04	0,889			
H4	4,03	0,82	0,631			
Trust (T)				0.520	0,82	0.812

T1	4,33	0,66	0.665			
T2	3,85	0,96	0.597			
T3	4,15	0,73	0.581			
T4	3,77	0,98	0.604			
Product Attitude (P)				0.774	0,89	0.931
P1	4,22	0,73	0.677			
P2	4,22	0,76	0.715			
P3	4,28	0,69	0.857			
P4	4,23	0,70	0.810			
Purchase Intention (PI)				0.657	0,83	0.852
PI1	3,84	0,87	0,783			
PI2	4,07	0,80	0,727			
PI3	3,88	0,91	0,705			

This study used Confirmatory Factor Analysis (CFA) to estimate the measurement model and confirm whether the number of constructs and indicator variables is as expected based on the theory (Malhotra, 2010). The measurement model results can be seen on Table 1. The latent variables (E, A, PA, SA, H, T, P, PI) have passed the factor loading criteria of 0,5, then tested for validity and reliability. The validity was tested using Average Variance Extracted (AVE), which is the variance in the indicator variables described by the latent construct and used to assess convergent and discriminant validity. This model needed to reduce an indicator from ME to meet the AVE criteria of 0,5. The reliability test was performed using Cronbach's Alpha and Composite Reliability (CR) which is the total number of true score variances in relation to the total score variance. The results show that Cronbach's Alpha passed the criteria of 0,7 and the CR passed the criteria of 0,6. So, the measurement model is accurate and reliable.

4.3 Structural Model

Table 2 Goodness of Fit After Respesification

No	GOF Measurement	Cut-off Value	Value	Result	Source
Absolute Fit Indices					
1	CMIN/DF	1,00 ≤ CMIN/df < 3	2.617	Good fit	Wijanto (2008)
2	GFI	≥ 0,90	0.704	Fair fit	Peng & Fuzhou, (2015)
3	AGFI	≥ 0,90	0.651	Fair fit	Peng & Fuzhou, (2015)
4	RMR	≤ 0,08	0.153	Unfit	Malhotra (2010)
5	RMSEA	< 0,08	0.099	Unfit	Malhotra (2010)
Incremental Fit Indices					
6	NFI	≥ 0,90	0.707	Fair fit	Wijanto (2008)
7	CFI	≥ 0,90	0.794	Fair fit	Wijanto (2008)
8	IFI	≥ 0,90	0.796	Fair fit	Wijanto (2008)
9	TLI	≥ 0,90	0.773	Fair fit	Wijanto (2008)
Parsimony Fit Indices					
10	PNFI	0,60-1,00	0.642	Good fit	Wijanto (2008)
11	PGFI	0,50-1,00	0.598	Good fit	Wijanto (2008)

The next step is to test the fit model to determine the feasibility of the structural model using AMOS 26. The model fit test is carried out by comparing the goodness-of-fit (GOF) value to the cut-off value of each indicator (Malhotra, 2010). The results showed that some of the GOF criteria did not meet the cut-off value proposed by Malhotra (2010), so it was necessary to re-specify the model using Modification Indices (MI). Respecification is done twice to get optimal results. The results of the model can be seen in Figure 1.

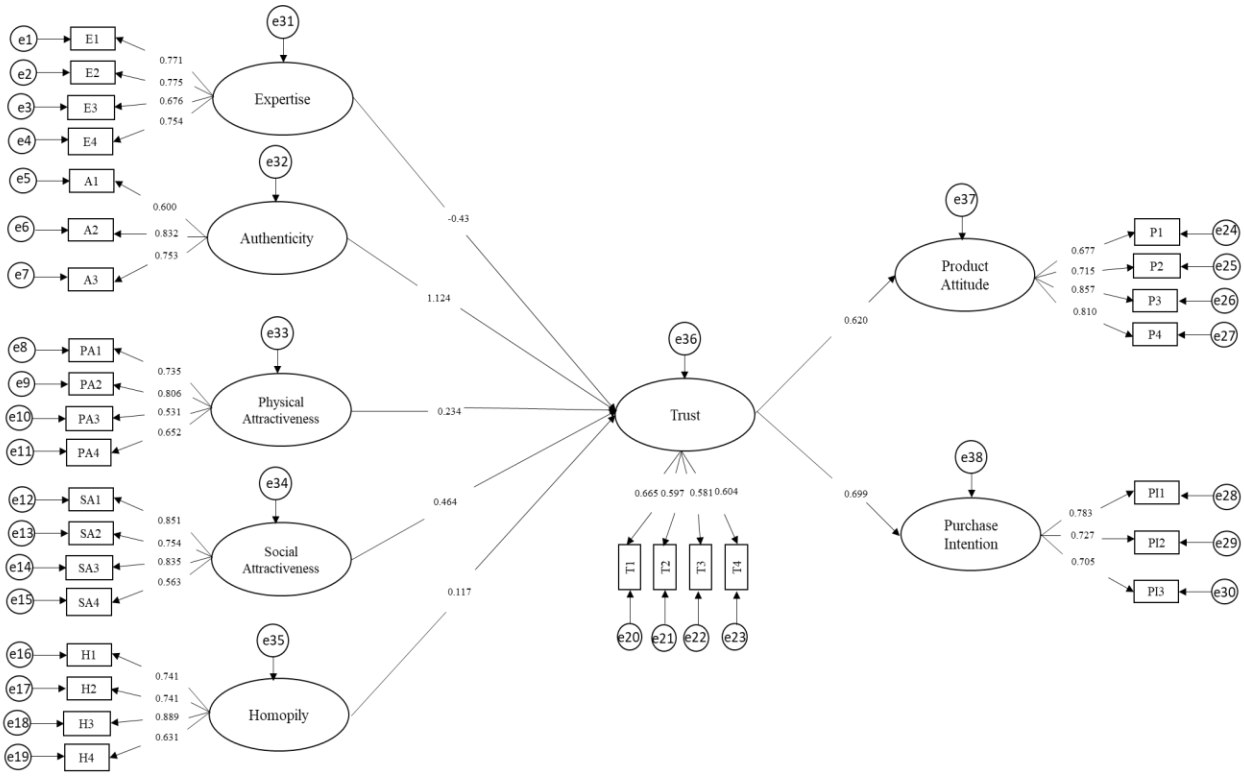

Figure 1 Research Model

4.4 SEM Hypothesis Results

The hypotheses were tested using SEM analysis by AMOS 26. The relationship between variables is expressed in standard coefficients contained in the path between variables (Figure 1). This study has seven hypotheses of direct I nfluence.

Table 3 Hypothesis

Hypothesis	Relationship			*β*	*P-value*	Result
H1	**Expertise (E)**	→	**Trust (T)**	-0.432	0.236	Rejected
H2	**Authenticity (A)**	→	**Trust (T)**	1.124	0.002	Accepted
H3	**Physical Attractiveness (PA)**	→	**Trust (T)**	0.234	0.040	Accepted
H4	**Social Attractiveness (SA)**	→	**Trust (T)**	0.464	0.040	Accepted
H5	**Homophily (H)**	→	**Trust (T)**	0.117	0.548	Rejected
H6	**Trust (T)**	→	**Product Attitude (P)**	0.620	***	Accepted
H7	**Trust (T)**	→	**Purchase Intention (PI)**	0.699	***	Accepted

The results of the direct influence hypothesis are summarized in Table 3. The results of the SEM analysis show that authenticity has a positive and significant effect on follower trust ($p < 0.05$; $\beta = 1.124$), so hypothesis H2 is accepted. physical attractiveness has a positive effect on followers' beliefs ($p < 0.05$; $\beta = 0.234$), so the hypothesis H3 is accepted. Furthermore, social attractiveness seems to have a positive and significant impact on follower trust ($p < 0.05$; $\beta = 0.464$), so hypothesis H4 is accepted. follower trust has a positive effect on product image t ($p < 0.05$; $\beta = 0.620$) and purchase intention t ($p < 0.05$; $\beta = 0.699$) so that hypotheses H6 and H7 are accepted. expertise and homophily have no significant effect on follower trust.

4.5 Managerial Implications

This research has some managerial implications to do social media marketing using influencers based on research findings. Marketers in doing social media marketing using influencers can choose SMIs that have high follower trust. This study found that follower trust has

a positive effect on product image and consumer purchase intentions. According to Wha & Kyung (2019) understand how SMI can garner their number of followers and gain the potential to influence them. Strong relationships with a foundation of trust and loyalty that have been built are very important in influencer marketing. This study also found that there are three variables that can affect followers' trust. First, authenticity, SMI that has a good image, and can be trusted can increase the trust of followers. Second, physical attractiveness, this study shows that the physical attractiveness of SMI can increase follower confidence. According to McGuire (1968) When a speaker is interesting, listeners are more likely to like and accept the speaker's message. Third, social attractiveness, this study shows that the social attractiveness of SMI can increase follower trust. Social attractiveness gives the impression that followers can get closer and become friends with SMI. This is something that greatly affects the level of trust of a follower to SMI.

This study has several managerial implications for SMI based on the research findings. First, SMI's authenticity can affect followers' trust, so it is very important for SMI to provide product reviews honestly and with the intention of giving followers positive things about the product. The intention felt by the listener of a message can be influenced by the speaker's efforts to persuade and manipulate it. This study recommends SMI to continue to provide honest reviews of products even though they have an affiliation with the brand that owns the product. Second, SMI's social attractiveness can affect follower trust. This study recommends SMI to create interactive and communicative content, which creates a sense of closeness and belonging between SMI and their followers because the sense of being able to socialize and make friends with SMI affects followers' trust.

This study also found that SMI's expertise had no effect on followers' trust. This provides knowledge that in terms of model credibility, the intention of SMI is more important than SMI's expertise in an area that is in line with the product or brand recommended by it. Homophily also had no effect on followers' trust.

5. CONCLUSIONS

This reserach aims to determine whether credibility and attractiveness of beauty influencers affects loyalty, purchase intention, and the image of the product. First, the results show that authenticity, physical attractiveness, and social attractiveness are important factors to improve followers trust. Then, trust driving followers' attitude toward the products promoted by SMI. For social media marketing activities, marketers can use highly trusted SMI to promote their products because strong relationships based on trust and loyalty that have been built are very important in influencer marketing. First, SMI should provide honest product reviews even though they have an affiliation with the brand and present positive things about the products to their followers. Second, SMI should create interactive and communicative content, which improve the relationship between SMI and their followers, because the sense of being able to socialize and make friends with SMI affects followers' trust.

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DEVELOPMENT OF WEBQUAL 4.0 MODEL ON E-COMMERCE SERVICES TO INCREASE USER SATISFACTION

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ABSTRACT

XYZ Online Store is one of the largest e-Commerce platforms in Indonesia that provides free C2C (Customer to Customer) business platforms for merchants and buyers. There was a significant decrease in the number of active customers from the XYZ Online Store after a customer data security incident occurred. The problem experienced by XYZ Online Store is a data leak which causes a decrease in customer satisfaction with the XYZ Online Store e-Commerce application. The decline in active customers, loyalty and customer's voice also shows negative sentiment towards the security aspect of XYZ Online Store. So from this, a WebQual 4.0 model was developed by adding an application security quality variable to analyze the security factors of the TokoOnline XYZ e-commerce platform. The model development was carried out to analyze the influencing factors in increasing user satisfaction (User Satisfaction). Literature study, the development of the WebQual 4.0 method which focuses on 4 variables namely Usability Quality, Information Quality, Service Quality and Security Quality based on a survey of respondents carried out to achieve the results in this study. The survey was conducted with a 5% precision, a sample of 396 active users of TokoOnline XYZ was used as the basis for the analysis. The results of this study indicate that information quality, service quality and usability quality have a significant effect on user satisfaction on e-commerce platforms and acknowledge that security factors also affect user satisfaction but are not significant. The higher the quality of information, service, usability and security, the higher the user satisfaction. Recommendations from the results of the analysis of the resulting hypothesis emphasize the development of personnel from e-commerce service developers in order to increase user satisfaction. The results of this study will help practitioners and researchers of e-commerce platforms to understand customer satisfaction in e-commerce services and become a reference for e-commerce platform developers in developing their services to match the achievement of customer satisfaction to the future

Keywords: e-Commerce; WebQual 4.0; User Satisfaction

1. INTRODUCTION

Zhou et. al (2005) in his research shows the rapid development of e-Commerce is in line with the increasing threat to property security and human privacy securit. Dijesh et.al (2020) stated that security breaches have an impact on customers' fear and lack of trust in their personal data on eCommerce websites. Yu et. al (2018) stated that distributed systems with high complexity pose challenges to system security, a design flaw in the e-Commerce security system causes serious security problems such as transaction property violations, loss of funds, or commonly known as structural security breaches. Xu et.al (2020) Lack of security and scalability of e-Commerce security protocols caused by the basis of e-Commerce based on open and free Internet which allows security holes to be exploited by intruders. Existing security protocols tend to be complex and inefficient protocols. In March 2020, one of the largest e-commerce web applications in Indonesia, Toko Online XYZ estimated that 91 million accounts and 7 million merchant

accounts were hacked. In fact, in 2019, an e-Commerce application which is well-known with the slogan of being complete, trusted, easy and safe, revealed that there were 91 million active accounts on its platform, which means that almost all accounts in this e-Commerce company were successfully retrieved by hackers. User data worth US $ 5,000 or equivalent to Rp. 75 million on the Dark Web. The average active visitor to the Tokopedia site has decreased significantly after the data breach incident occurred. Based on internal data, in March 2020, XYZ Online Store recorded 100.6 million active users in its system. However, after the data breach incident occurred in March 2020, precisely in April 2020, the number of active subscribers decreased by 35%, recording 65.2 million active subscribers and for the next 2 months to be precise, until May 2020, the increase in the number of subscribers was not significant, successively. also recorded in May 2020 67.8 million users and June 2020 69.2 million active subscribers. Labrecque (2021) shows that data breaches and data misuse are increasing every year, disrupting customer privacy and a lot of information is voluntarily provided by consumers through daily activities and connections to machine learning devices, which implies that data is often collected secretly. Tosun et al (2021) indicates that data breaches further lead to the exchange of confidential information about the company that was the victim of the attack and can cause further damage to the company. Data breaches affect company policies in the long term for up to 5 years after the attack occurs. Tosun et al (2021) stated that this is consistent with the hypothesis that security breaches result in a negative image for the company in terms of organizational reputation. This incident revealed confidential information and the loss of competitiveness against competitors in the same industry caused by the loss/damage/disclosure of important company data. Labrecque (2021) stated that data breaches and misuse of data interfere with customer privacy, while a lot of information is voluntarily provided by consumers through daily activities even though cases of data breaches are always increasing, research on the impact of data breaches on consumer feelings is less explored. However, previous studies and cases that discuss incidental security handling and evaluation of security sustainability to achieve increased customer satisfaction are less discussed. So this is worth researching as material for consideration and basic work in evaluating and anticipating incidents in order to create consumer confidence as end users of e-Commerce web applications. Dijesh et. al (2018) shows that the security aspect in e-Commerce development caused by increasing warnings of privacy security holes and security breaches has an impact on the fear and lack of trust of customers in their personal data on eCommerce websites. Yu et al. (2018) A design flaw in the e-Commerce security system causes serious security problems such as breach of transaction property, loss of funds, or commonly known as structural security breach. Djumadi & Barkatullah (2018) shows that the risks posed by e-Commerce include damaged goods, undelivered goods, lack of service and serious customer fraud. The identity of the seller who is easily hidden makes it difficult for customers to make claims/problems to the seller can lead to a loss of customer trust and e-Commerce transactions are also vulnerable to fraud and other hidden problems if the information presented is incorrect, illegal and other IT technical problems such as network breaks. High customer satisfaction is associated with customer intentions or intentions to re-purchase which has implications for an increase in the number of loyal transactions in e-Commerce, further implying that the higher the level of customer satisfaction, the higher the level of customer satisfaction.

2. LITERATURE REVIEW

According to Laudon & Traver, (2017), simply E-Commerce is a buying and selling transaction that occurs on the internet. This transaction makes it easy for buyers to access various products and make purchases of both goods and services through an online platform without having to visit the physical store. Often E-Commerce -equated with E-Business, the two have differences. According to Chaffey (2015), E-Business is a transformation of key business processes from all business processes that use the internet as the main technology. Cisco, (2021) Information security, often referred to as Information Security (Infosec), refers to the processes and tools designed and used to protect business information from sensitive and potentially damaging matters such as modification, tampering, destruction, and inspection. important part of cybersecurity, but refers exclusively to processes designed for data security. Kotler & Keller, (2016) satisfaction is a condition in which human feelings result from a comparison of the capabilities of the product/service received in meeting consumer needs and expectations. Negative sentiment towards satisfaction occurs if the product/service is not able to meet consumer expectations. Positive sentiment

occurs when the product/service is able to meet or even exceed consumer expectations. Companies need to measure customer satisfaction regularly in order to achieve customer satisfaction because satisfaction is one of the keys to retaining customers. Zahreza, et al., (2014) in his research said that WebQual is a development measurement technique or method from ServQual which was previously widely used in measuring service quality, in measuring the quality of a website application, WebQual focuses on end user perceptions, which incidentally in interaction E-Commerce is a consumer and WebQual 4.0 is a development of WebQual 1.0 which started in 1998 until now. According to Aljuboori, et al., (2011) to assist organizations/companies in managing their web applications, methods are needed to analyze web applications, because web applications have become the main area for corporate communication on a large scale. One of the commonly used analytical approaches in evaluating web applications is a questionnaire. Suradika, (2020) stated that most experts believe that there are two terms in data analysis, namely processing and analysis. Susilo, (2010) explains that "data processing and data analysis have different meanings, but are often used interchangeably". Data processing is transforming raw data into more meaningful data. Analysis is the process of converting raw data into data that has meaning and leads to conclusions with the aim of solving problems in the research conducted, such as questionnaire data, if data analysis is not carried out, it will not be meaningful. Sugiyono, (2017) explains that the sampling technique to be used as research analysis material is called the Sampling Technique. In general, there are two divisions of sampling techniques, namely Probability Sampling and Non-Probability Sampling. Both regulate how the probability of members of the population in the selection as a member of the sample. According to Schumacker, (2016) the basis for the preparation of the development of the SEM analysis model follows 5 sequences or logical sequence processes starting from model specifications, model identification, model estimation, model testing and model modification and these five sequences are essential for developing SEM analysis models. Ghozali, (2013) shows that the statistical analysis method commonly used in analyzing multivariate data is Structural Equation Modeling (SEM). SEM is generally used to test a quality or theory, 2.10 Partial Least Squares Path Modeling (PLS-SEM) serves to predict a model, explore, and test the truth of a hypothesis.

3. METHODS

In this study, model development, analysis using PLS-SEM and preparation of recommendations were made as the output of the research. The flow of the research methodology is divided into 3 stages of research that need to be carried out, broadly depicted in namely the model development stage, the data collection stage, and the testing and analysis stages of the model as well as the preparation of research recommendations. In the development stage, literature study was conducted on problems from case studies that are raised from research. Review of journal articles is carried out, especially research related to user satisfaction. Also looking for literature references regarding the Structural Equation Modeling (SEM) method and also the stages of its development, analysis, and model testing. Model specification is carried out with the aim of developing a theoretical model using all available theories, previous research, and relevant information. Therefore, before collecting or analyzing data, the researcher uses the variance-covariance data to determine the specific model that needs to be identified. In other words, the available information is used to determine which variables are included in the theoretical model (including implicitly excluded from the model) and how these variables are related. Model specifications include identifying each relationship and parameter in the model of interest to the researcher. Identification of models to form measurement models in research. There are two rules that must be obeyed in the identification of the model, namely the recursive rule and the t-rule. The recursive rule stipulates that the structural model requires a one-way relationship, while the t-rule stipulates that the structural model requires more known variables than unknown variables. In order for the variables to be known, an indicator is added to each variable based on previous research references and according to the research context, namely e-commerce customer satisfaction.

In the data collection phase, a questionnaire was developed to collect data for this survey. The survey is made by referring to the indicator draft made in the previous phase. The indicator draft contains statements that are appropriate to the context of this research. Article searches were also carried out to ensure that the statements made were absolutely correct and that these variables could be measured. Self-

filled questionnaires require careful construction with a clear articulation of objectives and depend on their format and wording. Statements should only cover one point, be clearly written and contained in short sentences. Words should be appropriate for the survey population and avoid sentence ambiguity to reduce the potential for confusion in filling out the questionnaire. At this stage, the questionnaire was tested before being distributed to respondents. The questionnaire is tested whether it is really able to visualize the achievement of the objectives to be measured in the study. The validity test was carried out to test the construct validity of the total value of each statement and the Cronbach's Alpha reliability test was carried out in accordance with and if the questionnaire proved invalid, it would be re-modified until the questionnaire passed the validity and reliability test. The output of this stage is a questionnaire that is ready to be distributed to respondents or ready for a survey. In the survey conducted, the number of respondents is determined first, then what needs to be known first is the population. In a survey, if the population is not too large, then the entire population must be used in the survey.

In the testing and analysis stages of the model as well as the preparation of research recommendations, In the Outer Model Testing (Measurement Model) there are three stages of testing carried out, namely convergent validity, discriminant validity, and internal consistency reliability. Convergent validity is seen from the estimated value of the loading factor on each indicator. Discriminant validity has a focus on the extent to which a latent construct distinguishes it from other constructs by looking at the AVE value and Internal Consistency Reliability is carried out to see the reliability of a model based on the analysis of each indicator on its variables and see how far an instrument is reliable enough to create consistent results. If the model does not pass the Outer Model testing stage, then one of the indicators that do not meet the test criteria is deleted. The output of this stage is the results of testing the research model and the results of its modifications that have passed the test and are ready to be used for testing the Inner Model (Structural Model). Inner Model Testing (Structural Model) Structural model testing is conducted to test the relationship between the constructs that have been formed in the model using R-Square (R2) and Q-Square (Q2) analysis. An evaluation of the path coefficient between constructs was carried out to determine the strength of the relationship between each construct in order to serve as a basis for supporting hypothesis analysis. If the critical value ratio is greater than or equal to 1.96 then the relationship between the constructs is significant. The output of this stage is a research model that has passed the Inner Model test and the results of the analysis of the significance of the relationship between the model constructs which are used as the basis for further analysis of hypotheses and drawing conclusions. At this stage, hypothesis analysis is carried out based on the results of the Inner Model Structural Model testing by looking at the results of the path coefficient evaluation between constructs. The acceptance of a hypothesis is decided based on the significance test value. Hypothesis analysis was strengthened by literature study and comparison with hypotheses in similar previous studies. The output of the results of this hypothesis analysis is used as a basis for reference for conclusions and preparation of recommendations.

4. RESULTS

Hypotheses are prepared based on previous studies and review of articles that form the basis for determining the hypothesis. There are 4 hypothesis stated in this research namely *H1 Information Quality has a significant effect on User Satisfaction of users in interacting with online store applications; H2 Security Quality has a significant effect on user satisfaction in interacting with online store applications; H3 Service Quality has a significant effect on user satisfaction in interacting with online store applications; H4 Usability Quality has a significant effect on User Satisfaction of users in interacting with online store applications*. Based on the categorization in **Table 1**, in **Table 2** is a detailed calculation of the index of the UQ (Usability Quality) variable, the results of processing respondent data on the UQ (Usability Quality) variable have an average index value of 1677 from the total index value of 1980. So in the form of a percentage , the index yields an average of 85%. On the aspect of UQ (Usability Quality) users are satisfied if the e-commerce application provides easy services, clear and understandable interactions. In line with that, the results of the calculation of the Usability Quality index in **Table 2** visualize that the majority of respondents as much as 85% feel satisfied with the usability quality of e-commerce applications such as operational ease, navigation, and clear and easy-to-understand e-commerce service interfaces. which leads

to a user friendly interface. And according to the index interval categorization of the Three Box Method, the UQ (Usability Quality) variable is included in the "High" category.

Table 1. Value Interval Index Category

Interval Index	Category
10% - 40%	Low
41% - 70%	Medium
71% - 100%	High

Table 2. Index Calculation on Usability Quality Variable

Variable	Answer Scale					Sum of Index	Interval Index Percentage	Notes
	1	2	3	4	5			
UQ1	0	0	40	192	164	1708	86%	High
UQ2	8	0	40	200	148	1668	84%	
UQ3	0	8	68	184	136	1636	83%	
UQ4	0	0	88	108	200	1696	86%	
					Average	1677	85%	

In **Table 3** is a detailed calculation of the index of the IQ (Information Quality) variable. The results of processing respondent data on the IQ (Information Quality) variable have an average index value of 1631 from the total index value of 1980. So in percentage form, the index produces an average of 82 %. In accordance with the explanation of the Key Performance Indicators of user satisfaction, on the aspect of information quality, users are satisfied if the e-commerce application provides accurate and relevant information. The purpose of accurate and relevant is that the information displayed on the e-commerce service interface is truly the original product offered in accordance with its real form and does not contain elements of fraud. In line with that, the results of the calculation of the information quality index (Information Quality) in **Table 3** show that the majority of respondents as much as 82% feel satisfaction with the quality of information from e-commerce applications that are accurate and relevant although not 100% perfect. And according to the index interval categorization of the Three Box Method, the UQ (Usability Quality) variable is included in the "High" category.

Table 3. Index Calculation on Information Quality Variable

Variable	Answer Scale					Sum of Index	Interval Index Percentage	Notes
	1	2	3	4	5			
IQ1	0	8	68	224	96	1596	81%	High
IQ2	0	8	80	172	136	1624	82%	
IQ3	0	8	68	160	160	1660	84%	
IQ4	0	8	48	216	124	1644	83%	
					Average	1631	82%	

In **Table 4**, is a detailed calculation of the index of the SQ (Service Quality) variable. The results of processing respondents' data on the SQ (Service Quality) variable have an average index value of 1694.4 of the total index value of 1980. So in the form of a percentage, the index produces an average by 86%. In accordance with the explanation of the Key Performance Indicators of user satisfaction, in terms of service

quality, users are satisfied if the e-commerce application meets the terms and agreements of service. The purpose of service terms and agreements is an agreement on services provided, the privileges provided by e-commerce services to users, ranging from transactional services related to financial, as well as non-financial services such as features obtained by users in accordance with the privileges they have. that add value to tangible and intangible services. In line with that, the results of the calculation of the service quality index (Service Quality) in **Table 4** show that the majority of respondents as much as 86% feel satisfaction with the service quality of e-commerce applications. And according to the index interval categorization of the Three Box Method, the SQ (Service Quality) variable is included in the "High" category.

Table 4. Index Calculation on Service Quality Variable

Variable	Answer Scale					Sum of Index	Index Percentage	Notes
	1	2	3	4	5			
SQ1	0	8	24	152	212	1756	89%	High
SQ2	0	0	64	164	168	1688	85%	
SQ3	0	0	48	224	124	1660	84%	
SQ4	0	12	72	164	148	1636	83%	
SQ5	0	12	24	164	196	1732	87%	
					Average	1694,4	86%	

In **Table 5** is a detailed calculation of the index of the SCQ (Security Quality) variable, the results of processing respondent data on the SCQ (Security Quality) variable have an average index value of 1440.57 of the total index value of 1980. So in percentage form, the index produces an average of 73%. In accordance with the Key Performance Indicator explanation of user satisfaction, in terms of security quality, users are satisfied if the user's confidential data on the e-commerce application that is shared does not cause material losses. The data breach case that occurred in the TokoOnline XYZ case study affected user satisfaction with the security of e-commerce services. In line with that, the results of the calculation of the security quality index in **Table 5**, visualize the majority of respondents on average as much as 73% feel satisfaction with the security quality of e-commerce applications but there are still doubts on the SCQ1 and SCQ 3 variables which show the percentage index of 54% and 63%. In accordance with the items in the questionnaire, in general, the statement of the SCQ1 and SCQ 3 variable indicators is how e-commerce service providers provide security to their users in the form of advanced security measures. In **Table 5**, the SCQ1 and SCQ 3 variables show a negative sentiment compared to other SCQ variable indicators. This makes an assumption that the security of TokoOnline XYZ's e-commerce service tends to be unsafe and will be proven in a hypothesis analysis. However, according to the index interval categorization of the Three Box Method, the SCQ (Security Quality) variable is included in the "High" category in terms of the percentage of the average index interval.

Table 5. Index Calculation on Security Quality Variable

Variable	Answer Scale					Sum of Index	Interval Index Percentage	Notes
	1	2	3	4	5			
SCQ1	0	16	88	192	0	1064	54%	Medium
SCQ2	0	24	80	200	92	1548	78%	High
SCQ3	0	12	40	196	148	1668	84%	
SCQ4	36	60	148	112	40	1248	63%	Medium
SCQ5	0	24	96	176	100	1540	78%	High
SCQ6	8	32	88	136	132	1540	78%	
SCQ7	8	36	112	140	100	1476	75%	

Average	1440,57	73%	

In **Table 6** is a detailed calculation of the index of the US variable (User Satisfaction), the results of processing respondent data on the US variable (User Satisfaction) have an average index value of 1710.22 from the total index value of 1980. So in percentage form, the index produces an average of 86%. In accordance with the explanation of the Key Performance Indicators of user satisfaction, on the aspect of overall user satisfaction, users are satisfied if the service aspects of e-commerce applications create positive sentiments for other users and the expectations held by users are in accordance with the reality of e-commerce application services. commerce. That is, the expectations from the user's perspective of the services received on e-commerce services are in accordance with those on the interface of e-commerce services. Positive sentiment visualizes the tendency of a good experience, not disappointing from users towards the experience of aspects of e-commerce services. In line with that, the results of the calculation of the overall user satisfaction index (User Satisfaction) in **Table 6**, visualize that the majority of respondents as much as 86% feel satisfaction with the service quality of e-commerce applications as a whole. And according to the index interval categorization of the Three Box Method, the US variable (User Satisfaction) is included in the "High" category.

Table 6. Index Calculation on User Satisfaction Variable

Variable	Answer Scale					Sum of Index	Index Interval Percentage	Notes
	1	2	3	4	5			
US1	0	8	52	180	156	1672	84%	High
US2	0	0	24	176	196	1756	89%	
US3	0	0	8	168	220	1796	91%	
US4	0	8	80	208	100	1588	80%	
US5	0	0	24	160	212	1772	89%	
US6	0	0	40	168	188	1732	87%	
US7	0	0	48	200	148	1684	85%	
US8	0	0	32	208	156	1708	86%	
US9	0	16	24	200	156	1684	85%	
Average						1710,22	86%	

Hypothetical Analysis were done after doing some testing of the model in sub-chapter 4.7 to get a fit model, hypothesis analysis was carried out. In this sub-chapter, the results of the significance analysis for all relationships are described. The results of the significance analysis are used as answers to the 4 hypotheses in this study which have been prepared previously. The path coefficient values for each variable relationship can be seen in **Table 7** and the visualization of the relationship between exogenous variables and the path coefficient values for endogenous variables is shown in **Figure 1**

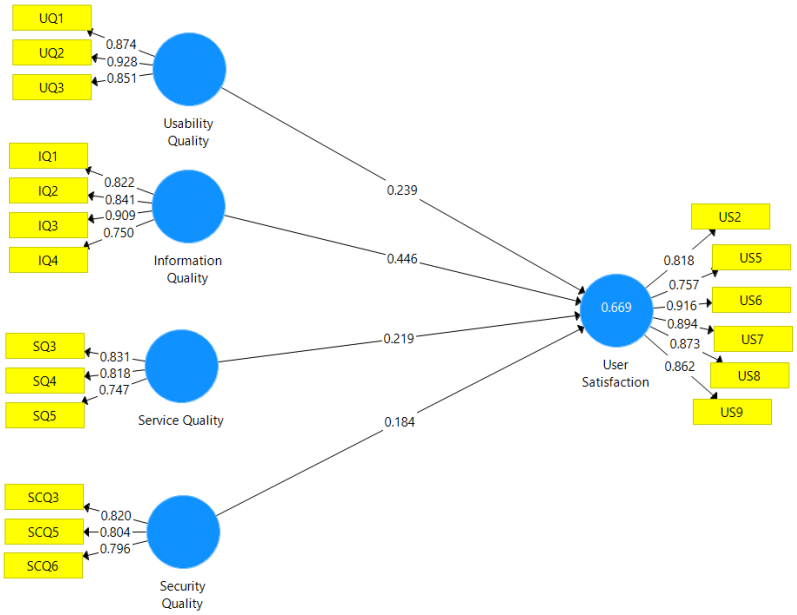

Figure 1. Developed *WebQual 4.0* PLS-SEM Model

Path	Hypothesis	Path Coefficient	T-Statistic	T-Table	Notes
Information Quality -> User Satisfaction	H1	0,446	4,732	1,96	Significant
Security Quality -> User Satisfaction	H2	0,239	1,617		Not Significant
Service Quality -> User Satisfaction	H3	0,219	2,103		Significant
Usability Quality -> User Satisfaction	H4	0,184	2,452		Significant

H1. Information Quality has a significant effect on user satisfaction in interacting with e-commerce applications.

It is known that the relationship between Information Quality and User Satisfaction has a path coefficient of 0.446, which means that Information Quality affects User Satisfaction by 44.6%. While the t-statistic value of the relationship is 4.732, which means the t-statistic value is greater than the t-table value of 1.96. This shows that Information Quality has a significant positive effect on User Satisfaction. So that hypothesis 1 can be fulfilled. That is, the quality of information from a service on an e-commerce platform has an impact on user satisfaction. The higher the quality of information on e-commerce services, the higher the level of satisfaction of e-commerce service users will also be. In line with this, previous research by (Ghasemaghaei & Hassanein, 2015) stated that the relationship between the quality of information on electronic platform services and user satisfaction was proven to be very strong and the focus of developing electronic service applications on information quality aspects was the accuracy, completeness and reliability of information to improve user satisfaction.

H2. Security Quality has a significant effect on user satisfaction in interacting with e-commerce applications

It is known that the relationship between the Security Quality variable and User Satisfaction has a path coefficient of 0.239, which means that Security Quality affects User Satisfaction by 23.9%. Meanwhile, the t-statistic value of the relationship is 1.619, which means the t-statistic value is smaller than the t-table value of 1.96. This shows that Security Quality has a positive but not significant effect on User Satisfaction. So that hypothesis 2 is not fulfilled. That is, the quality of information security of a service has an influence on customer satisfaction but the impact is not too significant. A note on this hypothesis, in

previous research stated that when the perceived benefits of a security practice outweigh the effort, it is more likely that users will be satisfied with the practice when using information system services. Even though a data breach security incident occurred on an e-commerce service platform, as long as there were no transactional or material losses related to the user and the user still felt the same benefits from the existing security protocol, negative sentiment on the security quality variable did have an impact on user satisfaction but not how significant.

H3 Service Quality has a significant effect on user satisfaction in interacting with e-commerce applications

It is known that the relationship between the Service Quality variable and User Satisfaction has a path coefficient of 0.219, which means that Service Quality affects User Satisfaction by 21.9%. While the t-statistic value of the relationship is 2.0398, which means t-statistic > 1.96. This shows that Service Quality has a significant positive effect on User Satisfaction. So that hypothesis 3 can be fulfilled. This means that the service quality of the e-commerce platform has a very impactful or significant influence on user satisfaction, the higher the service quality, the higher the level of satisfaction of e-commerce service users. In line with research by (Li, et al., 2021) service quality greatly influences customer satisfaction with the services provided and service quality includes cost effectiveness, personnel friendliness, and technical support when users experience difficulties. When customers achieve good service quality, they perceive it as good value and are happy to be loyal to the product because high quality leads to better perceived value.

H4 Usability Quality has a significant effect on user satisfaction in interacting with e-commerce applications

It is known that the relationship between the Usability variable and User Satisfaction has a path coefficient of 0.184 which means that Usability Quality affects User Satisfaction by 18.4%. While the t-statistic value of the relationship is 2.5203, which means t-statistic > 1.96. This shows that Usability Quality has a significant positive effect on User Satisfaction. So that hypothesis 4 can be fulfilled. This means that the higher the quality of usability on an e-commerce platform service, the higher the level of user satisfaction of the e-commerce platform service. Users are satisfied if the e-commerce application provides an easy service, the interaction is clear and understandable. In line with that, research in (Jeddi, et al., 2020) states that usability quality is one of the main features of the quality of information systems which is determined by the ease of use and the extent to which a product or service is used by certain users for certain purposes with effectiveness, efficiency, and satisfaction. A poor level of usability reduces the use of information systems and hinders user acceptance of their usefulness.

5. CONCLUSIONS

In this study, a model was developed to determine the quality factors that affect user satisfaction with e-commerce application services. Research is conducted on the impact of information quality, security quality, service quality and perceived usability quality in user interactions on user satisfaction on e-commerce platforms. The model development is carried out using the Partial Least Square - Structural Equation Modeling (PLS-SEM) model through five stages of model development, namely model specification, model identification, model estimation, model testing and model modification. Based on the systematic mapping of the literature, the Webqual 4.0 model was chosen to be developed in this study. The Webqual 4.0 model was chosen because it was previously widely used in measuring application quality and was able to visualize measuring the quality of an application and focusing on end-user perception. In the model specification, a variable is added to be added to the model, namely the security quality variable based on previous research which supports that security quality is one of the variables that affect user satisfaction. In identifying the model, indicators for each variable are arranged for measurement. With questionnaires and surveys that have been tested for validity and reliability as the basis for data collection methods. In testing the model, the measurement model and structural model were tested. In the measurement model, convergent validity, discriminant validity and internal consistency reliability were tested. In the structural model test, the significance test and path coefficient analysis were carried out. Hypothesis analysis was conducted to describe the results of the significance and path coefficient tests carried out on the structural model test. The results of this study draw the conclusion that information quality, service quality and usability quality have a significant effect on user satisfaction on e-commerce platforms and recognize that security factors also affect user satisfaction but are not significant. Therefore,

the managerial implication of this study is that these significant influencing factors such as information quality, service quality and usability quality can be taken into account in the development of e-commerce platforms in emerging markets for increased customer satisfaction. Theoretically, the results of this study become the theoretical basis for research related to the focus of future e-commerce development. This finding also confirms that information quality, security quality, service quality and usability quality are important components of e-commerce research and the model developed in this study is able to visualize the relationship of quality factors and the weight of their relationship from an e-commerce application to customer satisfaction.

For future research, a more in-depth analysis of descriptive statistics is not carried out in detail because the main focus of this research is to analyze the factors that influence the quality of an e-commerce application service on customer satisfaction. In future research, a more comprehensive descriptive statistical analysis can be carried out, for example in the age demographic sector. Because each age generation has different tendencies towards the use of the latest technology, for example in e-commerce application services (Kubiatko, 2013). Age demographic classifications such as Baby Boomers, Gen X, Gen Y, Millennials and most recently Gen-Z are interesting for future research because each generation has its own unique characteristics of adapting to information technology. Therefore, future research can use other approaches to increase the comprehensiveness of the current research.

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DIGITAL MARKETING ANALYSIS OF TOURIST VILLAGES IN BANGLI REGENCY OF BALI PROVINCE

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ABSTRACT

Digital marketing is now an important tool for promoting products to consumers. The promotion model is dominated by goods products and is very limited to tourist village services. This research aims to analyze the application of digital marketing models applied in tourist villages. The approach used is the mixed method that is the first to conduct a quantitative analysis of the data collected based on the spread of questionnaires and the next stage is carried out qualitatively through in-depth interviews based on the results of previous studies. A total of 31 tourist village managers in the Bangli regency as samples andinformants. The results of quantitative analysis explained that 9.49 percent of tourist villages have run digital marketing in full the rest are diverse. The managers are aware ofthe benefits of digital marketing such as Kintamani village, tucking village, and Terunyan village into a world destination. Other tourist villages in their application have constraints in human resources and funding. Digital marketing is run mostly using Search Engine Optimization (SEO) or known as a website. The results of this study encourage tourism village managers to further innovate in using digital marketing so that tourist visits can increase. The digital marketing model applied in tourist villages contributes to the development of marketing science that is oriented to the community.

Keywords: digital marketing, tourism village, search engine optimization, bangli

1. INTRODUCTION

The development of world tourism today continues to experience innovation, one of which is the CBT (Community Based Tourism) (Astawa et al.2019) approach. There are five principles in CBT, namely economic principles, social principles, cultural principles, environmental principles, and political principles (Suansri, 2020; Astawa et al.2019) which must be carried out by the principles of sustainable development. This concept has been developed in Indonesia through the village or rural units, this is because the village is a place for most tourist attractions that have a variety of uniqueness such as nature, culture, and other social life.

One of the regions in Indonesia that successfully manage CBT is the island of Bali which has been worldwide such as; Pandawa Beach and Kedonganan Beach in Badung Regency, Tanah Lot in Tabanan Regency, Ubud Monkey Forest, and Terasering Ceking in Gianyar Regency, as well as Penglipuran Tourism Village in Bangli Regency (Akama et al., 2017). All these destinations are proof that community-based tourism development (CBT) has been able to providebenefits for the lives of local people, and tourism management policies are not only carried out by the government but on the initiative of local communities. CBT activities that are professionally managed can lift Bali's image as a beautiful, majestic, exotic, sustainable tourist destination, with its friendly and unpretentious community behavior. Another difficult situation is its customs and culture based on the principles of harmony and balance.

Bangli is one of the districts in Bali managing thirty-one tourist villages spread across four sub-districts. The potential is possessed by diverse tourist villages ranging from cultural tourism, geological tourism, agro-tourism, spiritual tourism, to nature tourism. The development of tourist villages also affects the social and cultural life of the surrounding residents. This can be explained by Yoeti (2017) in his research concluded that the influx of tourists with a variety of habits, environment, education level, and different life backgrounds, can affect the population visited both those who provide direct and indirect services. The concept of CBT or rural tourism is certainly different from urban tourism, both in terms of objects, locations, functions, scales, and characters. Aspects such as the role of tourist villages in the specialization of locations and the availability of attractions and facilities deserve attention in the development of tourist villages that are expected to support rural diversification (Fajarwati, 2018).

Thirty-one tourist villages that there are only two tourist villages that are famous in the world such as the tourist village of slip and the tourist village Kintamani, the rest are not familiar (Hamzah, 2013). This condition is very concerning where the government is trying to encourage rural tourism as a center of economic resilience in maintaining village independence. Such problems based on previous research can be caused by a lack of communication media between products and consumers (Zhu &Gao, 2019). Effective product communication models through digital marketing will have a significant impact on product sales (Grossberg, 2016). Digitalmarketing has a very wide scope. This means that in digital marketing we talk ABOUT IT, social media, trends, netizens,business, advertising, and others. Advances in technology are a real manifestation that consumer behavior has now shifted. The needs and desires that want to be more practical and fast seem to be a trend in society that is touted as a modern society. In the modern era, products need to be wrapped in style, especially in the era of lifestyle that is very quickly developed due to globalization (Kartajaya, 2017).

Digital marketing is one of the marketing media that is currently in great demand by the public to support various activities carried out. They gradually began to abandon conventional marketing models to switch to modern marketing, namely digital marketing. Digital marketing communication and transactions can be done at any time in digital marketing. A survey conducted by Pradiani (2017) found that 132.7 million Indonesians are connected to the internet, which

currently plays an important role in determining consumer purchasing decisions. The increase in the number of internets and social media users becomes a huge opportunity for business people to market their products. Janathanan & Nizar (2013) uses the term red-hot, to describe such a large marketer opportunity in marketing over the internet. Internet product marketing can be further helped, as the internet enables a more effective marketing process, faster response, and cheaper costs (Hermawan, 2012). Low costs and rapid dissemination of information are expected toincrease sales so that they can achieve targeted turnover.

Based on the phenomenon and the results of the research described earlier, this research aims to conduct digital marketing analysis conducted by tourist villages, to provide the right information in choosing a digital marketing model. The analysis process uses two approaches quantitatively and qualitatively in order to be able to reveal deeper results (Creswell, 2012).

2. LITERATURE REVIEW

Digital Marketing

Since the early 2000s, information technology has entered key markets and developed deep into what is referred to as new wave technology. New wave technology is a technology that enables connectivity and interactivity between individuals and groups (Kotler, 2011). In the new wave era, the economy is considered not only economic growth, interest rates, and inflation but also the digital economy factor. The existence of the digital economy is characterized by the increasing rise of businesses or trade transactions that utilize the internet as a medium of communication, collaboration, and cooperation between companies or between individuals (Situmorang, 2011). Digital marketing is a marketing activity including branding (brand recognition) that uses various web-based media such as blogs, websites, e-mail, Adwords, orsocial networks. And of course, digital marketing is not just about internet marketing but morethan that (Sanjaya et al., 2009). Digital marketing or digital marketing has almost the same meaning as electronic marketing (e-marketing) both describe the management and implementationof gold using electronic media, so what is meant by digital marketing is the application of digital technology that forms online channels (online channels) to the market (websites, e-mail, databases, digital TV and through various other recent innovations including blogs, feeds, podcasts, and social networks) that contribute to profitable marketing activities and build and develop relationships with customers, In addition, develop a planned approach to increasingknowledge about consumers (to the company, behavior, values, and level of loyalty to the brand ofits products), then bring together targeted communication with online services according to the needs of each individual or specific customer. In short digital marketing is achieving marketing goals through the application of technology and digital media (Chaffey, 2015).

Digital marketing is a medium that is used as a platform to build a company's brand image or product and also supports the sales function to target consumers. The use of digital marketing is a way to facilitate in understanding about the purpose of communication about digital marketing, (Morissan, 2010) divide it into; (1) Dissemination of Information, (2) creating awareness, (3) research objectives, (4) building perceptions, (5) product experiments, (6) improving services, (7) increasing distribution.

Tourist Village

Tourist village is a rural area that offers a whole atmosphere that reflects the authenticity of the countryside itself ranging from socio-cultural, customs, daily, has a distinctive building architecture and structure of village layout and from socio-economic life or economic activities that are unique and interesting and have the potential to develop various components of tourism, such as attractions, accommodation, food-drinks, souvenirs, and other tourist needs (Mulyadin, 2001).

The development of a village area that does not change what already exists but is more likely to develop the potential of the existing village by utilizing the ability of elements in the village that serves as an attribute of tourist products on a small scale into a series of tourism activities or activities and can provide and meet a series of tourist travel needs both from the aspect of attraction and as supporting facilities (Muljadi, 2012).

Sustainable Tourism

Sustainable tourism according to muller's concept (Nieamah et al, 2018) is managedtourism referring to qualitative growth, which means improving welfare, economy, and public health. Improvement of living skin can be achieved by minimizing the negative impact of non- renewable natural resources. Meanwhile, according to sustainable tourism development, tourism development emphasizes the principle of sustainable development. Wto in Nieamah (2018), emphasizes there are three important things in sustainable tourism development, namely:

1. Quality. Sustainable tourism provides a quality experience for the visitors while improving the quality of the host community and protecting the quality of the environment.
2. Continuity. Sustainable tourism ensures the continuity of the natural resources upon which it is based and the continuity of the culture of the host community with a satisfying experience for visitors.
3. Balance. Sustainable tourism balances the need of the tourism industry, supporters of the environment, and the local community.

The concept of Green Tourism emphasizes more on environmental, human, and divine aspects (Belief in God) and Three responsibilities are the foundation in developing Green Tourism and require all tourism industry players, such as tourists, companies, communities, and governments, to play an active role (Astawa et al., 2019).

3. METHODS

This study uses a mixed-method (Creswell, 2012) explanatory sequential method approach where the quantitative study begins to explain the implementation of digital marketing. Data collection with questionnaires sourced from the results of Priharto's research (2021) on digital marketing consists of Content Marketing (CTM); Visual Marketing (VM); Mobile Marketing (MM); Continuous Marketing (CM); Integrated Digital Marketing (IDM); Personalized Marketing (PM); Affiliate Marketing (AM); Search Engine Optimization (SEO); Search Engine Marketing (SEM); Social Media Marketing (SMM). A total of thirty-one tourist village leaders as respondents and before the delivery of the questionnaire began with a letter of application to fill out the questionnaire. Questionnaires are delivered directly to the tourist village. The results of quantitative studies are in to determine digital marketing models that are suitable for tourist villages. Key informant is derived from the tourism office and the head of the tourist village.

4. RESULTS

Characteristics of Respondents

The results of the questionnaire dissemination obtained that the education of the managers of tourist villages all have undergraduate education, and have an average working length of 5 years. There are tourist villages in Bangli can be seen in **Table** 1.

Table 1. Tourist Villages in Bangli Regency

No	Name of Tourist Village	District
1	KUBU VILLAGE TOURISM VILLAGE	BANGLI
2	GULIANG KANGIN TOURIST VILLAGE BUNUTIN VILLAGE	BANGLI
3	PENGOTAN VILLAGE TOURIST VILLAGE	BANGLI
4	TOURIST VILLAGE SEDIT BEBALANG VILLAGE	BANGLI
5	UNDISAN VILLAGE UNDISAN TOURIST VILLAGE UNDISAN	TEMBUKU
6	JEHEM VILLAGE JEHEM TOURIST VILLAGE	TEMBUKU
7	KAYUAMBA TOURIST VILLAGE TIGA VILLAGE	SUSUT
8	TERUNYAN VILLAGE TERUNYAN VILLAGE	KINTAMANI
9	BAYUNG GEDE TOURISM VILLAGE BAYUNG GEDE VILLAGE	KINTAMANI
10	KINTAMANI TOURIST VILLAGE KINTAMANI VILLAGE	KINTAMANI
11	SUTER TOURIST VILLAGE SUTER VILLAGE	KINTAMANI
12	BUAHAN VILLAGE OF BUAHAN VILLAGE	KINTAMANI
13	SUKAWANA TOURIST VILLAGE SUKAWANA VILLAGE	KINTAMANI
14	BATUR TOURISM VILLAGE NORTH BATUR VILLAGE NORTH	KINTAMANI
15	CENTRAL BATUR TOURISM VILLAGE CENTRAL BATUR VILLAGE	KINTAMANI
16	BATUR TOURISM VILLAGE SOUTH OF SOUTH BATUR VILLAGE	KINTAMANI
17	BELANDINGAN TOURIST VILLAGE BELANDINGAN VILLAGE	KINTAMANI
18	ABANGBATUDINDING TOURISM VILLAGE ABANGBATUDINDING VILLAGE	KINTAMANI
19	ABANGSONGAN VILLAGE ABANGSONGAN VILLAGE	KINTAMANI
20	SONGAN A VILLAGE OF SONGAN A	KINTAMANI
21	SONGAN B DSA SONGAN B TOURIST VILLAGE	KINTAMANI
22	PINGGAN VILLAGE TOUR VILLAGE	KINTAMANI
23	KUTUH VILLAGE	KINTAMANI
24	KEDISAN VILLAGE TOURISM VILLAGE	KINTAMANI
25	BUNUTIN TOURISM VILLAGE BUNUTIN VILLAGE	KINTAMANI
26	TEMBUKU TOURIST VILLAGE TEMBUKU VILLAGE	TEMBUKU
27	SELULUNG VILLAGE	KINTAMANI
28	CATUR VILLAGE CATUR VILLAGE	KINTAMANI
29	PENINJOAN VILLAGE PENINJOAN TOURISM VILLAGE	TEMBUKU
30	LANGGAHAN VILLAGE TOURISM LANGGAHAN VILLAGE	KINTAMANI

31	GULIANG TOURISM VILLAGE KAWAN BUNUTIN VILLAGE	BANGLI

Source: Tourism and Culture Office of Bangli Regency, 2020

Based on table 1 it can be explained that the most tourist villages originating from the Kintamani sub-district amounted to twenty-one or 68% located in the mountainous area around Mount Batur. While the others are in the districts of Bangli, Tembuku, and Susut.

The Application of Digital Marketing in Tourist Villages

The results of the spread of questionnaires from 31 tourist villages relating to ten components in digital marketing can be explained in **Table** 2.

Table 2. The application of digital marketing in bangli regency tourist villages

NO	Name of Tourist Village	*Digital Marketing*									
		CTM	VM	MM	CM	IDM	PM	AM	SEO	SEM	SMM
1	ABANG BATUDINDING								√		
2	ABANG SONGAN			√					√	√	
3	BATUR SELATAN	√		√		√		√	√	√	
4	BATUR TENGAH								√		
5	BATUR UTARA								√		
6	BAYUNG GEDE								√		
7	BELANDINGAN								√		
8	BUAHAN			√					√	√	
9	BUNUTIN								√		
10	CATUR	√			√			√	√	√	
11	GULIANG KANGIN	√		√	√	√		√	√	√	√
12	GULIANG KAWAN								√		
13	JEHEM	√						√	√		
14	KAYUAMBA								√		√
15	KEDISAN			√				√	√	√	√
16	KINTAMANI	√	√	√	√	√	√	√	√	√	√
17	KUTUH							√	√		
18	LANGGAHAN							√	√		
19	PENGLIPURAN	√	√	√	√	√	√	√	√	√	√
20	PENGOTAN							√	√		√
21	PENINJOAN								√		
22	PINGGAN							√	√		√
23	SEDIT								√		
24	SELULUNG								√		√
25	SONGAN A			√					√		
26	SONGAN B			√					√		
27	SUKAWANA	√		√				√	√	√	√
28	SUTER	√							√		

29	TEMBUKU	√							√		
30	TERUNYAN	√	√	√	√	√		√	√	√	√
31	UNDISAN	√							√		√

Source: data processed (2021)

The results of the application of digital marketing in table 2 can be explained that of the thirty-one tourist villages that carry out CTM as many as 11 villages; VM as many as 3 villages; MM as much; 11 villages; CM as many as 5 tourist villages; IDM as many as 5 villages; PM as many as 2 villages; AM as many as 13 villages; SEO as many as 31 villages; SEM as much; 10 villages; SMM as many as 11 villages. Two villages that run a fully digital form or 9.49% of villages that run full digital marketing.

In-Depth Interview Results

The results of the quantitative study described earlier provide information that 90.51% of tourist villages do not run digital marketing perfectly, this condition is why this condition can occur? The results of interviews from informants of tourism village managers and tourism agencies are as follows:

Table 3. In-depth interview results

No	Informan	Manuscript	Conclusion
1	INF.A	We strive to improve in accordance with the ability in the village and the community needs the motivation to join the movement.	Limitations of knowledge
2	INF.B	Trying to follow what the government wants becomes an obligation but we need to eat and rarely want to be involved.	Want to change human resource limitations
3	INF.C	Management by the ability and required by the government or other parties to help	Support of all potential parties
4	INF.D	Management is still traditional not much that can be improved due to natural resource limitations.	Traditional Limited natural resources
5	INF.E	It takes time, funds, and support from indigenous leaders and governments.	Time and Funds

Source: data processed (2021)

5. DISCUSSION

Digital marketing is the application of internet-based technology in offering products that have very complex components and require special knowledge (Bala & Verma, 2018). This view supports what is happening in Bangli tourist village where the manager wants to market his product with full digital marketing, but there are not enough resources to move by his ability. Understanding of digital marketing is only carried out by two tourist villages and produceseconomically, socially, culturally, and environmentally in maintaining the sustainability of the village is felt in the village of Tourism and Kintamani Village. All components of digital marketing are well run and the village income results have increased and become a world-famous

village. The results of this study are in line with Kannan's view (2017) which explains that digital marketing can improve the company's performance.

Marketing activities in tourist villages are carried out for the design of promotions by holding events can be said that marketing through social media is easier, cheaper, and effective just by mobilizing the community of tourist observers, business providers of tourism bureau services that each of them has a blog and account on social media. The more beautiful and uniquea tourist destination will become more interesting to document with photos and videos and can be directly uploaded on social media to become popular. "Viral" becomes a free promotional advantage to attract tourist visits. Now many unique and new tourist attractions will be hunted by travelers along with increasing trends on social media such as posts on Instagram, Facebook, Path,or other social media (Kurnianti & Tidar, 2018).

Application in web service is the ability to communicate between different systems of websites and databases. One example of implementing a web service provides ease of integration efforts between systems with the same background. and make it easier for developers to integrate their systems. Integrating a website with social media is expected to attract the interest of users, it can also help synchronize the data needed in a website will be easier to do (Pandeirot et al., 2015).

One village that implements digital marketing is Penglipuran tourism that already has a website with Generic Top-Level Domain (GTLD) and Country Code Top Level Domains (CCTLD) that are by segmentation and targets. Penglipuran Village, Bangli, Bali, has become a tourist attraction for domestic and foreign tourists.

So desapenglipuran.com participated to introduce more broadly, that not only become a tourist attraction, but it turns out that in Penglipuran Village many things can be used as other activities, such as activities or programs for Group Events (Outing, Outbound, and Gathering), Adventure Tours (Cycling & Camping), and to promote that tour packages can also be combined with Penglipuran Village Tours.

Provided additional facilities, namely transport service with various choices of vehicle types, of course, this is one of the supporting factors when tourists vacation in Bali and decide to enjoy it with the choice of Penglipuran Village can be seen in **Figure** 1, the website of the tourist village also refers to the quality of service presented on the customer review page.

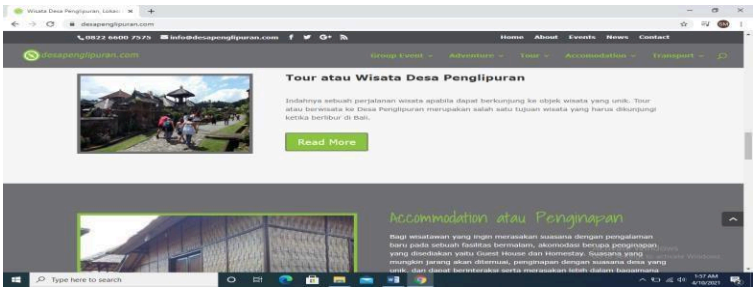

Figure 1. View of the tourist village website

6. CONCLUSION

Marketing tourist villages digitally by focusing more on government websites, channeling information about the existence of each tourism potential that is owned including accommodation and events that take place. In addition, tourism village marketing can be done through the businessman's website. Tourism images that have been globalized will help tourism marketing through its website page.

Not all tourist villages of Bangli Regency implement digital marketing, due to limited resources and Penglipuran tourist villages that already have websites with Generic Top-Level

Domain (GTLD) and Country Code Top Level Domains (CCTLD) by segmentation and target. Penglipuran Village, Bangli, Bali, has become a tourist attraction for domestic and foreign tourists. The use of village fund allocation has not been used evenly in the field of marketing.

The existence of an integrated and updated system in real-time whether it is content, images, animation or video, or sound will make it easier to promote tourist villages digitally. One side pampers customers or tourists to find the desired places without the need to go to a travel agent. And the business side can reduce operational costs, faster and more professional and the information conveyed can be directly all over the world know it. As one of the regencies in Bali that has quite a lot of tourist villages that continue to be developed, Bangli Regency continuously innovates and diversifies in various marketing products and services.

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RISK ANALYSIS OF THE SPREAD OF COVID-19 IN SURABAYA RAYA USING CAUCHY CLUSTER PROCESS

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ABSTRACT

Corona virus or commonly called SARS-COV-2 is a virus that lately has spread worldwide, including Indonesia with Surabaya Raya (Surabaya, Sidoarjo, and Gresik) as the epicenter in East Java. Therefore, it is important to provide epidemiological information to control the spread of COVID-19 in Surabaya Raya. The aim of this research is to study the COVID-19 transmission risk in Surabaya Raya related to spatial factors. The data used is the address coordinates of COVID-19 patients, the locations of crowds (factories, shopping centers, and places of worship) and population density. The inhomogeneous Cauchy cluster process is employed to model the COVID-19 cases to capture clustering due to transmission system and capture spatial trend due to locations of crowds and population density. The results show that Surabaya is the main epicenter of COVID-19 cases in Surabaya Raya. In addition, industrial centers (factories), places of worship, and population density show significant impact on COVID-19 risk transmission in Surabaya Raya. Policies related to control COVID-19 should then be prioritized in Surabaya, such as tracing, testing, and vaccination programs, especially in areas with large number of factories, places of worship, and an area with high population density then proceed to the Sidoarjo Regency and Gresik Regency.

Keywords: Location of Crowds, Population Density, SARS-COV-2, Spatial Point Pattern, Vaccines

1. INTRODUCTION

As from December 31st of 2019, COVID-19 was firstly reported in China with Wuhan City on Hubei Province as the epicenter. To February 6th of 2020, the positive cases of this virus has reached 31,481 with a death toll of 639 cases (Kang et al., 2020). At the moment, COVID-19 is the main focus of worldwide, including Indonesia. In Indonesia, this virus reached 1,691,658 confirmed positive cases based on the data of Mei 5th, 2021 with East Java placed fourth on the most cases of 148,959 (Satgas Covid-19, 2020). Thus, COVID-19 becomes the number one attention for East Java's Government, concerning on Surabaya Raya areas of Surabaya City, Sidoarjo Regency, and Gresik Regency, for their highest counts of cases of this virus through out East Java's cities and regencies. As for the last data on Mei 5th, 2021, this respiratory virus pushed through 23,582 cases (58.37%) for Surabaya City, 11,259 cases (27.87%) for Sidoarjo Regency, and 5,557 cases (13.76%) for Gresik Regency (Prov. Jatim, 2021).

The intense public mobility on these Surabaya Raya's areas is suspected as the cause of the peaked COVID-19's risk. As a location of economic activity's center, this statement was proved by the latest condition of Surabaya City. Thus, this study aims to assess the mobility and

interaction between the residents of Surabaya Raya, which focused on four aspects of social-demography, religion-culture, occupation, and social-economy.

Population issues occurrences are frequent in developing countries, particularly in countries with eminent population growth. In this COVID-19 pandemic condition, this issue of population growth is suspected to influence the growing number of infection cases, because the increasing population density makes the chance of people to gather and make a crowd increasing (Ganasegeran *et al.*, 2021). By considering the religion-culture aspect, the worship place is one of some other factors which derives the increasing COVID-19 cases. Worship places are sacred places which frequently visited by people to worshiping. This condition makes the worship places potentially gather crowds, thus it is likely to become a potential location for COVID-19 to spread (Baker *et al.*, 2020). Surabaya Raya has been known as an area which has intense mobility. This condition is caused by the high number of industrial activities on Surabaya Raya. The occupation of its population is mostly around industrial activities, causing the civilians to have plenty outdoor activities and interactions with others. This kind of interaction occurred on industrial areas such as factory sites (Shah *et al.*, 2020). Further more, understanding the economic activities on people's life as an essential support which also stands as a factor. These economic activities mostly performed as transaction of buy and sell between people. Surabaya Raya being known by its considerably vast shopping centers. As the second major city after Jakarta, Surabaya has numerous shopping centers as a frequent spot to be visited by people. However, with this condition of pandemic, shopping centers surely become suitable areas for the virus to spreading as this places provoke crowding and close interaction between people.

Pass through over a year COVID-19 infected worldwide, people all over are competing to have save and effective vaccine for this virus, including Indonesia. Beside, with the availability of this vaccine, a better economic condition is expected since the majority of people are heavily impacted by the pandemic (Forman *et al.*, 2021). On May 5th, 2021, the total number of Indonesian who have received the first dosage of the vaccine is 12,832,886 and 8,151,942 people already have the second dosage (Kementerian Kesehatan, 2021). The planned distribution of COVID-19 vaccine to the worldwide community is continuesly carried on. Thus, "Strategic Advisory Group of Experts (SAGE) on Immunization", a worldwide community of experts, is assigned to formulate recommendations for World Health Organization (WHO) to hand out recommended road map to be followed since the vaccine availability is limited (Aditama, 2020). As for this consideration, a spatial analysis is necessary in aiming the equally spreaded vaccine distribution which properly given according to the epidemiology situation on an area. The area in this study is Surabaya Raya.

This study is expected to: (1) inform about the risk mapping of COVID-19 spreading in Surabaya Raya through aspects of social-demography (population density), religion-culture (place of worship), occupation (factory sites), and social-economy (shopping centers), and (2) analyse the prediction result of risk mapping of COVID-19 for assisting the government's recommendation program of vaccinations and 3T (testing, tracing, and treatment).

2. LITERATURE REVIEW

Every area has its own population density level which is different from any other areas. This density level leads to people inside a certain area to have some form of contact with each other. It is suspected to affect the numbers of confirmed COVID-19 positive cases day to day because of the transmited virus become more immediate as for the immense interaction or contact between people (Ganasegeran *et al.*, 2021).

Crowd can be described as a number of individuals which formed as a group. Inside this crowd, a close contact between individuals are distinctly possible for the distances between each other are exceptionally close. The occurrence of crowds is one of the factors which triggered the COVID-19 virus spreads extensively for the inability to maintain a safe distance between each other. Crowding often occurs on some places such as communal dinning areas, cafés, auditoriums, and offices (Durán-polanco and Siller, 2020).

One of the approaches to be used in identifying the infection levels difference inside an administrative area limit is the Spatial Point Pattern. The procedure of this approach is to plot some points, resulting in spatial point pattern. From this pattern, the difference of density between points can be distinguished. The Point Pattern is Independent if the points are spreaded randomly without forming a pattern, and is Regular if the points are evaded each other. A Cluster Point Pattern is identified by the spreaded points is closing in and gather as groups (cluster). These pattern is visualized on Figure 1.

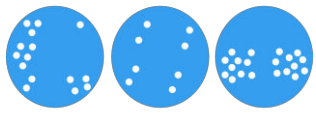


Figure 1. Basic Pattern in Point Pattern Independent (Left), Regular (Middle), Cluster (Right)

This study also used spatial analysis on location data of an area to identify the mobility level of the people inside. In COVID-10 case, the collected spatial data will be used to visualize the epidemiology information, track a case which is confirmed spatially, divide the epidemy risk and prevention level spatially. This gained information support the process of understanding the epidemic's behavior and the process of mapping the next vaccine distribution for controlling the risk of COVID-19 virus spreading (Franch-Pardo *et al.*, 2020).

Stated by Choiruddin *et al.* (2021), in spatial analysis, designs based on intensity can be used. One of intensity based designs is Poisson Process. Poisson Process is a design which often used on spatial point pattern case with random pattern as seen on Figure 1 (left).

A poisson process X on $\mathbb{R}^2$ with the intensity function of ρ and observation window $W \subseteq \mathbb{R}^2$ with $\mu(W) > 0$, thus, the object or occurrence counts at W (n(W)) Poisson distributed with mean $\mu(W)$ (Virania, Choiruddin and Ratnasari, 2021). Cauchy Cluster Process is one of various process of Neyman-Scott Cox Process (NSCP). Cox Process is a process which formed from Poisson Process.

3. METHODS

The object which will be observed by this study is the data contains addresses of patients who convirmed positive with COVID-19 in Surabaya Raya, retrived from Satgas COVID-19 for East Java. This data retrieved on March 18th, 2020 to April 4th, 2021 and resulting on 29,779 cases. The variable of crowd locations in this study is using factory sites (Z_1), shopping center (Z_2), and places of worship (Z_3), which contains 2,763 data of factory sites, 115 data of shopping centers, and 611 data of places of worship, also the population density level data for each districts all over Surabaya Raya (Z_4). The method applied in this study is the Cauchy Cluster Process Method, which requires Chi-Squared Test to examine the data consistency and K- Function visualisation for understanding the spatial data correlation. After carrying out the data exploration, the design is assembled thus resulting on a parameter which then formulate a data interpretation to recognize

the influence of crowd locations and population density toward the risk of COVID-19 spreading. The result of the design is being tested and visualized using K-Function Envelope for understanding the benefit of the used model. The data interpretation result is explained thus a managerial implication is gained for understanding the works of vaccination control and 3T program to be carried out in order to lessen the risk of COVID-19 spreading at Surabaya Raya.

4. RESULTS

4.1 Spreading Pattern Data and Density Plot of Crowd Factor

The amount of patients who confirmed positive of COVID-19 at Surabaya City, Sidoarjo Regency, dan Gresik Regency reaches 29,779 cases from March 18th, 2020 to April 4th, 2021, in which percentage diagram as seen on Figure 2, spread mapping on Figure 3, and density plot on Figure 4.

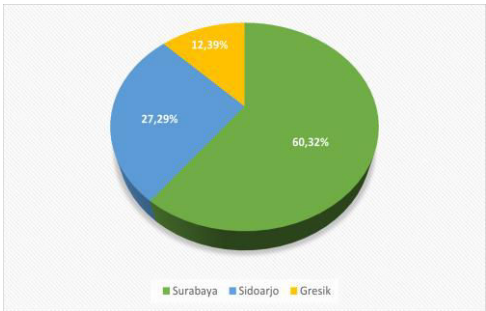


Figure 2. Diagram of Spreading Percentage of COVID-19 Positive Cases at Surabaya Raya from March 18th, 2020 to April 4th, 2021

The spreading point on Gresik Regency is lesser than the areas toward Sidoarjo Regency. When devided according to the city limits, Surabaya City has the most cases of 17,968 (60.32%), and Sidoarjo regency has 8,126 cases (27.29%), and lastly Gresik Regency with only 3,690 cases (12.39%).

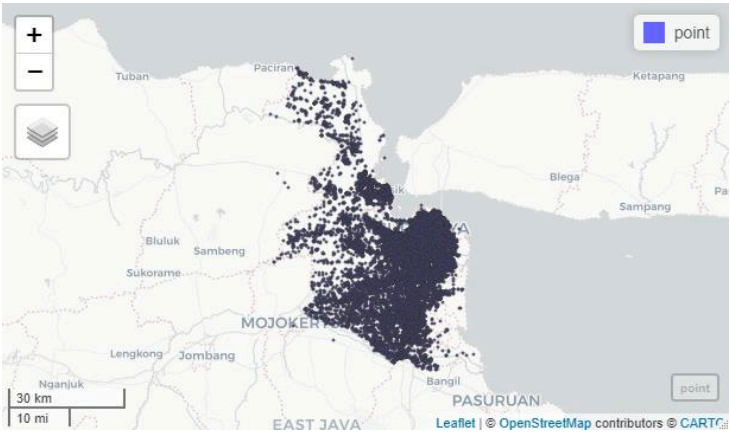


Figure 3. Map of Spreading of COVID-19 Positive Cases at Surabaya Raya from March 18th, 2020 to April 4th, 2021

The points on the spreaded pattern shows the exact point of COVID-19 positive patients' address which likely to grouped around Surabaya City's area and spread out to the border adjacent to Sidoarjo Regency. Those points spreading south (toward Sidoarjo Regency) to the epidemic epicentrum of Sidoarjo Regency. On Sidoarjo Regency, the pattern spreading south, southwest (toward Mojokerto Regency), and southeast (toward Pasuruan Regency), reaching the borderline

between Sidoarjo Regency and Pasuruan Regency before reducing. While on the northern part, this pattern spread to the border between Surabaya City and Gresik Regency on the northwest, and going on before decreasing within Gresik city territory near Paciran District of Lamongan Regency.

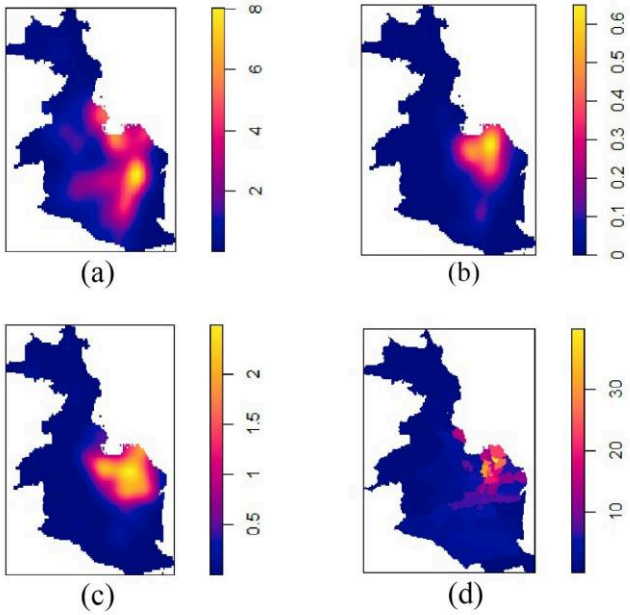


Figure 4. Density Plot of Crowds Center at Surabaya Raya and Population Density of: (a) Factory sites, (b) Shopping Centers, (c) Places of Worship, and (d) Population Density

Generally, the density pattern on Figure 4. is almost identical to Figure 3., where Surabaya City becomes an area with the highest numbers of cases and also has the highest numbers of factory sites, shopping centers, places of worship, and population density, compared to two other regencies. Figure. 4 explains about the intensity of each variable in 1 km^2 radius, with total units in 1 km^2 explained with presented colors (more yellow represent a higher intensity and more blue represent lower intensity). The intensity of shopping centers (Figure 4. (b)) is the lowest between other variables and the population density (Figure 4. (d)) has the highest intensity. Figure 4. (a), (b), and (d) has the similar patterns, where the highest intensity is on Surabaya City area then spread to the southern borders (Sidoarjo Regency) and a few pathches to the northwest (Gresik Regency). Meanwhile, the Figure 4. (c) shows an immense intensity at Surabaya City then spread to south and west directions.

4.2 Spatial Trend Detection based on the Chi-squared test

This Chi-Squared Test is carried on for examine the homogeneity of confirmed COVID-19 positive patients' data at Surabaya Raya. Through this test, the level of confidence is up to 95% and the level of error is 5%. The test result shows that the *p-value* is 2.2e-16, with a hypothesis of COVID-19 patients' address spreading is homogeneous, shows that the COVID-19 patients' address spreading is not homogeneous (not spreading equally) because the resulted value is under 0.05. Based on the result, it reckoned that the confirmed COVID-19 positive patients' data at Surabaya Raya has inhomogeneous pattern.

4.3 Spatial Correlation Analysis

Based on the Chi-Squared Test result analysis on 4.2, where the confirmed COVID-19 positive patients' data at Surabaya Raya has inhomogeneous pattern, thus the further analysis is carried on by analyzing the spatial correlation data using inhomogeneous K-Function visualization. The result of this inhomogeneous K-Function visualization can be used to understand whether the data pattern is inclined to has an independent (random), regular (evading each other), or cluster (forming groups). The inhomogeneous K-Function visualization's result is shown on following Figure. 5.

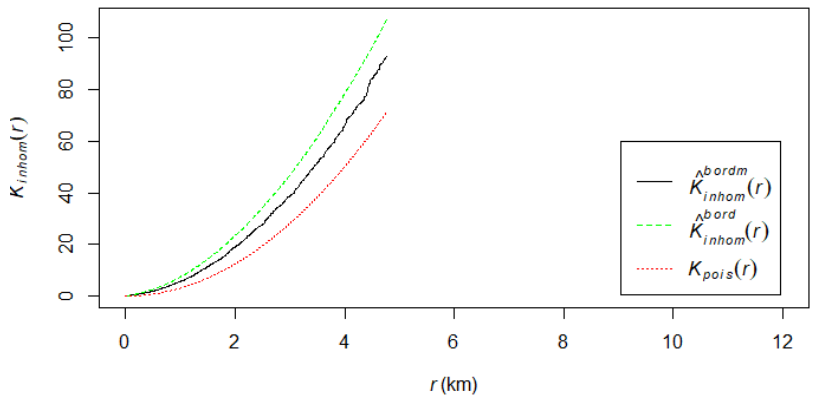


Figure 5. Curve of Inhomogeneous K-Function confirmed COVID-19 positive patients' data at Surabaya Raya

The green dotted line and black line show the K-Function empirical curve and red dotted line shows the K-Function theoretical curve. Based on the result of inhomogeneous K-Function visualization, it shows that the distance is quite close, about 0 to 2 km, with K-Function's empirical curve is relatively close and placed above the K-Function's theoretical curve. This position shows that the interaction between the data of the patients' locations tend to clustering (in groups), indicated by the empirical curve placed above the theoretical curve.

4.4 Effect of Population Density, Sources of Crowds, and Clustering

In the parameter's estimation process, the four factors which suspected to implicate the COVID-19 spreading at Surabaya Raya is being used and indicated a significant result on industrial locations (factories), places of worship, and population density, thus a design has been created with a result of:

Table 1. Parameter's Value of $\hat{\kappa}$, $\hat{\beta}$, and $\hat{\omega}$ with Crowd Location and Population Density Factors at Surabaya Raya

Coefficient	Estimation	Exp (Koef)	Sig α = 0,05
$\hat{\kappa}$	4,51919		
$\hat{\omega}$	0,06133		
$\hat{\beta}_0$	1,34427	3,83538	
$\hat{\beta}_1$ (Factory Density)	0,25020	1,28428	Significant
$\hat{\beta}_3$ (Place of Worship Density)	0,79991	2,22534	Significant
$\hat{\beta}_4$ (Population Density)	0,03493	1,03554	Significant

Based on the estimation on Table 1., it is reckoned that all the three factors show positive effect in increasing risk of COVID-19 positive case at Surabaya Raya. On a condition of adding 1 factory unit in 1 km^2 radius, the risk will be increased as much as 1.28 times. This situation is

assumed as the effect of some companies are not implementing WFH (Work from Home) program to their employee which later cause an immense people interaction on company spaces. There is a chance of increasing case numbers if this condition is to be left out which will lead to new cluster occurrence at work places.

On the other hand, Place of Worship Density factor gives greater impact than other two. For instance, adding 1 unit of place of worship within 1 km^2 will increase the case numbers as much as 2.22 times. It is suspected that on the place of worship, there is a lot of interactions between people. Between March 18th, 2020 to April 4th, 2021, there are a lot of religious holidays, particularly on May 2020, Hari Raya Idul Fitri is being celebrated by majority Indonesian which whom are muslim. On this holiday, people went to the mosque and met with each other which leads to increasing the contagious risk for immense contacts.

On the factor of Population Density, it can be reckoned that adding 1,000 more people inside 1 km^2 radius will increase the risk to 1.03 times, which is considered less than two other factors. This result shows that crowds factor has bigger effect than population density factor. It is assumed that both factory site and place of worship have higher chance in contacting others, despite the high number of population density which rarely display a close interaction between each other.

Using this analysis result, it can be seen that the width of the *observation window* as much as 2,118.34 km^2, $\widehat{\kappa}$ value of 4.51919, and $\widehat{\omega}$ value of 0.06133, thus the prediction of total new COVID-19 cases at Surabaya Raya as many as 9,573 cases, derived from the result of multiplication between *observation window* with $\widehat{\kappa}$ which has deviation standard of 0.06133 km or 61.33 m.

4.5 Model Validation

This Study carried out the Design Benefit Test using *envelope inhomogeneous K-Function* visualization. Shown below is the Figure 6. about the *envelope inhomogeneous K-Function* visualization using three factors.

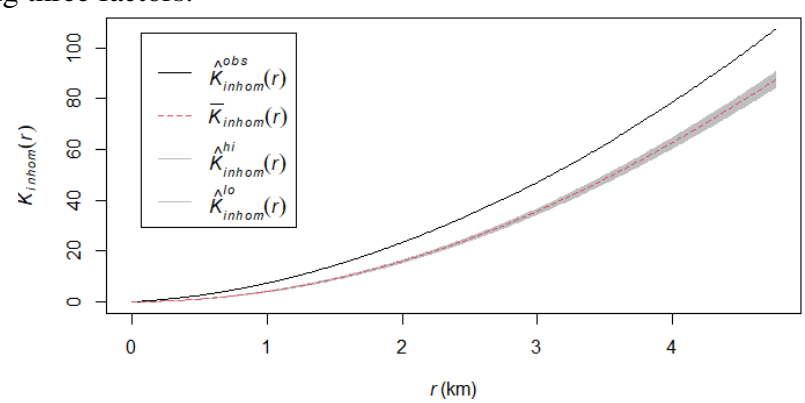


Figure 6. The Result of *Envelope Inhomogeneous K-Function* Visualization

Black line indicates the empirical curve of the data and the red line is the mean of the model, while the gray area represents the confidence interval. A model can be said to be good if the empirical curve of the data is in the confidence interval area. Figure 6 shows an unsuitable model because the empirical curve of the data is outside the gray area (confidence interval). This shows that the cluster effect shown using the Cauchy Cluster Process is less strong because it produces a high number of clusters. To get a strong cluster effect, a low $\widehat{\kappa}$ value is needed so that the number of clusters produced is not too high.

4.6 Prediction of the COVID-19 cases distribution in Surabaya Raya

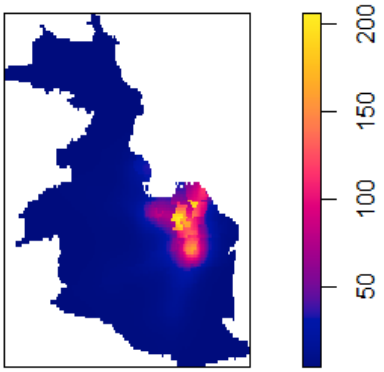
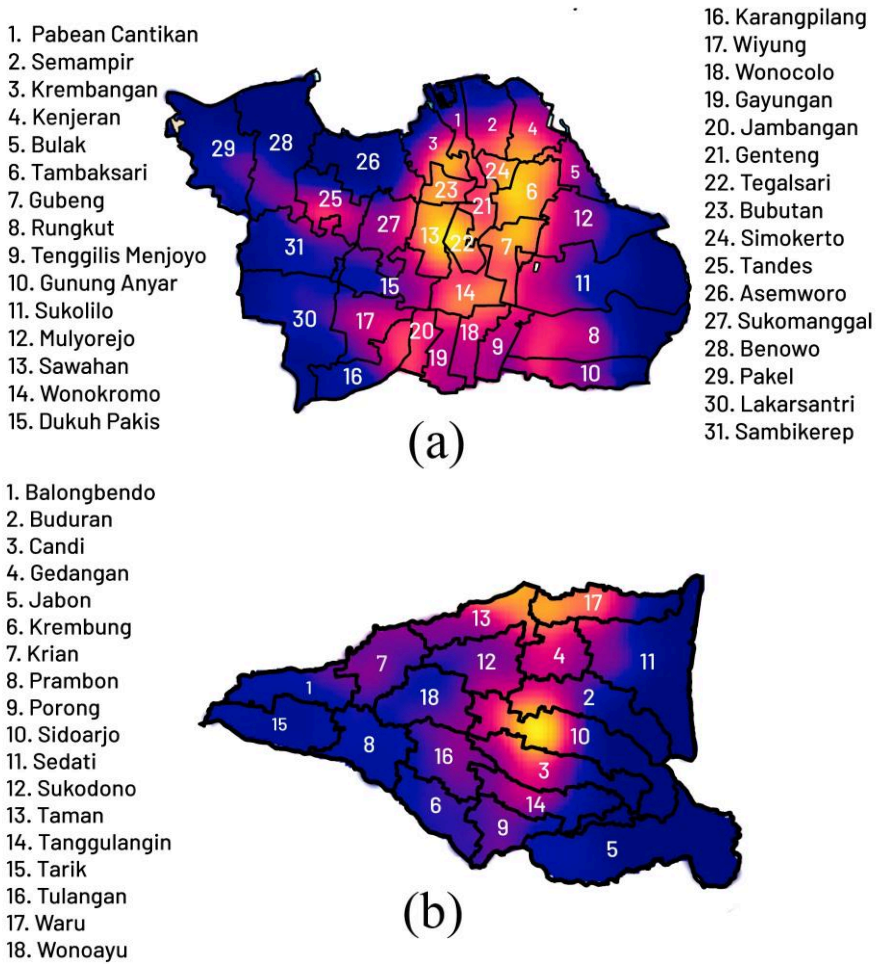


Figure 7. Map of Spreading Risk Prediction of COVID-19 at Surabaya Raya Using *Cauchy Cluster Process*

The spreading risk prediction has epicenter cases located on Surabaya City which has the highest numbers of infected cases, factory sites, places of worship, and population density, compared to Sidoarjo Regency and Gresik Regency. Based on this obtained result, the highest intensity on risk prediction is reaching above 200 cases for every km^2. The result is visualized by Figure 8.



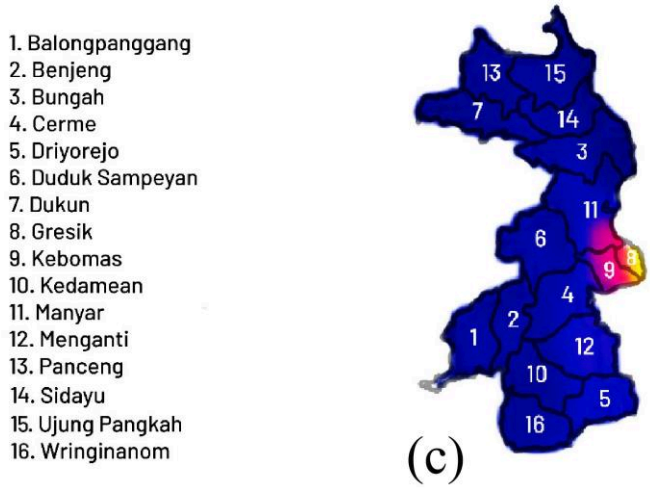


Figure 8. Map of Spreading Risk Prediction of COVID-19 at (a) Surabaya City, (b) Sidoarjo Regency, and (c) Gresik Regency

Surabaya City still becomes the prioritized area for distributing the vaccine up to complete dosage, as seen on the prediction map on Figure 7. According to Figure 8. (a), it is understood that in some districts the risk is higher than the others, as on Tambak sari, Sawahan and Bubutan Districts. On Figure 8. (b) the highest risk is on Waru District that spread to western direction toward Taman District and the western part of Sidoarjo District. Meanwhile on Figure 8. (c) the highest risk is located on Gresik District that spreaded to the west, reaching Kebomas District and a part of Manyar District. The other districts through out Gresik Regency has relatively low contagious level than the mentioned three districts.

Derived from those informations, it can be concluded that the distribution process of the vaccines and the strict health protocol implementation can be focused first on locations which have higher COVID-19 contagious risk (yellow colored) because by completing the vaccination priority to each prioritized districts at Surabaya City, it is expected that the virus spreading through out Sidoarjo Regency and Gresik Regency can be subsided for the case epicenter area has reached herd immunity. Beside, the government will be able to focus on stricter health protocol implementation on industrial areas, places of worship, and population density, particularly at Surabaya City thus the case reducing will be carried on faster and the vaccine program will be processed more effectively and efficiently.

6. CONCLUSIONS

The spreading pattern of this virus case happened mostly at Surabaya City with a total of 17,963 cases (60.32%), followed with Sidoarjo Regency with 8,126 cases (27.29%), and lastly Gresik Regency with 3,690 cases (12.39%). The factors of Factory Sites, Places of Worship, and Population Dencities are giving significant impact to the increasing of COVID-19 cases at Surabaya Raya. For instance, adding 1 unit of factory site or place of worship in 1 km^2 radius will give a rise to the spreading risk, each on 1.28 and 2.22 times. Meanwhile, when 1,000 people are added to a 1 km^2 area, the spreading risk will increase 1.03 times. As Surabaya is the the area with highest risk to COVID-19 compared to Sidoarjo and Gresik, the government can take priority programs such as tracing, testing and vaccination programs in Surabaya, especially an area with dense location of crowds such as Tambaksari, Sawahan, and Tegalsari district. Sidoarjo areas which are close to Surabaya such as Waru, Taman, and Sidoarjo district also need more attention. Moreover, the stricter health protocol could be carried on more effective and efficient, thus the

herd immunity can be gained immediately. In this study, we did not study the correlation among spatial factors (population density and all the three sources of crowds). When multicollinearity presents, regularization methods (Choiruddin et al., 2018, 2021) could be considered to handle such issue.

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ANALYSIS OF INFORMATION SYSTEMS DEVELOPMENT STRATEGY PLAN FOR RESEARCH ASSISTANCE – ITS DIRECTORATE OF INNOVATION AND SCIENCE TECHNO PARK

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ABSTRACT

Based on Presidential Regulation of the Republic of Indonesia No. 106 of 2017 concerning the Science and Technology Area, the Science and Technology Area is a professionally managed instrument to develop and encourage sustainable economic growth through the development and application of science and technology and the growth of technology-based startup companies. Sepuluh Nopember Institute of Technology (ITS) Directorate of Innovation and Science Techno Park is a forum for the management of funding programs for research, procurement of goods and services, as well as monitoring and evaluation of research in the ITS academic community. To support the program, it is necessary to plan using the governance road map approach and strategy analysis using the Agile Method in building an information system for the research assistance program, which serves as an integrated information center and database management system and can be used by all actors involved in organizing the Directorate of Innovation and Science Techno Park program.

Keywords: Innovation, Road Map, Agile Method

1. INTRODUCTION

Based on Presidential Regulation of the Republic of Indonesia No.106 chapter.8 (2017) concerning the Science and Technology area can be in the form of an integrated zone, which is an area that is unified in providing facilities and infrastructure for economic development and growth through the use of science and technology, and a connected zone, which is an area that is located in several separate but interconnected locations providing facilities and infrastructure for development and economic growth through the use of science and technology. The location in question must consider the effectiveness and accessibility of each location.

The university is synonymous with research and has great potential for creating activities that are updated or innovated by the entire academic community. Also, as a center of innovation, it will always have the potential to move innovatively, creatively, and adaptively to changes that move dynamically along with technological developments. Through the Science Technopark (STP), ITS provides space for all academic communities to conduct research, development, and as a center for the application of technology in various existing clusters.

In order to achieve the objectives of increasing the value-adding production chain in innovation, assistance is needed by utilizing information and communication technology to support the need to manage information, bureaucracy, information integration between sectors and organizers involved in the industry cluster set, as well as various other processes in Science and Technopark digitally and systematically. The Directorate of Innovation and Science Techno Park (DIKST) ITS has a specific program called Innovation Research Assistantship to assist the

academic community's capacity for innovation in the industrial cluster in an endeavor to develop Science and Technopark in order to boost competitiveness.

Research Assistance by DIKST ITS is responsible for the administration of research funding programs, procurement of goods and services, and research monitoring and evaluation. Currently, an information system that serves as an integrated information center and database management that can be used by all actors participating in the DIKST program's implementation is required to support the program.

Planning by combining the roadmap in projecting the business needs of the Innovation Research Assistance program by DIKST ITS and combining it with the agile method for information system development is expected to provide the right results to maximize innovation assistance services and can be used as a source of decision-making in determining business competitiveness strategies.

Based on this description, the purpose of this research to plan how to roadmap the objective of the Innovation Research governance and implement Agile Method approach to develop an information system.

2. LITERATURE REVIEW

2.1 Science Technopark

Based on Presidential Regulation of the Republic of Indonesia No.106 (2017), The Science and Technology Area is a specially prepared area and a vehicle that will facilitate the flow of inventions into innovation to increase productivity and competitiveness. professionally managed to develop and encourage sustainable economic growth through the development and application of science and technology and the growth of technology-based startups.

Science Technopark facilitates the potential of local industries to conduct research, innovate, and then create organizations, objects, and spin-offs. Conducting coaching and mentoring in developing the industry is carried out by entrepreneurial incubators on participants with the aim of developing and utilizing science and technology to encourage economic growth. Through technological assistance, Science

Technopark facilitates the development of industry through the assistance carried out by entrepreneurial incubators on participants with the aim of developing and utilizing science and technology to encourage economic growth.

2.2 Innovation

According to Gupta (2018) the type of innovation is divided into several types:

- Product innovation focuses on how to print the market and achieve profits. This innovation is related to ideas and creations in developing new product.
- Proses innovation consists in the process and implementation, including technical and administrative or managerial. Focuses on improve or create new process that can improve performance in an organization.
- Technical innovation focuses on creating something new, which can be new ideas, designs, prototype, data, and new discoveries.
- Managerial innovation focuses on how to make changes to existing work culture by evaluating risks and uncertainties in the business environment.

2.3 Roadmap

Firmansyah (2016) explained that road map specifies strategic and operational processing steps that lead to the marketing of a superior commodity and are implemented progressively and sustainably to meet the essential economic development objectives. The planning tool is designed to help speed the achievement of policy-driven development goals and objectives.

According to Loginov (2018) road map classification divided into several classifications:

- Public Roadmaps based on the reach area where creating a plan map strategy that suits the business or organization's environment.
- Corporate Roadmaps includes the reach of an organization that includes functions, products, and markets.
- Thematic Roadmaps is a roadmap that includes the business of an organization, innovation, and technology, which also involves problem-oriented, project, research, competency, and science.
- Project Roadmaps Roadmaps for project management, such as R&D and management plans.

2.4 Agile Method

According to System Analysis & Design An Object-Oriented Approach With UML Fifth Edition by Dennis (2015) explained that Agile System Development Methods are a group of programming-centric methodologies that focus on downsizing the System Development Life Cycle (SDLC). Focus on modeling, reducing document overhead and instead using direct communication is more in demand. The Agile Method is a project that emphasizes a simple model of application development with iteration, in which each iteration is a complete software project, including planning, analysis, coding, testing, and documentation. The system cycle in the Agile System Development Method is short (only one to four weeks), and the development team focuses on adapting to the business environment.

Pressman and Maxim (2015) explained that Agile System Development Methods is a set of software development methodologies based on iterative development, where requirements and solutions develop through organized collaboration between teams.

The Agile System Development Method is an incremental development method where the improvement is piecemeal and usually specifically available to the client every two or three weeks in the development period by Sommerville (2011).

2.5 Scrum Approach to Agile Method

According to Pressman and Maxim (2015) The scrum approach uses patterns in the development of information systems, with tight schedules and various changing needs. The process of each pattern in the scrum approach:

- Backlog it is a set of needs, features, and jobs that have been prioritized. Additional needed items can be added at any time in the system development process.
- Sprints the various needs, features, and tasks that have been defined at the backlog stage must be in accordance with the predetermined time span. Generally, the time span is 30 days.
- Scrum Meetings short meetings are held daily by the team to discuss the various tasks they are doing. Like what has been done, whether to find obstacles or what the next plan is for each individual in the team.

3. METHODS

This research conducted in several stages. In the stage of data collection, data and various needs are obtained by observing the DIKST ITS and its environment, as well as several websites related to the science and technology area. And they understand directly what needs must be met based on the data collected. Conduct interviews with several administrators and members to get a real of situation, conditions, and business processes of its DIKST, and then Collect some documentation to support research such as system flow documents and business processes that are currently running at ITS DIKST.

The next step is data processing. Data and information gathered in the previous stage will be processed. Data processing is the process of converting data into usable or desired forms according to research needs. Data processing is done to determine models and get insights that have an impact on a business process, especially in the development of information systems. In data processing systems, analysis of a business process is needed to know the real condition of a business process today. This stage is the stage of analysis to determine the roadmap and scrum approach plan to be implemented.

The next step is to determine the roadmap step, identify the problems with current conditions, determine the expected future output and outcomes, and determine the steps to prepare information systems that are tailored to the requirements of each user actor in the DIKST ITS. Information system development plans are based on requirements and data that have been collected either through observation, interviews, or documentation that has been collected, and then conducted analysis of information system design using the Agile Method. Perform a series of activity stages on the Agile Method, which in this study is limited to only phases:

- Planning in this step how to plan based on all requirements, how to of develop an information system design for innovation research assistance in its DIKST environment. Determine user stories and various requirements from users, determine the approach and iteration to be used.
- Analysis in this step is perform an analysis of the plan that has been determined at the previous planning stage. Analyze each user story and requirements that have been collected, and other possible changes to the research process.
- Design develop an information system design, determine the actors involved, and document it as a reference for the development team (in this case software engineers) in the future. This study was limited to design levels.

4. RESULTS

The next stage of this research is to implement the framework of the method used with the data that has been collected into a detailed and straightforward plan.

Define Roadmap

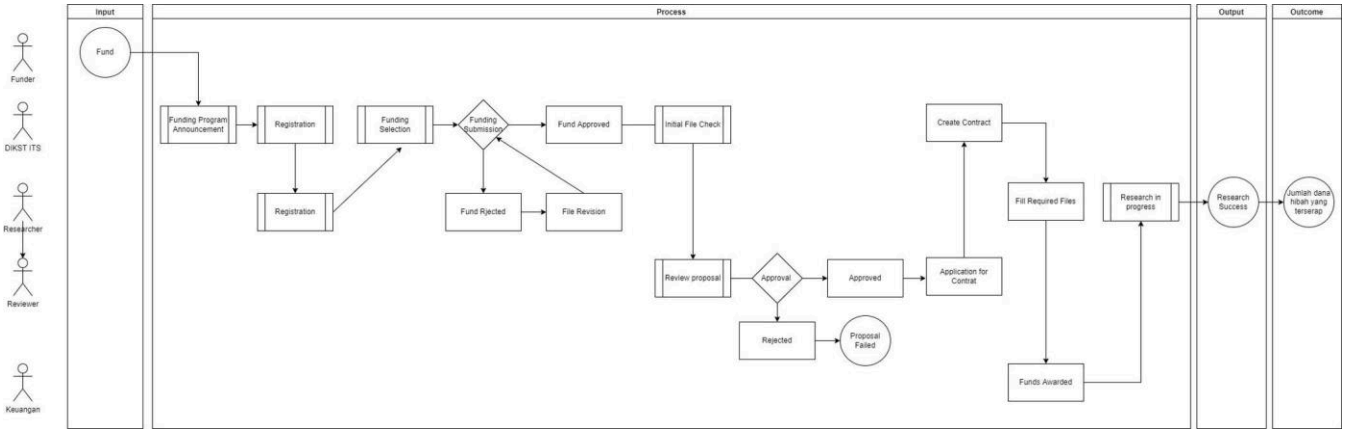

Figure 1 Innovation Research Assistant DIKST Business Process

Determining the roadmap of the business innovation research process can be done through governance that can be used as a reference in an organization in the present and how its future outcomes are achieved based on the business process from the picture above that has been collected from observations, interviews, and subsequent documentation.

Agile Methode

Using the Agile Method-Scrum by Pressman and Maxim (2015) and similar to the Sommerville (2011) approach, with the following activity stages, the time span for each sprint is only 2 weeks:

- It starts with planning a backlog. The client is involved in this process so that changes are immediately found if needed in system development.
- Phase selection (backlog grooming and sprint planning) involves all project teams working directly with clients and users to determine the function of the expected system.
- Hold a brief daily meeting to discuss what has been accomplished, any difficulties encountered, and the next steps.
- During the sprint's final stages, the completed work is reviewed and presented to stakeholders.

5. CONCLUSIONS

We can draw conclusions from a series of studies that vary from problem identification to needs analysis to determining information system design based on problem formulation and research objectives, all based on research and analysis. Furthermore, with the strategy of creating a roadmapping governance of innovation assistance business processes at ITS DIKST and creating a Management Information System Design using the Agile Method method with Scrum approach to

innovation research assistance at DIKST ITS, this conclusion can be used as improvement material in future research.

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INVESTMENT ANALYSIS OF ENTERPRISE DATA WAREHOUSE IMPLEMENTATION WITH IT BALANCED SCORECARD AND INFORMATION ECONOMICS : A RESEARCH PLAN

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ABSTRACT

Along with the development of the banking business in the complex and competitive digital era, PT. Bank Rakyat Indonesia. Tbk. Companies need good and fast preparation of data to help management make decisions for business needs going forward. This is then stated in one of the company's grand strategies, namely the Excel Data-driven Organization. To be able to achieve this, a data platform investment is needed, namely by investing in the implementation of an Enterprise Data Warehouse (EDW). One of the methods that can be used to measure IT performance is the IT Balanced Scorecard. In this study, it's taking one perspective, namely the company's contribution. There are 2 basic measurements in the perspective of corporate contribution, namely financial evaluation based on which is done by the Return on Investment (ROI) method and business evaluation based on which is conducted using the Information Economics method. By using this method, the company will get the results of how much profit and benefit it gets, both tangible and quasi-tangible, and intangible benefits, compared to the amount of investment spent on the implementation of EDW. Based on the analysis above, it can be seen whether the implementation of EDW the right investment is and whether EDW can provide performance results that can support the overall performance of PT. Bank Rakyat Indonesia Tbk. based on the company's vision, mission, and strategy.

Keywords: Investment, Bank BRI, Enterprise Data Warehouse, IT Balanced Score Card, Information Economics.

I. 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 (XinhuiTian, 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 methods of IT Balanced Scorecard development are based on the Traditional Balanced Scorecard that was developed by Wim Van Grembergen in 2005 to measure the performance of IT projects. In the IT Balanced Scorecard, there are 4 perspectives, namely (1) the Perspective of the Contribution of the Company (Corporate Contribution), (2) the Perspective of the Orientation of the User (User Orientation), (3) the Perspective of Operational Excellence (Operational Excellence), and (4) the Perspective of Future Orientation (Future Orientation).

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, Bank BRI can find out whether the implementation of the EDW is the right investment and whether the EDW can provide performance results that can support the overall performance of PT. Bank Rakyat Indonesia Tbk. based on the vision, mission, and strategy of the company.

Some of the purposes of this research were to analyze the feasibility of investment in the implementation of the Enterprise Data Warehouse in the PT. Bank Rakyat Indonesia Tbk. from the side of economics and business. It aims to examine the value of the contribution of each indicator to the benefits of the implementation of the Enterprise Data Warehouse in the PT. Bank Rakyat Indonesia, Tbk. Then another purpose was to examine whether the implementation of the Enterprise Data Warehouse is the selection of an investment that is appropriate for PT. Bank Rakyat Indonesia, Tbk. The expected benefits of the results of this study are to be able to contribute knowledge related to investment analysis on the implementation of EDW in PT. Bank Rakyat Indonesia, Tbk. And as an additional reference to developing science, especially in the field of information technology investment management.

II. LITERATURE REVIEW

2.1.Investment

Investment is the expenditure of capital on the assets of the moment in some period that will come to get the benefits that are in accordance with the capital that has been issued as the

attachment of assets at a time certain, the rate of inflation, and uncertainty of income in the future will come (Paul & Samuelson, 2003). Sunariyah, who stated that the investment is planting the capital's futures of time specified with the hope that it will give you benefits in the future (Sunariyah, 2003).

According to the definition, investment is the planting of capital used in the period-specific and term-long to find benefits in accordance with the capital investment.The benefits of an investment can be divided into two categories: intangible benefits (tangible benefits) and intangible benefits (intangible benefits).In their practice, the investment does not have a guarantee that the investor will acquire the benefits of a greater magnitude than the value that is already in the investment. Therefore, investors must be ready to accept the risk that will be obtained after the investment is made.

2.2.Technology Information Investment

Information technology today is fundamental in supporting the success of a company's business processes. According to Edmund W. Fitzpa trick in 2005 information technology investment is an investment in a project involving information technology, including operational costs after the implementation of the IT investment (Fitzpatrick, 2005).

The purpose of the investment implementation technology information, according to R. E. Indrajit, is as follows (Indrajit, 2004):

- As for the reasons for the survival of the company, the company sees that the existence of information technology in business is absolute.
- As a reason to improve efficiency. It is expected that with the implementation of information technology in a few fields or a particular activity, it can be done by process optimization to the allocation of company resources, such as human, time, cost, materials, and assets.
- To refine the effectiveness of business, it is to do what is called for to do what is supposed to be done. For example, the application of information technology decision-making systems, building data warehouses, or building business intelligence.
- The company's desire to get a competitive advantage means leaving its business competitors behind by developing information technology that is not owned by competitors.

2.3.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.

2.4.Microsoft SQL Server

Based on the Magic Quadrant (Gartner, 2019) that is issued by Gartner period of October 2020, Microsoft is the leader of the OPDBMS (Operational Database Management System) for 4 years in a row. The assessment criteria of this Magic Quadrant are to review the OPDBMS market that can run on the cloud that they provide themselves. Besides, it is also contained features enhancements such as machine learning, scenario a serverless (cloud) and streaming integration. Data and analytics should be balanced with the needs of today and the future. Microsoft gets the value of the highest to the satisfaction of the customers from all vendors evaluated based on

experience, the needs of the customer, pricing, negotiation, integration and deployment, service and support that is professional and programming that is quite easy. Microsoft is one of the 25% of vendors that reference customers who plan to buy additional products from their vendors in a one the year 2017.

Currently, BRI is using Microsoft SQL Server 2008 to support the processing of data and the needs of the reports on the data warehouse every day. However, Microsoft declared in the year 2018 that SQL Server 2008 will be discontinued, and customers are recommended to upgrade to the latest version. During this time, Microsoft SQL Server's most recent version is Microsoft SQL 2017. To conduct the upgrade version, there are a few things at the bottom of figure 4 that are an enhancement to the available capabilities and for the necessary understanding that good before may use it.

2.5.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 the 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.

In the IT Balanced Scorecard there are 4 perspectives, namely (1) the Perspective of the Contribution of the Company (Corporate Contribution), (2) the Perspective of the Orientation of the User (User Orientation), (3) the Perspective of the Advantages of Operational (Operational Execllence), and (4) the Perspective of the Orientation of The Future (Future Orientation). These 4 perspectives IT Balanced Scorecard were the result of the adjustment of the Balanced Scorecard that is with the mapping as follows:

- Corporate Contribution
  The goal of the Corporate Contribution perspective is to show how IT investments may help businesses achieve their objectives. From this standpoint, the purpose is to evaluate the business value of IT initiatives, strategic performance contributions, and IT investment management. The goal from this vantage point is to keep the cost of IT application investment under control while also maximizing the economic value of ongoing IT application services.
- User Orientation
  The User Orientation perspective is one that focuses on evaluating IT performance from the perspective of the user (both the internal and external users of a company). In the context of user orientation, factors to consider include being a source of application options, collaborating with users, and ensuring the user's happiness..
- Operational Excellence
  The operational excellence perspective is one that focuses on the efficacy and efficiency of IT processes in the firm, with the goal of IT being able to provide service excellence to users at the lowest feasible cost. The emphasis on the cost of IT is centered on two things: the quality of the product and the cost of IT. As for the factors—they are factors that are mentioned in the context of this process's quick response, management assurance, and protection, as well as security.

- Future Orientation

  The Future Orientation Perspective is the perspective that describes the increase in the company's ability, the effectiveness of management as a source of power, the evolution of the company's design, and technological research—new technology that appears. From this perspective, companies are required to be able to see the trend of IT into the future and anticipate the development of IT. Mastery of IT development is a prerequisite for a company's ability to compete.

2.6.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, & Trainor, 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.

2.6.1. Stages of Information Economics (IE)

Methods of Information Economics is a method that has an output that is the score that is used as a justification of the feasibility of investment. According to Parker (Parker, Benson, & Trainor, 1988), there are 4 stages of measurement of Information Economics, namely:

- The identification value and the total cost of the project
- Applying economic criteria while in the process of decision-making
- Estimate the existing alternatives
- Allocate valuable resources to projects that are important or of high value

In considering a project, IT is a factor of the cost (covering the cost of development and the cost of maintenance) and benefits of the project. IT is the benefits will be connected with the cost of using the method of calculation of ROI (Return On Investment). In doing the calculation of the cost, there are 2 types of cost which are calculated in Information Economics (Parker, 1988), namely as follows:

- The cost of system development (development cost)
- The cost of maintaining or running cost (maintenance cost/on - going cost)

The methods that can be used in calculating the relationship between cost and benefits are as follows:

- Return on Investment (ROI)

  This method is a method of assessing the ratio of the project's net income to the investment of the project. The formula is as follows:

$$\text{ROI} = \frac{\text{Net Profit}}{\text{Total Investment}} \text{ X } 100\%$$

- Net Present Value (NPV)

  This method is a method used to determine the cost benefits in the present value so that it can be seen whether the investment is feasible or not. The formula is as follows:

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

- Payback Period
  This method is the method that used to determine the amount of time required for the reception of cumulative cash to cover the initial investment that is issued by the company. The formula is as follows:

$$\text{Payback Period} = \frac{\text{Investment Value}}{\text{Total Nett Cash Flow or Project Age}}$$

2.6.2. Tangible Benefits

The Analysis of Tangible Benefits is a qualitative analysis, i.e., 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 between each other are using the Simple Return on Investment (ROI) and Traditional Cost-Benefit Analysis (TCBA).

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
  Is the worksheet that contains the list of costs that are used when setup on both systems. Such costs include the cost of system development, the purchase of hardware, and the cost of other services that appear during the initial implementation of the system.
- Information Economics Expenses Worksheet
  A worksheet that contains a list of the costs of periodic (e.g., annual) issues by the company for the running and maintenance of the investment made. This fee covers the cost of maintenance of the system, the addition of storage while the system is running, and other costs.
- Information Economics Impact Worksheet
  Is the worksheet that contains the list of previous information, a summary of the economic impact of either the costs incurred, or benefits obtained.

2.6.3. 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 Simple Return on Investment (ROI) and Traditional Cost-Benefit Analysis (TCBA). However, as the analysis of quasi-tangiblae is complicated to calculate, it can be assisted by using variables of the following:

- Value Linking (VL)
  It is the monetary value that is used to evaluate the overall financial results obtained from both IT and the improvement in performance that has an impact on the other's function. VL is connected to the benefits evaluation, which reflects the ripple effect of improving a function or process across parts, such as decreased cost, higher revenue, and the acceleration of growth due to the influence of TI, but it is not time dependent.
- Value Acceleration (VA)
  It is the monetary value assigned to the acceleration of work time effect that boosts job productivity. VL is related to the evaluation of benefits, which symbolizes the ripple effect of improving a function or process across parts, such as earning income as a result of a faster invoice preparation process owing to the influence of IT. However, this is time-dependent.

- Value Resturcturing (VR)
  It is an assessment of the evaluation of benefits due to the restructuring of existing functions in the company because of the implementation of IT.
- Innovation Valuation (IV)
  It is the benefits seen from the existence of a new function that have been created because of the application of IT.

2.6.4. 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 as follows:

- Business Domain
  It is the domain focused on profits generated over the existence of IT. This Domain has the following components:
  - Strategic Match (SM)
    It is a benefit measured by looking at how much IT contributes to the achievement of the company's strategic objectives. The higher the value of SM obtained, the more feasible the IT investment is implemented.
  - Competitive Advantage (CA)
    It is a benefit measured by looking at the contribution of IT to the competitive advantage the company achieved to create an edge in the competition. The higher the value of the CA obtained, the more worthwhile IT investment is implemented..
  - Management Information Support (MI)
    Benefits are measured by looking at the contribution of IT to the needs of management information to support decision-making. The higher the MI value obtained, the more worthwhile IT investment is implemented.
  - Competitive Response (CR)
    It is a benefit measured by looking at the contribution of IT to how much the risk of competition is accepted by the company if the project is delayed or cancelled. Therefore, the quicker the project is implemented, the greater the benefits received by the company. The higher the value of CR is obtained, the more worthwhile IT investment is implemented.
  - Organizational Risk (OR)
    It is a benefit measured by looking at the ability of the organization to adapt to the implementation of IT. The higher the value of OR obtained, the more worthwhile IT investment is implemented.
- Technology Domain
  It 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:
  - Strategic IS Architecture (SA)
    It is a benefit measured by looking at the company's ability to make changes to IT investments so that it can be measured the level of suitability of the project to the overall IT planning. The higher the SA value obtained, the more feasible the IT investment is implemented.

- Definitional Uncertainty (DU)
  It is a benefit measured by the amount of uncertainty that results from changes in the target. The higher the value of the DU, the lower the value of the feasibility of the project being implemented.
- Technical Uncertainty (TU)
  It is benefit measured by seeing how large dependence IT projects towards the expertise needed resources, and readiness of hardware and software. The higher the value of the TU, the lower the value of the feasibility of the project IT is implemented.
- IS Infrastructure Risk (IR)
  It is a benefit measured by looking at how much investment in other infrastructure to accommodate the project is. The higher the value of IR, the greater the value of the feasibility of the project IT is implemented..

In the Information Economics analysis, for tangible benefits and benefits of Tangible Quasi, monetary values and number scores from Enhanced ROI, while Intangible benefits will get a number score of 0 - 5 using the method of the questionnaire, so that according to Parker, the project value can be measured by the following formulation (Parker, 1988):

Project Score = Enhanced ROI + (weight of business domains + weights of technology domains)
Where Enhanced ROI has the formula as follows:
Enhanced ROI = Traditional ROI + (value linking + acceleration value + value restructuring + value innovation)

2.7.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.

2.8.The relationship between the IT Balanced Scorecard with Information Economics

The perspective of the contribution of the company (Corporate Contribution) in the IT Balanced Scorecard has the purpose of measuring how the investment in IT can contribute to achieving the goals of the business. From the perspective of the company's contribution, there are 2 basic measurements: financial evaluation-based and business evaluation-based. The financial evaluation-based method that is used is called Return on Investment (ROI). The Method This is a method of assessment of the ratio of earnings net project to the investment project. The method is obtained, and the value of the benefit is tangible in the project. The business evaluation-based method that is used is the method of information economics. With methods such as these, the obtained value of the benefits is quasi-tangible and intangible, which is then put into the assessment of the domain business domain and technology..

III. METHODS AND RESULT

In this research, the author uses an approach to measure IT performance called the IT Balanced Scorecard. The author takes 1 perspective, namely the contribution of the company. The next perspective in the measurement process has 2 bases, i.e., financial evaluation based, which is

done with the method of Return on Investment (ROI), and business evaluation based, which is done using the method of Information Economics. The following is the research plan and the stages carried out.

3.1. Gathering Data

First, namely, reviewing documents, especially related to the Work Order (SPK) document B.1539.P-PBJ/PIT/12/2018 regarding the procurement of Enterprise Data Warehouse (EDW) systems, SK documents EDM Nokep EDM/06/2021 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 related to the evaluation of the IT Balanced Scorecard and the benefits of Intangible Information Economics during a pandemic. This online questionnaire aims 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, where this benefit is a benefit that cannot be calculated financially but can increase the effectiveness of the company.

In selecting the sample of respondents, the researcher used a simple random sampling method with homogeneous respondents, namely stakeholders who used the EDW system, namely management and staff from the Enterprise Data Management Division of PT. Bank Rakyat Indonesia, Tbk. The calculation of the number of data samples uses the Slovin formula, where the total permanent employees of the Enterprise Data Management Division is 70, and the minimum sample required is 59.5, or 60 respondents.

3.2. Test Validity and Reliability 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. In the framework of the working information economy, the classification of data is divided into 2, namely financial data and non-financial data.

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.

Table 1 Information Economics Development Cost Worksheet

	Year
A. Development Effort 1. Incremental system and programming 2. Incremental Staff Support	
B. New Hardware 1. Terminal, Printers, communications 2. Others…	
C. New (purchased) software, if any 1. Packaged applications software 2. Others…	
D. User Training	
E. Other	
TOTAL	

Table 2 Information Economics Expenses Worksheet

	Year
A. Application Software Maintenance	
Development effort days Ratio of maintenance to development Resulting annual maintenance days Daily maintenance rate Total application software maintenance	
B. Incremental data storage required: _	
C. Incremental communication	
D. New Software Leases or Hardware Leases	
E. Supplies	
F. Others	
TOTAL ongoing expenses	

Table 3 Information Economics Impact Worksheet

	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	TOTAL
Net economic Benefit						
Operation Cost Reduction = Pre-tax income						
On going expanse from worksheet						
Net Cash Flow						
Simple ROI						

- 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 value innovation. On the value linking, we obtained the results of the analysis in the form of linkages between improved performance of the company after the implementation of the system. The results were obtained in the form of nominal cost savings. Then, on the acceleration value, the obtained results of the analysis in the form of linkages between benefits after the implementation of the system with other related functions, especially in a certain period of time, are obtained in the form of nominal cost savings. The results of the analysis related to the presence or absence of organizational restructuring in the company after the system implementation also show specialized nominal cost savings. While the value of innovation is the obtained results of the analysis in the form of new functions that are created after the implementation of the system with the results of the nominal cost savings.
- 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. In the domain of business, they obtain the value of the benefits and strategies that run when the implementation of the system EDW, while in the domain of technology, they can provide a calculation of risks and benefits to the company upon implementation of the system EDW. 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.

IV. CONCLUSIONS

All the above research stages aim to be able to:

1. Analyzing the investment feasibility of implementing an Enterprise Data Warehouse at PT. Bank Rakyat Indonesia. Tbk. from an economic and business point of view.
2. Assessing the contribution value of each benefit indicator on the implementation of the Enterprise Data Warehouse at PT. Bank Rakyat Indonesia. Tbk.
3. Investigating whether the implementation of Enterprise Data Warehouse is the right investment choice for PT. Bank Rakyat Indonesia. Tbk.

So, it is expected to know whether the implementation of EDW the right investment and whether EDW can provide performance results that can support the overall performance of PT. Bank Rakyat Indonesia. Tbk. based on the company's vision, mission, and strategy.

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ANALYSIS OF BUSINESS MODEL CANVAS IN DEFINING MANAGEMENT STRATEGY AT DIRECTORATE OF INNOVATION AND SCIENCE TECHNO PARK ITS

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ABSTRACT

ITS is one of the organizations that promotes technology innovation and commercialization, as well as the growth of creative entrepreneurship, job creation, and the economic worth of final research undertaken by lecturers and students. Science Techno Park ITS provides technology transfer offices, incubators, accelerators, and financiers to innovators and researchers, as well as four clusters: marine cluster, creative design cluster, robot and information and communication technology cluster, and automotive cluster. This research was conducted at DIKST ITS by analyzing 9 elements of the Business Model Canvas (BMC), namely customer segments, value proposition, channels, customer relationships, revenue streams, key resources, key activities, key partnerships, and cost structure. The analysis results indicate that DIKST ITS management team should reassess the business model that has been implemented thus far. It is vital to outline business processes as well as the primary activities that should be developed in the future. so that a technology-based ecosystem with excellent human resources may be formed and income at ITS can be supported.

Keywords: Science Techno Park ITS, Business Model, Business Model Canvas (BMC).

1. INTRODUCTION

One of the factors for defining a country's or region's level of competitiveness is the success and achievement of growing productivity, economic growth, and people's welfare. Competitiveness is one of the buzzwords associated with local/regional economic development. According to (Camagni, 2002) one of the fundamental concerns that leads to sustainable expansion of local/regional affluence and prosperity is competition. To be able to solve crucial challenges in the area economy, the industrial cluster plan must be implemented. In order to facilitate the growth and development of industry in Indonesia, especially small and medium-sized industries based on innovation, it is necessary to provide services for industry in a specially prepared area, and a vehicle that will facilitate the flow of inventions into innovations to increase productivity and competitiveness (Republik Indonesia, 2017).

According to (BAPPENAS, 2020-2024), one of the national priorities is the development and development program of Science and Technopark (KST) throughout Indonesia. The government then proposes to begin building and development of 100 KST throughout Indonesia (Muhammad, Muhyiddin, Faisal, Angger Anindito, & BAPPENAS, 2017). ITS is one of the

institutions that promotes technological innovation and commercialization, the creation of new businesses and jobs, and economic development as a result of downstream research conducted by lecturers and students. ITS offers the door to domestic and international strategic collaboration with the industrial world. In order to support research operations while enhancing ITS's ability to manufacture creative goods, ITS has underlined in its strategic plan that DIKST ITS is a strategic endeavor that will be developed based on ITS's superior fields thus far. The research conducted at ITS will be developed and evolved into a technology-based startup company (spin off) (DIKST ITS, 2020). This is intended to support the KST function, specifically as a vehicle for collaborative research and sustainable development between the Central Government, Regional Governments, Universities, Research and Development Institutions, and industry, as well as facilitators for the growth of Innovation-based companies through incubation and/or Spin Offs, and as service providers. KST service recipients will benefit from increased value and quality (Republik Indonesia, 2017).

This study aims to analyze the elements in the Business Model Canvas (BMC), namely Customer Segment, Value Propositions, Channels, Customer Relationships, Revenue Streams, Key Activities, Key Partnerships, Key Resources and Cost Structure for DIKST ITS (Management PPM Team, 2012). This is done to present an important element in the business model, so that we can define the current business model and accommodate innovative ideas in a straightforward and transparent manner from the management level, so as to create new strategies through improving business models and new business model prototype design.

2. LITERATURE REVIEW

2.1 Science and Technopark

Based on (DIKST ITS, 2020) the Directorate of Innovation and Science Techno Park (DIKST) is an institution at ITS Surabaya to support innovation and commercialization of technology, development of business creation and employment and economic development from the results of downstream research by lecturers and students. The DIKST has seven focuses, including the automotive industry, maritime and creative industries. Settlements and the environment, ICT and Nano technology incorporated in the Science Techno Park (STP). DIKST ITS was established to connect university research with the industrial world. The research conducted at ITS will be developed and expanded into a technology-based startup enterprise (spin off). As a result, the key actors in the quadruple helix, namely academics, business, government, and society, establish an innovation ecosystem. DIKST ITS is responsible for several number of business processes, including Product Research and Development, Engineering and Prototyping, Submission and Certification, Training and Certification, Business Incubation and Innovation, Technology Transfer (including IPR, Licensing, and Consulting), as well as Facilities, Mediation, and Promotion. DIKST ITS provides facilities to researchers/inventors/innovators to support all of these business processes, including a Technology Transfer Office, Incubator and Accelerator, Capital, and support for the Science Technology Area, which includes the Maritime Cluster, Creative Design Cluster, ICT and Robotics Cluster, and Automotive Cluster.

2.2 Business Model

A business model is a way of thinking about how a company develops, delivers, and collects value, whether that value is economic, social, or other (Osterwalder & Pigneur, 2010). A business model is a representation of a company's core characteristics, such as its goals and objectives, products and services, strategy, infrastructure, organizational structure, and operational policies and processes, that may be utilized in both formal and informal. According to

(Chesbrough, 2010), the business model's goal is to identify a company's potential distinctive contribution to the value creation system, as well as the contract's boundaries and relationship with its surroundings. The business model identifies the company's function in the network as a means of identifying markets and targets a broader range of stakeholders than just paying customers.

2.3 Business Model Canvas

Based on (Osterwalder & Pigneur, 2010) Business Model Canvas (BMC) is a framework that discusses the business model by presenting it in a visual form in the form of a canvas painting, so that it can be understood and understood easily. This model is used to explain, visualize, assess, and change a business model, in order to be able to produce more optimal performance. BMC can be used for all business lines without being limited to the business sector. BMC is very helpful to speed up the process of analyzing business strengths and weaknesses. The Business Model Canvas can explain the relationship between the nine elements of a business model (Management PPM Team, 2012) that is visually depicted, so that the innovations made in the company's business model will be easier to understand and understand. Here are the 9 elements of the business model canvas (Osterwalder & Pigneur, 2010):

1. Value Proposition
   In business there is always a product or service to offer. In the Value Proposition area block includes what products or services are offered to potential customers.
2. Customer Segments
   Customer Segments become the most important block area because it is from customers that we will get income.
3. Channels
   Channels are a means to convey the value or benefits of the product to the customer segment.
4. Customer Relationship
   Within this scope what is assessed is how to build relationships with customers. So that customers do not easily turn to other businesses, it is very important to establish good relationships. In addition, strict and intensive supervision is also required.
5. Key activities
   Key activities include all activities that must be carried out by a business person to produce a good and satisfying product or service. Included in this scope are branding, packaging, internet market and others.
6. Key Resources
   Included in the Key Resources area are various resources owned by a business or organization to realize a value proposition such as people, brands, equipment, and technology.
7. Key Partnership
   Key Partnership contains the parties who determine the running of a business. Key Partnership affects the success of a business. A good business is not only able to establish relationships with customers, but also with other relevant parties such as suppliers and the marketing team.
8. Revenue Stream
   Business model canvas is covering the steps that must be mastered by a businessman. Such as the use of advertising costs, subscriptions, retail sales, licenses, and so on.
9. Cost Structure

Includes what costs must be incurred to form, produce and market a business product or service. With proper cost management, the business we run will be more efficient, economical and minimize the risk of loss

3. METHODS

The qualitative research methods were used to perform this study. Qualitative research methods are research approaches that involve data analysis based on facts discovered in the field and then translated into hypotheses or theories (Sugiyono, 2013). The goal of adopting this qualitative method is to identify essential facts in the field that can be used as detailed study material. This study employs a Business Model Canvas approach, in which researchers uncover current difficulties through interviews in which the questions correspond to the nine main features of Business Model Canvas. This data mining process is carried out by involving the directors and senior managers in each cluster of DIKST ITS. In this process, we can briefly explain how they perform with their current business model.

4. RESULTS

The most difficult challenge in an organization is to create a fresh and innovative business model. This is done in order to obtain the greatest business model plan that may be used in the future. The DIKST ITS business model mapping yielded the following results:

Key Partnerships	**Key Activities**	**Value Proposition**	**Customer Relationships**	**Customer Segments**
1. Development Agency 2. Financial Institutions 3. Central Government 4. Local Government 5. Another Science and Technopark 6. Educational and Research Institutions	1. Product Research and Development 2. Engineering and Prototyping 3. Testing and Certification 4. Training and Certification 5. Business Incubation and Innovation 6. Technology Transfer 7. Facilitation, Promotion and Mediation	ITS Innovation Area and Best Resources	Business Facilities and Continuous Incubation and Some Tenants Can Use the Facilities for Free	1. College 2. Local Government 3. Micro, Small and Medium Enterprises 4. Its Community Member Community 5. Other Science and Technopark Associations
	Key Resources 1. Human Resources 2. Source Of Funding		**Channels** 1. Researcher 2. Innovator 3. Incubation Program 4. Promotional Activities	

Cost Structure	Revenue Streams
1. Service Program Fee 2. Salary and Honorarium 3. Operating Costs 4. Promotion Fee 5. Other Costs	1. Commercialization Of Technology 2. Parent Agency Funds 3. Training Service 4. Government Funds 5. Rental Facilities

Figure 1. Business Model Mapping

To be able to formulate this strategy, a business model canvas is used which consists of the following 9 elements:

1. Value Proposition
   The value that DIKST ITS wishes to emphasize is its innovation area as well as its top resources. DIKST ITS owns a variety of resources, including lecturers, heads of sub-sections, instructional personnel, and contract workers. In addition, each office, such as the technology transfer office (TTO), incubator, ICT Robotics, creative industry, maritime, automotive, and the main office, namely DIKST ITS, already has a distribution of resources. Human resource competencies that are in line with needs are also present in each existing office. DIKST ITS maintains a strategic office for each service it provides, which supports the service's business activities.
2. Customer Segments
   DIKST ITS is tasked with creating world-class universities that contribute to the nation's independence and serve as a model for education, research, community service, and the creation of innovations, particularly in the fields of industry and maritime affairs. Several consumers are served to make this happen, including other institutions, local governments, MSMEs, the entire community, and other techno park science area associations. Each DIKST ITS service already has its own collaboration partners, which are clearly defined in each cluster.
3. Channels
   Researchers either professors or students, innovators, incubation programs, and promotional efforts are the four channels held by DIKST ITS to communicate its value proposition to consumer segments. Customers will be served by DIKST ITS in compliance with current business processes. It will be made available to researchers.
4. Customer Relationship
   Customer Relationships that are built with customers are business facilities and continuous incubation. In addition, some tenants can also use the facilities for free. One of the customers at DIKST ITS are researchers. These researchers can get facilities such as guidance and funding on a scheduled and well-monitored basis.
5. Key Activities
   DIKST ITS uses seven main services to produce good and satisfying products or services, including product research and development, engineering and prototyping, testing and certification, training and certification, business incubation and innovation, technology transfer (which includes IPR recording, licensing, and consultation), and facilities, promotions, and mediation.
6. Key Resources
   Key Resources owned by DIKST ITS are divided into 2, namely:

a. Human Resources
   DIKTS ITS employs 21 individuals, including 17 educators and four contract workers. For the distribution of these 21 employees, there are 7 human resources in DIKST, 3 human resources in the incubator, ICT Robotics, Automotive, and Maritime, and 1 person in the technology transfer office and creative industry.
b. Sources of funding
   DIKST ITS is the owner of two types of funding sources: investment money and operational funds.

7. Key Partnership
   No organization, including DIKST ITS, can function without the help of others. DIKST ITS owns a key partnership with five partners, including development institutions, financial institutions, the national government, municipal governments, other techno park science sectors, and educational and research organizations.
8. Revenue Stream
   DIKST ITS generates revenue from a variety of sources, including technology commercialization royalties, parent agency funds, training services, government subsidies, and facility rental fees from each office rented by DIKST ITS.
9. Cost Structure
   DIKST ITS requires several costs to finance service programs, salaries, and honoraria for resources in order to realize its vision of becoming a world-class university that contributes to the nation's independence and becomes a reference in education, research, and community service, as well as the development of innovations, particularly those that support industry and maritime affairs. related human resources, operational costs for running all of its services, as well as promotional costs for renting out co-work space facilities to the general public, and other unforeseen expenses.

5. CONCLUSIONS

Based on the findings of the analysis of the 9 elements of the Business Model Canvas at DIKST ITS, it can be concluded that DIKST ITS has fulfilled its vision of becoming a world-class university that contributes to national independence and becomes a reference in education, research, community service, and innovation development, particularly those that support industrial and marine sectors.

This is demonstrated by the implementation of several key services, including the production of new technology-based entrepreneurs (Startup Companies) by ITS incubators located in creative industry locations, and the development of new technology-based entrepreneurs (Startup Companies) by ITS incubators located in creative industry locations, building an ecosystem to create the growth and development of innovation, new products, and new start up. The next factor is having people resources who can grasp science and technology in order to boost economic competitiveness and national independence through collaborative research programs, down streaming, and commercializing higher education innovative research results. The down streaming and commercialization of the outcomes of higher education innovation research has stalled due to a number of factors, including the intellectual property rights process. Building linkages between research institutions and industry so that all business operations involving

partners work smoothly, and expanding human resource capacity in the sectors of science, technology, and creativity so that many innovations can be developed are among the other services supplied.

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HUMANWARE COMPETENCE IMPROVEMENT STRATEGY WITH TECHNOMETRIC APPROACH IN PERUM AIRNAV INDONESIA, SURABAYA BRANCH

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ABSTRACT

This research was conducted by applying a technometric approach to all divisional lines and supported by the AHP method for the process of weighting HR criteria in accordance with the job description. With this research, it is hoped that in the future the mapping results related to the lack of human resource productivity and can be used as a supporting reference related to the implementation of the Human Resources development program. In addition, the contribution of Humanware can be made in carrying out mitigation in the event of disturbances outside the procedures that arise. With the implementation of good risk management on underperforming HR lines, it can certainly prevent the risk of a more severe operational failure from occurring.

Keywords:

Human Resources, *Underperformance, Humanware*, Teknometrik, AHP (*Analytical Hierarchy Process*), Teknometrik.

1. INTRODUCTION

The development of the air transportation sector must be supported by guaranteed, safe and comfortable flight safety services. One of the components that will be the focus of this research is the Humanware aspect. In practice, each dimension of Humanware competency measurement is measured in terms of the perspective and intensity of the use of broad technology components. So that in carrying out the assessment requires a multi-criteria analysis, one criterion with criteria can be independent or dependent and conflictual. This aims to find out how far behind in the humanware competence in Airnav Indonesia Surabaya Branch. In addition, it can be done to increase the competence where there is a gap between the current conditions and the expected conditions. so that the ultimate goal can be to formulate a strategy to minimize lagging behind in humanware competence. The main problem is when the company's operational employees who work operationally at work experience conditions that can be in the form of errors, which can be unprocedural or functional disturbances in the technology used to work. When experiencing these

incidents, panic often arises so that efforts to mitigate the risks posed by following procedures in the form of SOPs for Handling that have been provided are sometimes not carried out. This happened when the shift service activities occurred an incident of technical problems with the technology used to control flight traffic scouting. Technology is defined as a method or product that is produced based on a scientific discipline process so that it can provide added value for human interests (Khalil, 2000). To be able to optimize the use of technology that has been applied, of course, it needs to be accompanied by an increase and development of Human Resources (HR) or the existing humanware components optimally.

In an effort to improve the innovation and competence of superior humanware at international standards, the measurement that is commonly used to find out this information is the measurement of innovation strategy and humanware performance. This is because HR is an asset that can be utilized optimally to develop a company's core competency. This aims to determine the extent to which the existing humanware competencies at Airnav Indonesia Surabaya Branch can be formulated so that strategies can be formulated to minimize the lagging competencies in humanware.

1.1 Profile of Airnav Indonesia Surabaya Branch

Perum Airnav Indonesia Surabaya Branch is a form of Operational Office providing flight safety services at the branch level which began operating on September 13, 2012 and started operating on January 16, 2013. located in East Java.

Airnav Indonesia Surabaya Branch is one of the service office representatives who provide operational services for flight safety in the area that is the air side area in the Juanda airport area and the surrounding area.

1.2 Objective Research

Identify the criteria for indicators on what elements of humanware are considered in the assessment related to the level of sophistication (State of The Art) of humanware in Perum. Airnav Indonesia Surabaya Branch, while at the same time obtaining basic competency information to formulate policies related to human resource development in accordance with company needs.

2. LITERATURE REVIEW

2.1 Technometric

Technometric approach method used to assess the contribution of technology components. The technology component in question is Humanware. The technometric approach is used to measure the contribution of Humanware which is one of the four technology components. (Alkadri, et.al., 2001). Humanware is the ability of Human Resources which includes knowledge, skills/expertise, wisdom, creativity, achievement, and experience of a person or group of people in utilizing available natural resources and technological resources.

In the perspective of this research, the humanware component is the core of the technology function to describe the competence of Human Resources which will be tested to determine the extent of the competence of the Human Resources of Airnav Indonesia Surabaya Branch in carrying out its corporate activities.

Table 1. Degree of reliability of humanware

No	Humanware	Score
1	Ability to operate or operate production equipment	1 2 3

2	Ability to install/assemble production equipment	2 3 4
3	Ability to maintain/maintain production equipment	3 4 5
4	Ability to manage production equipment	4 5 6
5	Ability to adapt/modify production equipment	5 6 7
6	Ability to repair damaged production equipment	6 7 8
7	Ability to make an innovation of production equipment	7 8 9
8	Ability to improve one's own abilities	7 8 9

Source: ESCAP (1988b:22-28,50) in Alkadri, et al. (2001).

The Technology Contribution Coefficient (TCC) measurement model is a technometric approach that aims to measure the level of the combined contribution of the four technology components in a process of transforming input into output. To determine the calculation of the total contribution or Technology Coefficient Contribution (TCC) using the formula, which is as follows: TCC = Tβt x Hβh x Iβi x Oβo, where T, H, I, O are the contributions of the technology components Technoware, Humanware, Infoware, and Orgaware . Meanwhile, t, h, i, and o are the intensity of the contribution of the technology component. As for the price of TCC classification level:

Table2. TCC Price by Classification Level

0,1	Very low
0,3	Low
0,5	Normal
0,7	Good
0,9	Very good
1	Highly Sophisticated

Next is to determine the Technology Level based on the TCC Price, namely :

Table3. Technology Tier by TCC Level

TCC Price	Tech Grade
0<TCC≤0,3	Traditional
0,3<TCC≤0,7	Semi Modern
0,7<TCC≤1,0	Modern

2.2 Analytical Hierarchy Process (AHP) Method

The principle of using the AHP method begins with decomposition of a complex decision problem and then classifies the subject matter into decision elements in a certain hierarchy. At the same hierarchical level, the decision elements can be compared (pairwise comparison). by taking into account qualitative and quantitative factors

The process of evaluating comparisons between elements and criteria based on the "judgment" is documented and can be re-examined for the consistency of the assessment. This process utilizes a number/scale, which reflects the level of preference/importance of a comparison of decision elements in their contribution to the achievement of a goal at a higher hierarchy [SAATY, 1980]. Table 1 shows the numerical scale used to represent the numerical weighting "judgment" of decision makers when conducting evaluations.

Table4. Numerical Weighting Scale AHP Method of Decision Judgment

Numerical Scale	Qualitative Scale and Definition
1	The weight of the importance of one matrix element is considered equally important compared to the other matrix elements
3	The weight of the importance of one matrix element is considered slightly more important than the other matrix elements
5	The weight of the importance of one matrix element is considered quite important compared to the other matrix elements
7	The weight of the importance of one matrix element is considered very important compared to other matrix elements.
9	The weight of the importance of one matrix element is considered absolute (very important) compared to the other matrix elements.

Source: Saaty in Ciptomulyono[1985].

Note: The value between the two scales above is defined as having the weight of importance between the two adjacent scales.

Take the value of "pairwise comparison" as the ratio of the row element factors of the i matrix to the j column elements, for i, j = 1, 2, 3, . . n. A "judgment" matrix A can be constructed from the elements of a "pairwise comparison" matrix that utilizes the weights of the numerical scale above :

$$A = \begin{bmatrix} \frac{w_1}{w_1} & \frac{w_1}{w_2} & \frac{w_1}{w_3} & \cdot & \frac{w_1}{w_n} \\ \frac{w_2}{w_1} & \frac{w_2}{w_2} & \frac{w_2}{w_3} & \cdot & \frac{w_2}{w_n} \\ \frac{w_3}{w_1} & \frac{w_3}{w_2} & \frac{w_3}{w_3} & \cdot & \frac{w_3}{w_n} \\ \cdot & \cdot & \cdot & \cdot & \cdot \\ \frac{w_n}{w_1} & \frac{wn}{w_2} & \frac{w_n}{w_3} & \cdot & \frac{w_n}{w_n} \end{bmatrix}$$

Figure 1. Matriks perhitungan AHP

If the two elements of the matrix being compared have the same weight value, aij = 1, for a "reciprocal" matrix, there will be n(n-1)/2 paired "judgment" matrix elements for a matrix of size n x n.

In simple terms, AHP can be done with the following steps :

1. Design/decision structure of the problem at hand
2. Pairwise comparison (pairwise comparison)
3. Priority Synthesis (weight)

4. Consistency test

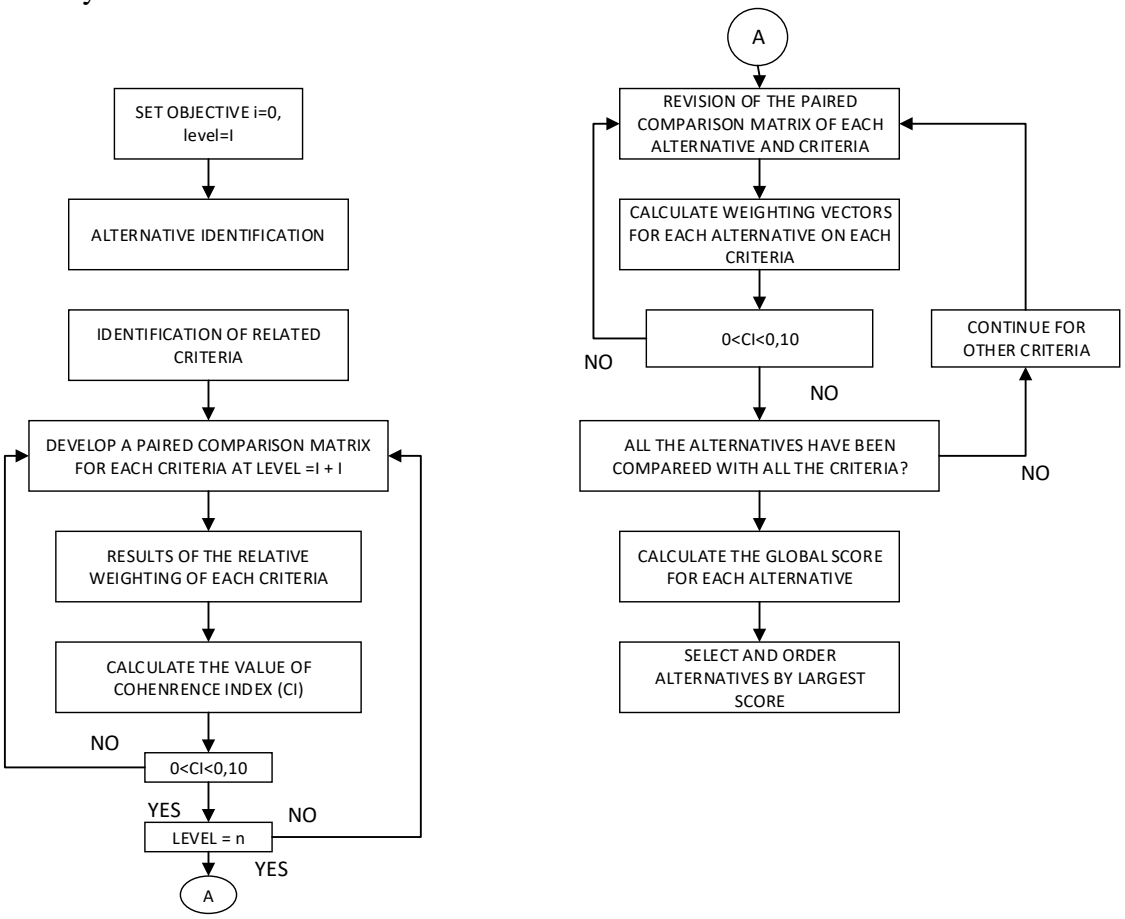

Figure 2. Hierarchical Analysis Process –AHP
Source: Saaty in Ciptomulyono[1985].

3. METHODS

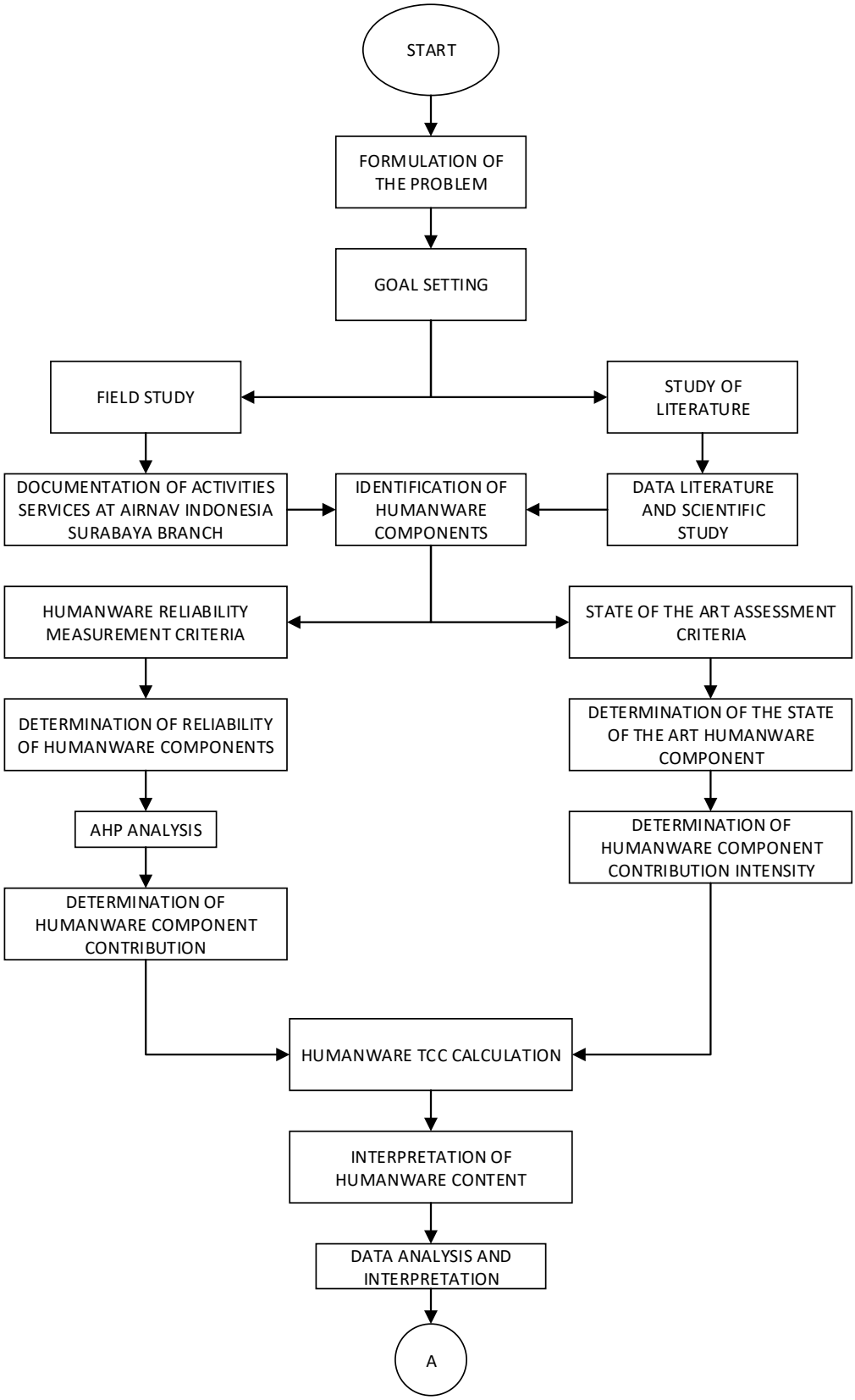

Figure 3. Stages of research flow

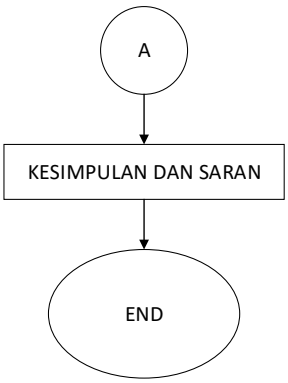

Figure 4. continued stages of the research flow

Research Flow Stages

The stages of the research flow that will be designed to produce an appropriate analysis are as follows:

1. Stages of Identification
2. Stages of Data Collection
3. Stages of Data Processing
4. Stages of Data Analysis and Interpretation

4. RESULTS

4.1 Analysis Results of Analytical Hierarchy Process (AHP) Calculations

Table 5. Results of AHP calculation analysis for each competency

No.	Division	Knowledge	Planning	Organizing	Leading	Controlling
1	CNSA Engineering	0,08	0,131	0,192	0,111	0,063
2	Supporting Facilities Engineering	0,082	0,087	0,127	0,111	0,091
3	Tower Planning and Evaluation	0,43	0,479	0,428	0,437	0,493
4	Aviation Communication Planning and Services	0,198	0,186	0,198	0,213	0,194
5	Planning and Evaluation of APP/TMA Services	0,43	0,479	0,428	0,437	0,493
6	Air Traffic Flow Management dan ATS System	0,048	0,053	0,048	0,05	0,055

The results of the calculation of the AHP weighting analysis, knowledge competence is a competency that is highly prioritized by the Aviation Communications Planning and Services unit, at airnav Indonesia Surabaya branch. In real conditions, aspects of knowledge are needed to support operations, especially knowledge of how to communicate in providing services to stakeholders.

Viewed from the planning aspect (Planning), the APP/TMA Service Planning and Evaluation Unit and the Tower Planning and Evaluation Unit, making the planning aspect a priority, how to make a good flight operational plan, including planning for human resources who serve as controller in the APP/TMA Unit.

In organizational management competence (Organizing), the units that make this competency a priority are the Tower Planning and Evaluation Unit and the APP/TMA Service Planning and Evaluation Unit. Because in real terms in the workplace, the Tower Service Planning and Evaluation Unit and the APP/TMA Service Planning and Evaluation Unit have the highest number of personnel compared to other units at Airnav Indonesia Surabaya Branch. So that with the majority of personnel compared to other unit personnel, it is necessary to be able to make arrangements for the right number of personnel when on duty and not. So that with good personnel arrangements, flight safety service operations will be guaranteed and run well.

For the Leading competency aspect, the main priority is the Tower Planning and Evaluation Unit and the Service Planning and Evaluation Unit

APP/TMA. This is considering the large number of employees, of course, must be able to organize and direct the employees who have the largest number of personnel. This aims to ensure the implementation of flight safety operations at Airnav Indonesia Surabaya Branch.

For Controlling competence, the main priority is from the Planning and Evaluation Division or Tower Unit and the APP/TMA Service Planning and Evaluation Unit.

4.2 SOA Calculation Analysis

In the SOA calculation analysis, the sophistication value of each competency is obtained. An example is knowledge competence, where each division or unit has a contribution value. In each of these contribution values, all the contribution values are added up which is called the level of sophistication value. All sophistication level values can be summarized in **Table 6.** as below:

Table 6. Calculation of Total Contribution to Five Competencies

Competence	Contribution Knowledge	Contribution Planning	Contribution Organizing	Contribution Leading	Contribution Controlling
Supporting Facilities Engineering	0,479	0,463	0,506	0,485	0,396
CNSA Engineering	0,573	0,547	0,566	0,566	0,517
Air Traffic Controller	0,492	0,570	0,623	0,579	0,632
Air Traffic Flow Management	0,973	0,680	1	0,433	1
Aviation Communication	0,479	0,479	0,807	0,504	0,371
Finance	0,479	0,395	0,395	0,364	0,340
Average Contribution Nilai	0,579	0,522	0,671	0,489	0,611

In theory, the contribution value that has the best humanware sophistication is organizing competence with an average contribution value of 0.671, so it is necessary to increase the contribution value by 0.329 if you want to experience an increase.

6. CONCLUSIONS

1. The conclusions that can be drawn from the research that has been done at Airnav Indonesia Surabaya Branch are :
    1. The largest total contribution value and the first priority is organizational management competence, with the unit having the highest contribution, namely Air Traffic Flow Management with a contribution value of 1, so it is necessary to maintain its contribution performance. So that the proposed development strategy that can be given is as follows:
        a. Utilizing Human Resources (HR) in the organization optimally and effectively.
        b. Identify human resources or employees who have strengths and weaknesses, so that they are expected to complement each other.
        c. Encouraging team members to continue to hone their competency skills so that employees will continue to race to continue to develop and improve their abilities and not be easily complacent.
        d. Encourage all employee members in their unit to work professionally and participate actively towards specific goals, and assign tasks according to the skills, knowledge and background of employees in the unit or team.
        e. Request input from team members or employees in an effort to improve the quality and quantity of competencies possessed, so that an overview of competency development programs can be obtained by members or employees in the organization.
2. And the stages of the research process that have been carried out on aspects of knowledge competence, planning or Planning, Organizational Management or Organizing, Directing or Leading, and Directing or Controlling, have been adjusted to the conditions and situations at Airnav Indonesia Surabaya Branch.

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EVALUATION OF LOCATION DECISION OF OPTIMAL TRUCK PARKING WITH INTEGER LINEAR PROGRAMMING: A CASE STUDY OF TRUCKING COMPANY

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ABSTRACT

The evaluation focus on truck parking aimed to reduce the company's operational costs to increase customer satisfaction. It is also considering an optimal number and location of truck parking that can minimize travel costs from truck parking to the customer's location. The interview results with experts describe the case, the management proposes 2 scenarios refer to the company's projections to close one of the truck parking. Integer Linear Programming model with Capacitated Location Problem used to be able to minimize the cost involved in facility operations. The model then is processed by Simplex method and simulated using Excel Solver to find out how the optimization results generated from this research suit PT X. The model was then developed with scenarios based on target reference data from PT X. The company's operational costs to meet customer needs in 1 year according to the truck parking land lease period, will be lower if it operates using 2 parking trucks with a difference of 594,859,750 lower. The model also shows the minimum allocation of each parking truck which Customer 1 and 2 are closer to support truck parking B, while customers 3, 4, and 5 are closer to support from truck parking A.

Keywords: Third Party Logistic (3PL), Trucking Company, Capacitated Facility Location Problem, Integer Linear Programming.

1. INTRODUCTION

This research was conducted in a trucking company, where the trucking company is one of the third-party logistics (3PL) companies. PT X is a trucking company that provides trucks as a distribution fleet for customers from PT X. The spread of the Covid 19 Pandemic in Indonesia since April 2020 has had an impact on PT X. The implementation of Large-Scale Social Restrictions affects the industrial sector. Many of the industrial sectors are affected by limited activities in the work environment. Some of them are customers of PT X, which has experienced a decline in operational activities that shown in figure 1. As a result, many customers are returning units to reduce their operational costs. On the other hand, PT X also needs to prepare land for the units to be returned. Because the number of units returned is too many, the units that enter the truck parking lot are full. Thus, the management decided to take the step of opening a new truck parking as a means of storing returned trucks. Over time, PT X's utility has started to return to normal. So, management needs to evaluate the number of truck parking required. This refers to the company's planning to conduct an evaluation. The company has a target to always improve customer satisfaction. This can be supported by providing the best prices and increasing the

company's service level to customers for provide fast response of providing they needs as company competitive advantage (Pribanus Wantara, 2019). So that this becomes a research reference to be able to evaluate the truck parking owned by PT X.

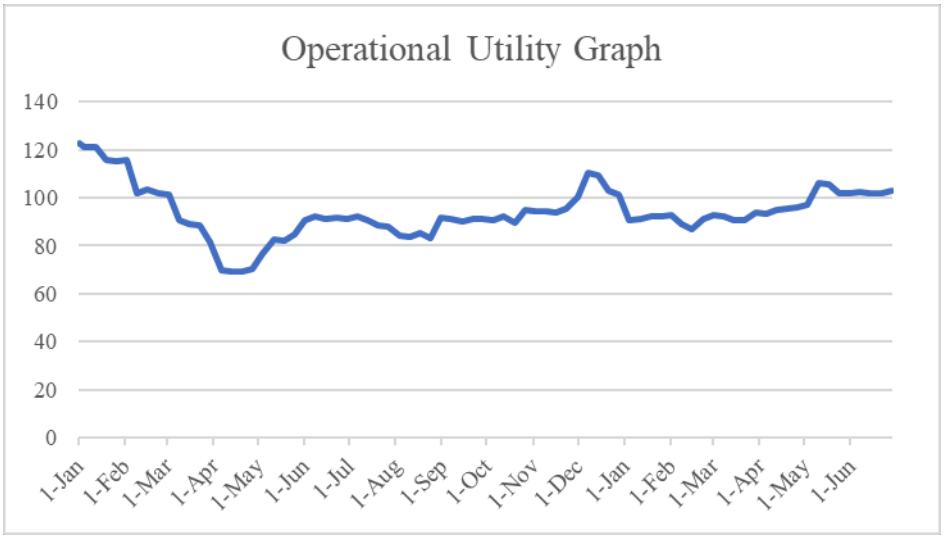

Figure 1 PT X's Operational Utility Graph From 2020 to Mid-2021

Currently, PT X's operational activities are facilitated by 2 truck parking. The two parking trucks have different areas. The main parking truck has an area of 65 x 29 which can accommodate 70 units, while the second parking truck has an area of 39 x 28 which can accommodate 50 units. The 2 parking trucks are used in PT X's operational activities to be able to allocate its trucks to its customers. However, the company has not seen how effective the truck parking is. Thus, the company wants to evaluate truck parking in order to reduce operational costs of delivering units to customer locations. Operational costs are the company's highest expenses. Operational costs account for 67% of the company's total expenses. Where, the costs incurred by PT X include operational costs, installments, and fixed costs. To be able to reduce operational costs, it is necessary to calculate the distance and also how to fulfill request units from PT X's customers.

Currently, PT X has 140 units of trucks to meet the needs of its customers. Where the 140 units are divided into 5 different types of trucks. 72 units of trucks of which are units that have been contracted by customers, so PT X does not need to provide daily parking. However, PT X still has 68 units of trucks to be rented by customers outside the contract. In addition, the company can also use 68 units of trucks to anticipate the replacement of units that have been in the contract. In this case, the researchers involved 68 trucks owned by PT X to be placed in the right truck parking. Based on data for the past 6 months, 58 of the 68 units of trucks are the largest number of units operating at PT X. The 58 units are spread to 5 customers of PT X. The 58 units are divided into 5 types of trucks. not all customers need all types of trucks owned by PT X. To minimize operating costs, the study will use this data as a reference for allocation in trucks parking. Besides that, it is also an illustration of the best scenario for PT X.

2. LITERATURE REVIEW

A. Facility Location In Third-Party Logistics

Customers from 3PL service users are the first parties who need logistics services as distribution actors who bring first-party products to their customers, namely the second party. The presence of a third party plays a role in the complexity of the transfer process from the first party

to the second party from 3PL customers. So that the first party can improve the service level of the company by staying focused on the company's internal activities for the quality and flexibility of product availability. As a 3PL provider, PT X assists the first party in expanding its reach to all its customers. The services of a 3PL company may vary according to the specialization of its activities. Activities involved in supply chain management include logistics activities in terms of transportation, warehousing, packaging, product returns, information systems, cross-docking, and inventory management. From the many types of activities, the 3PL needs to coordinate with each party involved in the delivery process to support the delivery of goods properly (Bang-Ning Hwang, 2015).

To support the needs of economic development and trade, transportation is used to facilitate the flow of goods and services. The type of transportation used can be through land, sea, and air. Where transportation is used as a liaison for the distribution of goods between supply chain elements. Based on the survey, transportation requires 50% of logistics costs. While the remaining 20% warehousing costs, 20% inventory handling costs, 7% customer service costs, and 3% administration costs in 2008 (Alan Rushton, 2014). The types of transportation modes provided by 3PL in the transportation sector can be in the form of a fleet of trucks, ships, trains, airplanes, pipelines, and the internet. Truck fleet providers need to have truck parking as a fulfillment center for providers to be able to maintain and carry out control units optimally.

The problem of choosing the location of the facility is a theory that can help in solving the problem of determining the location. To support the company's operations, the balance of the number of facilities needs to be considered to minimize fixed expenses. Determining the location of logistics facilities is very important to be able to minimize travel costs, maximize service levels, minimize waiting times and avoid mistakes in determining facilities. The exact location will reduce the total delivery distance to improve responsiveness. The location of the appropriate facilities will have an impact on the effectiveness of the company's operations (Olawale J. Adeleke, 2020).

The Capacity Facility Location Problem (CFLP) is part of the Facility Location Problem (FLP), which involves the capacity of the facility. Involving capacity as a limitation, the facility can cover all units that are considered to be able to support customers at a lower cost. so that truck facilities can be allocated according to their needs. The researcher uses CFLP to be able to evaluate the operational expenses so that the company can determine decisions related to minimizing costs. In this case, the CFLP helps in minimizing costs to open the best facilities as support for operational activities. Fixed costs are one-time expenses that vary from one location to another, which are expected to be recovered over the life of the facility. Besides that, in addition to affecting the rental cost, the location of the facility affects the distance from the unit delivery to the customer (Olawale J. Adeleke, 2020).

B. Integer Linear Programming

Linear Programming is one of the tools to assist in getting optimal results. Where, the model created in linear programming aims to be able to see minimal, maximum results or get predetermined results. The linear programming model consists of decision variables, objective functions, constraints, and parameters. Integer Linear Programming is one of the models in linear programming. Where linear programming contains a set of linear equations or inequalities. In using the Integer Linear Programming model, the decision variable is an integer.

Integer Linear Programming is used by Kai Wang (2020) to create a model for air traffic management to generate several operating scenarios based on historical data modeled by computation which states that the algorithm is close to optimal. Jorge Rodríguez-Veiga (2018)

also uses Integer Linear Programming to determine the model developed by the researcher shows the right solution with a maximum time duration of 5 hours after a simulation study on forest fire readiness is carried out. Madjid Tavana (2015) combines Integer Linear Programming with Data Envelopment Analysis (DEA) for the initial screening and the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) for ranking the projects for selecting the most suitable projects. Research conducted by Ruilin Ouyang (2016) also combines Integer Linear Programming with the Grid-Based Location Model to find an efficient model for solving small problems, tending to be medium for long-term decisions in health care facilities. Meanwhile, Serkan Gunpinar (2016) combines Integer Programming with Robust Optimization to find a model that can optimize Bloodmobile routes.

3. METHODS

The data needed to be able to calculate with the model is the unit requirement data from each customer. Where the data unit used is the highest data needed for each type of truck from each customer. In addition, data on transport costs is also needed as a component that has a direct impact on operational costs. Rental cost data is also needed as costs that have an impact on model calculations. The two parking trucks owned by PT X are in an area with the same standard of wages and salaries, so the researcher does not involve the calculation of wages for permanent employees in the calculation of the total cost. In addition, the costs incurred by the company for the addition of assets are reparations in the previous year which were paid on credit and have not been paid off. So that the author does not include these costs into the calculation. It also refers to the amount of debt that has no difference from year to year that must be paid annually. In addition, the company's debt installment costs also do not have a direct impact on operational activities.

The amount of operational costs incurred by the company will be evaluated. Where the main operational cost of the company is the cost to deliver the units needed by the customer to the customer point. The costs incurred to deliver the unit are travel expenses. The transport cost consists of the cost of gasoline, driver's wages, food allowance, and mel (illegal levies on the roads) which are different for each destination and type of truck. It also refers to the distance between trucks and customers. Where the location of the truck parking is a factor that directly affects the transport cost. Where, the farther the distance between, the greater the need for gasoline which directly affects the addition of transport costs. The model should be developed to involve 1-day, 1-month, 2-months, 3-months, 6-months, and 1-year. It is assumed that 1-month equals 25 workdays. The multiplication of the result is expected to show the company’s management comparation of those scenarios. In this case, the result will show which scenario will have the lowest total expenses based on operating cost and for opening facility cost (fixed cost). This is then carried out by researchers to evaluate the needs of PT X's truck parking which can affect the total costs incurred in the model.

Table 1 Maximum Utility Recorded

Maximum Utility	Truck 1	Truck 2	Truck 3	Truck 4	Truck 5
Customer 1	0	2	0	1	0
Customer 2	2	8	7	3	0

Customer 3	3	8	9	4	0
Customer 4	2	3	4	1	0
Customer 5	0	0	0	0	1

Table 2 Transport cost of Each Truck Type Based on its Customers

	Truck parking A					*Truck parking* B				
	Truck 1	Truck 2	Truck 3	Truck 4	Truck 5	Truck 1	Truck 2	Truck 3	Truck 4	Truck 5
Customer 1	309,975	353,300	390,960	444,950	444,950	227,144	259,525	288,430	329,288	329,288
Customer 2	195,706	225,942	253,130	291,413	291,413	115,450	135,600	154,720	180,900	180,900
Customer 3	149,463	172,617	194,140	223,925	223,925	184,763	211,350	235,620	269,525	269,525
Customer 4	147,531	170,042	191,050	220,063	220,063	198,281	229,375	257,250	296,563	296,563
Customer 5	103,219	119,292	135,150	156,438	156,438	193,775	223,367	250,040	287,550	287,550

Table 3 Truck Parking Profile

Truck parking	P	L	Area (m^3)	Capacity	Rent Cost/Year
A	65	29	1885	70	70,000,000
B	39	28	1092	50	67,200,000

a. Objective Function

The purpose of the model is to obtain a minimal result from the total costs of PT X's expenses. Where the researcher calculates the total cost of travel to deliver the unit to the customer as well as the addition of fees for opening truck parking. This is illustrated in the following model equation below:

$$Z = min\left\{\sum_{i\in A}\sum_{j\in F}\sum_{k\in T}\beta_{ijk}t_{ijk}+x_j f_j\right\} \quad (1)$$

$$x_j = \begin{cases} 1, & if\ truck\ parking\ j\ is\ operated \\ 0, & if\ truck\ parking\ j\ is\ not\ operated \end{cases} \quad (2)$$

$$\beta_{Ijk} \geq 0 \quad (3)$$

Based on equation (1), A is the set of all customers indexed with i; F is a set of all parking trucks indexed by j; T is the set of all types of trucks indexed by k. The decision variable is the value of x_j where if x_j = 1 facility j is open, and 0 otherwise (equation 2). Variable β_{ijk} as a variable that determines the distribution of the index k on each truck parking lot j which can be allocated to each customer i should be valued more than 0 (equation 3). Truck parking rental fees j is f_j. Facility capacity j is a_j. The number of each type of truck k is q_k. Total transport cost required by the type of truck k to head to the customer i from *truck parking* j is t_{ijk}.

b. Constraints

The constraint function is a function that is needed for the model in determining the constraint. The limitation is to be able to adjust to the real situation of the topic to be searched for optimal results. This limitation makes the model will distribute the number of each type of truck that will

be allocated to each customer to the selected truck parking will be more optimal if it is opened. Thus, the constraint function is described in the following table:

Table 4 Constraint functions

$\sum_{j \in F} \sum_{k \in T} \beta_{jk} \leq q_k$	To be able to limit the number of each type of truck, both in truck parking A and truck parking B, not exceeding the number of trucks available.
$x_j = 0,1 \qquad \forall j$	To be able to limit the variable x_j is an integer value to be able to determine which truck parking is still operating.
$\beta_{ijk} \geq 0$	To be able to determine that the value of the allocation of trucks in each parking truck is not negative.
$\sum_{j \in F} \beta_j \leq a_j$	To be able to limit the number of allocations for each truck not to exceed each truck parking.
$\sum_{i \in A} \sum_{k \in T} \beta_{ik} \geq d_{ik}$	To be able to limit the need for trucks in each area can be distributed maximally.
$\sum_{i \in A} \beta_i \geq d_i$	To be able to limit the types of trucks allocated by the maximum distributed model

4. RESULTS

After collecting data, the model is then translated into a mathematical model language. Furthermore, verification is carried out regarding the model whether it can run and produce optimal results. Running the model using the Simplex method with Excel Solver. The objective function, decision variable, and constraint function that have been translated are inputted to obtain optimal results of minimal operating costs. The model will be run to get the minimum result from the objective function of the model based on all the limiting functions that have been adjusted by the author by the PT X situation. The results are expected to show optimum results that will help in solving the problem. The model will be run to get the results of how the model allocates each type of truck for each customer and the allocation of the number of truck parking which is the determining variable of the objective function. The input from the Excel Solver tool is as follows:

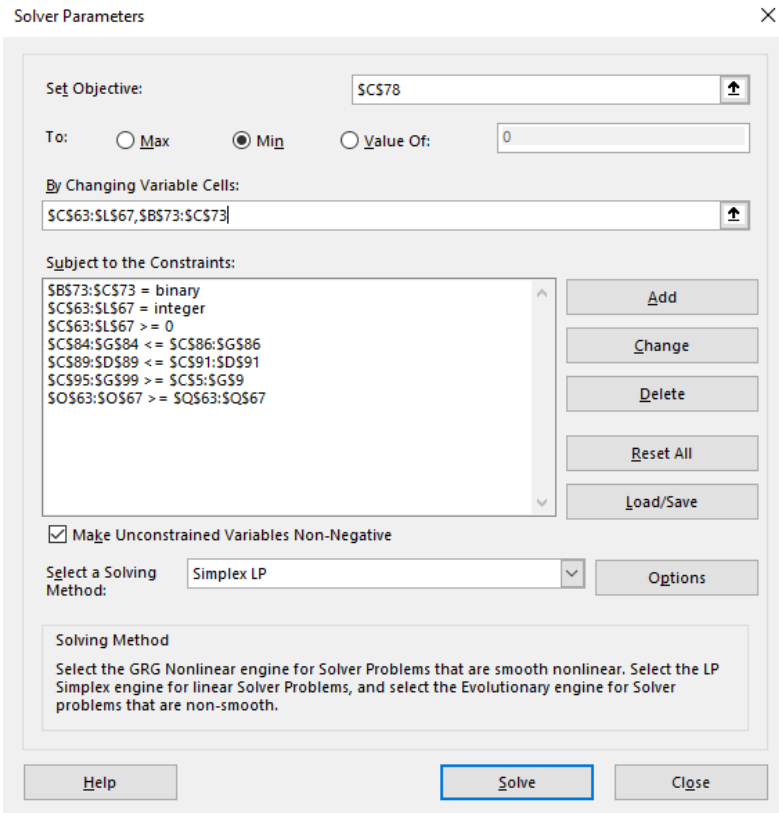

Figure 2 Excel Solver Input

All the objective function, variable decisions, and constraint functions model are input to be processed using the Simplex method on Excel Solver tool. Figure 2 shows that constraints in cell B73:C73 should be binary as it represents the constraint model $x_j = 0,1$ to be able to determine which truck parking is still operating. Constraint in cell C63:L67 should be an integer as it represents the amount of the truck and should be more than 0 that represents constraint model $\beta_{ijk} \geq 0$ to be able to determine the value of the allocation of trucks in each parking truck is not negative. Constraint in cell C84:G84 should be more than the total amount of each truck type as it represents constraint model $\sum_{j \in F} \sum_{k \in T} \beta_{jk} \leq q_k$ to be able to limit the number of each type of truck, both in truck parking A and truck parking B, not exceeding the number of trucks available. Constraint in cell C89:D89 should be less than the total amount of all trucks that allocated in each truck parking as it represents the constraint model $\sum_{j \in F} \beta_j \leq a_j$ to be able to limit the number of allocations for each truck not to exceed each truck parking. Constraint in cell C95:G99 should be more than the total demand of each customer as it represents constraint model $\sum_{i \in A} \sum_{k \in T} \beta_{ik} \geq d_{ik}$ to be able to limit the need for trucks in each area can be distributed maximally based on the history of truck type requests from each area. Constraint in cell O63:O67 should be more than the maximum amount of each truck type needed by each customer as it represents constraint model to be able to limit the types of trucks allocated by the maximum distributed model. It also considers the amount of allocation of each truck for a more specific area in each truck parking can be well prepared for support company's target to keep operating more than maximum demand record. The models were developed to cover some scenarios. Thus, the models cover how is each scenario affects the deviation between operational costs in both opening a truck parking or two truck

parking. The model was developed by involving 1-day, 1-month, 2-months, 3-months, 6-months, and 1-year data to calculate the difference between each scenario.

Table 5 Total Cost of Each Scenario

Scenario	Data	Total Cost
Operating 1 Truck Parking (Truck Parking A)	1 Day	82,414,812
	1 Month (25 Day)	380,370,292
	2 Month (50 Day)	690,740,583
	3 Month (75 Day)	1,001,110,875
	6 Month (150 Day)	1,932,221,750
	12 Month (300 Day)	3,794,443,500
Operating 2 Truck Parkings (Truck Parking A&B)	1 Hari	147,407,946
	1 Month (25 Day)	392,398,646
	2 Month (50 Day)	647,597,292
	3 Month (75 Day)	902,795,938
	6 Month (150 Day)	1,668,391,875
	12 Month (300 Day)	3,199,583,750

The results of the solver show that the decision variable decides the allocation of trucks for customers 1 and 2 that can be allocated to be parked in truck parking B. This shows that truck parking B is the closest parking truck to customer 1 and customer 2. Then, truck parking A will cover at minimum of 35 trucks while truck parking B will cover customer 3, customer 4, and customer 5 with minimum of 23 trucks. Based on the table above, the company's 1-day operation is to be able to deliver the unit to the customer by operating only the main parking truck at a lower cost. That is 82,414,812 compared to still operating 2 truck parking which is 147,407,946. The company's operations in 1 month using 1 truck parking will have lower operating costs, namely 380,370,292. While operating 2 truck parking for 1 month of operation, the cost is 392,398,646. After the second month, operational costs will be cheaper if operations are covered by 2 parking trucks. For 2 months operational costs, operational costs incurred by the company amounted to 647,597,292 compared to only covered by main truck parking, namely 690,740,583. Until the assumption from the company to be able to maintain maximum utility for 300 working days (1 year) by the truck parking rental period, the company incurs lower operating costs if it continues to operate both truck parking for 3,199.583,750 compared to operating costs which are only covered by 1 truck. parking is 3,794,443,500.

6. CONCLUSIONS

The models show that if the company would like to fulfill the maximum demand in a year operating two truck parking will save more costs than operating only main truck parking (truck parking A). It shows that the deviation between operational costs origin from main truck parking and truck parking B could cover the opening cost of operating second truck parking. Where the demand from customers 1 and 2 is still high enough to cover the cost of opening a truck parking B. On the other hand, the model also shows that the units allocated for areas 1 and 2 are allocated to be parked in truck parking B. This is due to lower transport costs so that it can reduce spending on gasoline. Scenarios involving a couple of certain cumulative data show that operating 2 truck parking will be more efficient if the company's operations can be maximized in the 3rd month and

so on. Calculations with 1-year data show savings of up to 600 million and have free space for the addition of other units parked in the truck parking can be well covered.

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SUSTAINABLE MANAGEMENT OF RIVER BASIN: A CASE STUDY OF FLOOD INUNDATION MAPPING

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ABSTRACT

River basin management must begin with the arrangement of tributaries in the main river. Lae Kombih River is one of the tributaries Lae Soraya and discharge has a very large impact on the Lae Soraya River. The previous observation showed that the upstream river was very steep and the downstream river was narrowing and meandering, and there was no embankment. This research aimed to map flood inundation to be used as a reference for the proper, efficient, and economic management of water resources. The research began with hydrological analysis, river cross-sectional capacity, and riverbank at five cross-sections to analyze river basin conditions from the upstream to downstream spatially. Flood inundation boundaries were determined by *Digital Elevation Model* (DEM) analysis and the 1-D hydrodynamic HEC-RAS. This research examined proper eco-hydraulics design so that it could reduce discharge, identify locations prone to flooding, and describe the magnitude of the flood impact quantitatively. The 2019 inundation flood has the same inundation area as the Q_5 with an area of 2,286.02 ha. Rice fields are the land function with the largest area affected by flooding. The research results revealed that inundation height of 0.1 - 0.6 m was required to analyze the height embankment.

Keywords*:* Flood Inundation, Flood Discharge, River Basin Management, HEC- RAS, *Digital Elevation Model* (DEM)

1. INTRODUCTION

Flood is one of the major disasters affecting many countries or regions globally for years and causes loss of property and fatalities (Azmeri et al., 2021; Brinke et al., 2017; Kelman, Gaillard, & Mercer 2015; Whitfield, 2012). Such disaster has been prominent worldwide, and more than 95% of the disaster trends in Indonesia are hydrometeorological (Azmeri et al.,2020).

Based on Presidential Decree No. 12 of 2012 concerning River Basin, Aceh has nine major river areas. One of them is the Alas-Singkil River area, covering an area of 10,090.13 square kilometers. This longest river in Aceh also witnesses to the history of billions of cubic meters of high-quality wood from the Singkil forest since 1969 were assembled and hauled by tugboats through the estuary to the sea and finally shipped to various countries.

The National Disaster Management Agency is addressing the problem of flooding around the Alas-Singkil watershed (DAS) in Aceh Province, where the conservation function of the

upstream to downstream areas needs serious attention. The area around the watershed experiences degradation due to several factors that are closely related to illegal logging, natural exploitation with mineral mining and area conversion. One solution is to restore the conservation function of the area around the watershed.

The Lae Kombih River is a tributary of the Alas-Singkil River, located in the City of Subulussalam, Aceh Province. The upstream of the river is very steep and narrow, while the downstream is long and short, resulting in erosion on the outer bend of the river. This river does not have an embankment, resulting in floods to overflow into the surrounding area frequently. Lae Kombih is categorized as a high flood-prone area. Changes in land use include forests turned into rice fields, plantations and residential areas.

Climate change and global warming are the anthropogenic factors affecting river channel processes, leading to more frequent and severe flooding. Floods are the leading cause of changes in river channels. Anthropogenic factors related to management are the most critical factors determining the condition of river channels, flood plains, and riverbanks. These factors mainly include deforestation, large-scale extraction of rock and gravel out of river channels, and building structures developed in floodplain areas. Changes in the riverbed are caused by the growth of residential areas and the economy due to the activities of the residents (Shevchuk et al., 2021).

The research location was selected as a tributary with a river basin area of 603.27 km^2. The basis for selecting a small river is that the relationship between hydraulic physical factors, morphological and ecological factors can be easily observed (Maryono 2007).

This study provides an alternative river area management that can be the basis for determining river boundaries for flood protection and river embankment construction.

2. LITERATURE REVIEW

One of the essential flood mapping inputs is the geometric description of floodplains and river channels derived from Digital Elevation Models (DEMs). With the increase in satellite-based technology over the past 30 years, several DEM sources, ranging from the delicate and accurate resolution but expensive to low cost and resolution, have been developed. In developing countries, hewever, telecommunication DEM solutions are the only available data sets for hydraulic modeling and flood inundation mapping (Azizian & Brocca., 2019; Stoleriu, Urzica, & Mihu-Pintilie., 2020; Maswood & Hossain., 2015).

To obtain the flood disaster mapping, software HEC-RAS 5.0.1 (Hydrologic Engineering Centers - River Analysis System) was developed by engineers from the United States Army Company in 1993. HEC-RAS is the auxiliary module for ArcGIS 10.2 used. This software has been widely applied in hydro science, such as one-dimensional and two-dimensional water flow simulations, the evolution of floods in space and time, and sediment transport modeling. Generally, this method is used to analyze small flood areas and moderate river inundation areas (Costache et al., 2015; Kaoje, 2016; Merwade et al., 2008; Patel & Gundalia, 2016; Zaharia et al., 2015).

3. METHODS

The research location was selected as a tributary with a river basin area of 603.27 km^2, with a main river length of 86.45 km. The research site was precisely the upstream to the downstream of Lae Kombih River, approximately 9.6 km. The location of the study can be seen in **Figure 1**.

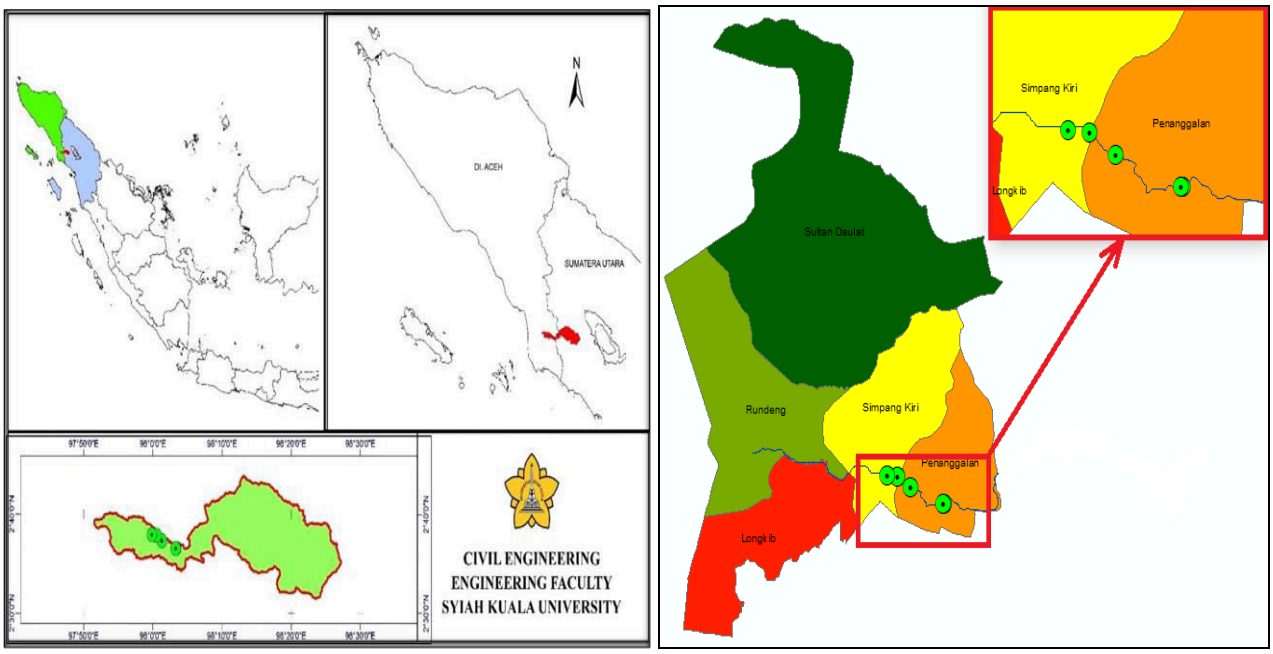

Figure 1 Map of Lae Kombih Watershed, Aceh Province

The data analyzed are climate data, rainfall, wind velocity, humidity, temperature, and duration of sunlight; raster data; location map; soil type map; and land use map. The sub-watershed boundaries and contour maps using were done using raster data with ArcGIS 10.3 software. The annual maximum daily rainfall was taken from available rainfall data is 23 years, namely for 1983, 1985 – 2003, and 2005 – 2007, and there was rain with a maximum height of 330 mm in 2000. The calculation of rainfall return period of are 2; 5; 10; 25; 50; and 100 years. Acordance with the interviews with the community reporting that there had been a major flood in 2000 and then repeated in 2019 which is estimated to be a 20year flood discharge.

Hydrometric measurements and flood inundation height was carried out at five bridges from upstream to downstream: Sikelang I, Sikelang II, Penanggalan, Silak, Longkip bridges. This research is quantitative research, namely research that is used to examine/measure something numerical, such as river water velocity data. The research was carried out from the bridge at each location and riverbank area. Flow chart River Network Modeling Process can be seen in Figure 2.

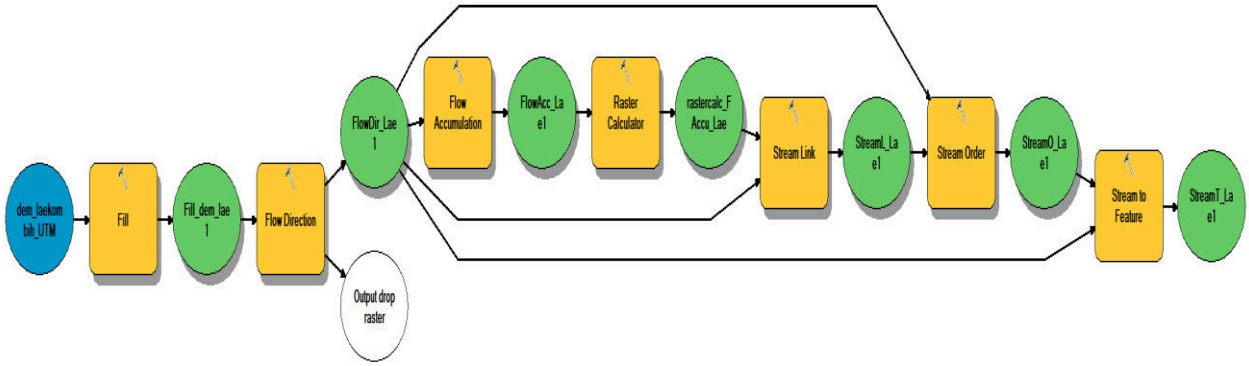

Figure 2 Flow chart River Network Modeling Process

Flow Chart Watershed Process can be seen in Figure 3, Flow Chart of DEM Data Cutting Process and River Network Based on Watershed can be seen in Figure 4. Flow Chart of Contour Map Making Process can be seen in Figure 5. Flow Chart of Mapping Process of Flood Inundation Area can be seen in Figure 6.

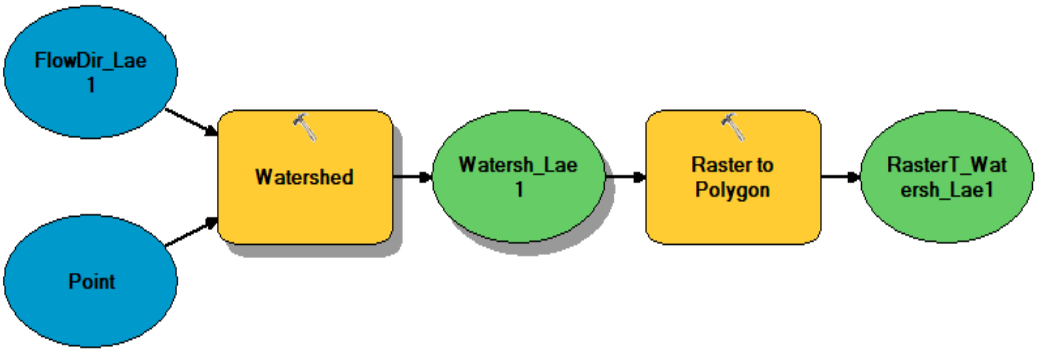

Figure 3 Flow Chart Watershed Process

The first step is to create a point using the “Create Feature Class” tool in the “Feature Class” toolbox located in the main “Data Management Tools” toolbox. Then the point is placed at the end (downstream) of the Lae Kombih River based on the river network that has been obtained in the previous method. Using the “Watershed” tool in the “Hydrology” toolbox. This process aims to create a distribution or mapping of the flow area where the flow flows downstream. Finally, convert from raster data into SHP data (polygons) using the “Raster to Polygon” tool in the “From Raster” toolbox which is located in the main “Conversion Tools” toolbox. The results of this process can be calculated for the area of the Lae Kombih watershed.

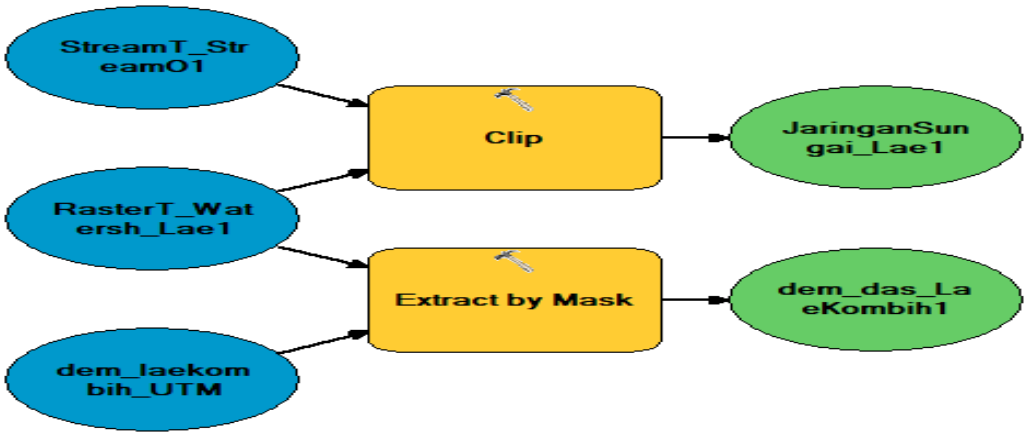

Figure 4 Flow Chart of DEM Data Cutting Process and River Network Based on Watershed

For cutting the river network, use the "Clip" tool in the "Extract" toolbox which is in the main "Analysis Tools" toolbox. The result of this process leaves a network of rivers within the Lae Kombih watershed.

For cutting the river network, use the “Extract by Mask” tool in the “Extraction” toolbox which is in the main “Spatial Analyst Tools” toolbox. The result of this process leaves DEM data limited to the Lae Kombih watershed.

Figure 5 Flow Chart of Contour Map Making Process

The previously obtained DEM data will be processed using the "Contour" tool in the "Raster Surface" toolbox located in the main "3D Analyst Tools" toolbox. This process is to get the elevation lines on the plain.

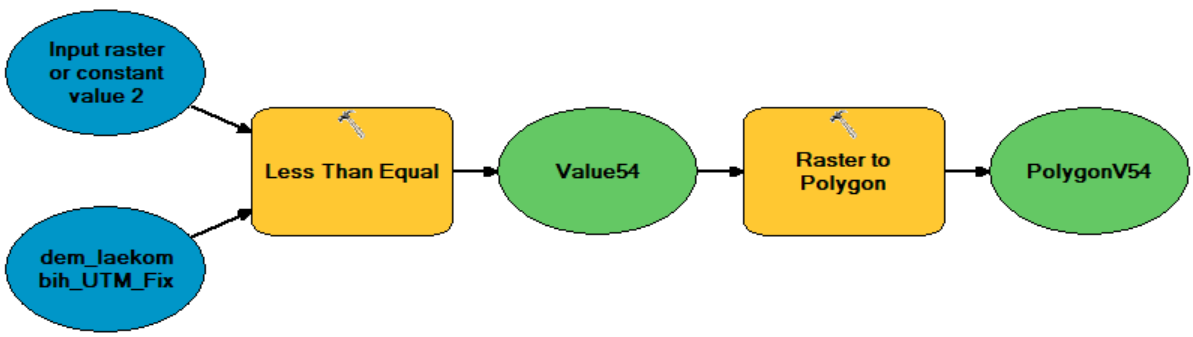

Figure 6 Flow Chart of Mapping Process of Flood Inundation Area

Using the "Less Then Equal" tool in the "logical" toolbox then "Math" which is in the main "Spatial Analyst Tools" toolbox. The value is filled in based on the elevation of the flood water level. The mapping results are converted into SHP data (polygons) using the "Raster to Polygon" tool in the "From Raster" toolbox located in the main "Conversion Tools" toolbox. Open the attribute table then select all the gridcodes with a value of "0" and delete them so that it will leave a polygon for the flood inundation area. From these results, it can be seen how much area is inundated based on its elevation.

4. RESULTS

In calculating the Flood Discharge using the unit hydrograph method, it is necessary to pay attention to the base flow discharge. The Flood Discharge is the sum of surface runoff and base flow for several variations of the Return Period, as presented in Table 2.

Table 2 Calculation Results of Flood Discharge with Various Return Periods

Return Periods (years)	Direct Runoff (m^3/s)	Base Flow (m^3/s)	Flood Discharge (m^3/s)
2	274.034	13.631	287.666
5	430.180	13.631	443.811
10	535.926	13.631	549.558
25	670.785	13.631	684.417
50	745.457	13.631	759.088
100	820.197	13.631	833.829

Analysis used the Land Use Map of the Alas-Singkil River Basin as a guideline for creating the Land Use Map in the Lae Kombih Watershed. Land Use Map for Alas-Singkil River Basin was digitized and the digitization results can be seen in Figure 7.

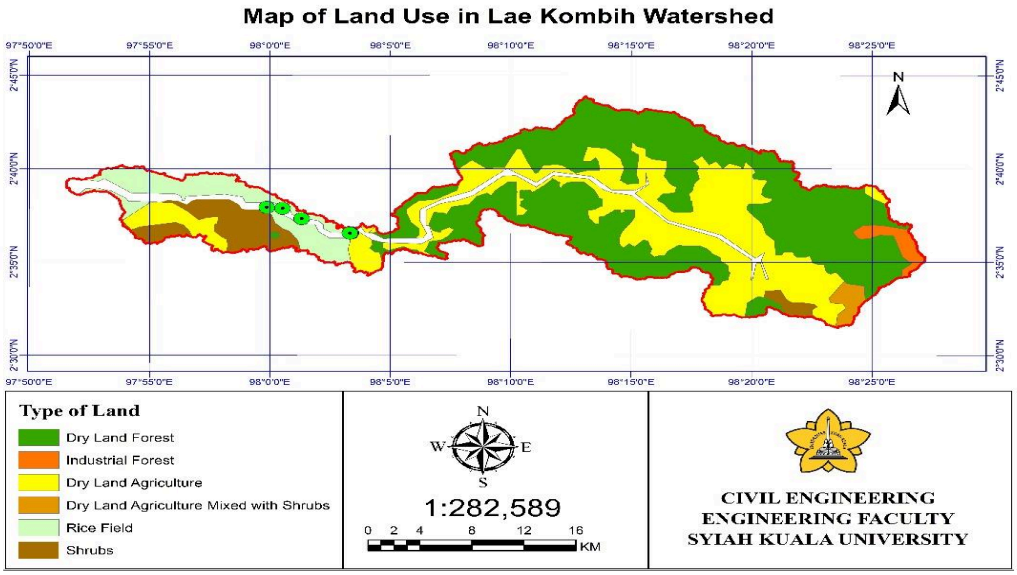

Figure 7. Land Use Map of the Lae Kombih Watershed

Table 3 presents the area of land use in the Lae Kombih watershed obtained from the map results.

Table 3 Area of Land in the Lae Kombih Watershed

Type of Land	**Area (ha)**	**Percentage (%)**
Dry Land Forest	28,319.99	49.55
Industrial Plantation Forest	893.68	1.56
Dry Land Agriculture	18,930.93	33.12
Mixed Dry Land Agriculture with Shrub	731.18	1.28
Rice fields	4,626.61	8.10
Shrubs	3,650.92	6.39
TOTAL	57,153.31	100

From the field survey results, it was found that the first two locations (Sikelang and Penanggalan) did not experience flooding at the end of 2019. It is assumed that the river water starts to overflow after crossing the Penanggalan's Bridge, approximately 300 m before the Silak's bridge with a flood height of 2 m. The floodwater level elevation at that point is 29 m. The Lae Kombih DEM data was then analyzed, using flood water level elevation data as a value for mapping the distribution of flood inundation. The flood inundation area was 2,286.02 ha and the flood inundation map can be seen in Figure 8.

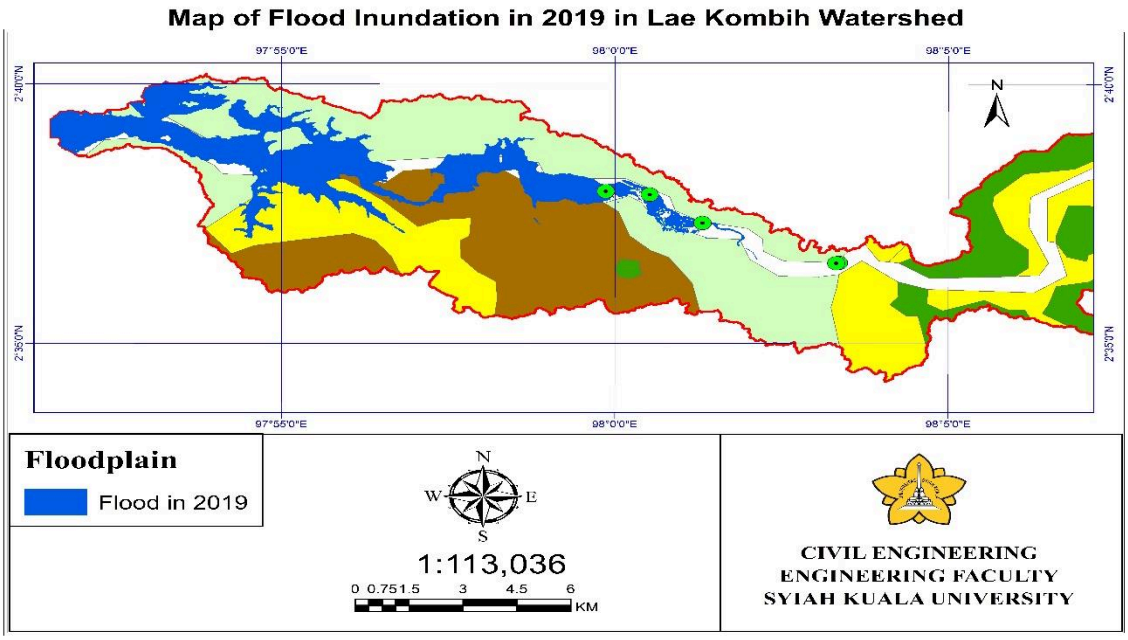

Figure 8 Map of Flood Inundation in 2019 in Lae Kombih Watershed

The Lae Kombih Watershed Land Use Map was cut using the flood inundation. This process resulted in a large area of Land affected by flood inundation. The impact of flood inundation on Land is shown in Table 4.

Table 4 Area of Land Affected by Floods in 2019

Type of Land	Area of Affected (ha)	Percentage (%)
Dry Land Forest	0	0
Industrial Plantation Forest	0	0
Dry Land Agriculture	206.76	0.362
Mixed Dry Land Agriculture with Shrub	0	0
Rice fields	726.96	1.272
Shrubs	219.42	0.384
TOTAL	1,153.14	2.018

Table 4 shows that the total area affected was 1,153.14 ha or 2.13% of the total Land in the Lae Kombih River Basin, covering 57,153.31 ha. Figure 12 displays the comparison of the total land area and the area affected.

In this study, the HEC-RAS version 5.0.7 software was used. The data required for this analysis were the cross-section of the river, the distance between the sections, the Manning's roughness figure, the return period flood discharge, and the longitudinal slope of the river (slope).

The flood water level profile analysis used the standard stage method, i.e., creating a flow direction line, inputting "Cross-section" with cross-sectional data and Manning's roughness values, and inputting "Steady flow data" with flood discharge values and slope. The analysis results revealed the location where the overflow started, as shown in Table 5.

Table 5 Locations of Start of Overflow

Return Period (Year)	Locations of Start of Overflow	Flood Water Level (m)	Inundation Height (m)
2	*Cross* 4 – Silak's Bridge	28.64	3.25
5	*Cross* 3 – Penanggalan's Bridge	29.52	3.61
10	*Cross* 3 – Penanggalan's Bridge	29.94	4.03
25	*Cross* 1 – Sikelang I's Bridge	47.47	0.22
50	*Cross* 1 – Sikelang I's Bridge	47.65	0.40

After entering all the data, the analysis was run on the "Perform a steady flow simulation" menu. An example of one of the river cross-sectional profiles resulting from the analysis is presented in Figure 9.

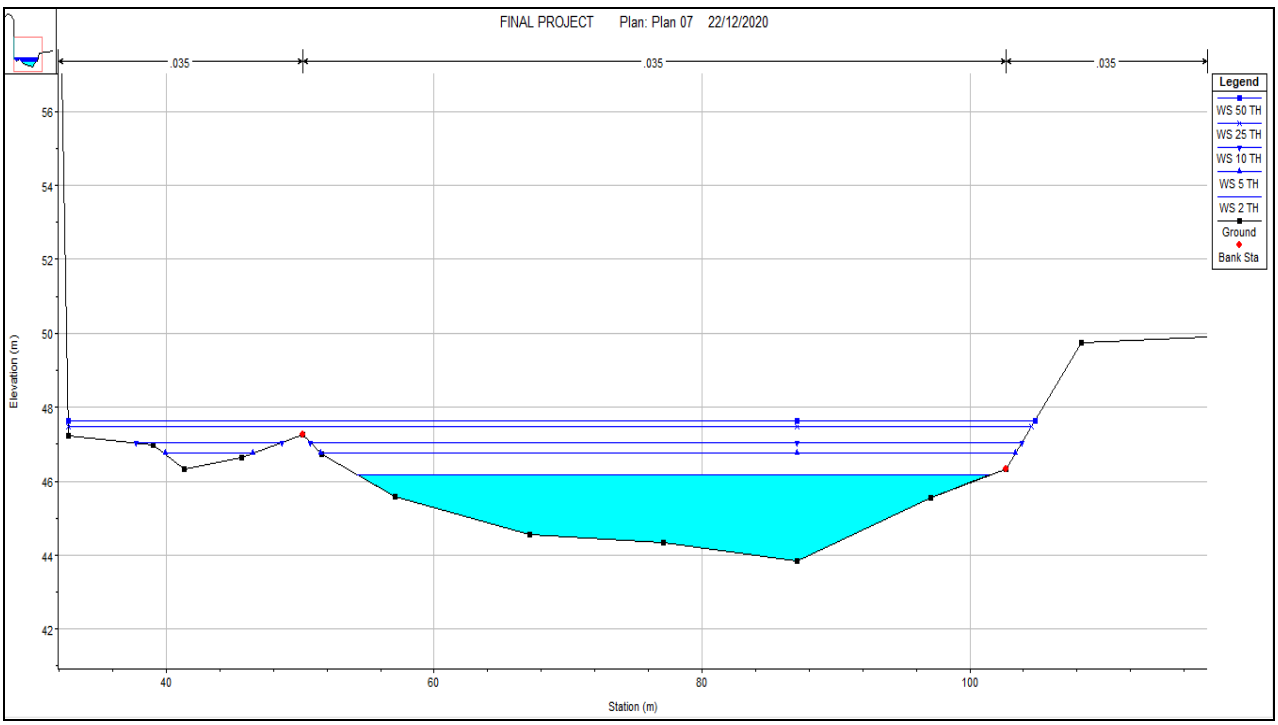

Figure 9 Flood water level profile at Sikelang I's Bridge

The flood water level elevation values in Table 2 were used as values in flood mapping and the results are attached in Figure 10. These results revealed the extent of return period flood inundation, as summarized in Table 6.

Table 6 The extent of Return Period Flood Inundation

Return Period (Year)	Inundation Area (ha)
2	2,085.18
5	2,286.02
10	2,472.42
25	5,012.07
50	5,136.27

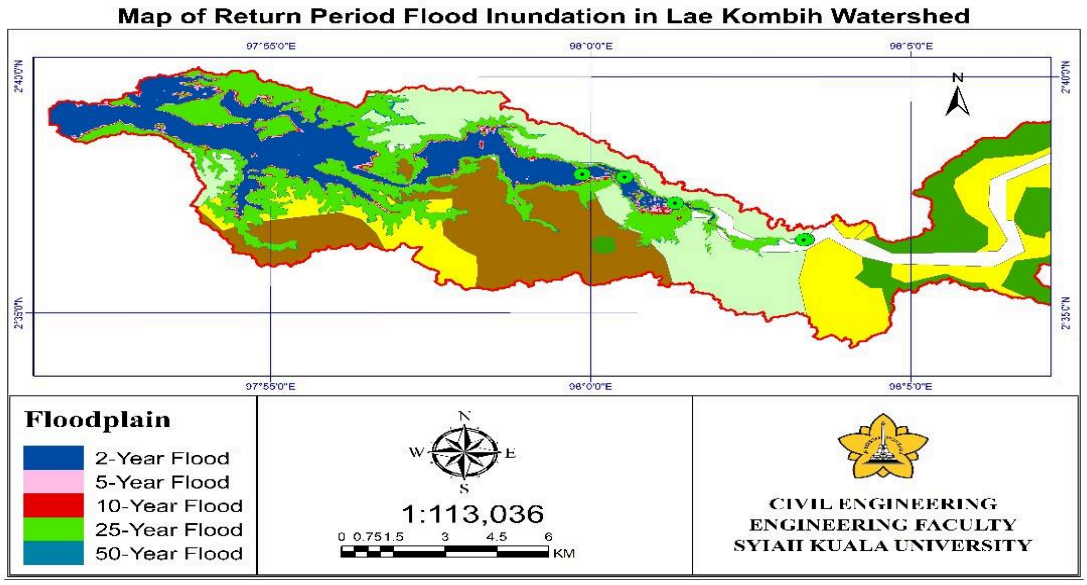

Figure 10. Map of Return Period Flood Inundation in Lae kombih Watershed

Table 6 and Figure 10 indicate that floods with a return period of two years and five years inundation conditions are similar as well as the discharge period of 25 years and 50 years. This finding is due to the steep condition of the area and watersheds affecting the inundation. The impact of flood inundation on land can be seen in Table 7. Table 7 show that paddy fields have the greatest influence on inundation, followed by shrubs and dryland agriculture.

Table 7 Area of Land Affected by Return Period Flood Inundation

Type of Land	Area of Affected (ha)				
	Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}
Dry Land Forest	0	0	0	0	0
Industrial Plantation Forest	0	0	0	0	0
Dry Land Agriculture	184.82	206.76	237.50	821.06	853.35
Mixed Dry Land Agriculture with Shrub	0	0	0	0	0
Rice fields	628.10	726.96	816.68	2101.99	2,151.75
Shrubs	199.89	219.42	237.85	675.87	710.98
TOTAL	1,012.81	1,153.14	1,292.03	3,598.92	3,716.08

5. CONCLUSIONS

The most significant land function in the Lae Kombih watershed is dryland forest with 28,319.99 ha, while the minor land function is dryland agriculture mixed with shrubs and industrial plantations with 731.18 ha and 893.68 ha. Flood discharge for 50 years (Q50) and 25 years (Q25) return period causes a very wide inundation impact compared to Q2, Q5 and Q10. The 2019 inundation flood had the same inundation area as the Q5 inundation flood, with an area of 2,286.02 ha. Rice fields are the most significant area affected by flooding in all return period flood discharges. The land functions that are not affected by the inundation flood are dry land forest, industrial plantation forest and dry land agriculture mixed with shrubs.

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ANALYSIS OF OBSTACLE AND SUPPORTING FACTORS FOR THE SUCCESSFUL IMPLEMENTATION OF CONSTRUCTION SAFETY MANAGEMENT SYSTEM (CSMS) IN CONSTRUCTION PROJECTS

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ABSTRACT

The construction industry has a high level of accident risk because construction work has many potential hazards, moving work locations, weather effects, limited execution time and involves many workers, so that enforcement of safety aspects tends to be weak. Construction safety is a serious problem because it affects the success of construction projects. The government has issued the Minister of PUPR Regulation No. 10/2021, concerning the Construction Safety Management System (CSMS). The implementation of CSMS has not been maximized, because there are still many work accidents in Indonesia in year 2018-2020, so it is necessary to conduct research to analyze the factors that hinder and support the successful implementation of CSMS in construction projects.The research uses descriptive quantitative methods, where problem solving is by describing the object of research in its current condition based on facts, then analyzed and interpreted. Collecting data using a questionnaire consisting of 2 (two) stages, namely: 1) Preliminary Questionnaire and 2) Main Questionnaire, to obtain data from respondents related to research. The target respondents are people who are experienced in road and bridge projects in state-owned construction companies that have implemented CSMS. The research analysis used the mean analysis method to obtain the main factors that support and obstacle the implementation of CSMS. This study found 17 factors that obstacle the success of implementing CSMS in construction projects, obtained 5 main factors that are very influential as a factor inhibiting the implementation of CSMS as follows : The condition of workers is less concerned about HSE, Placing HSE as a low priority, HSE culture is not strong yet, No HSE Officers yet, HSE is only the responsibility of HSE personnel. Also found that from the 33 factors supporting the successful implementation of CSMS, obtained 5 main factors that support the implementation of CSMS as follows : Availability of CSMS Documents, HSE Resources, There is an analysis of hazard conditions and their control, Commitment and responsible to HSE, Availability of HSE Targets and measure.

Keywords: CSMS, Mean Analysis Method, Construction SOEs

1. INTRODUCTION

The aspect of construction safety is still a problem that always arises in the construction sector. In Indonesia, until the end of 2020, construction accidents still frequently occurred in the 2017-2020 period, there were 32 fatal accidents at construction sites. The number of accidents proves that the implementation of the Occupational Health and Safety Management System (SMK3) in the construction sector is still weak. At the end of 2019, the Government through the Ministry of Public Works and Public Housing (PUPR) has issued regulations governing construction safety, namely Ministerial Regulation (Permen) PUPR Number 21/PRT/M/2019 concerning Guidelines for Construction Safety Management Systems (CSMS), which then replaced with PUPR Ministerial Regulation Number 10 of 2021 concerning CSMS Guidelines.

According to PUPR Ministerial Regulation number 10 of 2021 in Article 1, CSMS is part of the management system for the implementation of construction work to ensure the realization of construction safety. The implementation of CSMS must meet security, safety, health and sustainability standards, or hereinafter referred to as K4 Standards. In the implementation of construction activities, this standard includes guarantees for:

1) construction engineering safety, to save construction assets or equipment and materials used,
2) occupational safety and health, to protect construction workers, guests, suppliers and people involved in construction activities,
3) environmental safety, both in the work environment and the surrounding environment affected by the construction project, and
4) public safety, namely saving the community around the project from accidents or disturbances caused by construction activities.

Compliance with the K4 Standard is expected to prevent work accidents and prevent disease, environmental pollution and accidents or disturbances to the surrounding community during construction activities.

With the issuance of CSMS, all construction companies are required to implement CSMS in the implementation of their construction projects, including SOEs Construction companies. The implementation of this CSMS starts from the tender process where it is required to have a Construction Safety Plan Document, the fulfillment of the Construction Safety Unit organization which is filled by personnel with construction safety expert qualifications, and details of the construction safety implementation costs that must be prepared by all bidders. Not only at the project level, construction SOEs also have a special organization for QHSE (Quality, Health, Safety and Environment) at the Head Office which is directly responsible to the Board of Directors. However, there are still problems faced by construction SOEs in implementing CSMS. This can be seen from the occurrence of construction accidents and inconsistencies in the implementation of CSMS, especially on projects carried out in remote areas, and complaints or lawsuits from community members due to the negative impacts of project implementation (house/property damage, pollution, dust and noise). In order for the implementation of CSMS to be effective, the problems that hinder its implementation and what things can increase the success of implementation must be identified and analyzed so that management strategies can be formulated.

The emergence of the Covid-19 pandemic in early 2020 had an impact on the implementation of construction projects. The government has determined that construction project activities include activities that can continue to run with strict K3 protocols. The project must reserve the cost of implementing this protocol and monitor its implementation. The pandemic also has an impact on the widespread use of information technology in the construction sector. There has been a significant acceleration of the digitization process in construction companies. Information technology is not only used to facilitate project administration and reporting activities, but also as a tool to perform inspection and monitoring of work in real time, mapping, modeling that is integrated with decision making in Management. This provides an opportunity to reduce the number of work accidents as well as design errors and failures during construction. Thus, the successful implementation of CSMS is very relevant to the above developments. The implementation of construction supported by the

implementation of good CSMS improves quality, has a positive impact on the community and reduces potential losses due to accidents, declines in health and risks of construction implementation.

The aims of this research are 1). Analyzing factors that are inhibiting factors and supporting factors for the implementation of CSMS; 2). Obtain the main inhibitory and supporting factors that greatly affect the implementation of CSMS using Mean analysis method.

2. LITERATURE REVIEW

This study examines the literature and previous research journals that analyze the factors that cause work accidents in construction projects. The causes of work accidents, from the workers' point of view, are influenced by, among others, unsafe behavior, awareness of hazards, worker competencies, etc., and also from the management side, including management commitment and competence, culture of Health, Safety and Environment (HSE), organization, etc. From this study, it can be concluded that there are many variables that can be separated into inhibiting factors and success factors for implementing CSMS.

From literature studies and from research journals, it is possible to synthesize research variables, which can be seen in the following table:

Table 1. Synthesis of Obstacle Factors in the Implementation of CSMS

No.	Obstacle Factors that affect the successful implementation of CSMS in construction projects	Buniya (2020)	Xia (2018)	Damayanti (2018)	Durdyev (2017)	Nicole (2017)	Sutawijaya (2017)	Manu (2014)
X1	Lack of HSE standards	√		√			√	√
X2	Lack of HSE resources	√			√			
X3	Tight project schedule	√			√	√		√
X4	Inadequate commitment to HSE	√		√				
X5	Placing HSE as a low priority	√		√				√
X6	Lack of HSE training	√		√				
X7	No HSE regulations and policies	√					√	√
X8	HSE is only the responsibility of HSE personnel	√						
X9	Lack of HSE inspection	√	√	√				
X10	Top Management is not aware	√	√		√		√	√
X11	No HSE officers yet	√						
X12	Low competency of workers	√		√				
X13	HSE culture is not strong yet			√		√		√
X14	Project management is less active in HSE		√		√	√		√
X15	Project unsafe conditions		√					√
X16	The condition of workers is less concerned about HSE		√	√	√			√
X17	Sub-Contractor Barriers		√	√		√		

Table 2. Synthesis of Supporting Factors in the Implementation of CSMS

No.	Obstacle Factors that affect the successful implementation of CSMS in construction projects	Hinze (2013)	Bavafa (2018)	Mohammadi (2016)	Sutawijaya (2017)	Fernando (2016)	Kamar (2014)	Hua Li (2009)	Lin Teo (2005)	Lin (2001)	Sawacha (1999)
X1	Availability of construction safety manual	√		√				√			
X2	Construction safety program availability	√	√	√		√	√	√	√		
X3	Availability of CSMS Documents	√		√				√			
X4	Availability of HSE Targets and measure	√									
X5	Implementation of CSMS training as needed	√	√		√	√	√	√	√		
X6	HSE Award/Reward	√				√			√		
X7	HSE program implementation scheduling	√									
X8	HSE Routine Meeting and Follow-up	√							√		
X9	Monitoring the implementation of HSE program in subcontractors	√	√					√			
X10	Availability of HSE procedures at subcontractors	√				√					
X11	HSE training for foreman and workers	√				√					
X12	HSE Implementation Review	√									
X13	HSE inspection implementation	√	√					√	√		
X14	There is a post-work project site locking policy	√				√					
X15	There is a project helmet use policy	√									
X16	There is a job termination policy	√									
X17	There is a project emergency response plan	√	√					√			
X18	There is an analysis and mitigation of occupational hazards	√									
X19	There is an analysis of hazard conditions and their control	√		√					√		
X20	Accident investigation procedure	√	√	√		√					
X21	Near miss investigation	√	√			√			√		
X22	Control of hazardous substances and drugs							√	√		
X23	Management Commitment					√	√			√	√
X24	Worker involvement in HSE		√	√	√		√				
X25	There is an ongoing evaluation		√						√		
X26	HSE culture is well implemented			√	√			√			
X27	HSE Resources			√		√	√				
X28	Commitment and responsible to HSE		√	√	√		√				√
X29	There is a good HSE Organization			√			√			√	
X30	Availability of investment budget and sufficient cost for HSE			√							√

3. METHODS

Following the acquisition of the inhibiting and supporting factors for the successful implementation of CSMS as given in tables 1 and 2, the following stage is carried out:

1. First stage of Questionnaire or Preliminary Questionnaire. Respondents to this questionnaire are experts with a total of 5 respondents. These experts have more than 10 years of experience in implementing, monitoring and auditing the causes of work accidents. Validation of answers to this questionnaire used the Delphi method.
2. Second stage questionnaire or main questionnaire. The target respondents at this stage are those who handle the implementation of infrastructure projects, especially road and bridge projects in state-owned construction companies. The number of respondents is approximately 150 people with work experience above 5 years.

After getting the answers of respondents in the questionnaire stage 2 using the Likert scale, where this scale has intervals from scale 1 (minimum) to scale 5 (maximum), such as the following table:

Tabel 3. Assessment Criteria (Likert Scale) Obstacle/Supporting Factors

Scale	Criteria	Description
5	Very High	Greatly obstacle the successful implementation of CSMS / Strongly supports the successful implementation of CSMS
4	High	Hinder the successful implementation of CSMS / Support the successful implementation of CSMS
3	Medium	Enough to hinder the success of CSMS implementation / Enough to support the success of CSMS implementation
2	Low	Does not hinder the success of CSMS implementation / Does not support the successful implementation of CSMS
1	Very Low	Very not hampering the success of CSMS implementation / Very unsendorsed the successful implementation of CSMS

3. The respondent's quantitative answer was analyzed by the Mean Analysis Method as follows:

$$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$$

$\bar{x}$: Average value (Mean)

x_i : Respondents answers with Likert Scale of 1 to 5

n : Number of respondents

4. RESULTS

1. In the first stage of the questionnaire, the experts agreed with 17 inhibiting factors in table 1, while for the supporting factors, the experts agreed to add 3 more factors so that it became 33 factors.
2. In the Phase 2 questionnaire, the number of respondents was 147 people spread across 7 state-owned construction companies and 1 subsidiary of state-owned construction companies. The respondents involved had work experience of more than 20 years (82.31%), had been involved in road and bridge works (88.03%), worked in state-owned construction companies (95.24%) and the respondent's position in manager level and above is 82.99% and the majority have undergraduate education of 81.63%, it can be concluded that respondents

understand and are competent in filling out the research questionnaire given. Data is analyzed using mean analysis to find factors that greatly affect obstacle factors and supporting in implementation CSMS.

3. After being analyzed with the Mean method, then the ranking of the mean values for these factors is carried out to get the factors that are very inhibiting and which strongly support the success of the implementation of the CSMS as shown in table 4 and table 5.

The results of filling respondents in stage 2 questionnaires on obstacle factor data were analyzed using Mean Analysis Method, resulting in a mean rating that can be seen in the table as follows:

Tabel 4. Value Mean Questionnaire of Obstacle Factor

Code	Obstacle Factors	Mean	Rating
X16	The condition of workers is less concerned about HSE	4,20	1
X5	Placing HSE as a low priority	4,13	2
X13	HSE culture is not strong yet	3,89	3
X11	No HSE Officers yet	3,86	4
X8	HSE is only the responsibility of HSE personnel	3,84	5
X14	Project management is less active in HSE	3,84	6
X2	Lack of HSE resources	3,82	7
X15	Project unsafe conditions	3,80	8
X10	Top Management is not aware	3,78	9
X6	Lack of HSE Training	3,76	10
X9	Lack of HSE Inspection	3,73	11
X7	No HSE regulations and policy	3,70	12
X12	Low competency of workers	3,64	13
X17	Sub-Contractors Barriers	3,63	14
X1	Lack of HSE Standard	3,59	15
X3	Tight Project Schedule	3,48	16
X4	Inadequate commitment to HSE	3,39	17

From those tables, obtained 5 main factors obstacle the implementation of CSMS as follows:

1. The condition of workers is less concerned about HSE
2. Placing HSE as a low priority
3. HSE culture is not strong yet
4. No HSE Officers yet
5. HSE is only the responsibility of HSE personnel

In the preliminary questionnaire there are experts adding 3 influential factors as supporting factors so that the number of supporting factors changes to 33 factors. The results of filling respondents in the stage 2 questionnaire on supporting factor data, analyzed using Mean Analysis Method, resulted in a mean rating that can be seen in the table as follows:

Tabel 5. Value Mean Questionnaire of Supporting Factor

Code	Supporting Factors	Mean	Rating
X3	Availability of CSMS Documents	4,19	1
X27	HSE Resources	4,14	2
X19	There is an analysis of hazard conditions and their control	4,14	3
X28	Commitment and responsible to HSE	4,12	4
X4	Availability of HSE Targets and measure	4,07	5
X26	HSE culture is well implemented	4,05	6
X30	Availability of investment budget and sufficient cost for HSE	4,05	7
X23	Management Commitment	4,03	8
X18	There is an analysis and mitigation of occupational hazards	4,01	9
X24	Worker involvement in HSE	4,01	10
X20	Accident investigation procedure	4,01	11
X16	There is a job termination policy	4,00	12
X8	HSE Routine Meeting and Follow-up	3,97	13
X29	There is a good HSE Organization	3,97	14
X13	HSE inspection implementation	3,97	15
X12	HSE Implementation Review	3,95	16
X25	There is an ongoing evaluation	3,94	17
X2	Construction safety program availability	3,92	18
X7	HSE program implementation scheduling	3,92	19
X11	HSE training for foreman and workers	3,90	20
X15	There is a project helmet use policy	3,90	21
X17	There is a project emergency response plan	3,90	22
X31	External partnership with related stakeholders	3,88	23
X5	Implementation of CSMS training as needed	3,87	24
X10	Availability of HSE procedures at subcontractors	3,81	25
X33	HSE training center, mock up, safety & quality induction room	3,81	26
X32	Digitalization of HSE control (Permit, Reports, etc)	3,78	27
X21	Near miss investigation	3,77	28
X22	Control of hazardous substances and drugs	3,71	29
X9	Monitoring the implementation of HSE program in subcontractors	3,71	30
X1	Availability of construction safety manual	3,69	31
X6	HSE Award/Reward	3,59	32
X14	There is a post-work project site locking policy	3,51	33

From those tables, obtained 5 main factors supporting the implementation of CSMS as follows:

1. Availability of CSMS Documents
2. HSE Resources
3. There is an analysis of hazard conditions and their control
4. Commitment and responsible to HSE
5. Availability of HSE Targets and measure

5. CONCLUSIONS AND SUGGESSIONS

a) Conclusion

1. This study use Mean Analysis Method, resulting in the findings, that from the initial identification of 17 factors inhibiting the successful implementation of CSMS in construction projects, obtained 5 main factors that are very influential as a factor inhibiting the implementation of CSMS as follows: The condition of workers is less concerned about HSE, Placing HSE as a low priority, HSE culture is not strong yet, No HSE Officers yet, HSE is only the responsibility of HSE personnel.
2. The study also resulted in the finding that from the identification 33 factors supporting the successful implementation of CSMS in construction projects, obtained 5 main factors that support the implementation of CSMS as follows: Availability of CSMS Documents, HSE Resources, there is an analysis of hazard conditions and their control, Commitment and responsible to HSE, Availability of HSE Targets and measure.

b) Suggessions

1. For businesses in the construction service sector, it is necessary to pay attention to the obstacle and supporting factors to further increase the probability of successful implementation of CSMS in construction projects.
2. Businesses and stakeholders related to construction safety can also use the results of this analysis to formulate appropriate strategies so that CSMS related to occupational safety and health aspects can be implemented on construction projects widely in accordance with the mandate of Government Regulation no. 22 of 2020 article 84 and the Minister of PUPR Regulation Number 10 of 2021.
3. In this study, it is still limited to using Mean Analysis method to obtain the mean factors that obstacle and support the implementation of CSMS on Road and Bridge Projects carried out by Construction's State-Owned Companies. It is hoped that in further research other methods can be used and developed in projects other than the Road and Bridge Project such as high-rise buildings and other infrastructure carried out by construction companies in Construction's State-Owned Companies and Private Companies.

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BUSINESS MODEL INNOVATION FORMULATION OF AYAM GEPREK XYZ RESTAURANT

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ABSTRACT

Culinary industry in Indonesia is nowadays growing rapidly. Ayam geprek is one kind of food which is very popular on the market. Ayam Geprek XYZ was established as one of the pioneer restaurants with distinctive taste at affordable price. However, the company is now facing the global economic slowdown due to the ongoing covid-19 pandemic that caused a drastic decline in turnover for almost all business sectors. This research intends to formulate a business model innovation by applying a mix-method-research with a qualitative approach through the Business Model Canvas and quantitatively through the Internal-External Matrix as an effort to integrate a business model that enables successful operations of sustainable restaurant. This study's methodology is using descriptive analysis with in-depth interview techniques and observation of the business activities. The strategic position of the restaurant is at coordinates (X; Y) 2.73; 3.22 in the cell II area, namely Growth and Build. Therefore, the most appropriate business strategy is intensive strategy which consists of product and market development as well as market penetration. Thus, at least there is a path where the company can achieve profitability but supported by the achievement of a healthy economic unit. Restaurant must multiply the source of revenue streams and be able to balance the focus between growth and the proper strategy.

Keywords: business model, business model innovation, Business Model Canvas.

1. INTRODUCTION

The culinary industry, as we know, is the sub-sector of the creative economy industry that contributes the largest gross domestic product (GDP) in Indonesia. The main function now is not only as a fulfilment of the food needs but also as a new lifestyle for the society, resulting in its rapid growth and causing intense competition between entrepreneurs. One of poultry products is processed chicken: besides being the most favorite menu (cheap, affordable, and nutritious), the cuisine types are also varied (there are ayam penyet, kremes, geprek, and others), where particularly ayam geprek is nowadays very popular and greatly in demand. Another reason is because the taste is good, easy to make, and the creations of the dishes getting more varied.

Throughout 2017 to 2019, the data from Grabfood for Southeast Asia states that ayam geprek is the main choice of many food menus in Indonesia. In addition, the data shows that the consumption of ayam geprek in Bandung City has increased until 113.59%. Another data from Gofood itself also states that ayam geprek is the most frequently ordered menu in Indonesia.

The growth of the culinary industry, which recently becomes creatively and innovatively competitive, could attract people with the offered products, specifically the ones with good quality and uniqueness. Hence, restaurants are currently considered as the most profitable business. This has led to the phenomenon of the appearance and proliferation of new restaurants with similar products or even their imitation efforts to compete being the best restaurant. Out of this point, some questions should be asked: how to maintain a successful sustainable restaurant operation? The fact that Ayam Geprek XYZ has implemented a strategy of pioneer restaurant with a distinctive taste at an affordable price, is it enough just with this strategy of excellence?

Chesbrough (2006) said that the business strategy carried out by the company will not run optimally if it's not based on the study and formulation of the right business model. According to Levy (2001), act on the wrong business model results in a huge financial losses or opportunities missing, thereby this might increase the potential for going out of business. This shows that the evaluation of a business models is an important thing in the business world, inclusively the culinary field. Without the right business model, the company will be not able to survive long-lastly. A business model describes how an organization creates, delivers and captures the business value. The concept of a business model must be simple, relevant, and intuitively easy to understand without the intention of simplifying the very complex company functions (Osterwalder and Pigneur, 2010).

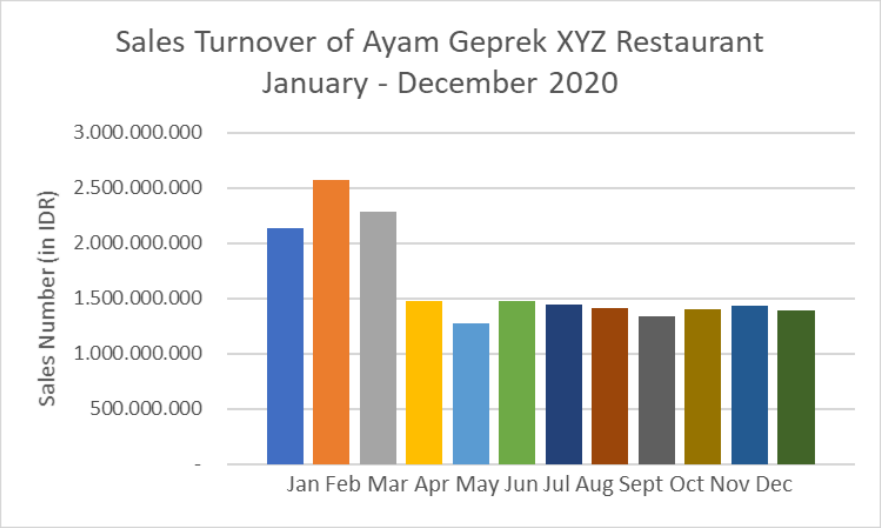


Figure 1. Sales Turnover of Ayam Geprek XYZ Restaurant All Month in 2020

However, the company is currently facing a rapidly changing business environment condition. The global economic slowdown due to the ongoing covid-19 pandemic, which entered this country in March 2020, has caused a drastic decline in turnover for almost all business sectors in Indonesia. Figure 1 shows the restaurant sales turnover throughout 2020. The sales in the first quartal of 2020 reached the peaks which are in the range of more than 2 billion Rupiah. However, the sales turnover fell to the range of around 1.5 billion Rupiah for the rest of the year. On the other hand, the competition of restaurants on the same business line, whether newbie or existing ones, also has a significant impact on the decreasing market share of Ayam Geprek XYZ Restaurant.

This research intends to formulate a business model innovation for Ayam Geprek XYZ Restaurant, by applying a mix-method research: qualitatively through the Business Model Canvas; and quantitatively through the Internal-External (IE) Matrix as an effort to integrate a business

model that enables the successful operations of sustainable restaurant. The newness of the research lies on the recommendation of new BMC-based business models and self-service technology, which act as company innovations during the pandemic. This study's methodology is using descriptive analysis with in-depth interview techniques and observation of the business activities.

2. LITERATURE REVIEW

2.1 FRAMEWORK STRATEGY

Hambrick and Fredrickson (2005) stated that strategy has several elements that form a coherent whole. Strategy is an important, integrated, and externally oriented concept of how a business achieves its goals. The figure below describes a strategic framework where the company's mission and goals are the foundation and guideline in strategy formulation. Besides strategy formulation, a strategic analysis can also be considered in the form of industrial analysis, consumer and market trends, forecasting of environmental conditions, competitor analysis, as well as strength; weakness; and internal resources analysis.

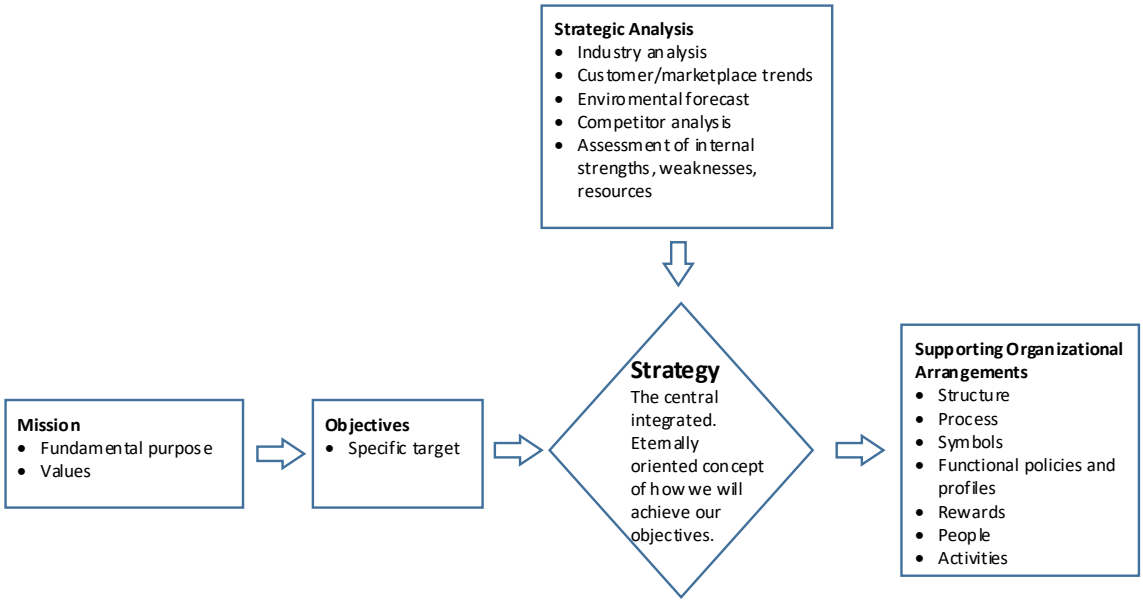


Figure 2. Putting Strategy in its Place

2.2 BUSINESS MODEL INNOVATION

According to Oliver Gassmann (2014), business model innovation is the integration of various dimensions of variables of excellence that exist within a company. Business model innovation refers to the activity of designing (creating, implementing, and validating) new business models.

2.3 BUSINESS MODEL CANVAS

Osterwalder and Pigneur (2010) stated that the Business Model Canvas is a simple business model that displayed on a canvas containing a map of nine elements. They are customer segment, value proposition, channel, customer relationship, revenue stream, key resources, key activities, key partnership, and cost structure.

2.4 VALUE PROPOSITION CANVAS

According to Osterwalder et al (2014), the Value Proposition Canvas is a part of the Business Model Canvas, which is detailed into a separate canvas. This is a reason that could convince the target consumers why they should buy a product. Moreover, it is a tool that eases finding the value proposition of the company's business model with adjustments to the customer needs and wants.

2.5 THE INTERNAL-EXTERNAL MATRIX

David and David (2017) stated that the Internal-External Matrix consists of 9 cells and divided into 2 dimensions. The total weighted score of Internal Factor Evaluation lies on the horizontal axis, while the total weighted score of External Factor Evaluation lies on the vertical axis. In addition, these matrices are also divided into three distinct areas which are shown in the following figure.

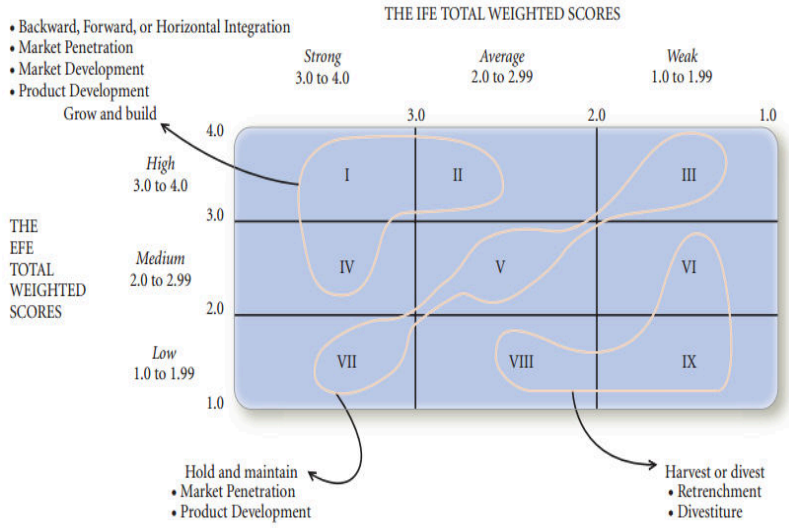


Figure 3. The Internal-External (IE) Matrix

3. METHODOLOGY

This research implements descriptive analysis, case study, and mix method of qualitative and quantitative as the main methodology. The informants and respondents are the highest authority holders of the company, or the Board of Directors in the departments of supply chain and finance, operations and continuous integration (CI), and business development. The data collection was conducted primarily using field observations, in-depth interviews, and questionnaires. Secondary data were also collected by literature studies from internal documents, textbooks, websites, etc.

Comprehensive strategic management model diagram states that the company's comprehensive strategy consists of formulation, implementation, and evaluation. However, this research focuses only on formulation. The strategy formulation framework analysis itself offers several applied methods, but this research uses Internal and External Factor Evaluation and Competitive Profile Matrix. Other strategic approaches for the input stage and the Internal-External Matrix for the matching stage were implemented as well. Several approaches at the input stage start from analyzing the initial data into the Business Model Canvas and Value Proposition Canvas. After this stage, the researcher recreates a new business model based on BMC and Self-Service Technology as company innovation during the pandemic.

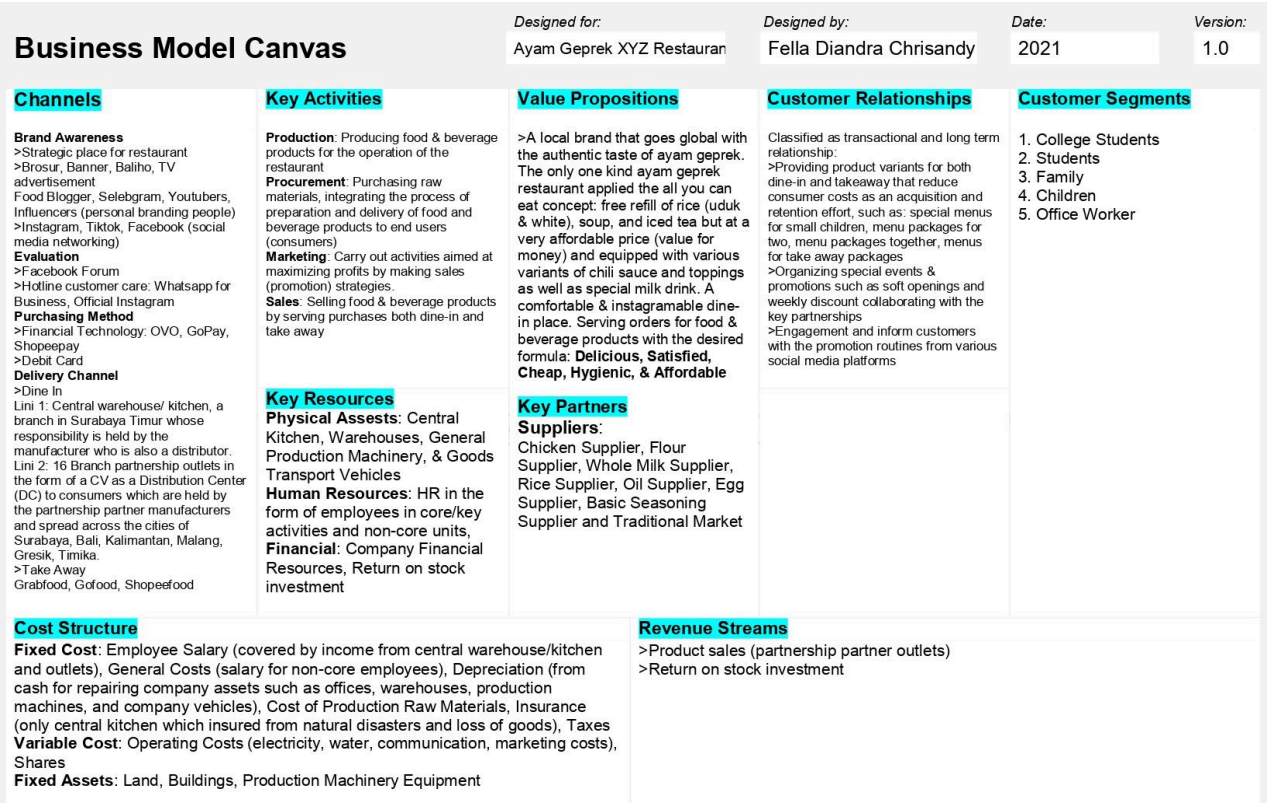
Then the researcher conducted an external evaluation in the form of Industrial Analysis and Environmental Forecasting Analysis using the Porter's 5 Forces and the PESTEL Method as well as Market and Consumer Trend Analysis and Competitor Analysis. In addition, an analysis of the company's internal activities in the form of strengths, weaknesses, and resources also Value Chain Analysis were implemented. External key factors are categorized into opportunities and threats, while internal factors are categorized into strengths and weaknesses. These factors will be evaluated for weighting on the Internal-External Matrix as a matching stage. Finalization lies on providing recommendations on the results of business model innovations formulation based on the generated current strategic position while also by discussing what goals and hopes are could company achieved for the development ahead, as a representation of the decision stage.

4. RESULTS AND DISCUSSION

4.1 INPUT STAGE

A. EXISTING BUSINESS MODEL

In the first stage BMC formulation, the restaurant already has a basic for it has fulfilled every element: customer segments (they're students, families, children, and office workers), value propositions, channels (focusing on brand awareness, evaluation, purchasing methods, and delivery channel), customer relationships (transactional and long-term), revenue streams (in the form of product sales and investment), key resources (there are physical assets, human resources, and financial), key activities (consist of production, procurement, marketing, and sales), key partners (collaborate with all selected supplier partners), and cost structure (there are fixed and variable costs, fixed assets).



Business Model Canvas

Designed for:	Designed by:	Date:	Version:
Ayam Geprek XYZ Restauran	Fella Diandra Chrisandy	2021	1.0

Channels

Brand Awareness
>Strategic place for restaurant
>Brosur, Banner, Baliho, TV advertisement
Food Blogger, Selebgram, Youtubers, Influencers (personal branding people)
>Instagram, Tiktok, Facebook (social media networking)
Evaluation
>Facebook Forum
>Hotline customer care: Whatsapp for Business, Official Instagram
Purchasing Method
>Financial Technology: OVO, GoPay, Shopeepay
>Debit Card
Delivery Channel
>Dine In
Lini 1: Central warehouse/ kitchen, a branch in Surabaya Timur whose responsibility is held by the manufacturer who is also a distributor.
Lini 2: 16 Branch partnership outlets in the form of a CV as a Distribution Center (DC) to consumers which are held by the partnership partner manufacturers and spread across the cities of Surabaya, Bali, Kalimantan, Malang, Gresik, Timika.
>Take Away
Grabfood, Gofood, Shopeefood

Key Activities

Production: Producing food & beverage products for the operation of the restaurant
Procurement: Purchasing raw materials, integrating the process of preparation and delivery of food and beverage products to end users (consumers)
Marketing: Carry out activities aimed at maximizing profits by making sales (promotion) strategies.
Sales: Selling food & beverage products by serving purchases both dine-in and take away

Key Resources

Physical Assests: Central Kitchen, Warehouses, General Production Machinery, & Goods Transport Vehicles
Human Resources: HR in the form of employees in core/key activities and non-core units,
Financial: Company Financial Resources, Return on stock investment

Value Propositions

>A local brand that goes global with the authentic taste of ayam geprek. The only one kind ayam geprek restaurant applied the all you can eat concept: free refill of rice (uduk & white), soup, and iced tea but at a very affordable price (value for money) and equipped with various variants of chili sauce and toppings as well as special milk drink. A comfortable & instagramable dine-in place. Serving orders for food & beverage products with the desired formula: **Delicious, Satisfied, Cheap, Hygienic, & Affordable**

Key Partners

Suppliers:
Chicken Supplier, Flour Supplier, Whole Milk Supplier, Rice Supplier, Oil Supplier, Egg Supplier, Basic Seasoning Supplier and Traditional Market

Customer Relationships

Classified as transactional and long term relationship:
>Providing product variants for both dine-in and takeaway that reduce consumer costs as an acquisition and retention effort, such as: special menus for small children, menu packages for two, menu packages together, menus for take away packages
>Organizing special events & promotions such as soft openings and weekly discount collaborating with the key partnerships
>Engagement and inform customers with the promotion routines from various social media platforms

Customer Segments

1. College Students
2. Students
3. Family
4. Children
5. Office Worker

Cost Structure

Fixed Cost: Employee Salary (covered by income from central warehouse/kitchen and outlets), General Costs (salary for non-core employees), Depreciation (from cash for repairing company assets such as offices, warehouses, production machines, and company vehicles), Cost of Production Raw Materials, Insurance (only central kitchen which insured from natural disasters and loss of goods), Taxes
Variable Cost: Operating Costs (electricity, water, communication, marketing costs), Shares
Fixed Assets: Land, Buildings, Production Machinery Equipment

Revenue Streams

>Product sales (partnership partner outlets)
>Return on stock investment

Figure 4. Existing Business Model Canvas Ayam Geprek XYZ Restaurant

B. VALUE PROPOSITION CANVAS

The VPC formulation helps to understand how consumers behave, to focus on exploring the problems facing by consumers, and to produce the products and services which can be the solution. The input from the customers for Ayam Geprek XYZ Restaurant mostly expressed their hopes for the re-activation of the official restaurant website, special membership status for loyal customers, and improved the restaurant's hygene through Self-Service Technology. VPC is such a bridge that aspires the change in a better way of the existing BMC, especially its relevance to the current pandemic conditions.

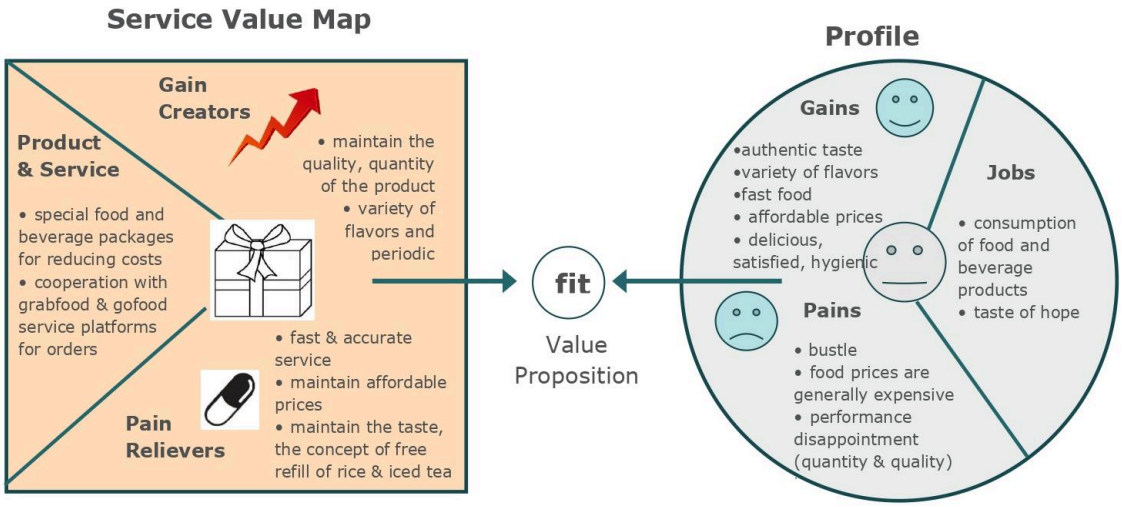


Figure 5. Value Proposition Canvas Ayam Geprek XYZ Restaurant

C. RECOMMENDED BUSINESS MODEL

From here, BMC novelty can be formulated and the part of the innovation lies in the customer segments where the occurring movement was the impact of the pandemic. The focus of the segmentation has changed where the main target originally were mostly students but then moved widely and become general consumers for a long time. To strengthen the relationship in a long term, restaurant should maintain the official company website, gives membership status for consumers as a customer engagement in retention effort, and implements the Self-Service Technology. The restaurant should employ a web developer to conduct the first action. In case of increasing the brand awareness when the situation goes back to normal (pandemic free), restaurant can actively participate in culinary bazaars or exhibitions in various schools and campus canteens.

Back to the main focus of the breakthroughs with help of technologies, in era of globalization and industry 4.0 as it is today, many uses of new technology have been discovered. Especially during this Covid-19 pandemic, almost every activity was conducted online because of social distancing measure. Reflected from this experience, Self-Service Technology becomes a promising solution for the future. It can become one of the information technology innovations of customer service optimization, giving customers more control in their own hands than before.

Business Model Canvas

Designed for:	Designed by:	Date:	Version:
Ayam Geprek XYZ Restauran	Fella Diandra Chrisandy	2021	2.0

Channels

Brand Awareness
>Strategic place for restaurant
>Brosur, Banner, Baliho, TV advertisement
Food Blogger, Selebgram, Youtubers, Influencers (personal branding people)
>Instagram, Tiktok, Facebook (social media networking)
>Culinary Bazaar ,School/Campus Stan
Evaluation
>Facebook Forum
>Hotline customer care: Whatsapp for Business, Official Instagram
Purchasing Method
>Financial Technology: OVO, GoPay, Shopeepay
>Debit Card
Delivery Channel
>Dine In
Lini 1: Central warehouse/ kitchen, a branch in Surabaya Timur whose responsibility is held by the manufacturer who is also a distributor.
Lini 2: 16 Branch partnership outlets in the form of a CV as a Distribution Center (DC) to consumers which are held by the partnership partner manufacturers and spread across the cities of Surabaya, Bali, Kalimantan, Malang, Gresik, Timika.
>Take Away
Grabfood, Gofood, Shopeefood

Key Activities

Production: Producing food & beverage products for the operation of the restaurant
Procurement: Purchasing raw materials, integrating the process of preparation and delivery of food and beverage products to end users (consumers)
Marketing: Carry out activities aimed at maximizing profits by making sales (promotion) strategies.
Sales: Selling food & beverage products by serving purchases both dine-in and take away

Key Resources

Physical Assests: Central Kitchen, Warehouses, General Production Machinery, & Goods Transport Vehicles
Human Resources: HR in the form of employees in core/key activities and non-core units, web developer
Financial: Company Financial Resources, Return on stock investment

Value Propositions

>A local brand that goes global with the authentic taste of ayam geprek. The only one kind ayam geprek restaurant applied the all you can eat concept: free refill of rice (uduk & white), soup, and iced tea but at a very affordable price (value for money) and equipped with various variants of chili sauce and toppings as well as special milk drink. A comfortable & instagramable dine-in place. Serving orders for food & beverage products with the desired formula: **Delicious, Satisfied, Cheap, Hygienic, & Affordable**

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>Organizing special events & promotions such as soft openings and weekly discount collaborating with the key partnerships
>Engagement and inform customers with the promotion routines from various social media platforms
>Maintenance the official website and applied a membership methods for customer retention as a customer engagement effort
>Pioneer of ayam geprek restaurant with self service technology

Customer Segments

1. Family
Age: 7-60 years old
Gender: women & men
Social Status: the general public upper middle class
Family: new family & small family
Occupation: variation (student, banking, civil servant, self-employed, private employee)
2. Children
Age: 7-15 Years
Gender: women & men
Social Status: the general public upper middle class
Family: new family & small family
Occupation: elementary & junior high school student
3. Office Worker
Ages:
>main target age is 22-28 years old (first generation of alumni from restaurant customer students 2015-2021)
>second target age 29-60 years old
Gender: women & men
Social Status: the general public upper middle class
Family: individual
Occupation: (banking, civil servant, self-employed, private employee)
4. College Student
Age: 20-22 years old
Gender: women & men
Social Status: the general public upper middle class
Family: individual
Occupation: College student
5. Student
Age: 13-17 years old
Gender: women & men
Social Status: the general public upper middle class
Family: individual
Occupation: junior & senior high school student

Cost Structure

Fixed Cost: Employee Salary (covered by income from central warehouse/kitchen and outlets), General Costs (salary for non-core employees), Depreciation (from cash for repairing company assets such as offices, warehouses, production machines, and company vehicles), Cost of Production Raw Materials, Insurance (only central kitchen which insured from natural disasters and loss of goods), Taxes
Variable Cost: Operating Costs (electricity, water, communication, marketing costs), Shares
Fixed Assets: Land, Buildings, Production Machinery Equipment

Revenue Streams

>Product sales (partnership partner outlets)
>Return on stock investment

Figure 6. Recommended Business Model Canvas for Ayam Geprek XYZ Restaurant

D. PESTEL ANALYSIS

The dimensions of the variables that become the benchmarks such as politics, economics, socio-cultural, technological, environmental, and legal can cause a domino effect or a chain of events which would affect the welfare and a country improvement from every aspect if one phenomenon occurs. However, the plus point here is that Ayam Geprek XYZ Restaurant started their business from the owner's personal funds in order without applying for a bank loan. So this is become a stable and independent business which minimize the future risk of external situations.

E. 5 FORCES PORTER ANALYSIS

In addition to external pressures, the company's sustainability is also influenced by internal factors called 5 Strengths of Porter's Analysis from the price, cost, and investment which required to compete in an industry. It is important to analyze the impact of these forces on profitability so companies can make decisions about where and how to compete. The following chart is a summary of how low, medium, or high the power that restaurant must face. The high of industrial's growth strength as well as the number of business units as food and beverage restaurants cause a barrier to exit the similar businesses become low potential.

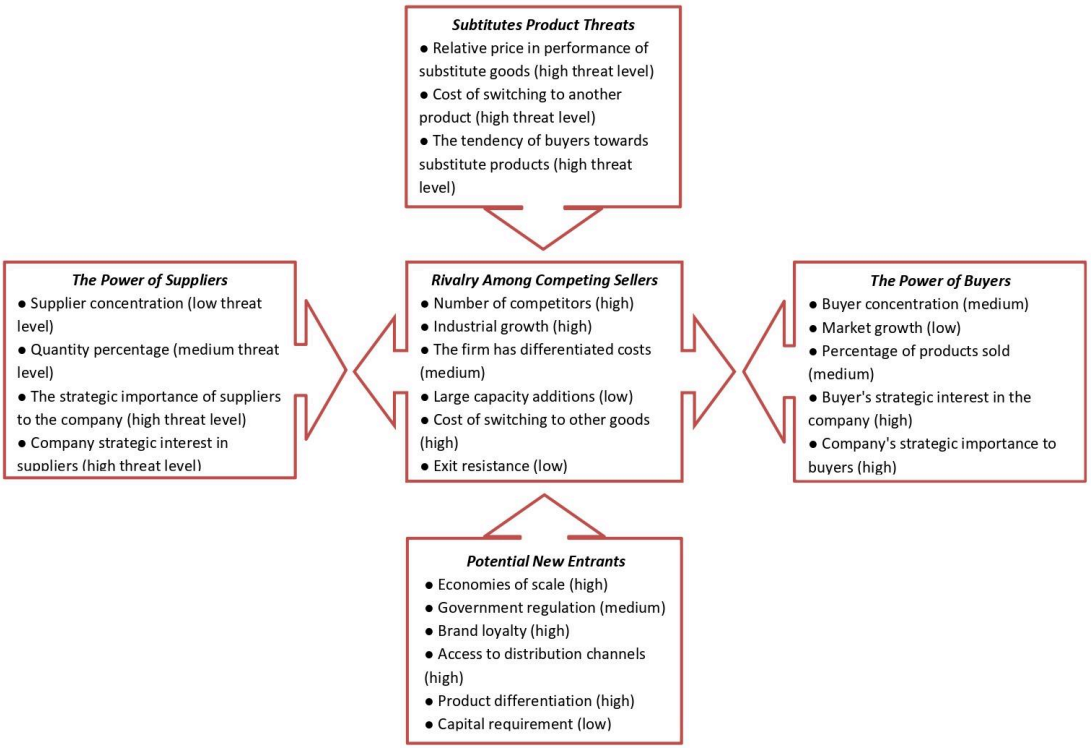

Figure 7. Five Forces Porter Analysis for Ayam Geprek XYZ Restaurant

F. COMPETITOR ANALYSIS

The main competitors that are considered as a threat are Ayam Geprek PQR and Mie ABC which strongly stand with similar or substitute products. Each of them has its own strengths and weaknesses as well as the similar strategy, but certainly that the value of Ayam Geprek XYZ still plays a different role. Ayam Geprek PQR is strong at the personal branding of its owner, an influencer which could cause high brand awareness but has also stumbled upon a legal case over the claim for the brand identity. The strength of Mie ABC lies in the affordable price to quality and high product differentiation, but there has been no official press release regarding the cooperation to open a branch. The Competitive Profile Matrix of Ayam Geprek XYZ and its competitors produces a total overall score where the highest is Mie ABC with the main factor being influenced by the product prices.

G. VALUE CHAIN ANALYSIS

There are two analyses from supply chain perspective, the inbound and outbound logistics. Ayam Geprek XYZ Restaurant is in the form of a limited liability company (PT), which consists of an office/central warehouse as well as a central kitchen and partnership outlets in the form of a commanditaire venootschap (CV). The basic spices are produced in the central kitchen and distributed to the outlets, while the main ingredients are supplied to the central kitchen and the outlets by partner suppliers and the nearest traditional market. The entrance and the storage of restaurant's raw materials have been neatly systemized, but because the restaurant produces finished food which sold out immediately, there is no outbound logistics.

H. INTERNAL RESOURCES AND CAPABILITY ANALYSIS

Restaurant already has a good employee engagement where there are training and resources for new employees. The fulfillment of employee rights is in accordance with legal

provisions, as well as the well-structured HR management functions and roles which consist of planning, controlling, and development. Here, the organizational structure of each outlet and the head office has been clearly laid out. In terms of the operational capabilities of the restaurant, the production process has been running according to the SOP, the availability of production tools and the facilities is also complete to support the business operational needs. The most interesting from the food production management is the application of a waste and deviation tolerance for the employees as a product defects preventive measure while the restaurant also conducts good quality control on the raw materials before they are received till become finished goods for the end users.

4.2 MATCHING STAGE

After conducting the various analyses of these approaches, the formed key factors are given weights and ratings to obtain a weighted score.

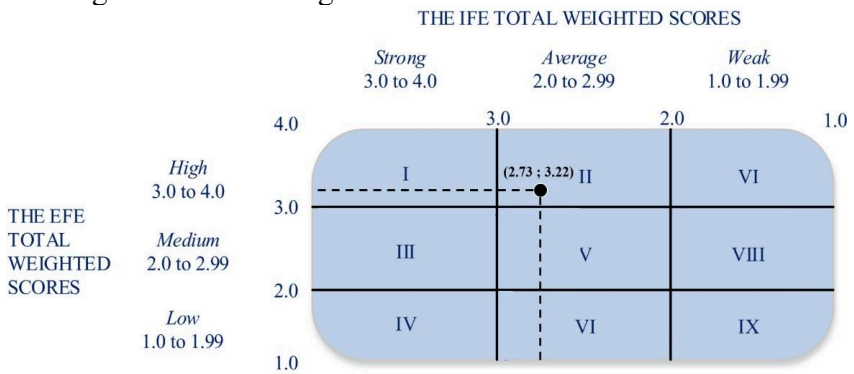

Figure 8. The Internal-External (IE) Matrix of Ayam Geprek XYZ Restaurant

4.3 DECISION STAGE

From the calculation of IFE and EFE, it can be detected that the strategic position of the Ayam Geprek XYZ Restaurant on the Internal External (IE) Matrix is located at coordinate (X; Y) 2.73; 3.22 in cell II which means "Growth and Build". Hence, the applicable strategy is intensive or integrative strategy.

Growth and build, in the sense that the restaurant tries to capture a larger market share. How the company sustains the business in the long term (even if this must sacrifice the short-term revenue) and its formulation goes beyond the current market conditions (still survive despite of an unexpected circumstances such a pandemic that weakens the global economy). This position refers to the scale increase of the company's operations and this is important for excellent competitiveness, because a settled businesses have much better resources and capabilities to seize opportunities and dominate the market. On the other hand, this project also requires a testing for several approaches because if it just grows without a careful planning, it would obviously fail.

Regarding the company's own internal conditions, the obstacle is the company's lack of agile ability to sudden changes in external circumstances, unpreparedness to adapt/lack of preparation for a defensive strategy (as evidenced by not having a previous business model and defensive strategic planning). Here the company can learn to find out what the solution is, which is to continue to innovate and upgrade the development of the business model by adjusting to market conditions and the influence of external factors.

It is estimated that the company's growth and profitability in many years ahead will depend heavily on business ideas and strategies in the midst of a pandemic (there are only two choices, providing the relevant products and services, or implementing a defensive strategy). Some companies may have difficulties on identifying where to get the revenue from, while it's always

better to enter the business with profitability in mind (tend to look first at the profit rather than finding multiple avenues for revenue streams).

Meanwhile, from external conditions, the obstacle is the impact of the pandemic situation which increases the threats from external. The beauty of Ayam Geprek XYZ is because of its value (see Figure 4). Hence, the restaurant should as much as possible strengthen these *values*, keep on surviving, and enlarge the reach of consumer segmentation through new ways as an effort to adapt during the pandemic when many culinary industries are shrinking due to failing to do so.

Based on the consideration of that company's real conditions, the most appropriate strategy to be applied in accordance with the growth and build position is the intensive strategy where this strategy indicates the company's intensive efforts to gain competitive advantage through product and market development.

5. CONCLUSIONS

a. Competitor analysis through CPM produces competitor mapping which is useful for determining the company's strategic steps up against the main competitors. The strength of the restaurant's main competitor for substitute products lies in the price of the offered product.
b. The current strategic position of Ayam Geprek XYZ Restaurant is growth and build with the most appropriate choice of strategy is intensive strategy and sustainable BMC innovation, and because of this, there is at least a way where the company can go to profitability but is still accompanied by the achievement of a healthy economic unit and can be achieved if in the future the restaurant expands the source of revenue streams while balancing the focus between growth and the right strategy.
c. Efforts that have been made or expectation for the future with an intensive strategy are existing products (product development) where it is necessary to procure a special research division to further optimize this strategy. Next is market penetration, where restaurants just need to continue to focus on the strength of their digital marketing strategy because this technique is one of the booming growth hacking strategies which is the best solution using by many startup companies in difficult times like this current pandemic. As for market development, restaurants can maintain their strength in dominating the consumer market through their image of value and brand awareness, this will greatly support the restaurant's long-term efforts to diversify.

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THE DOMINANT FACTORS CAUSING COST OVERRUN OF CHEMICAL TREATMENT PROJECTS IN OFFSHORE OIL AND GAS PRODUCTION FACILITIES

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ABSTRACT

Cost is an important component and indicator of the success of a project. In the implementation of projects in the oil and gas industry, it is very likely that there will be cost overruns. Likewise, there has been a cost overrun in the implementation of the 2018-2021 chemical treatment project at PT. Pertamina West Madura Offshore (WMO) which is an oil and gas producing company. In projects in the oil and gas industry, the challenge faced to maintain production in achieving national production targets is that project operations must continue to be carried out, where operational activities cannot be stopped on the grounds that there is no budget, effective measures are needed to deal with costs. on the project, especially to achieve the success criteria in terms of project costs. The chemical treatment project discussed in this study has an important role in producing quality oil and gas fluids according to the buyer's needs so that the desired specifications can be achieved. In the implementation of this project there is a big problem, namely the contract value has expired before the implementation time ends. This causes the process of direct appointment to the implementing contractor. Therefore, this study analyzes the factors that cause cost overruns. The research begins by identifying the factors that cause cost overruns that occur in this project through literature study and screening to obtain variables that are in accordance with the object under review. Then analyzed using the geometric mean deviation diagram vs. standard deviation used to find the dominant causative factor. Of the 25 indicators relevant to the project, 9 indicators are in the dominant quadrant or 35%. These factors are what should be a vigilance in the implementation of similar projects in the future.

Keywords: *cost overrun, chemical treatment, geometric mean vs std deviation diagram*

1. INTRODUCTION

According to Memon et al. (2011) Cost is a fundamental component during a project. Swelling of costs or cost overrun is one of the problems that arise in the implementation of a project. In another study the success of construction companies in carrying out projects in the international market significantly depends on how the risks originating from the conditions of the host country are managed as well as project-specific risk factors including cost risk. In relation to the risk of cost overrun or cost overrun Several authors have described risks specific to international construction projects Baloi & Price (2003) defining risk factors related to the socio-cultural, economic, technological, and political environment within which organizations operate as risk factors. Global. Upstream oil and gas projects also have almost the same conditions as in the construction world, the cost overrun in global upstream projects the oil and gas industry are ranked second with a percentage of 65% of the total project value. This can be the basis for all parties involved in the project to be the main concern so that the projects

implemented do not experience cost overruns. West Madura Offshore (WMO) is one of the working areas of the Cooperation Contract Contractors under the Upstream Sub Holding PT. Pertamina which is in the Offshore area. To be able to produce quality oil and gas production fluids in accordance with the criteria requested by consumers, a chemical injection project is carried out in the production pipeline. Overview of the overall process of the chemical injection project at WMO. With Total Oil and Gas Production Year to date (YTD) 2021 of 2,496 Barrel Oil Per Day (BOPD) and Gas 62.62 Million Standard Cubic Feet per Day (MMSCFD) from production report data as of October 6, 2021 or if combined with the same unit becomes 13,304 Barrel Oil Equivalent per Day (BOEPD), so this activity is a critical activity that will have a significant effect on the sustainability of the company's business and as an effort to achieve the company's mission of customer satisfaction. With an effective project management system, it is expected to optimize the use of budgeted projects.

Completion of a work project according to budget and time with the required quality standards is the main criterion for the success of a project(Memon et al., 2011). Previous research revealed that there are many factors that can lead to cost overrun in a project as stated Avots Ivars (1983) Lower estimates, changes in scope and plans, decreased productivity, increased main costs. In another study Doloi (2013) evealed that ineffective management, Fahadila Remi (2017) inaccurate cost estimates and Flyvbjerg et al (2014) Lack of knowledge about the complexity of the project is the cause of cost overrun in general in all projects. In previous studies Doloi (2013) used multivariate regression to determine the factors that significantly affect the cost overrun on construction projects. Meanwhile Fahadila Remi (2017) uses references from 6 previous studies to determine the significant factors that influence the occurrence of cost overruns and then group these factors into Ishikawa diagrams or fishbone diagrams, the object of this research is from the construction sector. The two studies above only look for the causal factors by using statistical analysis and both are carried out on construction projects. In this study, the object of the chemical treatment project in the oil and gas industry will be discussed using two analyses that will be used, namely Geometric mean vs standard deviation to determine which area is the dominant cause of cost overrun.

2. LITERATURE REVIEW

2.1. Project Cost Management

Project Cost Management or commonly referred to as project cost management is a method that uses technology to measure costs and productivity through the full life cycle of a company's projects. Project Cost Management includes several specific project management functions that include job estimating control, field data collection, scheduling, accounting and design. Project Cost Management is primarily concerned with the cost of the resources required to complete project activities. According to PMBOK 6th Edition (2017) Project Cost Management should consider the effect of project decisions on the subsequent recurring costs of using, maintaining, and supporting the product, service, or outcome of the project. For example, limiting the number of design reviews can reduce project costs but may increase the operating costs of the resulting product. Another aspect of cost management is recognizing that different stakeholders measure project costs in different ways and at different times. For example, the cost of an acquired item may be measured when an acquisition decision is made or made, an order is placed, an item is shipped, or the actual cost is incurred or recorded for project accounting purposes. In many organizations, predicting and analysing the prospective financial performance of project products is done outside the project. On the other hand, like facility project investment, Project Cost

Management may cover the work. When prediction and analysis are included, Project Cost Management can handle additional processing and general financial management techniques such as return on investment, discounted cash flow, and return on investment analysis.

2.2 Cost Overrun in Project

Cost overrun is a very important possibility in the cost control process because cost overruns can increase the final cost of the project and minimize profits Pandey (2012). Cost overruns are common across different types of projects and locations. In addition, cost overruns have become the norm, not the exception in the construction industry Baloi & Price (2003). As stated by Avots Ivars (1983), it is normal to expect that the final cost of the project exceeds the initial budget by 10 -20 percent. However, Morris (1987) summarized 40 reports on cost overruns in various types of projects and they concluded that about 50 percent of construction projects incur cost overruns. It mastered values usually between 40 and 200 percent. (Nevan Wright (1997) agrees with the authors and he suggests that a good way to deal with this excess is to add "50 percent to each estimate and 50 percent to the first estimate of the project". Moreover, (Olawale & Sun, 2010) how that the notion of cost overruns is becoming a rule in the construction industry in the UK. As mentioned earlier, several authors stated that there are several factors that have a positive impact on each project objective K H Chua et al. (1999) Although the objectives of the project vary depending on the individual assessing the project, there are three dimensions that are considered by almost all project participants: quality, budget, and schedule Iyer & Jha (2005). Therefore, cost overrun as a failure of cost performance must be identified in a project.

2.3. Causes of Cost Overrun

Factors causing cost overrun can be obtained from previous research, most of which are construction projects. In several previous studies, the causes of cost overruns include:

Cost estimation Fahadila Remi (2017). Cost estimation is a calculation carried out to plan the needs that will later be needed to solve a problem or work, either with a requirement or by using a contract. Based on PMBOK 6th Edition (2017) Cost estimation is a quantitative assessment of the possible costs for the resources required to complete an activity. These are predictions based on known information at a given point in time. The cost estimate includes the identification and consideration of cost alternatives for starting and completing the project. Cost and risk trade-offs must be considered, such as make versus buy, buy versus rent, and share resources to achieve optimal cost for the project. Cost estimates are generally expressed in units of several currencies (i.e., dollars, euros, yen, etc.), although in some cases other units of measure, such as staff hours or staff days, are used to facilitate comparisons by eliminating the effects of currency fluctuations.

Project implementation Doloi (2013). With effective project management in the field, a whole series of project activities can be produced. As a form of comprehensive and optimal management on aspects of labour, goods, or supporting factors. According to Fahirah F (2005) the bigger a project, the more complex the mechanism, which means the more problems that must be faced. If not handled properly, these various problems will result in the impact of delays in project completion, deviations in the quality of results, bloated financing, waste of resources, unfair competition among implementers, and failure to achieve the desired goals and objectives.

Approval drawings or project documents that are late having an Average Index (AI) of 1.80 Memon et al. (2011) are ranked 2nd for factors that significantly influence the cause of cost overruns in project implementation. According to Memon et al. (2011) the main purpose of all projects carried out in various industrial sectors is to complete the project in accordance with the time and budget provided.

Material according to Wira Hadinata et al. (2013) is a contributor to cost overrun. In the case of construction projects, the increase in material prices during the project can have a significant impact on project costs. According to Jaillon et al. (2009) cost overrun caused by material waste or waste is also a major problem in a project. This is certainly very detrimental for the construction service provider company if the waste material is a very large portion of the fairness. In addition, non-physical waste also often occurs such as wasted time caused by various problems in the field. Therefore, the author makes the topic to be able to identify what should be a concern for the existence of this potential waste. With the potential for waste that exists and can become excessive, Of course, the contractor must also prepare what steps must be taken so that the potential does not develop into an actual incident. This anticipation is an effort to mitigate the risks that occur in a project. With these risk mitigation measures, it is hoped that they will be able to control the amount of waste that occurs so that the project's resources can be empowered to the maximum without anything being wasted.

Unskilled labour Wattimury et al. (2015) is a factor that contributes to the occurrence of cost overruns in the implementation of a project. In the labour selection process, the project manager should address it so that it does not cause problems in order to make the project being handled successful.

Equipment according to Fahirah F (2005) is a factor causing cost overrun in project implementation. In the implementation of a project, equipment is a cost for everything that will be a component of the final project result and is also called a direct cost.

Financing according to Wattimury et al. (2015) is a component that must be controlled so that a project can run according to the budgeted target that has been planned. With good cost control performance can also provide maximum benefits for the course of a project.

2.4. Chemical Treatment Projects in Offshore

When producing an oil or gas well for exploitation, there are also other effects of the extracted oil and gas, namely formation water or produced water. According to Fakhru'l-Razi et al. (2009) produced water is the largest waste stream generated in the oil and gas industry. It is a mixture of various organic and inorganic compounds. Due to the increasing volume of waste worldwide in the current decade, the results, and effects of the discharge of produced water on the environment have recently become an important issue of environmental concern. On offshore platforms or offshore due to space limitations, comprehensive mechanical and chemical system handling is carried out. With good chemical handling, the quality of the produced water will be able to meet the quality standards set by the government and regulatory agencies that oversee the problem of produced water. In the chemical treatment project discussed in this research object, there is also a chemical to overcome the problem of produced water from oil and gas wells called a water clarifier which is useful for removing oil dissolved in the produced water

In the chemical treatment project that will be discussed by the author in this research, it is a project whose scope of work is contained in a contract entitled "Chemical Supply and Service" with a scope of 3 types of activities related to the project implementation method, namely:

1. Treatment Cost
2. Volume Cost
3. Other Activity Cost.

The components of the contract can be seen in Table 1. With each of these work items the success indicator will have an impact on the overall success of the project.

After calculating the components experiencing cost overrun, the weighting of the components experiencing cost overruns is carried out by visualizing using a Pareto diagram. Pareto diagram is one of the tools (tools) of Quality Control 7 Tools that is often used in terms of quality control. Basically, a Pareto chart is a bar graph that shows a problem based on the order of the number of occurrences or the highest number of parameters based on the measurements made.

In general, the tool that is often used for data collection is to use a Check Sheet. With the Pareto diagram tools, it can be said that the volume cost component and additional activities are the most significant contributors to cost overruns with a percentage of 32% and the second rank is other activity with a percentage of 14% while the third ranked activity is the H2S Scavanger service which is also a volume based component. in chemical treatment contracts with a percentage of 14%. Figure 1. shows which positions of the contract experienced a cost overrun.

Table 1. Chemical treatment project contract components

NO	Aktivitas	Unit
	Treatment Cost	
1	Demulsifier	Oil
2	Pour Point Depressant	Oil
3	Corrotion Inhibitor Three phase	Water
4	Corrotion Inhibitor Gas phase	Gas
5	Water Clarifier	Water
6	Scale Inhibitor	Water
	Volume Cost	
7	H2S Scavenger Three Phase	Usage
8	H2S Scavenger Gas Phase	Usage
9	Wax Remover Surface	Usage
10	Wax Remover Subsurface	Usage
11	Biocide	Usage
12	Scale Remover	Usage
13	Slugging Compound	Usage
14	Defoamer	Usage
15	Oxygen Scavenger	Usage
16	Anti Foulant	Usage
	Other Activity	
17	Carbon Filter <900 iodine Number	Kg
18	Cartridge Filter 0,5 micron	EA
19	Independent Laboratory Studies	Lot
20	Cleaning Package	Lot

By looking at the graph on the Pareto diagram, it can be seen which activities in the project experienced cost overruns in order of value from the largest to the smallest value. Slugging compound activity is an activity that is used to improve the quality of the delivered oil which is accommodated in the separator on the processing platform, this is necessary because after the fluid produced from the platform well has been injected with chemicals to separate the oil and formation water, mixing the two fluid phases This is also still happening in the distribution pipe that is under water. So, we still need a chemical booster called Slugging compound.

The second activity experiencing cost overrun is the use of a carbon filter, which is a material that is installed in the Wastewater Treatment Plant (IPAL) in the Onshore Receiving Facilities (ORF). While the third activity that experienced cost overrun is the H2S scavenger

service activity where this activity aims to reduce the H2S content in the production fluid according to the desired criteria. Because the need for these activities is very supportive of the smooth achievement of the company's targets, the success of this project will also be a critical factor in the success of achieving the quality of the products produced.

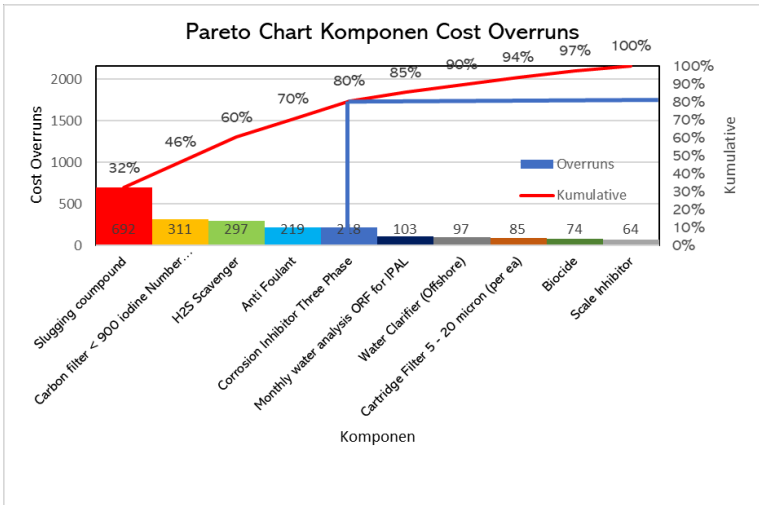

Figure 1. Pareto Chart Component Cost Overrun

3. METHODS

3.1. Research Concept

This study aims to determine the cause of cost overrun in chemical treatment projects. The causal factors will be analyzed with data from variables that have been filtered first. With a preliminary survey, the cause of the cost overrun will be obtained which has been validated in advance by the respondent. Furthermore, from the failure indicators that have been obtained and which have been validated by the respondent, an analysis of the basic causes of cost overruns in the project under review will be analyzed.

3.2. Preliminary survey for exploratory

After obtaining the filtered indicators and variables, a preliminary survey is arranged to obtain indicators of failure (events) that are still possible. The indicators that already exist in the literature will be included in the questionnaire for the respondents to know. In the preliminary survey respondents are also allowed to fill in additional variables and indicators that may exist based on the experience and knowledge of the respondents. The output of this survey will be used to obtain complete verification of variables and indicators based on the experience and knowledge of the respondents.

3.3. Finding the factors causing cost overrun

Based on the results of the preliminary exploratory survey, a questionnaire was conducted to assess what variables and indicators included in the dominant group caused the cost overrun to occur. The assessment is carried out by assessing using a Likert scale of 1 to 5 on indicators of failure that affect the variables causing cost overrun. Respondents were asked to put an "X" in the column provided to state the respondent's choice based on experience and education that these indicators do affect and cause cost overruns.

This analysis aims to describe the distribution of the dominance of factors based on the geometric mean value of respondents' answers to the assessment of each factor that needs to be compared with its standard deviation value. In this process, the geometric mean and standard deviation values are explained based on the largest value of each research variable. Based on this analysis, the variable with the highest geometric mean value is the most influencing factor of the variable causing cost overrun. Each analysis result with a high order of mean, is not always followed by a larger standard deviation value. The smaller the value of the standard deviation or the distribution of the data, the smaller the variation in the value of the data, and the larger the value of the distribution means the more varied the data. In this descriptive analysis, an analysis will be carried out using a comparison between the geometric mean and standard deviation of the overall respondents' assessment of each variable, with the aim of describing the grouping of indicators that affect cost overrun. By mapping the Geometric mean - standard deviation diagram where the X axis shows the Geomean value and the Y axis shows the standard deviation value. From the diagram, it will be known that the standard deviation value which is smaller than the threshold value and the Geomean value which is greater than the threshold value is the indicator that will be the most dominant indicator.

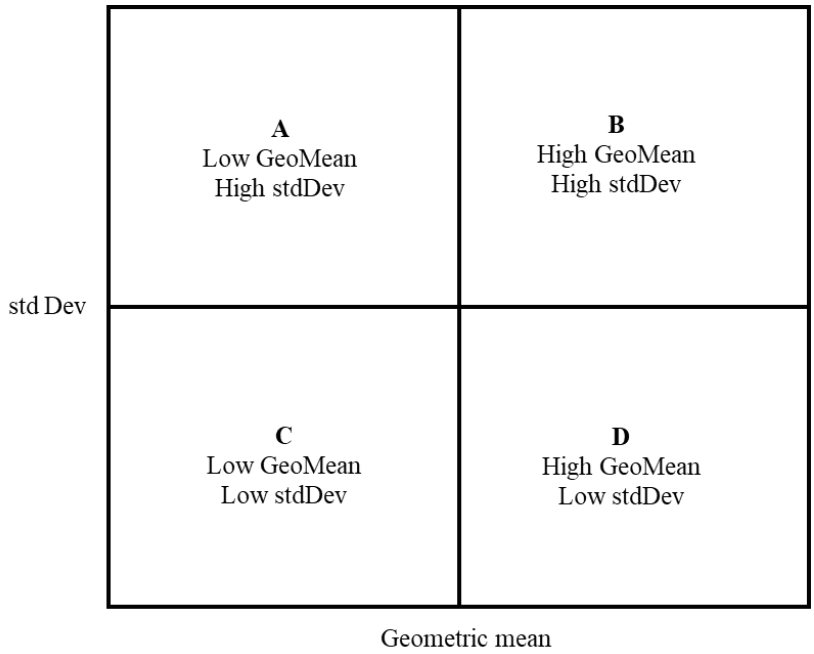

Figure 2. Geometric mean - standard deviation diagram

Using the formula to get the Geometric mean:

$$G = \sqrt[n]{X1xX2xX3 \ldots \ldots . . xXn}$$

Description:

G = Geometric value mean
n = Number of data sets
Xn = Data value to v

And in determining the standard deviation using the formula

$$s = \sqrt{\frac{\sum_y 2 \; - \frac{\sum y^2}{n}}{n-1}}$$

Description:

S = standard deviation
n = total number of data
y2 = the value of the square of the number of data (i = 1, 2…., n)
y = total value of data

4. RESULTS

The main survey is a quantitative analysis of the factors causing cost overruns that have been identified previously. The main survey was conducted in January 2022 by distributing a preliminary survey questionnaire according to attachment 3 to nine expert respondents consisting of project leaders and senior project planning members with more than 5 to 15 years of work experience and taken from the employee and employer as stated on

Table 2. Measured Failure Indicators

X	Failure indicator	X	Failure indicator
1	Wrong estimation method	14	Poor material quality
2	Incorrect cost estimation	15	Material delivery delay
3	Incomplete project data and estimates	16	Materials are often lost
4	Unexpected costs	17	Chemical content difference between contract and supply
5	Lack of coordination with contractors	18	Quality and breakdown of equipment on site
6	Poor quality control	19	Error in setting up equipment
7	Production rate changed	20	Cost of mobilization and demobilization
8	Problems with contracts	21	Equipment rental rates are high
9	Location conditions on the project	22	Conditions of equipment that are quite aging
10	Incompetent project manager	23	Unskilled workforce
11	Supervisors are inexperienced	24	Lack of manpower
12	Weather conditions offshore	25	Productivity of workers
13	Places of materials that are not suitable		

By analyzing using geometric mean - standard deviation, it is found that the failure indicator grouping that causes cost overrun is shown in Figure 3

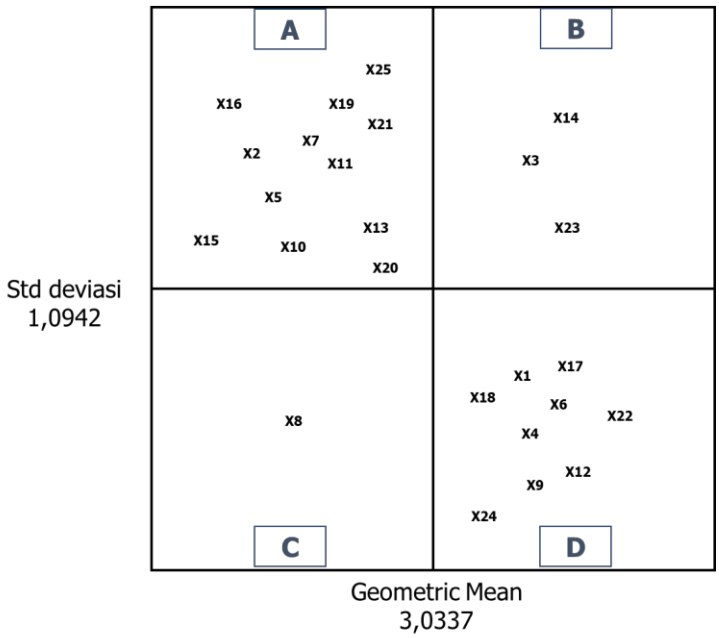

Figure 3. indicator position measured on the chart

To better provide an overview of the results of the following research, a graph is presented that describes the position of each quadrant in the geometric mean - standard deviation diagram.

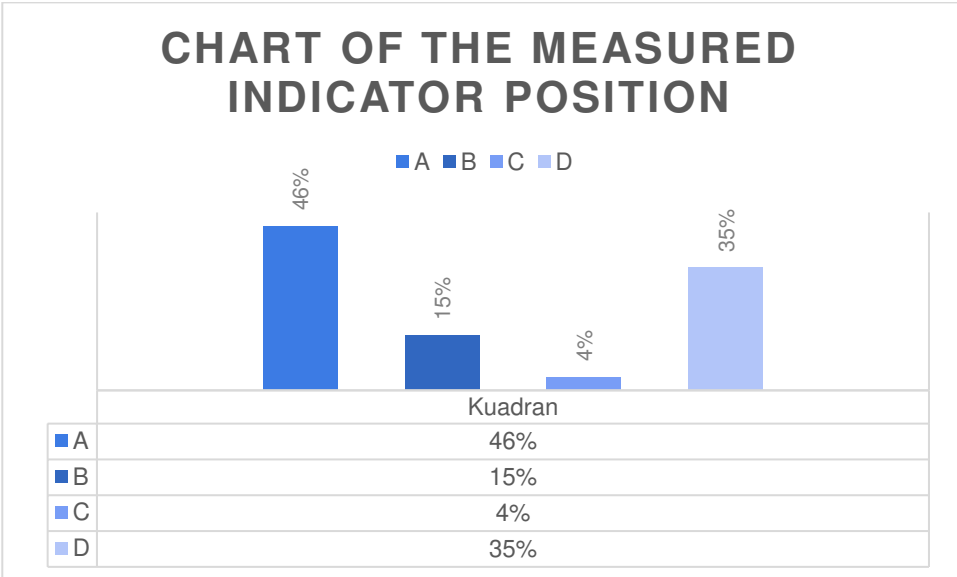

Figure 4. Chart of the measured indicator

6. CONCLUSIONS

n this study, it can be concluded that the indicators causing the cost overrun in this project are the factors that are grouped into quadrant D on the geometrik mean - standard deviation diagram, which is 35% of the total indicators measured, while in quadrant A it is 46%, in quadrant B ranks third with a percentage of 15% and the last position in quadrant C with 4% gains from the total of all indicators measured

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STRATEGIC PLANNING OF KOPERASI AND MICRO BUSINESS SERVICES IN SURABAYA CITY TO DEVELOP A CULINARY TOURISM CENTER WITH FRED R DAVID STRATEGIC MANAJEMEN METHOD

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ABSTRACT

Local government / city has a very important role for the progress of a city / region. The Surabaya City Government through the Surabaya Cooperatives and Micro Business Office began in 2015 relocating street vendors from a number of locations. Culinary tourism centers are an alternative to finding solutions to fulfill the economic rights of street vendors in the midst of the threat of business uncertainty caused by evictions by officials and a negative image circulating among the public. In 2021 a total of 50 culinary tourism centers have been built and spread across the Surabaya City Area.

The construction of Culinary Tourism Centers for street vendors who were relocated as of 2021, many still look deserted due to a lack of interest from the community which causes a decrease in merchant turnover. So many traders have closed their businesses. Many factors have contributed to the lack of visitors to culinary tourism center, one of which is the development of food ordering services with online applications, because in the past many workers came to culinary tourism center for lunch but not anymore.

In developing a culinary tourism center, the Surabaya City Cooperatives and Micro Business Office must be able to formulate strategies to optimize culinary tourism center business activities by understanding the role of technology that is currently developing, and primarily setting commitments to achieve goals and increase public interest, but with the right technology. will make the strategic process fully automated. Fred R David's strategic planning model was chosen in this research because it is a fast, effective, and efficient tool in finding possibilities related to developing, making decisions and expanding the organization's vision and mission.

Thus, the purpose of this study is to formulate a strategy that will be recommended to develop a culinary tourism center in Surabaya according to the theory put forward by Fred R David who applies the development of information technology to encourage traders to be more economically independent which will have a direct impact on increasing turnover.

Keywords: Planning, Strategic, SWOT, Fred R David

1. INTRODUCTION

.Local government / city has a very important role for the progress of a city / region. The city of Surabaya which has established itself as an international tourist destination with the city branding "Sparkling Surabaya" admits that culinary is one of the strengths or commodities of tourism. Surabaya City Government through the Office of Cooperatives and Micro Enterprises in Surabaya began in 2015 relocating street vendors from a number of locations (Dinkopum, 2015). Culinary tourism centers are an alternative to finding solutions to fulfill the economic rights of street vendors in the midst of the threat of business uncertainty caused by evictions by officials and a negative image circulating among the public. In October 2015, the Surabaya City Cooperatives and Micro Business Office had built 48 culinary tourism centers. That number will continue to grow, in 2021 a total of 50 culinary tourism centers have been built and spread across the Surabaya City Area.

Quoting from Surabayapagi.com based on the report of the journalist team Septyan Ardi and Alqomarudin on December 6, 2020, the guidance and revitalization of the Culinary Tourism Center by the Surabaya City Government seems to be still half-hearted. Many of the tables were empty, even some of the merchant stands with banners of various sales also chose to close. According to one of the traders at the Culinary Tourism Centers stand in Urip Sumoharjo, Nurfitri, this lack of visitors was not only during the Covid-19 pandemic but in previous years there were also few visitors. Jawapos.com News on February 21, 2020 also conveyed news of the development of Culinary Tourism Centers in Surabaya. One of the Jambangan traders, Winarni, said that when compared to the initial opening of Culinary Tourism Centers, there was a decline in turnover of up to 60 percent.

Andi, Titik, and Doddy (2019) in their research on "Development of Information Technology for Restaurant Businesses in Solo" said that increasingly rapid technological developments require business owners to be more creative in making strategic decisions to continue to survive in the competition. Rapid technological developments also have an impact on restaurant businesses, such as the payment system shifting to Card-Based Payment Instruments, providing facilities to pamper consumers in the form of Free Hotspots, food order transactions that shift to online through the GoJek or Grab applications, and the use of online media. For this reason, in order for businesses to continue to compete, they must be able to keep abreast of technological developments that occur in their fields.

In developing a culinary tourism center, the Surabaya City Cooperatives and Micro Business Office must be able to develop strategies to optimize Culinary Tourism Centers business activities by understanding the role of technology that is currently developing. The Surabaya City Cooperatives and Micro Business Office also needs to consider strategic issues, external factors, internal factors, and primarily establish commitments to achieve goals and increase public interest, but with the right technology, the strategic process will become completely automatic. Strategy as a process of determining a plan that focuses on the long-term goals of the organization, accompanied by the preparation of a method or an effort how to achieve these goals (Prasnowo, 2017). Fred R David's strategic planning model was chosen in this study because it is a fast.

Thus, it can be determined that the purpose of this research is to formulate a recommended strategy to develop a culinary tourism center in Surabaya according to the theory put forward by Fred R David who applies the development of information technology to encourage traders to be more economically independent which will have a direct impact on the economy and turnover increase.

2. LITERATURE REVIEW

2.1. Definition of Empowerment, Street Vendors, Government Policy on Public Order

2.1.1. Empowerment

Defined from its goal, empowerment is defined as increasing the power of people who are weak or disadvantaged, whereas if from the process empowerment is a process where people become strong enough to participate in controlling and influencing events and institutions that affect their lives and Allocating power by changing the social structure, and empowerment if defined in terms of ways, is an effort to control the people, communities, and organizations over themselves (Suharto 2009).

2.1.2. Street Merchant

According to Nugroho (2003: 159) Street Vendor is a term to refer to peddlers who carry out commercial activities on areas belonging to roads designated for pedestrians. According to Damsar (2002: 51) Street Vendors (Informal Sector) are those who carry out individual or group trading business activities which in carrying out their business use public facilities, such as sidewalks, public roadsides, and so on. Traders who carry out their business activities for a certain period of time by using facilities or equipment that have been moved, dismantled, and use land for public facilities.

2.1.3. Government Policy Regarding public order

The formulation of a State policy is a process that is not easy. Many factors influence the policy-making process. The existence of street vendors is a dilemma because it has an impact as a safety valve for opening up job opportunities, and as a provider of easily available necessities, on the other hand street vendors also create urban chaos. The city of Surabaya responded to these street vendors by making regulations in the form of Regional Regulation No. 17 of 2003 concerning the Arrangement and Empowerment of street vendors and as its implementation was stipulated in Mayor Regulation No. 17 of 2004.

2.2. Understanding Information Technology in Business

2.2.1. Information Technology

According to Sutabri (2014), Information technology is a technology used to process data, including processing, obtaining, compiling, storing, manipulating data in various ways to produce quality information, namely information that is relevant, accurate and timely, which is used for the purposes of personal, business, and government and is strategic information for decision making.

2.2.2. Business Definition

According to Sukirno (2010), business is an activity to gain profit, all people or individuals or groups carry out business activities, of course, to seek profit so that their needs are met. According to Griffing and Ebert (2007), business is an organization that provides goods or services for sale with the intention of making a profit.

2.2.3. Application of Information Technology in Business

According to Diana, the benefits of information technology for companies are: (1) It can develop national and global marketing. (2) Reducing costs, compiling, processing, distributing, storing, and accessing paper-based information. (3) Provide the ability to create special business opportunities through the internet site. (4) Other benefits such as a better image, better customer service, new business partners, access to wider information, and others.

2.3. Strategic Management Model Based on Fred R David Concept (2017)

Fred R. David explained that the strategic management process consists of three stages, namely, formulating strategies, implementing strategies and evaluating strategies. The strategy formulation stage includes establishing a vision and mission, identifying opportunities and challenges facing the organization from an external point of view, determining the organization's weaknesses and strengths from an internal point of view, preparing long-term plans, making alternative strategies and selecting certain strategies that will be implemented

The following is an image of a strategic management model based on the concept of Fred R. David:

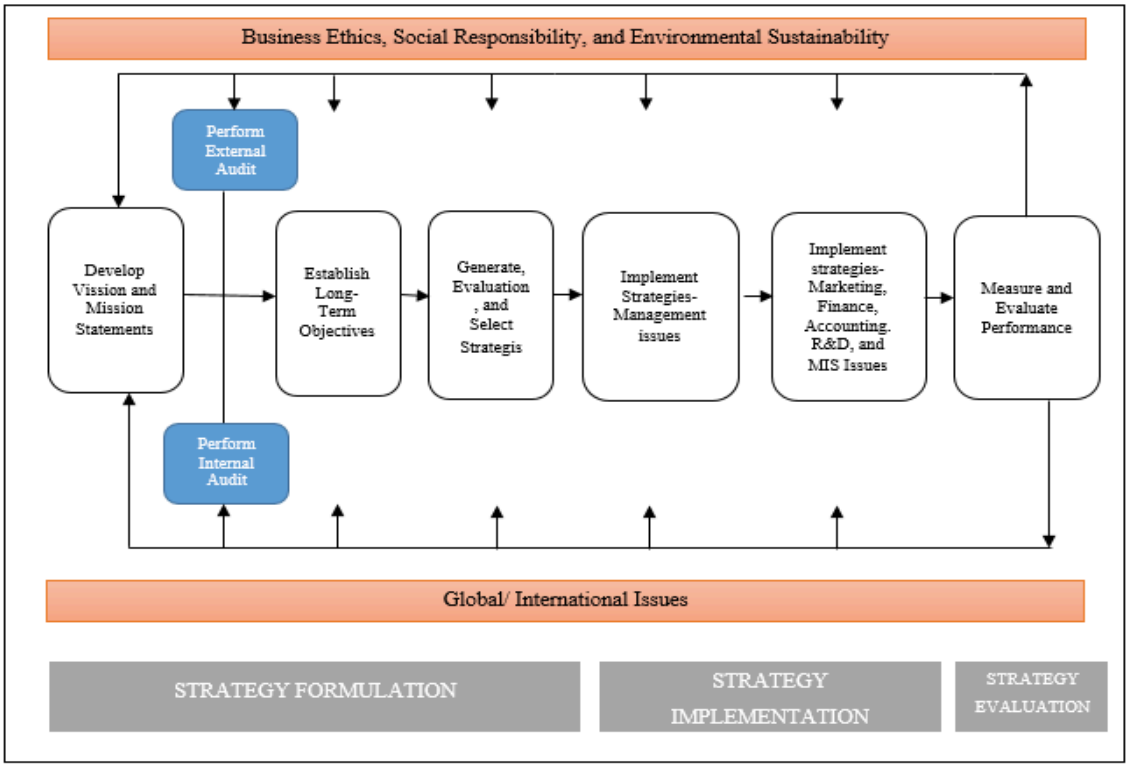

Figure 2.1. Fred R David's Strategic Management Model (2017)

3. METHODS

3.1 Preliminary studies

Preliminary studies are carried out to find the topic of the problem that will be the object to be studied. In this preliminary survey, this was conducted by interviewing the Micro Business Development Department of the Surabaya City Cooperatives and Micro Enterprises to obtain information or information about the Culinary Tourism Centers they foster. Documentation is done to see the current state of the Culinary Tourism Center.

3.2 Study of literature

Literature study is a support for solving problems in research that provides theories and information related to research and becomes the basis for carrying out research. The sources obtained from books, journals, and research that has been done by previous researchers, this literature is also obtained from the internet and libraries. The existence of a clear literature study will make it easier to formulate problems and determine how to solve these problems.

3.3 Data collection

Data is one of the important components, therefore the information obtained must be correct so that the data obtained is accurate. Data collection in this study was carried out by distributing questionnaires. The data in this study consisted of 2 types, namely primary data and secondary data.

1. Primary data

The distribution of IFE and EFE questionnaires to determine the rating was given to 10 Culinary Tourism Center traders at random, then tested the reliability of the distributed questionnaires and if the results of data processing were not valid, the next stage of questionnaire distribution was carried out. The distribution and collection of questionnaires after being declared valid was carried out during August 2021 online through the Google Form media to SWK traders, namely 100 traders at random and 50 consumers at random. The distribution of the QSPM questionnaire was given to the Micro Business sector of the Surabaya City Cooperative and Micro Business Office in September 2021.

2. Secondary Data

Secondary data is data that researchers collect directly to the Surabaya City Cooperatives and Micro Business Office which consists of interviews and documentation.

3.4 Identification of variables and indicators

Internal variables were obtained from interviews with the Surabaya City Cooperatives and Micro Business Office using the marketing mix, namely the 4Ps (product, price, place, promotion).

4. RESULTS

4.1. General Data of Surabaya Culinary Tourism Center

The Culinary Tourism Center in Surabaya is an alternative to finding solutions to fulfill the economic rights of street vendors in the midst of the threat of business uncertainty caused by the eviction and the negative image circulating among the public. The Culinary Tourism Center was built and fostered by the Surabaya City Government at the Surabaya City Cooperative and Micro Business Office.

The development of culinary tourism in the city of Surabaya with street vendors' businesses that are spread evenly in various sub-districts is a close correlation with the policies of the Surabaya city government. With the advancement of the Culinary Tourism Center in the city of Surabaya, the future of street vendors in the city of Surabaya can be saved.

4.2. Data collection

4.2.1. Analyzing and Identifying Conditions of Internal Factors for Culinary Tourism Center of Surabaya City

Table 4.1. Identification of Internal Factors

Internal factors	Strength	Weakness
Product	1. The products sold are the top order in meeting human needs 2. Raw materials are easy to get 3. The quality of the products produced is good and always maintained 4. Many variations of the food and beverage menu are sold.	1. Lack of innovation in the food and beverage menus that are sold. 2. The design of serving food and drinks sold is less attractive.
Price	1. The price of the product is quite affordable. 2. The price of the product is able to compete with other similar products.	1. Affordable product prices create an image of street vendors who pay less attention to quality.
The place	1. The location of the Culinary Tourism Center is spread across several strategic Surabaya areas	1. Simple table and chair arrangement 2. Unattended merchant stand arrangement
Promotion	1. Have city government officials and influencers who can help promote SWK.	1. Lack of use of information technology developments as a marketing and sales medium

4.2.2. Analyzing and Identifying Conditions of External Factors for Culinary Tourism Center of Surabaya City

External factor variables based on macro and micro external environmental analysis (David, 2010) are socio-cultural aspects, economic aspects, political and legal aspects, customer aspects, and competitors aspects.

Table 4. 2 Identify External Factors

External Factors	Opportunity	Threat
Socio-cultural	1. The development of information technology is increasingly advanced. 2. Utilization of information technology for transactions can be a way to increase people's purchasing power, due to the current tendency of people to transact through digital platforms.	1. People's purchasing power depends on economic conditions. An increase in the percentage of the poor and the number of unemployed is a potential decrease in people's purchasing power so that it becomes a threat to the level of sales of Culinary Tourism Centers. 2. The rapidly growing condition of information technology causes the competition between similar businesses to be even tighter.
Economy	1. The price of raw materials decreases, the price of food and beverages sold at the Culinary Tourism Center also decreases, affecting people's purchasing power.	1. The community's economy is unstable due to the COVID-19 pandemic, which reduces people's purchasing power.

External Factors	Opportunity	Threat
Politics and Law	1. The policy of the Surabaya City Cooperative and UM Office in dealing with the free market provides an opportunity for central traders to take advantage of developing information technology to improve the sales and marketing process of their products. 2. There is no government regulation regarding price fixing.	1. The existence of antitrust laws and consumer protection laws.
Customer	1. Consumer behavior that is selective and sensitive to the food and beverages to be purchased	1. Bargaining power of consumers is high
Competitor	1. The existence of competitors can be a benchmark to further improve the quality and quantity of products.	1. Culinary Tourism Center competitors have used online platforms to promote their products and transaction processes. 2. Culinary Tourism Center competitors are better known and in demand by the public.

4.2. Data Processing

4.3.1 Matrix Internal Factor Evaluation (IFE) And External Factor Evaluation (EFE)

From the IFE and EFE matrix, it can be seen that the results of the strength scores are greater than the weaknesses, while the opportunity scores are smaller than the threats.

Strength – Weakness = 1.664 – 1.276 = 0.388

Opportunity – Threat = 1.039 – 1.818 = - 0.779

The results obtained above are then used as a reference for the formation of a SWOT analysis to see the position of the Surabaya City Culinary Tourism Center as follows.

Figure 4. 1 SWOT Analysis Culinary Tourism Center of Surabaya City

4.3.2 Internal External (IE) Matrix

From the results of processing the IFE and EFE matrix data, the IFE value is 2.94 and the EFE is 2.86, then the Surabaya Culinary Tourism Center is located in cell no 5, using the Growth Strategy, namely growth and concentration strategies through horizontal integration. The growth strategy through horizontal integration is an activity to expand growth by building in other locations, and increasing product types.

4.3.3 SWOT Analysis Matrix

The tool used to develop the company's strategic factors is to use the SWOT matrix. This matrix can clearly describe how the external opportunities and threats faced by the company can be adjusted to its strengths and weaknesses. This matrix can produce four sets of possible alternative strategies, namely:

1. SO Strategy
   This strategy is based on the company's way of thinking, which is to take advantage of strengths to seize and exploit opportunities as much as possible.
2. ST strategy
   It is a strategy to use the company's strengths to overcome threats.
3. WO Strategy
   This strategy is implemented based on the utilization of existing opportunities by overcoming the weaknesses they have.
4. WT Strategy
   This strategy is based on activities that are defensive in nature and seeks to minimize existing weaknesses and avoid threats.

4.4. Quantitative Strategies Planning Matrix (QSPM)

After processing the data using QSPM, it can be concluded that the chosen strategy is strategy 2 (ST), because it has a large value of 5.193 with the following strategy:

1. Market expansion by utilizing internet platforms to be more pro-active in marketing products such as GoFood, GrabFood, and so on.
2. Adding a digital screen in each SWK that displays various variations of the menu along with prices and information on ingredients with nutrients contained, various promotions being offered, birthday wishes for visitors whose birthday is on that day.
3. Implementing a single cashier system
4. Utilize digital wallet technology in their transactions.
5. Designing the development of food and beverage product innovations that are sold in terms of taste and presentation to attract more consumer interest.
6. Provide the best promotions and offers on products sold without compromising product quality.
7. Posting menu content and promotions in real time on social media.

5. STRATEGY FORMULATING RESULTS

5.1. Eliminate-Reduce-Increase-Create Scheme (Blue Ocean Strategy)

After going through the analysis of the four-step framework based on the results of the QSPM formulation, the next step is to act in accordance with the results of the framework.

Table 5.1 Four-Step Framework Schematic (Blue Ocean Strategy)

No	Attribute	Currently	Action	Upcoming
1	There is not any	There is not any	Clear it	There is not any
2	Pricing	One of the strategic steps in the QSPM Matrix isprovide the best promotions and offers on products sold without compromising product quality.	Subtract	Promotions and offers by traders are done by reducing the selling price. Culinary Tourism Center traders should make special agreements with suppliers for pricing issues and the continued availability of raw materials, such as making work contracts for a certain period of time

No	Attribute	Currently	Action	Upcoming
				regarding the price of raw materials and the quantity to be purchased so that the price of materials does not follow the market price which continues to rise and the Service Office Cooperatives and Micro-enterprises of Surabaya City must make policies to reduce the booth costs of traders.
3	Utilization of Information Technology	Several strategic steps in the QSPM Matrix are increasing the use of information technology, including:market expansion by utilizing internet platforms, adding digital screens to each SWK, implementing a single casier system, utilizing digital wallet technology in transactions, and posting menu content and promotions in real time on social media.	Upgrade	Utilizing E-Commerce which is currently developing in the sales and marketing process, building an information system for Culinary Tourism Centers designed in accordance with the single cashier policy plan to be built by the Surabaya City Cooperatives and Micro Business Office as well as the use of digital wallets to facilitate sales transactions, and the use of social media such as youtube, instagram, facebook, and tik tok for marketing media for the Surabaya City Culinary Tourism Center.
4	Information System Expert	The Surabaya City Cooperative and Micro Business Office can create information system personnel to support the development of the Culinary Tourism Center information system in order to increase marketing and sales.	Create	The experts needed in creating this information system are Front-end Developers, Back-end Developer, and Android Developer.

6. CONCLUSIONS

Based on the analysis and discussion process that has been carried out, the following conclusions can be drawn:

1. The EFAS and IFAS Matrix shows that the position of the Surabaya City Culinary Tourism Center is in quadrant II, namely the Diversification strategy. The Culinary Tourism Center needs to develop a growth strategy that involves adding products, services and markets to its business. Basically the product diversification strategy is one of the important strategies in increasing sales volume.
2. Through the Internal-External Matrix (IE), it shows the Culinary Tourism Center of the City of Surabaya is located in cell no 5, using the Growth Strategy, namely growth and concentration strategies through horizontal integration. The Surabaya City Culinary Tourism Center is located in cell 5 so that it can expand market share, production facilities, and technology through internal and external developments through acquisitions or joint ventures with other businesses in the same industry.
3. Through data processing using QSPM it can be concluded that the chosen strategy is strategy 2 (ST), with the following strategies:
   - Market expansion by utilizing internet platforms to be more pro-active in marketing products such as GoFood, GrabFood, and so on.
   - Adding a digital screen in each SWK that displays various variations of the menu along with prices and information on ingredients with nutrients contained, various promotions being offered, birthday wishes for visitors whose birthday is on that day.
   - Implementing a single cashier system
   - Utilize digital wallet technology in their transactions.

- Designing the development of food and beverage product innovations that are sold in terms of taste and presentation to attract more consumer interest.
- Provide the best promotions and offers on products sold without compromising product quality.
- Posting menu content and promotions in real time on social media.

Based on the results of the study, it can be concluded as follows:

1. Culinary Tourism Center of Surabaya City can make promotions and offers by reducing the selling price. Culinary Tourism Center traders should make special agreements with suppliers for pricing issues and the continued availability of raw materials, so that material prices do not keep up with market prices that continue to rise and the Surabaya City Cooperatives and Micro Business Office must make policies to reduce the costs of traders' booths.
2. The Culinary Tourism Center of the City of Surabaya needs to increase the use of information technology by:
    - Utilizing E-Commerce which is currently developing in the sales and marketing process.
    - Develop a Culinary Tourism Center information system designed in accordance with the single cashier policy plan to be built by the Surabaya City Cooperatives and Micro Business Office.
    - Utilize a digital wallet to facilitate sales transactions.
    - Utilize social media such as YouTube, Instagram, Facebook, and Tik Tok as marketing media.
3. The Surabaya City Cooperative and Micro Business Office can create information system personnel to support the development of the Culinary Tourism Center information system in order to increase marketing and sales. The expert dragon needed in creating this information system is a Front-end Developer, Back-end Developer, and Android Developer.

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KNOWLEDGE INFRASTRUCTURE DEVELOPMENT ANALYSIS TO INCREASE RESEARCH PRODUCTIVITY

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ABSTRACT

This study aims to determine the application of knowledge infrastructure, the effect on research productivity, and strategies to increase research productivity at ITG. The research method used is Mix Methods with Explanatory Mix Methods Design using multiple linear regression analysis and triangulation. The study results indicate that in terms of organizational culture, ITG has implemented a culture in the form of a study center and knowledge sharing. In terms of information technology, ITG has implemented Technology in the form of electronic journals, plagiarism checks, and the use of Grammarly to assist writing. ITG has implemented the SADA system in its management in terms of organizational structure, and there is an LPPM that facilitates lecturer research. Meanwhile, ITG has implemented research incentives and grant schemes to improve lecturers' research performance in terms of research productivity. The results also show that, partially, organizational culture and information technology do not affect research productivity, while the corporate structure has a significant positive effect on research productivity. Strategies to increase research productivity are implementing regular meetings between LPPM and lecturers, establishing policies that require lecturers to have a research roadmap, directing lecturers to obtain research grants, and encouraging the active role of lecturers in conducting research.

Keywords: Knowledge Infrastructure, Research Productivity, Multiple Linear Regression Analysis, Triangulation.

1. PENDAHULUAN

Science and Technology can affect the development of the environment because this science and Technology create new demands for all fields to innovate. For innovation and renewal to continue developing, facilities or activities are needed to facilitate each individual to convey their ideas [1]. Facilities or actions are required to enable each individual to share his ideas or ideas [1]. One of them is through college. Universities have a role and social responsibility for the educational process of their students, not only about science but also honing soft skills and hard skills [2]. This form of accountability is embodied in the Tridharma of Higher Education. Based on the Tridharma points of higher education, research is one of the essential things to do.

However, in reality, the level of research in Indonesia is still low. This is proven based on SCIMAGO data in 2020. At the world level, Indonesia is ranked 21 for the number of documents published internationally. In the Asian region, Indonesia's position is rated 5 [3]. Meanwhile, based on [4], in 2021, Indonesia will be ranked first compared to other ASEAN countries. According to Muhammad Dimyati in [5], international publications have increased quite significantly in the last four years because there are around 100 thousand more potential Indonesian researchers who can publish both national and national and national-international magazines. Based on this, one way to improve the quality of research in Indonesia is through universities.

Garut Institute of Technology (ITG) is one of the universities located in Garut Regency, which has a vision of "To become a superior higher education provider in the field of engineering with outputs that are globally competitive and based on local wisdom by 2030". ITG research and publication level is still low and needs to be improved. The low level of publication is due to the limited knowledge and writing procedures among lecturers. Based on the level of publication of ITG in [6], in 2018, there were 36 publication documents. In 2019 there were 61 publication documents. In 2020, there were 21 publication documents, and in 2021 there were 21 publication documents. Based on the published data, from 2020 to 2021, there was a decrease in total publications from 2019. The factor that influenced this was the COVID-19 pandemic, which hampered the research process.

Overall, the level of publication of ITG can be said to be good. However, when viewed more specifically, the number of publications for each lecturer is still lacking due to the inequality of lecturers in conducting research publications. Therefore, it is necessary to share knowledge among lecturers regarding publications. Improvement efforts are made through Knowledge Management to transfer and share knowledge. However, it is essential to strengthening the KM process to have infrastructure support and complement, namely through knowledge infrastructure [7].

Previous research conducted [8] aims to identify the impact of knowledge-sharing behavior on research productivity. Based on the previous study, in general, knowledge management has been implemented at the Garut Institute of Technology, namely in sharing forums, joint publications, expertise groups, and incentives & research proceedings. However, this is not good enough to support the equality of this publication.

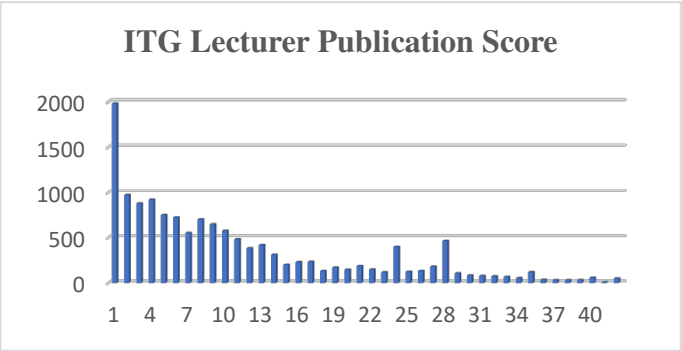

Figure 1. ITG Lecturer Publication Score
Source: (Author's Documentation, 2022)

2. LITERATUR REVIEW

Knowledge Infrastructure

According to (Alaarj, Zainal A.M., & Bustaman, 2016) in [9], Knowledge management infrastructure is an organizational condition that allows in helping organizations manage administrative knowledge processes. (Gold et al., 2001) in [9] also suggests that three main infrastructures allow maximizing social capital the three infrastructures are:

a. *Technology*

Technology in the knowledge infrastructure enables a more effective transfer of knowledge within and outside the organization. (Alameh et al., 2011) in [9], defines Technology as an "information infrastructure and its ability to support knowledge management architecture." According to (Ali et al., 2014) in [9], Technology can help every process of knowledge creation in knowledge management. Therefore, this Technology must continue to be developed because technology development positively impacts organizational strategy and performance.

b. *Organization Structure*

The organizational structure has an essential function of management that allows it to help achieve organizational goals. Creating an excellent corporate system can provide a conducive knowledge-sharing environment through collaboration and support from team members (Wen, 2009) in [9]. An organizational structure can encourage tacit knowledge exchange, enabling learning and growth among employees. (Walczak, 2005) in [9].

c. *Organization Culture*

According to (Meso & Smith, 2000; Imran, 2014) in [9], culture can be defined as shared beliefs, norms, ethics, and practices in an organization that can be observed even though they are intangible. Further (Gold et al., 2001) explains that the company's vision is essential in creating an influential knowledge management culture.

Research Productivity

Research in terms of publications has an essential role in a university because it is a criterion for measuring university rankings [10]. In addition, [8] said that research productivity is crucial in maintaining higher education management sustainability. Based on this, most governments worldwide have implemented assurance mechanisms for research productivity that include improving research and the quality of higher education institutions (Wills et al., 2013) in [10]. So that productivity can produce good research, it is necessary to take steps to improve both at the personal level of students and lecturers and from university management.

One way to achieve research productivity is to encourage all existing parties to share their knowledge through formal and informal methods. Knowledge Sharing has proven to be the best strategy for distributing knowledge in higher education institutions and other industries where knowledge is a strength [10]. Research publications have been recognized worldwide as a medium through which academics in higher education institutions expand their social interactions and knowledge economy (Dhillon et al., 2015) [10]. Quality research will affect the nation's development because considered a valuable asset for higher education institutions.

Hypothesis

The hypotheses of this research are as follows:

a. H1: Organizational culture (X1) positively affects research productivity (Y).
b. H2: There is a positive effect of *information technology* (X2) on research productivity (Y).
c. H3: Organizational structure (X3) positively impacts research productivity (Y).
d. H4: There is a simultaneous influence from X1, X2, and X3 on research productivity.

3. METHODS

The data in this study will be processed using a Mixed Methods approach. According to (Sugiyono, 2014) in [11], the combination method is a research method that combines qualitative and quantitative approaches to be used together in one study. The research design in this study uses Explanatory Mixed Methods Design, which combines quantitative and qualitative methods sequentially. The first stage uses quantitative methods through multiple linear regression analysis

and qualitative methods through triangulation analysis. This qualitative method describes the results obtained from the quantitative processing obtained. This study has three research objectives. The first objective will be obtained using the triangulation method through the interview process. The second goal will be obtained using the multiple linear regression analysis methods. The third objective will be obtained using the triangulation method through the interview process.

The population in this study is permanent lecturers at the Garut Institute of Technology, amounting to 53 people. Because the number of respondents is small, the sample is taken using a saturated sampling technique where all lecturers remain as respondents in this study. At the same time, the operational variables used in this study refer to research [7] on Knowledge Management Infrastructure and operating variables that refer to analysis [10] on research productivity. The statement questionnaire distributed to permanent lecturers at ITG uses the Likert Scale method.

4. RESULT

Validity Test

Tabel 1. Comparison of Validity Test

No.	Questionnaire Code	r count	r table	Description
1	OC1	0.274	0.2284	Valid
2	OC2	0.334	0.2284	Valid
3	OC3	0.345	0.2284	Valid
4	OC4	0.513	0.2284	Valid
5	IT1	0.522	0.2284	Valid
6	IT2	0.456	0.2284	Valid
7	IT3	0.324	0.2284	Valid
8	IT4	0.551	0.2284	Valid
9	OS1	0.292	0.2284	Valid
10	OS2	0.719	0.2284	Valid
11	OS3	0.552	0.2284	Valid
12	OS4	0.508	0.2284	Valid
13	PP1	0.724	0.2284	Valid
14	PP2	0.628	0.2284	Valid
15	PP3	0.690	0.2284	Valid
16	PP4	0.556	0.2284	Valid
17	PP5	0.687	0.2284	Valid
18	PP6	0.584	0.2284	Valid

Source: (Data Processing, 2022)

Provisions for data validity are carried out by comparing r count with r tables, provided that if r count > r table, then the data is declared valid. Based on Table 1, it can be concluded that all data are declared valid because the calculated r-value for each information is > from the r table.

Reliability Test

Table 2. Processing of Data Reliability Test

Reliability Statistics

Cronbach's Alpha	N of Items
.840	18

Source: (SPSS Processing, 2022)

The standard provisions used in the reliability test are that if the Cronbach's Alpha value is 0.60, the data is reliable (Panjaitan, 2018). Table 2. states that the reliability test produces a Cronbach Alpha value of 0.840 with a total of 18 questions. Based on this value, it can be concluded that the Cronbach Alpha value is > 0.60, and the data is declared reliable.

Descriptive Statistical Analysis

Table 3. Recapitulation of Descriptive Statistical Analysis

No.	Variable	N	Mean	%Mean	Category
1	*Organizational Culture* (X1)	53	4.55	90.94	Sangat Baik
2	*Technology Information* (X2)	53	4.42	88.30	Sangat Baik
3	*Organizational Structure* (X3)	53	4.05	81.04	Baik
4	Produktivitas Penelitian (Y)	53	3.88	77.55	Baik

Source: (Data Processing, 2022)

Table 3. This shows that the variables X1 and X2 applied at ITG have an excellent category, while the X3 and Y have a suitable type.

a. Organizational Culture

ITG already has a study center that aims to facilitate all lecturers who have the same competence to share knowledge between one lecturer and another. Then the manifestation of the discussion results includes conducting research publications involving one lecturer with other lecturers. In addition, ITG has also implemented a culture of sharing relevant topics and magazines in the future by the dynamics of development.

b. Technology Information

ITG is a university with an information technology background, so the support for this information technology facility is sufficient, including electronic journals such as algorithm journals, construction journals, PKM journals, and others. In addition, currently, ITG has also used Check Plagiarism to make it easier to check whether the level of plagiarism is still acceptable or not. Then from the language factor, ITG has used Grammarly to help with writing.

c. Organizational Structure

The organizational structure of ITG is carried out as streamlined as possible to prioritize efficiency. Therefore, ITG establishes decentralized decision-making. Meanwhile, ITG uses the SADA system (Administrative Centralization and Academic Decentralization) in management. Centralized Administration means that ITG manages all records, finances, and administrative management. In contrast, Academic Decentralization means that study programs work curriculum, floating courses, and related to academics. To encourage lecturers to be more critical and intelligent and to facilitate the discovery and creation of knowledge, ITG established a policy requiring lecturers to integrate research results with courses. In addition, ITG also definitely has a Research and Community Service Institute (LPPM), where this LPPM is to facilitate lecturer research productivity through its agenda.

d. Research Productivity

ITG has set a research incentive, a basic salary every year, plus incentive money for research. However, suppose in one year, the lecturer cannot research according to the standards at ITG. In that case, the research incentive money will not automatically be obtained again in the following year. On the other hand, ITG also has a research scheme in the form of internal grants, which means that ITG will provide funds when lecturers research according to specified standards. When viewed from the activeness of lecturers in attending conferences regularly, currently only some lecturers are still active in attending meetings.

Classic Assumption Test

a. Data Normality Test

Tabel 4. Processing of Data Normality Test

		Unstandardized Residual
N		53
Normal Parameters[a,b]	Mean	.0000000
	Std. Deviation	2.53078132
Most Extreme Differences	Absolute	.098
	Positive	.095
	Negative	-.098
Test Statistic		.098
Asymp. Sig. (2-tailed)		.200[c,d]

Source: (SPSS Processing, 2022)

Based on Table.4, it is known that the Asymp. Sig value is 0.20, meaning that the Asymp. Sig value is > 0.05, and the data is typically distributed.

b. Heteroscedasticity Test

Tabel 5. Heteroscedasticity Test Processing

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.798	3.396		.529	.599
	Organizational_Culture	.223	.182	.186	1.229	.225
	Information_Technology	-.054	.163	-.055	-.334	.740
	Organizational_Structure	-.177	.132	-.206	-1.336	.188

Source: (SPSS Processing, 2022)

The provisions of the heteroscedasticity test are if the significance value is > 0.05, then there is no heteroscedasticity. Table 5. shows the significance value of the organizational culture variable of 0.225 > 0.05, the information technology variable of 0.740 > 0.05, and the organizational structure variable of 0.188 > 0.05. Based on this value, it can be concluded that all variables do not have heteroscedasticity problems because the significance value of each variable is > 0.05.

c. Multicollinearity Test

Table 6. Multicollinearity Test Processing

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	3.632	6.041		.601	.550		
	Organizational_Culture	.512	.324	.219	1.581	.120	.831	1.203
	Information_Technology	.046	.290	.024	.157	.876	.709	1.411
	Organizational_Structure	.587	.235	.352	2.499	.016	.805	1.242

a. Dependent Variable: Produktivitas_Penelitian

Source: (SPSS Processing, 2022)

The provisions of the multicollinearity test are if the Tolerance value > 0.10 and the VIF value < 10, then multicollinearity occurs. On the contrary, if there is no multicollinearity, the Tolerance value is < 0.10 and the VIF value > 5. Table 6. shows that the organizational culture variable obtained a tolerance value of 0.831 with a VIF value of 1.203, the information technology variable received a tolerance value of 0.709 with a VIF value of 1.411, and the organizational structure variable obtained a tolerance value of 0.805 with a VIF value of 1.242. Based on this value, it can be concluded that all variables are declared free from multicollinearity problems.

Multiple Linear Regression Analysis

a. Partial Test

Table 7. Partial Test Processing

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.632	6.041		.601	.550
	Organizational_Culture	.512	.324	.219	1.581	.120
	Information_Technology	.046	.290	.024	.157	.876
	Organizational_Structure	.587	.235	.352	2.499	.016

Source: (SPSS Processing, 2022)

Based on **Table 7** using a significance level of 5%, the results obtained are:

1) I have known the value of Sig. for the Organizational Culture variable of 0.120 > 0.05 and the t value of 1.581 < 1.677. It can be concluded that accept H0 and reject H1, meaning that there is no influence of the Organizational Culture variable on Research Productivity.
2) I have known the value of Sig. for the Information Technology variable of 0.876 > 0.05 and the t value of 0.157 < 1.677. It can be concluded that accept H0 and reject H1, meaning that there is no influence of Information Technology variable on Research Productivity.
3) I have known the value of Sig. for the Organizational Structure variable of 0.016 < 0.05 and the t value of 2.499 > 1.677. It can be concluded that H0 is rejected and H1 is accepted, meaning that there is a positive and significant influence of the Organizational Structure variable on Research Productivity with a coefficient of determination of 0.352 or research productivity has an effect of 35.2%.

b. Simultaneous Test

Table 8. Simultaneous Test Processing

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	93.249	3	31.083	4.573	.007[b]
	Residual	333.052	49	6.797		
	Total	426.302	52			

a. Dependent Variable: Produktivitas_Penelitian

b. Predictors: (Constant), Organizational_Structure, Organizational_Culture, Information_Technology

Source: (SPSS Processing, 2022)

Based on **Table 8**, it is found that the calculated f value is 4.573 and f table is 1.677 so that the equation f arithmetic > f table (4.573 > 1.677) and the importance of Sig. of 0.007 < 0.05 so it can be concluded that the decision making is rejected H0 and accept H1 which means that there is an effect of X1, X2 and X3 simultaneously on research productivity.

c. Coefficient of Determination

Table 9. Coefficient of Determination Processing

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.468[a]	.219	.171	2.607

a. Predictors: (Constant), Organizational_Structure, Organizational_Culture, Information_Technology

Source: (SPSS Processing, 2022)

Based on **Table 9**. obtained R Square value of 0.171, it can be concluded that the effect of variables X1, X2, and X3 simultaneously on variable Y or research productivity is 17.1%. This means that 17.1% of research productivity can be explained by variables of organizational culture, information technology, and organizational structure, while other variables outside the model explained 82.9%.

Discussion

a. The Effect of Organizational Culture (X1) on Research Productivity (Y)

Data processing explains that organizational culture does not affect research productivity. However, when viewed from the average percentage of sub-variables, this corporate culture has a rate of 90.94%, meaning that the Garut Institute of Technology has implemented an excellent organizational culture. Based on the interviews conducted, information was obtained that the corporate culture currently applied at ITG may still be not strong in building research productivity because building a culture requires trust and cooperation. Meanwhile, if viewed from the questionnaire results on the organizational culture sub-variable, trust and collaboration have the smallest average percent to the first and second of the four indicators. One of the problems that often occur at ITG is cooperation because, in reality, there are many lecturers at ITG. They work independently, so they are only done alone without any collaboration. Based on this, it is necessary to increase the culture to support research productivity by increasing trust in the organization. This level of trust has a percentage of 87.17% and is the lowest value.

b. The Effect of Technology Information (X2) on Research Productivity (Y)

Data processing explained that Information Technology does not affect productivity. However, when viewed from the average percentage gain of the sub-variables, this information technology has a percentage of 88.30%, which means that the Garut Institute of Technology should already have good information technology that can support research productivity. Based on the interviews conducted, information was obtained that this information technology is supported or not supported by ITG. However, it is still available anywhere and anytime because, in the current condition, all groups can use information technology support independently. Then the technological infrastructure facilities owned by each individual are also well available. However, even so, ITG continues to provide good information technology facilities as a form of service even though it is not needed by personnel at ITG because currently all personnel also have independent information technology infrastructure, especially in pandemic conditions like now, the government has subsidized the use of pulses and quotas for students and lecturers to support the learning process during.

c. The Effect of Organizational Structure (X3) on Research Productivity (Y)

Based on the data processing results, it is explained that organizational structure influences productivity. When viewed from the average % acquisition of the sub-variables, this organizational structure has a percentage of 81.04%, meaning that the organizational structure at the Garut Institute of Technology is already in a suitable category. Based on the results of interviews conducted, information was obtained that several factors influence the level of research productivity at ITG in terms of the organizational structure, including the existence of the Institute for Research and Community Service (LPPM), the presence of research incentives, and research assistance schemes that are said to be effective in encouraging the research performance of lecturers at ITG.

a. There is an LPPM that Facilitates Lecturer Research

This LPPM can encourage lecturers' willingness to research to achieve research productivity. This statement is evidenced by the increasing number of research proposals for simlitabmas, as indicated by comparisons in 2020 and 2021. Before the management and research facilities, ITG had five research proposals, but after the management and facilities, ITG research proposals rose to 27 recommendations. This indicates significant changes caused by the existence of LPPM in ITG.

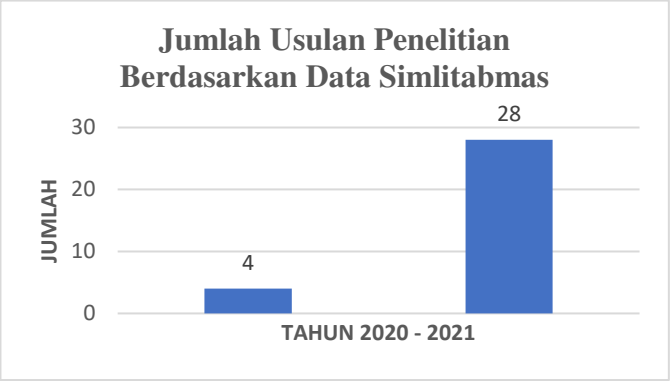

Figure 3. Number of Research Proposals Based on Simlitabmas Data

Source: (Data Processing, 2022)

b. There are Research Incentives and Research Funding Assistance

The implementation of research incentives and research funding assistance can increase research productivity and is considered effective in encouraging research performance. After this research incentive, lecturers become more frequent in submitting research proposals. Although this research incentive has not been applied for a long time at ITG so that representative changes cannot be seen, when viewed from the anomio side, research at ITG has increased, which is marked by increasing research proposals submitted to LPPM where there is a continuous increase from time to time.

The right Knowledge Infrastructure Development Strategy is used at ITG

The right strategies used at ITG to increase research productivity are:

a. Implement regular meetings between lecturers and LPPM to share related research conducted.
b. Establish a policy that every lecturer must have a research roadmap for the future so that future research can be mapped well.
c. Lecturers at ITG are directed to obtain research grants from outside, not only in grand schemes to improve lecturers' research performance. Based on the results of the questionnaire distribution, there are still many lecturers who disagree about the indicators of research grants.
d. We encourage lecturers' active role in researching by monitoring the progress of lecturers' research activities as a first step and forming the lecturers' habits.

5. CONCLUSION

The conclusions from this research are:

a. The result of processing on descriptive statistical analysis shows that:
   1) ITG has implemented an organizational culture in a study center to facilitate lecturers with the same competence and a culture of sharing topics and relevant publications.

2) ITG already has an electronic journal; check plagiarism to check the level of plagiarism from research and subscribe to Grammarly to help with writing.
3) ITG has implemented a decentralized decision-making system and SADA system in its management. All forms of Administration are managed directly by ITG, and study programs manage all literary forms. In addition, there is a policy to integrate research results with courses and an LPPM institution that facilitates research productivity.
4) ITG has implemented research incentives and grant schemes to support the research process.

b. Partially organizational culture and information technology do not affect research productivity. In contrast, the organizational structure affects research productivity by 35.2%, and other variables outside the model influence the rest. Simultaneously, corporate culture, information technology, and organizational structure positively and significantly impact research productivity with the acquisition coefficient of determination of 0.171, which means the magnitude of the effect is 17.1%.

c. The right strategy applied at ITG to increase research productivity is by implementing regular meetings between LPPM and lecturers, establishing policies that require lecturers to have a research roadmap, directing lecturers to obtain research grants, and encouraging the active role of lecturers in conducting research.

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STRATEGIES TO MAINTAIN ARABICA COFFEE FARMING DURING THE COVID-19 PANDEMIC (CASE STUDY OF CINTA VILLAGE FOREST FARMER GROUP)

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ABSTRACT

This study aims to identify internal and external factors in Arabica coffee farming to formulate alternative strategies for maintaining agriculture during the covid-19 pandemic. This research was conducted at the Cinta Village Forest Farmers Group in Garut Regency. The analytical method used in this research is the SWOT(Strength, Weakness, Opportunity, Threat) analysis method and Analytical Network Process (ANP). From the SWOT analysis data through the IFAS(Internal Strategic Factors Analysis Summary) matrix, which describes the company's strengths and weaknesses, the EFAS(External Strategic Factors Analysis Summary) matrix, which describes the opportunity and threat factors, is then calculated in the IE(Internal-External) matrix which shows the company is in a quadrant V means to hold and maintain. The most prioritized alternative strategy is selected using ANP. The priority sequence of the chosen method is to improve coffee quality and increase income by post-harvest processing through the development of clean coffee production, diversifying farming to increase farmers' income during the covid-19 pandemic, and maintaining income by processing and storing coffee beans for sale when prices rise again.

Keywords: Maintaining Strategy, SWOT Analysis, Analytical Network Process (ANP)

1. INTRODUCTION

Indonesia is an agricultural country, and the agricultural sector still plays a vital role in the national economy. It is proven that the contribution value of the Gross Regional Domestic Product in the farming sector is still at the top. There are five essential plantation commodities in Indonesia, one of which is coffee. Coffee is one of the plantation commodities that play a crucial role in the Indonesian economy (Direktorat Jenderal Pertanian, 2019). The average coffee export volume is about 430,000 tons/ year, consisting of 85% Robusta and 15% Arabica (Indonesian Investment, 2015). (KPPU, 2020), stated that in 2018 the country's foreign exchange from the export value was obtained at USD 579.98 from the contribution of the national coffee processing industry. One of

the coffee-producing areas in Indonesia that are now growing is West Java. The coffee it produces is known as the well-known Arabica Java Preanger coffee worldwide since the 18th century (BPS Jawa Barat, 2020).

Arabica coffee cultivation is spread in various areas of West Java, one of which is in Cinta Village, Garut Regency. The Cinta Village Forest Farmers Group cultivates an environment suitable for Arabica coffee cultivation. The coffee produced by the Cinta Village Forest Farmers Group is also known as Garut Coffee. Farmers widely grow this type of coffee because the quality possessed by this type of coffee is better than other types of coffee, so it has a higher selling value.

In its development, coffee farmer groups often face technical problems that affect their business, one of which is currently the coronavirus disease-19(covid-19) pandemic. According to the*World Health Organization (WHO), Covid*-19 is a disease caused by a new coronavirus called SARSCoV2 identified at the end of December 2019. Then on March 9, 2020, WHO officially declared that this disease was a pandemic because it had infected almost every country in the world (WHO, 2020).

The impact of this pandemic on coffee farmers is that the supply chain and international coffee marketing have been hampered for the past two years due to the application of restrictions in the region or country that is the destination. This causes a decrease in the purchase price of coffee at the farmer level, which impacts the decline in the coffee farmers' income. Meanwhile, the Cinta Village Forest Farmers Group only relies on revenue from the sale of cherry coffee because this Forest Farmers Group does not produce coffee bean processing.

Therefore, during the Covid-19 pandemic situation, various efforts are needed so that the Cinta Village Forest Farmers Group can maintain their farming. Things that can be done to overcome these problems are by formulating strategies. One of the tools used is a SWOT analysis. SWOT can be a reasonable basis for successful planning and policy formulation. However, the obstacle in this SWOT analysis approach is that it cannot explain the priority of the proposed factor or policy (Masozera, 2006). One of the decision-making methods used to select strategies for farming problem solving is the ANP method. In previous studies, ANP was used to decide on a robust coffee development strategy in Jember that could support stakeholders in decision-making by ranking alternatives. (Kasutjianingati, 2020). This research has a purpose to identify internal and external factors that influence the strategy of maintaining Arabica coffee farming in the Cinta Village Forest Farmers Group. And also to formulate alternative strategies in maintaining Arabica coffee farming in this Cinta Village Forest Farmers Group.

2. LITERATURE REVIEW

SWOT Analysis

The SWOT analysis identifies various factors systematically to formulate corporate strategy. This is based on a logic that can maximize internal strengths and opportunities and minimize external weaknesses and threats (Rangkuti, 1998). Furthermore, the business environment in SWOT is divided into two environments: the internal environment and the external environment.

1. The internal environment is the company's strengths and weaknesses in its functional areas. Examples are company management, marketing management, financial or accounting systems, information systems, and manufacturing operations (David, 2009).

2. The external environment is a process carried out by strategic planning that brings together factors from the external environment to identify opportunities and threats to the company

Then, an IFAS (Internal Factor Analysis Strategic) matrix and an EFAS(External Factor Analysis Strategic) matrix were formed, consisting of columns, weights, ratings, and the total value resulting from multiplying the weights and ratings. The weights and rating column is populated with the resulting values of grouping internal and external factors according to their importance.

SWOT analysis is an analytical tool used to identify various factors influencing strategy formulation. Companies can adopt alternative strategies through a qualitative approach to SWOT analysis by considering the relationship between SWOT factors (Novitasari, 2020).

Analytical Network Process (ANP)

Process Analytical Network or ANP is a mathematical theory that helps to take decisions to deal with relevant factors (dependencies) and systematic feedback. This connection is intended for lower-level elements only. A network has elements in one cluster interconnected with elements in other clusters (external dependencies) or the same cluster (internal dependencies). Hierarchies are specific networks that are connected in only one direction. Priority resulting from pairwise comparisons as part of the column in the supermatrix. The supermatrix prioritizes the influence of the elements on the left side of the matrix over the aspects above the matrix for specific control criteria (Novitasari, 2020).

ANP is a multi-criteria (parameter) based decision-making method developed by Thomas L. Saaty. This method is a new approach to the old way, a qualitative method that continues the analytic hierarchy process (AHP) (Saaty, 2008). An ANP network can contain criteria and alternatives called nodes. In addition to using a tiered network, you can create a feedback network to make decisions. As already mentioned, this network explains the situation of very complex research problems in more detail. The ANP method can improve AHP's weaknesses in examining relevance between criteria or alternatives (Saaty, 2006).

3. METHODS

Case study is the method that used in this study. Case study methods are helpful when researchers have little control over what they are studying and focus on modern phenomena in real-world situations (Hermanuadi, 2016).

3.1 Research Methods and Data Collection

The survey method is the method used in this research. As for the data used in this study consisted of primary data obtained from interviews and observations. In contrast, secondary data was obtained from the documentation of the Cinta Village government and various other literary sources.

3.2 Respondent Determination Technique

Determination of respondents in this study using purposive sampling technique in which the selected informants are four members of a farmer group and a coffee supplier. They are chosen based on the criteria of the researcher's needs.

3.3 Analysis Techniques

The analysis technique in this study uses the SWOT analysis method to formulate strategies and ANP to determine which strategy should be chosen.

4. RESULTS

4.1 Matrix Internal Strategic Factors Analysis Summary (IFAS)

Based on the results of interviews and data validation carried out, six internal factors (Strength & Weakness) indicators were obtained. The Cinta Village Forest Farmers Group is shown in Table.1:

Table 1. IFAS Matrix Cinta Village Forest Farmers Group

No	Strategic Factor	Weight	Rating	Score
	***Strengths* (S)**			
1	Availability of large enough land	0.19	3.72	0.71
2	Land characteristics suitable	0.07	3.22	0.23
3	Low production cost	0.25	3.46	0.87
	Amount	**0.51**		**1.81**
	***Weaknesses* (W)**			
4	Lack of capital for farming development	0.26	1.19	0.31
5	Farm owners are less innovative	0.07	1.68	0.12
6	Functional empowerment of farmer groups is not optimal	0.15	1.68	0.26
	Amount	**0.49**		**0.69**
	Total Weighted Score	**1.00**		**2.92**

4.2 Matrix External Strategic Factors Analysis Summary (EFAS)

Based on the interview results and the data validation conducted, six indicators of external factors (Strength and Weakness) were obtained. The Cinta Village Forest Farmers Group is shown in Table 2:

Table 2. EFAS Matrix Cinta Village Forest Farmers Group

No	Strategic Factor	Weight	Rating	Score
	***Opportunities*(O)**			
1	The demand for Arabica coffee is very large	0.20	3.72	0.73
2	Good relationship with suppliers	0.07	3.00	0.21
3	The increasing trend of Coffeeshop	0.12	3.00	0.35
4	Government policies that support farming	0.13	3.22	0.40
				1.69
	***Threats* (T)**			
5	Covid-19 pandemic	0.25	1.00	0.25
6	Many competitors from other regions	0.20	1.41	0.28
7	The presence of pests and diseases on Arabica coffee plants	0.04	2.00	0.09
	Amount	**0.49**		**0.62**
	Total Weighted Score	**1.00**		**2.78**

4.3 Internal External Matrix (IE)

After knowing the values of the IFAS and EFAS matrix, the next step is to compile the IE Matrix by entering the IFAS (2.92) and EFAS (2.78) scores as the coordinates of the IE matrix. So it can be seen that the position of the Cinta Village Forest Farmers Group is in quadrant V. Companies in quadrant V are companies that support the strategy to hold and maintenance. (Fred R, 2013).

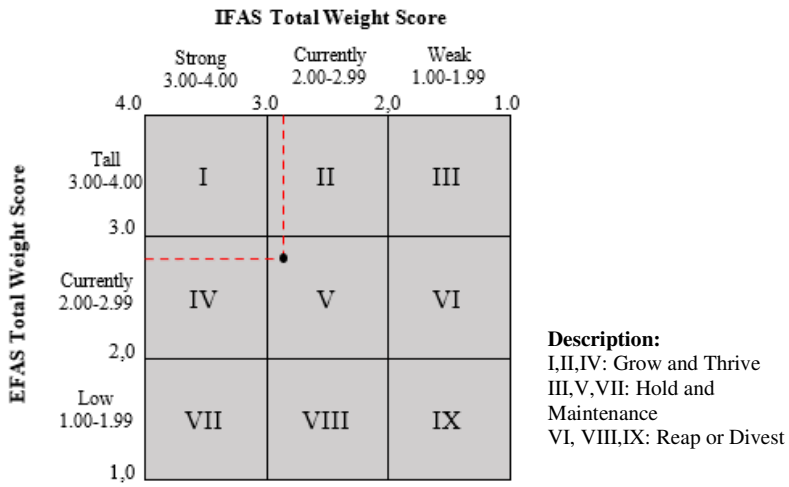

Figure 1. IE Matrix of Cinta Village Forest Farmers Group

4.4 SWOT Matrix

The SWOT Matrix is a tool used to make strategic decisions that consider strengths, weaknesses, opportunities and threats. The SWOT matrix consists of strategy formulations, namely SO (Strengths with Opportunities) strategy, WO (Weakness with Opportunities) strategy, ST (Strengths with Threats) strategy, and WT (Weakness with Threats) strategy. The following are the formulations of the strategy:

SO Strategy:

1) Provide added value for coffee by developing the processing of agricultural products (S1, S2, O1, O3)
2) Maximizing the processing of coffee fields through collaboration with the agriculture and plantation offices to receive training. (S1, S2, O4)

WO Strategy:

1) Seeking sources of business capital by partnering with government and private institutions to obtain business capital in providing inputs for farming businesses and maintaining their farms. (W1, W3, O4)
2) Maintaining farmer groups as a medium for efficient and productive coffee plant management through the assistance of local governments and suppliers. (W2, W3, O2, O4)

ST Strategy:

1) Improve coffee quality and increase income by post-harvest processing through the development of clean coffee production (S1, S2, S3, T2, T3).

2) Maintaining income by processing and storing coffee beans to sell when prices rise again (S2, S3, T1)
3) Diversify farming to increase farmers' income during the covid-19 pandemic (S1, S2, T1)

WT Strategy:

1) Prevent and minimize pest and disease attacks by farmer groups in collaboration with government agencies to carry out counseling (S3, T3)

From the alternative strategies in the SWOT matrix above, the strategy that best fits the criteria in the IE matrix in quadrant V is the strategy on ST (Strength-Theat). So the three ST strategies will be carried out by Cinta Village Forest Farmers Grouin the order of the most prioritized strategy, which will be selected later using the ANP method.

4.5 *Analytical Network Process* (ANP)

When using the ANP approach to determine strategic priorities, the first level of modeling is done using SuperDecisions software. The pairwise comparison matrix was evaluated with ANP modeling. In the pairwise comparison matrix, there are interactions between elements within a cluster (inner dependencies) and relationships between elements between different clusters (outer dependencies) (Iwan J, 2003).

Figure 2 shows an ANP model with super decisions:

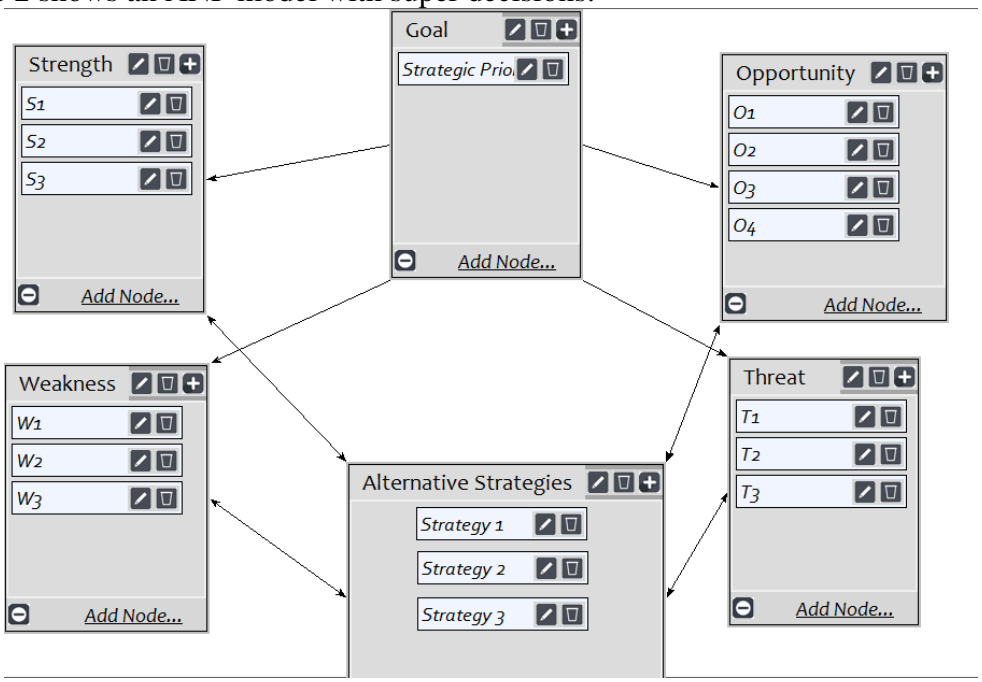

Figure 2. Strategy Model for Maintaining Farming Using ANP

4.6 Strategy Priority for Maintaining Arabica Coffee Farming in Cinta Village Forest Farmers Group

After the ANP modeling was done, pairwise comparisons were obtained by prioritizing the strategy to maintain the business with the help of SuperDecision Software. Based on the results of pairwise comparisons using SuperDecisions, it was found that the priority strategy for maintaining Arabica coffee farming in the Cinta Village Forest Farmers Group was obtained. Figure 3 shows the ranking of each chosen alternative.

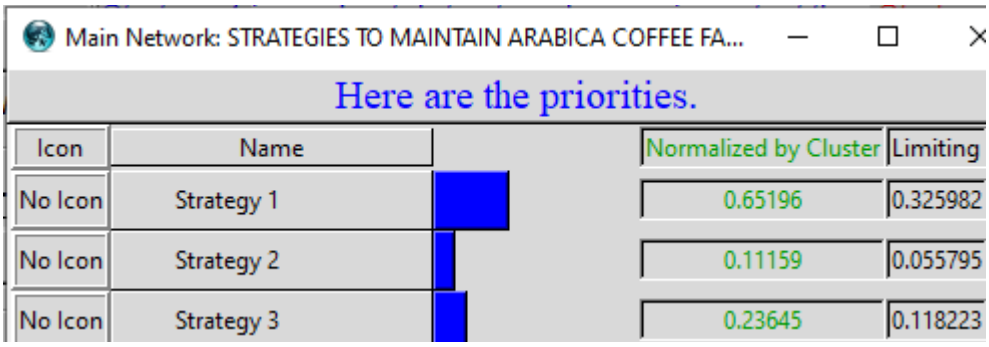

Figure 3. The results of the priority analysis of the strategy to maintain Arabica coffee farming using Super Decision

From Figure 3, we can see that the most valuable order of alternative strategies is the order of Strategy 1, Strategy 2, and Strategy 3. The following is a description of the explanation:

1) Strategy 1: Improve coffee quality and increase income by post-harvest processing through clean coffee production.
   The development of clean production is carried out to manage waste from the coffee processing process. This clean production can produce products including making tea (cascara), processed feed for livestock, block compost fertilizer and biogas, and organic liquid fertilizer. These products can be used directly by farmers and can be sold to increase income for farmers.
2) Strategy 3: Diversify farming to increase income during the Covid-19 pandemic.
   AlternativeDiversified crops that can be planted by coffee farmers in the Cinta Village Forest Farmers Group include food crops such as fruits and vegetables to meet daily food needs and can be sold if there is excess yield. Based on the information obtained from vegetable collectors, the cultivation of chayote vegetables is currently highly recommended. The demand is very high, then maintenance is simple and has a short harvest period so that profits can be generated quickly.
3) Strategy 2: Maintain income by processing and storing coffee beans to sell when prices rise again.
   These stored coffee beans are raw coffee beans or green beans, which have lost their husks and dried. These raw coffee beans are suitable for storage because they have the most extended shelf life than coffee products at other processing stages, which can last 1-3 years with good storage after the raw coffee beans are stored or appropriately warehoused as reserves and then resold at a later time when prices have risen.

5. CONCLUSIONS

Based on research done by researchers in deciding strategies for maintaining Arabica coffee farming in the Cinta Village Forest Farmers Group during the covid-19 pandemic, it can be concluded that there are nine alternative strategies and three strategies are obtained that best match the criteria in quadrant V in the IE Matrix. The selected strategies are sorted based on priority using the ANP method. Priority strategy brought based on calculations using SuperDecisions namely strategy 1, strategy 3, and strategy 2, namely improving coffee quality and increasing income by post-harvest processing through the development of clean coffee production, diversify farming to increase income during the Covid-19 pandemic and maintain income by processing and storing coffee beans to sell when prices rise again.

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THE FACTOR AFFECTED M-SERVICES ADOPTION IN AIRPORTS

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ABSTRACT

This research focus on the factors which affected m-Services utilization in airport from airport's functionaries point of view. Also, the background of this research is related to some former researches which defined some models that may increase the exertion of electronic mobile based service application (m-Services) such as: TAM, UTAUT, and UTAUT2. However, the former literature reviews only elucidate the factors which affect the increasing of m-Services or mobile technologies/ self service technology exertion from customer point of view. While, there are less of them apprising the factors affected m-Services adoption from airport's functionaries point of view. The purpose of this study is fulfilling the lack in the literature review by apprising the study towards airport's functionaries point of view. To reach the purpose of the study, this study applies literature review method. The literature review's source of this study is originated from some international journals which discuss the factors of airport's functionaries side. The result of this study are the Explanation of the factors affected m-Service adoption or mobile technologies/ self- services technology from airport's functionaries point of view and the development of conceptual model related to the factors affected m-Services adoption from airport's function perspective.

Keywords: *m-Services*, *mobile technologies*, *airport's self-services technology*, *technology adoption factor*.

1. INTRODUCTION

The utilization of technology and digital devices by company is being important to facilitate company business activities. Some companies which run in the airport and aircraft services give their priority on the good service for the customer prominently. One of the action to improve their service is the implementation of m-Services. m-Services is a digital service using mobile platform to increase effectiveness for customer (Sabri Alrawi, et al., 2020). Also, m- Services means the electronical mobile device which could make companies' business easier than before (Baabdullah, et al., 2014). m-Services has strong relation towards companies which have service marketing for their customer as their core business (Liu, et al., 2019). M-Services is expected to give unique selling point to compete companies' competitor (Liu, et al., 2019). In a very first place, m-Services aims to support service but it may be monetized into premium services to increase companies' income (Duartea & Pinhob, 2019). By the time, m-Services is not only applied in the retail field, but also applied in the medic, bank, and airport (Liu, et al., 2019 (Lu, et al., 2009). Airport's m-Services conveys unreliable system report which often reported by the functionaries each day. In average number, there are at least five unreliable system reports in a day. This m-Services' airport adoption phenomenon causes some research questions such as; is m-

Services airport adoption acceptable and applicative for airport's function?, what are the factors affected m-Services' airport adoption from airport's functionaries?.

This research aims to do systematical analysis towards newest literature review on m-Services technology utilization, by focusing on the factors which affected utilization numbers from airport's functionaries side. To reach this purpose, this study will take a look on international level journals through some sources related to the factors affected m-Services adoption, then select eligible sources which related to the focus of the study, next step is reviewing selected journals to get list of the factors affected airport m-Services adoption from airport functionaries' point of view, and those factors is developed by airport's m-Services adoption conceptual method.

2. METHODOLOGY

This part explains the stages of action on this research so this research could be done systematically and clearly. The plot of research actions as follows:

A. Conduct Literature Search Method

Conduct literature search method which applied in this paper utilizes search approach based on keywords finding of eligible journals. Some keywords which applied in this research such as: "m-Services", "mobile technologies", "airport's self- service technology", "technology adoption factor". Keywords search is done on well-known journal sites i.e (1) Science Direct, (2) IEEE, (3) Google Scholar, (4) Emerald from 2005-2021. The result of former journals finding utilizing keywords above is checked and confirmed having relation toward these keywords. The related journals finding bears some results portrayed on the Table 1.

Table 1. Number Of Related Journal Findings

Journal Portal	Results	Keywords
Science direct	17.449	*"m-Services"*
Science direct	18.219	*"mobile technologies"*
Science direct	850	*"airport's self-services technology"*
Science direct	17.430	*"technology adoption factor"*
Google Scholar	6.340	*"m-Services"*
Google Scholar	10.050	*"mobile technologies"*
Google Scholar	19.800	*"airport's self-services technology"*
Google Scholar	13.651	*"technology adoption factor"*
IEEE	43	*"m-Services"*
IEEE	12.156	*"mobile technologies"*
IEEE	22	*"airport's self-services technology"*
IEEE	263	*"technology adoption factor"*

Journal Portal	Results	Keywords
Emerald	190	*"m-Services"*
Emerald	11.000	*"mobile technologies"*
Emerald	54	*"airport's self-services technology"*
Emerald	14.000	*"technology adoption factor"*

B. Journal Selection

Then, the founded journals are selected to be the eligible ones. In this study, the writer will check the journals related to the app utilization number of factors and also mobile technology and m-Services utilization number. The content of selected journals should contain topic on m- Services adoption and airport's self-services technology.

C. Selected Journal Review

The founded and selected journals will be analyzed to gain list of factors which affect m- Services adoption in airport from airport's functionaries who uses the application. The number of reviewed journals are 35 in total. 25 papers are papers sourced from international journals indexed by Scopus and are in quartile 1 (Q1). 5 papers are papers sourced from international journals indexed by Scopus and are in quartile 2 (Q2). 2 papers are papers sourced from international journals indexed by Scopus and are in quartile 3 (Q3). 3 papers are papers sourced from national journals (Indonesia).

D. Factors Which Affect Airport m-Services Adoption From Airport's Functionaries Perspective Identification

In this stage, this study will analyze the review result which consisted of factors affected airport m-Services adoption number from airport's functionaries who use this application. Also, the identification of factors might be done by defining each factors and developing conceptual model.

3. RESULTS AND DISCUSSION

In this part of study, the result and discussion about the factors affected m-Services adoption in airport from airport's functionaries perspective will be explained.

A. Comparison of Related Work

Comparison of related work is done to compare the former researches related utilization of data source, context, or used research object, used based model, used research method, used antecedents, and outcome variables as result of related researches about m-Services technology. Here is the picture of research comparison which is collected from former researches related to m- Services technology adoption.

Table 2. *Comparison Of Related Work*

Study	Data Source	Context	Based Model	Method	Antecedents	Outcome Variable
(Duartea & Pinhob, 2019)	120 m-Health Users	Mobile Health	UTAUT2	Offline Survey, SEM	Performance Expectancy; Effort Expectancy; Social Influence; Facilitating conditions; Hedonic motivation; Price Value; Habit	Adoption of m-Health
(Taufik & Hanafiah, 2019)	500 Passeng ers	Self Service Technology	TAM	Offline Survey, SEM	Perceive Ease of Use; Perceived Usefulness	Need of Interaction
(Liébana-Cabanillas, et al., 2014)	201 Online payment users	Online Payment Systems	TAM	Offline Survey, SEM	Perceive Ease of Use; Perceived Usefulness,	Perceived trust; perceived risk;
(Sandy Kosasi, 2019)	112 managers	Online store	E-Service Quality	Offline Survey, SEM	ISSM; IT Service Management; IT Governance	E-Service quality
(Batouei, et al., 2020)	377 travellers	Airport experience	Airport Experience Model	Offline Survey, SEM	Sociological dimensions, Psychological dimensions, Service marketing dimensions	Social fairness, Service escape, Service encounter, self service technology, WoM, Revisit, Satisfaction
(Leong, et al., 2021)	309 e-wallet users	e-wallet	UTAUT2	Offline Survey, SEM	Performance Expectancy; Effort Expectancy; Social Influence; Facilitating conditions; Social Influence; hedonic motivation; Price Value;	Optimism; Innovativeness; Discomfort; Insecurity.
(Sabri Alrawi, et al., 2020)	400 Malaysi a smartph one users	Mobile commerce	UTAUT	Offline Survey, SEM	Performance Expectancy; Effort Expectancy; Social Influence; Facilitating conditions; Social Influence;	Personal Innovation; Mobility; Perceive trust; Perceive risk
(Liu, et al., 2019)	241 mobile health users	Mobile health service	Motivation Theory	Offline Survey, SEM	Perceived Usefullness; Perceived Enjoyment; Use Intention	Perceived Source Credibility; Perceived Service Availability; Perceived Competence.

(Wu, et al., 2007)	123 Mobile Health System Users	Mobile Health Systems	TAM	Offline Survey, SEM	Perceive Ease of Use; Perceived Usefulness; Intention To Use	Compatibility; Self Efficacy; Technical Support and Training
(wu, et al., 2011)	800 Mobile Healthc are Users	Mobile Healthcare	TAM & TPB	Offline Survey, SEM	Perceive Ease of Use; Perceived Usefulness; Subjective Norm; Intention To Use.	Perceived Service Availability; Personal Innovativeness
(Sezgin, et al., 2017)	151 Medical officer	mHealth	UTAUT	Offline Survey, SEM	Performance Expectancy; Effort Expectancy; Social Influence; Facilitating conditions;	Perceived Service Availability; Technical Support and Training; Mobile Anxiety
(Ginting & Azmi, 2021)	220 passenger at Indonesian Airports	Technology for Contactless Prosess (E-gates, self checkin, biometrics	TAM	Offline Survey, Likert scale techniq ues	Perceived Ease of Use; Perceived Usefulness;Actual use of Technology for Contactless Prosess	Perceived Ease of Use; Perceived Usefulness have a Significant effect on Actual use of Technology for Contactless Prosess
(Abdulla h, 2012)	383 passenger at Malaysia Airports	Self Service Technology	Technology Readiness Model	Offline Survey, ANOVA Method	Technology readiness (Optimism; Innovativeness; Discomfort; Insecurity); Customer satisfaction	Optimism and innovativen ess were significantly correlated with customer satisfaction. Discomfort and insecurity factors did not influence customer satisfaction

(Bakshi, et al., 2019)	600 passenger at North India	Online Review System	UTAUT2	Offline Survey, SEM (PLS-SEM)	Effort Expectancy; Social Influence; habit; hedonic motivation	Effort Expectancy; habit; hedonic motivation have a Significant effect of online review system. Social Influence have no Significant effect of online review system
(Morosan, 2016)	538 passenger at US Airports	biometric e-gates	UTAUT2	Offline Survey, SEM (Mplus)	Performance Expectancy; Effort Expectancy; Information sensitivity; intentions.	Performance Expectancy; Effort have Significant effect on Intentions. Information sensitivity have no Significant effect on Intentions.
(Kusumah, et al., 2020)	600 passenger at Indonesian Airports	Self Check In Kiosk	TAM	Offline Survey, SEM	Perceived Ease of Use; Perceived usefulness; Passenger attitude; Behaviour intention	Perceived Ease of Use; Perceived usefulness have significant effect on Passenger attitude & Behaviour intention.
(Park, 2020)	307 Passenger Incheon Airport, Korea	Airport IT service	TAM	Offline Survey, SEM	Perceived Ease of Use; Perceived Usefulness; Technology Acceptance Intention	Perceived Ease of Use and Perceived Usefulness have Significant effect on Technology Acceptance Intention

From the table 2 above, it can be concluded that data sources or respondents are dominated by external user from mobile services. Hence, this might be the lack of the former studies so it need further research which focused on respondent data from airport's functionaries perspective. The research model which utilized by other researchers is dominated of TAM and UTAUT model with common model: Structural Equation Modelling (SEM). Additional variables of TAM and UTAUT from former researchers is dominated by Service Availability; Technical Support and Training; Perceived Value variables.

B. M-Services Adoption Factors from Airport's Functionaries Perspective

M-Services adoption in airport refers to related former researches brings out the factors affected m-Services/mobile technology utilization by staff or airport's functionaries. Based on the review of some journals, there are some factors which affect m-Services utilization in airport, as follows:

Table 3. M-Services User Number

The Factors of m-Services Utilization Number	**Explanation**	***References***
Performance Expectancy	The functionaries believe that using m-Services system will support users reaching advantages of working performance.	(Alalwana, et al., 2017; Shaw & Sergueeva, 2019; Duartea & Pinhob, 2019); (Bakshi, et al., 2019); (Morosan, 2016)
Effort Expectancy	Functionaries' perspective emphasizes on how much effort towards system accessibility	(Baabdullah, et al., 2014; Alalwana, et al., 2017; Khan, et al., 2021; Tamilmani, et al., 2021; Duartea & Pinhob, 2019); (Bakshi, et al., 2019); (Morosan, 2016)
Social Influence	How deep a functionary feels their fellows and other functionaries should utilize m-Services too.	(Karuri, et al., 2017; Liu, et al., 2019; wu, et al., 2011)
Facilitating Conditions	The functionaries emphasizes the availability of technical and sufficient infrastucture supporting system utilization.	(Tayyba Fatima, 2021; Duartea & Pinhob, 2019; PhD, et al., 2012; Alalwana, et al., 2017; Tamilmani, et al., 2021)
Perceived Service Availability	The functionaries believe that the good and sufficient services availability could support performance	(PhD, et al., 2012; Sarvenaz Mehravani, 2011; Alqahtani & Abdullah, 2017; Sandy Kosasi, 2019)
Technical Support and Training	The functionaries are focused on supportive services availability which support system utilization.	(Sarvenaz Mehravani, 2011; Sandy Kosasi, 2019; PhD, et al., 2012; Alqahtani & Abdullah, 2017)

The factors of m-Services utilization from airport's functionaries point of view leads to some important points that should be considered by the companies who will apply m-Services so their functionaries will have sense of belonging towards m-Services, such as:

1) Companies should consider that the used system will bears advantages in working performance.
2) Companies should pay attention on their functionaries' effort accessing the system --the less effort they give, the system will be better.
3) Companies should consider the influence of important stakeholders related to functionaries in system utilization.
4) Companies should take a look on sufficient infrastructure and technical availability supporting the system.
5) Companies should take a look on sufficient services availability to support system utilization.
6) Companies should take a look on sufficient supporting services availability and training of system utilization.

C. Conceptual Model of Airport m-Services from Airport's Functionaries Perspective

The conceptual model of airport m-Services from airport's functionaries perspective will be explained in this part of study. There are six variables affected m-Services utilization, as follows:

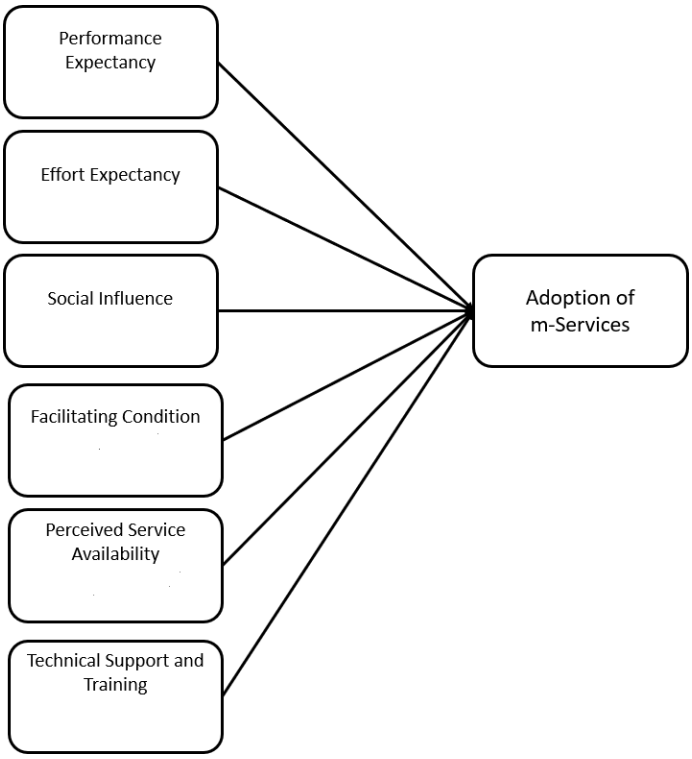

Figure 1. Illustration of Airport m-Services Conceptual Model

This research gains airport m-Services from airport's functionaries perspective conceptual model. Those are some points as the result of this research:

1) How Performance Expectancy affects m-Services adoption;
2) How Effort Expectancy affects m-Services adoption;
3) How Social Influence affects m-Services adoption;
4) How Facilitating Condition affects m-Services adoption;
5) How Perceived Service Availability affects m-Services adoption;
6) How Technical Support and Training affects m-Services adoption.

D. Discussion

The Development of TAM, UTAUT, and UTAUT2 Models

This part will explain the progress of TAM, UTAUT, and UTAUT2 models which are done by former researches and these models are proven could influence the adoption number or m-Services application acceptance.

1) *The Development of TAM Model in Public Service Industry: Mobile Healthcare Adoption by Hospital's Functionaries* (wu, et al., 2011).

This research explain that the adoption number of health mobile application service is quite low in hospital. This research presents technological acceptable model to inspect the factors which cause the hospital functionaries' willing to use the mobile based health service application.

Furthermore, this research does combination of TAM and TPB models to validate the models. TAM model has two main variables to influence technological adoption number, such as: Perceived Usefulness and Perceived Ease of Use (Jung, et al., 2020). While, TPB model has three main variables which influence technological acceptable model, such as: Attitude, Perceived Behavioral Control, and Subjective Norm (Isharyani, et al., 2020). This study also add additional variables, such as, Perceived Services Availability on TAM model and Personal Innovativeness in IT on TPB model (Ting, et al., 2015). Then, those variables will be validated by hospital functionaries. This research shows that Perceived Services Availability and Personal Innovativeness in IT give positive significance toward mobile services technological adoption number. From the result of the study, it gets new TAM model by adding two variables such as: Perceived Services Availability and Personal Innovativeness in IT so it is interesting to do further research in company who runs in hospital service field (Ray & Bala, 2021).

2) *The Development of TAM Model in Public Service Industry: Understanding The Use of Mobile Health Service* (Liu, et al., 2019).

The research aims to analyze and investigate relation between user's willingness and mobile based health service (m-Health). This research analyzes the user's willingness towards m-Health utilization. Researcher divides utilization grade into two categories, i.e. emergency use intention and routine use intention. Next, this research adopts TAM model as basic conceptual model which is made and add some variables (perceived source credibility, perceived service availability and perceived diagnosticity) to be tested its significance towards perceived usefulness and intention to use variables. Based on the data which are collected from 241 users, it is found that perceived usefulness variable could increase people's emergency use intention and user's routine willingness using m-Health service. Besides, this research finds that perceived source credibility, perceived service availability, and perceived diagnosticity could influence m-Health utilization. From this research, it gains new TAM model with three additional variables consisted of perceived source credibility, perceived service availability and perceived diagnosticity so it will be interested to do further research by this model implementation in a company who runs services field except hospital.

4. CONCLUSION

Based on systematic literature review which has done by this study, it could be concluded the factors affected m-Services adoption in airport are the sufficient services availability supporting system utilization, then assisting users reaching advantages on working performance, having the sufficient availability of supporting services in system utilization, giving less effort in accessing the system, management of important stakeholders who influence system utilization, and having infrastructure and technical availability in supporting system utilization.

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FORMULATION OF FOOD AND BEVERAGE SECTOR BUSINESS STRATEGIES AT CV ABC

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ABSTRACT

Industry 4.0 forced the strategic management in Indonesia to develope small medium enterprises. However, in 2020, Indonesia faced the covid-19 pandemic and had impacts on consumers from CV ABC who changed their face-to-face meeting habits and ordered rice and box cakes to become virtual, so the number of orders each month decreased. In addition, CV ABC experienced business imbalances in 3 cities, it was often found that producers could not meet the demands of consumers. This study combines 4 methods to formulate business strategies for CV ABC development, namely Bussiness Model Canvas, Internal and External Factor Evaluation Analysis, SPACE Matrix, IE Mtratrix and Blue Ocean Strategy. There are 2 ways to get data, namely by in-depth interviews and Focus Group Discussions. The results of this study were expected to be able to analyze business conditions using the Bussiness Model Canvas, Internal Factor Evaluation and External Factor Evaluation Analysis, analyze the factors that influence key resources with the SPACE Matrix and IE Matrix, then at the end of the study obtained a business strategy with the Blue Ocean Strategy in the sector food and beverages so that CV ABC can survive and even increase annual income. The results of the research on the input stage using BMC and IFE EFE analysis shows opportunities to expand sales coverage and increase the number of human resources, so that product prices and a large variety of menus can be maintained. In the matching stage using the SPACE matrix and the IE matrix, the strategy results that CV ABC should use are market penetration and product development. At the decision stage, the ERRC scheme in Blue Ocean Strategy shows more strategies on create, so that CV ABC's turnover can increase.

Keywords: Business Strategy, Blue Ocean Strategy, Small Medium Enterprises.

1. INTRODUCTION

The world has faced an industrial revolution that builds on the widespread availability of digital technology to carry out production processes. Indonesia is also one of the countries in this era to improve the quality of production in various sectors. CV ABC is a limited liability company domiciled in the City of Kediri based on Deed Number 07 dated 27 June 2019 made by Notary Tisnawati, SH.

Companies that are relatively new also need strategic management in competing. Passionate about supporting small businesses and building the nation,

CV ABC is engaged in food and beverage trading, general consulting services, advertising, logistics services as well as human health and social activities.

The food and beverage sector will be the focus of this research because it is already running and accounts for 95% of the total revenue at CV ABC. Food and beverage are the sector with the most potential to be developed.

In 2020 Indonesia and most of all countries are facing a pandemic due to the corona virus. The status of the COVID-19 pandemic set by WHO has also affected the economic conditions in Indonesia. Digitization is one solution for the running of the MSME industry even though some sectors find it difficult to implement an online system because it is related to public services.

The impact of reduced income due to the pandemic also occurred on CV ABC. This company is a limited liability company which was established in Kediri, but conducts trading activities in 3 cities, namely Kediri, Surabaya, and Bekasi. In the fourth quarter of 2019, CV ABC's business turnover was ±Rp. 150,000,000. while in 2020, the covid 19 pandemic, had a big effect where business circulation in 1 year was only 50% of the achievement in the fourth quarter of 2019. The following is CV ABC's competitor's monthly sales data:

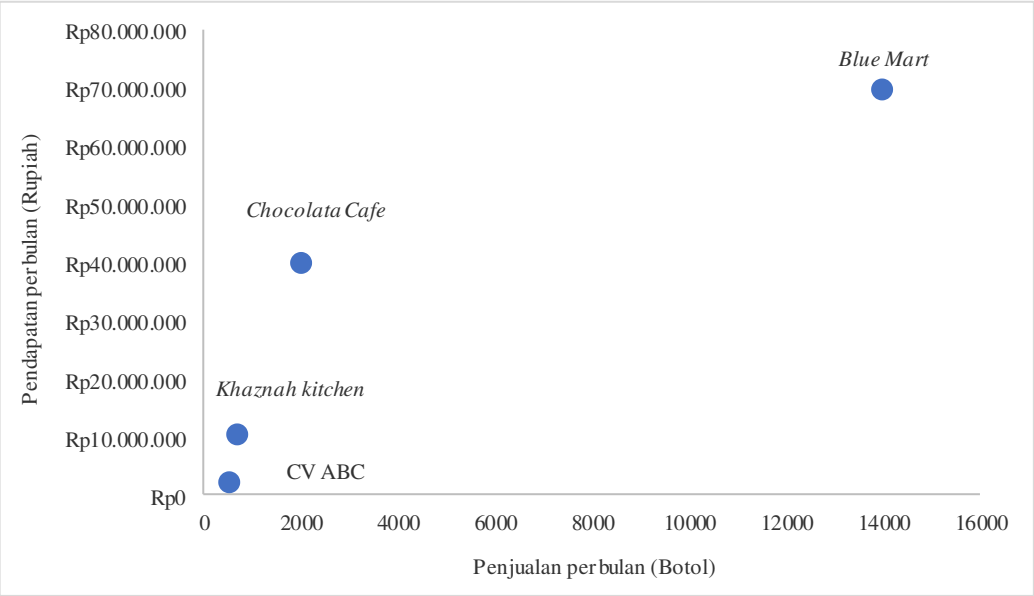

Figure 1. Position of CV ABC against Competitors

Based on Figure 1. CV ABC's position in terms of sales and monthly income is lowest against competitor. CV ABC is only able to sell 300 bottles of packaged drinks per month, this is very low when compared to Chocolata Café which can sell 2000 bottles of hot chocolate per month, but in terms of income compared to Khaznah store, CV ABC only gets 25% of Khaznah's income store, even though the number of bottles sold is almost the same.

Those data show the importance of strategic management for CV ABC as a small company that just started operating to compete in the food and beverage industry. Based on the description above, the problem to be researched can be formulated as follows: "How is the formulation of business strategy for food and beverage sector on CV ABC?"

2. LITERATURE REVIEW

2.1 Strategy Management

David (2017) defines "strategic management as a combination of science and art when formulating, implementing, and evaluating cross-functional decisions that enable an organization to achieve its goals." In addition, strategic management can also be interpreted as a set of decisions and actions that result in the formulation and implementation of plans designed to achieve company targets and objectives. David R. Fred (2017) states that the decision-making framework which consists of three stages including the input stage, matching stage, and decision stage.

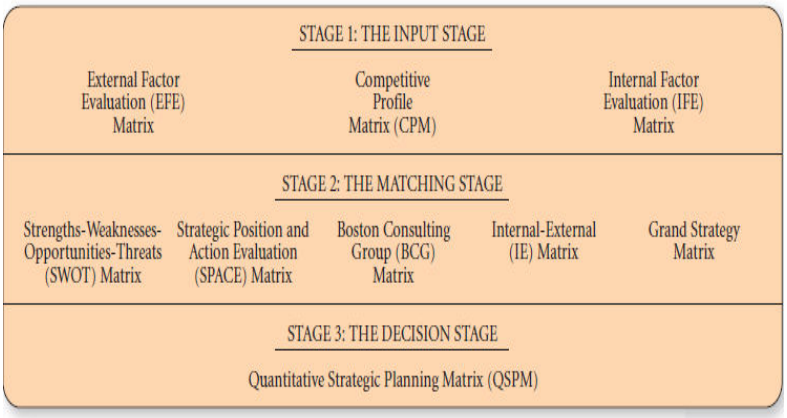

Figure 2. Strategy Formulation (David R. Fred, 2017)

The first stage in strategy formulation is the input stage. At the Input stage, it requires many experts to assess what are the external and internal factors of a company. There are many methods that can be used to analyze the input stage, including the CPM Matrix, IFE Matrix and EFE Matrix. Strategists will be more effective in generating, prioritizing, evaluating, and choosing among alternative strategies if they can complete several selected methods.

The second stage of strategy formulation is matching stage. It is time to look for the appropriate formula made by the company to be present in various businesses. Combining various resources and capabilities within the company as well as assessing opportunities and risks from factors outside the company are very important stages to be observed. The stage of matching the strategy formulation framework consists of four techniques including SWOT Matrix, IE Matrix, BCG Matrix, and SPACE Matrix.

The decision stage is the third or final step in strategy formulation. The priority list of the best strategies can be achieved by using the right strategy. QSPM offers adequate procedures to determine the attractiveness of various strategic options (David R. Fred, 2017).

2.2 Business Model Canvas

The Business Model Canvas is a modern and accurate tool for business ventures. This tool helps companies look holistically and integrated but still detail each element. There are 9 elements that are very essential and crucial to know clearly about the details of the company. A complete picture of the business will help entrepreneurs carry out evaluation and analysis so that they can finally take

the right steps to achieve business goals and targets (Fox, n.d.). The Business Model Canvas describes a visualized business model and is divided into 9 elements including Customer segments, Value proposition, Channels, Customer relationship, Revenue stream, Key resources, Key activities, Key partners, Cost structure. Business Model Canvas can simplify activities that look complicated in a company (Baumassepe-Andi, 2017)

2.3 Blue Ocean Strategy

Blue Ocean Strategy is often applied to large retail companies. The strategy applied is to dominate the market and assume that there are no competitors, thus creating irrelevant competition. Blue oceans can make companies have great potential for profit. Blue ocean strategy can be done by exploring consumer demand so that it can maximize profits because it is in accordance with the wishes of the market.

The big picture of business can be identified through the Eliminate, Reduce, Raise, and Create (ERRC) scheme. The ERRC scheme is a strategy to find factors that must be eliminated, reduced, improved, and created in a business offering (Ilham, Wilopo, & Mawardi, 2016).

3. METHODS

This study began by collecting secondary data from the literature study for CV ABC, then from the results of the researcher's observations, a problem statement emerged. Next, the researchers carried out the strategy formulation stage, at stage 1 "input stage", researchers used BMC and Internal External Factor Analysis as a tool to examine business strategy problems at CV ABC using in-depth interviews with consumers and producers to find out what factors influence the problem. In stage 2 “matching stage”, researchers used the SPACE Matrix and IE Matrix methods to conduct FGD with a team of experts from CV ABC. From these results, researchers can formulate a strategy for developing food and beverage sector resources for CV ABC with the Blue Ocean Strategy method to increase revenue.

4. RESULTS

4.1 Analyzing The Business Conditions Of The Food And Beverage Sector At CV ABC Using The Business Model Canvas And IFE EFE Analysis

Business Model Canvas

Researchers analyzed the position of the food and beverage sector in CV ABC compared to 2 competitors in Kediri and Surabaya with Business Model Canvas and IFE and EFE Analysis and used the Focus Group Discussion method with an internal team from CV. ABC.

CV ABC started sales in Kediri with packaged chocolate beverage products. As time goes by, there are meeting consumption orders in the city of Surabaya, so we cooperate with local MSMEs to fulfill orders. Then it developed in Bekasi in selling various packaged drinks according to customer demand.

If you look at the competition in each city, there are several business actors who have this type of beverage business. Chocolata café is a competitor in Kediri City,

Khaznah Kitchen is a competitor in Surabaya City and Blue Mart in Bekasi Regency.

Chocolata Café is a Café in the city of Kediri which has been running for 6 years. His signature drink is original warm chocolate which is thick and delicious. The advantages of Chocolata café are 24 hours open and free wifi so that many teenagers and families use this cafe as a place to spend time doing college assignments or just hanging out together. It is located in the center of Kediri City and is a home environment, however, the concept of a "homey" café makes customers always happy.

Khaznah Kitchen is an online shop that sells various seafood products typical of Madura Island. Since 2016 it has been established and has spread its wings to make Khaznah Kitchen and sell date milk drinks as its superior product. Some of the products already have P-IRT so that the cleanliness and quality assurance of the raw materials are better even though they are still on a household scale. Meeting orders are the main income, and the Pre Order system can help Khaznah Kitchen manage stock availability and reduce potential losses due to damaged and stale products.

Blue mart is a vending machine that stores various drinks and snacks, which are located in several strategic places, blue mart does not require humans to make sales transactions, so sales reports can be viewed through the system owned by blue mart. However, blue mart is constrained by an unstable (online) network system, causing the buying and selling process to be hampered.

The results of the FGD were then analyzed by the researchers in the framework of BMC, as follows: see table 1. BMC results of the FGD Formulation of Business Strategy CV ABC in the food and beverage sector

Table 1. BMC Research Formulation Of Business Strategy CV ABC Food And Beverage Sector

<table>
<tr><td rowspan="2">Key Partners

Housewife
Wholesale shop
Supermarket
Traditional market</td><td>Key Activities

Material shopping
Production every day
Stock in freezer 50% of daily sales
Sales entrusted to resellers
Through the marketplace</td><td rowspan="2">Value Propositions

Low product prices
Varied menu
Easy payments (cash, transfer, and virtual wallet).</td><td>Customer Relationships

Go to reseller
Social media advertising (online)
Partners (office)</td><td rowspan="2">Customer Segments

Factory employees (Private)
Civil Servant (PNS)
(Age 20 – 35 years old)</td></tr>
<tr><td>Key Resources

- Supplier of online and offline stores that sell raw materials
- Human Resources (employees)</td><td>Channels

Partner
Marketplace
Social media</td></tr>
<tr><td colspan="3">Cost Structure

Direct Costs (material costs, gas, water, and packaging costs)
Indirect costs (internet quota fees for promotions, electricity costs, promotion costs – give away).</td><td colspan="2">Revenue Streams

Research and product development
Train the Human Resources</td></tr>
</table>

This BMC shows the current conditions applied by CV. ABC in conducting food and beverage business in the cities of Kediri, Surabaya and Bekasi. During the FGD process shows the team in the CV. ABC is still running a conventional and micro-scale business. Arrangements and production are often carried out when there is a Pre Order, besides that daily production is still very minimal. This is related to HR in CV. ABC is still very lacking.

IFE EFE *Analysis*

IFE EFE Analysis was carried out by researchers by observing the process of activities that occurred at CV ABC. This section will discuss the analysis of Internal Factors and External Factors of CV ABC. On internal factors, CV ABC has the power of affordable product prices, quite a lot of menu variations, and payments can be made in cash or digitally. The weaknesses are the lack of human resources, the amount of stock and high production costs of food and beverage products.

Product prices from CV ABC are in the range of Rp. 5,000.00 to Rp. 35,000.00. Packaged drinks from CV ABC are in great demand when sold to resellers or when procuring events and meetings because they are cheap with the fresh taste of real sugar and the right 250 ml net. While on the CV ABC food menu, it adjusts to demand with a price range of Rp. 15,000.00 to Rp. 35,000. The rice menu with various side dishes but always complete with carbohydrates, protein and vegetables makes consumers feel satisfied with the price and quality served.

The variety of food and beverage menus is very developed and follows consumer demand. Drinks at CV ABC already have more than 20 recipes and the best seller is the iced coffee variant. While for the boxed rice, the cooked chicken rice menu varies according to trends, such as geprek chicken and grilled chicken being the most popular variants. The flexibility of CV ABC in serving the demand for consumer menu variations is the advantage of internal factors.

CV ABC still has problems with HR settings. There are currently less than 10 human resources in charge of the field and administration. Often members of CV ABC have to multi-task to handle material shopping, production to administration before the food falls into the hands of consumers. This is a big obstacle in running a business in 3 different cities.

Judging from external factors, the threat from restaurants and similar partners who sell food and beverage products is the main rival of CV ABC's business, besides that there are also opportunities from consumers, product advertisements and marketing areas that can be expanded so that they have the potential to increase the profits of the CV business. ABC in the food and beverage sector.

Looking at the current position, CV ABC's food and beverage sector based on analysis using BMC and IFE EFE Analysis shows that there is a great opportunity to expand sales coverage. This can be done by optimizing the value proposition, revenue stream and key resources. This is related to HR in CV. ABC is still very lacking. Meanwhile, from the IFE EFE analysis, CV ABC can increase the number of human resources so that product prices and a large variety of menus can be maintained.

4.2 Analyzing Factors Influencing the Food and Beverage Sector Key Resources in CV ABC with SPACE Matrix and IE Matrix

SPACE *Matrix (Strategic Position and Action Evaluation Matrix)*

In the second stage, which is the matching stage, the researcher uses 2 analytical tools, namely the SPACE Matrix and the IE Matrix. There are four quadrants in the SPACE Matrix, namely Conservative, Aggressive, Defensive and Competitive. From the results of the study, the researchers gave an average score of 5.5 on FP, -3.5 on SP, 4.25 on CP and -4.75 on IP. So the X average is -0.25 and the Y average is +1. The results of this calculation show CV. ABC is in the Conservative quadrant.

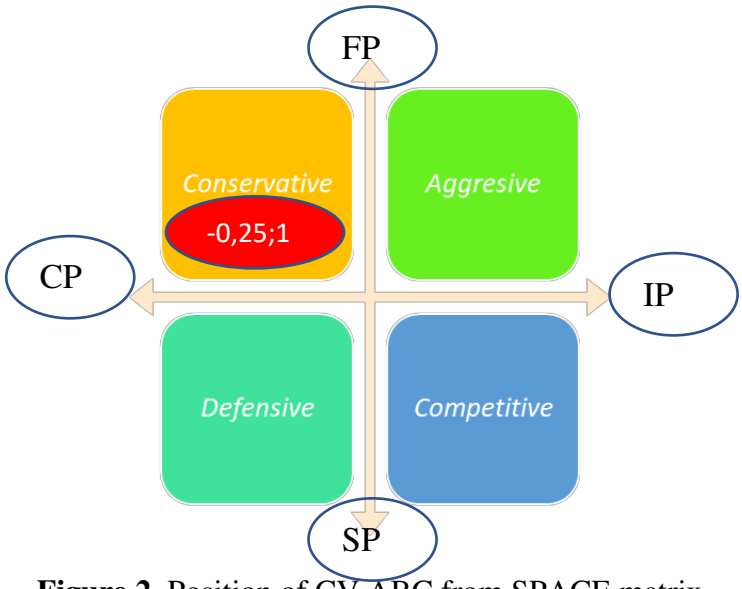

Figure 2. Position of CV ABC from SPACE matrix

In Figure 2. the position of CV ABC according to the results of the SPACE matrix, the conservative quadrant states that the company should still have proficient basic competencies and not take big risks. Conservative strategies most often include market penetration, market development, product development, and related diversification. This is very visible from companies that are less competitive. CV. ABC has sufficient capital and savings to carry out production, however, the lack of human resources makes the company's competitiveness very less.

IE *Matrix*

IE Matrix is a matrix obtained from calculating the scores of various items from the IFE EFE Analysis in sub chapter 4.2.2. The X axis in the IE Matrix is obtained from the IFE analysis and the Y axis is obtained from the Score in the EFE analysis. Here are the results of the IE matrix:

Table 2. Results of IE matrix CV ABC Business Strategy Formulation in the food and beverage sector

		IFE Wheigt Score		
		Strong (3,0 to 4,0)	Average (2 - 2,99)	Weak (1- 1,99)
EFE	High (3-4)	I	II	III
	Med (2-2,99)	IV	V	VI
	Low (1 - 1,99)	VII	VIII	IX

Keterangan : Makanan Minuman

CV ABC food sector is in cell VII and beverage sector is located in cell V, both of which are in region 2, namely Hold and maintain. The strategies used in Regions V and VII are market penetration and product development.

The results of the CV ABC analysis of the food and beverage sector using the IE matrix show a correlation with the results of the analysis using the SPACE matrix method. The conservative quadrant (top left) states that companies should still have advanced basic competencies and not take big risks. Conservative strategies are usually characterized by market

penetration, market development, product development, and related diversification. Both methods of analysis suggest strategies for market penetration and product development for the advancement of CV ABC.

4.3 Formulating the Food and Beverage Sector Business Strategy on CV ABC with Blue Ocean Strategy.

The business strategy for CV ABC in the food and beverage sector was determined using the Blue ocean strategy by the researcher. This strategy is carried out by exploring customer demands, but on the other hand, you must be prepared to face high risks even though it ultimately gives big results. Blue ocean strategy big picture is identified through the Eliminate, Reduce, Raise, and Create Schemes or ERRC for short. (Ilham, Wilopo, & Mawardi, 2016) The following is the result of the researcher's analysis to formulate a business strategy with the EERC scheme in Business Ocean Strategy:

1. Eliminate

a. Non-standard recipes

Product standardization is very important; therefore it is necessary to standardize recipes for food and beverage products at CV ABC.

2. Reduce

a. Standardized pricing of the same product

The habit of CV ABC is to determine prices based on consumers, this turns out to make new target consumers confused about product prices if they want to order. This habit will be reduced by making a standardized but flexible price list by providing discounts according to the quantity purchased.

b. The production process that has been carried out at partner locations is now made centrally standardized

Menu inspiration may come from partners, but the kitchen area for cooking is made to the same standard. This can reduce problems in the taste standards of the CV ABC food and beverage product variants.

3. Raise

a. Target Market that reaches a wider audience

CV ABC needs to penetrate the market further, by adding target consumers and regional coverage for the sale of food and beverage products.

b. Lots of menu innovations

To face intense competition in the food and beverage industry, CV ABC requires innovation of its products in the food and beverage sector, by adding product variants, sales are expected to increase.

4. Create

a. New products with premium quality

Creating new product variants that have premium quality with good raw materials, so as to increase sales of food and beverage products.

With this premium quality product, it can give consumers a good impression on CV ABC's products.

b. Online sales

The development of the digital world in today's business industry, causes the need for changes in the sales process not only by offline but also by adding online sales, with online sales it is expected to increase the sales capacity of CV ABC products.

c. Multiple payment systems

The development of the digital world also makes the current payment process also change, this is an innovation for the convenience of customers in making payments, therefore CV ABC is expected to be able to follow these changes, by creating or adding digital payment methods.

d. Make the outlet as the center of promotion

Currently CV ABC does not have an outlet for selling food and beverage products, therefore with the outlet as a product sales center, it will become an offline promotion center for products at CV ABC.

5. CONCLUSIONS

The position of the food and beverage sector in CV ABC compared to competitors in terms of income is the lowest, based on the results of the analysis in stage 1 (input stage) using BMC and IFE and EFE analysis, the results of both methods indicate a great opportunity to expand sales coverage**.**

Factors that influence the resources of the food and beverage sector at CV ABC are the lack of human resources, according to the results of the analysis in stage 2 (matching stage) using the SPACE matrix and IE matrix methods, indicating that product development is needed to penetrate the market by increasing quantity and quality of human resources.

The right business strategy for CV ABC, which is at the start-up stage, is to do a lot of innovation, so Blue Ocean Strategy is the right method.

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FINANCIAL FEASIBILITY ANALYSIS OF PRECAST PLANT DEVELOPMENT FOR CIVIL SERVANT APARTMENT PROJECT IN NEW STATE CAPITAL

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ABSTRACT

Studies related to the relocation of the National Capital City (IKN) have been carried out since 2017. From the results of the study, the largest positive impact was in Kalimantan. The transfer of IKN to the new government center will also transfer the State Civil Apparatus (ASN). PT ABC is one of the investors who will invest in the project with the targeted market being 400 apartment towers. Considering the three-year project implementation time, the best alternative used precast construction in collaboration with PT XYZ which will establish a precast plant to be built on an area of 41 ha to support the project. This research used quantitative research with the type of case study research, data collected by interviews and documents review. This study purpose analyze the financial feasibility analysis of investments using capital budgeting with financial criteria with Net Present Value (NPV) and Internal Rate of Return (IRR). The result of this research NPV was Rp.180,708,494,811 and IRR was 61.81%. From the analysis result can be said that the investment of precast plant was feasible from financial criteria.

Keywords: Feasibility Study, Capital Budgeting, Plant Precast, NPV, IRR

1. INTRODUCTION

PT XYZ is a company engaged in precast, ready mix, construction services, quarry, and post-tension service. PT ABC asked PT XYZ to build a new factory in Sepaku, East Kalimantan to meet the needs of the construction of 400 apartment tower units. The plant will be specifically to support the ASN apartment construction project in IKN with a plan to build Plant Precast for one year and an investment period of three years. To build and produce precast products requires a large capital in addition some risks can cause losses in the company. In starting a project it is necessary to pay attention to economic and financial aspects through feasibility studies to review the investment feasibility of the project. The feasibility study is an activity that studies in-depth about a business or business to be run, to determine whether or not the business is feasible (Kasmir & Jakfar, 2013)

Profitable long-term investments are vital for the sustainability and growth of a firm. The survival and vitality of a firm depend upon its ability to regenerate returns from long-term assets/investments through the proper allotment of capital (Ryan and Ryan, 2002; Arnold and Hatzopoulos, 2000). To increase the wealth of its shareholders, a firm needs to continuously identify, analyze and choose long-term investment projects that could help achieve these goals, i.e., increase in wealth, survival, and growth. This process of selecting, analyzing, and investing

capital in long-term assets/investments which provide returns for more than one year is known as capital budgeting (Fabozzi and Peterson, 2002). Investing in efficient investment projects is crucial because resources are limited and firms must grow their value (Klammer et al., 1991)

Table 1. Precast Product Needs Volume

No	Description	Unit	Year 1	Year 2	Year 3	Total
1	Column	pcs	56.000	56.000	56.000	168.000
2	Facade	pcs	84.533	84.533	84.534	253.600
3	Toilet Precast	pcs	30.667	30.667	30.667	92.000
4	Beam	pcs	297.333	297.333	297.334	892.000
5	Floor Plate	pcs	240.000	240.000	240.000	720.000

This journal aims to analyze the investment feasibility of the construction of Plant Precast Civil Servant Apartment from the financial aspect using the Capital Budgeting method. The expected result is to know the Net Precast Value and Internal Rate Of Return during the investment period to analyze the feasibility of the investment from financial criteria.

2. LITERATURE REVIEW

2.1 Investment

Investment can be interpreted as an investment in an activity that has a relatively long period in various businesses. Investments are invested in the narrow sense of certain projects either physical or non-physical, such as projects, the establishment of factories, roads, bridges, building construction and research projects, and development (Kasmir and Jakfar, 2013). According to Mubashar & Tariq (2019), Investment decisions are one of the three main pillars of corporate financial policy.

2.2 Feasibility Study

A feasibility study is an activity that studies in-depth about an activity or business or business to be carried out, to determine whether or not the business is viable (Cashmere and Jakfar, 2013). The feasibility study is an activity to assess the feasibility of investing in either a project or an ongoing business or to be carried out. A feasibility study conducted to assess the feasibility of a project to be run is called a project feasibility study.

For most companies, investment decisions have a greater impact on value than financing decisions, which relate to the acquisition of needed funds (Baker, et al, 2011). The benefits of feasibility study research can prevent future losses. (Plaza et al., 2021)

2.3 Plant Precast

According to Dinariana & Wijaya (2015), a precast system is a construction system fabrication of building/production components in a factory or on-site, and installed on-site into a single building unit. Because the production of these components is carried out in the factory or on-site, it can facilitate the production process, and precast components are given sufficient time to achieve the required concrete press strong plan before installation. Precast components are assembled with other components to become a building. Because this method is done in the factory and on the spot, the quality of structural components can be maintained properly, but the precast method can be used if the number of typical components of construction reaches a certain minimum amount.

Case study of construction implementation with a precast system in Indonesia one of which is the Rusunawa Polda Jatim project that uses a precast concrete system in its structural work is known to occur efficiency costs was Rp. 604,137,428.00 cheaper when compared to using

conventional methods or by 4.34% and time efficiency of 86 days faster implementation or 28.67% compared to structural work with methods Conventional. This shows that the use of precast concrete in the construction of Rusunawa Polda Jatim is very efficient when viewed from the cost and time needed (Sugiharti, 2014)

2.4 Capital Budgeting

According to Baker (2011), the capital budgeting process is an interrelated system for generating investment proposals to review, analyze, select implement, and follow up on the selected ones.

The industry stature and capital budgeting decision-making practices are significantly related. Conducted a comprehensive survey of trading and manufacturing listed firms of Sri Lanka and reported that Net Present Value (NPV) is the most preferred approach of capital budgeting followed by Pay Back Periode (PBR) and Internal Rate of Return (IRR). The size of the budget and education of CFO are significantly related with the use of sophisticated capital budgeting (Kengatharan, 2010).

Weighted Average Cost of Capital (WACC)

A project may be financed through a combination of equity and debt, with different interest rates for the two. The standard practice is to use as the discount rate in Eq. Weighted average cost of capital (WACC) that is given by a simple linear weighting of the two interest rates for calculating the discount rate, weighted average cost of capital (WACC) is the recommended approach as compared to "cost of equity" and "cost of debt." The weights used for calculating WACC (discount rate) should be based upon "target or market value weights" rather than "book value weights. (Mubashar & Tariq, 2019)

Net Present Value (NPV)

The NPV method calculates the difference between the present value of an investment and the present value of receipt – future net cash receipts. According to Kasmir and Jakfar (2013) Net Present Value is a method of calculating net value at present.

Internal Rate of Return (IRR)

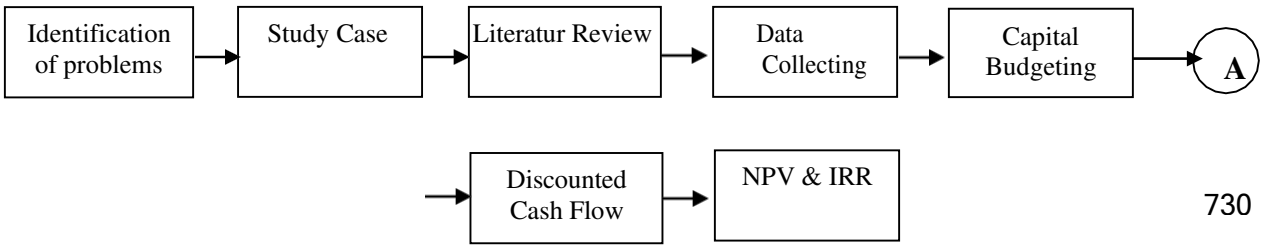
IRR is a discount rate that is a set of present values of a project equal to the value of an investment. In other words, an IRR is a discount rate that results in NPV being zero. The NPV and IRR methods are like having decisions accepted or rejected except when the project is mutually exclusive. When a conflict arises, it refers again to the NPV method. The Internal Rate of Return (IRR) is a return flow that produces an NPV of cash inflows = NPV of cash outflows. In the NPV method, the analysis is carried out by determining in advance the amount of the return (discount) (i), then calculating the present net value (PV) of the cash flow in and out (Sunaryo et al., 2019).

3. METHODS

3.1 Research Method

This research is a case study on the construction of plant precast civil apparatus apartments with the number of precast product requests to build 400 tower units.

The research stage can be seen in Figure 1.



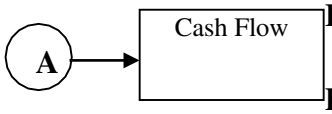


Figure 1. Research Flow

3.2 Data Collection

The data collection techniques used in this study are interview methods, review documents of existing projects, price requests for vendors. Interview sources consist of Marketing Director for revenue determination, General Manager Accounting for funding schemes, depreciation, and residual value, Business Development Manager and Budget Manager for the investment value of Plant Precast development, and General Manager precast to find out productivity and costs. operations during the investment period.

3.3 Capital Budgeting

3.3.1 Weighted Average Cost of Capital (WACC)

Weighted Average Cost Of Capital formula (Rehman & Raoof, 2010).

WACC = Wd Kd (1-T) + We Ke ……. (Equation 1)

Where,
Wd = Weightage of Debt in total Capital
Kd = Cost of Debt
We = Weightage of Equity in Total Capital
Ke = Cost of Equity
T = Tax

3.3.2 Net Present Value (NPV)

Net Present Value Formula (Sunaryo et al., 2019):

NPV = $NPV = \sum_{t=0}^{n} \frac{(C)t}{(1+i)^t} - \sum_{t=0}^{n} \frac{Co)t}{(1+i)^t}$ ……(Equation 2)

Where,
NPV = Net present value
(C)t = Annual cash inflows
(Co)t = Annual cash outflows
n = Total number of periods
i = Required return or discount rate
t = Number of time periods

The decision guideline is If NPV = positive, the project proposal can be accepted, the higher the NPV number the better. If NPV = negative, the project proposal was rejected. If NPV = 0 means neutral.

3.3.3 Internal Rate of Return

Internal Rate of Return Formula (Kasmir dan Jakfar, 2013):

IRR = $i1 + \frac{NPV\ 1}{NPV1 - NPV2} x(i2 - i1)$……...…….(Equation 3)

Where,
NPV1 = *Net Present Value* 1
NPV2 = *Net Present Value* 2
i1 = Interest rate 1 (discount rate that generates NPV1)
i2 = Interest rate 2 (discount rate that generates NPV2) Assessment criteria:

If the IRR is greater (>) than the interest on the loan, then it is accepted and vice versa.

4. RESULTS

4.1 Weighted Average Cost of Capital (WACC)

Cost of Equity

The composition of the funding to be used is the capital itself at 30% and the loan debt of 70%. Risk-Free Rate is obtained based on Saving Bond Retail (SBR) Series SBR 007 released by the Ministry of Finance of Indonesia and accessed in May 2021 with a coupon rate of 7.5%. Beta (β) for PT XYZ stock issuers was $2.25 in May 2021. Data Market Risk Premium (MRP) is a combination of Country Risk Indonesia which is 1.84%. So based on CAPM calculations, the cost of equity obtained is 9.58%.

Cost of Debt

The cost of debt consists of interest on bonds and Market Risk Premium Indonesia. The bond interest rate is 9.95% and the value of the market risk premium of 1.84%. The value of the cost of debt is 11.79%. In the calculation of Weighted Average Cost of Capital (WACC), the Cost of Debt will be reduced by a predetermined tax rate.

WACC

Based on the calculation with equation 1 of the Cost of Equity and Cost of Debt obtained a weighted average of capital costs that will be charged to the project by 9.69%.

4.2 Investment Costs

The investment cost incurred in the initial stage of building consists of equipment and *physical* workmanship of this Precast Plant based interview and review documents of existing projects, price requests for vendor with Business Development Manager and Budget Manager for the investment value of Plant Precast development as in Table 2.

Table 2. Investment Cost

No	Description	Total
1	Preparatory work	3.000.567.664
2	Plant Land Maturation	21.208.574.058
3	Roads and Environmental Access	15.035.378.290
4	Production Area	81.824.451.136
5	Production Support Building	8.324.500.000
6	Mechanical Electrical	8.588.850.000
7	Main Equipment	72.170.745.300
8	Auxiliary Equipment	22.747.117.040
9	Laboratory Equipment	316.260.000
10	Permissions	3.500.000.000
11	Permissions	3.500.000.000
12	Overhead Cost	11.835.822.174
13	Land Lease During Construction	4.300.000.000
Total		252.852.265.662

4.3 Variable Costs

To calculate the cost of the previous variable must know the production capacity needs that must be met during the investment period, the volume of product demand such as Table 1 so that the volume must be produced during the investment period in table 3 below.

Table 3. Production Capacity Needs

No	Item	Production Volume (pcs)	Concrete Volume (M3)
1	Column	168.000	282.240
2	Facade	253.600	304.320
3	Toilet Precast	92.000	285.200
4	Beam	892.000	584.930
5	Floor Plate	720.000	617.872
	Number of 3 years		2.074.561
	Number of 3 years		691.520

The quantity plan batching plant is 2 units with a capacity of 90 m3 / hour/unit. Based on the historical data of plant production utility tool by 85% with working hours of 25 days every month so that the precast plant can produce concrete with 2 units of batching plant of 734,400 m3 of concrete per year. The factory will operate for 16 hours with 2 shifts. The production capacity of the precast plant per year is 734,000 m3 greater than the requirement of 691,620 m3. Then the calculation of production costs are obtained from the multiplication between the volume and the base unit price on each precast product based on SNI 7833:2012 Precast Concrete Design Procedures and Precast Concrete for Buildings, while for material prices and wages obtained interview methods, review documents of existing projects, price requests for vendors. Interview sources and General Manager precast to find out productivity and costs. Variable cost during the investment period as in Table 3.

Table 2. Variable Cost

No	Description	Year 1	Year 2	Year 3
1	Column	341.363.162.112	351.604.056.975	362.152.178.685
2	Facade	205.535.391.499	211.701.453.244	218.052.496.841
3	Toilet Precast	214.490.014.400	220.924.714.832	227.552.456.277
4	Beam	586.203.227.216	603.789.324.033	621.903.003.754
5	Floor Plate	674.439.148.129	694.672.322.573	715.512.492.250
	Total	2.022.030.943.356	2.082.691.871.657	2.145.172.627.806

4.4 Fixed Costs

Operating expenses are routine expenses incurred annually during the investment period under company regulations and review documents of existing projects as in Table 3.

Table 3. Fixed Costs

No	Description	Year 1	Year 2	Year 3
1	Production Period Land Lease	4.100.000.000	4.223.000.000	4.349.690.000
2	Managerial Plant Salary	1.880.000.000	1.936.400.000	1.994.492.000
3	Staff Level Salary	20.632.000.000	21.250.960.000	21.888.488.800
4	Office Operating Expenses	20.432.633.579	21.045.612.586	21.676.980.964
5	Equipment Cost Maintenance	20.123.510.079	20.727.215.381	21.349.031.842
	Jumlah	67.168.143.657	69.183.187.967	71.258.683.606

4.5 Income

Revenue is obtained based on the number of products sold multiplied by the selling price, determination of the selling price of each product based on the break event point method of fixed costs and variable costs then to determine the selling price obtained from interviews with

marketing directors to get the expected profit, the expected profit interview result of 10%. The selling price of each product can be seen in Table 4.

Table 4. Selling Price of Each Product

No	Description	Sat.	BEP	Selling Price
1	Column	pcs	6.500.751	7.223.057
2	Facade	pcs	2.592.946	2.881.052
3	Toilet Precast	pcs	7.458.911	8.287.679
4	Beam	pcs	2.102.517	2.336.130
5	Floor Plate	pcs	2.996.860	3.329.844

Then from the selling price in Table 4 multiplied the volume sold in accordance with Table 1 for 3 years, but for payment is received by 90 calendar days after the precast product is delivered as in Table 5 below.

Table 5 Revenue

No	Description	Year 1	Year 2	Year 3
1	Column	404.491.192.358	404.491.192.358	404.491.192.358
2	Facade	243.544.895.309	243.544.895.309	243.544.895.309
3	Toilet Precast	254.155.489.821	254.155.489.821	254.155.489.821
4	Beam	694.609.344.704	694.609.344.704	694.609.344.704
5	Floor Plate	799.162.667.441	799.162.667.441	799.162.667.441
	Amount of Revenue	2.395.963.589.634	2.395.963.589.634	2.395.963.589.634
	Amount of Payment	1.796.972.692.225	2.395.963.589.634	2.994.954.487.042

4.6 Depreciation and Residual Value

Determination of depreciation and the residual value obtained from an interview with the General Manager of Accounting. Depreciation using methide Straight of line Depreciation then obtained the depreciation value of the tool in each period of investment period amounted to Rp. 84,284,088,554/ year and the residual value is Rp. 0.

4.7 Cash Flow

Cash Flow projections during the investment period then used Discounted Cash Flow results can be seen in Table 6.

Table 6. Cash Flow

No	Description	Year 0	Year 1	Year 2	Year 3
	WACC	9,69%			
1	Initial Cost				
	Investment Cost	(252.852.265.662)			
2	Debt				
	Investment Debt	176.996.585.963	-	-	-
	Production Debt	-	365.609.840.227		
3	Cost				
	Variable Cost		(2.022.030.943.356)	(2.082.691.871.657)	(2.145.172.627.806)
	Fix Cost		(67.168.143.657)	(69.183.187.967)	(71.258.683.606)
	Investment Debt Payment		(73.431.074.123)	(73.431.074.123)	(73.431.074.123)
	Production Debt Payment			(215.744.001.937)	(215.744.001.937)
4	Residual Value				0
5	Revenue		1.796.972.692.225	2.395.963.589.634	2.994.954.487.042
6	Net Income	(75.855.679.699)	(47.628.684)	(45.086.546.049)	489.348.099.570
7	Depreciation		(84.284.088.554)	(84.284.088.554)	(84.284.088.554)
8	Income After Depreciation	(75.855.679.699)	(84.331.717.238)	(129.370.634.603)	405.064.011.016
9	Tax (25%)	-	-	-	(101.266.002.754)
10	Net Cashflow	(75.855.679.699)	(47.628.684)	(45.086.546.049)	388.082.096.816
11	*Discount Factor*	1,00	0,91	0,83	0,76
12	*Discounted Cash Flow*	(75.855.679.699)	(43.422.744)	(37.475.232.903)	294.082.830.156

4.7 Net Present Value dan Internal Rate of Return

From the amount of discounted cash flow obtained Net Present Value was Rp.180,708,494,811 with equation 2. While the Internal Rate of Return result was 61.81% with equation 3.

5. CONCLUSIONS & SUGGESTIONS

5.1 Conclusions

From the results was Net Present Value of Rp.180,708,494,811 > 0 means feasible and Internal Rate of Return with NPV value equal to zero was 61.81% > 9.69% (WACC), it means that the assessment of feasibility study of precast dlant development investment for civil aparatus apartment project in the capital city of the country using capital budgeting method was feasible from financial criteria.

5.2 Suggestions for Further Research

Further research suggestions:

1. Further research to ascertain the feasibility limit can using sensitivity analysis on variables that influence investment to prevent future losses.
2. To measure risk can use monte carlo simulation because in an investment there will be uncertainty in terms of economics, culture, and politics prevent future losses.

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IMPROVING ON-SHELF-AVAILABILITY (OSA) OF GROCERY PRODUCTS IN ONE OF THE FOOD RETAIL NETWORKS IN GREATER JAKARTA AREA

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ABSTRACT

Ensuring high On-Shelf-Availability (OSA) or avoiding "Out of stock" events (OOS) is essential for retailers as it is one of the key factors for customer satisfaction. The term "Out-of-Stock" is used to describe a situation where a consumer does not find the product on the shelf, at the time he/she wishes to purchase it. The root cause could come from any party dealing with the supply of the products; the Supply Chain people, stores operations and the commercial team. In this study we report a project undertaken in one of the retail chains in Greater Jakarta that has been successful in reducing the OOS and hence improves OSA. The key underlying initiative was the cross-functional team. The team worked with a systematic approach to execute the tasks and resulting significant step change of the OSA performance. The result of this joint effort was the reduction of the OOS from 20.3% to 3.6% - 4.6%.

Key Words: on-shelf-availability, out of stock, cross functional team, retail, planogram

1. INTRODUCTION

From the consumer's point of view, a product will be seen as a set of benefits, in other words, consumers are not too interested in the technical data and services provided by the product compared to the benefits that will be obtained when the consumer buys it (Lai, 1995). Ensuring the products needed by consumers are always available on store shelves is one of the objectives for modern retail stores. The activity to measure the availability of products on store shelves is known as On-Shelf-Availability (OSA). Also known as Out of stock (OOS) which means measurement of unavailable stock. The definition of On-Shelf-Availability (OSA) is the availability of products for sale to consumers, where consumers expect and when consumers want to buy them. Out of stock (OOS) is also known as stockout, is a situation where a retail store physically does not have a certain product category, on its shelves, to sell to consumers (Saurav, 2016).

Ensuring On Shelf Availability is an important task, for otherwise consumers may find themselves in an out of stock situation which could waste of their time, money and energy. This situation can have a negative impact on the performance of retailers as well as their suppliers. Ensuring stock availability is a complex issue as the causes could be anywhere in the supply chain systems. The demand side, the supply side, the internal operations all could have an impact on stock availability.

This study was conducted in a large retail chain in Greater Jakarta. The chain has over 160 stores and employed about 11,000 people. The study was considered as an action research where we implement the recommendation and observe the results. At the time where the project started, the average OOS score was around 21.5% (or OSA score is 78.5%), which was much worse than the target. The underlying idea behind the improvements implemented in this project was that the problem could not be solved by a single function, but it needs to be through

a solid cross-functional team. Hence, the question to be addressed in this study is how much the cross-functional team could improve stock availability in this retail stores.

2. LITERATURE REVIEW

Many studies suggest that consumer loyalty to a particular brand is decreasing, whereas consumers will have a portfolio of brands in the category from which they make choices. Thus, product availability or On Shelf Availability becomes the main determinant of demand. There is evidence that more and more purchasing decisions are being made by the time the consumer is in front of the Store shelf, and if there is a gap in the shelf that should be a Brand A product, but a Brand B product is there, there will be a high probability that a Brand B product will be the consumer's choice (Christopher, 2011).

Moorthy revealed (Moorthy et al., 2015) that some of the causes of OOS, the number of products added is increasing which automatically reduces the storage capacity per item on the shelf or in the warehouse. The storage area in store warehouses is also reduced because retailers want to get additional sales space, as well as by implementing just-in-time procedures to reduce retailer inventory costs. Another cause is ghost inventory, when the inventory management system shows that a product is available when the product doesn't exist. This can be because a product is damaged and thrown away, stolen from the shelf, the product is recalled, or the product is still in the customer's cart.

Five categories as the main causes of OSA have been identified (Moussaoui et al., 2016):

a) The first four are operational, habitual, managerial, and coordination, the causes of failure from the planning and execution side of retail operations.
b) The fifth category is systemic causes, including contingent factors that strengthen supply chain failures in dealing with OSA.

The average OOS rate worldwide according to Corsten's research is around 8.3%, where the highest average reported in the study was around 12.3% and the lowest average was 4.9%. This is similar to the US benchmark of 8.2% reported in Coca-Cola 1996. (Corsten & Gruen, 2003)

New technologies, such as radio frequency identification (RFID) and the internet have many things proven beneficial for both manufacturers and retailers to reduce OOS and increase shelf availability of all goods (Pramatari & Miliotis, 2008) Studies by Bertolini have shown that the performance of RFID Technology has reached a level which allows its use in the FMCG supply chain. However, to provide an effective solution to the problem of out of stock, it is also necessary to identify and classify the root causes of OOS products, with the aim of determining the potential impact of RFID adoption on individual retailers (Bertolini et al., 2012).

Cross-functional teams have earned an important place in competitive organizations as a means to accomplish tasks from new product development to strategic planning, as well as being a major component of many quality improvement programs (Misterek, 1996). Denison and team describe the cross-functional team as a means to link the various departmental functions of an organization. They outline three characteristics that distinguish cross-functional team from "conventional teams" in organizations:

1. Different functional responsibilities of each member.
2. The temporary, project-driven nature of the team.
3. Unique performance with specific criteria and limited work cycle.

In other words, a cross-functional team is a group consisting of individuals from separate functional areas who come together for a specific purpose for a certain period of time (Denison et al., 1996).

Despite its prevalence in organizations, studies on this subject are limited, and further research is needed on how cross-functional teams facilitate processes in the quality of an organization's decisions, but the proliferation in the workplace shows that managers feel a significant advantage (Bowen, 1995).

3. METHODS

We use an action research approach. We started with problem definition. After the analysis of the problem, we then formulate the corrective actions, implement them, and record the results of the improvements.

3.1 Problem Definition

1. The research methodology begins with Brainstorming to identify problems with the Cross-function team (Supply Chain, Store Operation and Commercial), historical data and also a literature study, which was conducted in April 2018 to obtain a long list of potential problems causing OOS.
2. Furthermore, the entire long list is made a Fishbone diagram and grouped into each department that is most responsible for the problem. The goal is to get priority attention from the Leader of each Department in assigning teams that will be involved in the Cross-functional team.
3. Furthermore, on the planned day, in early May 2018, all 10 experimental pilot shops were collected from OOS product data (data from the SAP system and from Gap-check activities). Gap-check activities are scanned data with an RFID device on the barcode sticker on the price card listed on the store shelf where there is no product above the price card, then the Cross-functional team conducts a joint analysis, connecting the OOS data with transaction data in SAP related to products. the OOS product, to get the most ranking which problems have the greatest impact on OOS**.**

3.2 Formulating Corrective Action

1. Based on the highest ranking of potential problems that have been identified as mentioned in point 3.1.3 above, then brainstorming on what corrective actions should be done. The brainstorming involved almost all departments: Supply Chain, Store Operations, Commercial, IT and Finance, each department representative conveyed the recommended corrective actions to be taken where the implementation is planned to be carried out in the middle of May to the end of May 2018.
2. From the list of suggested corrective actions above, the priority corrective actions are ranked, then the corrective actions are made in the form of an action code, the action code is linked to transaction data in SAP, so that action recommendations are formed (in the form of a daily action report). what corrective actions must be taken by each department, and automatically emailed to each assigned Cross-functional team. The list of corrective actions must be simple and easy (in the sense that it is easy to understand and easy to do).

3.3 Implementation of Corrective Action

Then the implementation of corrective actions is carried out where the implementation took place from early June 2018 until mid-August 2021. Each team member assigned to carry out corrective implementation actions. These must be carried out every day, according to the recommendations for actions that appear from the daily report, where recommendations for action will be performed by different functions:

a. Stores Operations, which must be done in every Store.
b. Supply Chain, which must be done in DC for Logistics team and in Head Office for Supply Planning team and Commercial team

3.4 Impact Measurement

Measurement of the impact of corrective actions, was conducted in the mid-August 2018 until the end of October 2021.

4. RESULTS

The results can be outlined as follows:

1. Refer to discussion with Cross-functional team was identified 105 potential root cause of OOS which come from various departments.
2. Grouping 105 potential root cause of OOS by department: 31 comes from Supply Chain, 11 comes from IT, 3 from Finance, 15 from Stores Operation, 45 from Commercial.
3. Ranking of causes based on the number of cases causing OOS.
   A survey was conducted on 10 stores. The survey was conducted based on OOS product data in the SAP system and on scanned data with an RFID device on the barcode sticker on the price card listed on the store shelf where there was no product above the price card (called Gap-check Activity). From the survey, 24,211 OOS products were obtained from 102,725 total products listed in the planogram data from the 10 stores, meaning 23.6% of OOS products in the 10 stores, as shown in Table 1 below.

Table 1. Product OOS at 10 stores

No	Store code	Planogram		OOS Non Plano	Total OOS	% OOS
		SKU Plano	OOS Plano			
1	0624	10.768	2.173	761	2.934	27,2%
2	0628	11.264	2.323	860	3.183	28,3%
3	0655	11.211	1.072	482	1.554	13,9%
4	0674	11.257	1.668	751	2.419	21,5%
5	0126	8.552	1.443	620	2.063	24,1%
6	0112	10.169	1.890	605	2.495	24,5%
7	0124	9.195	1.476	354	1.830	19,9%
8	0210	10.241	2.173	478	2.651	25,9%
9	0310	10.167	1.950	624	2.574	25,3%
10	0350	9.901	1.900	608	2.508	25,3%
	Total	***102.725***	***18.068***	***6.143***	***24.211***	***23,6%***
OOS Planogram & non Planogram			***75%***	***25%***		

4. Link these OOS products to relevant historical data in SAP system and put all reason refer to 105 potential problems mentioned OOS root (SAP system are the IT system use on this Retail Company as main system for the whole company), resulting top 12 root cause as shown on figure 1 below.

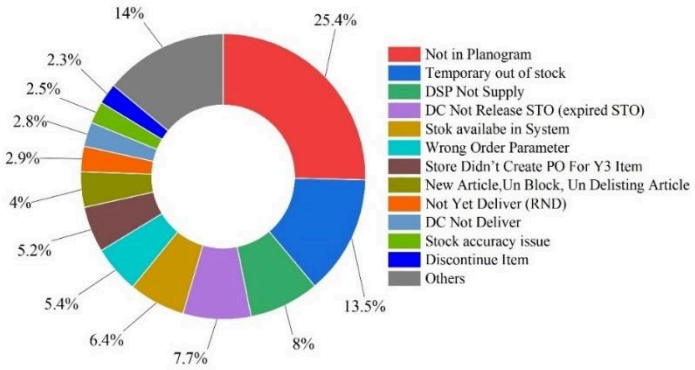


Figure 1. Top 12 root cause of OOS product

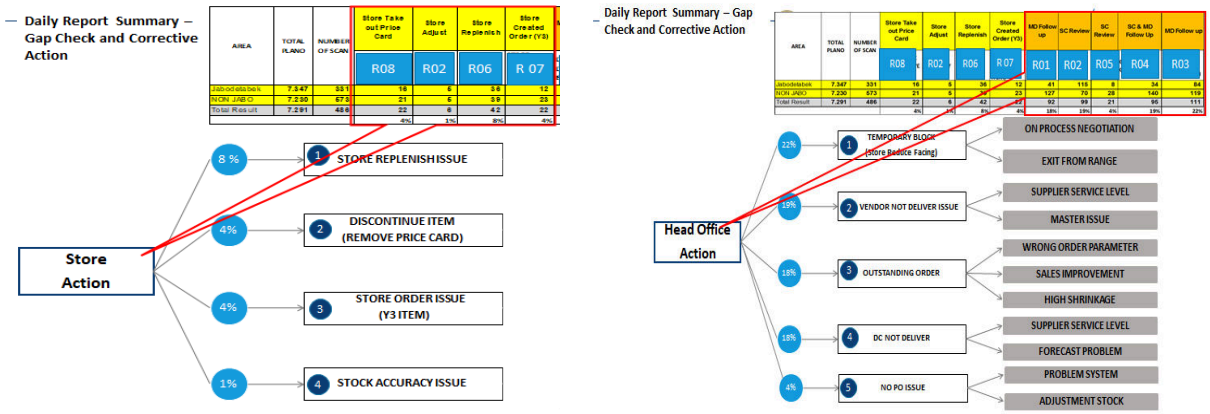
5. Applying 12 biggest root cause by Department, re-group become 9 and create new Code R01 to R09 in SAP system as shown on Table 2 below. This code become main source for Cross-functional team to execute recommendation of Daily Corrective Action, which generate automatic from system and email to each PIC or Group PIC.

Table 2. 12 root cause OOS and link to SAP system with 9 new Code in SAP

No	Department - Issue	Qty Issue	% Issue		Action Code	Corrective Action
	Store Operation					
1	Not in Planogram	6,143	25.4%	→	R08	Take Out Price Card
2	Stock availabe in System	1,548	6.4%	→	R06	Store Replenish
3	Store Didn't Create PO	1,257	5.2%	→	R07	Store Order
4	Stock accuracy issue	602	2.5%	→	R02	Stock accuracy
Total Store Issue		***9,551***	***39.4%***			
	Supply Chain					
5	DC Not Release STO	1,866	7.7%	→	R09	DC not Deliver
6	DC Not Deliver	670	2.8%	→	R09	DC not Deliver
7	Not Yet Deliver (RND)	695	2.9%	→	R04	Outstanding Order
8	Wrong Order Parameter	1,302	5.4%	→	R05	PO not Created
9	New Product, Un Block	970	4.0%		R05	PO not Created
Total Supply Chain Issue		***5,504***	***22.7%***			

	Commercial					
10	Temporary out of stock	3,271	13.5%	→	R01	Vendor not deliver
11	DSP Not Supply	1,927	8.0%	→	R01	Vendor not deliver
12	Discontinue Item	568	2.3%	→	R03	Change Planogram
Total Commercial Issue		***5,766***	***23.8%***			
Total 12 Issue		***20,821***	***86%***			

6. Stores Daily Report which generate from system, consist of recommendation action and root cause as mentioned on below figure 2a, this report as guidance to each Store Manager to lead their team to follow up the simple action daily.
7. Similar Daily Report which generates from system, consist of recommendation action and root cause as mentioned on below figure 2b, this report as guidance to each PIC in Supply Chain and Commercial Cross-functional team to follow up each correction action.



(a) (b)

Figure 2. Daily Store Report Summary, Gapcheck and corrective action on store action (a) and head office action (b)

8. Significant improvement result showing reduction from 20,821 product OOS become between 3,748 to 4,699 products, or from 20,3% to range between 3,6% to 4,6% (Table 3).
9. The highest OOS reduction came in R01 (6,143 to 526 in OOS average) and R08 (5,199 to 1,078 in OOS average).

Table 3. OOS Quantity reduction before and after correction action

Depart-ment	Gapcheck		Data OOS (Qty) by date								
			Before	**After**							
	Reason	**Code**	***1-Mei***	**18-Aug**	**26-Aug**	**4-Sep**	**19-Sep**	**27-Sep**	**01-Oct**	**11-Oct**	**26-Oct**
Stores	Stock accuracy	**R02**	*602*	33	129	126	120	112	138	189	198
	Store Replenish	**R06**	*1,548*	94	70	103	120	90	74	136	124
	Store Order	**R07**	*1,257*	25	156	55	71	168	163	84	96
	Take Out Price Card	**R08**	***6,143***	**40**	**756**	**577**	**593**	**674**	**461**	**583**	**521**
Supply Chain & Commercial	Vendor not deliver	**R01**	***5,199***	**686**	**1,299**	**1,114**	**1,081**	**1,194**	**939**	**1,165**	**1,147**
	Discontinue Product	**R03**	*568*	1,017	391	317	383	408	440	433	403
	Outstanding Order	**R04**	*695*	1,290	747	675	667	679	583	731	735
	PO not Created	**R05**	*2,272*	304	100	92	97	77	81	114	110
	Warehouse not Deliver	**R09**	*2,536*	259	870	1,022	1,096	903	978	1,264	1,184
	Store Total		***46%***	***9,551***	***192***	***1,111***	***861***	***904***	***1,044***	***836***	***992***
	Average Stores				***860***	***860***	***860***	***860***	***860***	***860***	***860***
	SC & Commercial Total		***54%***	***11,270***	***3,556***	***3,407***	***3,220***	***3,324***	***3,261***	***3,021***	***3,707***
					3,384	***3,384***	***3,384***	***3,384***	***3,384***	***3,384***	***3,384***
	Total All			***20,821***	***3,748***	***4,518***	***4,081***	***4,228***	***4,305***	***3,857***	***4,699***
	% OOS		***20.3%***	***3.6%***	***4.4%***	***4.0%***	***4.1%***	***4.2%***	***3.8%***	***4.6%***	***4.2%***

6. CONCLUSIONS

Based on the results of research conducted on 10 retail stores in Greater Jakarta, corrective actions to reduce Out of stock (OOS) show the following results. The initial survey data obtained 24,211 total OOS products and based on brainstorming with the cross-functional team we obtained 105 potential problems causing OOS. After tracing the source of the problem causing OOS and ranking it, we finally focused on 12 types of problems. The total improvement results show a very significant decrease in OOS from 20,821 to 4,244 OOS or from 20.3% to about 3.6% - 4.6%. This major improvement was due to a systematic and

constant change in the way the team worked. We substantially improved the cross funtional team that involved the supply chain team, the comercial and the store oprations people.

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THE DEVELOPMENT OF THE MAXIMUM COVERING LOCATION PROBLEM MODEL FOR EQUALIZATION DISTRIBUTION OF THE COVID-19 VACCINE (STUDY CASE: MALANG REGENCY)

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ABSTRACT

This research intended for Covid-19 vaccine equal distribution to the population in some regions, which still was not prevalent. This model development was expected to increase vaccine percentage to reach the target and break the Covid-19 virus deployment chain. Generally, this model using The Maximum Covering Location Problem. The Government makes a rule to achieve the herd immunity program from the government, it requires 70% full vaccinated of the population. The model had a completion stage started from determining the demand location points, determining the regional location candidate used as the vaccine location, calculating the distance between the demand region location points, making a mathematical model, and determining a numeric scenario for the model. This research had two scenarios which; the first scenario determined maximum 5 health facility locations with 500.000 doses vaccine supply capacity. The second scenario was determining maximum 10 health facility locations with 300.000 doses vaccine supply capacity. The result of these scenario are, the first scenario requires 8 times of running the model to achieve the vaccination target of 70%. Then, the second scenario 12 times running the model to get the vaccination target of 70%.

Keywords: distribution vaccine, Covid-19 vaccine, increase coverage rate, model maximum covering location problem, health facility.

1. INTRODUCTION

In an immunization program, a vaccine is the main component that must be guaranteed its availability as long as the vaccine has a particular standard that has a function to select vaccine when it is produced in the pharmaceutical factory and pharmaceutical retail, meanwhile on the distributor to distribution chain in the hospital, vaccine stock must be managed well. However, vaccine shipment in some extensive regions have an extremely complex problem that as vaccine administration in the population that does not reach the target yet. The supply chains in some of these areas are limited in their storage capacity and ability to transport vaccines quickly to various points throughout the city. Despite these supply chain limitations, many of these countries have geographically dispersed populations. Part of their population has limited or no access to vaccination

sites due to poor infrastructure (poor road conditions or limited transportation) or other geographic barriers (Lim, et al, 2016). Planning in covering location has a significant influence on the behavior of the entire vaccine distribution chain. In some countries have succeeded in increasing the total vaccine administration level that must be given to the community. Therefore, it is very important for countries to consider a covering location program's design and objective when designing and completing the entire supply chain process (Farahani et al., 2012).

Vaccine distribution is a complex issue and the effectiveness of delivery is critical to reducing mortality in some under-resourced areas. Therefore, to increase the effectiveness of the location coverage, it is widely used. The purpose of this study was to maximize the number of people who could be vaccinated against COVID-19 based on the different doses vaccine supply capacity to delivered to each location. The Government make a rules to achieve the herd immunity program from the government, it requires 70% full vaccinated of the population.

2. LITERATURE REVIEW

The previous research that closest its relation with the one described discusses health facility location to maximize service, with linear degradation assumption in service probability as a distance to the nearest health facility increase. The research presents an integer programming formulation and describes the results using data from two locations in the United States and Canada (Verter & Lapierre, 2002). Similar research related to maximal covering location to intensify vaccination rates in developing countries with relatively low incomes. In which the focus of this research is to make a new facility location place that is accessible by their population (Lim et al., 2016).

There was research that proposed continuous maximal covering location problem (C-MCLP), which is often confronted in natural disasters rescue such as earthquakes, floods, and storms. The objective of this research was to optimize (dynamically and rapidly) the continuous location of communication centers (e.g., moving vehicles or ships) (Yang et al., 2020). This research developed two mixed-integer linear programming models (MILP) for C-MCLP. The first model was the single-period C-MCLP model, which was applicable to a stochastic rescue environment where the rescue team had no planned movement and could move in any direction. The second was the multi-period C-MCLP model, which was for cases where the rescue team planned the movement in several periods/phases.

3. METHOD

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This Maximum Covering Location Model for Vaccine Distribution was used to conduct prevalent COVID-19 vaccine distribution in some regions during the pandemic. This developed model used a fair objective function to distribute vaccines to health care providers with the target recipients starting from health workers, elderly, workers, students, and the youth community.

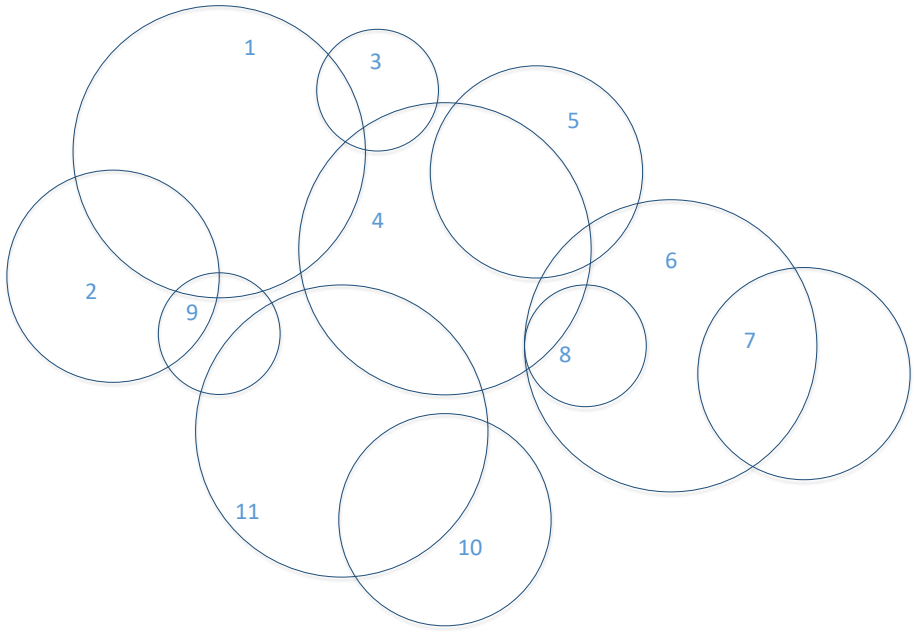

Figure 1. Illustration Coverage distance Facility Location

From the picture above, it is explained that when one of the sub-districts is used as a health location for the vaccination, the sub-district can serve the population with a maximum distance of coverage distance that has been determined from the sub-district of origin of the population. For example, if sub-district 1 is used as the location of a health facility for vaccination by determining a coverage distance of 20 kilometers, then residents from sub-districts 2, 3, 4, and 5 can vaccinate in sub-district 1 as long as the sub-district receives a vaccine allocation from the health office.

Notation	Description
i	Set of sub-district locations i = {1,2,3,…,n}
j	The set of health location facilities j = {1,2,3,…,n}
dij	Distance between districts
D	Maximum coverage distance
hi	Number of people who were vaccinated
P	Number of candidates for facility locations j
K	Vaccine dose supply capacity
Variable Decision	
aij	1 if the candidate location of facility j can provide vaccines to residents of sub-district i 0 otherwise
Xj	1 if the location of the facility is used as the location for the vaccination 0 otherwise
Zi	1 if my sub-district location can be served by a candidate for the facility location j

	0 otherwise
pi	Proportion of population that can be vaccinated if my sub-district location can be served

Formulation Model:

$$\text{Maximize} \sum_{i} Zihipi \quad \text{(a)}$$

st

$$\sum_{j} X_j \leq P \quad \text{(b)}$$

$$Zi \leq \sum_{j} a_{ij} X_j \quad \forall i \quad \text{(c)}$$

$$pi \geq 0 \quad \forall i \quad \text{(d)}$$

$$pi \leq 1 \quad \forall i \quad \text{(e)}$$

$$Zi \geq pi \quad \forall i \quad \text{(f)}$$

$$\sum_{i} Zihipi \leq K \quad \forall i \quad \text{(g)}$$

$$X_j \in \{0.1\} \quad \forall j \quad \text{(h)}$$

$$Z_i \in \{0.1\} \quad \forall i \quad \text{(i)}$$

$$a_{ij} \in \{0.1\} \quad \forall (i,j) \quad \text{(j)}$$

.

The objective of developing this model was to maximize the number of people who could be vaccinated by considering vaccine dose supply quantity (a). The number of health facility location candidates at j sub-district used as the COVID-19 vaccination implementation location had to have a smaller or equal value with the determined health facility location(b). Population in i sub-district could not be served if at least one health facility candidate location in j sub-district could serve the population in i sub-district(c). If the population in i sub-district could be served with the COVID-19 vaccine, so request proportion allocation from the total vaccinated population at each dose, was the p_i value must be more than or equal to 0 and had a value less than 1(d) and (e). If the population in i sub-district location could not be served by COVID-19 vaccination administration, so no request proportion allocation from the total population could be vaccinated(f). The number of people who could be served for COVID-19 vaccination first and second dose in all i sub-district must be less than or equal to the total dose supply capacity provided by the health office party(g). Variables X_j , Z_i and a_{ij} were indicator variables that had binary values (h),(i),(j)

4. RESULT

In this study, the model was performed in two scenarios which were implemented in 33 sub-districts located in Malang Regency. Each sub-district had two request types. The first request was for a population who still did not get the first dose COVID-19 vaccine. Meanwhile, the second request was for a population who would get the second dose COVID-19 vaccine. The following was a list of 33 sub-districts, total population data that could be vaccinated, population data number who have been vaccinated with two complete doses, those who have got the first dose vaccine, and those who have not got the vaccination, and the distance between sub-districts in Malang Regency.

This model was done by a numerical experiment with scenario 1, which was to determine a maximum of 5 health locations with a vaccine dose supply capacity of 500,000 with. Meanwhile, scenario 2 was to determine a maximum of 10 health locations with a vaccine dose supply capacity of 300.000.

Table 1. Result of Scenario 1

Vaccine implementation number-	Number of first dose vaccination	Number of second dose vaccination	Percentage of first dose vaccination	Percentage of second dose vaccination
Current accumulation	213.901	118.181	8.16%	4.51%
1	652.243	179.839	24.90%	6.86%
2	1.038.480	293.602	39.64%	11.21%
3	1.245.190	586.891	47.53%	22.40%
4	1.279.643	1.052.439	48.84%	40.17%
5	1.596.230	1.235.852	60.93%	47.17%
6	1.701.776	1.630.306	64.95%	62.23%
7	2.201.776	1.630.306	84.04%	62.23%
8	2.297.764	2.034.318	87.70%	77.65%

Table 2. Result of Scenario 2

Vaccine implementation number-	Number of first dose vaccination	Number of second dose vaccination	Percentage of first dose vaccination	Percentage of second dose vaccination
Current accumulation	213.901	118.181	8.16%	4.51%
1	513.901	118.181	19.61%	4.51%
2	746.359	185.723	28.49%	7.09%
3	1.046.359	185.723	39.94%	7.09%
4	1.054.784	477.298	40.26%	18.22%
5	1.213.566	618.516	46.32%	23.61%
6	1.290.487	841.595	49.26%	32.12%
7	1.490.414	941.668	56.89%	35.94%
8	1.708.499	1.023.583	65.21%	39.07%
9	1.708.499	1.323.583	65.21%	50.52%
10	1.822.740	1.509.342	69.57%	57.61%
11	1.905.617	1.726.465	72.73%	65.90%
12	1.986.122	1.945.960	75.81%	74.27%

Table 2. PPKM Level from Government

Level	Vaccination Percentage
1	60% - 70%
2	50% - 60%
3	40% - 50%
4	≤ 40%

From the table result above, it was indicated that there was an influence from changes in the facility location maximum parameters that could be a vaccination implementation location candidate and the amount of vaccine dose supply capacity allocated to each vaccination activity trial. For scenario 1, with a maximum of five candidate locations for vaccination health facilities with a supply of 500,000 doses, it obtained eight vaccine implementation trials. The result for

scenario 1 was increase in vaccination was more constant and gradual. In each vaccination implementation trial, both on the first dose vaccine allocation and vaccine allocations at the second dose, they all experienced an increase. For the first vaccination implementation, the dose increase was more significant for the vaccine allocation at the first dose. It was because to consider at least the population got the first dose vaccine initially so that the vaccine given could form antibodies in the body. Vaccination increase in the first implementation had an increase from the previous that was 8.16% to 24.90%. Meanwhile, for complete vaccination, 2 doses increased from 4.51% to 6.86%. In the sixth vaccination implementation trial, the percentage number between first dose and second dose vaccine administration was almost the same; it was an allocation effort to accelerate the vaccination rate to achieve herd immunity planned by the government. In the first dose vaccination administration, the percentage reached 64.95%, while for second dose vaccination it reached 62.23%. Then, by eight experiments, vaccination implementation would give a positive impact in Malang Regency by increasing vaccination rate achievement level, which was formerly at level 4 then increased to level 1 and met herd immunity target of more than 70%. With first dose vaccination achievement, 87.70% of the population had got the vaccine. Meanwhile, those given complete 2-dose vaccinations reached 77.65% of Malang Regency's total population.

Meanwhile, for scenario 2, with a maximum of ten health facility locations, the vaccination implementation with 300,000 dose supplies was obtained through twelve vaccination trials. The result for scenario 2 vaccination percentage enhancement was slower if compared to scenario 1 due to less supply allocation. As well as for every vaccination trial, several times did not experience enhancement for one of the vaccine dose service administrations. As in the first and third experiments, vaccination was only given on the first dose vaccine, so for the second dose, there was no increase in those who received complete vaccination. For the first vaccination implementation, the dose administration was greater for vaccine allocation at the first dose initially. It was because considering at least the population got the first dose vaccine first so that the vaccine given could form antibodies in the body. Vaccination increase on the first implementation experienced an increase from the previous 8.16% to 19.61%. Meanwhile, for the complete 2-dose vaccinations, there was no increase from 4.51%. In the fourth vaccination trial, there was also no increase in second dose vaccination. The achievement level remained at 7.09%. In scenario 2, it could be seen that vaccination administration allocation was more focused on serving the first dose vaccine. It could be seen by vaccination achievement percentage improvement, which was higher than the second dose vaccination. It was an allocation effort to accelerate the vaccination rate to achieve herd immunity planned by the government. It was due to the limited vaccine allocation owned by the Malang District Health Office, which would be allocated equally in each health facility location of vaccination implementation. Similarly, in the nine vaccination trials, vaccination was only given to those who would receive the second dose vaccine. For the first dose vaccination, there was no increase from 65.21% carried out in the eighth vaccination. Meanwhile, the second dose vaccination experienced a significant increase that was from 39.07% to 50.52% of the total population. Vaccination achievement until the twelfth trial between the first dose and the second dose vaccine administration had almost the same percentage level in which for the first vaccination reached 75.8%, and for the second dose vaccination reached 74.27% of Malang Regency total population.

6. CONCLUSION.

1. This research produces *The Maximum Covering Location problem* model to maximize the population who can be vaccinated by the COVID-19 vaccine by considering the current achievement level in Malang Regency. The development of this model shows a vaccination achievement percentage increase significantly.

2. According to the numerical test experiment result conducted when determining the difference from candidate location maximum number for facility location that would be used as vaccination implementation and the difference of vaccine dose supply capacity has obtained the result that the number of locations that can be used as a vaccination implementation location does not have too many differences. The location facilities that can be used as vaccination services are three to eight locations that can serve from various sub-district locations that the population can reach within a certain distance. From the numerical experiment result, it was obtained the result:
   a. With a supply capacity of 500.00 vaccine doses, it produced a more constant vaccination increase from eight vaccination implementation trials by achieving the herd immunity target of 70%. Health facility locations used were consistent with 3 to 5 vaccination locations.
   b. With a supply capacity of 300,000 vaccine doses, it produced a slower vaccination that was twelve vaccine implementation trials to achieve the herd immunity target of 70%. The facility location used for vaccination implementation was more diverse due to a fewer vaccine dose allocations that started with only two location facilities until there were eight location facilities used for vaccination implementation.

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FACTORS AFFECTING CONSUMER BUYING INTEREST IN INTERIOR DESIGN SERVICES

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ABSTRACT

The success of a company is to understand how the behavior of the target market. By paying attention to what factors can affect potential customers of a company, especially companies engaged in interior design services whose products are not tangible products. Research on these factors has been carried out by many previous researchers, but still, no one has examined the influence of these factors on interior design services comprehensively. This study aims to observe the influence of these factors on consumer buying interest in Indonesia with the Decomposed Theory of Planned Behavior (TPB) approach. This study observes several factors such as Perceived Value, Perceived Quality, Satisfaction, Perceived Reputation, Involvement, Attitude Marketing, Perceived Risk, Interpersonal Influence, and External Influence. These factors will determine other dependent factors such as Trust, Perceived usefulness, satisfaction which will determine consumer buying interest. This study uses the PLS-SEM method with data as many as 50 respondents who have used interior design services. The results showed that the variables of trust, satisfaction and perceived usefulness had a significant impact between variables on buying interest. While the other variables have a positive but not significant effect. Based on the research results, it is important for service providers to expose the design results, both design explanations and resolved problems, as well as testimonials from consumers as service users.

Keywords: Behavior, Purchase Interest, Interior Design, Decomposed Theory of Planned Behavior (TPB), PLS SEM.

1. INTRODUCTION

Through the efforts of the interior design services, businesses can distribute ideas, creativity and a variety of inspiring unique to set an object in the room, furthermore, it looks more attractive and creates a sense of comfort to the inhabitants. Fandy Tjiptono (2005) states five characteristics of the principle, among others, intangibility, perishability, heterogeneity, i*nseparability*, and lack of ownership. Sumaryanto (2009) added the above characteristics with two more characters: people-based and contact customers. Then how about goods or services that are not included in the category primary for most people, as is the case with the goods or services is categorized as goods of luxury. At the time before the onset of the pandemic this creative industry either services or goods is luxury which can increase pride, self-esteem someone, even on the segment limited is no longer considered as a luxury item, although a complementary good to equip the house which is the primary goods.

Following the development of the era, the mindset of the society changed to a more modern, causing people's lifestyle changes. According to Bekraf, during the last two decades, the subsector of interior design in Indonesia amounted to Rp. 1,483 trillion in 2016, an increase on the previous year of Rp 1,354 trillion in 2015. Public appreciation of this field is also getting better. Some things still need to be considered of the sector such as certification and copyright protection.

Shifting of today's society that relies heavily on the internet and social media, making the strategy of marketing a company must also follow this shift. Many emerging e-commerce platforms support the companies that sell the product to sell products to customers, social media is also highly influential to increase the engagement of the company, (Cahyono, 2017)

Different from the company engaged in the services of the interior because platform such as e-commerce is less suitable for marketing. It is because the interior design service is not a product that can be directly purchased, while is a service that continued until the contract is completed. Thus a portfolio is far more important than just selling a certain product (Santoso,2016). The consumer's decision to choose or buy services depends very much on how the service provider can identify the influential factors in each stage of the consumer decision process. Adjustment to the culture has become very important because of the emergence of market opportunities in the era of globalization. The design needs pure as the design of the course without furniture is needed in the field of commercial, from shops, cafes, hotels, showrooms, malls and commercials other. A good design can increase the purchase intention of the customer, attract the attention of prospective buyers, and there are still many more benefits. Interior design is very important for commercial and public spaces in Indonesia. However, the number of people who understand the importance of interior design is still very little. While, with the increasing trend design interior before the pandemic, many universities that open the interior design department with a capacity of tens and hundreds each year, will be more interior designers. The Association of Interior Designers Indonesia estimates that there are at least 3,000 interior designs in Indonesia. The study sought to develop a theory of the previous research on the buying interest of the market to the interior design and try to predict the relationship between these factors.

2. LITERATURE REVIEW

Desain Interior

Based on Kamus Besar Bahasa Indonesia (2008) said the design of the interior and has the meaning of the motive or pattern of space in the building. Interior design is the activity of planning, organizing and designing spaces in buildings. The arrangement of space aims to make the user feel comfortable, feel at home and happy to be in the room

SEM (Structural Equation Modeling)

Structural Equation Modeling (SEM) is a method of multivariate statistics, which involves the estimation of parameters for a system of simultaneous equations (Schreiber, et. al., 2006). Stein, et. al. (2012) added, SEM has the general framework that includes regression analysis, path analysis, factor analysis, equation econometric simultaneous, and model growth curves latent, to name a few.

SEM consists of 2 parts, namely the model of the latent variables and the measurement model (Ghozali, 2008). The first part is a model of the latent variables (latent variable model) adapted to the model of simultaneous equations in econometrics. If on the econometrics of all the variables are some of the variables measured/observed (measured/observed variables), then in this model, some variables are latent variables (latent variables that are not measured directly).

PLS-SEM (Partial Least Square-SEM).

There are two approaches in Structural Equation Modeling (SEM), i.e. SEM-based covariance or also called Covariance-Based SEM (CB-SEM) and with the approach of variance (VB-SEM) technique with Partial Least Squares SEM (PLS-SEM). The approach of PLS is more suitable because this approach assumes that all the size of the variance is the variance that is useful to the described. The presence of the method of PLS-SEM is not a competitor CB-SEM, but rather to be a compliment and an alternative to regression multiple, customized with the purpose of research (Priyono & Sunaryo, 2013).

Evaluation structural model

The purpose of the evaluation of the structural model at this stage is to see the significance of the relationship between latent variables by looking at the coefficient of the path (path coefficient), which suggests there or not there is a relationship between the latent variables in the research model. To perform the evaluation of the structural model starting from seeing the value of R-Square(R2) for each of the predictions of the structural model, the value of R2 is used to explain the influence of latent variables (exogenous) to the latent variable (endogenous) or how great its influence is.

3. METHODS

Determination of Hypotheses

A hypothesis is a temporary answer to a problem that is still presumption because it still has to be proven true. A hypothesis is basically a proposition or assumption that may be true and is often used as a basis for decision making or problem solving or for the basis of further research.

From the modified Decomposed of The Theory of Planned Behavior model on the online purchasing decisions of prospective customers, the hypothesis in this study can be as follows.

H1: Perception of usefulness in the use of design services has a positive and significant effect on prospective customers' attitudes towards design services

H2: Attitudes towards marketing have a positive and significant effect on prospective customers' attitudes towards design services

H3: Risk perception has a negative and significant effect on the attitude of prospective customers towards design services

H4: Interpersonal Influence has a positive and significant influence on the subjective norm of prospective customers on design services

H5: External influence has a positive and significant influence on the subjective norm of prospective customers on the purchase of design services.

H6: Self-belief has a positive and significant influence on the perception of prospective customers' behavioral control on the purchase of design services

H7: The condition of the facility has a positive and significant influence on the perception of the prospective customer's behavioral control on the purchase of design services

H8: The involvement of prospective buyers has a positive and significant influence on the trust of potential customers to design services.

H9: Perceived value has a positive and significant effect on perceptions of the usefulness of prospective customers for design services

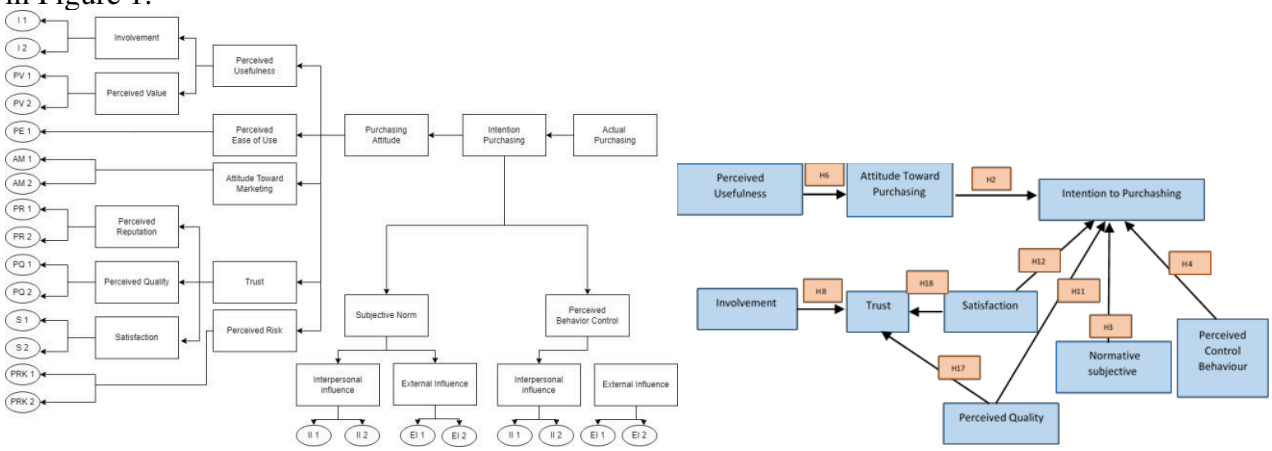
H10: Perception of reputation has a positive and significant impact on potential customers' trust in design services.

H11: Perception of quality has a positive and significant influence on the trust of potential customers to purchase design services at the company

H12: has a positive and significant effect on customer confidence to purchase design services again

H13: Perception of quality will affect the satisfaction of prospective customers when buying design services later.

From the 13 hypotheses that have been described above, the model in this study is depicted in Figure 1.



(a) (b)

Figure 1. Research Methods (a) first-order (b) second-order

Data Collection

In this study, the data was collected in the form of primary data with a survey method, namely the collection of structured data in the form of a questionnaire. The questionnaire is a digital questionnaire using Google Forms. The method used in filling out the questionnaire is a self-administered survey, where the questionnaire is filled out by the respondent and the questions are structured questions where alternative answers have been provided. The minimum number of samples in PLS itself ranges from 30-100 (Hair, Black, Babin, Anderson, & Tatham, 2006). The author takes a sample of at least 50 samples.

Operational Variables

- For independent variables there are 12 latent variables, namely perceived ease of use (PE), marketing attitude (AM), perceived value (PV), perceived reputation (PR), perceived risk (PRK), involvement (I), satisfaction (S), perceived quality (PQ), interpersonal influence (II), external influence (EI), self-efficacy (SE), and facilitating conditions (FC). Every latent variable has several indicator variables and there are 25 indicator variables, namely ease of getting services (PE1), ease of using services (PE2), beneficial (PV1), suitability (PV2), involvement (I1), in accordance with the wishes (I2), the importance of reputation (PR1), trust (PR1), the importance of quality (PQ1), trust (PQ2), results (S1), service (S2), the importance of marketing (AM1), take effect (AM2), useful (AM3), at-risk (PR1), wrong risk (PR2), get info (II1), take effect (II2), get info (EI1), take effect (EI2), self-efficacy (SE1), comfort (SE2), time (FC1), financial (FC2).
- There are 6 dependent variables, namely trust, perceived usefulness, attitude toward purchasing, normative subjective, perceived control behavior, and intention to purchase.

Data Analysis

In this study, data processing using Partial Least Square (PLS). PLS is a data analysis technique to analyze the relationship between a set of variable blocks. This is based on the assumption that the relationship between the specified blocks refers to and considers a clear knowledge base (theory). Each variable block is assumed to represent a theoretical concept which is represented in the form of a latent variable (Yamin & Kurniawan, 2011).

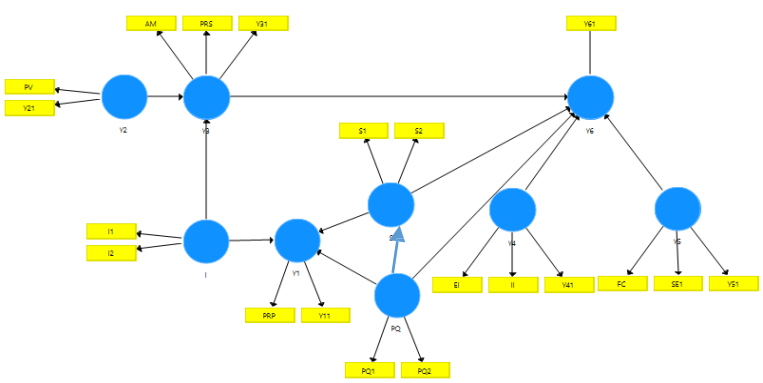
An outer model or evaluation of the measurement model is carried out to assess the validity and reliability of the model. While the inner model is a structural model evaluation that describes the relationship between latent variables in a research model. Testing of the structural model is done by looking at the value of R-square (R^2). Changes in the R-Square value are used to assess the effect of the independent latent variables on the dependent latent variable and whether it has a significant effect.

4. RESULTS

4.1 Structural Equation Model – Partial Least Square

This study uses Structural Equation Modeling based on variance, namely Partial Least Square. This method does not require assumptions, the sample used tends to be small, a method that can analyze constructs with reflective and formative indicators, the method used to confirm theory, and can be used for very complex models consisting of many latent and manifest variables, whereas if using covariance-based SEM requires a sample that tends to be large at least 500 samples. The first step in the Structural Equation Modeling - Partial Least Square method is to construct from the path diagram the independent latent variable, and the dependent latent variable, based on the 13 existing hypotheses.

The formation of the model path diagram (Figure 2) is based on the previous literature which is shown and explained in Figure 1 by modifying several latent variables that will be used in the outer model to become indicators of other latent variables according to their relationship. In practice, it will be carried out in two orders. The first order describes the path of all existing latent variables and is carried out to test the validity of the influence of the measuring indicator on the latent variable. Then in the second order, testing the validity of the influence between the dependent latent variables.



Description :
Y1 : Endogenous latent variable 1, Trust
Y2 : Exogenous latent variable 2, Perceived usefulness.
Y3 : Endogenous latent variable 3, Attitude toward purchasing.
Y4 : Exogenous latent variable 4, Normaive subjective.
Y5 : Exogenous latent variable 5, Perceived control behavior.
Y6 : Endogenous latent variable 6, Intention to purchase.
I : Exogenous latent variable 7, Involvement.
S : Exogenous latent variable 8, Satisfaction.
PQ : Exogenous latent variable 9, Perceived quality.

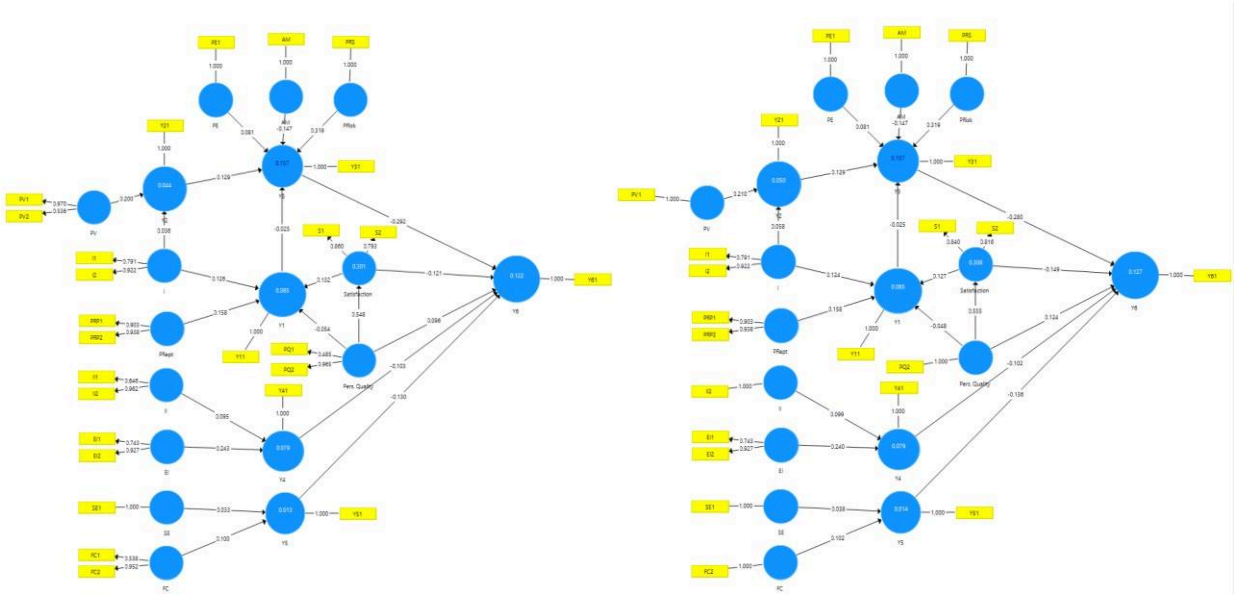
Figure 2. Construct Model Path Diagram

4.2 Ouer Model Evaluation

The relationship of the 12 independent latent variables to the 6 dependent latent variables in full along with their respective indicators is presented in Figure 3 (a). Testing the validity of the Outer Model is done by looking at the loading factor value of each indicator with the aim of seeing the validity of the indicators in measuring latent variable. The minimum loading factor limit for indicators that are declared valid is 0.7 thus the indicators with a loading factor value of less than 1.7 must be omitted. The results of the validity test are shown in Table 1.

Table 2 shows that there are indicators with loading factor value is equal to 1, which means it is a single indicator of a latent variable, for example indicators Y11 – Y61 the six indicators are single indicators of each dependent latent variable, Trust, Perceived Usefulness, Attitude Toward Purchasing, Normative Subjective, Perceived Control Behavior, and Intention to Purchase. In

addition, there is also PV1 which contributes to the latent variable PV of amount 0.970. There are 4 indicators that do not fulfilled the convergence validation criteria, there are FC1, II1, PQ1 and PV2.



(a) (b)

Figure 3. (a) First Order Path Diagram (b) First Order Path Diagram after Validation

In addition, checking the AVE (Average Variance Extracted) value for each latent variable. Variables with an AVE value of less than 0.5 are said to be invalid. The AVE value of the First Order Model is shown in Table 2. All latent variables have an AVE value greater than 0.5 thus all variables have fulfilled the validity criteria. However, according to the results on the value of loading factors in Table 1 which shows that there are 4 indicators are invalid, then these indicators must be deleted.

Table 1. Result of Loading Factor

Indicator	Loading Factor	Indicator	Loading Factor	Indicator	Loading Factor
AM	1.000	PE1	1.000	S2	0.793
EI1	0.743	PQ1	0.485	SE1	1.000
EI2	0.927	PQ2	0.965	Y11	1.000
FC1	0.538	PRP1	0.903	Y21	1.000
FC2	0.952	PRP2	0.938	Y31	1.000
I1	0.791	PRS	1.000	Y41	1.000
I2	0.922	PV1	0.970	Y51	1.000
II1	0.646	PV2	0.536	Y61	1.000
II2	0.962	S1	0.860		

Table 2. Result of AVE

Variable	AVE	Variable	AVE	Variable	AVE
AM	1.000	PRP	0.848	Y1	1.000
EI	0.706	PRS	1.000	Y2	1.000
FC	0.598	PV	0.614	Y3	1.000
I	0.738	PQ	0.584	Y4	1.000
II	0.671	SE	1.000	Y5	1.000
PE	1.000	S	0.684	Y6	1.000

Further modeling is carried out as shown in Figure 3 (b). The value of loading factors on the Outer Model after validation (Figure 3 (b)) is shown in Table 3. All indicators have loading factors value greater than 0.7 thus all indicators fulfill the validation criteria. The PRP2 indicator (consumers have more confidence in interior design services that have a good reputation) is the indicator –besides a single indicator, that has the largest contribution to the latent variable PQ (Perception of Quality) which is 0.938. Then, checking the AVE value as shown in Table 5.

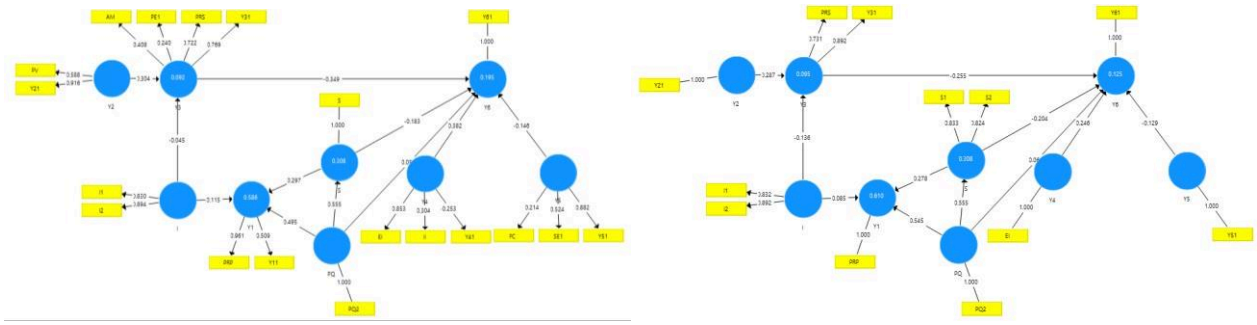
Table 3. Result of Loading Factor after Validation for First Order Model (Outer Model)

Indicator	Loading Factor	Indicator	Loading Factor	Indicator	Loading Factor
AM	1.000	PQ2	1.000	SE1	1.000
EI1	0.743	PRP1	0.903	Y11	1.000
EI2	0.927	PRP2	0.938	Y21	1.000
FC2	1.000	PRS	1.000	Y31	1.000
I1	0.791	PV1	1.000	Y41	1.000
I2	0.922	S1	0.840	Y51	1.000
II2	1.000	S2	0.816	Y61	1.000
PE1	1.000				

Table 4. Result of AVE after Validation for First Order Model (Outer Model)

Variable	AVE	Variable	AVE	Variable	AVE
AM	1.000	PRP	0.848	Y1	1.000
EI	0.706	PRS	1.000	Y2	1.000
FC	1.000	PV	1.000	Y3	1.000
I	0.738	PQ	1.000	Y4	1.000
II	1.000	SE	1.000	Y5	1.000
PE	1.000	S	0.686	Y6	1.000

The results from Table 4 show that all variables have fulfilled the validity criteria in terms of discriminant also based on the previous loading factor in Table 3, which also shows that the indicators have fulfilled the validity criteria in terms of convergent. The deletion of indicators with low loading factor (<0.7) on latent variables increases the AVE value on existing latent variables. Thus, for further analysis, the indicators in Table 3 are already valid.



(a) (b)

Figure 4. (a) Second Order Path Diagram (b) Second Order Path Diagram after Validation

In the second order path, the latent variable is simplified, where the independent latent variables related to the dependent latent variable are used as indicators of the dependent latent variable. Figure 4 (a) shows that the independent latent variable PV is one of the indicators of the dependent latent variable Y2 (Perceived usefulness), this also applies to other dependent latent variables. Second order validation tests are shown in Table 5. There are 8 indicators that do not fulfill the criteria for convergence validity, AM (Attitude Marketing), FC (Facilitating Conditions), II (Interpersonal Influence), PE1 (easy to get services), PV (Perceived Value), SE1 (Faithfulness and trust in using services), Y11 (the level of confidence of potential consumers to use the service after knowing the quality of the service) and Y41 (the level of

influence from the environment regarding the consideration of using the service). Furthermore, the modeling is carried out again by removing the eight indicators from the model, as shown in Figure 4 (b).

The loading factor results from the second order after validity are shown in Table 6, where all indicators have fulfilled the criteria for convergence validity. Furthermore, the testing of AVE value is shown in table 7. All variables are valid according to discriminant criteria. This happens because changes in the latent variable construct affect the AVE value. The construct of the model in Figure 4 (b) has been valid and reliable in the measurement model (Outer Model), thus the analysis can be continued with structural testing.

Table 5. Result of Loading Factor for Second Order Model

Indicator	Loading Factor	Indicator	Loading Factor	Indicator	Loading Factor
AM	0.408	PQ2	1.000	Y11	0.509
EI	0.853	PRP	0.961	Y21	0.916
FC	0.214	PRS	0.722	Y31	0.769
I1	0.830	PV	0.588	Y41	-0.253
I2	0.894	S1	0.837	Y51	0.882
II	0.304	S2	0.819	Y61	1.000
PE1	0.240	SE1	0.524		

Table 6. Result of Loading Factor after Validation for Second Order Model

Indicator	Loading Factor	Indicator	Loading Factor	Indicator	Loading Factor
EI	1.000	PRP	1.000	Y21	1.000
I1	0.832	PRS	0.731	Y31	0.892
I2	0.892	S1	0.833	Y51	1.000
PQ2	1.000	S2	0.824	Y61	1.000

Table 7. Result of AVE after Validation for Second Order Model

Variable	AVE	Variable	AVE	Variable	AVE
I	0.744	Y1	1.000	Y4	1.000
PQ	1.000	Y2	1.000	Y5	1.000
S	0.686	Y3	0.665	Y6	1.000

4.3 Inner Model Evaluation

Structural model evaluation can be done to ensure that the structural model built is accurate, which is seen from the R^2 value. The greater the value of R^2, the greater the influence of the exogenous latent variable on the endogenous variable.

Table 8. R^2 Value

Endogenous Latent Variable	R Square
S (*Satisfaction*)	0.308
Y1 (*Trust*)	0.610
Y3 (*Attitude Toward Purchasing*)	0.095
Y6 (*Intention to Purchasing*)	0.125

Table 4.8 shows the value of R^2 for the latent variable of endogenous satisfaction is 30.8% variation of the latent variable, satisfaction has been able to be explained by exogenous variables. The R^2 value of the latent variable Trust is 61% or approximately half of the variation in the level of trust of potential consumers to use interior design services can be explained by exogenous latent variables and the remaining 39% is explained by other variables outside the model. The goodness of the structural model can be explained through the value of Q^2 (predictive relevance). The magnitude of Q^2 has a value with a range of $0 < Q^2 < 1$, the closer the value is to 1, the better the structural model. The calculation of Q^2 is as follows.

$$Q^2 = 1 - (1 - R_1^2)(1 - R_2^2)(1 - R_3^2)(1 - R_4^2) = 1 - 0{,}209 = 0{,}791$$

The results of the Q2 calculation above show a value of 0.791 (greater than 0) thus it can be concluded that the structural model formed is appropriate or fit to research data related to the

factors that influence consumer buying interest in interior design services. Then the analysis is continued by looking at the path coefficient of the relationship that occurs between latent variables in the structural model presented in Table 9.

Table 9. Path Coefficient

Relationship Between Variable			Direction	t
I	→	Y1	Positive	0,085
I	→	Y3	Positive	-0,136
PQ	→	S	Positive	0,555
PQ	→	Y1	Positive	0,545
PQ	→	Y6	Positive	0,061
S	→	Y1	Positive	0,278
S	→	Y6	Positive	-0,204
Y2	→	Y3	Positive	0,287
Y3	→	Y6	Positive	-0,255
Y4	→	Y6	Positive	0,246
Y5	→	Y6	Positive	-0,129

4.4 Parameter Hypothesis Testing

Table 10. Measurement Model Parameter Coefficient

Relation	*Loading Factor*	*t*	*P-Values*
Involvement → Trust	0.674	0.674	0.501
Involvement → Attitude Toward Purchasing	0.996	0.996	0.320
Perceived Quality → Satisfaction	4.356	4.356	0.000*
Perceived Quality → Trust	3.174	3.174	0.002*
Perceived Quality → Intention to Purchase	0.322	0.322	0.748
Satisfaction→ Trust	2.096	2.096	0.037*
Satisfaction→ Intention to Purchase	1.183	1.183	0.238
Perceived usefulness → Attitude Toward Purchasing	1.717	1.717	0.087*
Attitude Toward Purchasing → Intention to Purchase	1.322	1.322	0.188
Normative Subjective → Intention to Purchase	1.262	1.262	0.208
Perceived Control Behaviour→ Intention to Purchase	0.875	0.875	0.383

*) significant in *alpha* 0,1.

Table 10 shoes there are 4 significant relationships at alpha 0.1 or 10%. Based on the results, from total of 11 existing relationships, only hypothesis 1, hypothesis 11, hypothesis 12 and hypothesis 13 were proven correct as described in Chapter 3. Interior design is able to satisfy potential customers and increase consumer confidence in interior design service providers. In addition, the satisfaction obtained by consumers with interior design services is also able to increase consumer confidence in service providers. Perceptions of the usefulness of interior design also have a significant effect on determining consumer attitudes towards purchasing interior design services.

4.5 Managerial Implications

The efforts that can be made in accordance with the results of the research and the correct hypothesis above are:

1. Interior design consultant service providers need to improve the quality produced by the company. The quality must be able to compete with the standart market quality and even higher quality is produced. Must also be maintained in order to always provide good and consistent quality, therefore the consumers will get satisfaction and trust. Interior design service providers also need to expose how the quality is produced on social media, thus the potential buyers can indirectly see the quality produced by service providers

2. Consumer satisfaction is the most important thing for interior design service providers, therefore the need for satisfaction is maintained, because based on the research above, customer satisfaction also has a significant effect on consumer and prospective customer trust. Satisfaction of consumers who have used interior design services can also be displayed on the web and social media, thus the potential consumers would know that the results and services provided can satisfy consumers who have worked with interior design service providers. service providers can request testimonials from clients and then these testimonials can be uploaded to social media and the web.
3. Perceived usefulness has a significant effect on attitudes toward purchasing, it shows that if potential consumers see the interior design as useful, it will increase consumers' intention or desire to use interior design services. Interior design service providers must pay attention to how they convince potential consumers are useful and beneficial for them, both in the quality of the services produced, and what problems can be solved with the services offerred. For example, service providers can upload photos on social media and web and explain the situation and condition of the room before and after. after it is designed, then explain what has been changed, what problems exist and how to solve it on insta stories and captions on Instagram posts or on web pages. Thus the potential consumers know more clearly the difference between using interior design services and not using them, what problems are solved in the explanations uploaded on social media and the web.

5. CONCLUSIONS

The results of the study show factors that can significantly influence the interest in buying interior design services are factors of perceived usefulness, perceived quality, trust, and satisfaction. The interior designers can focus on improving matters related to those factors thus their resources can be allocated to proper sections and divisions. Other factors besides significant factors that have a positive impact but are not significant to buying interest are perceived ease of use, marketing attitude, perceived risk, perceived reputation, perceived value, interpersonal influence, external influence factors. However, there are also negative research results, namely involvement, and self-efficacy, facilitating conditions, this can happen because there are still influencing factors other than those studied and the lack of indicators on the dependent variable in this study.

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HOUSEHOLD NATURAL GAS DEMAND PREDICTION IN SURABAYA USING DECISION TREE MODEL

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ABSTRACT

Natural gas is one of the sources produced, both from renewable energy sources and non-renewable energy sources. However, the utilization of natural gas that has not been maximized, especially for households, has made the government accelerate the expansion of the gas network system. This study aims to formulate an accurate predictive model related to household natural gas consumption. PT Perusahaan Gas Negara Tbk. ("PGN") requires a strategy as a basis for planning development in Surabaya to increase the consumption of natural gas in the household group. The method used is a Decision Tree to understand the factors of household natural gas consumption and test the accuracy of the model using the MAE, MAPE, and RMSE methods. The results showed that the Decision Tree method was proven to be accurate as indicated by the MASE, RMSE, MAE values , which showed a slight difference in obtaining the relationship between building characteristics, socio-demographic, and psychological factors. PGN in Surabaya, especially in the household segmentation, in order to determine the right target group to increase natural gas consumption, can target groups by considering, such as income level, type of customer, age, employment status of housewife, civil servant, a private employee and customers who care about prices and others and who prioritize CER values, altruistic, biosphere, social norms, egoistic, and pro-environmental self-identity.

Keywords: *Decision Tree, Household Consumption, MAE, MAPE, Natural Gas, RMSE.*

1. INTRODUCTION

Natural gas is one of the new energy sources produced by new technology, renewable, and non-renewable energy sources. The utilization of natural gas that has not been maximized, especially for households, has made the government accelerate the expansion of the gas network system. Surabaya is one of the big cities in Indonesia, and the consumption of natural gas by household customers in 2019 was still approximately 30% of the target. The average use of natural gas for household customer groups in a month is around 4-50 m3. Not integrated the gas pipeline network, no nearby natural gas network or infrastructure, the price of natural gas is less competitive, and the cost of developing an expensive distribution network are the obstacles in constructing a household natural gas network. The small usage makes the growth rate of gas use run slowly. A good understanding of the behavior of the household customer in terms of natural gas consumption will help state companies that are operators of natural gas, PT Perusahaan Gas Negara, Tbk. (PGN), choose the right target group in formulating policies and plans that can increase gas consumption by the household customer. Also, a strategy is needed to increase natural gas consumption in households that already use natural gas as the primary fuel.

There have been many research models on the relationship between psychology and human behavior, but the theory of planned behavior is the most satisfying to study human behavior and psychology (Cooke *et al.,* 2004). There is still little research that aims to understand someone using household natural gas—most research studies about the use of electricity or water in households. Psychological factors will influence a consumer in making a decision.

Considering that the data built is quite large, the classification will be built using the Decision Tree method. This Decision Tree method will connect several variables in data with a reasonably large size and identify significant variables and the relationship between several predictor variables.

PGN requires accurate predictive models to support natural gas consumption and future planning. This study took place in Surabaya because it already has a natural gas network for households spread over several sub-districts with varying residential characteristics, and there are state companies that are natural gas operators.

This study aims to apply the Decision Tree model to predict household consumption of natural gas and the basis for planning and development for PGN, especially in Surabaya.

2. LITERATURE REVIEW

PT Perusahaan Gas Negara Tbk. (PGN) founded on May 13, 1965, based on Government Regulation Number 19 of 1965, it is the largest Indonesian national company in the transportation and distribution of natural gas that fulfills domestic natural gas (PGN, 2021). Vision and Mission of PT Perusahaan Gas Negara Tbk. are "To be a Leading and Trusted National Gas Company with World Class Standards in Infrastructure Provision and Natural Gas Utilization." One of the steps taken to achieve the Vision and Mission is to launch the Seven National Gasification Programs (Sapta PGN), one of which is the "PGN Sayang Ibu" program, namely the market development program and city gas infrastructure for the household segment of customer.

A customer is an individual or group of people who buys a product, whether physical or service, by considering various factors such as; price, quality, place, service, and so on, based on their own decisions (Greenberg, 2010). PGN's is dividing household customers into two groups: PGN Sayang Ibu household customers or PSI for short, which is the market and infrastructure development program for the household segment where financing uses PGN's budget (APGN). The second is Jargas household customers, which is the market and infrastructure development

programs for the household segment using the government budget (APBN). For the household customer group, in 2021, Surabaya will again receive an allocation for the government program of natural gas network connections of 6,088 house connections after previously in 2016 it received an allocation of 24,015 house connections.

The factors that are part of and will use in the Decision Tree model approach. First, the building characteristics, the building's energy consumption during a specific period, is normalized by the floor area of the building used to express performance (Hong et al., 2015). Second, Leth-Peterson (2002) conducted a microeconomic analysis of the demand for natural gas for households. The year in which the house was built and the type of house was found to be essential determinants of Gas demand. Nesbakken (2001). The next factor is the socio-demographic factor. Demography is a science that studies the population of an area (such as age and gender)(Harli, 2015), and the last is psychological factors. In research on psychological factors regarding energy conservation behavior, a distinction is made between thrifty behavior and restrictive behavior (Gardner et al., 2008).

Ghozali (2011) states that using the Validity Test to measure the validity of the questionnaire. Test the validity using the Product Moment correlation formula. Testing the instrument's validity is done by comparing the correlation between variables with the total variable score of the sample of respondents with a significance of = 5 percent. The test criteria are if Rcount > Rtable, then the instrument is declared valid, and if Rcount < Rtabel, the instrument is declared invalid. According to Ghozali (2011), reliability is a tool to measure a questionnaire, which is an indicator of something. A questionnaire is reliable or reliable when the respondents' answers to the statements are consistent from time to time. If the value of Cronbach's Alpha > 0.60, then the questionnaire is declared reliable or consistent. Meanwhile, if the value of Cronbach's Alpha < 0.60, then the questionnaire is declared unreliable or inconsistent. Cronbach's alpha value can be seen in table 1.

Prediction is a process of systematically estimating something that is most likely to happen in the future based on past and present information to minimize errors (Herdianto, 2013).

A Decision Tree is a predictive model using a tree structure or hierarchical structure and is one of the most popular algorithms and is widely used practically in many small to medium scale data mining-based applications and systems (Kumar, 2009). The selection of attributes that are root nodes and internal nodes as test attributes is based on the size of the impurity of each attribute. The impurity measures are information gain, gain ratio and gain index. The attribute with the highest impurity result will be selected as the test attribute. Three indicators are used to determine whether the Decision Tree prediction results are accurate. Namely, the mean absolute error (MAE), the root mean squared error (RMSE), and the mean absolute percentage error (MAPE). If the smaller the error value of MAE, RMSE, and MAPE, the better the modeling.

Table 1. Cronbach's Alpha Values

Cronbach's Alpha Value	Criteria
0-0,2	Less Reliable
0,21-0,4	Rather Reliable
0,41-0,6	Quite Reliable
0,61-0,8	Reliable
0,81-1	Very Reliabel

3. METHODS

The object of this research is PT Perusahaan Gas Negara Tbk. Area Surabaya (PGN) and the population in this study are PGN's household customers. The location of the research was carried out in 12 sub-districts in Surabaya, including: Benowo, Genteng, Gubeng, Gunung Anyar, Karangpilang, Rungkut, Sambikerep, Sawahan, Sukomanunggal, Tandes, Tegalsari and Wonokromo. These sub-districts are locations where there is already a household gas pipe connection.

The questionnaires will distribute to determine the prediction of natural gas consumption by household customers who have been PGN customers for at least one year since 2019. The variables of this study were house size (X1), number of rooms (X2), number of occupants of the house (X3), age (X4), household status (X5), education level (X6), employment status (X7), income level (X8), primary constraint to gas subscription (X9), biosphere value (X10), egoistic value (X11), hedonic values (X12), altruistic values (X13), corporate environment responsibility (X14), self-identity pro-environment (X15), individual norms (X16), social norms (X17), and total gas (Y) namely data consumption of household customers were obtained from the PGN Surabaya Area Gas management report from January 2020 to December 2020. The questionnaire will send via email, Whatsapp, and the meter recording officer visits. The population in this study were 10,972 PGN Area Surabaya household customers, and based on the formula notation for the minimum research sample size by *Slovin* with a margin of error of 5% or 0.05, the minimum sample used was 340 customers. The questionnaire uses a seven-point Likert scale where 1 (one) strongly disagree and 7 (seven) strongly agree. The questionnaire results will be calculated for the X10-X17 variables on average by using the validity test with the Product Moment correlation principle, while for the reliability test using the Cronbach's Alpha statistical test. The dataset will divide into the training dataset and the testing dataset. The method used is Decision Tree, and the model will evaluate using three methods: MAE, MAPE, and RMSE. If the training and testing data values are very similar in both the training and testing data, it will conclude that the model built is good. RStudio software will use to build the model. The results and conclusions of this study help answer problems and suggestions will be used as input for PGN and used as guidelines for further research.

4. RESULTS

Based on the collected questionnaire data, respondents from the questionnaire results can be classified by gender, as shown in Figure 1.

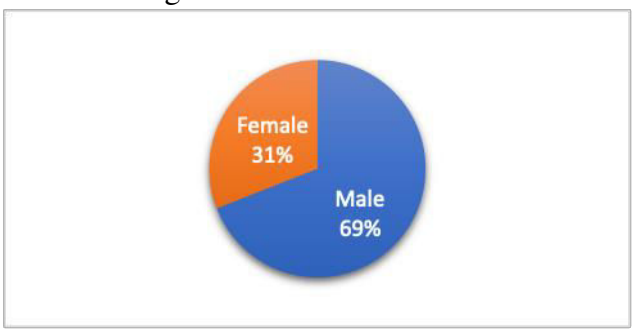

Figure 1. Graph of Respondents by Gender

The next step is to do the cleaning and integration data by deleting 50 respondent data with the value of 0 m3 on the consumption of natural gas, deleting 4 data duplication, and removing 10

data with missing values, so that from the 349 respondents who filled out the questionnaire, 285 data were obtained and eligible for analysis.

From the results of the analysis was identified that from the building characteristics, the most customers who became PGN household customers were customers with house size (X1) of 120-150 m2 as many as 134 (47.02%), the number of rooms (X2) less than three rooms as many as 167 (58.59%) and the number of occupants (X3) from 2 to 5 people, as many as 175 (61.40%). The characteristics of the socio-demographic factors of PGN's household customers are respondents with age (X4) between 30 years and 50 years as many as 238 (83.51%), household status (X5) married with children as many as 248 (87.02%). education level (X6) is 148 high school equivalent (51.92%), employment status (X7) civil servant / BUMN is 141 (49.47%), and income level (X8) is between IDR 5,000,000 to IDR 7,500. 000 as many as 119 (41.75%). Variable X10-X17 in the questionnaire is valid if the value of the r count is positive and more significant than the value of the r table.

Variable X10-X17 in the questionnaire is valid if the value of the r count is positive and more significant than the value of the r table. The r table value for respondents N = 285 and = 5% in this study is 0.116. The validity test using the Pearson Product Moment correlation, and the results of the correlation value as shown in table 1 were more significant than the r table (0.05; 285) = 0.116, so the data is valid can be used for Decision Tree testing.

Table 2. Summary of Pearson Product Moment Correlation Test Values

Variabel	X10	X11	X12	X13	X14	X15	X16	X17
X10	1,000	0,166	0,369	0,333	0,230	0,332	0,410	0,291
X11	0,166	1,000	0,516	0,267	0,209	0,362	0,249	0,461
X12	0,369	0,516	1,000	0,472	0,355	0,360	0,444	0,511
X13	0,333	0,267	0,472	1,000	0,454	0,382	0,451	0,388
X14	0,230	0,209	0,355	0,454	1,000	0,477	0,422	0,464
X15	0,332	0,362	0,360	0,382	0,477	1,000	0,657	0,512
X16	0,410	0,249	0,444	0,451	0,422	0,657	1,000	0,559
X17	0,291	0,461	0,511	0,388	0,464	0,512	0,559	1,000

The reliability test uses the Cronbach's Alpha method. The variables X10-X17 of the questionnaire are Reliable if the value of the reliability coefficient (r) is> 0.6. Cronbach's alpha values for each factor are between 0.81-1, indicating that all question items in the questionnaire are very reliable and they can use in Decision Tree testing as it shown in table 2.

Table 2. Characteristics of Psychological Factors

Variabel	Cronbach's Alpha	M (SD)	Min	Max
X10	0,84	6,0 (0,54)	4,00	7,00
X11	0,84	5,4 (0,75)	2,00	7,00
X12	0,81	5,9 (0,67)	3,00	7,00
X13	0,82	6,2 (0,61)	4,00	7,00

Variabel	Cronbach's Alpha	M (SD)	Min	Max
X14	0,82	6,0 (0,63)	4,00	7,00
X15	0,81	5,8 (0,66)	4,00	7,00
X16	0,81	5,9 (0,59)	4,00	7,00
X17	0,81	5,8 (0,65)	4,00	7,00

PGN's total household gas usage and its probability density from January 2020 to December 2020. The violin plot above shows the distribution of the total natural gas usage of PGN's household customers each month, where the wider shape indicates the possibility that the sample will use an enormous amount of gas. In contrast, the thinning shape indicates the possibility that the sample will use a lower amount of given gas. For example, the average total gas usage for one year from January 2020 to December 2020 is 15.76 m3 with a standard deviation of 15.62 m3, as shown in figure 2.

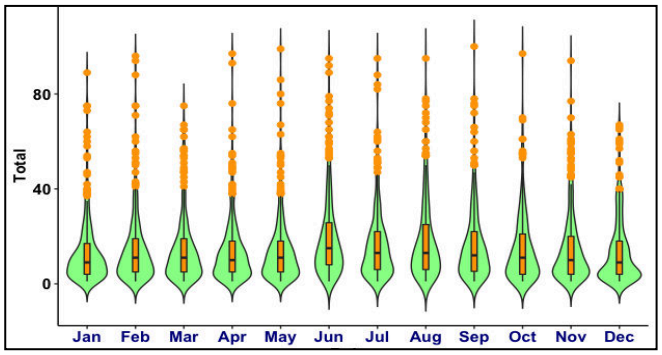

Figure 2. Violin Plot PGN's Total Gas Consumption

The next step is partitioning by dividing the dataset into two groups of datasets, namely training datasets and testing datasets with a proportion of 80 percent for training data and 20 percent for testing data, from 258 respondent data obtained 228 training data and 57 testing data.

The Decision Tree model was built using RStudio and got the results according to Figure 3, showing the results are 71 nodes with 35 leaf nodes. Type of customer, building characteristics, socio-demographic factors, and psychological factors are variables or attributes which can explain the total natural gas consumption of PGN's customers. The type of customer describes the type of customer who subscribes to PGN's natural gas, the characteristics of the building describe the house building occupied by the customer's natural gas, socio-demographic factors explain the characteristics of the customer's PGN natural gas, and psychological factors explain the psychology of a customer that influences his decision to consume PGN's natural gas. The color of the nodes indicates that the greener the color in a leaf node, the tendency for consumption of natural gas will be greater. On the other hand, the bluer the color of the nodes, the tendency to consume natural gas will be lower.

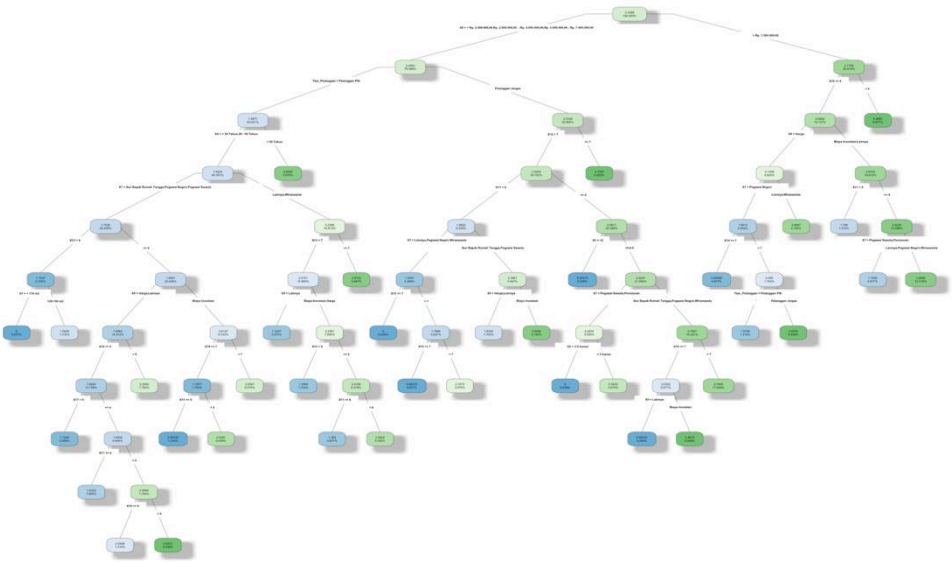

Figure 3. Decision Tree

Based on the results of the Decision Tree processing, further analysis is using the if-then rules with vertical readings, namely from top to bottom and horizontally from right to left, so that the following results are:

1. If the respondent's income level (X8) is above Rp. 7,500,000.00, the value of the psychological factor, namely Corporate Environment Responsibility (X14), is < 6, then the total consumption of PGN's natural gas is an average of 4.28 m3 per month,
2. If the respondent's income level (X8) is above Rp. 7,500,000.00, the value of the psychological factor, namely Corporate Environment Responsibility (X14), is >= 6, so the total consumption of PGN's natural gas is an average of 2.54 m3 per month.
3. If the respondent's income level (X8) is above Rp. 7,500,000.00, the value of the psychological factor, namely Corporate Environment Responsibility (X14) is >= 6, with the primary constraint for subscribing to gas is investment costs, others and the egoistic value of <5, the total consumption of PGN natural gas is an average of 1, 71 m3 per month.
4. If the respondent's income level (X8) is above Rp. 7,500,000.00, the value of the psychological factor, namely Corporate Environment Responsibility (X14) is >= 6, with the primary constraint for subscribing to gas is the investment cost, others and the egoistic value >= 5, the employment status is other, civil servant and self-employed, then the total PGN's natural gas consumption is an average of 3.00 m3 per month.
5. If the respondent's income level (X8) is above Rp. 7,500,000.00, the value of the psychological factor, namely Corporate Environment Responsibility (X14), is >= 6, with the primary constraint for subscribing to gas is the investment cost, others, and the egoistic value >= 5, the job status is a private employee and retired. As a result, the total consumption of Gas PGN's natural resources is 1.70 m3 per month on average.

The reading is continuous until the last node starts from right to left. Some of the most extensive uses of Natural Gas are shown by the following results:

1. If the respondent's income level (X8) is above Rp. 7,500,000.00, the value of the psychological factor, namely Corporate Environment Responsibility (X14), is < 6, so the total consumption of PGN's natural gas is an average of 4.28 m3 per month.

2. If the respondent's income level (X8) < Rp. 2,500,000,000.00, Rp. 2,500,000 – Rp. 5,000,000.00, Rp. 5,000,000.00 – Rp. 7,500,000.00, customer type is PSI customer, respondent's age (X4) < 30 years, 30-50 years, respondent's employment status (X7) is housewife, civil servant, private employee, altruistic value (X13) >=6, the main constraint for subscribing to Gas (X9) is price and others, biosphere value (X10) >=6, social norm value (X17) >=6, egoistic value (x11) < 6, and pro-environmental identity value (X15) <6, PGN's total natural gas consumption is an average of 4.04 m3 per month.
3. If the respondent's income level (X8) is above Rp. 7,500,000.00, the value of the psychological factor, namely Corporate Environment Responsibility (X14) is >= 6, the main obstacle to subscribing to Gas (X9) is the price, the job status of the respondent (X7) is a civil servant, the value of the psychological factor is Corporate Environment Responsibility (X14).) is <7, and the type of customer is a PSI customer, so the total consumption of PGN's natural gas is an average of 3.64 m3 per month.

Meanwhile, the most negligible use of natural gas is shown by the following results:

1. If the respondent's income level (X8) < Rp. 2,500,000,000.00, Rp. 2,500,000 – Rp. 5,000,000.00, Rp. 5,000,000.00 – Rp. 7,500,000.00, customer type is JarGas customer, hedonic value (X12) <7, egoistic value (x11) >=6, number of occupants (X3) >5, 2-5 people, employment status (X7) private employee, retirees, and the number of rooms (X2) 3-5 rooms, then the total consumption of PGN's natural gas is an average of 0 m3 or tends not to use natural Gas
2. If the respondent's income level (X8) < Rp. 2,500,000,000.00, Rp. 2,500,000 – Rp. 5,000,000.00, Rp. 5,000,000.00 – Rp. 7,500,000.00, customer type is JarGas customer, hedonic value (X12) <7, egoistic value (X11) <6, employment status (X7) is other, civil servant, self-employed, altruistic value (X13) >=7, the total consumption of PGN's natural gas is an average of 0 m3 or tends not to use natural gas.
3. If the respondent's income level (X8) < Rp. 2,500,000,000.00, Rp. 2,500,000 – Rp. 5,000,000.00, Rp. 5,000,000.00 – Rp. 7,500,000.00, the type of customer is PSI customer, respondent's age (X4) <30, 30-50 years, employment status (X7) housewife, civil servant, private employee, altruistic value (X13) <6, and the size of the house (X1) is 120-150 m3, then the total consumption of PGN's natural gas is an average of 0 m3 or tends not to use natural gas.

Figure 4 shows an important variable, where the egoistic value (X11) is an important variable that affects the total use of PGN Gas. The second important is the employment status variable (X7) variable that affects the total use of Natural Gas, followed by the type of customer, size house (X1), the primary constraint is a gas subscription (X9), altruistic value (X13), income level (X8), number of rooms (X2), number of occupants (X3), biosphere value (X10), Corporate Environment Responsibility or CER (X14), hedonic values (X12), pro-environmental self-identity (X15), social norms (X17), age (X4) and education level (X6). In contrast, marital status (X5) and individual norms (X16) become less important variables that affect the total use of Natural Gas.

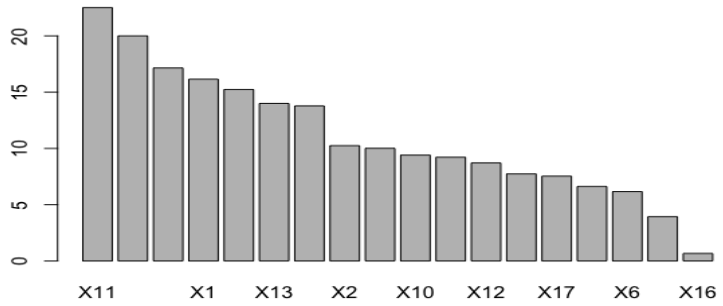

Figure 4. Plot Variable Importance

Furthermore, an evaluation of the Decision Tree model is to determine whether the results of the Decision Tree predictions above are accurate using three methods, namely mean absolute error (MAE), root mean squared error (RMSE), and mean absolute percentage error (MAPE) using RStudio. When an evaluation uses the mean absolute percentage error (MAPE) formula, there are component values that cannot be defined, and the results of NaN on training data evaluation and -Inf on testing data evaluation.

The solution to this problem is an evaluation using the mean absolute scaled error (MASE) method, and the results show in Table 3 the MASE, RMSE, and MAE values in the training and testing data. RMSE can range from 0 to. RMSE can be negatively oriented where a lower value indicates a better value. The accuracy of the measurement error estimation method is indicated by the presence of small MASE, RMSE, and MAE values. The testing data's MASE, RMSE, and MAE values are higher than the training data. However, the difference between the RMSE and MAE values in the training and testing data is relatively small, so the model formed is entirely accurate.

Table 3. Evaluation of the Decision Tree Mode

	MASE	RMSE	MAE
Train	0,440	0,635	0,473
Test	1,237	1,001	0,820

6. CONCLUSIONS

1. The Decision Tree method is accurate in modeling, as seen from the difference between MASE, RMSE, and MAE, which is relatively minuscule in training and testing data.
2. Building characteristics factors, social demographic factors, and psychological factors using the Decision Tree model can explain household natural gas consumption. The results show that building characteristics, social demographics, and psychological factors play an essential role in consuming natural gas and understanding household gas consumption better. Therefore, understanding household gas consumption is not limited to just one predictor.

Suggestions in further research are PT Perusahaan Gas Negara Tbk. Area Surabaya (PGN) can target the right group in increasing consumption of natural gas by focusing on those with the level of income, type of customer, age, employment status of housewives/fathers, civil servants, private employees, and customers who are very concerned about prices, and others, as well as groups that prioritize corporate environmental responsibility, altruistic, biosphere, social norms, egoistic values , and pro-environmental self-identity.

In predicting household natural gas consumption, further research does not rule out the possibility to use or combine it with other methods or other approaches to refine the approaches and methods in this study, for example, compared to the Decision Tree method, which considers correlations.

This study uses the default settings, and then future research can optimize the model by setting the depth parameter that will be used in building the Decision Tree model to avoid overfitting the model.

A broader scope of research can be carried out in further research, both regional locations and other customer group segments, and assist respondents when conducting surveys so that the data obtained can be more accurate.

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RISK MITIGATION IN THE PROCUREMENT UNIT AT FERTILIZER COMPANY USING HOUSE OF RISK (HOR) METHOD

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ABSTRACT

PT. XYZ is a manufacturing company engaged in the fertilizer and chemical industry. Currently, risk management at PT. XYZ has not focused too much on supply chain risk, especially in the procurement unit. Risk management through regular monitoring and review has not been carried out optimally, and the lack of risk awareness in the procurement unit can affect the company's business continuity. This study aims to propose supply chain risk management, from identification to recommendations for preventive action in the procurement unit of PT. XYZ. The research was conducted using the house of risk (HOR) method. The risk identification process is based on business processes with reference to the supply chain operation reference (SCOR) model. The results showed that there were 22 risk events and 33 identified risk agents. After an evaluation using HOR, there were 3 risk agents that needed to be prioritized and 9 preventive actions that could be applied by the company. The three preventive actions that have the highest effectiveness to difficulty ratio are Making long-term contracts with multi-winner schemes, The Evaluation Process was carried out only in 1 Departement and Vendor Management System Improvement.

Keywords: Procurement Unit, House of Risk (HOR), Supply Chain Operation Reference (SCOR), Preventive Action

1. INTRODUCTION

PT. XYZ is a manufacturing company engaged in the fertilizer and chemical industry. One of the supply chain activities at PT. XYZ that needs attention is the procurement process. The procurement function includes activities including : supplier selection, evaluating supplier performance, purchasing raw materials and components, monitoring supply risk, fostering and maintaining relationships with suppliers (Pujawan, 2005). The procurement process will have an impact on the costs incurred by the company when buying goods and services.

As seen in Figure 1, for Urea Fertilizer products, the cost of raw materials and maintenance/spare parts accounts for 70% of the COGS (Cost of Good Soldfertilizer components). This means that the savings from the procurement side (cost of purchasing raw materials and materials/spare parts) can increase the company's competitiveness, so that the selling price of fertilizer in the market is more competitive. In other words, efficiency in the procurement sector at PT. XYZ can significantly reduce the COGS value of fertilizers.

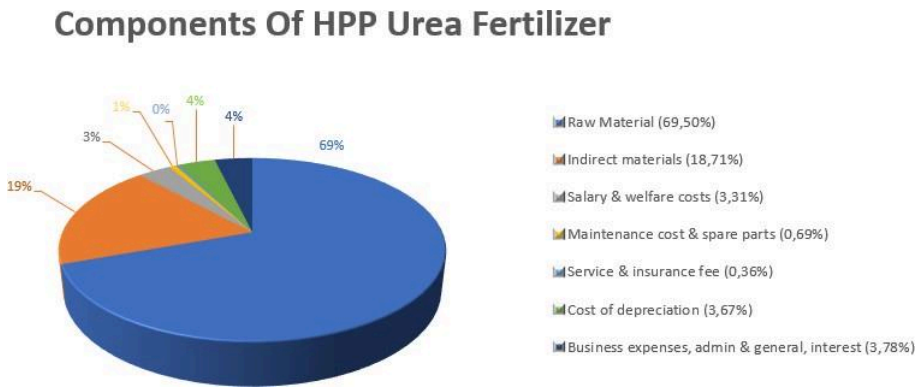

Figure 1. Components of COGS Urea Fertilizer (PT. XYZ, 2021)

Currently, the management of risk management at PT. XYZ has not focused too much on supply chain risk, especially in the procurement unit. There are several risks that have not been identified, and the priority of corrective steps has not been found. In addition, periodic monitoring and review related to risk management in the procurement unit has not been optimal, because it has not become a work priority due to the busyness of daily work operations, limited human resources and lack of risk awareness about how risks are taken is an integral part of the business process.

One of the risks that have not been identified properly and has the potential to disrupt the operations of the procurement process at PT. XYZ is related to the vendor management process, starting from the partner registration process, supplier selection and partner performance appraisal. Inappropriate selection of suppliers of goods/services can have an impact on delays in material supply, non-conformance in specifications and the quality of work that is not optimal.

Procurement is part of the supply chain, but the consequences of poor Procurement Risk Management (PRM) can be similar to or the same as supply chain risk management (Zhen Hong, 2018). Where the poor performance of partners can affect the performance of the procurement unit related to the process of procuring goods/services. According to data from Vendor Management PT. XYZ in 2020 (Table 1), from the 2,103 vendors registered with PT. XYZ, there are 232 (11.03%) vendors that have poor performance and 590 (28.06%) vendors have very poor performance.

Table 1. Vendor Performance Assessment Data PT. XYZ year 2020

No	Category	Domestic Vendor	Overseas Vendor	Subsidiary Company	Total	Percentage (%)
1	Very Good	80	1	11	92	4,37%
2	Good	164	8	2	174	8,27%
3	Medium	905	109	1	1.015	48,26%
4	Poor	175	57	-	232	11,03%
5	Very Poor	441	149	-	590	28,06%
	Total	**1765**	**324**	**14**	**2.103**	**100%**

In addition, with the large number of overseas vendors registered in the Procurement Unit of PT. XYZ, a total of 324 (15.41%), the potential risk of delay in shipping goods from abroad is

greater because the goods arriving at the port must first be processed first by the forwarder for custom clearance dan the completeness of documents. Sometimes it takes quite a long time related to the bureaucracy with related agencies for the release of goods in the port area and customs. During this Covid-19 pandemic, the procurement unit at PT. XYZ is still required to maintain the procurement lead time according to a predetermined schedule. With many purchases of spare parts from from overseas vendors, the risk of late delivery of goods becomes greater.

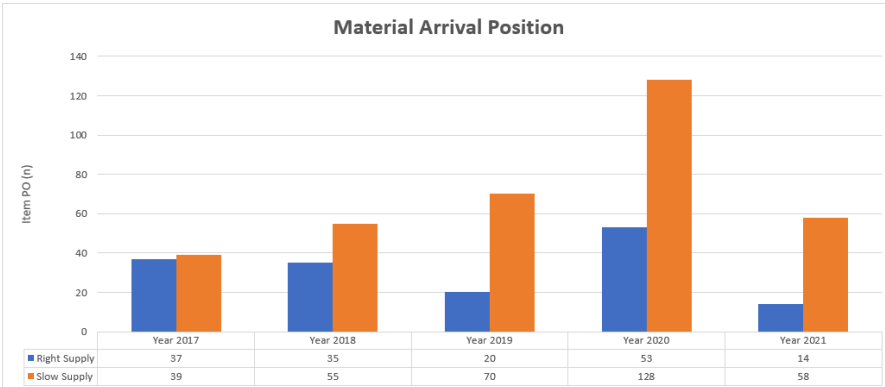

Figure 2. Material Late Arrival Data (PT. XYZ, 2020)

In general, the poor performance of vendors in the procurement unit of PT. XYZ has the potential to affect the company's operations, the material sent by the vendor is late and even the material that arrives at the warehouse is not appropriate (as shown in Figure 2). Risk management in the procurement unit related to vendors needs to be carried out, so as to ensure that vendor performance is in line with company expectations, for example the supply of goods/services is on time, in the right quantity, and the quality is in accordance with the company's request.

2. LITERATURE REVIEW

2.1 *Supply Chain Operation Reference* (SCOR)

SCOR Model is an approach method for measuring the performance of a supply chain. The SCOR model is also a process-based model. The advantage of the SCOR model is its ability to integrate Business Process Reengineering (BPR), benchmarking and Best Practice Analyze (BPA) into the supply chain framework. The SCOR model is a method that continues to evolve and the metrics in it can be developed flexibly according to the needs of each supply chain.

SCOR divides supply chain processes into 6 core processes (Figure 3) as described below:

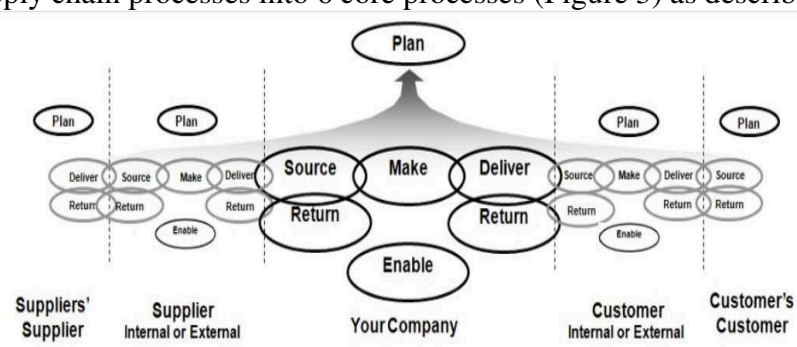

Figure 3. Core Processes in the SCOR Model (APICS, 2017)

2.2 Risk Management

The purpose of risk management is to provide adequate confidence in achieving the company's performance targets through a process of understanding the inherent risk, measuring, formulating a management plan and realizing a plan for handling and realizing an effective management plan, and communicating risk management to stakeholders (Fahmi, 2010).

In the risk management process according to ISO 31000:2018, there are several stages or processes which include setting a context, risk identification, risk analysis, risk evaluation, risk treatment, monitoring and review. ISO 31000:2018 is a standard that is used to align risk management processes to existing standards, and to future risks. This standard provides a general approach to support standards relating to specific risks.

2.3 Supply Chain Risk

According to Alexander (2009), the cause of risk in the supply chain begins with the uncertainty inherent in the supply chain which consists of demand uncertainty, capacity uncertainty, delivery time uncertainty, technological changes, changes in market conditions, competition, political issues, and government regulations. Usually one risk cause can stimulate more than one risk event.

2.4 House of Risk (HOR) Methods

House of Risk (HOR) is a model based on the need for risk management that focuses on preventive measures to determine which risk causes are a priority which will then be given risk mitigation or mitigation measures (Pujawan & Geraldin, 2009). In this study propose two dispersion models called HOR, both of which are based on a modified HOQ. HOR phase 1 is used to determine which risk sources are prioritized for preventive action, while HOR phase 2 is to provide priority actions by considering cost-effective resources.

2.4.1 HOR Phase 1

In this stage, the identification of risks that may occur in each business process is carried out. This stage can be started by mapping each stage of the business process. HOR phase 1 focuses on ranking ARP (aggregate risk potential) which consists of 3 factors, namely occurrence, severity and correlationship or in other words, this phase focuses on the risk identification process which includes risk events and risk agents.

2.4.2 HOR Phase 2

In this phase, HOR phase 2 focuses on determining what is the most appropriate step to take first by considering the effectiveness of the resources used and the level of performance of the object or project involved. The organization or company must determine the appropriate form of response or risk mitigation, this form of mitigation must be easy to apply but can reduce the probability of a risk agent.

3. METHODS

In this study, risk identification was carried out based on the SCOR (Supply Chain Operation Reference) model to see risk events from each major process. The SCOR model is a supply chain model that is used in various industrial contexts in designing, describing, and configuring various types of business activities.

The business process in the procurement unit of PT. XYZ consists of several processes or sub-processes that contain all activities that are interrelated and work together to achieve certain goals. Identification of business processes will assist in finding risk events or risk events as well as risk agents or risk causes that have the potential to occur in the company's business processes (Figure 4).

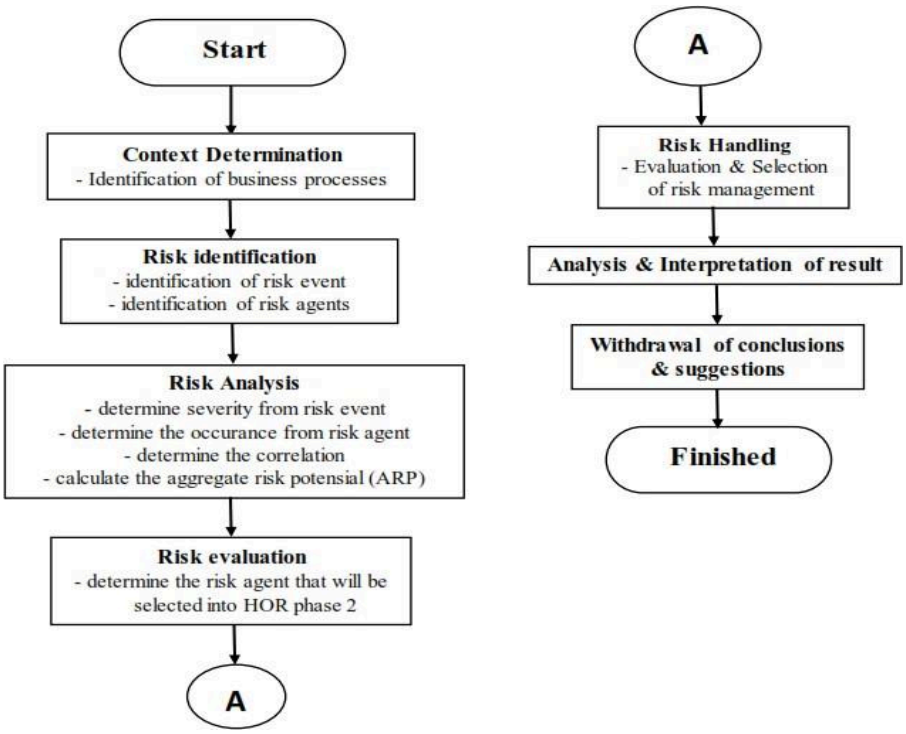

Figure 4. Research flow chart (PT. XYZ, 2020)

This research only focuses on 5 main business processes in the procurement unit of PT. XYZ, which has correlation and overlapping scope with other processes, namely plan, source, return, deliver and enable. While the "make" business process is located in another work unit (production unit), so it is not the subject of this research (Table 2).

Table 2. Vendor Performance Assessment Data PT. XYZ year 2020

No	Proses	Sub-Proses
1	*Plan*	- Raw Material Inventory Control - Purchase Planning
2	*Source*	- Procurement Process - Delivery Schedule (Material/Raw Materials) - Vendor Management
3	*Deliver*	- Delivery of Goods to the User
4	*Return*	- Handling of Goods Returned by the User
5	*Enable*	- Human Resources Management - Contract Management - Budget Management - Compliance & Risk Management

This risk identification stage consists of identifying risk events and risk agents. The results of the identification of risk agents and risk events are obtained from literature studies, previous studies that discuss operational risks and observations in field studies.

The risk analysis stage is the stage of data collection and supply chain risk recapitulation which includes risk events and also risk agents contained in procurement activities at a fertilizer manufacturing company, PT. XYZ. The risk variables used in the study were obtained from the results of verification through interviews with several people who have experience and specific expertise in the field according to the topic of discussion.

The purpose of risk evaluation is to determine which risk agent will be selected from a high priority level based on the output of the House of Risk (HOR) phase 1 which will enter HOR phase 2. Then generate a priority sequence for risk handling for further handling.

At the risk management stage, it focuses on determining what risk management steps are most appropriate. The priority of risk management is based on the ETD (Effective to Difficulty) rate, by dividing the total effectiveness value (TEk) by the degree of difficulty (Dk) taking action. The calculation of the effectiveness of the degree of difficulty aims to determine the priority ranking of all actions.

The results of data processing in the research are then analyzed and interpreted in more depth so that a conclusion can be drawn that can answer the objectives of conducting research on risk mitigation in the procurement unit at a fertilizer manufacturing company, PT. XYZ.

Table 3. Result of Risk Event Measurement

Code	Risk Events	Severity
E1	Overstock / Shortage Raw Materials	5
E2	Limited warehouse capacity	4
E3	The gap between stock recorded & available	4
E4	Sudden Changes in the production process	5
E5	Error Writing Specification in PR	3
E6	Uncertainty in the procurement plan from the User	3
E7	Error in determination of Owner Estimate	3
E8	Long technical evaluation time	4
E9	Acquisition of The Bid Prices above the Owner Estimate value	3
E10	Supplier Selection is not optimal	3
E11	Breach of of contract agreements by suppliers	4
E12	Delivery delays caused by Supplier	5
E13	Disruption of raw material supplies	5
E14	Supplier competency is limited	3
E15	Supplier performance evaluation is not optimal	3
E16	Delay in the shipping process to the User	3
E17	Complaints related to the goods that arrived (reject)	3
E18	Limitations of the number of Human Resources	3
E19	Competency gap of Employee	3
E20	Expired Contracts	4
E21	Limitations Budget of the Requestor Work Unit (User)	4
E22	Lack of Administrative & Risk Reporting	3

Table 4. Result of Risk Agent Measurement

Code	Risk Agent	Occurance
A1	Delay in the arrival of raw materials	4
A2	Inaccurate Purchase Planning	4
A3	Limited Warehouse Capacity	4
A4	There are No Integrated Tools for Recording Stock in Real Time	3
A5	There is no integrated database between the Procurement, Production and Sales unit	3
A6	Error from Identification of Material/Services Request	2
A7	Incomplete Tender Supporting Documents	4
A8	Sudden Changes in Production Patterns	4
A9	Uncertain Increase in Currency Rate	4
A10	Compiler of Owner Estimate does not yet have adequate competence	2
A11	Digitizing the Procurement Process is not optimal	4
A12	The Specifications of Goods /Services requested are complex	3
A13	The Technical Evaluation time is quite long	4
A14	To Many Purchase Requisition (PR) items to be Processed	4
A15	Centralized Procurement through Holding Company	3
A16	Fluctuations in Raw Material Prices & Spare Parts	5
A17	Error in Supplier Selection during Tender	4
A18	Negligence from suppliers	3
A19	There are No Strict Sanction against Suppliers if they violate the contract	4
A20	Constraints during Custom Clearance of goods at the port	3
A21	Changes in Global Supply Chain Patterns due to Pandemics / Political Conditions	4
A22	The lack of the selection process at the time of registration as a partner	4
A23	Identification of Scope of Supply (SOS) & Supplier Performance Assessment Not Optimal	5
A24	Too Many Suppliers and Not Managed Properly	4
A25	Lack of shipping transportation equipment (from Warehouse to User)	2
A26	Material that comes is Not according to specifications	3
A27	Damage (or losses) Goods during delivery	2
A28	Moratorium Policy related to Human Resources (No employee recruitment)	3
A29	Less Sharing Knowledge among Employees / by Management	3
A30	There is no contract monitoring mechanism (manual)	4
A31	Company's Cashflow Setting Policy	3
A32	The Role of Three Lines of Defense Not Optimal	3
A33	Employees work not according to Procedure	2

After all stages which include identification, collection, recapitulation, processing, analysis and interpretation of data are carried out, conclusions can then be drawn relating to the allocation and design of risk mitigation forms that can be carried out in procurement activities at a fertilizer manufacturing company, PT. XYZ.

4. RESULTS

The results of the research that has been carried out first is the mapping of supply chain activities using the SCOR model, this mapping process is carried out by brainstorming. From the results of the mapping process with the SCOR model in table 2, then identify and measure risk events and risk agents. This measurement is carried out to determine the scale of severity of the results of the identification of risk events and to determine the scale of occurrence of the risk agent. This measurement is done by distributing questionnaires. The results of these measurements are shown in table 3 and table 4.

4.1 House of Risk (HOR) Phase 1 :

Mapping in this model is done by entering the results of measuring the severity of risk events (table 3) and occurrence of risk agents (table 4) and measuring the correlation. The purpose of this mapping is to find the ARP (aggregate risk priority) value. The ARP value is obtained from the multiplication of the severity value, the occurrence value and the correlation value of the risk event and the risk agent (figure 5).

	Risk Agent																																	
Risk Event	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16	A17	A18	A19	A20	A21	A22	A23	A24	A25	A26	A27	A28	A29	A30	A31	A32	A33	Severity of Risk
E1	9	3	3	1				9													1													5
E2			9																								1							4
E3	1			3																									1				3	4
E4					1			3								1					3					3								5
E5						3	3					1	3																1				3	3
E6	3	3	1					3				3									1													3
E7									1	9						3																	3	3
E8						3	3				3	3	9	1	3			1					1					3					3	4
E9									3				3			3							3											3
E10															1		9						3	1										3
E11									3				1			3			3		1					3				3				4
E12	1												3			1		3	1	3	3									1				5
E13	3															3					3													5
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Occurance of Agent	4	4	4	3	3	2	4	4	4	2	4	3	4	4	3	5	4	3	4	4	4	4	5	4	2	3	2	3	3	4	3	3	2	
ARP	312	124	252	51	15	42	84	276	96	54	64	72	292	16	45	275	120	111	104	60	228	36	290	48	18	162	32	63	66	248	27	81	102	
Ranking	1	10	6	24	33	27	16	4	15	23	20	18	2	32	26	5	11	12	13	22	8	28	3	25	31	9	29	21	19	7	30	17	14	

Figure 5. Matriks House of Risk Phase 1

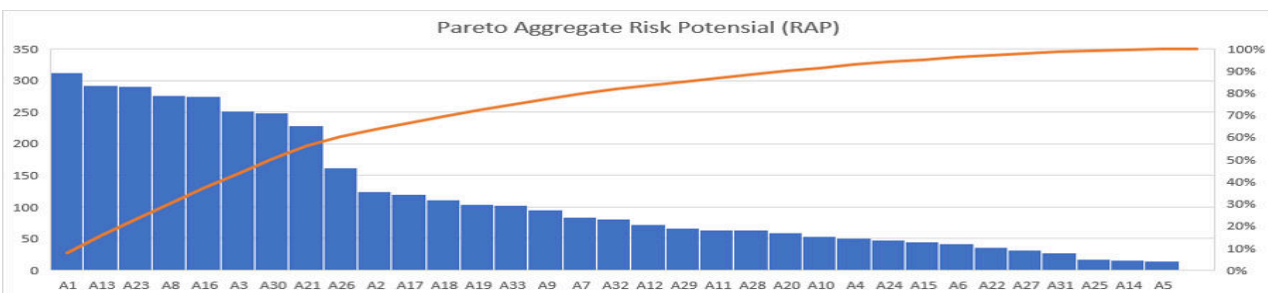

Figure 6 Pareto Diagram Risk Agent

From Figure 5 and using the Pareto 80/20 principle (Figure 6), the risk agent selected that will be taken into consideration in the preparation of mitigation actions risks are shown in table 5.

Table 5. Result of Risk Agent Measurement

Ai	Risk Agent	ARP	%	% Cum
A1	Delay in arrival of raw materials	312	8,07%	8,07%
A13	The Technical evaluation time is quite long	292	7,55%	15,62%
A23	Identification of Scope of Supply (SOS) & Supplier Performance Assessment Not Optimal	290	7,50%	23,12%

These risk agents will then be incorporated into the HOR phase 2 model to mitigation action planning. Mitigation action in question is action to reduce the impact of a risk agent before the risk occurs. Alternative mitigation actions are obtained from brainstorming. The focus of this mitigation action design based on the selected risk agent (table 5).

4.2 House of Risk (HOR) Phase 2 :

Mitigation action mapping is carried out with the aim of seeing the effect of mitigation actions on risk agents. By mapping mitigation action options with selected risk agents. The first step that must be taken is to measure the correlation value between the mitigation action and the selected risk agent (table 6). The second step is to measure the degree of difficulty (D_k). The purpose of this measurement is to determine the degree of difficulty of implementing mitigation actions. The value scale in D_k in scale 3,4 or 5. The third step is to measure the total effectiveness (TE_k), by multiplying the correlation value between risk agents (Ai) and preventive actions (PA). Calculation of TE_k aims to assess the effectiveness of mitigation actions.

Table 6. Result of Risk Agent Measurement

Risk Event	**Code PA**	***Preventive Action***
Delay in arrival of raw materials	**PA1**	Purchase Timing & Delivery Schedule Setting
	PA2	Monitoring of Stock & Consumption Rate (CR) of Raw Materials
	PA3	Make a long-term contract with a multi-winner mechanism
The Technical evaluation time is quite long	**PA4**	The evaluation process was carried out only in 1 Department
	PA5	Standardization of Leadtime Procurement Procurement Process
	PA6	Supply Chain Control Tower in Procurement with Integrated Dashboard
Identification of Scope of Supply (SOS) & Supplier Performance Assessment Not Optimal	**PA7**	Development of an integrated Web-based Supplier Performance Evaluation System
	PA8	Added Supply Intellegence & Strategic Sourcing Functions in Procurement Unit
	PA9	Vendor Management System Improvement

The fourth step is to measure the effectiveness of the degree of difficulty ratio (ETD), by dividing the total value of effectiveness (TE_k) by the degree of difficulty (D_k) in preventive action (PA). Finally, the calculation of ETD aims to determine the priority ranking of all actions as shown in table 7.

Table 7. House of Risk Phase 2, Preventive Actions from selected risk agents

To be threated risk agent	**Preventive Action**									
	PA1	**PA2**	**PA3**	**PA4**	**PA5**	**PA6**	**PA7**	**PA8**	**PA9**	**ARP**
A1	3	3	9					3		312
A13			3	9	3	3				292
A23							3	3	9	290
TE_k	936	936	3.684	2.628	876	876	870	1.806	2.610	
D_k	4	3	4	3	4	5	4	4	4	
ETD	234	312	921	876	219	175,2	217,5	451,5	652,5	
Rank	6	5	**1**	**2**	7	9	8	4	**3**	

4.3 Managerial Implication :

a) Making Long-Term Contracts with Multi-winner Mechanism (PA-3)

This long-term contract with a multi-winner scheme is useful for maintaining stock levels in a safe condition, ensuring the availability of goods and speed in delivery. With the multi-winner scheme, PT. XYZ does not only depend on one partner in terms of meeting the needs of the goods to be sent. Because it is feared that if there is a delay problem with the partner, the impact will greatly affect production operations and maintenance in the factory unit. With the cover from several partners who are bound through long-term contracts, it is hoped that the guarantee of the availability of goods and the speed of the delivery process will be fulfilled.

b) The Evaluation Process was carried out only in 1 Department (PA-4)

So far, the evaluation process carried out by PT. XYZ is still done in 2 different departments. Evaluation of specifications and administration (owner estimate) is carried out by the PPBJ Department (in the Technical Evaluation Identification section), while users in the Maintenance Department also carry out technical evaluations. This causes a very large inefficiency in terms of time (delay).

The evaluation process, both administrative and technical evaluations, should be carried out in the same department, namely the PPBJ Department (IET section). That way the evaluation process will run faster and there is no need to ask the user because there are already parties who understand the requested specifications (Figure 5.4). So, users can focus on doing their main work in the field in carrying out maintenance at the factory

c) Vendor Management System Improvement (PA-9)

It is hoped that with good vendor management, relationships with vendors can be built as strategic partners to strengthen the business of both parties so that they can grow together. So that vendors can have performance in line with the company's business goals with the target of supply arriving on time, in the right quantity, with the right quality and right on purpose.

In organizational structure, it is expected that the vendor management will become a separate section in procurement unit, which stands independently so that it can focus on carrying out the vendor management process. The Supplier Relationship Management (SRM) function need to be upgraded, and other process should be improved are : Develop vendor database, vendor analysis & risk assessment, Vendor selection, Negotiation, contract management, vendor performance management, Vendor development and also Implementation of continuous improvement plan.

5. CONCLUSIONS

From the results of supply chain risk identification in the procurement unit of PT. XYZ there are 22 risk events or risk events and 33 causes of risk or risk agents. The risk agent which is prioritized for prevention in the procurement unit of PT. XYZ consists of 3 risk agents, that is Delay in arrival of raw materials, technical evaluation is too long and Supplier Performance Assessment is not optimal.

There are 9 preventive actions taken to prevent risks in the procurement unit of PT. XYZ using HOR methods. Proposed recommendations for preventive action should be prioritized are supply chain control tower in procurement with an integrated dashboard, making long-term contracts with a multi-winner scheme, and adding supply intelligence & strategic sourcing functions.

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SPREADSHEET-BASED SUPPLIER SELECTION SYSTEM DESIGN USING AHP AND TOPSIS METHODS

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ABSTRACT

The supplier process in the supply chain of a business is an important step to ensure the ability of suppliers to provide supply so as to ensure the availability of goods for a business. This research was conducted at the KMS, which is one of the BPJS Health partner clinics. KSM is currently upgrading its pharmacy services to become pharmacies, but the existing suppliers are performing unsatisfactorily which causes several losses, including many medicines being discarded due to expiration and potential loss of revenue due to the supplier's inability to fulfill orders. This study identifies the criteria used in the supplier selection process by means of a brainstorming process and a group discussion forum (FGD) conducted with 5 members of the KSM team, starting from the director, vice director, pharmacist and 2 pharmacist assistants. The values that have been collected will be calculated using the Analytic Hierarchy Process (AHP) method to get the weights of the criteria and sub-criteria. AHP also provides decision structures and alternatives in the supplier selection process. The Engineering Method for Order Preference based on Similarity to the Ideal Solution (TOPSIS) used to submit applications based on specified criteria. The results of the study obtained 6 criteria and 7 sub criteria used in the supplier selection process. Among other things, price and payment method, quality, delivery, warranty, product variant and historical performance. In addition, this research also produces a spreadsheet-based supplier selection system that can display supplier performance ratings that are used as wishes in the supplier selection process.

Keywords: *Decision Support System, Analytical Hierarchy Process* (AHP), *Technique for Others Reference by Similarity to Ideal Solution* (TOPSIS).

1. INTRODUCTION

Responding to competition in the health industry requires the management of the health industry to provide the best possible service to customers. Meeting what customers need is one way to grow customer loyalty to the company. KSM, one of BPJS Health's partners where located in Pasuruan Regency, is currently upgrading pharmacy services to become pharmacies, so that it can serve medicines sales to the public.

The cost of raw materials and components is the main cost in a product, even some sources say it is 70% (Sunyoto, 2018). Therefore, the selection of raw material suppliers is very important because it will have an impact on the operations of a business. Currently, KSM only has 1 medinice supplier, but the supplier's performance is unsatisfactory. The first problem is the supplier was not being able to fulfill the request of the KSM that every drug sent had an expiration date of at least 1 year which resulted in an increasing number of medicines being destroyed due to expiration. The second problem encountered was the item return policy which required the KSM to send all items in 1 purchase order document, this was considered inflexible because it would potentially disrupt the existing stock. The third problem is that suppliers are unable to meet demand by 15 – 21% when there is an increase in covid 19.

The supplier search process is difficult because the KSM does not have a supplier selection system. Therefore, this study aims to determine what criteria are needed in the supplier selection process, and to design a supplier selection system. The criteria and priority values are determined by means of brainstorming and group discussion forums. After that, the priority value of the criteria is calculated using the Analytical Hierarchy Process (AHP) method to get the weight of each criteria. AHP is a method of weighting (determination of integrity) from a series of existing problems, both against criteria and alternatives. This method can be used to solve complex problems. (Noer, 2010: 9). The supplier assessment process is carried out using the Technique for Others Reference by Similarity to Ideal Solution (TOPSIS) method. TOPSIS is a multi-criteria decision-making method introduced by Yoon and Hwang (1981). The calculation results of the TOPSIS method will provide an alternative with the closest distance from the positive ideal solution and the farthest from the negative ideal solution which uses the Euclidean distance to determine the relative closeness of the most optimal alternative.

2. LITERATURE REVIEW

2.1 Supplier Selection

Currently the supplier selection process is one of the strategic activities, moreover suppliers supply goods that have a major influence on the sustainability of the company's business processes. In the supplier selection process, criteria that match the needs of the company are needed. According to Sunyoto (2017), in a study entitled "Implementation of drug supplier selection in harmonized pharmacies with the AHP method in Surabaya" there are 5 criteria needed for the pharmaceutical service business process, including quality, delivery, trust, cost and responsiveness. In determining the supplier there must be through the right mechanism. According to Pujawan (2017: 190) there are 6 steps in the process of selecting suppliers, including:

1) Determine the selection criteria.
2) Determine the weight of each criteria.
3) Identify alternatives (suppliers) to be evaluated.
4) Evaluate each alternative with predetermined criteria.
5) Calculate the weighted value of each supplier.
6) Sorting suppliers based on the weighted value.

2.2 AHP Method

The Analytical Hierarchy Process (AHP) is a multi-criteria analysis method that can be used in the decision support system development process (Montolalu et al., 2013). The purpose of the AHP method is to determine the priority / weight of the criteria and alternatives from several series of problems to be faced into a hierarchy. The concept used in AHP is the concept of

pairwise comparison, which is the process of comparing two criteria that need to be considered in making a decision (decision making). The AHP hierarchy is a representation of complex problems in a multilevel structure. The first level is the goal, followed by the next level, define the criteria, sub-criteria, until the last level is an alternative. The steps taken in using AHP are making a pairwise comparison matrix, normalizing the initial matrix, calculating relative weights/priorities, calculating lambda max (λmax) and finally testing the consistency of the calculations.

2.3 Metode TOPSIS

TOPSIS is a multi-criteria decision-making method that considers alternatives with the smallest distance from a positive ideal solution and the largest distance from a negative solution with a geometric point of view using Euclidean distance. Each alternative given by the TOPSIS method does not always have the largest distance from the negative ideal solution, therefore TOPSIS considers both. TOPSIS will sort each alternative based on the priority of the value of the relative proximity of an alternative to the positive ideal solution. The alternatives that have been sorted are then used as a reference for decision makers to choose the best desired solution. According to (Marzouk & Sabbah, 2021) there are 5 stages of TOPSIS, namely changing performance attributes into non-dimensional attributes and then normalizing using equations. The second determines a normalized weighted decision matrix. The third stage identifies positive and negative ideal solutions. The fourth is to measure the difference between positive and negative ideal solutions. The last is to measure the relative closeness of existing alternatives.

2.4 Decision Support System

Decision support system (DSS) is a model or knowledge-based system that aims to support the managerial decision-making process (Ahuja & Hanna, 2004: 3). The system is not a decision-making tool, but is used to expand capabilities in the decision-making process. In order for DSS to run optimally, data is needed which is combined with insights from the person or group who will make the decision. According to (Ahuja & Hanna, 2004: 11), there are 5 stages in the spreadsheet-based DSS design process, including:

1) Application overview, is the initial part of an application. This section is one of the most important parts in a DSS application. This section considers the entire flow of a running application.
2) Spreadsheets, is part of the application that is mostly in the form of calculations. This section usually supports the mathematical performance performed by the system.
3) User interface, is the overall view for application users. There are many options for creating a user interface for an Excel DSS. Among them is to add functional buttons, spreadsheet form controls, or depending on the application required by the user.
4) Procedures, is a code to input, perform calculations, display output, and others. This step is used to develop DSS applications by creating procedures to perform flow and perform computations through coding.
5) DSS components, this process is the stage of checking the overall function of DSS components in the application. In this step, the main function is the resolve options function.

3. METHODS

KSM is one of BPJS Kesehatan's partners who is developing its business by opening a new pharmacy. In this effort, the KSM is looking for suppliers who can provide supplies as expected.

The steps taken are looking for what criteria are needed in the supplier search process and designing a supplier selection system. The following is the design of this research.

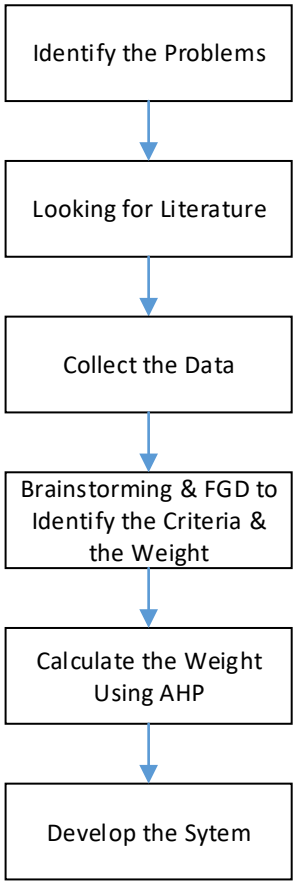


Figure 1 Reseach Framework

This research begins with brainstorming to find out what criteria are needed in the supplier search process and priority values. Furthermore, calculations are carried out using the AHP method to determine the weight of each criteria. Furthermore, a system design is carried out that can calculate supplier performance using the AHP method.

4. RESULTS

4.1 Running the Model

The results of the brainstorming and group discussion forums that were carried out found the criteria used in the supplier selection process, namely prices and payment methods in which these criteria have 3 sub-criteria, including product prices, payment methods and payment deadlines. The second criteria is the quality of the goods where the quality is judged from the expired date of the goods sent. The third criteria is delivery that has 2 sub-criteria, including ETA and the distance from the supplier's location to the KSM. The fourth criteria is a warranty which has 2 sub-criteria, namely the claim policy and the duration of returns. The fifth criteria is product variants and the last criteria is performance history. The following is a pairwise comparison matrix that shows the relationship between the criteria and the available alternatives.

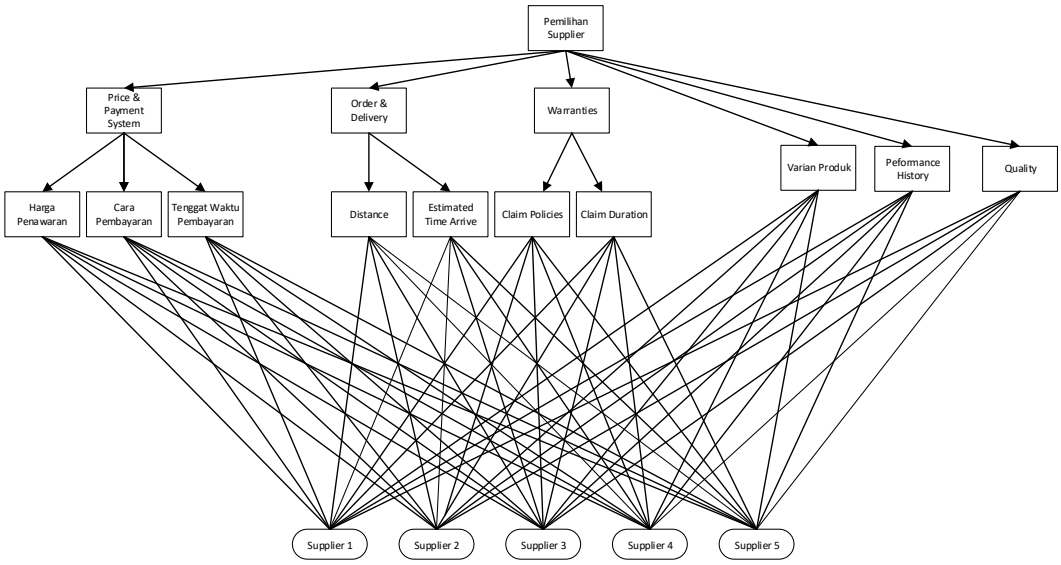


Figure 2 Hirarki AHP

The FGD process also determines the priority value of the criteria and sub-criteria. These values are processed mathematically using the AHP method and the criteria and sub-criteria weights are obtained as shown in table 1 below.

Table 1 Criteria & The Weight

Kriteria / Sub Kriteria	Bobot
Price & Payment System	**0.410**
Price Product	0.22
Payment System	0.14
Deadline Payment	0.03
Quality	**0.22**
Delivery	**0.11**
ETA	0.086
Range	0.028
Warranty	**0.14**
Claim Policy	0.07
Duration	0.07
Product Variant	**0.04**
Peformance History	**0.06**

The criteria that have the greatest weight are price and method of payment, second quality, third warranty, fourth is delivery, fifth is performance history and product variants. The greater the weight of the criteria, the greater the influence of these criteria in determining the supplier later.

4.2 Design the System

The next process is the design of the supplier selection system. The system is designed using Microsoft excel and visual basic advance using the TOPSIS method. In the system, the user can enter the weight of the criteria and the supplier's performance value. The following is a display of the system that has been designed.

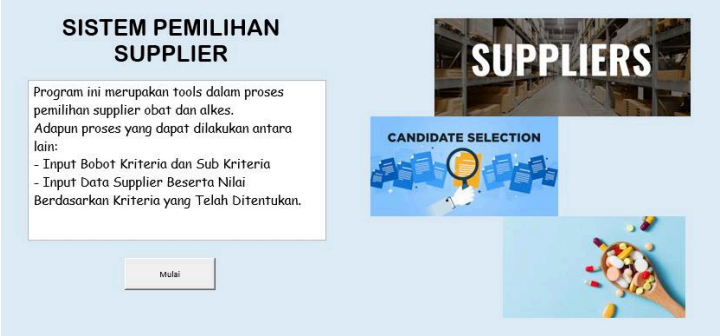


Figure 3 Welcome Sheet

The picture above is a welcome sheet display which is the initial display when the user opens the application. The welcome sheet has a function to provide information for the user what processes can be done in this system. The following is a design view of the welcome sheet.

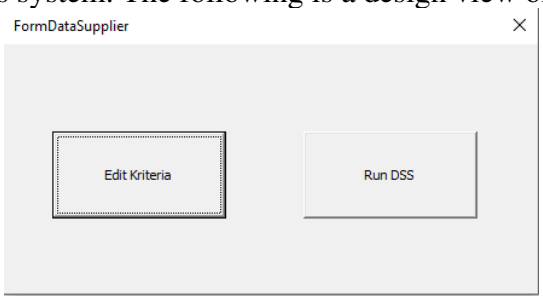


Figure 4 Form Menu

After the user presses the start button, then the system will display a menu form with 2 buttons display, that was the edit criteria button and run DSS. The edit criteria button functions when the user wants to make the process of changing criteria. While the DSS run button will allow the user to carry out the supplier selection process without changing the weight of the existing criteria.

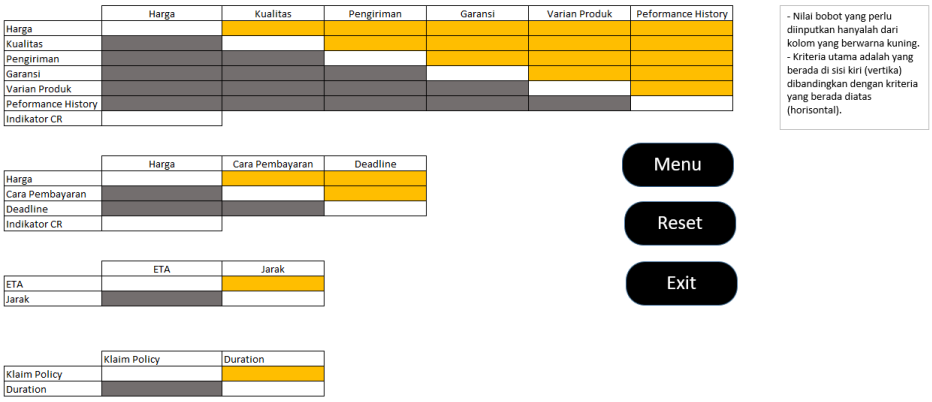


Figure 5 Criteria Edit Sheet

In the criteria edit sheet, the user only needs to fill in the criteria values in the yellow column. The criteria on the left will be compared to the criteria on the top side. The gray column will be automatically filled when the user fills in the value in the yellow column. When the user has filled in all values, then a sign will appear in the CR indicator column whether the entered value is consistent or not.

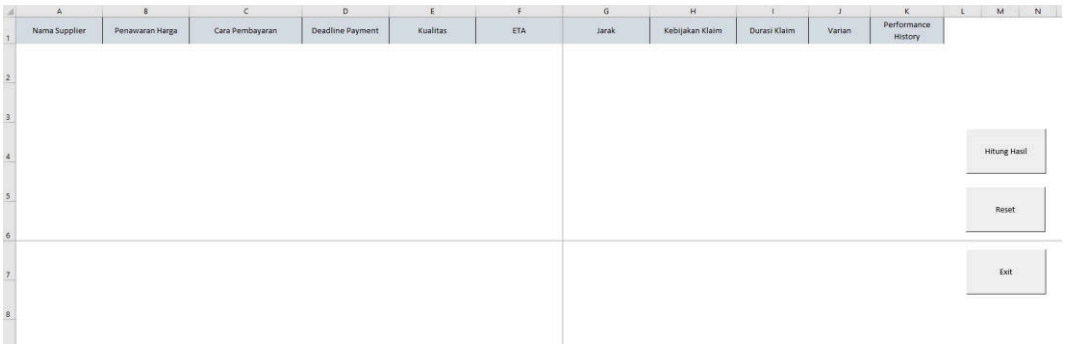
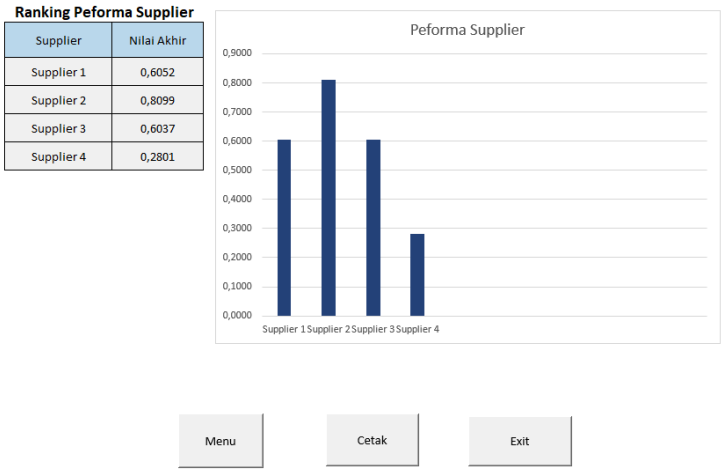


Figure 6 Supplier Sheet

The DSS run sheet allows the user to enter supplier data and their performance values. Users can enter up to 10 supplier data. When the user has finished entering supplier data and wants to know the calculation results, the user can press the calculate results button.



Ranking Peforma Supplier

Supplier	Nilai Akhir
Supplier 1	0,6052
Supplier 2	0,8099
Supplier 3	0,6037
Supplier 4	0,2801

Figure 7 Result Sheet

Figure 6 is the final result sheet that displays the supplier's performance shown in tables and diagrams. The greater the value, the better the performance of the supplier.

6. CONCLUSIONS

There are 6 criteria that can be used in the supplier selection process at the KSM, namely price and payment methods, quality, delivery, warranty, product variants and performance history. The criteria that have the most influence in selecting suppliers are the price and the method of payment, where this criteria has 3 sub-criteria, namely the offer price, payment method and

deadline payment. The second most influential criteria is quality, then warranty which has 2 sub-criteria, namely claim policy and claim duration. The criteria with 4th priority are shipments that have 2 sub-criteria, namely ETA and distance. Furthermore, performance history and variants have little influence in the supplier selection process.

Supplier selection system designed using Microsoft Excel and Visual Basic Advance. The system design consists of several stages, starting with system requirements analysis, application overview design, spreadsheets, user interfaces, procedures. In ensuring the system is in accordance with the design made, 3 tests are carried out, including verification, validation and prototype tests. The system that has been designed can display supplier performance based on ranking and presented in a sequence of tables and diagrams.

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ANALYSIS OF THE POTENTIAL OF MICROSERVICES ARCHITECTURE FOR MSME WEBSITES IN INDONESIA

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ABSTRACT

The COVID-19 pandemic raises various problems, especially for MSME business players. However, on the other hand, there are new opportunities that can be exploited for MSME businesses. MSME actors can take advantage of information and communication technology, where electronic commerce in 2020 will reach US$ 130 billion. Electronic commerce transactions have increased dramatically during the COVID-19 pandemic. The high demand for products using digital media demands that the technology used is reliable enough to handle this demand. MSME actors who use information technology in their business processes often experience problems in the form of the unreliability of the information technology used. One of the problems that are often experienced is the website server is down due to excessive requests, therefore a solution is needed to overcome this problem. The solution provided is the use of microservices architecture. This trend emerges as a pattern of real-world experience in building distributed applications and has no formal definition. Microservices are architectural styles that plot service architectures that develop from traditional service-oriented architectural styles (Zanella, 2014). This study uses a literature study to determine the potential for website development for MSME actors in Indonesia using microservices architecture by reviewing references using scientific articles and analyzing the potential for developing a microservices architecture for MSME websites in Indonesia. The microservices architecture is a new solution for MSME players for website development to anticipate a surge in consumers so that the information technology used can work reliably and not experience downtime.

Keywords: Covid-19, MSME, Microservices, Website.

1. INTRODUCTION

The Covid-19 pandemic that occurred in Indonesia had a major impact on the MSME sector. The most felt impact is a decrease in turnover of up to 30%. The decline in turnover that occurred

was inseparable from the constraints experienced by MSMEs such as capital problems, difficulty in obtaining raw materials, as well as a decrease in customers and hampered distribution due to the Covid-19 Pandemic (Rais A.B, 2021). The number of MSMEs in Indonesia which reaches 64.19 million, with the composition of MSEs or Micro Small Businesses as much as 64.13 million or around 99.92% proves the importance of the role of MSMEs in the economy. MSMEs play an important role in improving the national economy with the contribution of the MSME sector to gross domestic product (GDP) of 61.07% and in 2021 it is targeted at 62.36% (Linkumkm.id, 2021). To achieve this target, MSME actors must increase sales by utilizing increasingly advanced information technology.

Today's increasingly advanced information technology can play a role as a means of promotion, marketing for MSME actors. Information technology (Website) containing MSME products will be easier to reach by consumers without having to come into contact and face to face with producers. Extensive marketing is also an advantage for MSME actors because consumers only need to use the internet without having to worry about contracting Covid-19. However, the problem with the MSME website that often occurs is that if one part is damaged, the system will be stopped as a whole to make repairs.

The solution to the MSME website problem can be solved with a microservices architecture. Microservices architecture can help in managing costs that must be incurred during business processes and can also manage interactions between buyers and sellers by using scalable properties. In addition, the MSME website will become more resilient because if there is damage to certain services, it will not cause other services to drop. This can make repairs easier and there is no need to shut down servers and services if you want to perform maintenance.

2. LITERATURE REVIEW

The development of website-based MSMEs is considered very effective in expanding the market and increasing the turnover of MSME actors. However, the obstacle that is often experienced is the number of website users so that it goes down. Therefore, there is a solution to overcome this, namely the microservice architecture. The microservice architecture can handle a lot of user loads, so as to minimize disruption to the website. Some researches on website-based MSMEs and microservice architecture applications on applications and websites can see in table 1.

Table 1. Researches on website-based MSMEs and Microservice Architecture Applications on Applications and Websites.

Writer	Sample	Title	Source	Research result
Rizki Mufrizal and Dina Indarti (2019)	PT. Graha Usaha Teknik	*Refactoring* Arsitektur *Microservice* pada Aplikasi Absensi PT. Graha Usaha Teknik	Jurnal Nasional Teknologi dan Sistem Informasi	The microservice architecture can handle a load of 15 tps. Compared to monolithic architecture, the use of microservice architecture is more optimal when the number of users is increased to 15 tps. Microservice architecture has great potential when used in applications or websites with many users
Erry Julio and Magdalena A.	API's Payment	Implementasi API Payment	Jurnal Informatika	The use of a microservice architecture in the API's

Ineka Pakereng (2021)	Gateway	Gateway menggunakan Arsitektur *Microservice*		Payment Gateway can reduce errors in application development and maintenance. When researchers want to integrate with a new bank, it is enough to create a new microservice.
Hatma Suryotrisongko	Association/ membership management system	Arsitektur *Microservice* untuk Resiliensi Sistem Informasi	Jurnal Sisfo	The use of microservice architecture can improve the quality of the resilience aspect. If there are many users or when some service modes are interrupted, the system continues to run as it should.
Yuli Syafitri, Agus Prasetyo, and Reni Astika	MSMEs in Bumi Nabung District, Central Lampung	Sistem Informasi Pemasaran Produk UMKM Berbasis Web pada Kecamatan Bumi Nabung Lampung Tengah	Jurnal Informasi dan Komputer	The existence of web-based MSMEs can increase the sales turnover of MSME actors, expand the market, be more effective, and more efficient.

3. METHODS

3.1. Literature Study Method

The method used in this research is a literature study by collecting data related to the potential of architectural microservices. Based on research from Kartiningsih (2015) about the literature study method is a series of activities related to data collection activities, data management, and reading research results and is related to the concept to be studied. The literature study method aims to be the basis for obtaining theoretical foundations, frameworks of thinking, and determining hypotheses in research. The theories needed to support the research are the basic potential of MSME, technology needs, microservice architecture solutions and MSME website problems.

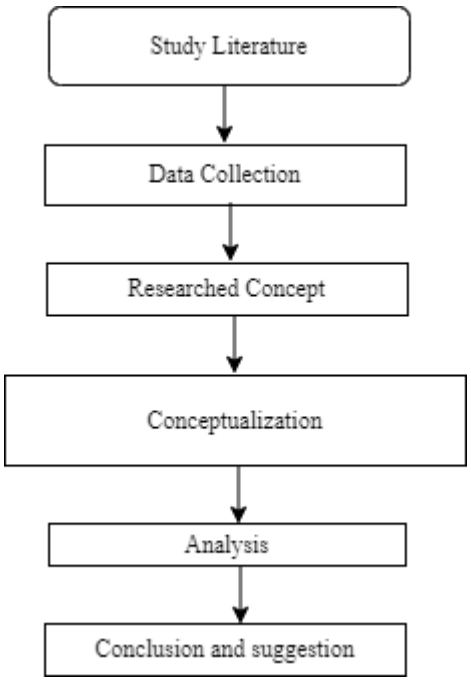
3.2. Data collection

The data collection technique used in this study is to browse the literature from various kinds of literature used. The literature used must be related to research, which can be searched through primary and secondary sources. The primary sources used are scientific articles, research journals and posiding, while the secondary sources used can be in the form of books that can be searched through the internet. The data that has been obtained is then analyzed so that it can be used as supporting material in research. Literature and data that have been collected, then carried out the preparation of a writing plan regarding the formulation of the problem to be studied.

3.3. Data analysis

This research uses descriptive qualitative analysis in accordance with the subject matter. Qualitative descriptive analysis was carried out to find out the description of the explanation of the data that had been collected which was presented in the form of writing, pictures and diagrams. This analysis was carried out by reading the literature that supports the problems regarding the potential of MSME, technology needs, microservice architecture solutions and MSME website problems. Qualitative methods are used to formulate the problem, then collect data and information in depth by selecting and reducing data. The stages used in data processing include collecting information, selecting data that has been collected in accordance with the problems to be discussed. This research must answer the problems that have been formulated. In addition, in analyzing the problem, it is necessary to connect the data with one another in accordance with the theoretical basis outlined. Then a descriptive analysis is carried out regarding the facts that have been obtained and solutions to these problems are given

The following is a flow chart of the research stages carried out, namely:



4. RESULTS

4.1 Monolithic architecture vs microservices architecture

Monolithic architecture has a principle that describes an application that runs all functions or logic programs on a single application server (Katuwal, 2016). This architecture makes it possible to run multiple functions on a single server. The problem with monolithic architecture is that if one part is damaged, the system must be stopped as a whole to make repairs. In addition, if you want to add features or functions, it will be a risk that can cause errors in other services (Uminingsih and Handayani, 2020).

In dealing with this problem, using a microservices architecture is a solution. Microservices architecture is an architecture in application development in the form of web services where each service is divided into smaller modules that communicate with each other. This architecture is more flexible and more scalable, by breaking down applications into stand-alone functions and can use different technologies according to needs. The difference between monolithic architecture and microservices architecture can see in the figure 1.

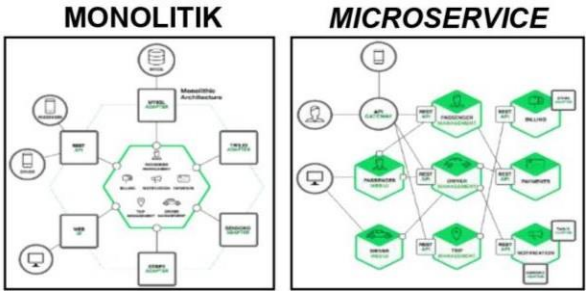


Figure 1. Difference Monolithic Architecture and Microservices Architecture

4.2 Scalability architecture microservices

Scalability is the ability of a service to increase resource capacity in dealing with increased workloads (Lehrig et al, 2015). Adjusting the use of resources is not lacking which results in decreased performance or hyperbole which results in increased costs and waste of existing resources, as a result using this scalability can provide resources according to the needs of the workload at that time. To implement a scalability process, you will need a metric as a threshold to determine whether the system needs to add or reduce the use of resources, both containers and servers & this will maintain the equilibrium of a system if at any time the number of requests according to the user is getting higher or lower.

4.3 Use of Websites for MSME

Websites for MSME actors can be used as promotion, marketing and sales media for the products they offer. Websites have an impact in terms of disseminating information to the wider community. Through the website, the content contained in it is more easily accessed by the public without having to become followers such as social media (Widayat et al, 2021). Especially during the Covid-19 pandemic, causing purchasing activities to change online, consumers avoid physical contact to avoid transmission (Cholilawati and Suliyanthini, 2021). This epidemic has prompted the global community to adopt a new lifestyle to prevent the increasing incidence of transmission. One of them is that the governments of many countries encourage their citizens to stay or stay at home during the pandemic if there is no urgent activity to do outside the home.

As a result, many people prefer to do all their activities from home, one of which is doing shopping transactions (Aulia, 2020). During this pandemic, it has accelerated the process of moving consumers from offline to online, especially in purchasing activities. Previously, people shopped online occasionally and only shopped for non-essential items, now people do it regularly and also shop for daily necessities. This can be utilized by MSME actors in using information technology such as websites as a medium for marketing, promoting and selling the products they offer.

4.4 Architectural Design

The application of the microservices architecture design on the MSME website can be seen in the image above. The application is divided into several small parts with the functions of product services, order services, notification services. While the supporting tools used are gateways,services discovery and message brokers (Alchuluq and Nurzaman, 2021). This architecture is suitable for MSME websites that offer products to be sold widely. Microservices here separates each service and their respective databases into different containers and puts on different servers. In addition, the microservices system also has a gateway that functions as a communication intermediary between one service and another (Tanuwijaya, 2021). So that the functions of each will stand alone but still communicate with each other for business processes. The microservices architecture design can see in the figure 2.

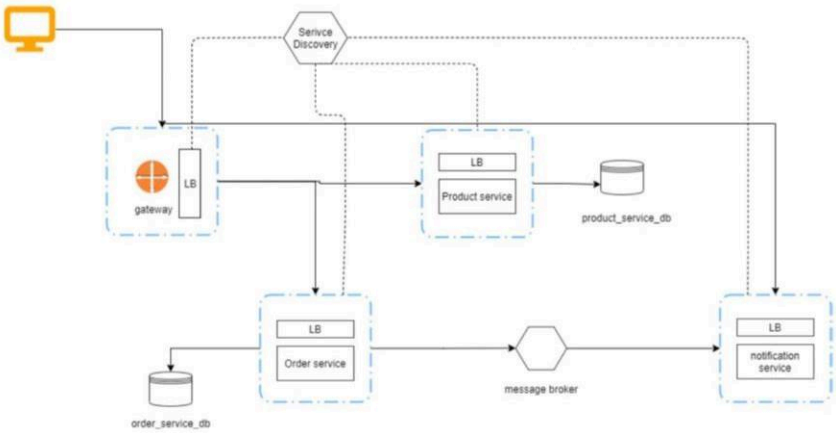


Figure 2. Microservices Architecture Design (Alchuluq dan Nurzaman, 2021)

Performance tests conducted by (Alchuluq and Nurzaman, 2021) show the performance of a comparison between monolithic architecture and microservices architecture. The performance can see in the table 2.

Table 2.Performance Test

Scenario	Monolitic Architecture	Microservices Architecture	Difference
Get 200 Product	5.027,61 / minute	5.916,051 / minute	888,441 / minute

The performance shows that APIs that use microservices architecture can access data faster.

4.5 Advantages of implementing microservices architecture

Developing applications as independent small services provides several advantages and disadvantages (Newman, 2015) (Richardson, 2015). These advantages are: flexibility in technology selection, more resilience to bugs, ease of scalability, ease of developing each service. In the context of MSMEs, this can help in adjusting the costs that must be incurred during the business process and can also adjust traffic from buyers and visitors by using scalable properties. This is an advantage for MSME actors so that the websites they use are not easily down when traffic is high. The use of technology can adapt to the needs so that each service can use different technologies. The MSME website will become more resilient because if there is damage to certain services, it will not make other services drop. This can make repairs easier and there is no need to close servers and services if you want to do maintenance.

5. CONCLUSIONS

The Covid-19 pandemic that occurred in Indonesia had a major impact on the MSME sector. Today's increasingly advanced information technology can play a role as a means of promotion, marketing for MSME actors. Information technology (Website) containing MSME products will be easier to reach by consumers without having to come into contact and face to face with producers. In addition, the MSME website will become more resilient because if there is damage to certain services, it will not cause other services to drop. This can make repairs easier and there is no need to shut down servers and services if you want to perform maintenance. Monolithic architecture has a principle that describes an application that runs all functions or logic programs on a single application server. Microservices architecture is an architecture in application development in the form of web services where each service is divided into smaller modules that communicate with each other. This architecture is more flexible and more scalable, by breaking down applications into stand-alone functions and can use different technologies according to needs. Scalability is the ability of a service to increase resource capacity in dealing with increased workloads. Websites for MSME actors can be used as promotion, marketing and sales media for the products they offer. Especially during the Covid-19 pandemic, causing purchasing activities to change online, consumers avoid physical contact to avoid transmission. As a result, many people prefer to do all their activities from home, one of which is doing shopping transactions. During this pandemic, it has accelerated the process of moving consumers from offline to online, especially in purchasing activities. In addition, the microservices system also has a gateway that functions as a communication intermediary between one service and another. Performance tests conducted by Alchuluq and Nurzaman show the performance of a comparison between monolithic architecture and microservices architecture. These advantages are: flexibility in technology selection, more resilience to bugs, ease of scalability, ease of developing each service. This is an advantage for MSME actors so that the websites they use are not easily down when traffic is high.

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IDENTIFYING THE CRITICAL SUCCESS FACTORS OF INDONESIA MEDICAL DEVICE DISTRIBUTOR IN E-PURCHASING ERA WITH ANALYTIC HIERARCHY PROCESS APPROACH

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ABSTRACT

The health sector in Indonesia is one of the sectors that received a national budget of 132.2 trillion Rupiah in 2020 which occupies the position of the 4th biggest national budget and is growing annually. In 2015, medical device procurement was switched from offline bidding to online trading (e-purchasing). This change has impacted in the business processes of Indonesian medical device distributors. Company XYZ is one of the medical device distributor companies in Indonesia that sales decreased after e-purchasing was implemented. Therefore, the purpose of this study is to identify and prioritize the critical success factors for Company XYZ in the digital age. An analytic hierarchy process that uses several success factors from previous studies is used to determine the success factors for this study. In addition, a focus group discussion was held to determine the actual implementation of XYZ's critical success factors. The results of this study show that customer relationship management, customer purchasing procedures and standards, company image, cash flow management, product quality, actively build relationships with key persons from associations and health practitioners are top priorities for improving Company XYZ's performance as medical device distributor in the electronic purchasing era.

Keywords: Critical Success Factor, Medical devices distributor, E-Purchasing, Analytic Hierarchy Process

1. INTRODUCTION

The health sector in Indonesia is one of the sectors that received a national budget of 132.2 trillion Rupiah in 2020 which occupies the position of the 4th biggest national budget. In addition, these values have been growing every year and in 2020 grew by 13% (Kemenkeu, 2020). Along with the trend of national budget for the health sector, the number of hospital also increase every year. This shows the huge potential of the medical device market in Indonesia. Thus, the condition of the medical device industry is also expected to develop. However, PT XYZ as one of the medical device distributor in Indonesia found a significant decrease in sales volume from 2016 to 2020. This condition happened since the transformation of government procurement system from tender to direct purchase through government electronic catalog in 2016.

Under such circumstances, developing a competitive advantage strategy will require a new approach from company management. Several obstacles in the early implementation of e-

procurement include the need for adaptation for users, infrastructure and technology needs; technology adaptation for suppliers, data security and trust between business partner Alvarez (2014). Therefore, guidelines are needed for medical device distributor companies to find out determinants of success in the era of e-purchasing. A critical success factors concept is able to systematically identify the main areas that require special attention from management on an ongoing basis to achieve the company's performance goals Corkindale (2013).

The objective of this paper is to identify critical success factors of PT XYZ as a medical device distributor in the e-purchasing era using the Analytic Hierarchy Process (AHP) as a method to determine the priority of success factors.

2. LITERATURE REVIEW

2.1 E-*procurement* Indonesia Public Sector

E-Procurement is an auction system in the procurement of goods/services by the government by utilizing internet-based technology, information and communication facilities. There are two types of government e-procurement, namely e-tendering and e-purchasing. According to Indonesia Presidential Regulation Number 4 of 2015, Ministries/Institutions/Regional Apparatus Work Units/Institutions (K/LD/I) are required to conduct e-Purchasing on goods/services that have been contained in the electronic catalog system in accordance with applicable regulations. K/L/D/i needs. The procurement process allowed by the K/L/D/I does not use the e-Purchase mechanism if the goods/services are not listed in the e-Catalogue; The technical specifications of the goods/services listed in the e-catalogue are not in accordance with the technical specifications required by the K/L/D/I; The goods/services provider does not respond to orders while the need for goods/services is urgent and cannot be delayed any longer; providers of goods/services cannot provide goods, either partially or wholly within the period specified in the implementation plan for the procurement of goods/services due to the scarcity of availability of goods; providers of goods/services cannot serve orders for goods/services due to the limited range of providers of goods/services; the price of the online shop commodity electronic catalog and the results of the negotiation of the price of goods/services through the online shop commodity e-Purchase in the sales period, the quantity, brand, place, technical specifications and terms are the same, more expensive than the price of goods/services owned other than through e-purchasing (LKPP, 2015).

2.2 Critical Success Factors

Davila, Gupta and Palmer (2002) noted that e-Procurement technology will become an important part of supply chain management and will be adopted aggressively. E-Procurement technology is still considered to involve significant risks. From a technology point of view, the overall lack of accepted standards discourages a large number of companies from adopting the technology.

Rockart (1981) first used critical success factors (CSFs) in the context of information systems and project management. Identifying and communicating the CSF ensures everyone involved in the project team is focused. Pinto and Slevin (1987) define a success model S = f (X1, X2,……, Xn) where S is the success of a project and Xi is the critical success factor i. In addition, according to Butler (1996) states that a CSF concept is able to systematically identify the main areas that require constant and careful attention from management. The process of identifying *critical success factors* should be implemented at many levels of the organization, units, and even

sepcific working groups. If the process is well handled, it is apparent that it can be used at many levels of the organization and industry, as well as at higher economic, social, and political levels (Zhou,2011).

2.3 Balance Scorecard

The Balanced Scorecard is one of the methods introduced by David P. Norton and Robert Kaplan (1996) to measure the success of a company or organization in carrying out its vision and mission. Historically, the measurement of company performance has only focused on the financial aspect. The Balanced Scorecard maintains financial measurement as an important summary of managerial and business performance but the Balance Scorecard highlights a series of more general and integrated measurements that relate to several other aspects, namely customer aspects, internal business process aspects, learn & growth aspects and system performance with long-term financial success.

2.4 Analytic Hierarchy Process (AHP)

Analytical Hierarchy Process (AHP) is one of the methods used to solve multiple criteria decision making problems. AHP solves complex problems by means of their own interactions. AHP requires information and assessment of several processes to identify critical problems, to determine their structure, and to find solutions to the problems themselves. Through a mathematical sequence AHP can make the relative priority of alternative actions (Saaty,1994).

In solving problems using the AHP method, there are Some of the basic principles of the AHP method that must be taken are as follows (Saaty,1994):

1. Decomposition (principle of compiling a hierarchy).
2. Synthesis of Priority (preparation and determination of priorities).
3. Logical Consistency (principle of logical consistency).

The decomposition principle describes and describes the problem in detail hierarchical, i.e. breaking the problem into separate elements. For get more accurate results, the elements are broken down again until they are not it is possible to do further solving, so that several levels are obtained. Preparation and setting of priorities, namely determining the ranking of elements according to their relative importance by making pairwise comparisons of these elements. Logical consistency is to ensure that all elements grouped logically and ranked consistently according to criteria logical one.

2.5 Expert Choice

For the study of hierarchical data, a variety of backup software has been developed, with Saaty and colleagues developing the most widely used expert selection program (Forman et al., 2000). Many aspects of the software include the ability to create hierarchical decision graphs for designing questions, determining preferences and priorities, calculating total weight, and making parameter modification decisions. A sensitivity analysis feature is also available. Above all, charts and graphs are frequently used to display results and performance (Saaty, 1994).

3. METHODS

3.1 Literature review

Literature review was conducted to study the methods and theories as the basis of the researcher's thinking which includes e-procurement, critical success factors and analytical hierarchy process. Literature review help researchers in determining critical success factors adopted from several previous studies.

3.2 Identification and Verification of Critical Success Factors List

Several critical success factors adopted from several related studies will be used as references by researchers. Furthermore, critical success factors will be communicated with the Director of PT. XYZ to get CSF that really fits the company's conditions and strategy.

3.3 Prioritization of the AHP Approach.

Determining the priority of critical success factors by experts is done by doing pairwise comparisons between success factors. Then, the results of pairwise comparisons will be processed using expert choice software to get the priority weight calculation for each critical success factor. The results of data processing must show a consistency index below 0.1 to be declared valid.

3.4 Focus Group Discussion

Focus Group Discussion (FGD) is a data collection technique carried out to gain an understanding of the meaning of a group. The FGD method was carried out by two-way interaction between researchers and research informants. The FGD conducted in this study aims to gain an understanding of the problems that occur and various alternative solutions that can be done to improve the work performance of PT. XYZ in the era of e-purchasing.

4. RESULTS

4.1 The Hierarchy Model

After conducting interviews and confirmation to the director of PT XYZ regarding the CFS list that has been adopted from several related studies as table 1.

Table 1. Critical Success Factor of Organization

Criteria	Factor	Reference
Financial	Company Budget Planning	Sulaymonov (2018)
	Cash Flow Management	Bradley (2008)
	The Role of Finance advisor and technology	Philippon (2016)
	Third Party Financing Loan	Pourhanifeh (2016)
Customer Experience	Product Quality	Shaharudin (2011)
	Product Price	Richard (2010)
	Company Image	Cetin (2015)
	Customer Relationship Management	Pourhanifeh (2016)
Bussines Process	Digital Data-driven Business Processes	Kane (2015)
	Sales Planning	Richard (2010)
	Compliance with customer purchasing procedures and standards	Vaidya&Callender (2006)
	Changing advertising technology	VR Montequin (2014)
	Ability to handle emergency orders	Yang&Huang (2011)
	Actively build relationships with key persons from associations and health practitioners	Yunmei (2011)
Learning & Growth	Regular employee training	Rodriguez (2019)
	Combining human and digital resources	Kane (2015)
	Financial rewards (bonuses) related to employee performance	Richard (2010)
	Employee recommendation acceptance	Rodriguez (2019)

A three-stage analytical hierarchy process (AHP) model was established to rank the PT XYZ's critical success factors (CSF) as medical device distributor in e-purchasing era . The first stage represents the model's goal of prioritizing PT XYZ critical success factors (CSF). The second level represents four criteria that distinguish each critical success factor based on the balanced scorecard theory. The third level is used as a determinants of criteria in the four PT XYZ success factors categories (CSF). Following the hierarchy research model.

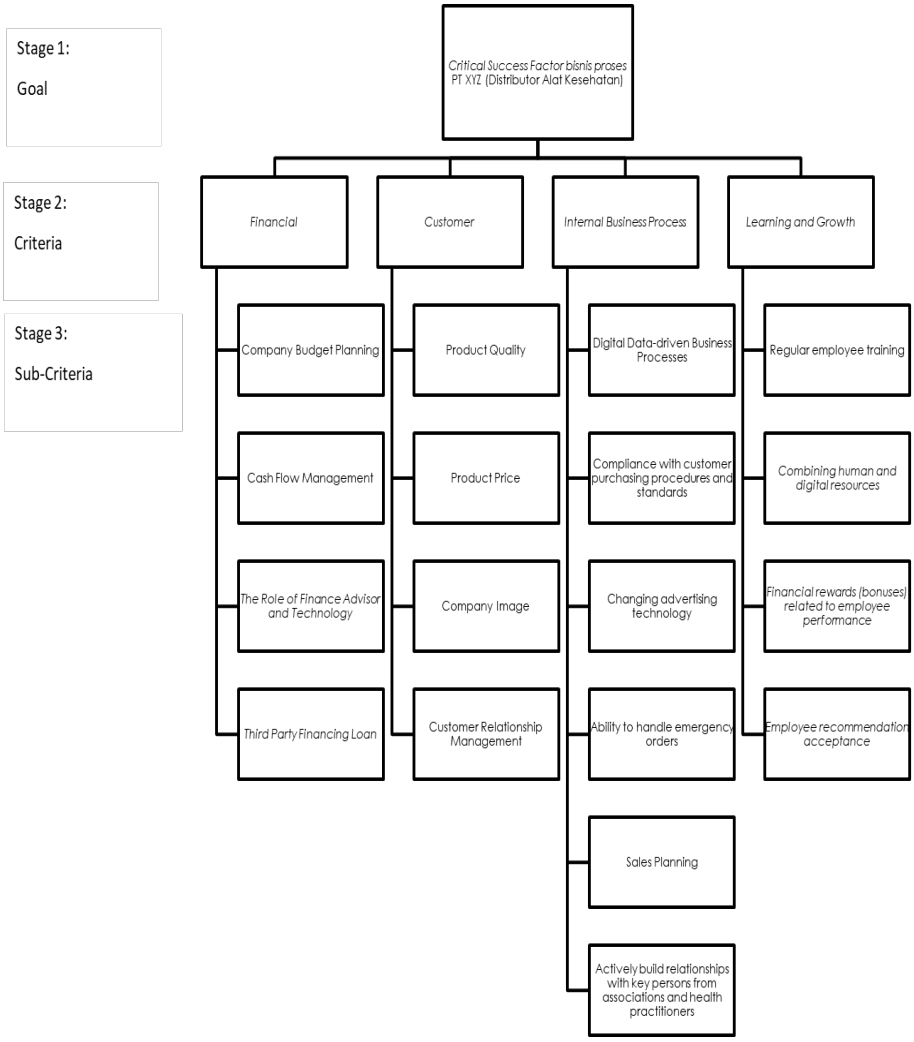

Figure 1. Hierarchical structure for PT XYZ as Medical Device Distributor in e-purchasing era

4.2 Prioritization of the AHP approach.

The hierarchy for critical success factor of PT XYZ in e-purchasing era is shown in Figure 1. Inline with the hierarchy, we designed a questioner complying with the AHP format. The questioner was distributed to five selected members of PT XYZ who have the positions of manager and director and also have at least four years of experience in the sector. Then the results of the questionnaire were processed using the Expert Choice software as figure 2.

Figure 2. The output of Expert Choice software

Table.2 Weight and rank of the PT XYZ critical success factors

Criteria	Critical Success Factors	Local Weight	Global Weight
Financial (0,169)	Cash flow management	0,542 (1)	0,092 (4)
	The role of finance advisor and technology	0,233 (2)	0,039 (9)
	Company budget planning	0,168 (3)	0,028 (11)
	Third party financing loan	0,056 (4)	0,009 (17)
Customer (0,462)	Customer relationship management	0,562 (1)	0,26 (1)
	Company image	0,251 (2)	0,116 (3)
	Product quality	0,130 (3)	0,06 (5)
	Product Price	0,056 (4)	0,026 (12)
Internal Business Process (0,304)	Compliance with customer purchasing procedures and standards	0,397 (1)	0,121 (2)
	Actively build relationships with key persons from associations and health practitioners	0,192 (2)	0,058 (6)
	Digital data-driven business processes	0,158 (3)	0,048 (7)
	Changing advertising technology	0,149 (4)	0,045 (8)
	Ability to handle emergency orders	0,068 (5)	0,021 (13)
	Sales planning	0,036 (6)	0,011 (15)
Learning & Growth (0,064)	Regular employee training	0,507 (1)	0,032 (10)
	Combining human and digital resources	0,258 (2)	0,017 (14)
	Financial rewards (bonuses) related to employee performance	0,168 (3)	0,011 (15)
	Employee recommendation acceptance	0,066 (4)	0,004 (18)

As shown in the figure 2, inconsistency index shows 0.02 which is acceptable and indicates the validity of the data. Based on the data in table 2, it can be shown the priority of the critical success factors of PT XYZ in the e-purchasing era. Customer relationship management is ranked first with a global weighted score of 0.26. The second rank is compliance with customer purchasing procedures and standards with a global weight value of 0.121. The third rank is company image with a global weight value of 0,116. The fourth rank is cash flow management with a global weight value of 0,092. The fifth rank is product quality with a global weight value of 0,06. The sixth rank is actively build relationships with key persons from associations and health practitioners with a global weight value of 0,058. These six can be considered as the most influential factors, since these six factor will affect about 70 % on the success of PT XYZ as medical device distributor in e-purchasing era.

4.3 Focus Group Discussion.

The FGD was conducted based on the results of the CSF priorities, which focused on six factors that would have the greatest influence on the success of PT XYZ. The following is an illustration of the actual conditions contained in the six success factors with the highest priorities:

1. Customer Relationship Management has not been implemented in a structured manner so it is difficult to track the activities of the sales team. The number of parties that must be met for the sale of an online communication tool is considered less effective for long-term relationships.
2. The products that PT XYZ normally market has not been registered in the government e-catalog so that if there are competing products that have been published in the government e-catalog, PT XYZ can no longer market similar products to government hospitals.
3. The company's image has not been actively built on digital media such as websites or social media
4. Long average collection period affects cash flow management. This is because the majority of consumers have a very long average payment period due to the e-purchasing system that does not require down payment
5. PT XYZ as a distributor of medical devices has not been accredited by good distribution practice even though all medical devices have a permit thus product quality cannot be controlled consistently according to standards.
6. Company management is actively involved with medical device company associations but not with health practitioners associations.

6. CONCLUSIONS

Based on the results of testing and analysis, several conclusions can be drawn as follows:

- There are 18 factors that can influence the success of PT XYZ as a distributor of medical devices in the era of e-purchasing. six of them have an influence of 70%, namely customer relationship management, customer purchasing procedures and standards, company image, cash flow management, product quality, actively build relationships with key persons from associations and health practitioners.
- It should be noted that the role of top management in understanding the actual condition of the company for each critical success factor parameter is very important because each company has different conditions for each critical success factor that has been modeled.

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FEASIBILITY STUDY OF RICE HUSK PELLETS AS BIOMASS ENERGY BASED ON COST-BENEFIT ASPECTS

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ABSTRACT

Today the energy issues are being discussed around the world. Indonesia as a developing country is also trying to reduce dependence on fossil energy. In 2007 the Indonesian government carried out energy conversion from kerosene to LPG (Liquified Petroleum Gas). But the problem occurs when domestic LPG production is decreasing every year. In addition, subsidies from the government only reach certain circles and cannot reach the upper-middle industry and all levels of society. The government also experienced a trade balance deficit and caused huge losses because Indonesia had to import LPG from other countries. The problems related to LPG require us to find new energy alternatives that are more effective and efficient with renewable energy. The purpose of this study was to analyze the feasibility of a biomass business. The problem that exists today is that there are still few companies that are willing to produce biomass on a large scale, while there is a lot of material and a large market. One alternative that can be used is rice husk biomass. As an agricultural country, Indonesia produces large amounts of rice husks. Only a small amount of rice husk was used today, and most of it was thrown away. Processing rice husks into alternative fuels can be a business that can be considered. By using a cost-benefit analysis approach, it can be seen whether the business is feasible or not. After calculating the cost-benefit analysis using the NPV, IRR, and cost-benefit ratio methods. It is known that the NPV value is Rp. 563,101,143 and an IRR of 49%. While the cost-benefit ratio shows the number 2.09. From the three indicators, it is known that the business is feasible to do. It is hoped that this research can be a consideration for companies that want to develop the rice husk biomass industry.

Keywords: alternative fuels, biomass, cost-benefit analysis, energy, LPG, renewable energy, rice husk

1. INTRODUCTION

Today the energy issues are being discussed around the world. Indonesia as a developing country is also trying to reduce dependence on fossil energy. In 2007 the Indonesian government carried out energy conversion from kerosene to LPG (Liquified Petroleum Gas). This program is the government's effort to reduce dependence on non-renewable energy and save the budget from the energy supply process in the country. The infographic Figure 1.1 shows that the government has succeeded in converting kerosene to LPG. It can be proven that after the program started, there was an increase in the use of LPG to replace firewood and kerosene. Until 2017, the level of use of LPG

as a source of fuel for cooking was 76.2%. Meanwhile, firewood and kerosene are below LPG with a percentage of 17.5% and 3.7%, respectively.

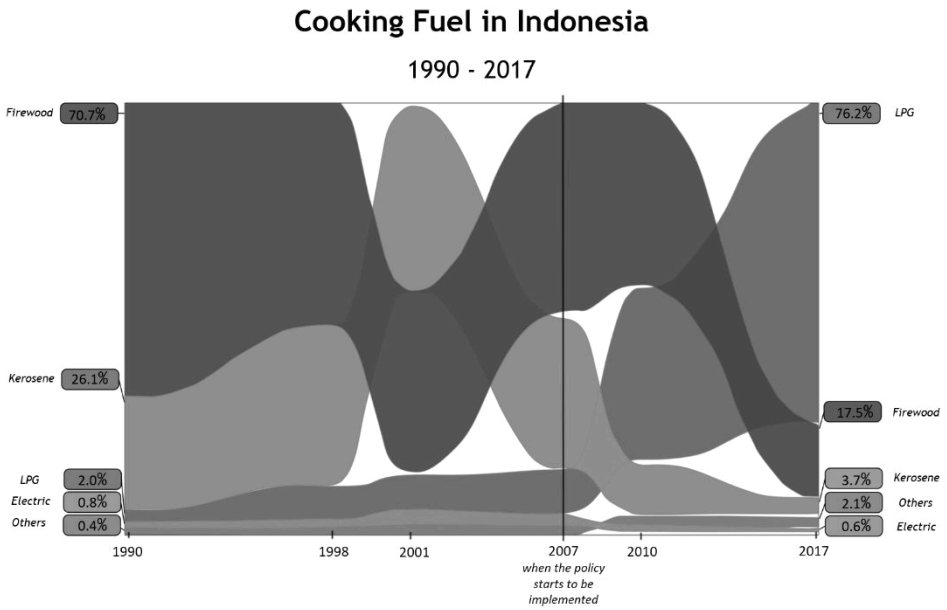

Figure 1.1 Cooking Fuel in Indonesia from 1990 to 2017

Putra and Siahaan (2020) mention there is a new problem that arises when Indonesia has to import LPG because domestic production has decreased and is unable to meet the needs of the community. Meanwhile, LPG demand continues to increase from year to year. Many LPG subsidy programs are not right on target, where the upper-middle class can enjoy subsidized LPG

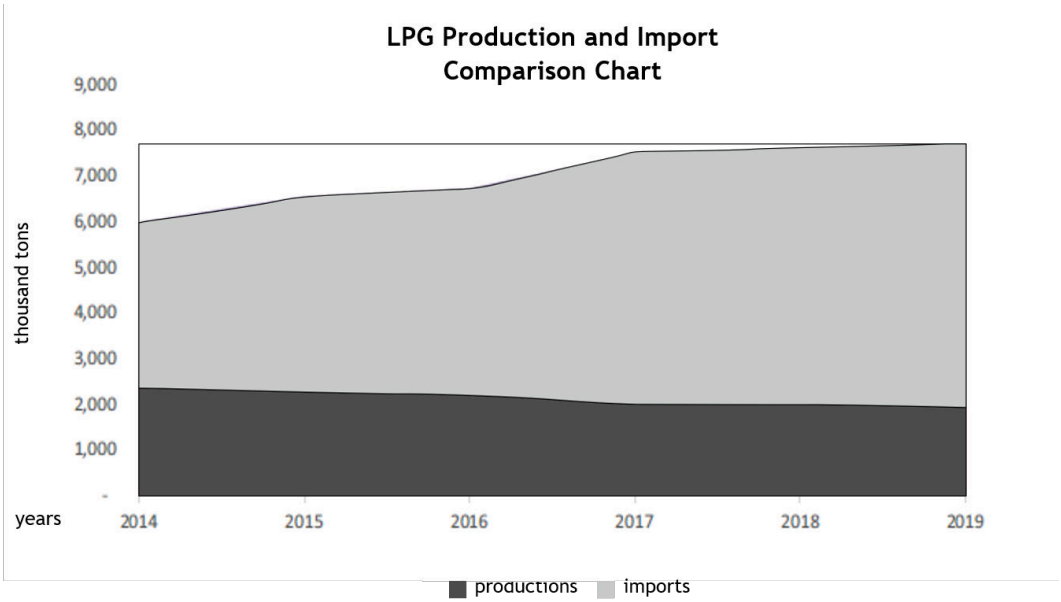

Figure 1.2 LPG Production and Import Comparison

In the Laporan Kajian Neraca Energi Nasional from the Ministry of Energi and Mineral Resources (2020) which is shown in Figure 1.3. illustrates that domestic LPG production has continued to decline since 2014 forcing the government to import to meet domestic energy needs. The increase in LPG imports is very burdensome for the government so it makes Indonesia's trade balance into a deficit. In this case, the government is trying to suppress the volume of imports and limit the consumption of 3 kg LPG (subsidy) which is allocated only for household consumers. In addition, efforts have also been made to substitute LPG for DME (Dimethyl Ether) as another alternative energy that is processed from coal. Besides DME, biomass is an alternative energy that needs to be developed. Kusuma and Badaruddin (2013) state that as an agricultural country, Indonesia produces large amounts of biomass. One of the agricultural wastes that can be used as biomass is rice husk, the weight of the husk produced is 20% of the weight of milled dry grain.

Prawoto, Mahdie, and Sari (2019) in their research say that biomass is organic material that is relatively young and comes from plants, animals, products, and waste from the aquaculture industry (agriculture, plantations, forestry, animal husbandry, fisheries. The concept of biomass has been applied by our ancestors by utilizing wood, leaves, and other natural products as a source of energy. However, this method is not optimal because the use of biomass directly and without processing will cause respiratory diseases caused by carbon monoxide, sulfur oxide (SO2), and particulate matter. To improve the characteristics of biomass, densification is carried out in the form of briquettes or biopellets.

To find out the advantages and disadvantages of biomass with rice husk material, it is necessary to research the producer's point of view. The method used in this research is cost-benefit analysis. It is hoped that this research will determine the feasibility of investment if the waste utilization program is mass-produced.

2. LITERATURE REVIEW

2.1. Liquified Petroleum Gas (LPG)

According to Kuncoro (2016) LPG is a hydrocarbon gas produced from oil refineries and refineries gas with the main components being propane and butane and packed in a tube. In Indonesia, LPG is used mainly as a fuel for cooking. LPG consumers are from several clusters, like households, commercial (restaurants, hotels, etc), and industry. Among industries, LPG is used as fuel in the food industry, ceramics, glass, and forklift fuel. In addition, LPG can also be used as a raw material in industry environmentally friendly aerosols and refrigerants. LPG cylinders consist of several sizes, ranging from gas cylinder sizes 3 kg to 50 kg.

2.2. Biomass

Jin Li (2021) state that biomass is organic material produced through photosynthetic processes, both in the form of products and waste. Examples of biomass include plants, trees, grass, sweet potatoes, agricultural waste, forest waste, feces, and livestock manure. Besides being used for the primary purpose of fiber, food, animal feed, vegetable oil, building materials, and so on, biomass is also used as an energy source (fuel). Generally used as fuel is biomass that has low economic value or is a waste after the primary product is taken.

2.3. Pelletizing

Saptoadi (2006) interpret that pelletizing is one way to develop the function of biomass. Energy volume per unit of biomass can be increased through densification, also transportation and handling costs can be decreased. Pellets were first used for small-scale indoor heating in Sweden in the 1980s. Pellets are made from the main by-product of sawdust. Pellet sizes vary, in Sweden, the

size of the pellet diameter is 6-12 mm with a length of 10-20 mm. The effectiveness of pellet burning is higher due to the very low moisture content in the pellets

2.4. Cost-Benefit Analysis

Cost-Benefit Analysis is a method used to evaluate and select the best investment alternative. The concept of this method includes finding the costs and benefits of each investment alternative, finding the present value of the costs and benefits found, comparing the present value of the benefits and benefits with the costs invested, then choosing one of several investment options based on the results. These comparisons are detailed steps for the cost-benefit analysis process. There are several ways to determine the cost-benefit analysis, which are the NPV, IRR, and Cost-Benefit Ratio methods (E. Hsu, 2020).

2.5. Net Present Value (NPV)

From Hsu (2020), net present value is an estimated cash flow that will be carried out in the future and is adjusted to current conditions. In simple terms, net present value is the difference between the present value of several cash inflows and compared with the current value of cash flows out over a certain period. Generally, the term net present value is used in a cash flow projection or profit and loss projection in a project, business, or investment. The purpose of calculating the net present value is to find out the current value of the company's assets or cash, which is also equated with the cash value in the future. Net present value also has a close relationship with the theory of the time value of money, namely money with the same certain amount will have a different value in several future periods.

2.6. IRR

The internal rate of return is an indicator of the efficiency level of investment. IRR is also known as a method for calculating the interest rate of investment and equating it with the current investment value based on calculating future net cash. If the calculation of the internal rate of return shows a number greater than the capital issued, then the investment is feasible. if the result of the IRR calculation is less than the cost of capital, the investment is not feasible.

2.7. Cost-Benefit Ratio

The benefit-Cost Ratio (BCR) is a ratio used to analyze the costs and benefits of a project to be undertaken. If a project has a Benefit-Cost Ratio greater than 1.0, then the project is expected to provide positive value in the future to the company and its investors. However, if the project provides a value of less than 1.0 then the project costs are greater than the economic value that will be generated, so the project should not be continued. BCR is calculated by dividing the total profit from a project by the total cost of the project.

3. METHODS

In this study, an analysis of the feasibility of investing in a business of making biomass pellets made from rice husk was carried out. The research was only carried out from the point of view of the biomass pellet producer. The method used is cost-benefit analysis. Where the assessment indicators are calculated using the net present value (NPV), an interest rate of return (IRR), and cost-benefit ratio (CBR) methods. To calculate NPV can use the following formula:

$$NPV = \sum_{t=0}^{n} \frac{B_t - C_t}{(1+r)^t}$$

Where B_t is the profit in period t, C_t is the cost in period t, and r is the discount rate. The investment must also be assessed from the payback period of the investment required by this project. The faster the payback time, the better the assessment of an alternative.

The internal rate of return is the discount rate that makes the NPV of a project zero. IRR calculation is done manually through a series of experiments. However, with a calculator that can calculate financial functions, these experiments are not necessary. The project will be selected if the IRR value is more than the opportunity cost value.

The last indicator is a cost-benefit ratio, determined by dividing the present value of costs (PV cost) by the present value of profits (PV Benefit). The investment is feasible when the ratio value is >1. If the ratio is 1, it means that the investment value is equal to the benefits. And it is said not feasible when the ratio value <1.

$$BC\ Ratio = \frac{PV_{Benefit}}{PV_{Cost}}$$

4. RESULTS

4.1. Pricing of Pellets

To determine the selling price of pellets, the thing that must be done is to know the production capacity in units of time. The first step is to calculate the total cost then divide it by the productivity of the machine so that the unit cost is obtained. By adding a profit margin, the selling price of husk pellets per kilogram will be known. Total cost is obtained by adding capital cost, operating cost, and cargo handling cost. And the Table 1 below shows the production capacity and obtained material requirements in one year.

Table 1 Production Capacity

Items	Quantity	Unit
Machine Capacity/Productivity	1.000	Kg/Hour
Load Factor	1	
Working Hours	8	Hours/Day
Admission Day	312	Per Year
Total Productions	1.996.800	Kg/Year
Price of Material	300	Rp/Kg
Weight Loss of Material (%)	0	
Material Requirement	2.096.640	Kg/Year

After the production capacity is known, the next step is to determine the variables of the cost and the value of these variables in rupiah. As said above, the total cost consists of Capital Cost, Operating Cost, and Cargo Handling Cost. The value of these variables can be seen in the Table 2, Table 3, and Table 4 below.

Table 2 Capital Cost

No.	Item	Cost	Unit
1	Price of the Machine	Rp450.000.000	
2	Workshop & Storage Building	Rp75.000.000	per year
		Rp1.125.000.000	(for 15 years)
	Total Capital Cost	Rp1.575.000.000	

Table 3 Operating Cost

No.	Item	Cost	Unit
1	Salary (4 crews)	Rp15.000.000	per month
		Rp180.000.000	per year
2	Repair & Maintenance	Rp2.000.000	per month
		Rp24.000.000	per year
3	Lubricating oil	Rp5.000.000	per year
4	Documents & Administration	Rp2.000.000	per Year
5	Electricity Cost	Rp1.500.000	per month
		Rp18.000.000	per year
6	Water Consumtion Cost (PDAM)	Rp100.000	per month
		Rp1.200.000	per year
7	Materials	Rp628.992.000	per year
	Total Operating Cost	Rp859.192.000	per year

Table 4 Cargo Handling Cost

No.	Item	Cost	Unit
1	Loading Cost	Rp25	per Kg
	Total Cargo Handling Cost	Rp49.920.000	per year

The total cost value from the data above is Rp 2.484.112.000. So that the unit cost value can be obtained which is equal to Rp 1.244,05. If the expected profit is 5%, the selling price of pellets is Rp 1.360 per Kilograms. The unit cost that has been obtained is used to calculate revenue by multiplying the unit cost result by the total production in one year.

4.2. Cost-Benefit Analysis

Table 5 shows the results of the calculation of NPV and IRR. The calculation is done by projecting cash flow for 15 years. Where the NPV is Rp 9,672,253,547 and the IRR is 678%. From the NPV, it is known that the investment is feasible because the NPV value is positive. The IRR also shows that the investment is worth it. Where the IRR value is more than cost of capital, cost of capital in this research is interest rate of loan with value 10%.

Table 5 Analysis Result

MARR	10%				
Item		Value	Criteria	Min	Remarks
NPV		Rp 9.672.253.547	Ok	0	Positive Incr. Wealth
PI		48,2	Ok	0	Null
IRR		678%	Ok	10%	MARR
BEP	Year	1,0	Ok		
Accum cash on BEP		Rp 1.187.483.026	Ok	0	Positive Accum Cash

More detailed results can be seen from the Figure 3 which illustrates that in the first year there was a break-even point. Because the break-even point occurs in the first year, this pellet business can be very profitable. Although every year the cash flow has decreased, until the 15th year it can still generate a profit of more than 1 billion per year

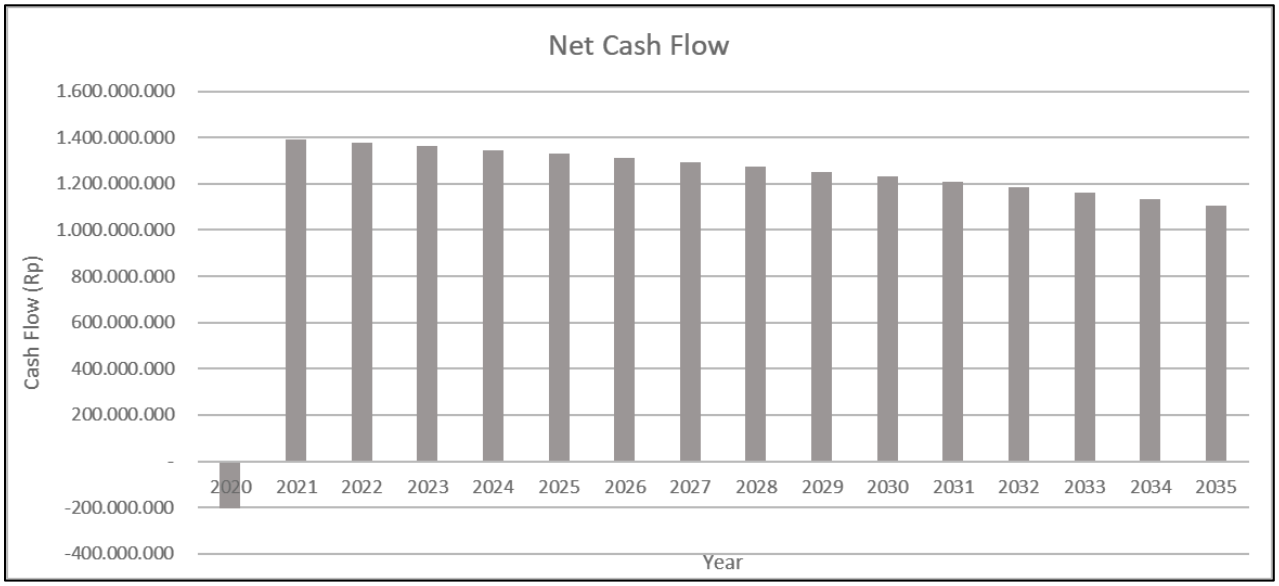

Figure 3 Cash Flow Chart

The last method is the cost-benefit ratio. After knowing the value of costs and benefits. Then we get the following results

$$PV_{Benefit} = Rp\ 20.368.763.751{,}83$$
$$PV_{Cost} = Rp\ 9.723.183.288{,}31$$

$$\frac{PV_{Benefit}}{PV_{Cost}} = \frac{Rp\ 20.368.763.751{,}83}{Rp\ 9.723.183.288{,}31} = 2{,}09$$

The cost-benefit ratio method also shows that the investment is feasible. This is because the ratio is 2.09 and by the theory, if the ratio value is more than 1, the investment is feasible Of the three ways of analyzing cost-benefit analysis, all of them answered that the investment to produce pellets made from rice husks was feasible.

5. CONCLUSIONS

This study aims to analyze the cost-benefit aspect if a company is built to produce biomass in the form of pellets with rice husks on a large scale. The analysis uses 3 methods, namely Net Present Value (NPV), Interest rate of Return (IRR), and Cost-Benefit Ratio (CBR). From these three methods, it is concluded that the investment to produce rice husk pellets on a large scale is feasible. This is evidenced by the NPV result of Rp. 9,672,253,547 and IRR are equal to 678%. In addition, the cost benefit-ratio also shows a value of 2.09. The NPV is said to be feasible if the value is greater than 0, while the IRR is said to be feasible if the value is greater than the cost of capital, and the cost-benefit ratio is said to be feasible if the value is more than 1.

The managerial implication of this research is that cost-benefit analysis can be used as a method for decision-making and feasibility test for a new business. With results stating that the business to produce rice husk pellets is feasible. With large-scale production, it is hoped that it will reduce dependence on LPG as cooking fuel

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GREY RELATIONAL ANALYSIS FOR OPTIMIZATION IN OPENING BOILER OUTLET VALVE AT ADDITIONAL START OF COMBINED CYCLE POWER PLANTS

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ABSTRACT

Combined Cycle Power Plants played significant role in generating electricity in Indonesian grid system as a peaker power plant. There was additional start process in their start operation that consists of three main parts: opening the damper until fully opened, opening BOV (Boiler Outlet Valve), and fulfilling pressure steam set. Work instruction of combined cycle operation in the company mentioned there are two options in opening BOV, with HP (high pressure) BOV first or LP (low pressure) BOV first. In this study, the grey relational analysis is specially adopted to determine the optimum option for opening BOV. Moreover, sampling time in every 15 minutes of the experiments and 5 weighting values combination applied to evaluate the added production and vacuum value results properly and objectively. The results of confirmation experiments reveal that grey relational analysis can effectively acquire the optimal options of opening BOV in additional start process was at 45 minutes of sampling time and the best option was opening HP BOV first. The proposed algorithm greatly simplifies to compare and define the optimization of opening BOV options and it can be used to investigate the options related to other critical risk criteria in future.

Keywords: added production, grey relational analysis, opening BOV options, optimization, vacuum value.

1. INTRODUCTION

Electricity is an importance energy source to support most of sectors in a country. It also as a infrastructural component that enhances life quality of the people. In terms of fulfilling the electricity demand of the country, an electric power system is needed. An electric power system consists of three major electrical component: power plant, a high voltage trans-mission grid and a distribution system. More than 60% of the environmental impacts associated with the electricity sector were caused by electricity generation or power plant (Sinaga, 2021).

In 2020, PT. PLN (Persero) as the Indonesian electricity company still largely depends on thermal power plant, which accounted for 90,9% of the total electricity production. The steam power plants and combined cycle power plants played the most significant role in generating electricity with a 64,32% and 16,94%. But steam power plant and combined cycle power plant have different function in grid system. Steam power plant usually used as a base load and combined cycle power plant as a peaker power plant. The peaker power plant is a power plant that

was operated when the grid system at peak load and increased start-stop frequency of it (Zuhdi, 2019).

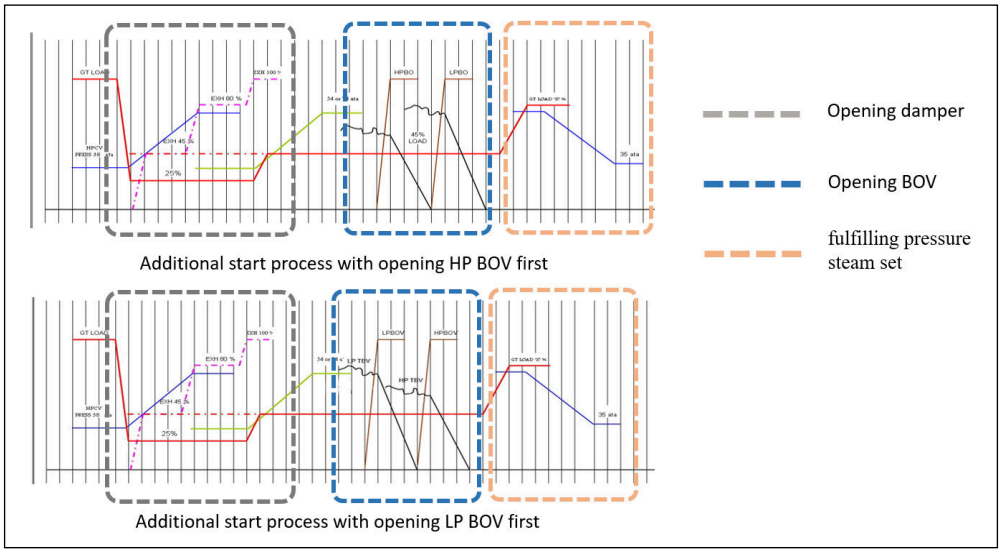

Figure 1. An additional start process diagram

Combined cycle power plant consists of three major component: gas turbine, Heat Recovery Steam Generator (HRSG) and steam turbine (Yuntyansyah, 2022). The function of HRSG is the place where the water warms up to become superheated steam then delivered to steam turbine. There are two kinds of steam was sent from HRSG to steam turbine, high pressure and low pressure steam. High pressure steam moved through HP BOV (High Pressure Boiler Outlet Valve) and low pressure steam moved through LP BOV (Low Pressure Boiler Outlet Valve). The opening process of HP BOV and LP BOV included in a process called additional start. We have two options in this opening process, HP BOV or LP BOV opened first.

An additional start process consists of three main parts: Opening the damper from fully closed until fully opened, opening BOV, and fulfilling pressure steam set. Furthermore, there were many operational parameters must be observed. The mayor issue of additional start process is increased electricity production. Generally, two important indexes to evaluate the performance of combined cycle power plant are availability's equipment and their production. Therefore, this kind of observation is regarded as a multiple problem. Basically, availability's equipment and the production are correlated with operational parameters such as condenser vacuum, inlet outlet steam pressure, vibration, and others. A study of combined cycle power plant in Canada was categorized condenser and steam pressure system into high risk criterion (Khan, 2012). Decreasing vacuum value in a condenser was indicated condenser and steam pressure system in abnormal condition.

The steps of an additional start are determined on work instruction of the company. Both options ever been used every day. Fortunately, they are successfully to started combined cycle power plant until synchronize to the grid system but their was never evaluated which one of the options are optimum. In this paper, the proposed method is grey relational analysis to study the optimization of opening BOV options in additional start of combined cycle power plant.

The grey system theory proposed by Deng in 1982 has been proven to be useful for dealing with the problems with poor, insufficient, and uncertain information. The grey relational analysis based on this theory can further be effectively adopted for solving the complicated inter-

relationship among the designated performance charac-teristics. Through this analysis, a grey relational grade is favorably defined as an indicator of the multiple performance characteristics for evaluation (Lu, 2009). Grey relational analysis can solved effectively to optimize the electrical discharge machining process with multiple performance characteristics (Lin, 2002) and it can be used to propose a comprehensive evaluation method for large-scale coal-fired power plants, which is beneficial to the comprehensive consideration of resources, economy and environment factors in optimizing the design and operation of a power plant with successfully (Xu, 2011). On the other hand, this paper introduces grey relational analysis for optimization the options of additional start for determining the best options related to the electricity production and condenser vacuum.

2. LITERATURE REVIEW

A. Signal-to-noise ratio

Signal-to-noise (S/N) ratio is used to represent a performance characteristic and the largest value of S/N ratio is required. There are three types of S/N ratio, the lower-the-the-better, the higher-the-better and the nominal-the-better (Ross,1988). Electricity production and condenser vacuum can be analyzed with a higher-the-better characteristic that can be expressed as:

$$(S/N) = -10\, log\left(\frac{1}{n}\sum_{i=1}^{n}\frac{1}{y_i^2}\right) \quad (1)$$

where y_i is the ith experiment, n is the total number of the tests in experiment.

B. Normalize the S/N ratio

This process is normalized data in the range between 0 to 1 using the formula (2) to avoid the effect of different units and to reduce the variability. The normalized S/N ratio is expressed as:

$$X_i^*(k) = \frac{X_i^{(0)}(k) - \min X_i^{(0)}(k)}{\max X_i^{(0)}(k) - \min X_i^{(0)}(k)} \quad (2)$$

where $X_i^*(k)$ is the normalized value and $X_i^{(0)}(k)$ is the S/N ratio of the experiment.

C. Grey relational coefficient

After normalized the S/N ratio, a grey relational coefficient can be calculated. It is defined as follows:

$$Y\left(X_0^*(k), X_i^*(k)\right) = \frac{\Delta_{min} + \zeta.\ \Delta_{max}}{\Delta_{0i}(k) + \zeta.\ \Delta_{max}} \quad (3)$$

Where $\Delta_{0i}(k)$ is the deviation sequence of the reference sequence $X_0^*(k)$ and ζ is distinguishing coefficient, $\zeta \in [0,1]$. ζ is set as 0,5 in this study.

D. Grey relational grade

The grey relational grade is a weighting-sum of the grey relational coefficient. It is defined as follows:

$$r(X_0^*, X_i^*) = \sum_{k=1}^{n} \beta_k y(X_0^*(k), X_i^*(k)) \quad (4)$$

Where β_k represents the weighting value of the kth perfor-mance characteristic.

The grey relational grade $r(X_0^*, X_i^*)$ represents the level of correlation between the reference sequence and the compara-bility sequence. If the two sequences are identically coincidence, then the value of grey relational grade is equal to 1. The grey relational grade also

indicates the degree of influence that the comparability sequences could exert over the reference sequence (Lu, 2009).

3. METHODS

The experiments were carried out on a combined cycle power plant that consists of gas turbine type MW701D and steam turbine type TC2F-355 with a capacity of 100 MW and 150 MW. In practice, the different options in opening BOV influence the increase of electricity production and condenser vacuum fluctuation. So, different options will be observed. Furthermore, data of added electricity production during the time and condenser vacuum are taken in every 15 minutes from a full opened damper until 75 minutes process of additional start. The experimental layout is shown in Table 1. The experiments are performed in order and each experiment is repeated three times on different day to get more reliable data.

The algorithm of grey relational analysis to determine the optimization of the opening BOV options at additional start of combined cycle power plant is described step by step as follow:

1. Convert the experimental data into S/N values.
2. Normalize the S/N ratio.
3. Calculate the deviation of normalized S/N ratio.
4. Calculate the grey relational coefficients.
5. Calculate the grey relational grade.
6. Conduct confirmation the optimal results.

Table 1. Experimental Layout

Experiment (No.)	Option	Sampling time (Minutes)
1	LP BOV First	15
2	HP BOV First	15
3	LP BOV First	30
4	HP BOV First	30
5	LP BOV First	45
6	HP BOV First	45
7	LP BOV First	60
8	HP BOV First	60
9	LP BOV First	75
10	HP BOV First	75

4. RESULTS AND DISCUSSION

Generally the bigger production and vacuum value are desirable result. From the experimental results that presented in table 2, we can find that average of the added production in opening LP BOV first option was greater than opening HP BOV first option in each experiment. It was not equal to the vacuum condenser value, it showed that LP BOV first option was less than HP BOV first option in their averages. The grey relational analysis is used in this study to confirm which one of the option is more optimum.

Table 2. Experimental Results

No	Added Production (MW)				Vacuum Condenser (mmHg)			
	Day-1	*Day-2*	*Day-3*	$\bar{y}$	*Day-1*	*Day-2*	*Day-3*	$\bar{y}$
1	4,8	-5,1	11,5	3,7	681,4	683,8	681,6	682,3
2	5,8	-5,3	-1,7	-0,4	688,8	678,1	690,5	685,8
3	38,7	32,4	49,4	40,2	682,3	688,6	685,7	685,5
4	39,3	24,8	21,1	28,4	693,5	679,3	690,1	687,6
5	57,9	55,5	76,6	63,3	682,4	686,2	676,8	681,8
6	55,9	31,2	43,0	43,4	689,7	685,3	695,0	690,0
7	55,0	52,3	71,5	59,6	683,3	687,0	677,6	682,6
8	61,6	33,8	70,5	55,3	687,6	685,7	688,0	687,1
9	64,3	52,4	67,4	61,4	680,8	686,6	677,9	681,8
10	57,1	19,2	68,3	48,2	689,1	690,9	688,7	689,6

The result of experiment are initially converted into S/N ratio to search the smallest variance of data. To calculate the S/N ratios of added production and vacuum value is used higher-the-better formula. The experimental results in table 2 are substituted into formula (1). Usually, the larger S/N ratio showed the better data characteristic. All the original sequence of S/N ratio are then substituted into formula (2) to be normalized. According to previous reference, larger values of the normalized results corresponds to better data characteristic, and the maximum normalized results that are equal to 1 indicates the best experiment result. Furthermore, the deviation is formulated as :

$$\Delta_{0i}(k) = |x_0^*(k) - x_i^*(k)| \qquad (5)$$

Where $x_0^*(k)$ is the kth normalized value and $x_i^*(k)$ is equal 1,00 from the maximum normalized result for reference. The outcomes overall are shown in table 3.

Table 3. The Values of S/N Ratio, Normalized S/N Ratio, and Deviation

No.	Added Production (MW)			Vacuum Value (mmHg)		
	(S/N)	$X_i^*(k)$	$\Delta_{0i}(k)$	*(S/N)*	$X_i^*(k)$	$\Delta_{0i}(k)$
1	15,26	0,2442	0,7558	56,68	0,0643	0,9357
2	8,63	0,0000	1,0000	56,72	0,4871	0,5129
3	31,70	0,8497	0,1503	56,72	0,4610	0,5389
4	28,22	0,7217	0,2783	56,75	0,7079	0,2920
5	35,78	1,0000	0,0000	56,67	0,0036	0,9964
6	32,01	0,8613	0,1387	56,78	1,0000	0,0000
7	35,27	0,9813	0,0187	56,68	0,1054	0,8946
8	33,50	0,9161	0,0839	56,74	0,6528	0,3472
9	35,60	0,9935	0,0065	56,67	0,0000	1,0000
10	29,67	0,7752	0,2248	56,77	0,9515	0,0485
Max	**35,78**	**1,0000**	**1,0000**	**56,78**	**1,0000**	**1,0000**
Min	**8,63**	**0,0000**	**0,0000**	**56,67**	**0,0000**	**0,0000**

Table 4. Weighting Values Combination

Combination	Added Production	Vacuum Value
A	0,55	0,45
B	0,60	0,40
C	0,65	0,35
D	0,70	0,30
E	0,75	0,25

In order to reflect the importance for each experiment in grey relational analysis is determined corresponding weighting values of added production with vacuum value. After grey relational coefficient was calculated and defined with formula (3), they are substituted into formula (4) to calculate the the grey relational grade. In practice, the added electricity production is more desired, so the weighting values of added production was determined greater than vacuum value. Hence, to make this study more objective for each data characteristic, the combination weighting values listed in table 4.

According to table 3 and formula (3), the grey relational coefficient $Y\left(X_0^*(k), X_i^*(k)\right)$ of added production can be calculated as follows:

$$Y\left(X_0^*(1), X_i^*(1)\right) = \frac{0{,}000+0{,}5\times 1{,}000}{0{,}7558+0{,}5\times 1{,}000} = 0{,}3891$$

$$Y\left(X_0^*(2), X_i^*(2)\right) = \frac{0{,}000+0{,}5\times 1{,}000}{1{,}000+0{,}5\times 1{,}000} = 0{,}3333$$

Similar procedure is applied for experiment number 1-10 and for vacuum value. Table 5 shows the grey relational coefficient for all comparability values. Furthermore, using the weighting values

Table 5. The Grey Ralational Coefficient and Gray Relational Grade Combination

Grey Relational Coeff.		**Grey Relational Grade Combination**				
Added Production	*Vacuum Value*	*A*	*B*	*C*	*D*	*E*
0,3981	0,3483	0,3757	0,3782	0,3807	0,3832	0,3857
0,3333	0,4936	0,4055	0,3975	0,3894	0,3814	0,3734
0,7689	0,4812	0,6394	0,6538	0,6682	0,6826	0,6970
0,6424	0,6313	0,6374	0,6380	0,6385	0,6391	0,6396
1,0000	0,3341	0,7004	0,7337	0,7669	0,8002	0,8335
0,7828	1,0000	0,8806	0,8697	0,8588	0,8480	0,8371
0,9639	0,3585	0,6915	0,7218	0,7520	0,7823	0,8126
0,8564	0,5902	0,7366	0,7499	0,7632	0,7765	0,7898
0,9872	0,3333	0,6930	0,7257	0,7583	0,7910	0,8237
0,6899	0,9116	0,7897	0,7786	0,7675	0,7564	0,7453

presented in table 4 and formula (4), we can find that the grey relational grade of combination A are as follows:

$$r(X_A^*, X_1^*) = 0{,}55 \times 0{,}3981 + 0{,}45 \times 0{,}3483 = 0{,}3757$$

$$r(X_B^*, X_1^*) = 0{,}60 \times 0{,}3981 + 0{,}40 \times 0{,}3483 = 0{,}3782$$

Using the same procedure, the grey relational grade of all combination for i = 1-10 can also be obtained and shown in table 5.

Basically, the larger grey relational grade, the better corresponding multiple data characteristic. Accordingly, we select the combination that gives the largest response in each combination. From the response table for the grey relational grades shown in table 5, the best combination of additional start options is opening HP BOV first at 45 minutes. All the grey relational grade combination responses supported it. From the experiments, this option resulted 43,4 MW of added production and 690,0 mmHg of vacuum value in average. For the LP BOV option, the best combination showed in 5th experiment at 45 minutes too. This option resulted 63,3 MW and 681,8 mmHg. From this information, we can conclude that the optimum corresponding data based on added production and vacuum value is experiment at the 45 minutes. If the added production described performance of the combined cycle power plants and vacuum values described one of the critical criteria for their availability, so the optimum corresponding described that the maximum performance of the combined cycle power plant can reach with the best of its availability.

6. CONCLUSIONS

This paper presents an application of grey relational analysis for optimizing the options of additional start with the electricity production and condenser vacuum responses. The results are summarized as follows:

1) The grey relational analysis is proven to be capable of objectively compare both of options in opening BOV at additional start process with various weighting values combination.
2) The optimal options of opening BOV in additional start process reached at 45 minutes and the best option is opening HP BOV first. At that time, the experiment resulted 43,4 MW of added production and 690,0 mmHg of vacuum value in average.
3) The proposed algorithm greatly simplifies to compare and define the optimization of opening BOV options. Thus, the solutions from this method can be the new insight for practitioner and researcher to investigate an additional start process especially in opening BOV related to other critical risk criteria.

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DETERMINING FACTORS OF CONSUMER PURCHASE INTENTION ON THE MARKETPLACE IN THE COVID-19 PANDEMIC PERIOD: A CASE STUDY OF FROZEN FOOD PRODUCTS

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ABSTRACT

In the Covid-19 pandemic, the offline buying and selling activities of frozen food underwent changing due to the sales volume dropped for entrepreneurs. With the online marketplace, online buying and selling activities of frozen food can run in the current difficult situation. This study focuses on determining the determinants of consumers in the city of Jakarta on their interest in buying frozen food products on online marketplace such as the approach to credibility of Expertness, Trustworthiness, Objectivity, Homophily, Perceived Risk, and Information Adoption mediated by the Argument Quality, Information Usefulness and Purchase Intention. This research data was obtained through filling out questionnaires from online marketplace users who shop for frozen food products in the Tokopedia, Shopee, or Bukalapak. 194 data obtained from the online questionnaire were analyzed using the SEM (Structural Equation Modeling) method. From the results of the study, it is known that eight of the total nine variables that have a positive relationship between variables are Expertness, Trustworthiness, Objectivity, Perceived Risk, Argument Quality, Information Usefulness, Information Adoption, Purchase Intention and one of total of nine variables that are not proven to have a positive relationship between variable. variable, namely Homophily.

Keywords: Purchase Intention, Frozen Food, Online Marketplace, Structural Equation Modeling

1. INTRODUCTION

World Health Organization (WHO) declares that the spreading of covid-19 virus into all over the world is classified as a pandemic. Since then, the spreading of covid-19 virus occurs in all over the world especially in Indonesia. It is hard to stop for the virus develops increasingly and quickly since March 2020. The government has limited the public activity in order to decrease the spreading of Covid-19. The effect of the emergency public activity restrictions is the space of public activity limited tightly, application of work from home (WFH) for employees and enforcement of lockdown in some red zone areas is changing of public needs in Indonesia. This one influences their life style to consume. Consequently in pandemic area, it enables the public to increase their stuff like the processing food product from frozen food.

In general, frozen food has many choices in which all public elements love to consume like frozen food especially the fried and boiled ones- the ready eaten as well. The public loves to

consume frozen food as a public choice is caused by many choices and more durable because they can be food stock and the best price. Next, the frozen food can be bought online marketplace. In fact, the people consume frozen food reach 30% in Indonesia. The data showed that there was an increasing of consumers every year (Anggraini, 2010). Next it can be showed by the increasing of frozen food purchasing in platform online marketplace like Tokopedia, Shopee, dan Bukalapak. From the third of the online marketplaces have similarities on its feature like supplying column on review and consumer rating, inclusion of product description, and prices labelling as well, inclusion of picture or product video, customer service in online marketplace so that the purchasing of the product becomes creative. According to (Cheng & Zhou, 2010) that by enclosing eWOM, consumers can obtain the product information that is going to influence the willing to buy on an explanation in online marketplace.

In the Covid-19 pandemic, fulfilling the public consume needs in Indonesia become unbalance due to there is a changing of supply and demand in the Indonesia especially in Jakarta city. The business sector is the victims of the effect of pandemic Covid-19. The indicator was the decreasing of the online purchasing transaction. In fact, business sector can utilize the platform of online marketplace well in order supply and demand can run in the Covid-19 pandemic. The result of this research is expected to increase the horizon of entrepreneurs and open the business opportunities in pandemic Covid-19 era and the other hardest economic situation.

2. LITERATURE REVIEW

By using platform online marketplace can change the activity of purchasing and selling of frozen food, so that it can be the best choice in the pandemic era Covid-19. Online marketplace is an online shop by business model of marketplace concentrator in which the owners of online shop only as facilitators to focus on many kinds of information through product (Loudon, 2000). In this study, the researchers use 3 top online marketplaces like Tokopedia, Shopee, and Bukalapak.

In determining the determinant factors in the willing to buy the frozen food in online marketplace toward on the previous literature and developed by some existing theories. There are nine variable on this study namely variable Expertness, Trustworthiness, Objectivity, Homophily, Perceived Risk, Argument Quality, Information Usefulness, Information Adoption that are developed by (Hussain et al., 2017) and purchase intention that constitute the important factors in purchasing some foods by electronic system and the willing of purchasing consumers (Erkan & Evans, 2016). This study have nine hypothesis namely (H1) The Positive Relationship Expertness on Perceived Risk, (H2) The Positive Relationship Trustworthiness on Perceived Risk, (H3) The Positive Relationship Objectivity On Perceived Risk, (H4) The Positive Relationship Homophily on Perceived Risk, (H5) The Positive Relationship Perceived Risk on Argument Quality, (H6) The Positive Relationship Perceived Risk on Information Usefulness. (H7) The Positive Relationship Argument Quality on Information Adaption, (H8) The Positive Relationship Information Usefulness on Information Adaption, (H9) The Positive Relationship Information Adaption on Purchase Intention. The figure 1 of the research model is as follow:

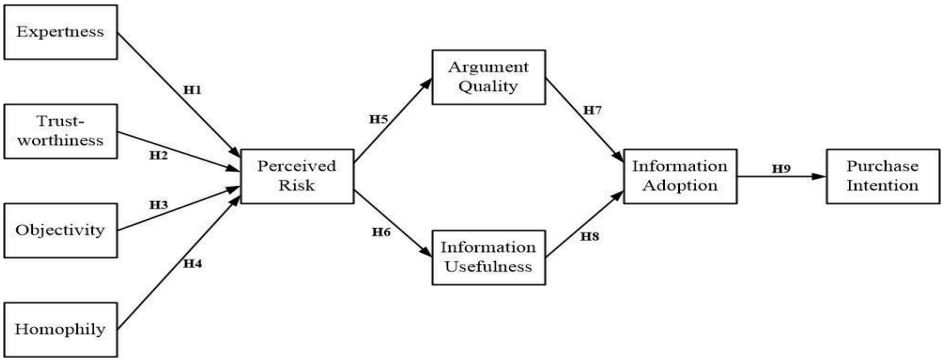

Figure 1. Research Framework

3. METHODS

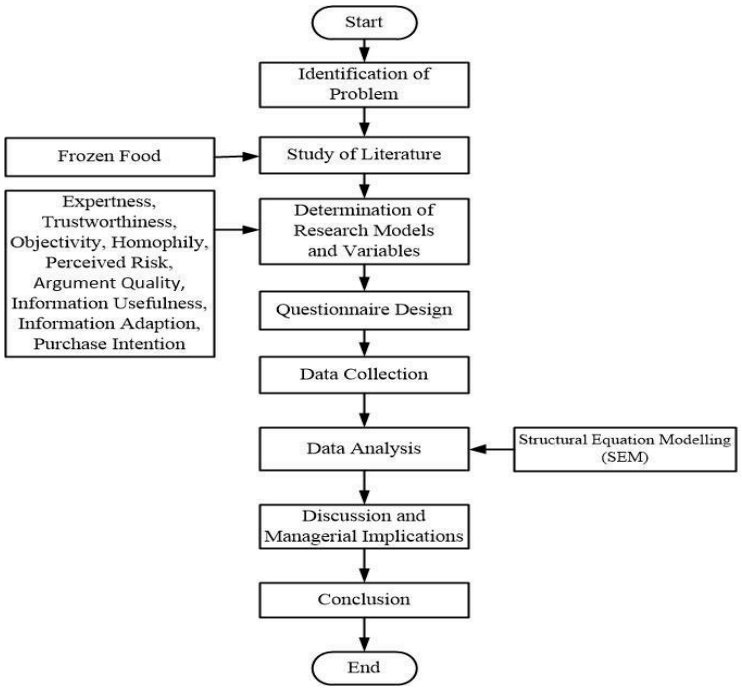

Figure 2. Research Flowchart

Figure 2 shows the outline of the research flowchart. The method used is questionnaire google form which consists of written questions in which the respondents have to answer (Malhotra, 2019). These ones were distributed by online in social media. Data collection technique was done by approaching non probability sampling, in which all selected respondents were selected by using purposive sampling. The selection of purposive sampling on this study was based on certain characters from respondent, such as 1) the public in Jakarta city area, 2) The respondent having an account online marketplace and ever purchased in frozen food, 3) The respondents who were ready to enclose their accounts number in online marketplace.

First step. Assessing the data on 30 respondents by using pilot test. The result of the test pilot data was stated reliable and valid, so that the main questionnaires can be spread to all respondents. There were 194 questionnaires done by a set of assumption assessment like Validity test, Construct reliability test, and model evaluation (Goodness of Fit). Next, questionnaires data

were analyzed by Structural Equation Modeling (SEM) method to find out the determiners factor in which the consumers' willing to buy frozen food in online marketplace during pandemic Covid-19. Structural Equation Modeling (SEM) aims at testing and analyzing the relationship patterns among the existing variables on a model (Hair, 2008).

4. RESULTS

Survey sample represents many kinds of characteristic. Table 1 showed the category of respondent demographic characteristics. All surveys for respondents were taken from the public which have accounts online marketplace, purchasing experiences of frozen food in 10 the last months, and being ready to enclose their own account marketplace.

Table 1. Demographic Respondent

Characteristic	Percentage (%)
Domicile	
South Jakarta	39.7
North Jakarta	9.1
East Jakarta	12
Central Jakarta	16.7
West Jakarta	22.5
Gender	
Female	67.9
Male	32.1
Age Range	
< 18 years	14.8
18 – 43 years	63.2
> 43 years	22
The ownership of account online marketplace	
Yes	98.1
No	1.9

Characteristic	Percentage (%)
Purchasing of frozen food in 10 the last months	
Yes	96.2
No	3.8
Enclosing account in online marketplace	
Yes	92.8
No	7.2
Online Marketplace	
Shopee	39.2
Tokopedia	52.6
Bukalapak	8.2
Frequency of purchasing frozen food	
A month isn't more than once	40.2
A Month is more than once	59.8
Frozen Food	
Fried (otak-otak, nugget)	45.4
Steamed (dimsum)	35.1
Boiled (bakso, beef slice)	12.9
Ready to eat (sosis kenzler)	6.7

On this study is followed up by testing classic assumption. The result of data test on classic assumption as follows:

1. Validity Test and Construct Reliability Test

Validity Test and Construct Reliability Test use the data processing result by using Amos Graphics. Each indicator taken from the questionnaires have score of standardized loading factor in which the results were taken from the result of Amos Output on Table standardized regression weight. Minimum scores on convergent Validity used was the result of scores factor loading being on the above of minimum score 0,5, Average Variance Extracted (AVE) was the above of minimum score 0,5, Cronbach's Alpha was the above of minimum score 0.6 and Construct Reliability (CR) was the above of minimum score 0,6 (Ghozali, 2006; Ismail, 2017; Malhotra, N.

K., & Birks, 2007). Table 2 shows the result of validity test processing and reliability test by using program Amos Graphics as follows:

Table 2. Convergent Validity and Reliability

Variable	Loading Factor	Loading Factor^2	Error	CR	Cronbach's Alpha	AVE
Expertness						
EX1	0.841	0.707	0.159	0.814	0.870	0.754
EX2	0.793	0.629	0.207			
EX3	0.699	0.489	0.301			
EX4	0.841	0.707	0.159			
Trust-worthiness						
TW1	0.762	0.581	0.238	0.813	0.871	0.754
TW2	0.728	0.530	0.272			
TW3	0.854	0.729	0.146			
TW4	0.831	0.691	0.169			
Objectivity						
OB1	0.900	0.810	0.100	0.783	0.841	0.766
OB2	0.813	0.661	0.187			
OB2	0.691	0.477	0.309			
Homophily						
HO1	0.797	0.635	0.203	0.787	0.855	0.729
HO2	0.695	0.483	0.305			
HO3	0.809	0.654	0.191			
HO4	0.802	0.643	0.198			
Perceived Risk						
PR1	0.782	0.612	0.218	0.863	0.892	0.839
PR2	0.892	0.796	0.108			
PR3	0.901	0.812	0.099			
Argument Quality						
AG1	0.769	0.591	0.231	0.837	0.897	0.688
AG2	0.914	0.835	0.086			
AG3	0.777	0.604	0.223			
AG4	0.772	0.596	0.228			
AG5	0.781	0.610	0.219			
AG6	0.572	0.327	0.428			
AG7	0.624	0.389	0.376			
Information Usefulness						
IU1	0.855	0.731	0.145	0.829	0.871	0.809
IU2	0.808	0.653	0.192			
IU3	0.843	0.711	0.157			
Information Adaption						
IA1	0.903	0.815	0.097	0.824	0.861	0.852
IA2	0.834	0.696	0.166			
Purchase Intention						
PI1	0.679	0.707	0.159	0.699	0.800	0.653
PI2	0.829	0.629	0.207			

Variable	Loading Factor	Loading Factor^2	Error	CR	Cronbach's Alpha	AVE
PI3	0.752	0.489	0.301			
PI4	0.623	0.707	0.159			

On table 3 shows that all indicators from each variable have fulfilled the minimum limit of convergent validity and it is not necessary to decrease variable so that it can be continued to analyze SEM.

2. Evaluation Model (Goodness of Fit)

Evaluation model aims at ensuring the compatibility model with the whole data. The processing of the whole data result uses Confirmatory Factor Analysis (CFA) test in which the validity and reliability from the laten construct were tested and compared with the criteria of Goodness-of-Fit (GOF) (Latan & Ramli, 2013).

Evaluation model would be compared with the result of Goodness-of-Fit (GOF) with the score cut-off. Score GOF was obtained with Confirmatory Factor Analysis (CFA) by using program Amos Graphics and score range of cut-off were arranged based on the previous study by (Haryono & Wardoyo, 2012). The result of evaluation model presented on table 3.

Table 3. Evaluation Model with Goodness-of-Fit

Type of GOF	Score *Cut-off*	Result	Status
Absolute Fit Indices			
Chi Square	C	0	Not Valid
GFI	≥ 0,7	0.810	Valid
AGFI	≥ 0,7	0.782	Valid
RMR	≤ 0,1	0.056	Valid
RMSEA	< 0,1	0.054	Valid
Parsimony Fit Indices			
PNFI	0,60 - 0,90	0.741	Valid
PGFI	0,50 - 1,00	0.705	Valid
Incremental Fit Indices			
NNFI	≥ 0,7	0.803	Valid
CFI	≥ 0,7	0.918	Valid
IFI	≥ 0,7	0.911	Valid

On table 3 shows that each parameter of GOF has fulfilled score cut-off (valid) so that it was not necessary for re-specification model and analysis can be continued to analyze SEM. The model can be said fit if it can fulfill Goodness-of-Fit (GOF) minimal 5 indicators.

3. Analysis on Structural Equation Modeling (SEM)

In testing hypothesis, this study used analysis Structural Equation Modelling (SEM). On testing analysis Structural Equation Modelling (SEM), the relationship among variable had significant value or not significant through P-value. If P-value, the score was smaller than 0.05, so the result was significant. While to know the relationship among positive variable or not positive through value β (standardized coefficient). If β has a positive score, so it showed the positive relationship among variable. Path Coefficients was helped by a program of Amos Graphics with reliability level 95%, and significancy 5%. The figure 3 shows the positive relationship among variables and hypothesis answer.

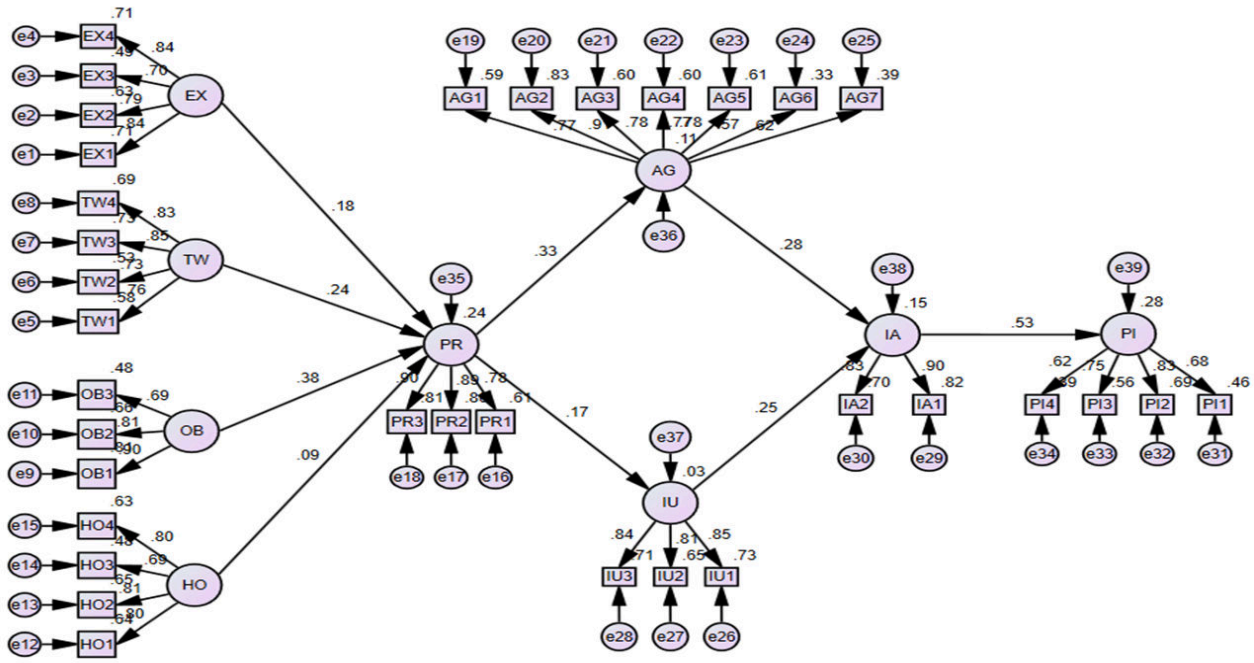

Figure 3. Path Coefficient

The result of testing on proposed hypothesis in this study model concisely was shown by the table 4.

Table 4. Hypothesis Test Result

Hypothesis	β	P-value	Status
H1 Expertness → Perceived Risk	0.139	0.018	**Significant**
H2 Trustworthiness → Perceived Risk	0.260	0.002	**Significant**
H3 Objectivity → Perceived Risk	0.317	***	**Significant**
H4 Homophily → Perceived Risk	0.082	0.250	**not Significant**
H5 Perceived Risk → Argument Quality	0.332	***	**Significant**
H6 Perceived Risk → Information Usefulness	0.227	0.042	**Significant**
H7 Argument Quality → Information Adaption	0.293	***	**Significant**
H8 Information Usefulness → Information Adaption	0.192	0.002	**Significant**
H9 Information Adaption → Purchase Intention	0.566	***	**Significant**

Expertness has positive effect and significant on Perceived Risk due to p-value 0,018 and β (standardized coefficient) amount 0.139. Source Credibility was receiver perception depending on information sources attribute by receiver (Petty & Cacioppo, 1986). This result is suitable with the

previous study showing that Expertness has positive effect on Perceived Risk (Hussain et al., 2017) so that Hypothesis 1 was accepted. This finding shows that the information obtained by the consumers and the consumers frozen food purchasing experiences have positive effect on the willing of them to buy in pandemic Covid-19.

Trustworthiness has positive effect and significant on Perceived Risk because p-value amount 0,002 and β amount 0.260, so that the Hypothesis 2 was accepted. On the previous study Trustworthiness has positive effect on Perceived Risk (Hussain et al., 2017). The result of this study showed that consumers tended to have "trust" to read the review contained in online marketplace before they bought the frozen food product.

Objectivity has the positive affect and significant on Perceived Risk because p-value *** and β amount 0.317 so that Hypothesis 3 was accepted. On the previous study, Objectivity has positive effect on Perceived Risk (Hussain et al., 2017). On this study showed that if there was disaster and labors strike, so it can influence the quality of frozen food product.

Homophily has positive effect and not significant on Perceived Risk because p-value 0,250 and β amount 0.082 so that the hypothesis was rejected. On the previous study, Homophily has an unsignificant effect on Perceived Risk (Hussain et al., 2017). On this study showed that Homophily did not have on consumers' willing to buy the frozen food product online marketplace since the public did not pay any attention on the same their age, grouped in the same sex and having the similarity on a part of consumers review among of them.

Perceived Risk has positive effect and significant on Argument Quality because p-value *** and β amount 0.332 so that the hypothesis 5 was accepted. The consumers considered getting the information useful when the argument quality during product purchasing and depending on product category (Cheung et al., 2008; Sussman & Siegal, 2003). On the previous study, Perceived Risk has significant effect on Argument Quality (Hussain et al., 2017). On this study, Perceived Risk has a significant effect on Argument Quality. This one showed that Argument Quality can influence the willing of consumers to read the product review and description because it can influence the willing of the consumers to buy frozen food product.

Perceived Risk has the positive effect and significant on Information Usefulness because p-value 0,042 and β amount 0.227 so that the Hypothesis 6 was accepted. On the previous study, Perceived Risk has an significant effect on Information Usefulness (Hussain et al., 2017). This one proved that the information being perceived by the consumers can decrease the risk and Information Usefulness became the important factor for an information because reviewers sought the information which enable the customers to decrease the risk (Cheung et al., 2008). On this study, the customers sought the information from the review, so that enable them to decrease the risk.

Argument Quality has the positive effect and significant on Information Adoption since p-value *** and β amount 0.293 so that the Hypothesis 7 was accepted. This result was obtained from the previous study that argument quality an significant effect on Information adoption for consumers to be involved in the review and make a decision (Cheung et al., 2008). The consumers tended to be involved in any information when the information of the frozen food product in online marketplace beneficial and can be adopted.

Information Usefulness has the positive effect and significant on Information Adaption since p-value 0,002 and β amount 0.192, so that hypothesis 8 was accepted. The result of this study was suitable with the previous study that consumers were sure that the information can be beneficial when an review and rating can influence the attention and the attitude of individual which were directed centrally (Cheung et al., 2008)

Information Adaption has the positive effect and significant on Purchase Intention because p-value *** and β amount 0.566 so that the hypothesis 9 was accepted. The result of this study was suitable with the previous study that Information Adaption has the positive effect and significant on Purchase Intention (Erkan & Evans, 2016). This one showed that the consumers can adopt the product information of frozen food with the review from the online marketplace and could influence the willing of purchasing on the pandemic covid-19 like nowadays.

4. Implication Of Business

Next, the result of questionnaires was analyzed from the operational of business attitude in order to improve the selling of frozen food like installing product photo completed by the beneficial description of frozen food product in order to be interesting for consumers visually to compare the price among competitors in order to the set price can be achieved by all level of public. Being active to keep the consumers loyalty and improve the costumers' response from the point of view of customer service and answer each review which was given by costumers to make the positive impression for customers become a priority need. On this occasion, the entrepreneur can build the public trust to be competitive to follow the trend of selling in the pandemic covid-19 so that the creativity improves significantly in a mutual beneficial online marketplace.

5. CONCLUSIONS

Based on the analysis and study result above, the determiner factors effect on the costumers' willing on purchasing frozen food product especially public in Jakarta, the capital of Indonesia online marketplace in pandemic period of Covid-19 was Expertness, Trustworthiness, Objectivity, Perceived Risk, Argument Quality, Information Usefulness, Information Adaption and Purchase Intention have the significant relationship effect, but Homophily did not have the significant relationship effect because the public did not have any attention on their ages, grouped of sex type and did not have the similarity on the part of review among of the costumers.

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ANALYSIS OF THE EFFECT OF VARIABLE PERCEIVED VALUE AND PERCEIVED RISK ON ADOPTION TECHNOLOGY BIG DATA ON MSMEs

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ABSTRACT

MSMEs in Indonesia face many obstacles in optimizing their performance. Whereas MSMEs play an important role in improving the national economy. Some of the main obstacles faced by business actors are limited capital and operations. Therefore, the role of technology is very important in helping MSMEs to overcome these obstacles. Big data technology has uses that are needed by business actors in solving problems, especially in making decisions to create strategic steps and improve their performance. However, this technology has not been fully implemented in MSMEs in Indonesia. Thus, this study aims to measure the effect of value and risk perceived by business actors on the adoption of big data technology before this technology is used. This research method uses a partial least square approach and the research sample is 122 business actors in the Surabaya area through purposive random sampling. Thus, the results of this study indicate that the perceived variable has a significant influence on the adoption of big data technology compared to the variable perceived risk.

Keywords: Keywords: MSME, Technology, Big Data, Value, risk

1. INTRODUCTION

The COVID-19 pandemic has had a significant impact on the development of the entire MSME sector in Indonesia. Many problems faced by MSMEs in Indonesia have hampered the COVID-19 pandemic, such as: hampered distribution, decreased production and limited capital (Septya, 2022). In addition, the performance of MSMEs in Indonesia has decreased due to limited access to capital, because business actors' knowledge of financial literacy is very limited (Djuwita & Yusuf, 2018).

However, as many as 80% of MSMEs in Indonesia can survive the impact of the pandemic by adapting to digital technology. Most business actors use the marketplace platform to market their products (Smesco, 2022). Therefore, the government hopes that around 30 million MSMEs in Indonesia can dominate the digital world by 2024.

The role of digital technology in MSMEs provides significant benefits, namely expanding the target market, work effectiveness, increasing business opportunities and expanding employment opportunities. In addition, the opportunity to increase sales by 80% and products to be more innovative, as well as international market access is getting bigger (Yudistira, 2019).

Meanwhile, the use of digital technology coincides with the current era of Big Data. More and more people are using digital technology which is marked by the high use of the internet in Indonesia. However, the government is trying to encourage MSME actors to gain literacy in the use of digital technology and data science assistance for their business. In addition, the role of data science in MSMEs will provide benefits and opportunities for MSMEs in Indonesia in increasing their competitiveness (Sadikin, 2021).

Then, the role of this technology makes it easy for business actors to be open to digital financial literacy which is useful for making good financial records and records (Supit, 2021), making it easier for MSMEs to access capital loans in financial institutions. Therefore, this study aims to determine the effect of perceived value and perceived risk in influencing the adoption of big data technology on SMEs in the city of Surabaya..

2. LITERATURE REVIEW

Technology Big Data

Big Data is a large collection of data that is managed by a software that functions to manage, store, analyze data (Manyika, 2011). In addition, big data technology as Big Data Analytic (BDA) is an expression of a very complex, unorganized data set that is stored and managed by certain methods into an application form that is useful in decision making in business processes (Ularu et al., 2012). Big data analytics has the benefit of managing data with a method approach that is very useful for companies in dealing with obstacles in data management, which have an impact on business profits (Ularu, 2012) (Gandomi, 2015).

Perceived Value

Perceived value is the value felt by individuals on the expected benefits of a product (Zhu, 2010). Perceptions experienced by individuals on what has been given and received by the use of a product as a whole (Zeithaml, 1988)

Perceived Risk

Perceived Risk is a view related to the risk of a product that is perceived by individuals. In addition, risk is a doubt and uncertainty experienced by an individual regarding the use of a product (Tan, 2016). Thus, it causes anxiety and concern about the use of a product and reduces the desire to adopt a product or technology (Kumar, 2012). Therefore, every new technology that will be introduced to users must predict the risks that will occur related to financial problems (Soon, Lee, & Boursier, 2016).

3. METHODS

This research methodology begins with a study of literature related to the Influence of Perceived Value and Perceived Risk Variables on Big Data Technology Adoption in MSMEs. Then, the formulation of state of the art research is to produce a research model consisting of perceived value, risk and big data adoption variables. Then, operationalize research variables to produce a number of question items, and determine research hypotheses consisting of 2 (two) research

hypotheses. Furthermore, the process of collecting data using a purposive sampling approach and processing research data using a partial least squares approach. Finally, data analysis consists of demographic analysis and research hypotheses. The unit of analysis for this research is SMEs in the city of Surabaya who have used the marketplace for marketing their products/services.

Meanwhile, the data collected was obtained through distributing questionnaires to respondents (business actors) in the city of Surabaya as many as 122 business actors. The research questionnaire relates to the demographic data of the respondents and research variables consisting of perceived value, risk and big data adoption. Each question on the questionnaire was measured using a Likert scale approach from a value of "1" (strongly disagree) to "5" (strongly agree).

The research uses several research variables, including: perceived risk, perceived value and big data adoption. All research variables are arranged into 2 (two) research hypotheses, as follows:

H1 : Is the Perceived Value Variable significant to Big Data Adoption?
H2 : Is Perceived Risk Significant to Big Data Adoption?

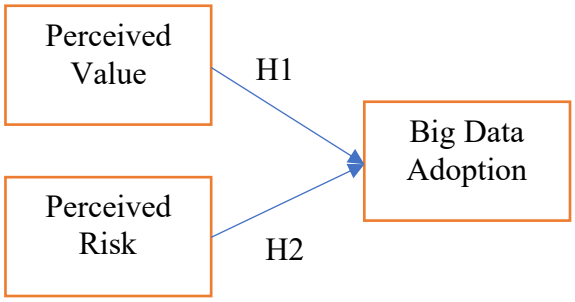

Fig 1. Research Model

The research data was processed using SPSS 23.0 to test the validity and reliability of each question item in the questionnaire. Then, the research data were analyzed using the PLS (partial least square) approach with SMART PLS to produce a research hypothesis test. All items in the questionnaire were measured for reliability using Cronbach's alpha coefficient and composite reliability (CR) at levels of 0.858, 0.768 and 0921. Meanwhile, composite reliability (CR) was 0.6 and still acceptable for exploratory research and the mean-variance rate (AVE) extracted and item loading was more than 0.50 (Hair, 2008). Furthermore, the test results are accepted if the significance value = 5% with a statistical value greater than 2.0.

Table 1. Measurement model

Constructs	CR	Cronbach's alpha	AVE
BDA	**0,6**	0,858	**0,611**
PR	**0,6**	0,768	**0,603**
PV	**0,6**	0,921	**0,6319**

4. RESULTS

The sample of this study consisted of 122 MSME actors in the city of Surabaya consisting of several sectors, including: culinary (36.1%), fashion (24.6%), automotive (6.6%), service (24.6%), furniture (2.5%), agriculture (2.5%), electronics (3.3%). Most of the business actors in the city of Surabaya are engaged in culinary, fashion and service. This shows that the majority of digital technology users are in this sector.

Table 2. Business Fields in SMEs

Business Fields	**Freq**	**%**
Culinary	44	36,1
Fashion	30	24,6
Automotive	8	6,6
Service	30	24,6
Furniture	3	2,5
Agriculture	3	2,5
Electronics	4	3,3
	122	100,0

Based on the results of data processing, the results of the research hypothesis test were determined from the t-statistic value.

H1 : Is the Perceived Value Variable significant to Big Data Adoption?

The results of the first hypothesis test resulted in a t value of 12.755. This shows that the perceived value variable is of significance to the big data adoption variable. The advantages of big data technology can be felt by users through factors of security, convenience, and efficiency, thus influencing users to adopt the technology (Shin, 2016) (Kwon, 2014).

H2 : Is Perceived Risk Significant to Big Data Adoption?

The results of the second hypothesis test produce a significance value with a t value of 0.869. This shows that the perceived risk variable is not significant to the big data adoption variable. Perceptions about the risks of using big data technology by users, raise doubts caused by user's lack of understanding in using this technology. This resulted in something unexpected and dissatisfaction with this technology (Maroufkhani, Khairuzzaman Wan Ismail, & Ghobakhloo, 2020). Some users are worried about involving big data technology on corporate privacy data, related to the management and storage of data on this technology (Priyadarshinee, 2017).

Table 3. Structural model

Path			***(t)***	**Comments**
PER	->	BDA	0.869	Not Supported
PV	->	BDA	12.755	Supported

6. CONCLUSIONS

Most business actors are engaged in the culinary, fashion and service sectors. This proves that the sector is already using digital technology in marketing its products. However, the use of big data technology has not been implemented in MSMEs in Indonesia. This study tries to predict the effect of perceived value and perceived risk variables on the desire of business actors to adopt big data technology. However, based on the results of this study, it shows that the perceived value variable has a significance for the big data adoption variable with a t value (12,755). Meanwhile, the perceived risk variable shows results that are not significant with the t value (0.869). Thus, the value of benefits and uses offered by big data technology can actually influence business actors to adopt this technology in the future. However, the perception of business actors on the risks that occur in big data technology raises doubts about adopting big data technology. Therefore, business actors must be given the right education in recognizing the benefits of big data technology in supporting their business.

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FORMULATION OF MARITIME SATELLITE TELECOMMUNICATIONS STRATEGY USING THE DELPHI TECHNIQUES AND ANP

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ABSTRACT

The maritime satellite telecommunications industry is currently facing enormous challenges due to the Covid-19 pandemic and the change in trend in the satellite industry from geostationary satellites to low earth orbit that has changed the landscape of the world. maritime satellite telecommunications industry. It is increasingly forcing players in the maritime satellite telecommunications industry to adapt and determine new strategies to maintain their existence during the new normal era. PT. Telkom Satellite Indonesia is the largest satellite telecommunications company in Indonesia with a vision by 2025 to become number 3 in Asia. The maritime satellite telecommunications segment is currently one of the biggest contributors of revenue and is expected to be able to restore the performance and image of the company to survive, recover and grow.

The research aims to formulate the strategies of the company that has the potential to realize its objectives and vision, in particular by identifying the internal and external factors of the maritime business sector and formulating strategies using David's model. David's strategy formulation framework, namely, the entry stage, the matching stage, and the decision stage. The Analytic network process (ANP) is used to determine the weight of internal and external factors. The Balanced Score Card is used to create an implementation strategy and monitor the implementation of the formulation that has been made.

Keywords: Strategic management model David, Analytic Network Process (ANP), Delphi Technique

1. INTRODUCTION

The Covid-19 pandemic has caused affected countries to take precautionary measures to contain the virus, some of the measures implemented included the imposition of full lockdowns, partial lockdowns, and movement control orders. These measures are not economically favorable. Data from the Ministry of Finance of the Republic of Indonesia, as shown in Figure 1, shows that the COVID-19 pandemic has had a significant impact on the sectoral performance of the national economy. The maritime industry, which accounts for the market share of maritime satellite telecommunications, has also suffered a considerable impact. Sectors that have been heavily affected include business groups linked to maritime activities, such as the passenger and freight transport services sector, fishing, as well as tourism, and warehousing. Figure 2 concrete evidence that covid-19 affects the revenue performance of PT. Telkom Satellite Indonesia (Telkomsat), is a telecommunications company whose business is engaged in maritime telecommunications. There was a decrease in revenue of 35 percent compared to the previous year in the achievement of the

same period. The decrease in the company's internal revenue was also due to the impact of the merger of 3 Telkom Group entities including Patrakom which was later merged into a single merged entity i.e. Telkomsat so a strategy was needed to rebuild the company's portfolio. In addition, some domestic competitors have started to enter the maritime telecommunications business.

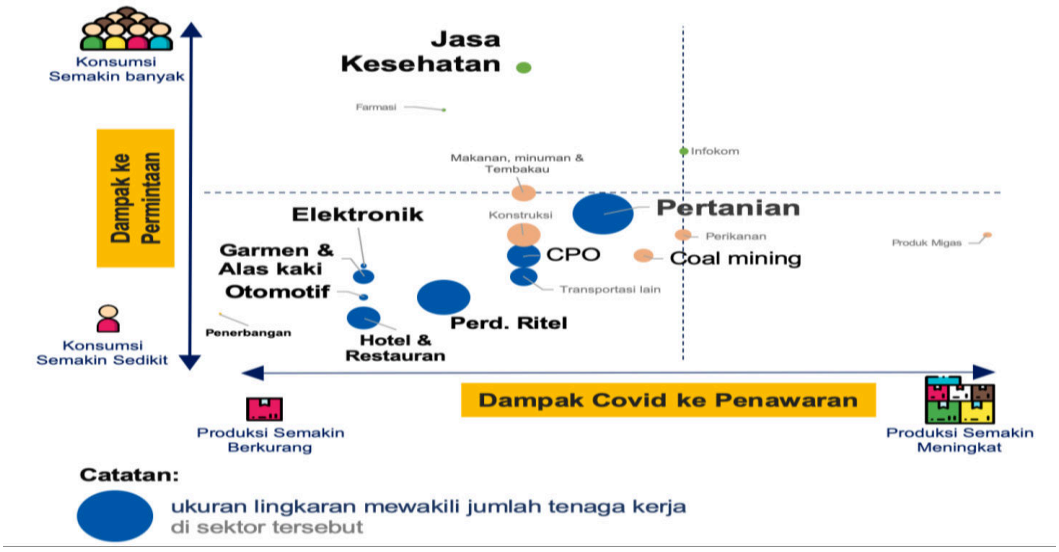

Figure 1. The impact of Covid-19 on supply and demand in various industrial sectors in Indonesia (Ministry of Finance of the Republic of Indonesia, 2020)

On the external side, data from the Northern Sky Research Institute 2019 are shown in Figure 1.3. shows an opportunity based on Compound Annual Growth Rate (CAGR) data for the Maritime Satellite Communications industry through 2028, showing a 7.8% increase with the addition of 76,000 vessels. This causes Telkomsat. Therefore, companies need to be more observant to see internal strengths and take advantage of existing external conditions. All the capacities and resources held by the company must be mobilized and demanded to be more creative and competitive with the existing competition. To meet customers' demands and outperform competitors.

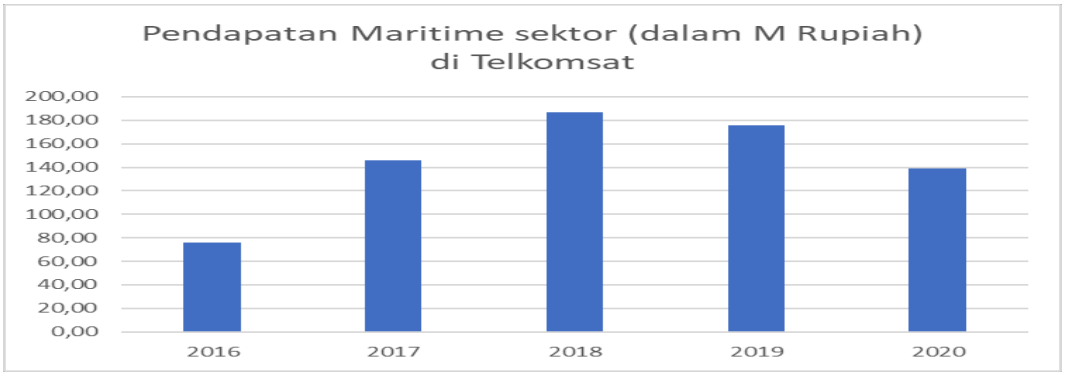

Figure 2. Performance of maritime segment revenue 2016 – 2020 (Telkomsat 2020 Annual Report)

An indicator of a company's success in improving its performance is how well it can formulate a strategy amid existing conditions. Companies must be able to adapt to trends to continue to be able to survive and be sustainable (Padash & Ghatari, 2020). In this case, a strategy formulation method is needed that can be used to help companies formulate strategies in the maritime telecommunications sector. Strategy Formulation with the David Model (2017) is a comprehensive, integrated, implemented, and cross-functional assessment model that enables the organization to achieve its goals. Before strategy formulation with David's model. According to David & David (2017), there are 3 stages in strategy formulation, namely the entry stage, the matching stage, and the decision stage.

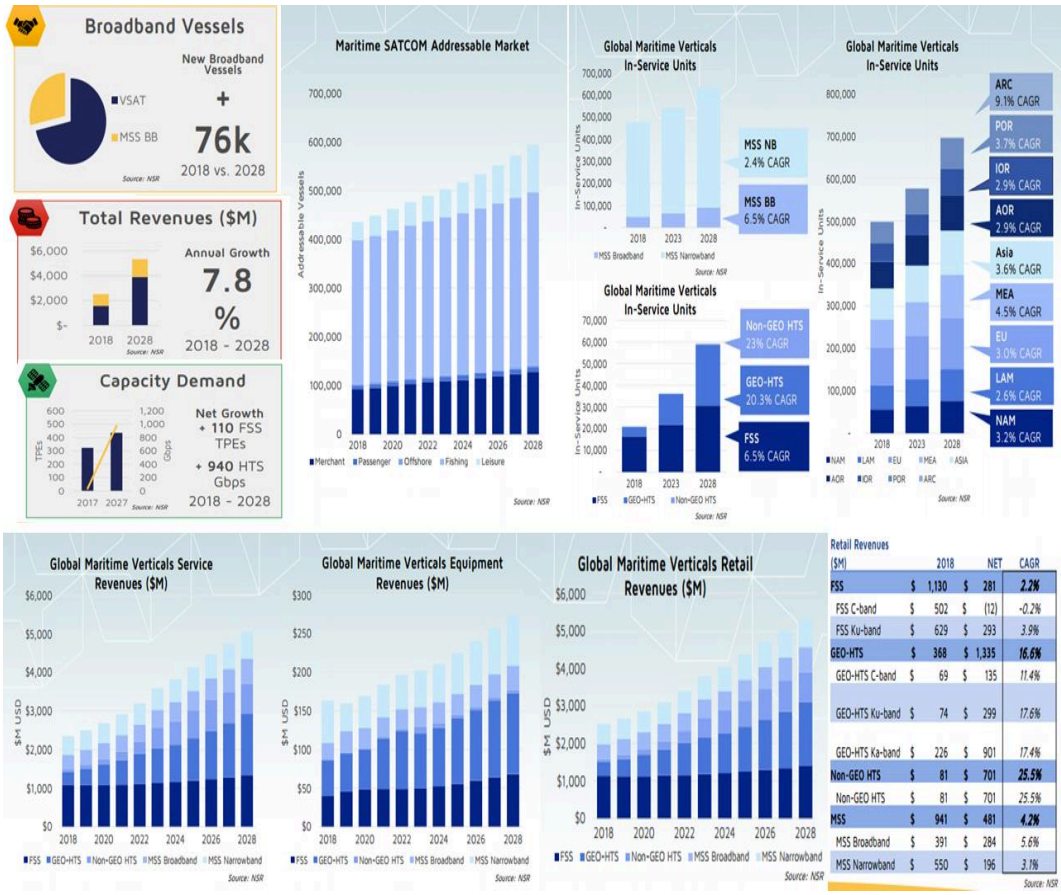

Figure 3. Growth Analysis of the maritime telecommunications sector 2018 – 2028 (Northern Sky Research 2019)

The input stage is the first stage made with BMC, IFE, EFE, CPM. To determine the value of each component of IFE, EFE, and CPM, the Delphi technique and Analytical Network Process (ANP) methods were used. When entering the matching phase, the company tries to use several existing tools such as SWOT matrix, BCG matrix, IE matrix to SPACE matrix (David & David, 2017). Some of these tools are used to help businesses match data at the entry stage. Once the matching step has been completed, the company then chooses from the data and information available to it. Here, the decision step uses the Quantitative Strategic Planning Matrix (QSPM) from the mapped choice strategies. According to Hosseini & Milani (2012) using the QSP matrix, it is hoped that the strategic priorities that will be driven by the company will emerge. After that, it turned out that it was the strategic implications of the initiative that became a recommendation for

the company. Based on the above, the authors focus on finding management strategies using the Delphi technique and Analytical Network Process (ANP) formulations to improve business performance in the maritime satellite telecommunications sector.

Based on the above background, it is known that the shipping world is one of the businesses that has been hit hard by COVID-9 and PT. Telkomsat, which is one of its business units for maritime satellite telecommunications services, also saw a decline in revenue. On the other hand, external analysis indicates that post-covid-19 maritime satellite telecommunications services also have room to grow. Therefore, the issues to be analyzed while writing the thesis are:

1. How to identify the most significant internal and external factors to PT Telkomsat that affect the Maritime Satellite Communications industry business?
2. How to formulate the PT management strategy. Telkomsat in the maritime telecommunications sector?
3. Recommendations of business strategies that will be used by PT Telkomsat during the new normal period after the covid-19 pandemic to increase revenue performance and corporate image, especially in the shipping line based on this analysis?

2. LITERATURE REVIEW

According to David & David (2017), important strategy formulation techniques can be integrated into a three-stage decision-making framework: entry stage, matching stage, decision stage.

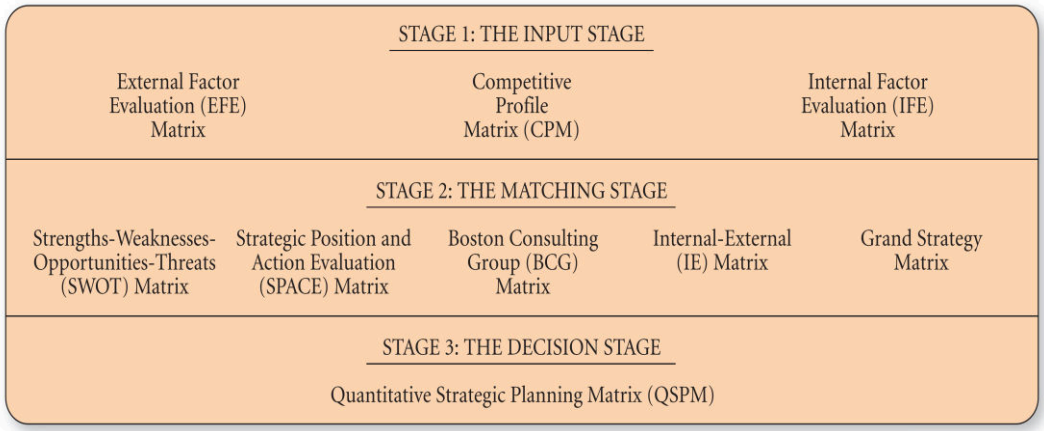

Figure 4. strategy formulation techniques (David & David, 2017)

The Delphi method, according to Kalanaki (2013), the stages of implementing the Delphi technique are carried out with three rounds for each questionnaire, including:

1. In the first round, questionnaire questions were distributed to experts like a brainstorming where all the answers are collected and will be listed again as the second round of questions.
2. The second round, the results of the answers in the first round are listed and used as the second round questions. the result of the answer in the second round is in the list and if there is a result that no one chooses, then the answer is omitted in the third round question
3. In the third round, the answers in the second round are listed and used as the third round questions. The answers collected are analyzed again, if there are less than three votes for the results during these three rounds, it will be omitted from the final answer results.

According to Büyüközkan (2016) and Kheybari (2020), how to make decisions using the Analytic Network Process (ANP) can be simplified into the following steps:

Stage 1: Building the model, transforming the problem into a network structure as shown in Figure 3, making a pairwise comparative survey

Stage 2: Determine the relative weights of each criterion and create a pairwise comparison matrix.

Stage 3: Calculate the Eigenvalues and Eigenvectors from the comparison matrix from step 2

Stage 4: Check consistency test: Consistency index (C.I) and consistency ratio (C.R) are used to estimate the consistency of pairwise comparisons

Stage 5: Creating a super-matrix

Stage 6: Creating a super-matrix weight

Stage 7: Creating super-matrix limiting

Stage 8: Obtain criteria and sub-criteria weight

3. METHODS

This research method is carried out with a strategic management approach referring to the David model with the Delphi technique to determine the external factors, the internal factors, the profiles of competitors. A quantitative approach with ANP (Analytical Network Process) is used to determine the weight of internal factors, external factors, and the Competitive Profile Matrix (CPM). The research flowchart is summarized in Figure 4:

The data collected in this study are the opinions of five experts who meet the following requirements:

For the internal company:

1. Work in a company specializing in maritime telecommunications.
2. Minimum of 10 years of experience in the field of maritime telecommunications.

Regarding external companies:

1. Experience in the use of maritime satellite communication services for at least 7 years.
2. Minimum of 5 years experience in the use of maritime satellite communications services.

The five experts were chosen to represent all stakeholders in determining the assessment of SWOT factors in maritime telecommunications companies. Step 1.2 Focus Group Discussion (FGD) is carried out by these experts to verify determine the evaluation of the external factors (EFE), the evaluation of the internal factors (IFE) and it will be used in ANP stages.

The data processing method uses the ANP method using super decision software. The process of determining the values of EFE, IFE, and CPM which was obtained from the data collection process using the ANP method, with the ANP method, it is expected that the selected EFE, IFE, and CPM factors and weights are detected correctly, as they also take into account the relationship between the factors. EFE, IFE, and CPM factors.

EFE, EFE, and CPM results that have been weighted for each factor along with secondary data that has been collected is then taken into account in formulating the strategy of David's (2017) model. First, a table of EFE, EFE, and CPM is created, which has been assigned a weight for each factor, where all three are part of the input stage. After that, it is formulated for strategy determination with matching steps using SWOT Matrix, IE Matrix, BCG Matrix analysis so that it can produce useful informative presentations for the business. Further processing is done using the quantitative strategic planning matrix (QSPM) must be a strategic choice to be taken by the company.

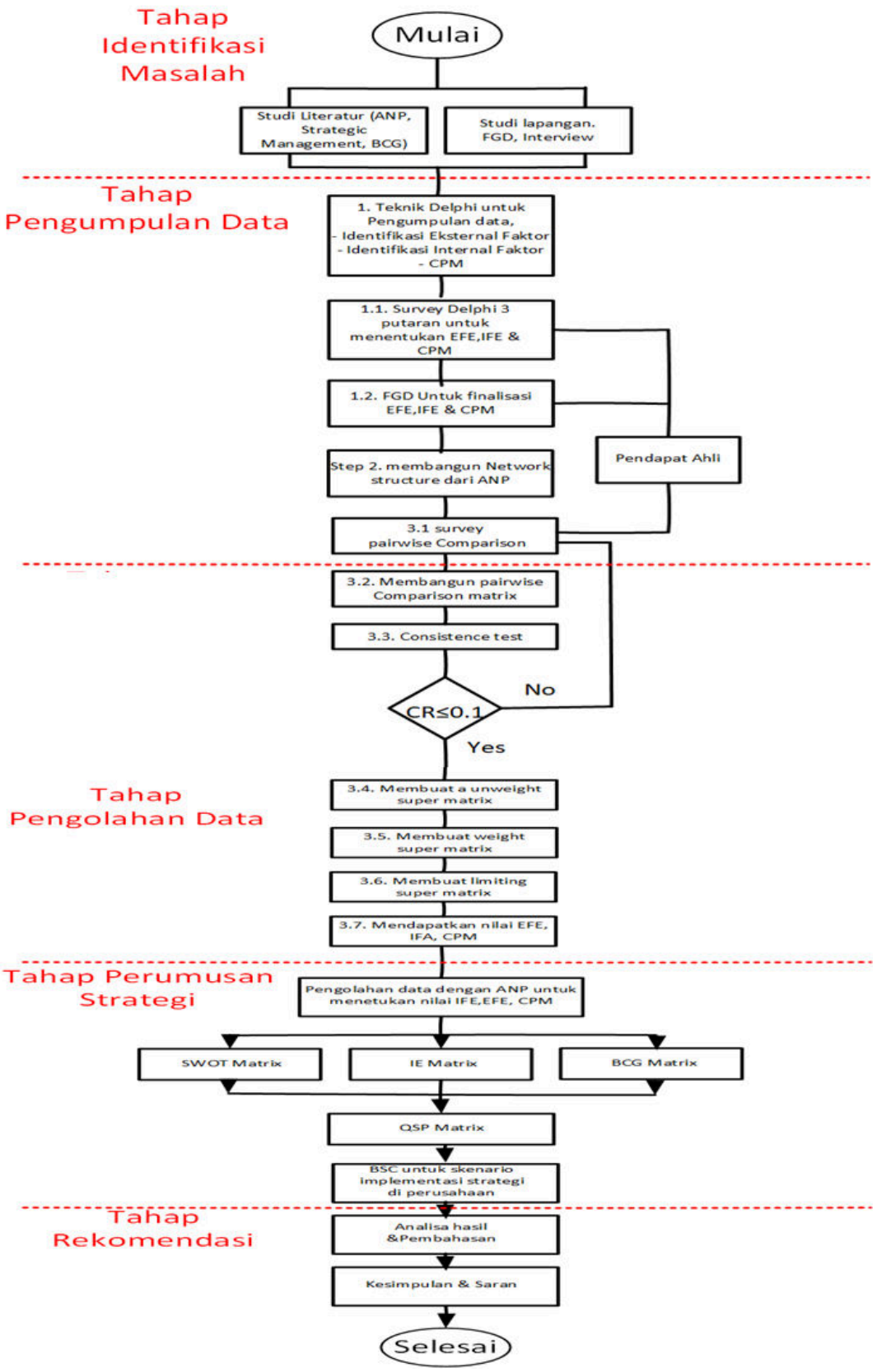

Figure 5. The proposed research flowchart

4. RESULTS

Delphi Technique uses 3 rounds, the first round accommodates all the answers to all the criteria and sub-criteria written by, and this final answer is verified by a team of experts through a Focus Group Discussion (FGD) of these experts. the final results of IFE (Strength & Weakness) and IFE are obtained:

- IFE (Strength) factors, namely: 1. Telkomsat is a subsidiary of PT. TELKOM, 2. Market leader in maritime services in Indonesia, 3. Strong brand image, 4. Has 2 satellites namely Telkom-3S and MP-Satellite as well as rental satellites which can reach all parts of Indonesia even as far as ASEAN and South Asia. With ground segment supportable to adapt to maritime conditions, Telkomsat Maritime Products can be a mainstay such as FBB, VIS, AIS Data, VSAT Gyro.
- IFE (Weakness) factors, namely: 1. Bureaucratic, 2. Pricing, 3. The prices of maritime products and services are still relatively expensive, 4. Limitations of marine engineers who have good skill
- EFE (Opportunity) factors, namely: 1. Many Telkom chains in the region, 2. Many types of services, leverage gyro assets because the most expensive component is in gyro assets, the infrastructure is already available, the market is still large and wide open, 3. Still very good because the market potential is still large and has not been optimally exploited 4. The opportunity is very strong because the infrastructure is already available, it is enough to give it a specialization in maritime.
- EFE (Weakness) factors, namely: 1. There are already several local suppliers who are quite strong and already have quite a strong maritime brand image in the market. Some foreign providers can also provide services in Indonesia. Therefore, Telkomsat must have special characteristics to strengthen the brand image in the market, 2. There are organizers with a small budget, Foreign regulations, and suppliers, 4. External parties that come in bring their products and services which are relatively cheaper as there is no government protection as a regulator for local players.

The process of determining the values of EFA, IFE and, CPM using the ANP method with the help of super decision software is suitable with formulate the strategy of the David (2017) model. After that, it is formulated for strategy determination with the matching stage using SWOT Matrix Analysis, IE Matrix, BCG Matrix so that it can produce informative presentations that are useful for the company. Further processing is carried out using Quantitative Strategic Planning Matrix (QSPM) to be a strategic choice to be taken by the company the result of strategic choice:

1. Business expansion to the global market with strategic partnerships with Telkom subsidiaries that already have offices abroad such as Telkom Internasional (Telins).
2. Penetration of the domestic market with strategic collaboration using the telkom group chains in the region and the synergy BUMN.
3. Strengthening the domestic market share (improvement of service quality & customer satisfaction, making an effective marketing plan).
4. Development of new products and forging strategic alliances (development of new businesses and acquisition of high revenue impact projects, innovation of new solutions in the maritime sector, and strategic cooperation/partnerships).

5. CONCLUSIONS

Based on the results of the research and analysis and interpretation of the data carried out, it can be concluded that:

1. Based on the results of determining EFE and IFE using 3 rounds Delphi Technique, the are four IFE (Strength) factors, four IFE (Weakness) factors, four EFE (Opportunity) factors, and EFE (Weakness) factors.
2. The result of strategic choice:
   a) Business expansion to the global market with strategic partnerships with Telkom subsidiaries that already have offices abroad such as Telkom Internasional (Telins).
   b) Penetration of the domestic market with strategic collaboration using the telkom group chains in the region and the synergy BUMN.
   c) Strengthening the domestic market share (improvement of service quality & customer satisfaction, making an effective marketing plan).
   d) Development of new products and forging strategic alliances (development of new businesses and acquisition of high revenue impact projects, innovation of new solutions in the maritime sector, and strategic cooperation/partnerships).

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DECISION ANALYSIS TO SELECT NEW BRANCH LOCATION FOR A CONVEYOR BELT COMPANY BY USING VALUE FOCUSED THINKING AND ANALYTIC HIERARCHY PROCESS

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ABSTRACT

PT. XYZ is a company that provides conveyor belt needs for its clients with an office location in Central Java. PT. XYZ is currently getting a profit that is deemed not high enough and will use the market expansion strategy to overcome that problem. PT. XYZ wants to open a new branch of the company in West Java. In selecting the best location for PT. XYZ, Value Focus Thinking (VFT) and Analytical Hierarchy Process (AHP) methods will be used. The VFT method will be used to determine alternatives and criteria used in branch selection and the AHP method will be used in selecting the best new branch location for PT. XYZ. Based on the results of the analysis of the VFT method, the alternative locations to be reviewed are Bekasi, Karawang, and Purwakarta. Meanwhile, the criteria used are cost, workforces, supply chain, and facilities. Using the AHP method, the best location for the new branch of PT. XYZ is Karawang and followed by Bekasi and Purwakarta.

Keywords: Conveyor Belt, Market Expansion, Decision Making, Value Focused Thinking, Analytic Hierarchy Process.

1. INTRODUCTION

A conveyor belt is a tire or belt connected to two or more rotating pulleys to transport and move the goods. With these benefits, conveyor belts are used for many industries such as manufacturing, aviation, metallurgy, and many more. In recent years, the global conveyor belt market has continued to increase to reach US$ 6.1 billion in 2020 (IMARC Group, 2021). According to the Expert Market Research's Report (2021), Asia Pacific is estimated to account for the largest share of conveyor belts in 2020. Indonesia is also expected to increase and have high growth in the conveyor belt market.

PT. XYZ is a company that offers a variety of conveyor belt products with offices located in Central Java. PT. XYZ is currently getting a profit that is deemed not high enough for its shareholders even though it already has clients who are leading national companies. The chosen main problem of PT. XYZ is the lack of a number of clients to work with because customers have a very significant role in the success of a business and the company's financial sector (Musumali, 2019). The root cause analysis of the problem is that there are not many industrial areas in the PT. XYZ at this time.

In overcoming the problem of the lack of clients, the company can carry out various market strategies such as market expansion, market development, diversification, and product development. Market expansion is a strategy used to increase primary demand and increase the number of customers (Bang & Joshi, 2008). In addition, market expansion produces a positive correlation with sales revenue and profit (Bang & Joshi, 2010). Following the analysis, the strategy will be applied by PT. XYZ is market expansion.

PT. XYZ needs to choose the right location in conducting market expansion because the location is one of the most significant factors in the success of a business (Justis & Judd, 2003; Indarti, Nurul, 2004). Based on the data from the Ministry of Industry, West Java province is the province with the largest number of industries. The more the number of companies in an area, the more conveyor belt needs are needed. PT. XYZ decided to open a new branch of the company in a city in West Java province.

In determining the city that is suitable and appropriate for PT. XYZ, two decision-making methodologies will be used. The Value-Focused Thinking (VFT) method is used to obtain a systematic approach to formulate complex decisions that will then be analyzed (Morais, et al., 2013). The Analytic Hierarchy Process (AHP) methodology is widely used in determining the location of a company (Lobo et al., 2016; Yap et al., 2016). AHP handles the qualitative and quantitative data effectively (Timor & Sipahi, 2005). In this research, the VFT and AHP methodology will be applied in determining the city location for the new branch of PT. XYZ.

2. LITERATURE REVIEW

2.1 Value-Focused Thinking (VFT)

Value-Focused Thinking (VFT) is applied to obtain a systematic approach to formulate complex decisions that will then be analyzed (Morais, et al., 2013). VFT also helps uncover hidden purposes and leads to more productive information gathering. That can improve communication between interested parties about a decision, facilitate the involvement of multiple stakeholders, and enhance the coordination of interconnected decisions. Compared to Alternative Focus Thinking (AFT), VFT is more creative, advanced, and proactive. Below are the following steps to design VFT:

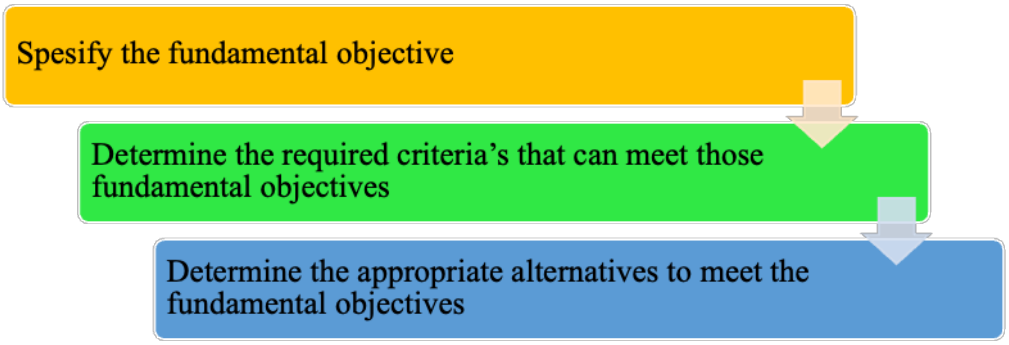

Figure 1. VFT Step by Step (Widi and Putro, 2017)

2.2 Analytic Hierarchy Process (AHP)

AHP is a decision support model developed by Thomas L. Saaty. AHP is one of the most popular decision-making methods (Aziz, et al., 2016). Some of the reasons why AHP is often used as a problem-solving method compared to other methods is because AHP has a hierarchical structure and takes into account validity up to the inconsistency tolerance limit (Pebakirang, et al., 2017). Below are the following steps to design AHP:

Figure 2. AHP Step by Step (Sarjono and Novani, 2016)

3. METHODS

This research will determine the best branch location for PT. XYZ to increase the number of clients who cooperate with PT. XYZ. In determining the best alternative, the VFT and AHP methods will be applied. The VFT methodology was used in this study because VFT can assist in determining better decisions and often results in a better set of objectives for evaluating the alternatives (Keeney, 2008). The AHP methodology is used in this study because AHP has a hierarchical structure and takes into account validity up to the inconsistency tolerance limit (Pebakirang, et al., 2017).

In applying the VFT and AHP methods, the fundamental objectives of this research are first determined. At this stage, the VFT method will be used and continued by determining the alternatives and criteria used in the decision-making process. Those alternatives and criteria will then be used by the AHP method to make a decision hierarchy, make pairwise comparisons, and synthesize the results to determine the best alternative to be used by PT. XYZ. In the synthesizing results process, a consistency ratio test will be carried out from processing the data from the questionnaire, and a priority ranking will be calculated to determine the best alternative for PT. XYZ. The following is the research process that will be conducted in the research:

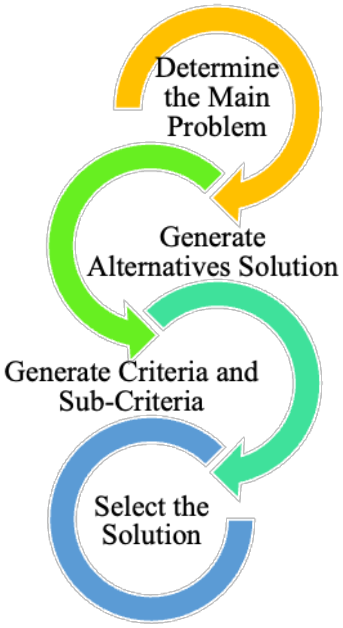

Figure 3. Research Process

4. RESULTS

4.1 Value-Focused Thinking (VFT) Analysis

The first stage in the VFT method is to determine the fundamental objective of the research to be carried out. In this study, to deal with the problems being faced, the company decided to carry out market expansion in one of the cities in West Java province. By doing this, it is hoped that the company can increase the number of clients and obtain higher profits. Therefore, the fundamental objective is to determine the best city to increase the company revenue. In determining the criteria and sub-criteria, a modification of Chang and Lin's list of criteria and sub-criteria in their research (2015) will be used. After modifying the list, the following is a list of criteria and sub-criteria that will be used in this study,

Table 1. List of Criteria and Sub-Criteria

No.	Criteria	Sub-Criteria	Descriptions
1.	Cost	Land purchasing cost	Costs required by the company in buying land
2.		Construction cost	Costs required to build a company
3.	Workforces	Labour force population	Population and number of workers in an area
4.		Minimum wages	The minimum wage provided by the company and can be adjusted according to the branch location
5.	Supply Chain	Supplier network	Good network with suppliers such as on-time delivery of goods from suppliers
6.		Logistics	Speed logistics process with one way to use logistics park
7.		Ports	The close distance between the new branch location and ports or airport
8.	Facilities	Availability of Industrial Site	The high number of industrial sites in the branch location
9.		Availability of Markets	The high number of markets in the branch location

In the next stage, an appropriate alternative will be determined to achieve the fundamental objectives that have been determined in the first stage. PT. XYZ decided to open a new branch of the company in one of the cities in West Java province that has high number of industries in West Java. Therefore, the alternative city locations that the company will choose in this research are Karawang, Bekasi, and Purwakarta. Following is the VFT hierarchy that was obtain from the previous analysis,

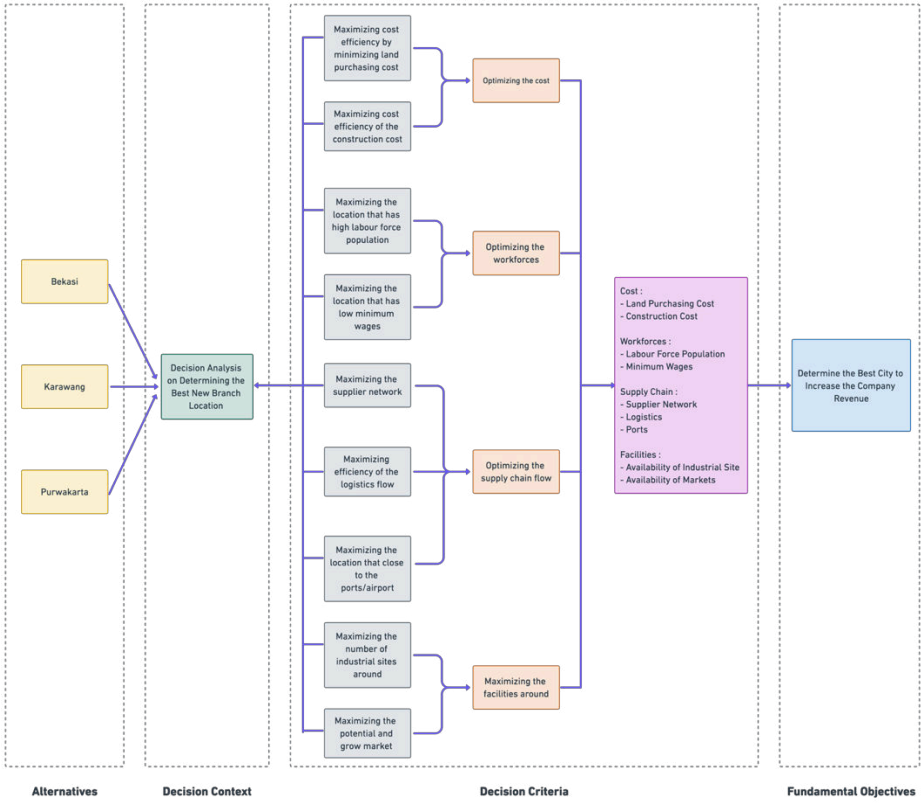

Figure 4. VFT Hierarchy

4.2 Analytic Hierarchy Process (AHP) Analysis

The decision hierarchy is the first stage in the AHP process. The decision hierarchy consists of general goals or goals, criteria and sub-criteria used in the selection of alternatives, and alternatives in the selection of solutions. One of the purposes of making a decision hierarchy is to illustrate the relationship between criteria and sub-criteria with alternatives. The following is the decision hierarchy in this study,

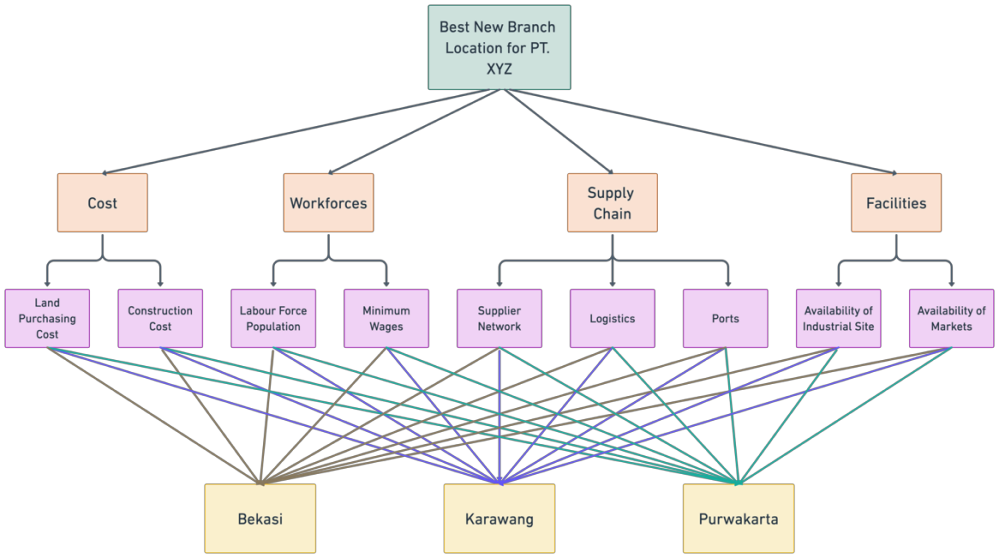

Figure 5. Decision Hierarchy

The next stage in the AHP process is to make pairwise comparisons. Pairwise comparisons are comparisons of one indicator with another indicator. Respondents were asked to make a comparative assessment of the relative importance of each pair of indicators related to the factor that was being measured. In this assessment, numbers 1-9 are used for the prioritization process. In this research, there are several types of levels in filling out the questionnaire. The questionnaires that have been designed include level 2, level 3, and level 4 questionnaires. Level 2 is a comparative assessment of the level of importance for each criterion used in the study. Level 3 is a comparative assessment of the level of importance for the sub-criteria in each criterion used in the study. Level 4 is a comparative assessment of the level of importance for alternatives in each sub-criteria. Pairwise comparisons are made on the results of each respondent's questionnaire which will then be combined to get a combined prioritized decision matrix.

The next stage in the AHP process is to synthesize the results to determine the best alternative in research. Synthesizing the result is a step that needs to be conducted at each level. This stage has several processes that need to be carried out, namely, calculating the eigen vector, test consistency ratio (CR), obtaining weights of all alternatives and criteria/sub-criteria, calculating the priority ranking, and determining the best alternative and solution. From the results of this stage, obtained eigen vectors and rankings at levels 2, 3, and 4 using Expert Choice 11 software. From the results of the CR test, all levels have a ratio of less than 10%, thus the degree of consistency in pairwise comparison for all levels is acceptable. The following is a hierarchy tree whose values are obtained from the results of the analysis in the previous process,

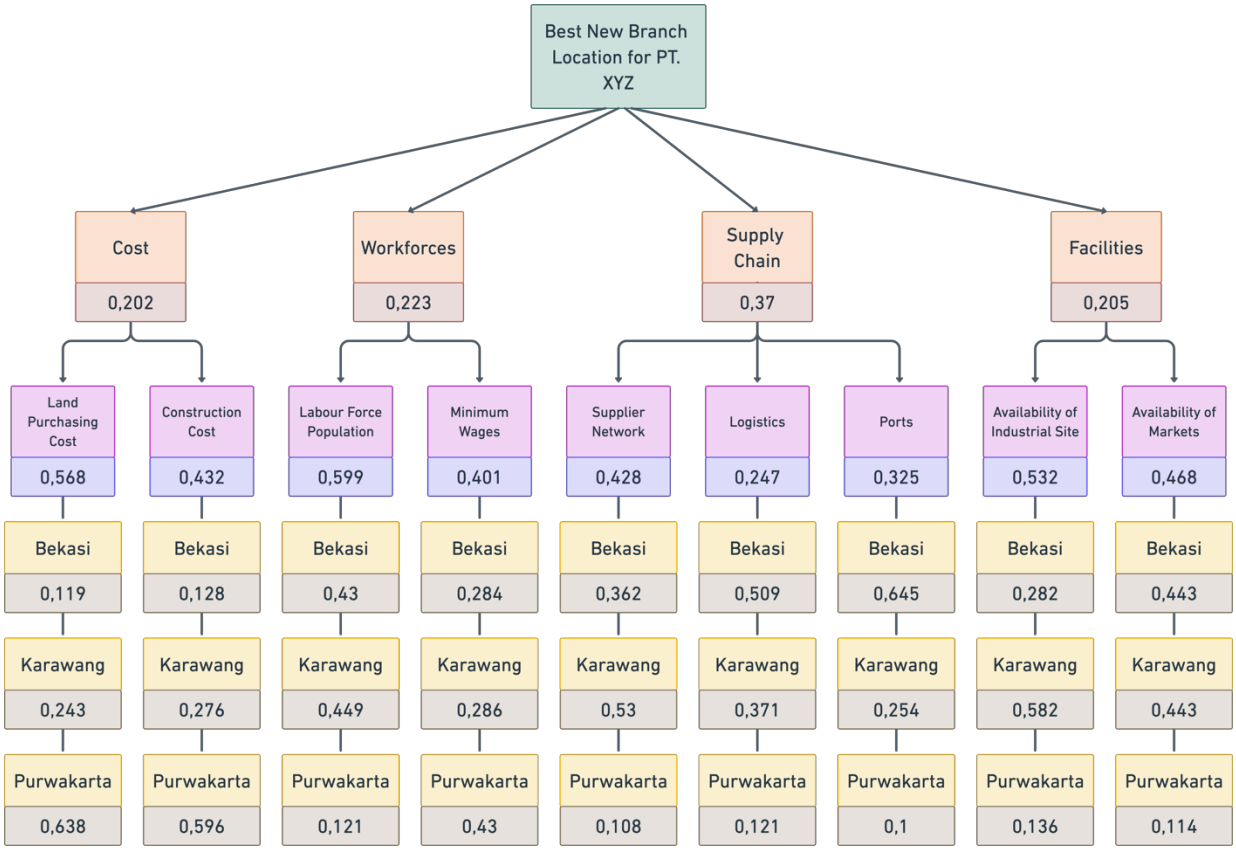

Figure 6. Hierarchy Tree Results with Weights of All Alternatives and Criteria/Sub-Criteria

The last step that needs to be done is to calculate and determine the priority ranking to obtain the best alternative. In this research, there are four (4) criteria, namely, cost, workforces, supply chain, and facilities. The calculation of the matrix multiplication between the priority matrix and the sub-criteria weights will be carried out for each of these criteria. The following is a calculation of determining priority ranking,

$$[\ \textit{Cost Criteria Weight x (| Cost Priority Matrix | x | Cost Sub Criteria Weight |) }\ ]$$
$$+ [\ \textit{Workforces Criteria Weight x (| Workforces Priority Matrix | x | Workforces Sub Criteria Weight |) }\ ]$$
$$+ [\ \textit{Supply Chain Criteria Weight x (| Supply Chain Priority Matrix | x | Supply Chain Sub Criteria Weight |) }\ ]$$
$$+ [\ \textit{Facilities Criteria Weight x (| Facilities Priority Matrix | x | Cost Sub Criteria Weight |) }\ ]$$

$$\begin{vmatrix} \textit{Bekasi} \\ \textit{Karawang} \\ \textit{Purwakarta} \end{vmatrix} = \begin{vmatrix} 0{,}366 \\ 0{,}397 \\ 0{,}237 \end{vmatrix}$$

5. CONCLUSIONS

PT. XYZ is a company that offers a variety of conveyor belt products with offices located in Central Java. PT. XYZ is currently getting a profit that is deemed not high enough for its shareholders. The chosen main problem of PT. XYZ is the lacks a number of clients to work with the company. The root cause analysis of the problem is that there are not many industrial areas in the PT. XYZ at this time. In overcoming that problem, the strategy that PT. XYZ will apply is the market expansion in a city in West Java province. In determining the city that is suitable and appropriate for PT. XYZ, Value-Focused Thinking (VFT) and Analytic Hierarchy Process (AHP) will be applied.

Using the VFT method, the criteria that will be used in this research are cost, workforce, supply chain, and facilities. The sub-criteria used are grouped into four (4) types according to the number of criteria used. The sub-criteria are land purchasing cost, construction cost, labor force population, minimum wages, supplier network, logistics, ports, availability of the industrial site, and availability of markets. Alternative solutions in the decision-making process are cities with a large number of industries in West Java, namely, Bekasi, Karawang, and Purwakarta.

Using the AHP method, the best alternative is obtained for PT. XYZ. Based on the results of the priority ranking calculation, the alternative with the highest priority is the city of Karawang with a weight of 39.7%. The order of priority after Karawang is Bekasi and Purwakarta with 36.6% and 23.7% respectively. The ranking is used in determining the best alternative in this study. Therefore, the city of Karawang is the best alternative that can be chosen by PT. XYZ for opening a new branch in West Java.

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REVIEW OF METHODS IN RESEARCH ON CUSTOMER SATISFACTION

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ABSTRACT

Customer satisfaction compares the performance expected by consumers to actual performance in the field. There are many studies on customer satisfaction and service quality, both offline and online services. This study aims to describe several literature reviews on customer satisfaction to conclude which method is the most appropriate and widely used by researchers. The method used in this study was to conduct a literature review of 12 reputable journals from 2012 – 2021. The most commonly used method is the Servqual method using Structural Equation Modelling from the literature review.

Keywords: Customer Satisfaction, Servqual, Structural Equation Modelling.

1. INTRODUCTION

Consumer satisfaction or dissatisfaction is the consumer's response to the discrepancy between previously perceived expectations and actual service performance after using it. Perception is an opinion about something seen and assessed by consumers on products or services; because every consumer has subjective beliefs, then consumer perceptions are related to consumer satisfaction. If the perceived service is close to or in line with consumer expectations, consumer satisfaction will appear (Octabriyantiningtyas et al., 2019). According to Kotler (2012), satisfaction is a person's feeling of pleasure or disappointment that comes from comparing his impression of the performance or results of a product and his expectations.

There are several methods to measure and analyze customer satisfaction: Servqual Method, Performance Importance Analysis, Description Analysis, and MUSA (Multiple Criteria Customer Satisfaction Analysis). Some studies applied Structural Equation Modeling using Servqual Method to measure customer satisfaction, such as in studies Rita et al. (2019), Kiran and Diljit (2012), Li and Shang (2020). This paper is meant to determine the research method used to measure customer satisfaction.

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2. LITERATURE REVIEW

According to Zeithaml and Bitner (2003), consumer satisfaction is a consumer's evaluation of a product or service in terms of whether the product or service meets the needs and expectations of consumers. Gerson (2001) states that consumer satisfaction is a condition where a product or service meets or exceeds customer expectations so that customers feel satisfied; it is said that there is a relationship between quality, service, and satisfaction. This difference becomes more evident

by considering that customer perceptions determine quality and service, and customer satisfaction is the perception of customers whose expectations have been met. Parasuraman et al. (1985) stated that service quality is a dynamic condition associated with products, people, processes, and the environment that meet expectations, including the level of perfection expected and control over that perfection to meet consumer needs. In other words, two factors affect quality, namely the desired service and the unexpected service. E-Servqual, according to Madu (2002), can be measured from features, performance, reliability, aesthetics, storage capacity, comfort and system integrity, serviceability, trustworthiness, differentiation, responsiveness, web policies, warranties, reputation, and empathy. Consumer satisfaction on the quality services have been carried out in previous studies, such as the Rares study (2014) argues from a brief analysis of his research conceptualization that the first definition of quality focuses on product reliability, and over time changes to a focus on meeting the interests desired by consumers. The definition of quality related to service quality emphasizes meeting consumer needs as determined by consumers themselves. In addition, Parasuraman and Zeithaml (2005) state that the service quality perceived by consumers from certain service companies is the result of comparing the company's performance with the general expectations of consumers.

3. METHODS

This research analyzes the method used in measuring customer satisfaction based on the previous studies. Various sources from reputable journals in this study are to be analyzed. There are 12 publication journals published from 2012 – 2021. The following is a list of journals with rank and SJR of each journal listed in table 1. Based on table 1, information about 12 journals was obtained to measure customer satisfaction.

Table 1. Selected journal's

Journal Publication	SJR	Quartiles Category	Numbers of Papers
International Journal of Research in Marketing	3.725	Q1 in Marketing	1
Information and Managements	2.147	Q1 in Information System and Management	1
Telematics and Informatics	1.567	Q1 in Computer Networks and Communication	1
Library Information Science Research	1.255	Q1 in Library and Information Sciences	1
Socio – Economic Planning Sciences	1.02	Q2 in Economics and Econometrics	1
Business Research Quarterly	0.995	Q1 in Business and International Management	1
Journal of Heliyon	0.455	Q1 in Multidisciplinary	4
Journal of Sustainable Development	0.151	Q4 in Management, Monitoring, Policy, and Law	1
Data in Brief	0.122	Q4 in Multidisciplinary	1

4. RESULTS

Based on the literature review, several methods used to measure customer satisfaction were obtained. The following explains the types and research data used in 12 journal publications. There is an explanation Y (Yes) is used to state the use of research types and data that are appropriate, and N (No) is used to express the use of research types and data that are not appropriate. The following explains the theoretical mapping from previous research presented in table 2.

Table 2. Theoretical mapping of previous research

No	Customer Satisfaction	Type Research				Methods	Objectives
		Qt	Ql	Primary Data	Secondary Data		
1	Kassemeier et al. (2021)	Y	Y	Y	Y	Survey and Regression Analysis	Developing a theoretical framework based on social identity theory and identifying specific characteristics–need matches for customer
2	Li and Shang (2020)	Y	N	Y	N	Survey, Servqual Method using SEM	Developed a chain model of e-government service quality, perceived value, and citizens' Continuous of government website service
3	Nilashi et al. (2021)	Y	Y	Y	Y	Text mining, clustering, and prediction learning techniques	Reveal the travelers' satisfaction in Malaysian hotels during the COVID-19 outbreak through online customers' reviews
4	Kiran and Diljit (2012)	Y	N	Y	N	Survey, Servqual Method using Structural Equation Modelling	Development and empirical testing of a proposed conceptual model of service quality that encompasses environment, delivery, and outcome quality for web service library
5	Ferreira et al. (2021)	N	Y	Y	N	Survey, Multiple Criteria Customer Satisfaction Analysis	To assess customer satisfaction determinants in a public pediatric inpatient service and propose some strategies to enhance the

Commented [CU1]: Jangan disingkat, atau dengan kode yang diberi note di bawah tabel

						(MUSA)	consumer and customer experience
6	Chicu et al. (2019)	Y	N	Y	N	Survey, Servqual Method using Structural Equation Modelling	Explore the human or employee related factors that shape customer satisfaction in the context of call centres
7	Uzir et al. (2020)	Y	N	Y	N	Servqual Method using Structural Equation Modelling	Investigate the effect of product quality (PQ), quality of service (SQ) and perceived value on customer satisfaction (CS)
8	Nguyen (2020)	Y	N	Y	N	Servqual Method using Structural Equation Modelling	Develop reliable and valid five constructs of customer satisfaction theoretical model of Beauty and Cosmetic Online Shopping in the Vietnamese market
9	Rita et al. (2019)	Y	N	Y	N	Servqual Method using Structural Equation Modelling	Develop new knowledge to better understand the most important dimensions of E-service quality
10	Fajriyati et al. (2020)	Y	N	Y	N	Servqual Method using Structural Equation Modelling and Performance Analysis	Identifies and classifies generic and Islamic attributes as basic, performance, and excitement factors theory of customer satisfaction with different impacts on tourist satisfaction
11	Husain et al. (2017)	Y	N	Y	N	Servqual Method using Performance Importancee Analysis	Investigate the management perception of organizational service quality practices
12	Rukuni and Maziriri (2020)	Y	N	Y	N	Servqual Method using Structural Equation Modelling	Determined the coronavirus readiness strategies at retail stores and their consequences for consumer behavioural intentions

Note: Qt: Quantitative Research; Ql: Qualitative Research

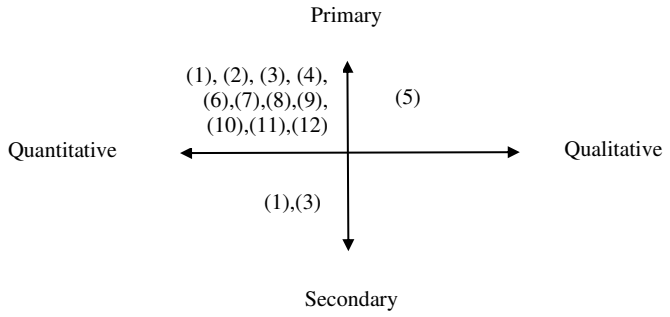

Figure 1. Mapping diagram of type and data research

The dominant analysis used is Servqual Method using Structural Equation Modelling as in the studies of Li and Shang (2020), Kiran and Diljit (2012), Chicu et al. (2019), Uzir et al. (2020), Nguyen (2020), Rita et al. (2019), Fajriyati et al. (2020), Rukuni and Maziriri (2020). Based on figure 1, it is found that the most dominant method used in research used quantitative types with primary data.

5. CONCLUSIONS

The most widely used method in research with quantitative methods with the types of primary data described in journals Roland et al. (2019), Li and Shang (2020), Nilashi et al. (2021), Kiran and Diljit (2012), Chicu et al. (2019), Uzir et al. (2020), Nguyen (2020), Rita et al. (2019), Fajriyati et al. (2020), Husain et al. (2017), Rukuni and Maziriri (2020). From the explanation above, it is also obtained that the most widely used analysis is the Servqual Method using Structural Equation Modelling. This paper can help future research on the application of measuring customer satiscation by using appropriate methods and analysis.

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TARGET OFF BLOCK TIME (TOBT) PERFORMANCE MEASUREMENT STRATEGY THROUGH BALANCED SCORECARD APPROACH AT THE AIRPORT : LITERATURE REVIEW

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ABSTRACT

The purpose of this study is to understand and fundamentally analyze the potential for combining airport operational measurements through measuring Target Off-Block Time (TOBT) as one of the stages in the implementation of Airport Collaborative Decision Making (A-CDM) with company performance measurements in the field of airport operators through the measurement of the Balanced Scorecard (BSC). This study uses literature review data which will provide an overview of several relevant sources. The results of the study indicate that the implementation of BSC in the airport industry will be able to consider external factors and turn them into internal processes that remain balanced with other perspectives to keep the entire system structure alive and effective, while TOBT will provide accuracy in achieving punctuality and be able to have a significant impact on the effectiveness of airport operational resources. With the result that strategy of merging airport operations based on Target Off-Block Time (TOBT) and company performance through the perspective of measuring the Balanced Scorecard (BSC) will be an interesting thing for further research.

Keywords: A-CDM; Target Off-Block Time; SWOT; Balanced Scorecard

1. INTRODUCTION

The operational complexity of airport management can no longer be done partially and manually. Diversity, technological developments and social and environmental dynamics require airports to carry out collaborative activities between stakeholders. In line with this, the implementation of A-CDM (Airport Collaborative Decision Making) is expected to answer the operational challenges of the airport industry.

According to Netto et.al, (2020) stated that the short A-CDM approach is the support for the implementation of ATFM (Air Traffic Flow Management) which in this case aims to regulate and control the demand for capacity on the air side or flight traffic. Meanwhile, A-CDM focuses more on a predictability approach and optimizing operational resources, especially in airport operations. For example, if an airport is having problems, then through an information sharing approach, the problem can be mitigated earlier, to the planes that will fly there. Thus the aircraft can make

adjustments. Because if you keep flying, you have the potential to experience holding, divert and even RTB and there will be a waste of fuel (Liu et al., 2017).

Decision making related to whether or not an aircraft flight is permitted will be conveyed through an integrated system between stakeholders so that if there is a reduction in capacity in the airspace or at the airport, a Ground Delay Program will be applied, i.e. the aircraft will be asked to remain on the ground until conditions are the destination airport or in the affected airspace is clear (Liu et al., 2017)

With the application of the A-CDM system in Indonesia, aircraft operations can be planned more effectively and efficiently because A-CDM needs to be formalized in the form of worst-case scenarios that may occur, and serve as a routine activity so that when certain conditions occur, both Authority, Airport, AirNav and Airline will be able to anticipate it better and flight safety will be better maintained and flight efficiency will also be more guaranteed (Directorate General of Civil Aviation, 2019)

The biggest challenge currently in the implementation of A-CDM is the lack of collaboration between aviation stakeholders. In addition, there are still different definitions or views on various focuses, and there is no understanding and unification of opinion. A-CDM is shown to increase efficiency in flight operations by optimizing the use of various existing resources and On time performance is very important for smooth flight operations. Airlines provide real-time flight plans for the size of the type of aircraft, the number of passengers and so on. The airline also provides information about the target time for the aircraft to be ready to leave the parking lot (Target Off-Block Time/TOBT) for departure. The provider of flight navigation services, in this case is AirNav Indonesia, provides information regarding the use of the runway currently in use, the planned use of the runway, runway capacity, and other information related to aviation traffic. Through closer collaboration through A-CDM, efficiency and effectiveness can be achieved.

In general, the measurement of company performance in the perspective focuses on the financial side, whereas if the performance appraisal is only carried out on the financial side, it can mislead the company. This is because the current good financial achievements in the company can be achieved at the expense of the company's long-term interests. Kaplan, (2002) introduced the Balanced Scorecard as a work measurement that not only considers financial aspects but also includes customer focus, operational efficiency and innovation. According to him, the balanced scorecard allows managers to see the business from four important perspectives, namely the customer perspective, internal perspective, innovation and learning perspective, and financial perspective. state that the balanced scorecard is an effective method for entrepreneurs to evaluate company performance in accordance with the steps that have been taken.

The purpose of this research is to analyze Target Off-Block Time (TOBT) Performance and performance measurement strategies at the airport. Compilation of research entitled TOBT Performance Measurement Strategy on Domestic Aviation, will provide the following benefits: Companies can apply the recommendations from this research, in order to improve the quality of performance that can improve company performance and can deepen knowledge about strategic management in theory and practice so that it can be applied in the industrial world.

2. LITERATURE REVIEW

2.1 Target Off-Block Time (TOBT)

Target Off-Block Time (TOBT) is the time the airline or handling agent predicts the aircraft will be ready, all doors closed, bridge lifts pushing back vehicles available, and ready to start or push back immediately after receiving 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 is characterized by an evolutionary approach in a dynamic environment. The task of setting a TOBT is just one component of a larger decision-making problem that doesn't just end with setting a TOBT and requires continuous monitoring of the turn-round situation, as unforeseen events can significantly affect TOBT. Thus, 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.

During flight operations at congested airports, the minimum time available for turnaround is often limited by a predetermined minimum period called the Minimum Turn-round Time (MTTT). However, the MTTT is not based on the actual required lap duration, but is a fairly arbitrary choice of airlines. If only MTTT is available, the TOBT needs to be updated even when only one turn-round process is delayed during the so-called critical path of a sequential turn-round process. 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.

2.2 Balanced Scorecard

According to Kaplan, (2002), the balanced scorecard is a performance measurement and management system that views the company from four perspectives, namely the financial, customer, internal business processes and learning and growth perspectives to improve strategic decisions in achieving company goals and provide managers with an understanding of business performance. In addition, the balanced scorecard also provides a framework for describing the company's strategy in terms of operations. In measuring performance based on the balanced scorecard there are 4 important aspects which include financial, customer, internal business processes and learning and growth perspectives (Kaplan, 2002)

However, for all methods, the BSC approach has some limitations. The output of the BSC is purely based on expert opinion, and this makes the results quite subjective. As a result, different representatives of the same stakeholders may interpret the scoring criteria differently, resulting in

different final scores. The Balanced Scorecard method is able to predict the steps that actors can use to align their strategies so that CDM benefits all parties involved. Thus, the main conclusion that can be drawn from this study is that collaborative CDM measures can be used by management as a feedback mechanism to encourage better decision making and use of airport resources.

3. METHODS

The research design used is the Literature review method. Literature review is a research conducted by researchers by collecting a number of books, magazines related to the problem and research objectives. This technique is carried out with the aim of revealing various theories that are relevant to the problems being faced and investigated as reference material in the discussion of research results. Literature review can be carried out from several sources, such as national and international journals. Literature study data collection consisting of journal articles, textbooks, handbooks, archives and regulations is a way to solve problems by tracing the sources of previously written writings. In this study, researchers used literature review data collection with thematic structure sequence.

According to (Hasibuan, 2014), the literature review contains a description of the theory, findings and other research materials obtained from reference materials to be used as the basis for research activities. The description in this literature review is directed to develop a clear framework of thinking about solving the problems that have been described previously in the formulation of the problem. Literature review contains reviews, summaries, and author's thoughts on several library sources (can be articles, books, slides, information from the internet, etc.) about the topic discussed, and is usually placed at the beginning of the chapter. The results of research conducted by other researchers can also be included as a comparison of the results of the research that will be tested here. Literature review means not only reading the literature, but more towards an in-depth and critical evaluation of previous research on a topic. Literature Review is a critical and in depth evaluation of previous research. A good literature review is one that evaluates the quality and new findings of a scientific paper.

The research procedure used in Literature Review research has several stages that must be passed from observing research subjects to making data analysis results from the results of concluding various articles, journals and scientific writings that have similar themes in order to obtain data that is considered the best, as follows.

1. Problem Observing Stage
   This stage includes the formulation of the problem, determining the problem, and limiting the scope to be studied.
2. Planning Stage
   This stage includes a follow-up to the previous stage, which includes: clarifying the problem formulation, availability of literature and development of literature.
3. Identification Stage

This stage consists of a literature search, and the need to explain and justify how the completeness of the search is ensured.

4. Screening Stage
   This stage includes selecting articles for review, and determining which ones are not feasible and which ones are eligible without further examination. This stage is a very important stage of the Systematic Review, where the articles to be analyzed are selected according to several categories including:
   a. Keywords research formulation.
   b. The articles selected are articles sourced from Google Scholar.
   c. The articles analyzed are in Indonesian and in English
   d. The articles analyzed have an ISSN number/Journal number
   e. The articles analyzed are articles with the year 2010 - 2020

5. Feasibility test
   This stage is the stage of outlining the criteria for assessing articles of sufficient quality to be included in the assessment.

6. Data Collection Stage
   This stage is the identification stage, researchers need to systematically extract applicable information from each article.

4. RESULTS

Table 1. Result

No	Tittle	Author	Purposes	Method	Conclusion
1	Application of Balance Scorecard Customer Perspective in an Airport Environment	(Mikula et al., 2021)	The goal of this paper is a presentation of a role of customer´s impression as a valuable forward-looking indicator in BSC´s customer perspective.	Quantitative and qualitative methods are carefully stored and evaluated.	The customer perspective in the Balanced Scorecard method has its important role in measuring how airport services can impact on passengers. The Balanced Scorecards considering external factors and transform them into the internal processes which remain balanced with other perspectives and keep that system live and effective.

No	Tittle	Author	Purposes	Method	Conclusion
2	A-CDM Impact Assessment	(Huet et al., 2016)	The objectives of this study have been to collect evidence from 17 CDM airports a. The local benefits enjoyed by CDM airports could be collated and communicated within airport specific A-CDM factsheets. b. The outcomes of the previous EUROCONTROL A-CDM network study could be refined	Quantitative and qualitative methods	A-CDM is already facilitating a reduction in average ATFM delay of 3 minutes per regulation in restrictions in which 30% or more of the flights are originating from CDM airports. This benefit increases as the proportion of flights originating from CDM airports increases through the sector.
3	The Airport A-CDM Operational Implementation Description and Challenges	(Netto et al., 2020)	To address an issue that today is a significant challenge for all signatory countries of the International Civil Aviation Organization (ICAO) which involves three of the most critical stakeholders in the Air Sector, which are Airlines, Airports and Air Traffic Control Bodies	Multiple Case Study	The complexity of a CDM deployment at large airports, receives several approaches from signatory countries and their ATM Systems, based on the recommendations of the ICAO Global Air Navigation Plan. The process will always involve three significant stakeholders: airport, air traffic control and air carriers

No	Tittle	Author	Purposes	Method	Conclusion
4	Building airport collaboration model based on dynamic capability and environmental dynamism	(Agustiana et al., 2021)	Discusses the airport collaboration about the airport management capabilities in adapting to environmental dynamism and dynamic capability factors.	Quantitative Partial Least Square for causality analysis	The dynamic capability of airport managers tends to contribute more to the success of collaborating at airports and is followed by the ability to adapt to ever-changing environmental conditions (environmental dynamism) contributing to an influence on airport collaboration. It was also found that the ever change environmental factors also contribute to a direct influence on building dynamic capability.
5	Balanced Concessions for the Airport Industry Delivering Win-Win Outcomes for Successful Airport Concession Contracts	(Dorian Reece et al., 2018)	To provide the necessary safeguards through effective forms of economic oversight and regulation.	Qualitative methods	Inefficiency or issues in operations can adversely impact the airport ecosystem and, given the complex nature of airport and airline operations However, in many instances, concession agreements do not mandate or incentivize concessionaires to be transparent or to adopt a collaborative decision-making framework for key operational decisions that impact customers and consumers

BSC customer perspective being applied by airport managers as an essential part of their business strategies. The goal of this paper is a presentation of a role of customer´s impression as a valuable forward-looking indicator in BSC´s customer perspective. The existence of loyal customers is a vital element for profit making airports. Airports have a variety of direct and indirect customers such as carriers, retailers, tenants and others. But the most important customer segment element is

a passenger. An in-depth understanding of a customer profile is extremely important for airports planning and making a maximum revenue.

Passengers proceed directly to gates, after have entered a departure hall. One, in past mandatory break at check-in counter, is now skipped. Anyway, if a passenger does not hold a home printed boarding pass, or baggage tag, or this is a passenger with special needs, or travelling with a live animal, sport or music equipment or similar, still must contact serviceable check-in counter and register himself for a flight. Security control is mandatory process, and the most important one. Passengers´ security is at utmost importance of all airports. Security controls represent a sophisticated system of actions to make airports and flights safe. Gates configuration, space, seating comfort, and relaxing zones particularly weight on passengers´ feelings, and satisfaction. This was very briefly described passenger journey through the airport on departure. From a moment a passenger passes factious airport area borders, a mix of impressions and experiences start to model a final judgement how the airport was found, and how satisfying its services were

The customer perspective in the Balanced Scorecard method has its important role in measuring how airport services can impact on passengers. This perspective is a perfect combination of passengers´ experiences and managers´ ideas how to meet and even exceed customers´ expectations. Competitors with their research tool, market analyses, and a will to risk, can very easily devastate activities of any airport in a region or even in a whole country. The Balanced Scorecards considering external factors and transform them into the internal processes which remain balanced with other perspectives and keep that system live and effective. Airports must have a complex system of measurements which unify lagging indicators with ones which show how airport is able to mix vision, strategy and initiatives in one stream.

The Collaborative Decision Making (CDM) Concept of Operations (ConOps) in the near-term considers three key milestones to be found in the operation of a Surface CDM (A-CDM) that need to be completed before a flight can depart. These milestones are (Huet et al., 2016):

a. Relative to the milestone of filing a flight plan, network-wide resource planning enables a Flight Operator to achieve maximum utilization of its resources by adapting to changing conditions based on accurate, timely information. For example, Flight Operators may use airport aircraft surface surveillance data, integrated with airspace and National Airspace System (NAS) status data, to detect and understand the nature of any demand/capacity imbalances affecting airport surface traffic.
b. Pushback
   Relative to the milestone of pushing back from a gate/parking stand, it is anticipated that the participating Stakeholders will share the following information:
   a) Scheduled Off-Block Time (SOBT);
   b) Earliest Off-Block Time (EOBT);
   c) Updated flight intent information;
   d) Operating limitations affecting the departure of an aircraft;
   e) Actual Off-Block Time (AOBT); and
   f) Access to pushback and other specified event data.
c. Taxiing on the Airport Surface

Taxiing to a Holding Area - A gate may be needed for an arrival, making it necessary to push back a departure earlier than otherwise would be required. In such cases, Ramp Control and ATC coordinate as essential to taxi the aircraft to the designated AMA holding area. Using surface surveillance and flight intent information, Surface CDM monitors current and predicted the capacity of the holding areas. Three notifications are provided to subscribing Stakeholders to improve their situational awareness regarding the designated Airport Movement holding areas.

5. CONCLUSIONS

The customer perspective in the Balanced Scorecard method has its important role in measuring how airport services can impact on passengers. This perspective is a perfect combination of passengers´ experiences and managers´ ideas how to meet and even exceed customers´ expectations. Competitors with their research tool, market analyses, and a will to risk, can very easily devastate activities of any airport in a region or even in a whole country. The Balanced Scorecards considering external factors and transform them into the internal processes which remain balanced with other perspectives and keep that system live and effective.

A-CDM is already facilitating a reduction in average ATFM delay of 3 minutes per regulation in restrictions in which 30% or more of the flights are originating from CDM airports. This benefit increases as the proportion of flights originating from CDM airports increases through the sector. The trends in historical ATFM delay suggest that 40 CDM airports could yield reductions in average ATFM delay of between 20% and 25%. This is compared to flow restrictions in which there are no regulated flights originating from a CDM airport. These results are consistent with the findings generated in the previous EUROCONTROL impact study. Departures from CDM airports receive less ATFM delay than non A-CDM flights through the same restriction - by an average of a 1 minute per flight.

The complexity of a CDM deployment at large airports, receives several approaches from signatory countries and their ATM Systems, based on the recommendations of the ICAO Global Air Navigation Plan. In all of them, especially those of greater importance, we have seen confluent points that, regardless of airport size, should always be part of A-CDM processes.

6 RECOMMENDATION

Based on the conclusions above, the recommendation that can be given to airports in Indonesia is to measure performance through A-CDM implementation as an operational management perspective that is integrated with the Balanced Scorecard (BSC) as a company performance. This is very relevant considering that Indonesia is an archipelagic country with several large state-owned airports that have competed at regional and international levels.

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Technology Acceptance Model of Using Biometric Technology With Taspen Otentikasi Using Modified UTAUT2 Method

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ABSTRACT

The rapid development of information technology has had a major impact on everyday life. The high level of public satisfaction with information technology is a benchmark for technological development, one of which is biometric authentication technology. Along with the development of user needs such as easy to use authentication application especially for target users who are retirees and easy access to authentication from wherever the user is located without having to visit a registered bank. It is necessary to improve and develop the biometric technology application itself so that it is expected to provide more convenience to its users. This encourages the author to conduct research to find out what factors can influence user interest in using biometric authentication technology. In this study, the application of PT Taspen's biometric authentication technology was used. The data were analyzed using an integrated evaluation model UTAUT2, where the method was modified with the addition Task-technology fit and Satisfaction variables. The results showed that of 19 hypotheses, there were 10 hypotheses that had a significant relationship. The application of Taspen Otentikasi biometric authentication technology is proven to be acceptable to consumers. The results of the analysis can be used as recommendations and suggestions for further exploration development.

Keywords: UTAUT2, Taspen Otentikasi, Task-technology fit, Satisfaction, Authentication.

1. INTRODUCTION

Rapid technological developments change people's lifestyle patterns so that they become more dependent on information technology because it is able to facilitate all activities to be more effective, efficient, and economical (C. K. Han, Lee, and You 2016). Quality technology is very important in achieving user satisfaction. One of them is using biometric authentication technology. Biometric authentication technology is a technology service that makes it possible to verify identity without a password. This technology relies on unique biological characteristics such as fingerprint, face and voice to verify identity for secure more access to electronic systems. Biometric authentication services are currently popular to be used to authenticate users. Even though there are not many service providers that provide biometric authentication services in

Indonesia yet, PT Taspen makes a similar authentication solution that relies on biometric data. The biometric data used by Taspen are face, fingerprint, and voice data (Taspen 2019).

Currently, the biometric authentication service belonging to PT. Taspen (Taspen Otentikasi) is used by recipients of taspen pension fund. Recipients of pension funds are required to register their biometric data as legitimacy that pension funds are still entitled to be distributed. Previously, recipients of pension funds had to come to the bank regularly every 1, 2, and 6 months to process documents that prove they are still alive and entitled to receive pension funds. With this digital authentication solution, recipients of Taspen funds only need to verify via the application. In the Taspen Otentikasi application, recipients of Taspen funds can authenticate anytime, anywhere.

In this study, an analysis of the user acceptance model will be carried out on the Taspen Otentikasi application belonging to PT. Taspen using the Unified Theory of Acceptance and Use of Technology 2 (UTAUT2) method. UTAUT is a model that can explain user behavior towards technology (Venkatesh, Thong, and Xu 2012). UTAUT uses Performance Expectancy, Effort Expectancy, Social Influence, and Facilitating Condition variables. UTAUT2 is an extension of the UTAUT method by adding 3 variables, namely Hedonic Motivation, Price Value, and Habit.

The difference from previous studies, this study is comparing using the UTAUT2 method by adding 2 (two) construct variables, namely Task-technology fit and Satisfaction. In previous study, Task-technology fit has been adopted to research on consumer perspectives on the use of biometric technology with mobile banking (Clark 2021). This study explains that task-technology fit plays an important role in user behavioral interest in accepting a technology. In a research conducted in other studies, it is stated that Use Behavior has a significant influence on Satisfaction, where the behavior of using a technology affects user satisfaction with the technology (Baabdullah, Alalwan, Rana, Kizgin, et al. 2019). This becomes the basis for adding the Satisfaction variable in this study.

Based on this research, the result that is expected in this study is a user acceptance analysis report on the biometric authentication application, namely Taspen Otentikasi. This report is expected to be a reference for developers in improving and developing the biometric authentication application under study so that they can evaluate how much users accept this technology.

2. METHOD

2.1. Biometric Technology

Biometric technology is a technology that utilizes individual physiological identity, so that it can be used as a tool or key in controlling access to a system. Biometric technology is part of a security system, the main purpose of this technology is to maintain and protect a person's identity. The way biometric technology works is by using pattern recognition techniques. The pattern to be recognized can vary, such as face, iris, signature, fingerprint, palm line and voice recognition. This is evidenced by the existence of several studies, including based on research that proves that "the palm line can be used as a person's self-recognition pattern with an accuracy rate of 98%" (C. K. Han, Lee, and You 2016). Meanwhile, other studies have proven that "Fingerprints can be analyzed to be used as a form of recognition supporting various types of image extensions, such as .jpg, .png, .tif and others" (C. C. Han et al. 2003).

2.2. Taspen Otentikasi

The Taspen Otentikasi application is a digital service that is presented by PT Taspen (Persero) as an alternative for conducting online authentication on a regular basis. This step is considered as a form of service development so that there will be no more delays for Civil Servants (PNS) who immediately retire in receiving their rights. The Taspen Otentikasi application on October 8, 2019 already supported with the main feature of claiming their rights, can be anywhere, anytime, without having to go to the Taspen branch office. In order to be able to use the Taspen Otentikasi Application, participants must re-register with the assistance of officers at certain places specifically designated by PT Taspen (Persero) (Taspen, 2019).

2.3. UTAUT2

The Unified Theory of Acceptance and Use of Technology 2 (UTAUT2) method is an advanced research model from the UTAUT model. This method measures the factors of acceptance or rejection of users against a technology. The UTAUT model has been tested in various Information Technology work environments, is found to be useful for evaluating the level of user acceptance of a technology. UTAUT itself can be used to examine what factors influence the application of the technology, to make it easier to design a technology update so that it can be more accepted by users. As information technology develops, a technology that has a wider scope than UTAUT has been developed, namely UTAUT2. UTAUT2 has the same construct model as UTAUT with the addition some constructs.

- The extent to which a person's belief in using a technology or system can achieve an advantage in his daily performance is called performance expectations or it can also be called a significant relationship from a person's intention to use a technology so that it can be said that a technology or system can help the work of someone who uses a technology. the system and think they will continue to use the technology for a long time (Venkatesh, Thong, and Xu 2012). Performance Expectancy relates to an individual's belief about how useful a technology can help him/her in various activities, where gender and age differences have been shown to have an effect in the context of technology adoption (Alalwan, Dwivedi, and Rana 2017; Dajani and Abu Hegleh 2019; Farooq et al. 2017; Mehta et al. 2019).
- The level of convenience associated with the use of a technology is called effort expectancy (Venkatesh, Thong, and Xu 2012). Based on various literatures on technology acceptance, this variable has been shown to have an effect on the context of technology adoption (Baabdullah, Alalwan, Rana, Patil, et al. 2019; Maneejuk and Yamaka 2020).
- Internalization, compliance, and identification are three mechanisms that exert social influence on one's behaviour. (Venkatesh, Thong, and Xu 2012). It is concluded that the greater the social influence presented by a circle to new users of a system in using a new system, the greater the interest or intention that arises from the individual potential of users of the technology in using it because of the large influence of the social environment and its surroundings.
- Facilitating Conditions are defined as a level of an individual's belief that the available technical and organizational infrastructure can support the use of technology (Venkatesh, Thong, and Xu 2012).
- Hedonic Motivation is defined as a pleasure obtained when using a technology, and it is believed to have an important role in determining the acceptance and use of technology (Venkatesh, Thong, and Xu 2012). Thus, the adding the Hedonic Motivation variable to predict consumer behavior interest in using technology is carried out.

- Determination of the structure of the cost and pricing has a significant influence on the use of technology. Price Value is a cognitive exchange between the perceived benefits of technology and the costs involved in using the technology (Venkatesh, Thong, and Xu 2012).
- Habit can be interpreted as a measure of the degree to which a person can behave automatically to use an application or technology without any coercion in it. Habits have a significant effect on the use of technology, especially in diverse and changing situations (Venkatesh, Thong, and Xu 2012). Based on this conclusion, the researcher assumes that this construct has a positive influence on behavioral intention so that the variable is adopted in this study.
- Task-Technology Fit (TTF) is defined as the level of the technology according to consumer needs (Clark 2021).
- Behavioral Intention is the consistency of the underlying theory in all intention models. Behavioral Intention is a variable that measures the level of individual intention on technology usage (Venkatesh, Thong, and Xu 2012). A person's intention to use technology has an impact on the frequency with which that person uses the technology. Based on this conclusion, the researcher assumes that behavioral intention needs to be included as the dependent variable to see the level of the intention to use technology.
- Use Behavior is defined as the level of a person's behavior towards the use of technology, or also how often a person uses technology (Venkatesh, Thong, and Xu 2012). This variable is related to a person's reaction and behavior to technology so that it has an impact on the frequency of using the technology.
- Satisfaction (SATIS) is a variable that states the level of user satisfaction in using technology (Baabdullah, Alalwan, Rana, Kizgin, et al. 2019).
- Age is a variable that states the age of the respondents who filled out the questionnaire. The Age variable acts as a moderator variable which is useful to find out how the age influences the acceptance of a technology (Venkatesh, Thong, and Xu 2012). Gender is a variable that states the gender of the questionnaire respondents (Venkatesh, Thong, and Xu 2012). Experience is a variable that states the level of experience of respondents in using technology (Venkatesh, Thong, and Xu 2012).

2.3. PLS-SEM

PLS-SEM is usually used for the purpose of predicting a model, explaining the validity of a hypothesis and also for exploration purposes. In previous studies, it was stated that PLS can also explain the relationship between latent variables and at the same time be able to analyze a construct both on formative and reflective indicators (Dajani and Abu Hegleh 2019). In this research, the researcher uses the PLS approach, because the method is considered more suitable for adoption. The stages of PLS-SEM analysis in this study consisted of model specification, parameter estimation model, structural model testing and measurement model testing (Sarstedt, Ringle, and Hair 2017).

2.4 Conceptual Model

From the literature review that has been carried out, the conceptual model that will be used in this study was obtained. The conceptual model is described in figure 1.

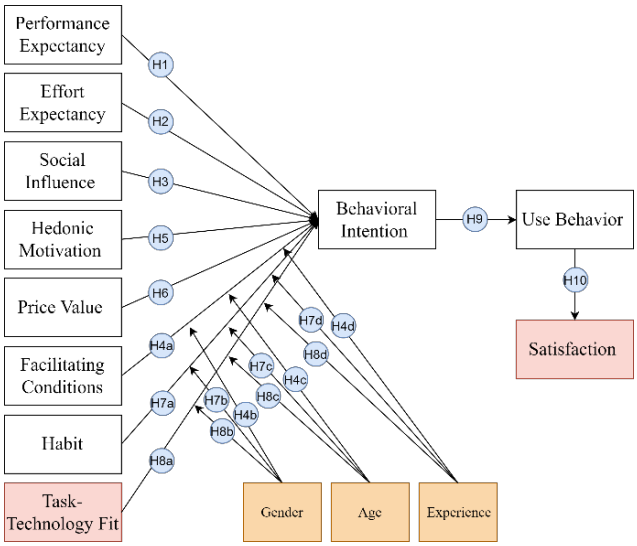

Figure 1. Conceptual Model

There are 14 variables in the conceptual model, which consists of 8 variables with addition task-technology fit, 3 endogenous variables with addition satisfaction, and 3 moderating variables.

2.5 Hypothesis

In this study, a hypothesis will be determined based on the UTAUT2 model developed by Viswanath Venkatesh, et al., in 2003 and 2012 which will be combined with research conducted by Clark in 2021 and Baabdullah's research in 2019 (Clark 2021), (Baabdullah, Alalwan, Rana, Kizgin, et al. 2019).

Table 1. Hypothesis

Code	Hypothesis
H1	Performance Expectancy → Behaviour Intention
H2	Effort Expectancy → Behaviour Intention
H3	Social Influence → Behaviour Intention
H4a	Facilitating Conditions → Behaviour Intention
H4b	Facilitating Conditions → Behaviour Intention Moderated by Gender
H4c	Facilitating Conditions → Behaviour Intention Moderated by Age
H4d	Facilitating Conditions → Behaviour Intention Moderated by Experience
H5	Hedonic Motivation → Behaviour Intention
H6	Price Value → Behaviour Intention
H7a	Habit → Behaviour Intention
H7b	Habit → Behaviour Intention Moderated by Gender
H7c	Habit → Behaviour Intention Moderated by Age
H7d	Habit → Behaviour Intention Moderated by Experience
H8a	Task-Technology Fit → Behaviour Intention
H8b	Task-Technology Fit → Behaviour Intention Moderated by Gender
H8c	Task-Technology Fit → Behaviour Intention Moderated by Age
H8d	Task-Technology Fit → Behaviour Intention Moderated by Experience
H9	Behaviour Intention → Use Behaviour

H10	User Behaviour → Satisfaction

Viewed from Table 1, there are 19 research hypotheses generated.

3. RESULT AND DISCUSSION

3.1 Analysis Outer Model

The evaluation of the reflective model measurement described in Table 4 includes validity testing using the AVE value, reliability testing on indicators using Cronbach's alpha value and composite reliability values.

Table 3. AVE Test Value

Variable	AVE	CA	CR
PE	0.821	0.793	0.741
EE	0.75	0.805	0.837
SI	0.776	0.817	0.805
FC	0.843	0.741	0.837
HM	0.753	0.797	0.82
PV	0.862	0.755	0.861
HT	0.843	0.816	0.797
TTF	0.904	0.858	0.829
HI	0.867	0.804	0.885
UB	1	0.88	0.927
SATIS	0.942	0.755	0.82

A variable is declared to have good validity if it has an AVE value > 0.5. Each variable has met the Convergent Validity criteria so that all variables have been declared valid. Based on the test table, the value of Cronbach's alpha and Composite Reliability for each variable is above > 70. So it can be said that all indicator data has met a good reliability test. After passing the reliability test on the measurement model, the next step is the researcher will conduct a structural test (inner model).

3.2 Analysis Inner Model

The next stage is to test the Structural model (Inner Model). This test aims to determine the relationship between the latent variables. This test can be known through the relationship between exogenous variables and endogenous variables, also between endogenous variables with other endogenous variables. So that it can be known whether the hypothesis of the study is significant or not based on available empirical data.

Table 4. R-Square, Q-Square Test Value

Variable	R^2	Q^2
Behaviour Intention	0.795	0.706
Use Behaviour	0.681	0.678
Satisfaction	0.499	0.486

Based on the table, it shows that the R-Square test value of the dependent variable Behavior Intention (BI) is 0.795 or 79.5%. This value shows the variance of changes in the endogenous Attitude variable which can be strongly explained by the exogenous variables that influence it

(Performance Expectancy, Effort Expectancy, Social Influence, Facilitating Conditions, Hedonic Motivation, Price Value, Habit, and Task-Technology Fit) of 79.5%, while the remaining 20.5% is explained by other variables outside the studied. The R-square test value of the dependent variable Use Behavior (UB) is 0.681 or 68.1%. The R-square value of the endogenous Satisfaction variable is moderately influenced by the exogenous variable (Use Behavior) which is 49.9%.

The value of Q^2 indicates that the dependent variable in this study, namely behavior intention, use behavior and satisfaction, has a high level of predictive effect, respectively 0.706, 0.678 and 0.486. These results indicate that the structural model of the development model proposed in this study has a high level of predictive effect.

Table 5. P-Value, T-Statistic Test Value

Code	Variable	P -Val	T -Val	Status
H1	PE → BI	2.429	0.008	Accepted
H2	EE→ BI	0.212	0.416	Not Accepted
H3	SI → BI	0.313	0.377	Not Accepted
H4a	FC → BI	1.116	0.133	Not Accepted
H5	HM → BI	0.765	0.223	Not Accepted
H6	PV → BI	2.173	0.016	Accepted
H7a	HT → BI	5.697	<0.001	Accepted
H8a	TTF → BI	3.272	<0.001	Accepted
H9	BI → UB	12.714	<0.001	Accepted
H10	UB → SATIS	10.617	<0.001	Accepted

The bootstrapping method is based on standard error values as the basis for calculating T-Statistics and P-Values. In this research, a two-tailed test was carried out because the expected t-statistic value was greater than 1.96 with alpha equal to 5% and p-value more than 0.05. In the table, it can be seen that the variables of effort expectancy, social influence, facilitating conditions and hedonic motivation have no significant effect on behavioral intention. This is because it is not in accordance with the criteria set by the current study, which are a t-statistic value of less than 0.961 and a p-value of more than 0.05.

Furthermore, the inner model analysis of the moderating effect is carried out. The test value obtained was obtained from the P-Value value and the T-Statistic value generated from the analysis using Warp software.

Table 5. P-Value, T-Statistic Test Value Moderating Effects

Code	Variable	P -Val	T -Val	Status
H4b	GEND * FC → BI	0.827	<0.001	Not Accepted
H4c	AGE* FC → BI	1.363	0.173	Not Accepted
H4d	EXP*FC → BI	2.629	0.004	Accepted
H7b	GEND * HT → BI	1.547	0.122	Not Accepted
H7c	AGE* HT → BI	2.061	0.039	Accepted
H7d	EXP*HT → BI	3.678	<0.001	Accepted
H8b	GEND * TTF → BI	3.064	0.06	Not Accepted
H8c	AGE* TTF → BI	0.41	0.681	Not Accepted
H8d	EXP*TTF → BI	3.709	0.001	Accepted

Based on Table 4.34, gender does not moderate the relationship between variables. That the age variable only has a significant effect on the relationship between habit and behavior intention. Meanwhile, the experience variable has a significant effect on the relationship between facilitating conditions and behavior intention, habit and behavior intention.

The results of the Performance Expectancy (PE) test with Behavioral Intention (BI) resulted in a t-statistic value of 2.429 and a p-value of 0.004. The analysis results obtained mean that performance expectancy has a significant effect, which means that Taspen Otentikasi provides benefits and helps solve problems faster for users.

The results of the Effort Expectancy (EE) and Behavioral Intention (BI) variables produce a t-statistic value of 0.212 and a p-value of 0.416, which is insignificant, indicating that the user feels a great effort in using the Taspen Otentikasi application.

The results of the Social Influence (SI) and Behavioral Intention (BI) variables produce a t-statistic value is 0.313 and a p-value is 0.377 which means that it has an insignificant effect, even though the influence of the environment to use technology is great, it does not have any influence on users' intention to use the technology.

The results of the Facilitating Conditions (FC) and Behavioral Intention (BI) variables resulted in a t-statistic value is 1,116 and a p-value is 0.133, moderated by gender resulting in a t-statistic value is 0.827 and a p-value of 0.204, moderated by age produces a t-statistic value is 1.159 and a p-value is 0.123 and moderated by experience based on the length of time the respondents using Taspen Otentikasi produces a t-statistic value is 2.388 and a p-value is 0.008. So as a measure an individual believes that the provision of facilities supports the use / acceptance of technology. This shows that the more comprehensive the supporting facilities, the more often the user will use it.

The results of the Hedonic Motivation (HM) and Behavioral Intention (BI) variables resulted in a t-statistic value is 0.765 and a p-value is 0.223, meaning that it does not have a significant effect on Behavioral Intention in using Taspen Authenticatio. The feeling of pleasure obtained by the user in using the technology does not influence the user's intention.

The results of the Price Value (PV) and Behavioral Intention (BI) variables produce a t-statistic value is 2.173 and a p-value is 0.016 which means it has a significant effect. This shows that the greater the benefits obtained by the user when using the Taspen Otentikasi application, the greater the user's intention to use the application.

The results of the Habit (HT) and Behavioral Intention (BI) variables resulted in a t-statistic value is 5.697 and a p-value is <0.001, which was moderated by age resulting in a t-statistic value is 2.061 and a p-value of 0.039 and which is moderated by experience of how long the user is using the technology produces a t-statistic value is 3.678 and a p-value is <0.001. This shows that the more accustomed the user is to use the Taspen Otentikasi application, the greater the level of frequency a user using the application.

The results of the Task-Technology Fit (TTF) and Behavioral Intention (BI) variables resulted in a t-statistic value of 2.503 and a p-value is 0.007, which was moderated by gender resulting in a t-statistic value is 3.064 and a p-value is 0.06, which was moderated by age produces a t-statistic value is 0.41 and a p-value of 0.681 and which was moderated by experience produces a t-statistic value is 3.709 and a p-value is 0.001. The results of the analysis obtained indicate that Task-Technology Fit has a significant effect, which means that the suitability of existing technology affects a person's intention to use technology.

The results of the Behavioral Intention (BI) and Use Behavior (UB) variables resulted in a t-statistic value is 12.714 and a p-value is less than 0.001. The results obtained indicate that Behavioral Intention has a significant influence on Use Behavior in using Authentication Taspen. Behavioral Intention indicates a person's desire/intention to use a certain technology.

The results of the Use Behavior (UB) and Satisfaction (SATIS) variables resulted in a t-statistic value is 10,617 and a p-value is less than 0.001. The analysis results obtained indicate that Use Behavior has a significant influence on Satisfaction in using Taspen Otentikasi. The relationship between the use of Taspen Otentikasi technology and user satisfaction in this study shows that the frequency of users in using the technology is significant, in which the higher the frequency of using the technology, the higher the level of user satisfaction in using the technology. This relationship is supported by data which stated that there is an increase in the number of users of Taspen Otentikasi from year to year.

From the various tests that have been carried out, the results of the final research model are presented in Figure 2.

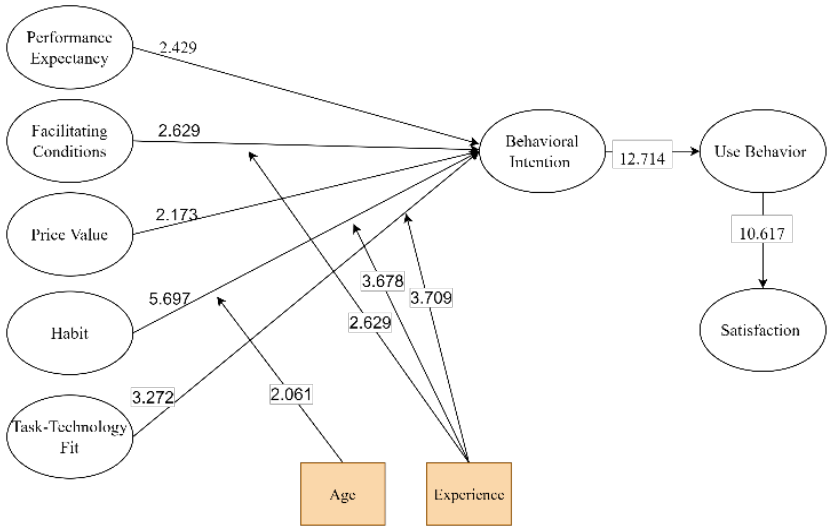

Figure 2. Final Research Model

Based on the final research model produced in this study, it can be seen that the variables of Performance Expectancy, Price Value, Habit, and Performance Expectancy have a significant influence on Behavioral Intention. Likewise, Behavioral Intention to Use Behavior, and Use Behavior to Satisfaction and Experience has a significant effect on moderating Facilitating Conditions and Habits on Behavioral Intention. All the relationships between the variables mentioned above have a significant influence.

Meanwhile, the variables Social Influence, Hedonic Motivation and Facilitating Conditions in this study did not have a significant influence on the endogenous variable, namely the Behavioral Intention variable so that these variables were not included in the final model of this study. Likewise, the moderating variables age and gender in using the Taspen Otentikasi have an insignificant influence on the relationship between the moderated endogenous variables (Facilitating Conditions and Habit on Behavioral Intention), so that these moderating variables not included in the final research model.

4. CONCLUSION

The results showed that of 19 hypotheses, there were 10 hypotheses that had a significant relationship. This study examines 10 main factors or variables, namely performance expectancy, effort expectancy, social influence, facilitating conditions, price values, habits, task technology fit, behaviour intention, use behaviour, and satisfaction. And 3 moderating factors or variables, namely gender, age, and experience. Where out of the 10 main factors, only 7 factors are influential, namely performance expectations, facility conditions, price value, habits, technological suitability of tasks, behaviour intentions, use behaviour, and satisfaction. From 3 moderating factors, only 1 influential factor is experience. Meanwhile, social influences, effort expectancy, hedonic motivation, age, and gender did not affect the behavior of using Taspen Otentikasi.

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A LITERATURE REVIEW OF METHODS ON HIGHEST AND BEST USE ANALYSIS

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ABSTRACT

The development of land investment requires the best use of land that can bring financial benefits to the company and gain added value to the land. Decision making on land use is often problematic by many variables and conflicting stakeholder goals. This requires the use of methods to support decision making for the highest and best land use by using HBU analysis. The development of studies on the best use of vacant land requires studies for decision making. Currently, research with HBU analysis is developing and several studies on land use decision making with different methods. This paper discusses previous research on HBU in the best use of land and other possible methods used for land development decision making. The method to be used is literature study a review of 15 relevant reputable journals from 2014-2021. The purpose of this paper is to get an overview of the research in the last few years on making the best land use decisions so that it can be used as a reference for further research.

Keywords: highest and best use, best land use, decision making

1. INTRODUCTION

Land and buildings are one of the properties that are in demand in investing because of their ability to inflation. The value of land and buildings tends to increase over the years. Determination of land use and utilization is an important factor in determining the right added value and benefits the company. Planning of buildings to be built on land determines the added value of the actual land value. In land use arrangements, one of the parties must make the best choice and decision on the use of land for a particular achievable purpose. A lot of land owned by individuals and companies that have not been used optimally and is often neglected. Optimization of its management is carried out by planning for the development of land functions so as to increase the value that provides financial benefits for the owner and supports regional development. One of the best land use decision-making concepts is to use the HBU concept. The HBU concept is to estimate what alternative uses of property will produce the highest present value of future benefits so that property owners can realize them (Fanning et al, 1994).

One approach to determining the use of land/property is reviewed HBU, where this approach is more favorable to the market or stakeholder opinion. HBU of vacant land or property it meets the requirements of being physically feasible, legally supported and financially feasible which yields

the highest value (The Appraisal of Real Estate, 2001). HBU based on an analysis of the most competitive and most profitable use of the property. This usage is influenced by the area where the property is located and the analysis of the property market in the surrounding area. HBUs require that their use is physically and legally feasible, properly supported by public infrastructure and markets and that their use is financially feasible. Alternative land functions in the HBU concept can be in the form of the development of one function or mixed use. HBU is a valuation concept on land or buildings which is usually assumed to be the most profitable land use that can maximize the owner's wealth (Dotzour, 1990). The value of a property depends on the development of land with several alternative properties based on the principle of Highest and Best Use (Ratterman, 2008). By complying with the principle of Highest and Best Use, the property value will be optimal in accordance with the provisions and the market.

2. LITERATURE REVIEW

This paper aims to identify the use of the most profitable and competitive methods for further studies in land use decision making and to develop new knowledge that provides direction for further reputable studies (Kuncoro, 2003). In general, the type of research is divided into 2 types, namely quantitative and qualitative research. The quantitative method is a method that explains the data obtained into statistics, while the qualitative method is a method that explains the data obtained descriptively to produce meaning and understanding of something (Yusuf, 2016). For research data sourced from primary data and secondary data, for primary data is data collected by researchers directly through questionnaires and interviews. While secondary data is data that has been collected and analyzed previously through previous research (Adam et al, 2007).

3. METHODS

The papers used in the theoretical mapping are papers obtained from various reputable journal sources. This is done to ensure the academic standard of the literature analyzed in the paper [18]. In this literature review, there are 15 publications from 2014-2021. Table 1 will list the journals used and their ranking based on SJR. Here is a list of journals that are used along with their rankings based on the SJR. These journals are: Land Use Policy (Q1), Journal Cities (Q1), Journal of Computers, Environment and Urban Systems (Q1), cultural heritage (Q1), Journal of Environmental Science & Policy (Q1), Journal of Global Environmental Change (Q1), Habitat International (Q1), Journal of Landscape and Urban Planning (Q1), Transportation Research, Part A: Policy and Practice (Q1), Journal of Behavioral and Social Sciences Librarian (Q3), International Journal of Development and Sustainability (Q4)

Table 1. Selected journal publications

Journals Publication	SJR	Q category	Number of papers
Journa of Land Use Policy	1.668	Q1 in Social Sciences: Geography, Planning and Development	4
journal cities	1.771	Q1 in Social Sciences: Urban Studies	1
Journal of Computers, Environment and Urban Systems	1.549	Q1 in Social Sciences: Urban Studies	1
Journal of cultural heritage	0.663	Q1 in Arts and Humanities: Conservation	1
Journal of Environmental Science & Policy	1,716	Q1 in Social Sciences: Geography, Planning and Development	1
Journal of Global Environmental Change	4.659	Q1 in Social Sciences: Geography, Planning and Development	1
journal of Habitat International	1.542	Q1 in Social Sciences: Urban Studies	1
Journal of Landscape and Urban Planning	1.938	Q1 in Social Sciences: Urban Studies	1
Journal of Transportation Research, Part A: Policy and Practice	2.178	Q1 in Decision Sciences: Management Science and Operations Research	1
Journal of Behavioral and Social Sciences Librarian	0.18	Q3 in Social Sciences: General Social Sciences	2
International Journal of Development and Sustainability	0.179	Q4 in Environmental Science: General Environmental Science	1

4. THEORETICAL MAPPING

Furthermore, a theoretical mapping was carried out on the collected literature, the results showed that there were various methods for making the best land use decisions. The research method uses qualitative methods and some uses quantitative as well as primary and secondary data types. There are several kinds of variables depending on the method used. Table 2 will present the results of the explanation of the theoretical mapping.

Table 2. Theoretical mapping from previous research

no	Author/Year	Research type and data				Method
		Secondary Data	Primary data	Quantitative	Qualitative	
1	Adebayo, 2015	Y	Y	Y	N	HBU and Regression Analysis
2	Ribera et al, 2020	Y	Y	Y	N	Literature review, HBU and AHP
3	Ustaoglu et al, 2020	Y	N	Y	Y	Literature review AHP, Fuzzy AHP and Sensitivity analys
4	Nesticò et al, 2020	Y	Y	N	Y	Literature review, Linear Programming (LP), Goal Programming (GP) and ANP
5	Popovic et al, 2019	Y	N	Y	Y	Literature review and MCDM
6	Martins et al, 2021	Y	N	Y	N	Literature review, case study and quigg model
7	Morano et al, 2016	Y	N	Y	N	Literature review, case study, MCDA and AHP
8	Spina, 2016	Y	N	Y	N	Literature review, case study, MCDA and AHP
9	Mosadeghi et al, 2015	Y	N	Y	N	Literature review AHP, Fuzzy AHP and Sensitivity analys
10	zheng et al, 2015	Y	N	Y	N	Literature review, Clue S model and Regression Analysis
11	zhuang et al, 2019	Y	Y	Y	Y	Literature review, interview, survey and weighting of criteria
12	Langemeyer et al, 2016	Y	N	N	Y	Literature review, case study and weighting of criteria
13	Hersperger et al, 2018	Y	N	N	Y	Literature review and research
14	Hrelja, 2015	Y	Y	N	Y	Literature review and case study
15	Butsic et al, 2014	Y	Y	Y	N	Case study, HBU and LMB

5. RESULTS

In this section, the analysis carried out is by using a literature positioning analysis based on data sources and types of research. Furthermore, it will be grouped based on the year of preparation. This can be seen in Figure 1 below. Determining the best land use decision in this literature review uses previous data sources, literature reviews from government data and results from previous studies. Some use case studies in research [6], [7], [8], [12], [15] and use interviews in research [11]. for the method, use more quantitative methods. Urban land use considers the correlation between HBU and accommodation, type of building, building costs and land costs [1]. The aim of the HBU research is to restore the use value of the historic Palazzo Genovese building in Salerno, Italy [2]. to evaluate the suitability of land use in the pendik area, Istanbul Turkey using aspects geo-physical, accessibility, built-up areas and infrastructure, vegetation, and green facilities [3]. Multi-criteria decision-making involves multiple interests, and is multi-objective with a view to social, financial, environmental and cultural sustainability [4]. To evaluate urban land that is unexploited in Portugal, property development by evaluating the real estate market with the contribution of real options analysis, using the Quigg model [6]. For optimal land use selection, some use the MCDM and AHP methods involving aspects of capacity, demand and opportunities, corporate strategy, promotion, industry competition stri and government [5], [7], [8].

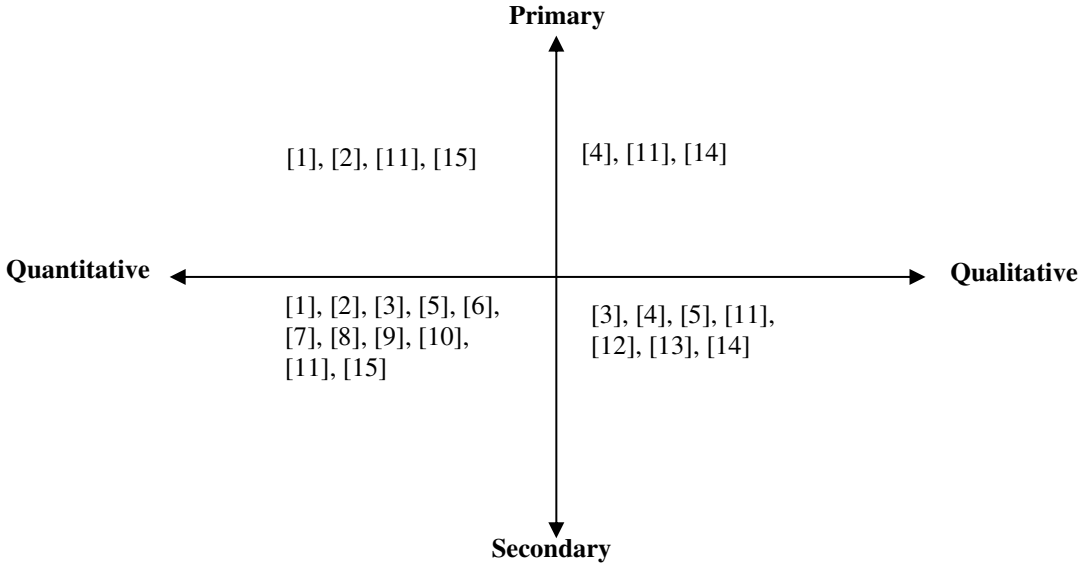

Figure 1. Mapping of literature on research types and data

Based on Figure 1, the research method that is widely used is research that uses quantitative method with secondary data. For the second order uses qualitative type with secondary data.

6. CONCLUSIONS

Based on the above discussion, the HBU method is used to determine the best land use and it is concluded that there are several research methods identified that were used in previous research on the best land use decision method. Most of the research from 2014 to 2021 discussed in this study is Research using quantitative methods with secondary data types. It's the method most often carried

out, this is described in the journals [1], [2], [3], [5], [6], [7], [8], [9], [10], [11] and [15]. The results of this study are expected to be useful in further research in this field, especially in determining the research methods and data used in the study. In addition, further studies can also use the approach generated in this paper. This paper can help further research on the best land use with the right method and analysis

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SYSTEMATIC LITERATURE REVIEW : INFLUENCE OF LIFESTYLE, VISUAL COMFORT AND LIVING AREA WITH INTEREST TO BUY MULTIFLOOR HOUSING

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ABSTRACT

The Millennial Generation in 2020 makes up 64% of the total population in Indonesia. The increasing population certainly has an impact on housing development and what millennials want from it. Hence, there needs to be in-depth analysis on what millennials seek in housing. The intention of purchasing a house is a person's behavioral response to wanting to own property and one must understand the millennial intent to understand the direction of housing development in the years to come. The research method used in this study is the SLR (Systematic Literature Review) method. This research aims to review, evaluate and interpret previous research by describing their methodology and key findings. The purpose of this research is to identify millennials' interest in buying multi-floor housing so that developers have guidance in building housing relevant to current needs.

Keywords: interest to buy, lifestyle, living area, multi-floor housing, visual comfort

1. INTRODUCTION

The Millennial Generation in 2020 makes up 64% of the total population in Indonesia. The increasing population certainly impacts housing development and what Millennials want from it. Hence, there needs to be more analysis on what Millennials seek in housing. The intention of purchasing a house is a person's behavioral response to wanting to own property. Property-seeking Millennials are influenced by a variety of factors. Lifestyle is the most significant.

Lifestyle is identified by how a person spends their time on activities, what they consider important in their environment, and what they think about themselves and the world around them. The lifestyle of one society is different from another. Even over time, the lifestyle of individuals and community groups will move dynamically. However, lifestyle does not change quickly. Meaning that for a period, cultural lifestyle is relatively stagnant. (Setiadi, 2008).

In addition to lifestyle, many activities occur at home. Hence, it is necessary to have room for movement to support activities for its residents. While at home, residents need comfort and space to carry out their activities. One of the comforts that can affect activities is visual comfort (e.g. lighting) and the property size. These are important factors that millennial value when searching for housing.

In the research, part one describes the composition of the Systematic Literature Review in this study . Part two explains the research methodology used, the year of publication, and the journal findings that were compiled into one. Part three discusses the influence that lifestyle,

visual comfort and living area has on millennials looking to buy property. Section four provides a summary and concludes the results of the Systematic Literature Review.

2. METHODS

This study uses a Systematic Literature Review (SLR) which summarizes research done from 2010 to 2020 on the influence of residential buying interest. SLR is based on journals sourced from several databases including Science Direct and Google Scholar.

The keywords used to search the journal are "residential buying interest," "the influence of lifestyle on buying interest," "the influence of visual comfort on buying interest," and "the influence of living area on buying interest."

After using keywords, 10,451 articles were obtained. Then, filtered by relevant journals, namely those published in scientific journals. From these results obtained 7,581 journals. From the previous number, they were sorted again to obtain a total of 12 journals relevant to this research.

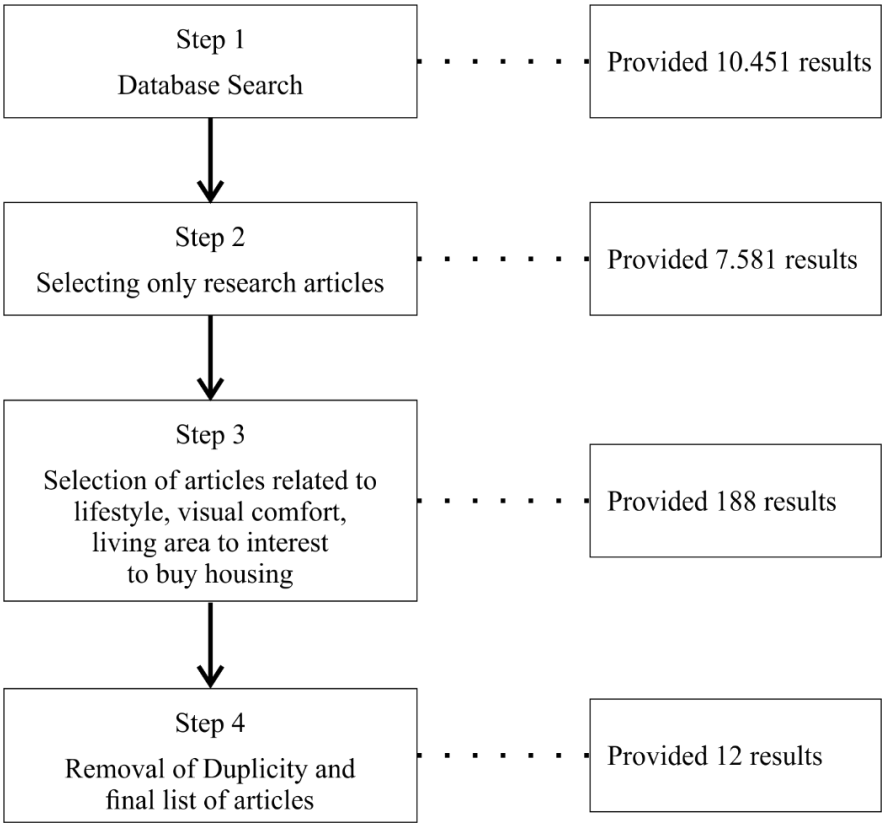

Figure 1. Steps to identify a research journal

3. RESULTS

Identify journals based on the year of publication and the journals that have been published.

3.1 Year of Publication

In the findings of journals from year to year, 2020 saw an increase of 388 journals. Meanwhile, in 2016 and 2017 there was no significant increase. The increasing number of publications from 2019 to 2020 shows that researchers saw a phenomenon about the influence of

interest in buying housing. This coincided with an increase in the population of the millennial generation in 2020.

3.2 Journal

There are 12 journals in the SLR, consisting of different journal sources. The following is a summary of the journals that have been obtained.

Table 1. Research journal

No.	Authors (years)	Type of study	Research methodology	Key findings/contribution
1.	Sulistyawati (2019)	Conceptual	Qualitative research	There is a significant influence between the Industrial Revolution, Millennial Generation and Physical Settings on the Behavioral Patterns of Residential Users
2.	Fahimah (2020)	empirical	Regression Model	Price, design and lifestyle affect residential purchasing decisions
3.	Nurdin (2018)	empirical	Quantitative research	lifestyle, perceived value and customer value can form well and positively people's buying interest
4.	Azizah (2018)	empirical	Explanatory research	price, location and lifestyle have a significant and positive influence on purchasing decisions.
5.	Maedot (2019)	Conceptual	Literature review	In addition to indoor environmental conditions, occupant characteristics, building-related characteristics, and the outside environment can significantly affect occupant comfort at MURB
6.	Prajogo (2020)	Conceptual	Quantitative research	lifestyle has an impact on the development of apartments from year to year, namely changes in unit area, completeness of space and also the amount of space in the dwelling.
7.	Lutfi (2020)	empirical	Explanatory research	The direct influence of consumer behavior and lifestyle has an impact on buying interest and purchasing decisions that is greater than the indirect effect
8.	Farraz (2020)	empirical	Quantitative & qualitative research	There is a lifestyle paradox between the two groups of Gen Y Junior and Gen Y senior, which is influenced by housing location and accessibility of educational facilities on housing purchase intention.

9.	Difarissa (2014)	empirical	Quantitative research	the area and size of the building, garage, number of floors, design, material, area and layout of the dwelling, affect consumer buying interest
10.	Zhang (2020)	empirical	Survey based	between lifestyle and housing preferences including travel, eating habits, shopping, basic education and exercise habits have an influence on housing selection decisions
11.	Listyorini (2012)	empirical	Explanatory research	Lifestyle factors with an approach to activities, interests and opinions, which initially consisted of 3 factors, became 5 factors that consumers considered in choosing a house, namely social, household, reference, fun and identity factors.
12.	Suriansyah (2019)	empirical	Simulation research	visual comfort in apartment housing that has green building certification has an impact on customers in choosing housing

Lifestyle can affect buying interest and customer purchasing decisions in choosing the house (Fahimah,2020; Nurdin, 2018; Azizah, 2018; Zhang, 2020). The younger millennial generation without children prioritize family, public transportation facilities, and prefer to live in the suburbs. The older millennial generation (who already have children) focuses on social status and prefers urban areas with complete amenities close to schools (Farraz, 2020). Different lifestyles influence social status. Resulting in different interests and decisions that residential buyers make (Zhang 2020).

In addition, lifestyle also has an impact on the development of apartments every year. The biggest challenges are changes in unit area, completeness of space, and the size of the dwelling. There needs to be a solution to be more efficient and effective due to changes in the unit's space area by analyzing the occupancy size, zoning, layout, circulation, and space. (Prajogo, 2020).

The space and the size of the building influence interest in buying housing because housing with a sufficient area accommodates the movement activities of its users while in residence (Difarissa, 2020; Prajogo, 2020). Indoor activities carried out by users can affect performance, so visual comfort can also be considered in every corner of the room, especially since the residential building has been certified as a green building (Suriansyah, 2019).

4. CONCLUSIONS

The Systematic Literature Review in this study was found in 12 research journals sourced from databases published in 2010-2020 time figures. The key findings of the Systematic Literature review in this study are:

- Various research techniques were carried out using quantitative, qualitative, explanatory, and simulation techniques to identify the influence of lifestyle, visual comfort, and residential area on residential buying interest.
- In 2010-2020 there was an increase in research on residential buying interest and several factors that influence it (especially in years 2019-2020. This is in line with the increase of millennials in 2020.

The results of the study illustrate that previous researchers have seen the effect that lifestyle changes have in regards to housing needs This is seen every year with an increase in the number of research journals from 2010 to 2020. The lifestyle influence that has been studied in depth finds that lifestyle can affect social status, the area of occupancy, and also the comfort needed by residential users later.

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METHODOLOGY REVIEW IN LAND USE SELECTION: COMBINING HIGHEST AND BEST USE AND DECISION MAKING

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ABSTRACT

Land conversion produces productive land value or productive land along with the building. Highest and best use (HBU) identifies the most profitable and competitive permitted use of the property for land use. In determining land use selection, HBU requires more analysis, because HBU is a subjective assessment that is basically unable to accommodate decision making by stakeholders in it. Therefore, stakeholder assessment is carried out to determine the best alternative in land use selection. Several relevant researches that are reputable were collected and analyzed. This paper will describe previous researches on HBU and decision making in land use considering their required methods and data. About 15 relevant reputable papers were collected published from 2013-2021. Furthermore, the papers will be mapped according to their methods, namely qualitative or quantitative and based on their sources that are primary data or secondary data. The purpose of this paper is to obtain research opportunities in the future on HBU and decision making so those future researches are renewable and use the correct methods and data.

Keywords: land use selection, highest and best use, decision making, previous researches

1. INTRODUCTION

The development and growth of city is commonly followed by population growth, economic growth and land conversion (Kumar and Sangwan, 2013). Land provides wealth as the site of income-generating activities or as the source of natural resources. Land use is increasing to meet the needs of communities such as settlements, industry and public infrastructure that will result in reduced land availability (Rupini, 2017). Many land conversions do not provide benefits and are unable to compete with surrounding properties. One of the causes of abandoned properties is the absence of Highest and Best Use (HBU) analysis on a land before it was developed. Highest and best use can be defined as the reasonably probable use of property that results in the highest value. Although the parcel may be improved, the application of highest and best use analysis will still require the development of an opinion of land value (Rattermann, 2018). The choice of HBU requires a rational study approach that can employ the Multi-criteria Decision Making (MCDM)(Ribera et al., 2020) .

Decision making analysis is necessary considering to accommodate stakeholder goals in land use selection. Wang (2018) states that land use decision making requires knowledge integration from a wide range of stakeholders across science and practice. So that highest and best use calculating is followed by decision making analysis. There are several approaches that can be used in decision-making analysis on land use. This article aims to identify methods that can be used for

future studies in land use decision making. The approaches used in previous research are a reference for relevant future research so that methods and data are appropriate and renewable.

2. LITERATURE REVIEW

2.1 Highest and Best Use

HBU is defined as the possible legal and logical use of a property, physically qualified, financially viable and enabling it to deliver the highest value. HBU has four criterias, namely legal aspect, physical aspect, financial aspect, and maximum productivity (Rattermann, 2018).

2.2 Decision Making

Simultaneous investment corresponds to a static decision-making process. By integrating different local and scientific knowledge sources, it may be possible to develop a more rigorous understanding of the future (Johnson et al, 2004), and thus increase the possibility of application of the research results into decision making.

2.3 Methods of Previous Research

2.3.1 Data Types of Research. In general, the type of research is divided into 2 namely quantitative and qualitative research. Aliaga, and Gunderson (2002), describes quantitative research methods as the explaining of an issue through gathering data in numerical, while Shank (2002) defines qualitative research as a form of systematic empirical inquiry into meaning. Primary data is data collected by researchers directly. Secondary data is data that has been collected and analyzed by others.

2.3.2 Previous Methods. Some methods used in previous research regarding land use selection are showed below

a. Multi-Criteria Decision Making (MCDM)
   The fundamental procedure for multi-criterion decision making is to determine the appropriate MCDM tools to solve the problem under consideration. The selection of the MCDM tool that best suits the objectives of the decision-making problem can significantly affect the efficiency of the evaluation process. (Haroun et al., 2019). Saaty (2013) proposed several tools used in MCDM such as Analytic Hierarchy Process (AHP) and Analytic Network Process (ANP).
b. Fuzzy Delphi
   The Delphi method was introduced by Dalkey and Helmer (1963) and has been broadly applied in topics that require a consensus among experts. Fuzzy inference was used to measure the influence factors of each category of project based (Chen et al., 2018).
c. Real Option Theory (ROT)
   ROT is used to evaluate real assets, which are not traded such as capital investment projects, intellectual property evaluation, natural resources and research and development project evaluations. While the initial application area was financial markets, over the past years many different topics were been included to defer, to abandon, to switch inputs-outputs of risky assets, to alter operating scale, to growth options, to stage the investment (Schwartz & Trigeorgis, 2001; Guthrie, 2009; Bravi & Rossi, 2013)
d. Discounted Cash Flow (DCF)
   Discounted Cash Flow supports verification of the financial feasibility of the investment. In the DCF analysis, cash flows are represented by the difference in each time period between revenues due to sales or services and costs. This increase in wealth, assessed at the initial moment that the operator achieves thanks to the investment, is defined as the Net Present Value (NPV), is the first indicator of the profitability of the investment calculation (Della Spina, 2021).

e. Monte-Carlo Simulation
In project management monte-carlo simulation is used to calculate the cost and time of a project using randomly selected values of the probability distribution of costs and possible time, with the aim of calculating the distribution of the probability of the cost and the total time of a project (Project Management Institute, 2013). Monte-Carlo for DCF involves simulations of thousands of paths the underlying asset value can take during the time span of the project, given the boundaries of the cone of uncertainty (Bravi & Rossi, 2013).

3. METHODS

This study uses a literature review from previous studies. 15 relevant reputable papers were collected for analysis. Various sources from reputable journals in this study are analyzed. Those journals are published from 2013-2021 by quartile 1 to 3. The list of papers with rank and SJR of each journal are listed in Table 1.

Table 1. Selected relevant reputable journals

Journal Publication	SJR	Quartile Category	Number of Paper
Journal of Cultural Heritage	0.66	Q1 in Economics, Econometrics, and Finance	1
Sustainable Development	1.12	Q1 in Development	1
Land Use Policy	1.67	Q1 in Geography, Planning and Development	3
Alexandria Engineering Journal	0.58	Q1 in Engineering	1
Habitat International	1.54	Q1 in Nature and Landscape Conservation	1
Aestimum	0.21	Q3 in Economics, Econometrics, and Finance	1
Buildings	0.58	Q2 in Building and Construction	1
Sustainability (switzerland)	0.61	Q1 in Geography, Planning and Development	2
Real Estate Management and Valuation	0.3	Q3 in Economics, Econometrics, and Finance	1
Sustainable cities and society	1.65	Q1 in Geography, Planning and Development	2
Economic Development Quarterly	0.68	Q1 in Urban Studies	1

Based on Table 1, information about 15 relevant reputable papers were obtained to analyze land use selection using highest and best use and decision making. Next each paper will be grouped according to the data type used. It aims to find out what methods are used in the analysis of land use selection. The papers are then regrouped by year of publication to find out their novelty.

4. RESULTS

Based on the results of the literature review of 15 previous papers, it mentioned what data types are used in land use decision making. Grouping methods is notated with Y if the paper uses that data type, and with notation N if the data type does not match. After that it is also mentioned what types of methods are used to support the data type obtained. And the recapitulation of the theoretical mapping is listed in Table 2.

Table 2. Theoretical mapping of previous research

Land Use Selection	Type and Data of Research				Methods
	Qualitative	Quantitative	Primary	Secondary	
Ribera et al., 2020[1]	Y	N	N	Y	Literature review, HBU, AHP
Walacik et al., 2020 [2]	Y	Y	N	Y	Literature review, HBU, Scenario analysis
Lavee, 2015 [3]	N	Y	Y	Y	Regression, land value estimation
Wang et al., 2018 [4]	Y	N	Y	Y	Literature review, survey, observation
Linkous & Skuzinski, 2018 [5]	Y	N	N	Y	Descriptive, institutional analysis and development
Haroun et al., 2019 [6]	Y	N	N	Y	Literature review, descriptive, AHP
Chen et al., 2018 [7]	Y	Y	N	Y	Descriptive, Fuzzy delphi, ANP
Bravi & Rossi, 2013 [8]	N	Y	Y	Y	Monte-carlo simulation, DCF
Spina [9]	Y	Y	N	Y	HBU, Case study, AHP, DCF
Kim et al., 2020 [10]	Y	Y	Y	Y	HBU, interview feasibility study, fuzzy theory, AHP
Holloway, 2020 [11]	Y	N	Y	Y	Literature review, survey, Markov-chain Monte-Carlo
Grzesik & Źróbek, 2017 [12]	Y	N	N	Y	HBU, literature review
Rahman & Szabó, 2021 [13]	Y	Y	N	Y	Pareto front-based, reviews and meta-analyses, literature review
Bacca et al [14]	Y	Y	N	Y	GIS/MCDA, Mixed-Integer programming, NPV
Chapple, 2014 [15]	Y	Y	Y	Y	Literature review, descriptive, survey, regression

The use of MCDM such as AHP and ANP is used in paper [1], [3], [6], [7], [9], [10], [13]. Papers using DCF analysis are [2], [3], [8], [9], [10], [14]. Paper [7] and [10] also use fuzzy approach. Paper [8] and [11] have an additional monte-carlo approach.

According to the theoretical mapping, the papers are illustrated in a diagram based on a combination of type and data research usage. Papers will be grouped into primary-quantitative, primary-qualitative, secondary-quantitative, and secondary-qualitative. The mapping diagram is mentioned in Figure 1.

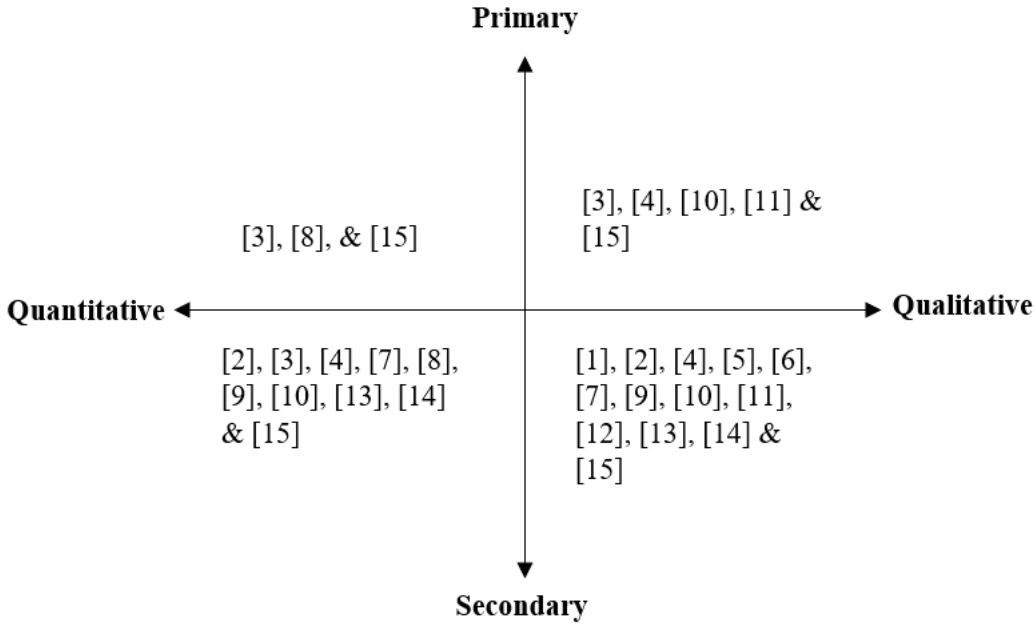

Figure 1. Mapping diagram of type and data research

Based on figure 1, it is mentioned that the most dominant method used is research that uses qualitative types with secondary data. Followed by paper using quantitative types with secondary data. Papers using the primary-quantitative approach are paper [3], [8], & [15]. The papers conduct a direct search of data and then analyze the calculations to determine alternative land use. Papers with a primary-qualitative approach are paper [3], [4], [10], [11], & [12]. All of these papers actually do not fully use the primary-qualitative method, but secondary data is still needed to support research. In this method, researchers conduct surveys or in-person interviews with stakeholders. Paper [2], [3], [4], [7], [8], [9], [10], [13], [14], & [15] use secondary-quantitative methods with a literature review approach then performed calculations such as DCF, monte-carlo simulation, and others. Paper [1], [2], [4], [5], [6], [7], [9], [10], [11], [12], [13], [14], & [15] use secondary-qualitative methods where literature review is conducted and then analysis of decision-making with related tools.

According to the review, not many papers use a primary-quantitative approach because in determining land use is not enough to look for data directly and by calculation only. In land use decision making, previous data on land and the opinions of experts or related stakeholders who understand objects from various disciplines are required. This is supported by the number of land use papers that use a secondary-qualitative approach. Quantitative approaches also need to be done such as HBU or DCF calculations, but in the selection of land use still requires further analysis, especially accommodating the opinions of experts.

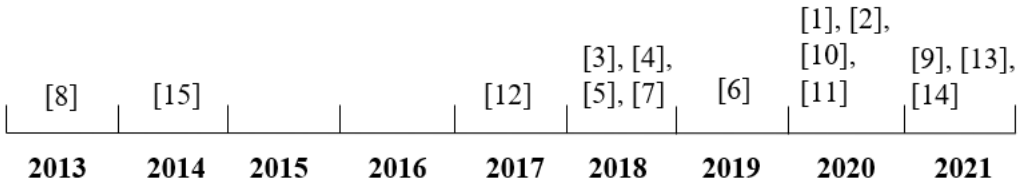

Figure 2. Mapping by year of paper published

Figure 2 shows the mapping of year papers were published. In collecting 15 relevant papers it took the last 10 years to find a pattern of improved approaches. The more relevant papers reviewed, the better the results of mapping methods for further research. Paper [8], and [15] were published in 2013 and 2014, while 12 other papers were published between 2017 and 2021. The mapping papers based on their year of publication can define their novelty considering the methods used for future research.

6. CONCLUSIONS

The most widely used method is research with qualitative methods using secondary data types described in papers [1], [2], [4], [5], [6], [9], [10], [11], [12], [13], [14], and [15]. It shows that in land use selection requires more analysis that can accommodate the opinions of experts and related stakeholders. From the explanation above, it is also obtained that the most widely used analysis in land use selection combining with highest and best use is MCDM approach mentioned in papers [1], [6], [7], [9], [10], and [14]. This paper can help future research on land use selection by using appropriate methods and analysis.

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DESIGN THINKING FOR INNOVATION: DEVELOPMENT OF "BILL SPLITTING" FEATURE IN DIGITAL PAYMENT

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ABSTRACT

Digital payments as a transaction solution are currently experiencing growth and popularity around the world due to the many conveniences and benefits. However, despite the benefits offered, digital payments still face a situation in their adoption and use, especially in the process of dividing payments to fellow users in a transaction. The payment process for a group is represented by individuals, but in its division or split bill to each member provides unequal calculations and the use of time obtained is less efficient. This research develops digital payment innovations to help users in sharing transactions with fellow users to be effective and efficient. The methods used in this study using Design Thinking with five main stages, namely empathize, define, ideate, prototype, and test. The study found digital payment innovations together in one transaction (jointventure) or split bill with the recommended additional features, namely Optical Character Recognition. (OCR), split bills that can choose according to purchase items, split bills that can divide equally the nominal payout,and split bills that can write the division of payments manually.

KEYWORDS
Digital Payments; Split Bill; Design Thinking; Innovation.

1. INTRODUCTION

The use of gadgets such as mobile phones in this time is very much a major need by living things. The use of mobile phones becomes more widespread, one of which leads to finance totake over in the process of transactions and money storage. In doing the process, there needs to be internet assistance (Nurqamar, 2021). The process that includes transactions using gadgets and the internet can be referred to as fintech, where fintech or financial technology is related to the economic and technological fields, so it can be mentioned that fintech is a combination of economy and technology (Erturk, 2016). Fintech has a purpose for the process of funding or financial transactions online (Aydin, 2016). One form of fintech that we can find is Digital Payment. Digital Payment is a fintech-type gadget feature that can function in making transactions and also as a money storage medium (Dastan, 2016).

Lockdowns, online shopping, and fear of germs during the COVID-19 pandemic have hastened the shift toward all types of digital payments. Gen Z, particularly, has fully embraced electronic wallet services, contactless payments, peer-to-peer (P2P) payment apps, and digital uses of credit, including buy now, pay later (BNPL). Digital Payment users, especially in Indonesia, always increase from time to time, this is seen from the data presented by Bank Indonesia. There was an increase of 57.4% which means that there is a change in user behavior or lifestyle of Indonesian society. According to Bank Indonesia the value of electronic money transactions reached a total of 23.7 trillion, taken for data in 2020 (Indonesia, 2020).

The increasing use of Digital Payments in Indonesia is not only for transactions in the online shopping process but in other shopping transaction processes as well. The condition of using Digital Payments in everyday life can be used to conduct individual or group transactions, for example when the people shared moments together, it was often in person – whether at the movies, sharing brunch or hanging out at the mall, and of course, splitting the bill. Over the past two years, the pandemic has evolved new digital ways to share moments with friends, supported by technology. In the transaction process to meet the needs of the group, there will be a process of distributing payments to someone who made the previous payment. Currently the process of splitting bills or split payments is done manually, namely by dividing based on ordered and other bills that need to be divided equally such as taxes and so on. This results in uneven payments and does not match the nominal that should be paid. This also results in the process being less efficient because the process is quite time consuming. Difficulty in doing split bill supports the need for Digital Payment in having a split bill feature. Split Bill can provide convenience to users in billing transactions made. With the split bill feature users will be more efficient in the use of billing time. This research builds a split bill feature on Digital Payments using the design thinking method approach.

2. LITERATUR REVIEW

A. Design Thinking

Design thinking is the process of creating new and innovative ideas that can solve problems (Pressman, 2019). Design Thinking has five main stages: empathize, define, ideate, prototype, and test. The first three stages of design thinking are important steps where there will be a design process and relationships with system users (Balaram, 2011). In this study using design thinking using the five keys in design thinking. Figure 1. Demonstrate the stages of design thinking.

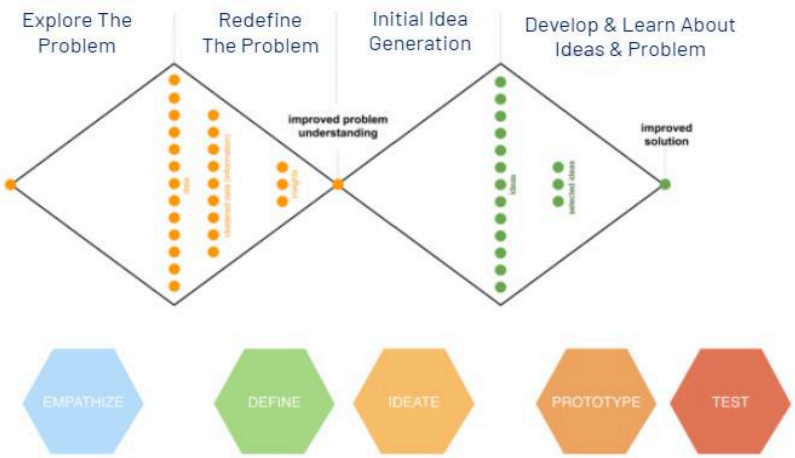

Figure 1. Design Thinking Stage Flow

1. Emphathize
   The empathize stage aims to collect information and understanding empathy from prospective users who are the target of the Digital Payment. At this stage we divide into 2 sub-sections namely quantitative research (survey) as the initial trigger for the submission of ideas and qualitative research (interview) to explore further user problems. Quantitative survey method which is a method of data retrieval to obtain diversity of understanding and experience from a population. (Vogt, 2011). This method is used when research requires information that is more than just an absolute choice. For example, such as comments, feedback, stories, suggestions and other responses related to the problems they experience where the answer is difficult to present in the form of numbers. After quantitative research, the next stage is qualitative research to dig deeper into the problem and validate the qualitative research hypothesis before (Silverman, 2022).
2. Define
   Define is the stage of analyzing and understanding the results that have been carried out in the Emphatize process. the process of analyzing and understanding various insights that have been obtained through empathy, with the aim of determining the problem statement as a point of view or main concern for research (Simon, 1996).
3. Ideate
   Ideate is a transition process from problem formulation to problem solving, while in this ideate process it will concentrate on generating ideas or ideas as a basis for making prototype designs that will be made (Deaton, 2003).
4. Prototype
   Prototype is known as the initial design of a product to be made, to detect errors early and obtain new possibilities. In its application, the initial design made will be tested on users to obtain appropriate responses and feedback to improve the design (Deaton, 2003).
5. Testing
   Testing is carried out to collect various user feedback from various final designs that have been formulated in the previous prototype process. This process is the final stage

but is a life cycle so that it allows looping and returning to the previous design stage if there are errors (Deaton, 2003).

B. Digital Payment

A digital payment is the transfer of money or digital currency from one account to another using digital payment technologies, such as mobile wallets or mobile payment apps. Digital payments can also be referred to as electronic payments. (Chen, 2008). Digital payment itself is very easy to use and efficient in saving money in smartphone electronic devices (Yang, Lu, Gupta, Cao, & Zhang, 2012). Payment methods using digital payment services are more often used because they are more practical, efficient and have many attractive promos. Promos provided by digital payment services such as discounts and cashback. Currently, there is a shift in the focus of cellular service providers from developed countries to developing countries. Emerging markets have set the pace when it comes to the adoption and use of digital payments. Digital Payment has a positive impact and more benefits on users. The advantages obtained by users are in terms of time, economy, versatility, use of cash, and search for the use of money. In its development Digital Payment has been used on online shopping platforms (Muniraju, 2019).

C. Split Bill

The "Split bill" feature lets users split bills with other users and helps them keep track of how much everyone owes. The users can use it to send money to the person who paid, or request that others pay them with cash or their apllication pay balance.

3. METHOD

This research was conducted using design thinking methods. The stage of this research starts from the empathize stage, the stage is equipped with data collection with a combined method that starts from Quantitative Research and then qualitative research. The second stage is define, researchers use several methods to complete this define stage, such as affinity mapping, user charm, emphaty map, and as-is scenario. Furthermore, in the third stage, namely design using Hi-Fi Design and supported in the next stage, namely prototyping. The final stage in this research method is to do testing using usability testing methods. One of the main roles in this research process is the user, because the final result is focused on the user. Researchers see that the design thinking method is very suitable for use in this study, considering that it will use and fulfill the main Digital Payment users.

4. RESULT AND DISCUSSION

Broadly speaking, design thinking is a collaborative method that gathers many ideas from disciplines to obtain asolution. Design thinking is very useful in relation to technologies that are synonymous with startup companies (Loewe, p. 2019). This method can create new products and services for consumers, to increase productivity in internal operations. The details of the process of this research can be seen in figure 1.

Figure 2. Research Flow with Design Thinking Methods

1. Empathize

Qualitative and quantitative methods are carried out at this empathize stage

a. Quantitative Research

The question in a qualitative survey is a question with an open answer. Researchers conducted quantitative research online to 50 respondents with survey methods. The criteria of respondents are those Digital Payment users who are already working, aged 20-29 years, men and women. Based on the results of quantitative research, researchers began with several hypothesis problems about current Digital Payment transactions.

b. Qualitative Research

Researchers conducted quantitative research online to 20 respondents with interview methods. Researchers developed the Research Plan as a guide in conducting this research. Then, define the research objectives as follows:

- Find out the user's goals/motivation and behavior when making transactions using an Digital Payment.
- Identify the user's paint point when making a transaction using an Digital Payment.

2. Define

The define stage is done analysis and determination of the data that has been collected at the empathize stage related to the needs and desires of prospective users. At this stage, several methods are carried out, including affinity mapping, need statement, user pesona, emphathy map, and as-is scenario.

a. Affinity Mapping

Affinity mapping is a brainstorming method that uses diagrams to organize a large number of ideas that. Researchers organized the user's interview results and changed them to affinity diagrams that can be seen in the figure 3.

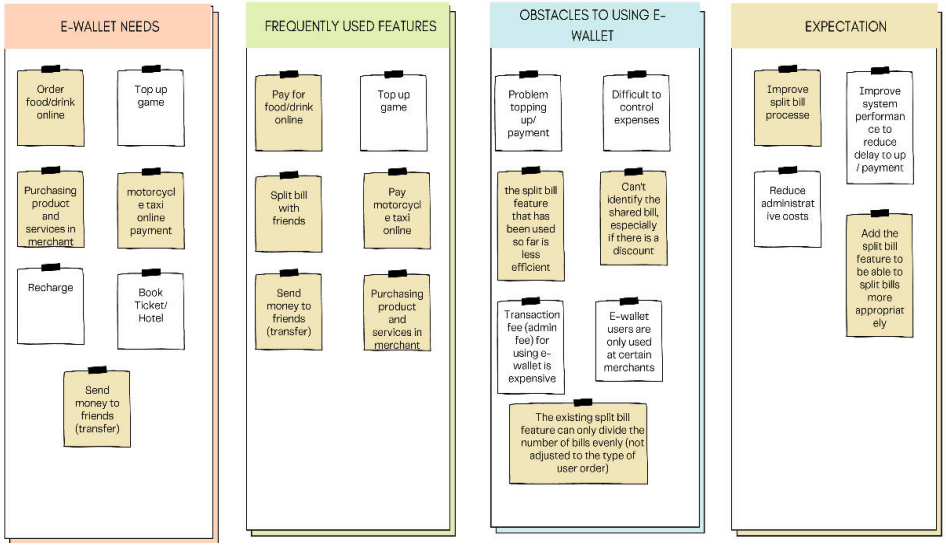

Figure 3. Affinity Mapping Results

b. Need Statement

After getting key insights the next stage researchers develop need statements. Statements help in focusing on the specific needs that have been found. Here are the needs statements made:

Table 1. Needs Statements

User	Needs	Insights
Digital Payment users who are already working, aged 20-29 years, men and women.	Development of innovative split bill features that provide effective and efficient performance	• People do not know about the split bill feature in most digital payment applications • People have not felt the ease of using the split bill feature

c. User Persona

User persona is one of the tools that can be used by UX designers to better understand their users. With this user persona you will find it easier to find a design solution that is ultimately able to create a user-friendly application experience. Researchers created 1 user personas based on observation patterns obtained from interviews that can be seen in the figure 4. This persona will help in making better design decisions and help better get to know who the user is, what issues to address, and what behaviors are appropriate.

Figure 4. User Persona

d. Empathy Map

After creating a user persona, in order to understand more user. Researchers did some mapping on emphaty map. Empathy Map is a tool to get to know the target audience to align business strategies and value propositions with customer wants, needs, goals, and feelings. In general, empathy maps make stakeholders think about the user and not the product to be created. The empathy map can be seen in the figure 5.

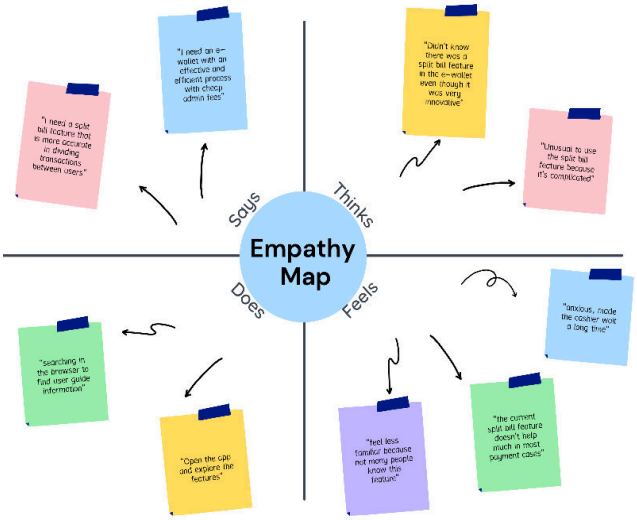

Figure 5. Empathy Map

e. As-Is Scenario

This process provides a clear picture of what specific steps the user goes through in performing the scenario. This process helps in building user flow in the next process. We made an as-is scenario split bill.

3. Ideate

In the ideate stage, the determination of ideas and solutions is done to produce broad ideas or ideas about specific topics, without assessing, evaluating or justifying any of them. There are several method processes applied at the ideate level, among others:

a. Competitive Analyze

Competitve analyze or competitor analysis is a field of strategic analysis whose specialization is in the collection and analysis of information about competing companies. This stage is a way to collect, identify, and compare what is done. Based on the findings of this study, Digital Payments in Indonesia that have split bill features are currently Go Pay and LINE Split Bill.

b. Impact Effort Matrix

The Impact-Effort Matrix can quickly help a process group activities into four main categories:

- Top left. Low-Impact Efforts High. Do it now
  These are the items that have the greatest impact on the business and usually, without much extra work. This is the quadrant with the most important features and the team should focus on those features.
- Upper right. High Impact Efforts High Impact. Do it right away.
  This is an important project for the business, but it is not easy to do, or there is no urgent need for the business to do so.
- Bottom left. Low Impact Efforts. Do it later.
  Some of this work is unavoidable, but it is the kind of item that can be done when. They usually don't have a big impact on the business, but they are also very easy to do.
- Bottom right. Low Impact High Efforts
  This quadrant has a high effort but the resulting impact is low, so innovation in this quadrant should not be done.

The team began to prioritize using the Impact-Effort Matrix framework to help look for alternative solutions that might solve the problem. This solution is built on previous insights, both from needs and user behavior. This useful matrix can later narrow the solution down to an impactful and efficient solution. Based on the results of key insights and competitive analyze processes, researchers decided to develop the following solutions:

- Adding a three-way Split Bill feature to make it easier for users when making joint transactions is split per item, split evenly, and split manual.
- Add the Transaction Financial Registrar feature to assist users in maintaining their finances.
- Using Optical Character Recognition (OCR) technology is by reading the print receipts obtained to shorten the transaction time.

c. User Flow

User flow is a visualized step that a user can follow through an application to complete one or more tasks. The creation of user flow makes it easy in this research to get certainty that the design made is in accordance with the solution that has been determined. In this study, two flows for split bills are for users who make split bill requests and users who receive split bill requests.

5. Prototype

In this last stage, researchers have provided an overview of the product as desired by both informants, as it has been formulated at the empathize and ideate stages. Researchers convey prototyping through images that researchers design themselves and show product examples according to the wishes and inputs of user informants.

6. Testing

The next step is testing conducted with prospective users directly through usability testing, researchers want to get feedback from users and paint points that are felt when using prototypes. At this stage researchers use UT metrics namely success rate and SUS (System Usability Scale) Success rate is measuring the success rate of users in completing all existing "tasks". While SUS is a questionnaire to measure the perception of usability. The System Usability Scale (SUS) contains 10 questions where participants are given a 1–5 scale option to answer based on how much they agree with each statement on the product or feature tested (Bangor, Kortum, & Miller, 2009). The test was conducted with 20 participants who had the same criteria as the previous interview. Each participant was assigned 4 tasks. Here's the testing scenario:

- Task 1: Split Payment With Item-By-Item Division. Make it until the payment is complete.
- Task 2: Split Payment With Equal Share. Make it until the payment is complete.
- Task 3: Split Payment With Manual Sharing. Make it until the payment is complete.
- Task 4: Enables transaction financial registrar feature. Make it until the payment is complete.

Based on the results presented, the entire participant can complete the tasks given. Based on the results obtained through the SUS Score test, the proposed innovation gets a value of 76. The score exceeds the minimum standard of acceptable minimum value in reference to the SUS guideline.

7. CONCLUSION

Digital payment methods are often easy to make, more convenient and provide customers the flexibility to make payments from anywhere and at anytime. These are a good alternative to traditional methods of payment and speeden up transaction cycles. With the era of global trade, the financial possibilities grew and with them the challenges of collecting payments, one of them is the split bill feature. The "Split bill" lets users split bills with other users and helps them keep track of how much everyone owes. The feature is very innovative, but still but it needs to be developed in its feature innovation. Currently the process of splitting bills or split payments is done manually, namely by dividing based on ordered and other bills that need to be divided equally such as taxes and so on. This results in uneven payments and does not match the nominal that should be paid. This also results in the process being less efficient because the process is quite time consuming. So that in this research builds a split bill feature on Digital Payments using the design thinking method approach.

Design Thinking can build business model innovation by providing additional value and creating products in accordance with user expectations through empathize, define, ideate and prototyping stages. Recommendations and innovations found from the validation process are the existence of a joint venture or split bill feature with additional features, namely OCR (Optical Character Recognition), split bill that can choose according to items, split bill that can

divide equally or calculates the split automatically, and split bill that can write the payment division manually by amount.

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EVALUATION OF CUSTOMER SERVICES USING ITIL V3 AND ISO 9001:2015 ON PT POS INDONESIA

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ABSTRACT

PT Pos Indonesia is a state-owned company in the field of logistics and package delivery, the role of information technology is of strategic importance. Reliability of information technology will increase the ability to compete with other logistics companies, especially in service quality assurance. This is the background of the research applying the framework at PT Pos Indonesia. The framework used is the Information technology infrastructure library or ITIL version 3 and ISO 9001:2015 which is a quality assurance framework. The first step is to make observations and collect data in the form of interviews and distributing questionnaires. The research uses two service perspectives, namely users and management. Users fill out questionnaires given research which is an adaptation of ISO 9001:2015 to find out how good the services, facilities and spatial planning at PT Pos Indonesia are. Meanwhile, the application of ITIL V3 which focuses on request fullfield or domains to measure the fulfillment of service needs is aimed at PT Pos Indonesia's information technology party. This research obtained satisfactory results from the customer and management perspective. However, there are still aspects that need to be improved in the service. So at the end of the research, the researcher provides recommendations on processes that need to be improved by PT Pos Indonesia which can be used as a reference in developing services in the future.

Keywords: ITIL V3, ISO 9001:2015, request fullfielment, service management

1. INTRODUCTION

PT Pos Indonesia is a state-owned company in the field of logistics and package delivery, the role of information technology is of strategic importance. Information technology reliability will increase competitive advantage (Firmansyah, 2017). In addition, the fulfillment of business needs in improving service to customers must be considered. PT Pos Indonesia must manage the quality of information technology services that meet business needs. Meeting customer needs must be balanced with information technology resources in the service. The role of information technology is very important in this case so there is the term IT Service Management (Taylor, 2012).

In its implementation, IT Service management requires a framework as a basis for using technology from an internal and customer perspective. The use of a framework in the use of information technology and service management is needed to describe the role of information technology and customer satisfaction with the services provided (Pramyastiwi, 2013). This research uses ITIL or Information Technology Infrastructures Library implementation. Information Technology Infrastructures Library is a collection of best practices that are structured as a series of processes that communicate with each other.

ITIL provides the governance and management and control of information technology services. One of the domains in it is a request fullfield. Request Fullfiement is a domain to enable users to request and receive standard services, to source and deliver these services, to provide information to users and customers about services, and to assist with general information, complaints and comments (Cartlidge, 2012). This research uses ISO 9001:2015. ISO 9001:2015 is a framework for service quality assurance. In assessing customer satisfaction, this study adopted ITIL V3 and ISO 9001:2015 by assessing customer satisfaction with services and processes that exist at PT Pos Indonesia. The objective is to create evaluation material for improvements PT Pos Indonesia in the future.

2. LITERATURE REVIEW

Audit of Information Technology using ITIL V.3 Domain Service Operation on Communications and Information Technology Agency (Wijaya, 2016)

This study describes the analysis in ITIL V3 with the service operation domain in which there is a fullfield request as an indication of measurement. Overall this study uses capability level as a measurement of maturity. Measurements are carried out on the company's internal parties, especially on information technology stakeholders. After the maturity is measured, then a gap analysis is implemented to see the process that needs to be improved. The research ends by providing recommendations on the evaluations that have been carried out in the research case studies.

Evaluation of Maturity Level Monitoring Service Management Base Transceiver Station (BTS) in the Network Monitoring System (NMS) Unit Based on ITIL V3 With Domain Service Operation in Kominfo (Mahardhika, 2019)

The research begins with reviewing research documents, making observations and collecting data. Then a mapping was carried out using RACI to find out the parties involved in conducting the evaluation in this study. After that, the level of maturity was assessed based on the questionnaires that had been distributed. The results of the assessment of the maturity level are compared to the organization's expectations in the form of gaps. This gap becomes a reference for providing recommendations for research results.

Analysis of Customer Satisfaction on ISO 9001: 2015 Implementation using Servqual Approach (Case Study: Telkom Purwokerto Institute of Technology) (Shahrullah, 2018)

The research was conducted by approaching the 5 attributes in ISO 9001:2015. Sampling was distributed to 95 people. The next thing to do is to test the correlation and validation of the influence of the research variables and get positive results. Furthermore, the researchers conducted a gap analysis by comparing the perceived value and the expected value of the 95 people. The final result is a discussion of points that need to be improved in improving services in research case studies.

3. METHODS

Ths research was conducted by steps in Figure 1

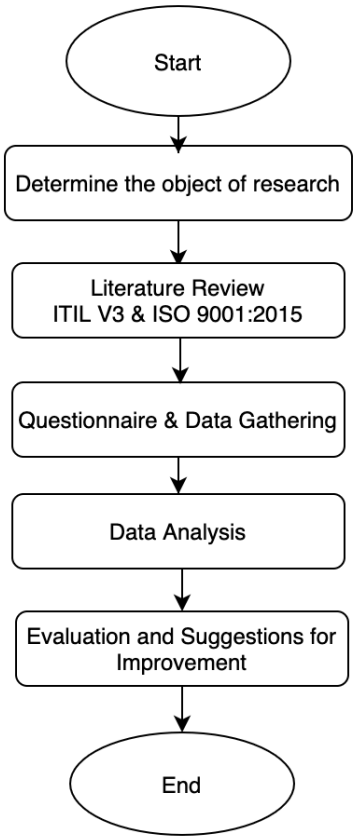

Figure 1. Methodology

Determine the object of research

The first stage is to determine the data collection or research location. In this study, researchers chose PT Pos Indonesia as the object of research on the implementation of services provided to customers. The research uses two perspectives, internal parties as service providers and customers as service users. So as to get the appropriate results between the wishes of the customer and the quality of service provided by the management.

Literature Review

This research uses two main frameworks, namely and ITIL V3. The application of ITIL V3 uses a fullfield request in knowing the process of meeting the needs of the services provided to customers. Meanwhile, for customer assessment of services, researchers use ISO 9001:2015 as a reference for quality services which is a framework issued by PT Pos Indonesia internal parties as a benchmark for services obtained by customers.

Questionnaire and Data Gathering

The selection of questionnaire respondents was based on visitors who came to PT Pos Indonesia, the Sidoarjo branch with a random sampling method to ten visitors who came. For the internal service process, the researcher conducted interviews with the information technology development department in the agency, especially the information technology manager and on several questions validated the information technology staff and financial managers. This is done to determine the two different perspectives between users and service developers. The rating table for customer satisfaction is depicted on a Likert scale shown in table 1. Satisfaction scale

Table 1. Satisfaction Scale

Point	Satisfaction
1	Very unsatisfied
2	Not satisfied
3	Less satisfied
4	Quite satisfied
5	Satisfied
6	Very satisfied

In the ITIL V3 data collection for measuring the maturity level, it is described in the table 2. Maturity Level

Table 2. Maturity Level

Point	Maturity Level
1	Unsure
2	Strongly disagree (NO)
3	Disagree
4	Agree
5	Strongly agree (YES)

Data Analysis

Data analysis is data management in calculating maturity to determine the level of maturity in the organization (Mahardhika, 2019). This stage collects the results of the questionnaire and the data obtained for mapping the framework. After that, the data is described in a table to find out the gap between management's expectations and the conditions when the research was carried out.

Evaluation and Suggestion for improvement

This stage contains a description of activities in meeting customer needs. The description will also get an improvement if the measurement process gets an unsatisfactory value so that it can be applied in the future as a reference for improvement. The recommendations given are based on the application of the applied framework.

4. RESULTS

The following is the result of an assessment of the maturity level of the services provided by PT Pos Indonesia with an assessment of the value of 1 being the lowest level of satisfaction and a value of 6 with the highest level of satisfaction. This assessment is a reference result of the implementation of ISO 9001:2015 regarding service quality. First, the assessment is carried out on the services provided by employees to customers shown in the table 3. Employees Service Assesment

Table 3. Employees Service Assesment

Services Provided by Employees		
No	Activity	Average
1	The alertness of the counter staff in providing services	5.1
2	CS readiness in receiving complaints	4.7
3	Security alertness in managing and directing queues	4.8
4	The Alertness of parking attendants	4.4
5	Fulfillment of requests by the counter staff	5.1
6	Fulfillment of information needs by CS	4.6
7	Fulfillment of information needs by Security	4.5
8	Fulfillment of parking needs by parking attendants	4
9	Counter staff friendliness	4.8
10	CS friendliness	4.9
11	Counter staff reassure customers	5.1
12	CS can convince customers	4.2
13	Security Friendliness	4.9
14	Parking attendants can ensure safety for customers	3.7
15	Offer recommendations as needed by the counter staff	4.7
16	Offer recommendations as needed by the counter staff	4.9
17	Offer recommendations as needed by the counter staff	5.1
18	Parking attendants help customers to get out	4.2
Average Score		4.65

Based on the results above, it is found that customers are quite satisfied with the services provided. However, the availability and security of parking are points that need to be improved because customers doubt the safety of the existing parking facilities. Recommendations that need to be implemented are to check whether the parking number and vehicle certificate are in accordance with the owner's vehicle.

The results of the assessment based on the spatial layout and facilities provided by PT Pos are described in the table 4. Facilities and Layout Assesment

Table 4. Facilities and Layout Assesment

Facilities and Layout		
No	Activity	Average
19	Cleanliness of public service spaces	4.3
20	Adequate public service space lighting	3.7
21	Coolness and comfort of adequate service room	3.3
22	Seats in the waiting room are adequate	4.1
23	Queue engine supports transaction speed and order	4.6
24	Instructions and service information are adequate	4.3
25	Spacious and safe parking facilities	3.7
26	The appearance of parking attendants, security, counters and CS is clean and neat	4.2
27	Washroom is clean and adequate	3.8
28	Complaint facilities at CS are adequate	4.22222
Average Score		4.022
Total Score		4.420

Based on the two tables above, it is found that the average customer satisfaction is at 4,022. However, there are some points that are below average. Recommendations related to problems that occur. Lack of lighting in the room can be overcome by changing the lighting or adjusting the layout so that visitors can get sufficient lighting. The next thing that becomes a problem is the service room that is not comfortable because it is considered quite hot, the thing that needs to be considered by the managerial side is to add adequate cooling according to the service capacity, and the last thing regarding the cleanliness of the toilet, the management can clean the toilet regularly and check cleaning regularly.

The next stage is conducting an internal ITIL V3 assessment on the fullfield request domain. The results of the implementation are presented in the table 5.Request Fullfielment assesment

Table 5. Request Fullfielment assesment

Readiness Assessment	Expectation Level	Average Score	Gap
Service Management as a Practice	3	3,5	0,5
The Service Lifecycle	3	3	0
ITIL Concepts and Definitions	3	3,5	0,5
Key Principles and Models	3	3,7	0,7
Processes	3	2,3	-0,7
Functions	3	3,375	0,375
Roles	3	3	0
Average			3,19642857

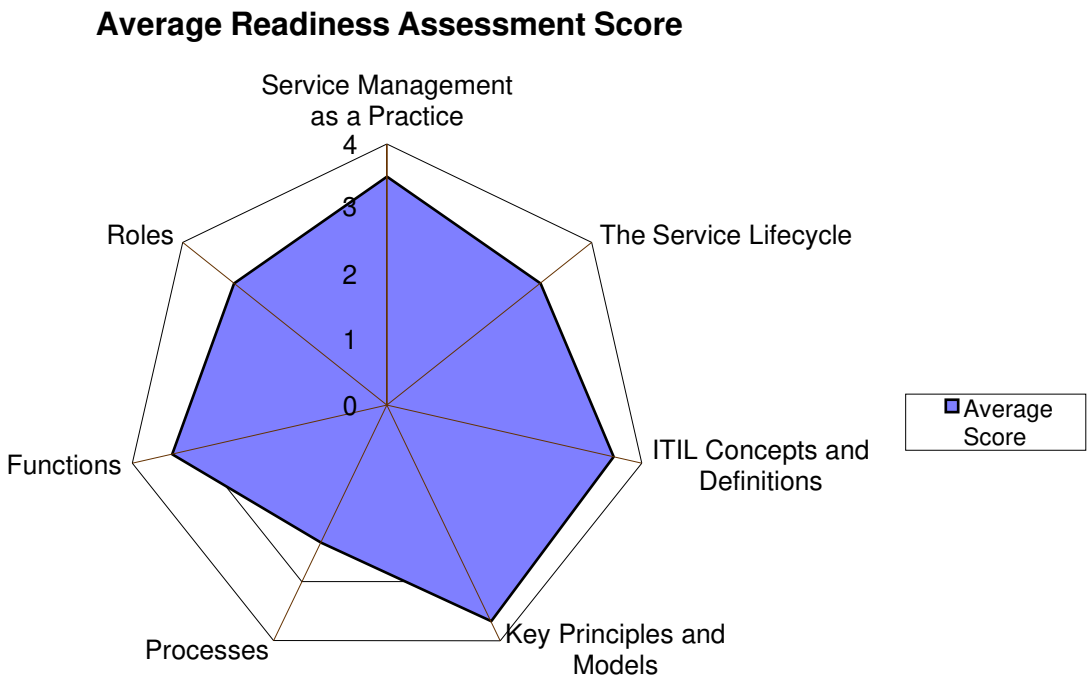

Figure 2. Radar Chart Assesment Score

Based on the table and the distribution of the image above, it was found that there was a deficiency in the fullfield request management process, so that the description and recommendations were described in the table 6. Recommendation ITIL Process

Table 6. Recommendation ITIL Process

Request Fullfielment Management		
Process	Existing Condition	Improvement Recommendation
Receive request , request logging, validation	Requests by telephone regarding letters and packages, log form in the form of tracking packages and validation in the form of names and addresses	Added service availability for non-packaged transactions

Request categorization and prioritization	Requests mostly regarding postal and parcel services	Providing service priority to majority requests
Request authorization	The request will be fulfilled if the package is according to the standart operational procedure	-
Request view and model executiion	Users can do tracking at the time of delivery of goods	Adding process status to the payment section
Request Clousure	Package or service has been used	-

5. CONCLUSIONS

The implementation of the ISO 9001:2015 framework has been going well. This is based on the results of the assessment which indicates that the customer is quite satisfied with the services provided by PT Pos Indonesia. Some small aspects need to be improved, especially in the spatial arrangement, so that the maximum value can be obtained in maintaining good quality. Meanwhile, in the implementation of ITIL (Information Technology Infrastructure Library), especially the full field request, there are many aspects that exceed the level of expectations from the management. This indicates that the service management at PT Pos Indonesia has been very good by getting an average value above 3. It is hoped that future research can assess other service components so that it can be known not only from one aspect.

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ROAD SERVICE ANALYSIS FROM THE USER'S PERSPECTIVE (CASE STUDY: JALAN RAYA JATI – CEMENGKALANG SIDOARJO)

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ABSTRACT

Road service is an important parameter in assessing the success of road infrastructure. Although there have been several previous studies on the analysis of road level of service, there are still limited studies that analyze from the user's perspective. This research aims to find road service criteria and also to assess their performance from the user's perspective. Raya Jati-Cemengkalang road in Sidoarjo was selected as the study object as it plays an important role and has a degree of saturation of more than one. The criteria were identified from the literature and verified through a preliminary survey involving five transportation experts. This survey resulted in 20 relevant criteria and 1 additional criterion from the expert. The main questionnaire was distributed to obtain 100 samples from road users to assess road service level. According to Service Quality (Servqual) analysis, the road's satisfaction level (3,624) is still below the user's expectation (4,626) with an average gap score is -1,002. Importance Performance Analysis (IPA) resulted six criteria that need to be improved, namely: smooth traffic flow conditions, adequacy of road shoulder width, no traffic disturbances (due to community activities on the side of the road), availability of parking areas, adequacy of road drainage, and road signage positioning.

Keywords: *Road Level of Service, Road User, Road User Satisfaction, Servqual, Importance Performance Analysis.*

1. INTRODUCTION

Roads have a significant role in the economy of a region. As a manifestation of the concept of public service, the road level of service (LoS) is an important parameter in assessing the success of road infrastructure. In Indonesia, LoS is measured in a technical approach. Speed, degree of saturation (DS), degree of accompaniment are used as an indicator of traffic behavior (on roads) (MKJI, 1997).

Raya Jati – Cemengkalang road as one of the provincial roads in Sidoarjo is a major collector road (JKP-2). This road is located on the access point of the Sidoarjo toll gate and extends to the west towards Mojokerto. Its plays a vital role in Sidoarjo which connecting the central business distric (CBD) and the Surabaya – Gempol Toll Road with sub urban areas and other city (Mojokerto). There are many housing, industry, offices, trade and services among this route. Therefore, it has a high traffic density which causes traffic jams almost every day, especially in the morning and evening. The data shows that the daily traffic volume (LHR) is on 61,292 vehicles/day, with a degree of saturation (DS) is 1.1 (> 0.75) (Bina Marga of East Java Province, 2019). As yet, DS is an approach in assessing the performance of road level of services.

Road users are important stakeholders in the using of road infrastructure. Attention to stakeholders is important throughout the planning process of infrastructure maintenance projects because 'project success' is defined by stakeholders depending on their valuation of the infrastructure (Hietbrink et al, 2012). Therefore, involving road users who are end users is very important in the success of road infrastructure. Although there have been several previous studies on the analysis of road level of service, there are still limited studies that analyze from the user's perspective, especially in the study area.

Referring to the problems, this research aims to find road service criteria and assess their performance from the user's perspective. The service criteria are translated into relevant parameters. The Measurement of customer satisfaction level was carried out using the Service Quality (Servqual) method. The measurement of importance level was carried out using the Importance Performance Analysis (IPA) method. This integration method is expected to provide information about road service criteria from the perspective of road users and practical benefits in identifying problems to find solutions in road services at the same time.

2. LITERATURE REVIEW

2.1. Roads and Road Level of Service

Roads are land transportation infrastructure that includes all parts of the road, including complementary buildings and their equipment intended for public traffics, located on the ground surface, below the ground and/or the water surface, as well as above the water surface, except for rails and cableways (Law No. 38 of 2004, Government Regulation No. 34 of 2006 on Roads). Roads have a significant role in economic development. Regions with adequate infrastructure in the sense of having high accessibility will have high productivity.

Road Level of Service (LoS) is defined as a qualitative measure used in HCM 85 United States and describes operational conditions in traffic flow and road users (generally expressed in speed, travel time, freedom of movement, traffic interruptions), traffic, convenience, comfort, and safety). This service level concept was developed for use in the United States. In Indonesia, LoS does not apply directly, but through a technical approach that at MKJI uses the calculation of the definition of traffic volume, road capacity, speed, travel time, freedom of movement, traffic interruptions, comfort, degree of saturation as indicators of traffic behavior (MKJI, 1997).

In general, road services are facilities provided by roads. This could be the condition of the road surface, the width of the traffic and pedestrian lanes, the environment around the road, crossing facilities, security, safety, public toilets, refreshment facilities, parking facilities, lighting, road signs, and emergency services. Every service, whether road infrastructure or otherwise, the quality of service has more impact on satisfaction. Service quality is one of the performance indicators in the category of effectiveness. It consists of accessibility, amenities, convenience, convenience and security (Hasan et al, 2019).

2.2. Customer Satisfaction

Giese & Cote (2000) identify customer satisfaction into 3 things, namely: (1) customer satisfaction is a response (emotional or cognitive); (2) the response concerns a particular focus (expectations, products, consumption experiences, and so on); and (3) the response occurs at a certain time (after consumption, after product/service selection, etc.)

Measurement of customer satisfaction is obtained by various methods. Kotler (2013) identified 4 methods to measure customer satisfaction, namely: Complaints and Suggestion System, Ghost Shopping, Lost Customer Analysis, and Customer Satisfaction Survey.

2.3. Road Users Satisfaction

Travel satisfaction can be considered as a type of road user satisfaction. This level of satisfaction is often due to the services provided by the road infrastructure and is also related to user reactions to these services. Satisfaction is the level of customer approval when comparing the perceived performance of a service with its expectations. It is based on information from all previous experiences with service providers.

Road user satisfaction is influenced by various road service criteria. There are various criteria studied that significantly affect the level of user satisfaction. Road service criteria were selected from various literature reviews and justified through a pilot survey. Kadiyali (2003) in Hasan et al (2019) states that comfort and safety are the quality of services offered by a means of transportation. Although difficult to assess, this is an important aspect as many road users are ready to take longer routes for comfort and safety. Suanmali (2015) in Hasan et al (2019) shows that road conditions are the most significant factor affecting road user satisfaction. Better road surface conditions are also very important for higher comfort for road users as it reduces travel time.

Research of road services on Surabaya – Gresik toll roads (Pancawati et al, 2013) found that the smooth flow of traffic, queues at toll gates, cleanliness of toll roads, road geometry, road surface conditions, lighting and safety fences are the dominant variables to get improved handling. Akakpo (2016) found that road surface conditions and pedestrians' safety are the significant service quality dimensions that influence the satisfaction of road users. The findings of this study have empirically affirmed that, the service quality dimensions that influence the satisfaction of road users cannot be ignored or underrated in road infrastructure delivery. It further informs the road agencies and operators of the need to give due attention to satisfaction of road users during design and construction stages. Meanwhile, the criteria for a sustainable road management are efficiency, mobility, safe and comfortable, community participation, restrictions on emissions, natural resources, habitats, and ecosystems (Lawalata 2013).

2.4. *Service Quality*

Servqual is a compact scale selection. However, it has a high level and high validity that can be used by management to better understand how consumer precepts and consumer expectations of services provided. Where the satisfaction of service consumers is determined by the level of consumer interest before using the service and the results of consumer perception of the service after the consumer feels the performance of the service. The concept of Servqual is used to calculate the gap between consumer perception and the value of expectations or expectations for services that have been provided. Here's the equation:

$$Q = P \text{ (Perceived Service)} - E \text{ (Expected Service)}$$

Description:
Q : Quality of Service
P : Perceived service
E : Expected service

If the perception score is the same as the expectation score, then the quality of service is perceived to be good and satisfactory. If the perception score is greater than the expectation score, then the quality of service is perceived as the ideal quality. Conversely, if the perception score is smaller than the expectation score, then the quality of service is perceived poorly.

2.5. *Importance Performance Analysis*

Importance Performance Analysis (IPA) is a method that provides a two-dimensional performance-interest grid, in which the importance and performance values among various

attributes are plotted against each other and the resulting performance-interest space is generally divided into four quadrants (Feng et al., 2014). The IPA technique combines measures of customer perceived performance and importance into a two-dimensional plot to facilitate data interpretation (Martilla & James, 1977). This plot classifies attributes into four categories or quadrants to set priorities in allocating limited resources. The science technique is described in the form of a Cartesian diagram, which is a shape divided into four quadrants bounded by two lines that intersect perpendicular to the points (X, Y) where is the average score of the perceived performance or service assessment and X is the score. the average rating of the expected importance/service that affects customer satisfaction. The Cartesian diagram of the IPA method can be seen in the following figure.

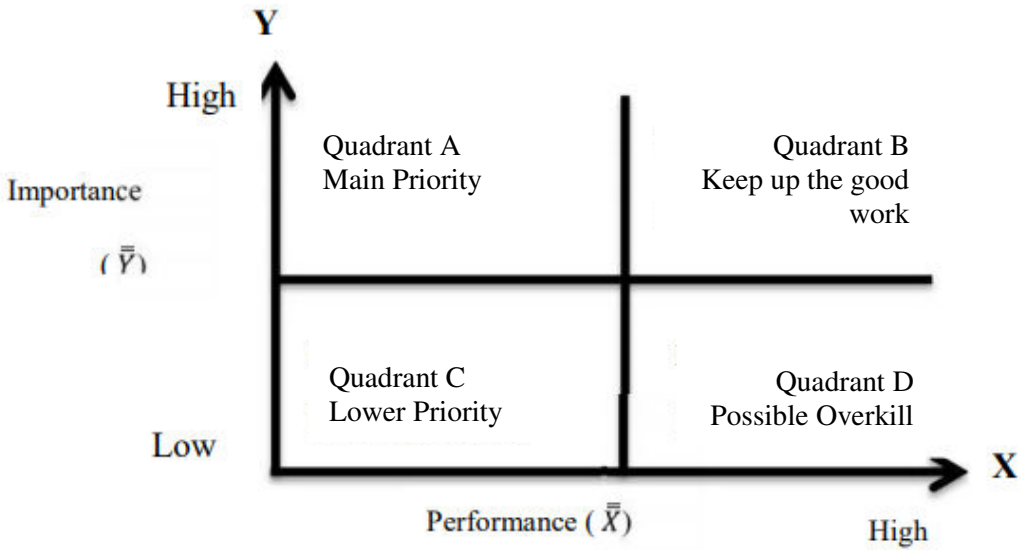

Figure 1. Importance Performance Analysis

3. METHODS

Road service performance is analyzed by measuring the level of user satisfaction based on the respondent perceptions. The research variable or criteria were obtained through literature review which was verified by five experts through a preliminary survey using a Semantic scale between 1 to 5 (1=very irrelevant, 2=not relevant, 3=fairly relevant, 4=relevant, 5=very relevant). The preliminary survey result is presented in the next section.

Relevat variables were used in the main survey using questionnaire to obtain the users' perception regarding their level of satisfaction which was compared by the expectations The number of respondents targeted were 100 according to the Slovin Formula. Respondents represented all the groups of passing vehicles which include: motorcycles, private vehicles (sedans, jeeps, station wagons), public passenger cars (oplets, pick ups, box cars), trucks (trucks and containers), non-motorized vehicles (bicycles, tricycles, carts).

Respondents were asked assess the expectation regarding the criteria and their actual performance of the criteria (reality). The actual performance was assessed by 1 to 5 scale (1 = very dissatisfied, 2 = dissatisfied, 3 = quite satisfied, 4 = satisfied, 5 = very satisfied). Meanwhile, the expectation was assessed using 1 to 5 Likert scale (1=very low, 2=low, 3=high enough, 4=high, 5=very high). Data were analyzed using Servqual method to understand the road user satisfaction and Importance Performance Analysis (IPA) method to map the priority scale of road service criteria that needed improvement.

4. RESULT

4.1. Relevant Criteria

Preliminary survey involving five transportation experts which with minimum 12 years experience. They consist of Academic, Bina Marga, Dinas Perhubungan, Masyarakat Transportasi Indonesia (MTI) and Himpunan Pengembangan Jalan Indonesia (HPJI). According to the analysis all criteria were relevant and there was 1 (one) additional criterion which was proposed by two experts, namely side disturbance (traffic disturbance due to community activities on the side of the road).

Table 1. Relevan Criteria

No	Criteria	Mean	SD	Keterangan
A	Comfort			
1	Road surface condition	4.6	0.548	Relevant
2	Smooth traffic flow conditions	4.4	0.548	Relevant
3	Carriageway width	3.8	0.837	Relevant
4	Road shoulder width	3.6	0.894	Relevant
5	Roadside disturbance (due to community activities on the side of the road)			Proposed by 2 experts
B	Safety			
1	Alignment condition (safe)	4.8	0.447	Relevant
2	Adequacy of driving visibility	4.4	0.548	Relevant
3	Low accident rate	3.8	0.837	Relevant
4	Road Crossing Facility	3.6	0.894	Relevant
5	Pedestrian Width	3.4	1.140	Relevant
C	Amenity			
1	Road lighting	4	0.707	Relevant
2	Availability of road drainage	3.8	0.837	Relevant
3	Availability of green line (plants)	3.2	0.447	Relevant
4	Parking facility	3	1.225	Relevant
5	Cleanliness of roads	3	0.707	Relevant
6	Information and services lanes	3	1.000	Relevant
D	Road Signage			
1	Adequacy of Road Signage	4.4	0.548	Relevant
2	Road Signage Positioning	3.8	0.837	Relevant
E	Road Work			
1	Speed of repair to road damaged roads	4.2	0.837	Relevant
2	Performance of road maintenance/repair	4	0.707	Relevant
3	Quality of road maintenance/repair	3.8	0.837	Relevant

4.2. Service Quality Analysis

Service Quality (servqual) analysis was conducted to calculate the gap between the perception of road users (reality) and the value of expectations (expectations) for the road services provided. Gab score is obtained by the formula: Service Quality = Perception – Expectation. If the perception score is the same as the expectation score, the service quality is perceived to be good and satisfactory. If the perception score is greater than the expectation score, then the service quality is perceived as an ideal quality. On the other hand, if the perception score is less than the expectation score, then the service quality is perceived as bad.

Table 2. Service Quality Analysis

No	Criteria	Perseption	Expectation	Gap
A	Comfort			
A1	Smooth traffic flow conditions	3.380	4.690	-1.310
A2	Adequacy of carriageway width	3.570	4.590	-1.020
A3	Adequacy of road shoulder width	3.280	4.630	-1.350
A4	Road surface condition	3.710	4.630	-0.920
A5	No traffic disturbances (due to community activities on the side of the road)	3.490	4.650	-1.160
	Average number of Comfort	3.486	4.638	-1.152
B	Safety			
B1	Alignment condition (safe)	3.640	4.690	-1.050
B2	Adequacy of driving visibility	3.790	4.490	-0.700
B3	Availability of pedestrian	3.280	4.560	-1.280
B4	Availability of crossing facility	3.470	4.560	-1.090
B5	Low accident potential (Low accident rate)	3.860	4.740	-0.880
	Average number of Safety	3.608	4.608	-1.000
C	Amenity			
C1	Availability of paking area	3.050	4.690	-1.640
C2	Adequacy of road lighting	3.960	4.680	-0.720
C3	Availability of road drainage	3.450	4.680	-1.230
C4	Availability of green line (plants)	3.800	4.630	-0.830
C5	Cleanliness of roads and pavement	3.680	4.580	-0.900
C6	Availability of Information and services lanes	3.770	4.600	-0.830
	Average number of Amenity	3.618	4.643	-1.025
D	Road Signage			
D1	Adequacy of Road Signage	3.730	4.570	-0.840
D2	Positioning Road Signage	3.580	4.660	-1.080
	Average number of Road Signage	3.655	4.615	-0.960
E	Road Work			
E1	Speed of repair to road damaged roads	3.860	4.570	-0.710
E2	Performance of road maintenance/repair	3.780	4.590	-0.810
E3	Quality of road maintenance/repair	3.970	4.670	-0.700
	Average number of Road Work	3.870	4.610	-0.740

Table 2 shows that the highest actual performance is 3.970, namely Quality of road maintenance/repair and the lowest performance is 3.050, namely the availability of parking areas. According to the result it can be seen that all the service criteria had score which are larger than three (quite satisfied) which means the road users are quite satisfied with existing road service. The highest expectation value is 4.690, namely smooth traffic flow conditions, alignment conditions

(safe) and availability of parking areas. The lowest expectation value is 4.490, which is Adequacy of driving visibility.

So that the expected value for all service criteria is above 4 (high), which means that road users have high expectations and tend to be very high on road services. The highest gap value is (-) 1,640, which is the availability of parking areas. Meanwhile, the lowest gap value is. -0.700, namely Adequacy of driving visibility and quality of road maintenance/repair. The resulting gap value for all service criteria is negative (poor). This is because even though customers are quite satisfied with the perceived road service, it turns out that customer expectations are still higher for the intended road service. In other words, customers feel quite satisfied or satisfied but hope that there is an increase in service that is better than what is currently being provided.

4.3. Importance Performance Analysis

To increase customer satisfaction, basically a service/product needs to increase all service criteria which have negative values. However, due to limited capabilities, it is necessary to improve the quality of services that are efficient and effective, so it is necessary to carry out an importance performance analysis (IPA). By using this method, it is possible to know the priority scale of service criteria that need to be improved. IPA is carried out by combining the perceived value (performance) and the expected value (importance) of the service criteria.

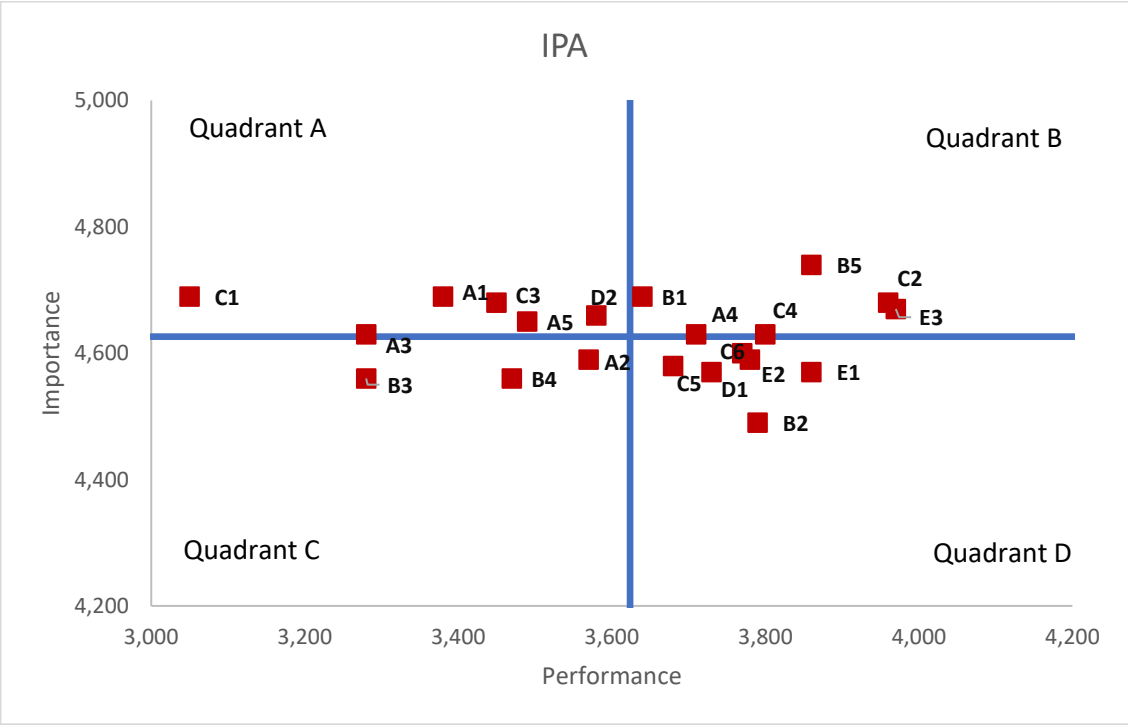

Figure 2. *Importance Performance Analysis*

From Figure 2. above, it can be seen that there are 6 (six) criteria in quadrant A, 6 (six) criteria in quadrant B, 3 (three) criteria in quadrant C, and 6 (six) criteria in quadrant D.

A. Quadrant A

Quadrant A contains service criteria that are the main priority for improvement. The service criteria in this quadrant are considered important or have high expectations for users but in fact

have not been able to meet expectations significantly. Therefore, the level of performance in this service must be a top priority to be improved in order to significantly improve road services. The service criteria in this quadrant are:

1. Smooth traffic flow conditions;
2. Adequacy of road shoulder width;
3. No traffic disturbances (due to community activities on the side of the road, ie: parking, shops, roads in and out of housing, billboards, etc.);
4. Availability of parking areas;
5. Adequacy of road drainage (roads are free from flooding);
6. Road signage potitioning

B. Quadrant B

Quadrant B contains service criteria that are considered important and perform well. In other words, road users perceive these criteria as important criteria and have good performance. Therefore, road operators must maintain the performance of these services. The service criteria that must be maintained in its performance are:

1. Road surface condition;
2. Alignment condition (safe);
3. Low accident potential (Low accident rate);
4. Adequacy of road lighting;
5. Availability of green line (plants);
6. Quality of road maintenance/repair.

C. Quadrant C

This quadrant contains road service criteria that are considered less important than the other criteria and whose performance is less good than the other criteria. With the level of importance and performance that are both lower than the other criteria (in other quadrants), then improvements or efforts to improve these criteria need to be reconsidered because their effect on the benefits felt by users is considered less significant. Therefore, the criteria in this quadrant are classified as low priority in improvement efforts. Criteria in quadrant C are:

1. Adequacy of carriageway width;
2. Availability of pedestrian;
3. Availability of crossing facility.

D. Quadrant D

This quadrant contains road service criteria that are considered important compared to other criteria and their performance is good compared to other criteria. With a relatively lower level of importance and relatively better performance, it is considered redundant to make improvements because it is less significant in increasing road performance from the user's perspective. The service criteria in this quadrant are:

1. Adequacy of driving visibility;
2. Cleanliness of roads and pavement;
3. Availability of Information and services lanes;
4. Adequacy of Road Signage;
5. Speed of repair to road damaged roads;
6. Performance of road maintenance/repair.

5. CONCLUSIONS

From the Servqual analysis, it is found that all service criteria have negative gap values which in the service quality have a bad meaning. However, there is something interesting in this

measurement, namely the perceived value for all service criteria that have a satisfied value. This is because the expected value is still higher for the intended road service. In other words, road users are quite satisfied or satisfied with the current road service, but hope that there will be an increase in better service in the future.

From the Importance Performance Analysis (IPA), the service criteria that become the main priority (Quadrant A) for improvement, namely Smooth traffic flow conditions, Adequacy of the road shoulder width, no traffic disturbances due to community activities on the side of the road, availability of parking areas, Adequacy of road drainage and the road signage potitioning.

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THE DEVELOPMENT OF PREDICTIVE MODEL FOR MUNICIPAL SOLID WASTE IN MALANG CITY USING BAYESIAN NETWORK AND HOLT'S

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ABSTRACT

Accurate prediction of municipal solid waste is crucial for integrated waste planning and decision-making. However, predicting the amount of generated waste have faced difficulties in obtaining accurate results due to missing values data, and complex relationship among various variables affect it. The predictive model integrates Bayesian Network and Holt's models in this study. The proposed model selects population, consumption expenditure, GDP, tourism, and the number of trader factors in Malang City. The relationship between predictive variables and generated waste will be introduced to the path analysis. Compared with other combinations of forecasting methods Simple Average and Inverse MSE Weight include Naive, Double Moving Averages, and ARIMA, the proposed model has higher accuracy, with a mean absolute percentage error (MAPE) of only 1,36%, a mean absolute deviation (MAD) value of 275.0603, and a mean square deviation (MSD) of 110639.477, with a percentage of matching pattern with actual of 58% in predicting the amount of municipal waste in Malang city. Results can have more advantages than traditional methods in predicting municipal solid waste generation

Keywords: Municipal Solid Waste, Missing Values, Prediction, Holts and Bayesian Network, Malang City

1. INTRODUCTION

The waste problem is often faced by big cities with a large population. Malang City is the second-largest city in East Java Province, Indonesia. As one of the big cities that becomes the center of economic and education in East Java, it will certainly increase the waste generated. To improve waste management at the final disposal site, a controlled landfill system will be transformed into a sanitary landfill. It is critical to improve waste management by having an accurate prediction method for establishing a sanitary landfill.

The current prediction method only focuses on the population projection and the rate of waste generation per capita in predicting the amount of waste. So, this study aims to establish a predictive model by considering several factors suspected of affecting municipal solid waste and uses historical data of generated waste in Malang city to obtain more accurate predictions. Unfortunately, due to missing values of historical data and uncertainty on the amount of waste, it is difficult to build an accurate prediction model of municipal solid waste.

In recent years, Bayesian Networks (BNs) have been applied in many studies. This method combines probabilistic and graph models that represent knowledge about an uncertain domain

where each node corresponds to a random variable (Yang, 2019). Each edge represents the conditional probability for the corresponding random variables. This technique effectively explains the presence of uncertainty and deals with missing data (Ma & Chen, 2018).

In the BN method, the forecasting results are in the form of probabilities, which are insufficient to represent the needs of the numbers for the amount of waste. In this research, BN method combines with a time-series model. More robust and accurate models can be achieved by combining predictions. Through the case of Malang, a city in the province of East Java in Indonesia, this study will analyze the accuracy result of the combined BN and Holt's models in forecasting the amount of municipal solid waste.

2. LITERATURE REVIEW

There has been a lot of research into forecasting models for determining the amount of waste. Forecasting methods that are commonly used are time series, regression models, gray and fuzzy models, simulation models, non-probabilistic statistical learning models, and probability model-driven statistical learning approaches (Jiang & Liu, 2016). A time series model extrapolates into the future with historical data representing repeated patterns over time. One of the studies using the time series model was conducted using Double Exponential Smoothing (Holts) for forecasting the amount of industrial waste in Thailand (Lertpocasombut & Sriploy, 2017). This forecasting technique is suitable for describing general patterns or trends. Moreover, the application is inexpensive and simple to use. However, this method ignores the factors that influence the variables to be predicted (Green & Armstrong, 2012), whereas in real cases there are factors that influence municipal solid waste. The time series prediction model requires historical data with higher quality. If the historical data is not smooth enough, the precise prediction can't be obtained (Chen & Dai, 2020).

The probability model-driven statistical learning approach can provide a framework that considers various sources of uncertainty (Ressie et al., 2009). One of the methods commonly used in research is the Hidden Markov Model (HMM). HMM is a statistical model that models a system as a Markov process with a sequence of unobserved conditions (Amayri et al., 2017). HMM has a limitation in that it cannot display induced dependencies or non-transitive dependencies, where two independent variables will be directly connected to the edge, just because some other variables depend on these two variables. o overcome for the limitations of this method, another probabilistic-based statistical method, the BN can be used. BN has a richer language than the Markov Network. Using a directed graph, the arrows' direction shows real dependencies, not false dependencies caused by hypothetical observations (Pearl, 1988).

Bayesian approach have been applied in various fields, such as manufacturing, project management, medical, technology, electrical energy, and others. However, the Bayesian method is not widely used in waste management research. Song et al. (2018) use the BN method with scenario analysis and sensitivity analysis to estimate household food waste in China, which considers the socioeconomic factors. This study will combine Holt's model with the BN model to generate a more accurate predictive model of municipal solid waste. Combining forecasting methods can reduce model uncertainty and inaccurate model, resulting in improved prediction accuracy (Zhao et al., 2019).

3. METHODS

3.1 Description of the study area and context

Malang City is located in the East Java Province of Indonesia, between the coordinates 7.06° - 8.02° South Latitude and 112.06 112.07° East Longitude. This city is the second-largest

city in East Java, with 11,006 hectares. The population in Malang in 2020 will be 874,890 people, according to the Central Statistics Agency of Malang City. Waste management is one of the focuses of the Malang City Government. Waste management based on its source in the regional regulation of Malang City consists of household waste, household-type waste, and specific waste. This study will focus only on the source of household waste and household type waste. Household waste comes from daily activities in the household, excluding feces and specific waste. Meanwhile, household-type waste originates from commercial insight, industrial areas, social facilities, public facilities, etc.

3.2 Influencing factors

Since no research has identified the factors that affect municipal solid waste in Malang, the first step is to identify the factors influencing municipal solid waste by conducting a literature study. The factors will be filtered based on the variable categories of consumption-related (CR) and production-related (PR), study area at the city level (CL), and the similarities GNI status of Indonesia in lower-middle-income countries (LM) and upper-middle-income economies (UM). The results of the screening of influencing factors of municipal solid waste from the literature study are presented in **Table 1**.

Table 1. The results of the screening of influencing factors of municipal solid

Category	Factors	Number	Reference
Social	Population	18	(Rahardyan et al., 2015), (Azadi & Karimi-Jashni, 2016), (Chu et al., 2016), (Adamovi et al., 2017), (Sun & Chungpaibulpatana, 2017), (Viera & Matheus, 2017), (Abbasi et al., 2018), (Chhay et al., 2018), (Ramachandra et al., 2018), (Z. Han et al., 2018), (Fan & Fan, 2019), (Zhang et al., 2019), (Chen & Dai, 2020), (Kala et al., 2020), (Cheng et al., 2020), (Nguyen et al., 2021), (Pathak et al., 2020), (Popli et al., 2021)
	Age	5	(Xu et al., 2014), Grazhdani, 2015), (Adamovi et al., 2017), (Sun & Chungpaibulpatana, 2017), (Kolekar & Chakrabarty, 2017)
	Unemployment	3	(Adamovi et al., 2017), (Abbasi et al., 2018), (Popli et al., 2021)
	Household size	7	(Xu et al., 2014), (H. Han & Zhang, 2017), (Hoang et al., 2017), (Kumar & Samadder, 2017), (Thi et al., 2017), (Abbasi et al., 2018), (Song et al., 2018)
Economy	GDP	9	(Rahardyan et al., 2015), (Adamovi et al., 2017), (Abbasi et al., 2018), (Chhay et al., 2018), (Fan & Fan, 2019), (Liu et al., 2019), (Cheng et al., 2020), (Chen & Dai, 2020), (Popli et al., 2021)
	Income	12	(Xu et al., 2014), (Grazhdani, 2015), (Khan et al., 2016), (Kumar & Samadder, 2017), (Sun & Chungpaibulpatana, 2017), (Viera & Matheus, 2017), (Thi et al., 2017), (Abbasi et al., 2018), (Song et al., 2018), (Z. Han et al., 2018), (Kala et al., 2020), (Ramachandra et al., 2018)
	Expenditure	11	(Grazhdani, 2015), (H. Han & Zhang, 2017), (Kolekar & Chakrabarty, 2017), (Sipangkar, 2018), (Z. Han et al., 2018), (Liu et al., 2019), (Zhang et al., 2019), (Pathak et al., 2020), (Chen & Dai, 2020), (Nguyen et al., 2021), (Zhu & Atikur Rahman, 2020)
	Trade	7	(Pramitaningrum, 2014), (Hartono et al., 2015), (Matsui et al., 2015), (Yukalang et al., 2017), (Sipangkar, 2018), (Ali & Christiawan, 2019), (Phu et al., 2019)

Category	Factors	Number	Reference
Education	Education Level (*None/elementary school/junior high/high school/professional degree*)	6	(Grazhdani, 2015), (H. Han & Zhang, 2017), (Kumar & Samadder, 2017), (Ramachandra et al., 2018), (Song et al., 2018), (Kala et al., 2020)
Cultural	Tourism	7	(Adamovi et al., 2017), (Sun & Chungpaibulpatana, 2017), (Fan & Fan, 2019), (Kasavan et al., 2019), (Phu et al., 2019), (Zhang et al., 2019), (Salazar-Adams, 2021)

Based on the table above, the most frequent factors that affect the amount of waste include population, income, household expenditure, GDP, retail, tourism, and household size (occurrence percentage is above 7%). Before collecting data for each factor, researchers need to discuss with the Malang City Environmental Service (DLH) sides whether these factors can be used in the model and have represented the factors that influence the amount of waste in Malang City. The conclusion from the discussion with direction from Malang City Environmental Service was that the income and household size factors were not used in the model in this study.

Household income is indeed related to the production of the amount of waste. However, household expenditure is considered more representative and directly affects the amount of waste in Malang City. Household income is easy has deviated value of household economic status because income is vulnerable to fluctuations in temporary events, one of which is layoffs. However, household expenditure is considered relatively stable over time. It also has a better measure of living standards, so household expenditure is considered to capture long-term prospects rather than income. In addition, for the household size factor, the population is considered more to be representative. As a result, the factors chosen for this study are population, household expenditure, trade, GDP, and tourists.

3.3 Data collection

The data in this study are historical data from municipal waste and the quantification of each factor from January 2017 to December 2020. Data will be divided into training, test, and prediction data. Training data to build models based on predefined structures and parameters (Jan 2017-Dec 2018). Test data will evaluate the model's accuracy (Jan 2019-Dec 2019). Then, Predictive data is the overall data used to project data in the future (Jan 2017-Dec 2020). The forecasting result will be expected in monthly data. Data that is still in the annual period requires processing missing values such as data on population, household consumption expenditure, GRDP, and the number of traders in Malang city. Missing value processing will be carried out by interpolating annual data into monthly data with Eviews 9.

3.4 Relationship between factors

To determine the causal relationship between the factors contributing to municipal solid waste. Path analysis is used in this research to determine the significance and direct and indirect effects of one variable on another. Path analysis is a type of confirmatory research in which the variables used in the path must be based on theory or previous research. The first step in path analysis is to design a model based on the literature, then try out several models until the model with the best fit is obtained. The best model is shown in **Figure. 1**. which shows that the model fulfills the goodness of fit. The result of value goodness of fit, standard error (S.E.), and significance (P-Value) in **Table 2 and Table 3** shows that the null hypothesis is rejected or there is an influence between the independent variables on the dependent variable.

Table 2. The result of value goodness of fit

Goodness of Fit Index	Cut off value	Result	Decision
Chi-Square	≤ 2	0,00	Good Fit
GFI	≥ 0,90	0,940	Good Fit
AGFI	≥ 0,90	0,980	Good Fit
CFI	≥ 0,90	0,963	Good Fit
RMSEA	≤ 0,08	0,067	Good Fit
RMR	≤ 0,05	0,002	Good Fit

Table 3. The result of value standard error (S.E.), and significance (P-Value)

			S.E.	P-Value
Expenditure	<---	GDP	0,072	***
MSW	<---	Population	0,130	,005
MSW	<---	Tourist	0,089	***
MSW	<---	Traders	0,082	,015
MSW	<---	Expendiure	0,114	***

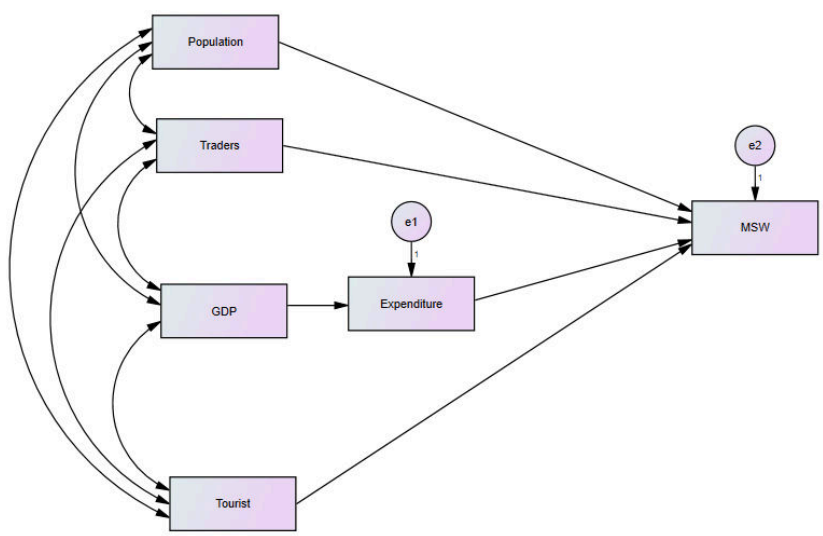

Figure 1. Best fit model on path analysis

3.5 Development Model

3.5.1 Bayesian Networks (BNs) Model

BNs contain structure learning and parameters learning, which refer to constructing the directed acyclic graph (DAG) and obtaining the related conditional probabilistic tables (CPTs). The DAG display will be the same as the path analysis diagram, but the path diagram must be adjusted to fit into the DAG. When generating a path diagram in AMOS, the covariance between independent variables must be drawn, so then the assumption of the covariance in the path can be eliminated in the DAG. The state in the BN can be divided into increasing and decreasing. Increases state when the data of the current period is greater than the previous period, while decreases state when the data of the current period is smaller than the previous period. The DAG display is shown in **Figure 2.**

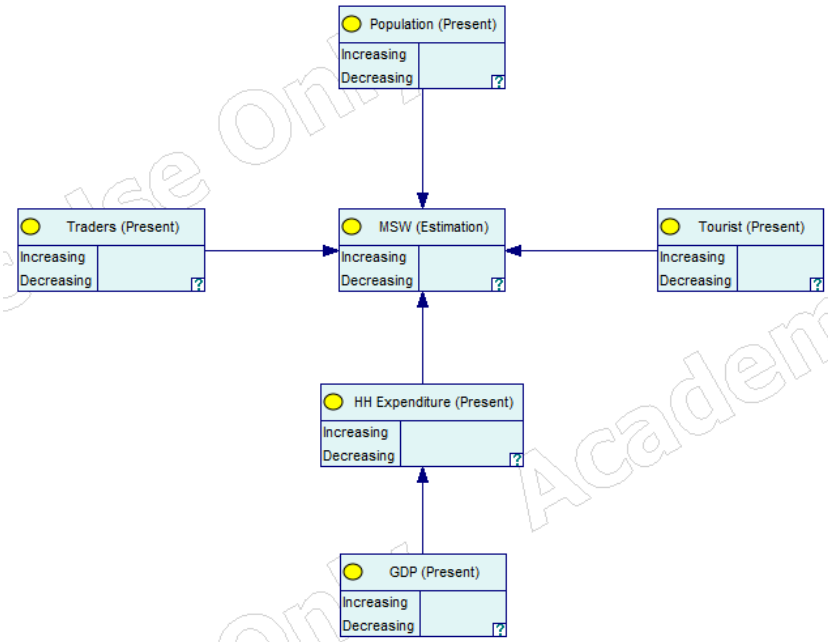

Figure 2. The DAG of development model

The mathematical basis of BNs is the Bayesian equation, as shown below in Equation 1:

$$P\ (B|A) = \frac{P\ (A|B)\ x\ P(B)}{P\ (A)}$$

P (B|A) is the posterior probability of B given the evidence A, P (A) is the prior probability that the evidence A is true, while P (B) is when the evidence B is true.

3.5.2 Double Exponential Smoothing (Holt's) Model

This research uses Double Exponential Smoothing (Holt's) time series forecasting method. Prediction results for p periods in the future use the sum of the estimated values of levels (Lt) and trends in period t (Tt). α and β are smoothing constants for level and trend values in the range of values 0 and 1, which are obtained from ARIMA optimization results in Minitab. The equation for level and trend values, and Holts predictions are shown in equation 2 below:

$$\boldsymbol{L_t} = \alpha Y_t + (1-\alpha)(L_{t-1} + T_{t-1})$$
$$\boldsymbol{T_t} = \beta(L_t - L_{t-1}) + (1-\beta)T_{t-1}$$
$$\hat{\boldsymbol{Y}}_{t+p} = L_t + pT_t$$

3.5.3 Combination of BN and Holt's Model

The Proposed Model is built by combining Holts and BN. This combination model follows the equations in the Holts model, which begins by finding the estimated level and trend values. Forecasting results are obtained by adding and subtracting the estimated level value (L_{t-1}) by multiplying the probability of occurrence (Pt) and the estimated trend value (T_{t-1}) (Suwandi & Yuniarto, 2017). The addition and subtraction of probabilities depend on the forecasting results of the BN model. The equation for forecasting the combination of Holts and BN is shown in Eq 3.

$$Y_t = L_{t-1} \pm (\ P_t\ x\ T_{t-1})$$

3.6 Model Validation

The performance of forecasting models was measured using mean absolute deviation (MAD), mean absolute percentage error (MAPE), and mean square deviation (MSD), which were computed as follows:

$$MAD = \frac{1}{n}\sum_{t=1}^{n}|Y_t - \hat{Y}_t|$$

$$MAPE = \frac{1}{n}\sum_{t=1}^{n}\frac{|Y_t - \hat{Y}_t|}{Y_t} x\, 100\%$$

$$MSD = \frac{1}{n}\sum_{t=1}^{n}(Y_t - \hat{Y}_t)^2$$

4. RESULTS

In this study, before forecasting the amount of municipal waste in 2021 and 2022, a model was built using training data (2017-2018) and tested using test data (2019). The prediction of the combination of BN and Holts using the training data are shown in **Table 2** below.

Table 2. The result of prediction of BN and Holts with training data

	BN		Holts		BN + Holts	Description	Actual	Description	Compatibility
	Inc	Dec	Level	Trend	Prediction				
Dec18			20433,99	32,34	-	-	-	-	-
Jan19	78%	22%	20466,34	32,34	20459,22	Increasing	19844	Decreasing	x
Feb19	78%	22%	20498,68	32,34	20491,57	Increasing	19991	Increasing	v
Mar19	82%	18%	20531,03	32,34	20525,20	Increasing	20124	Increasing	v
Apr19	83%	17%	20563,37	32,34	20557,87	Increasing	20624	Increasing	v
May19	84%	16%	20595,71	32,34	20590,54	Increasing	20682	Increasing	v
Jun19	85%	15%	20628,06	32,34	20623,21	Increasing	20657	Decreasing	x
Jul19	70%	30%	20660,4	32,34	20650,70	Increasing	20514	Decreasing	x
Aug19	64%	36%	20692,74	32,34	20681,10	Increasing	20348	Decreasing	x
Sep19	58%	42%	20725,09	32,34	20711,50	Increasing	20438	Increasing	v
Oct19	86%	14%	20757,43	32,34	20752,90	Increasing	20243	Decreasing	x
Nov19	82%	18%	20789,78	32,34	20783,95	Increasing	20576	Increasing	v
Dec19	62%	38%	-	-	20809,83	Increasing	20677	Increasing	v
MAPE									1,36%
MAD									275,060375
MSD									110639,477
% Matching Pattern with Actual									58%

The results of the municipal solid waste probability show varying results in increasing or decreasing states due to changes in the frequency of state combinations after adding the frequency of events from the previous month. Then the performance in the development model BN and Holt's can be compared with other combination methods. The comparison method combines the two best time series methods from Naive, Double Moving Average, and ARIMA. The selected time series method will be combined using a simple average and Inverse Mean Square (MSE) Weight.

The performance in the development model BN and Holt's can be compared with other combination methods. The comparison method combines the two best time series methods from Naive, Double Moving Average, and ARIMA. The selected time series method will be combined using a simple average and Inverse Mean Square (MSE) Weight. The results of MAPE, MAD,

MSD, and percentage of matching pattern with actual from the proposed model of BN and Holts, with a comparison combination model of simple average and inverse mean square (MSE) weight are shown in the **Table 3** below.

Table 3. The results of MAPE, MAD, MSD, and percentage of matching pattern with actual of proposed model and comparison model

No	Predictive Model	Result			
		MAPE	MAD	MSD	% Matching Pattern with Actual
1	Proposes Model	1,36%	275,060375	110639,477	58%
2	Simple Average Combination	2,954%	599,0744	420585,0474	58,3%
3	Inverse Mean Square (MSE) Weight Combination	2,4186%	489,80646	302199,0699	58,3%

Compared with the comparison method with the proposed BN and Holts, the percentage of matching pattern with actual tends to have the same results. However, the accuracy level of the proposed model is higher. The low value according to the percentage of matching pattern with actual is caused by the limited test data in the test. So, in this study chosen the method proposed by BN and Holts to estimate the amount of municipal solid waste for 2021-2022.

After the proposed model of the combination of BN and Holts has been selected, by showing better model reliability, it is then possible to forecast in 2021 and 2022 using predictive data (January 2017 to December 2020). The BN probability results from the prediction data are shown in **Figure 3**. The probability of the amount of municipal waste generated from the BN model is 64% increased and 36% decreased because the probability value of the amount of waste increasing is greater. It is predicted that the amount of waste will increase in the future.

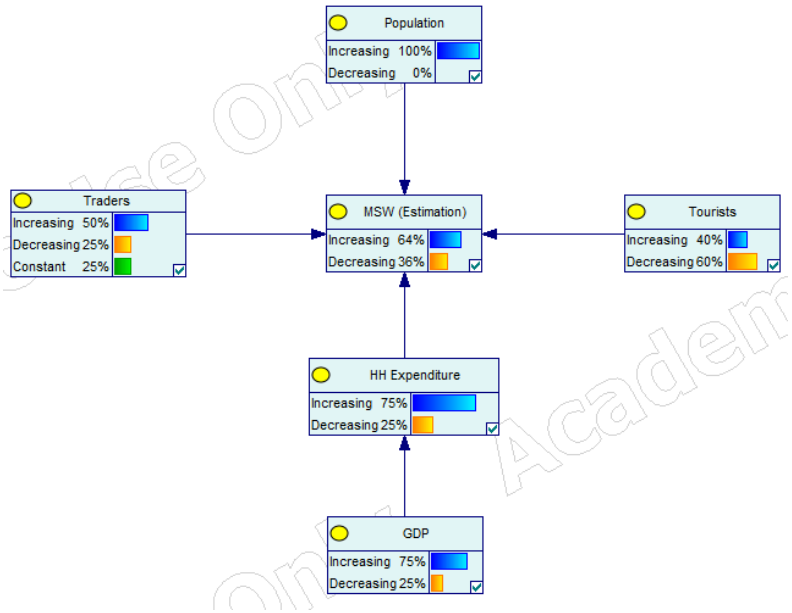

Figure 3. The BN probability results from the prediction data (2017-2020)

Forecasting using predictive data (January 2017-December 2020) on the BN method shows that the population always increases throughout the year so that the state increases in the total population of 100%. For total household consumption expenditure, GDP, Number of Traders have increased from 2017 to 2019 (state increased 75%). The state decreased by 25% due to the 2020 (Covid-19) economic crisis. The number of tourists from 2017 to 2020, dominated by a decrease

of 60%. The number of tourists most days decreases on weekdays, and the effects of the Covid-19 Pandemic also caused the number of Traders in 2017-2019 did not decrease during the pandemic (2020). The optimal value of level and trend constants is used, based on ARIMA on Minitab, namely 0.26089 and 7.57885. The results of the BN and Holt forecasting for 2021-2022 are shown in **Table 4.**

Table 4. The results of the BN and Holt forecasting for 2021-2022

	Level	Trend	Prediction Result of BN and Holts	Description
Dec20	15496,61	405,7975	-	-
Jan21	15902,41	405,7975	15756,32	Increasing
Feb21	16308,21	405,7975	16162,12	Increasing
Mar21	16714	405,7975	16567,92	Increasing
Apr21	17119,8	405,7975	16973,71	Increasing
May21	17525,6	405,7975	17379,51	Increasing
Jun21	17931,4	405,7975	17785,31	Increasing
Jul21	18337,19	405,7975	18191,11	Increasing
Aug21	18742,99	405,7975	18596,9	Increasing
Sep21	19148,79	405,7975	19002,7	Increasing
Oct21	19554,59	405,7975	19408,5	Increasing
Nov21	19960,38	405,7975	19814,3	Increasing
Dec21	20366,18	405,7975	20220,09	Increasing
Jan22	20771,98	405,7975	20625,89	Increasing
Feb22	21177,78	405,7975	21031,69	Increasing
Mar22	21583,57	405,7975	21437,49	Increasing
Apr22	21989,37	405,7975	21843,28	Increasing
May22	22395,17	405,7975	22249,08	Increasing
Jun22	22800,97	405,7975	22654,88	Increasing
Jul22	23206,76	405,7975	23060,68	Increasing
Aug22	23612,56	405,7975	23466,47	Increasing
Sep22	24018,36	405,7975	23872,27	Increasing
Oct21	24424,16	405,7975	24278,07	Increasing
Nov21	24829,95	405,7975	24683,87	Increasing
Dec21	20366,18	405,7975	25089,66	Increasing

In 2020, the frequency of decreasing waste increases, but by the end of the year (Dec 20), it begins to increase so that the prediction results from BN and Holts show an increase in waste in the city of Malang. To find out the most influential factor on the amount of waste during 2017 to 2020 using Netica. The entropy reduction value was obtained, which resulted in the number of traders having the most significant influence on the amount of waste in Malang, followed by household consumption expenditure factors and GDP. The results of the entropy reduction values are shown in **Table 5.**

Table 5. The results of the entropy reduction values (sensitivity analysis)

Node	Entropy Reduction Value	Percentage
MSW	0,94433	100%
The number of traders	0,04160	4,41%
Household consumption expenditure (HCE)	0,02149	2,28%
GDP	0,02149	2,28%
The number of tourists	0,00596	0,631%
Population	0,00000	0%

6. CONCLUSIONS

1. The factors that influence the amount of waste in Malang City are:
   - The population
   - The number of traders.
   - The household consumption expenditure
   - The GDP
   - The number of tourists.

   Factors that have an indirect relationship with MSW is the GDP. The GDP factor is connected to municipal solid waste through household consumption expenditures. While other factors are directly related to MSW.
2. The proposed model development for the BN and Holts methods has a MAPE value of 1.36%, a MAD value of 275.0603, and an MSD of 110639.477, with a percentage of matching pattern with actual of 58%. The value of the pattern fit tends to be small due to limited data collection on training data and small test data. Still, this proposed model has better accuracy than the comparison model.
3. The sensitivity analysis in this study shows that the number of traders has the most influence on the amount of MSW compared to other factors. For comparison with the population factor, it shows that the population has the slightest impact from other factors on the data on the amount of waste throughout 2017-2020.

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DEVELOPMENT OF INVENTORY ROUTING PROBLEM MODEL FOR BLOOD DISTRIBUTION BY BLOOD LIFE FACTOR

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ABSTRACT

Blood is one of the resources that is needed, especially in supporting some of the treatments in the hospital. During the Covid-19 pandemic, the number of blood donors has decreased. This has an impact on PMI inventory, namely the limited and lack of blood supply. Lack of blood supply, especially during the Covid-19 pandemic like this, can certainly cause immeasurable loss of life and distribution costs that increase significantly and have an impact on not properly utilizing vehicles. The problem becomes more complex when researchers look at the limited lifespan of blood. In which, blood cannot be accumulated and stored in large quantities like ordinary commodities, and the quality of blood products is rapidly decreasing. This is due to the perishable nature of blood, which is aged 6-8 hours before processing. Based on the description of the problems above, it is necessary to do good management starting from blood collection activities, blood inventory, to blood distribution to hospitals to meet patient needs, so that total distribution costs can be more optimal, blood stock in inventory is well monitored, and vehicles can be utilized properly. The contribution of this research is to structure the supply chain of blood products with a distribution process modeled as Inventory Routing Problem with Pickup and Delivery (IRP-PD) by considering the age of blood. The proposed Mix Integer Linear Programming will be decomposed into distribution subproblems and route planning subproblems, which are then solved and integrated to reach a problem solution. The completion algorithm was completed by using VBA from Microsoft Excel, and the result was a lower total distribution cost of Rp. 190,800 per 7 periods.

Keywords: Blood Distribution, Perishable Products, Inventory Routing Problem, Pickup and Delivery.

1. INTRODUCTION

Blood is an indispensable resource, especially in supporting some existing treatments in hospitals, such as for surgery and for the treatment of patients with chronic diseases, such as cancer (Hemmelmayr et al., 2009). Currently, the need for blood transfusions is increasing. This is not matched by an increase in blood supply and blood demand. Moreover, so far there is no alternative product that can completely replace blood (Liu et al., 2020).

In Indonesia, there are two blood service units, namely the Blood Transfusion Unit (UTD) and the Hospital Blood Bank (BDRS). The Blood Transfusion Unit (UTD) is responsible for blood donation, blood supply, and blood distribution. Meanwhile, the Hospital Blood Bank (BDRS) is responsible for the availability of blood in the hospital and directly distributes it to the patients in the hospital. The availability of blood in the Blood Transfusion Unit is largely determined by the

community's participation in the willingness to donate blood voluntarily. Moreover, the number of blood donors during the Covid-19 pandemic has decreased drastically, due to the fear that donors will be exposed to the virus during the blood donation process.

Lack of blood supply, especially during the Covid-19 pandemic like this, can certainly cause immeasurable loss of life and significantly increase costs. For example, based on the results of an interview with one of the PMI parties in the city of Surabaya, the results obtained when a health facility, in this case is a hospital, if there is a shortage of blood stock, the hospital will take blood stock from the PMI without any scheduling. regular. This has an impact on not utilizing the vehicle properly and will lead to increased distribution costs. Thus, it is necessary to carry out good management starting from blood collection, to blood distribution to hospitals to meet patient needs.

The problem becomes more complex when researchers look at the limited lifespan of blood. In which, blood cannot be accumulated and stored in large quantities like ordinary commodities, and the quality of blood products is rapidly decreasing. This is due to the perishable or short-lived nature of blood, which is 6-8 hours before processing, and between 5 to 35 days after processing (Belien & Force, 2012). Therefore, the unique nature of blood also requires effective and efficient management of the appropriate supply chain, which can ensure the fulfillment of demand, reduce the total operating cost and maintain the quality of blood products (Liu et al., 2020). An unbalanced blood supply and demand, together with various consequences, require effective and efficient management of blood products (Gao, 2018).

An efficient way to deal with issues of concern today is to integrate all supply chain processes. In this context, the Inventory Routing Problem (IRP) method can achieve research objectives by managing distribution and storage simultaneously with PMI having flexibility in managing delivery schedules and the amount of blood products transported. Basically, IRP is a development of vehicle routing problems that have the objective of minimizing transportation costs, where the decision variables are not only vehicle routes, but decisions related to inventory control are also considered, namely when customers are visited and how many goods are sent to each. customers (Lmariouh et al., 2017).

In this study, PMI will be fully responsible for planning for blood collection which is carried out at potential blood collection points, namely at the blood center car, using the same vehicle (with limited capacity) and at the same time sending blood products to the hospital. Currently, each PMI, including the PMI in Surabaya, already has several cars or minibuses that can be used to make visits to potential blood draw points. Each car that visits will operate for approximately 4 hours plus approximately 2 hours for the return and departure journey due to the age limit of the blood itself. In addition, for one car, there is a limit on the capacity of blood that can be accommodated, which can only accommodate blood for approximately 140 donors.

Thus, the contribution of this study is firstly, structuring the blood product supply chain, where the distribution process is modeled as IRP-PD, where PMI monitors the demand for blood in the hospital and determines the optimal distribution scheme. The proposed Mix Integer Linear Programming is decomposed into distribution subproblems and route planning subproblems, which are then solved separately and integrated to reach an overall solution for the original model. Third, numerical calculations based on the real blood distribution network are carried out to describe the performance of the models and algorithms created.

2. LITERATURE REVIEW

2.1 Boold

Blood is a liquid tissue consisting of two parts, namely blood plasma and blood cells. There are three types of blood cells, namely erythrocytes, leukocytes, and platelets. The total blood volume is one twelfth of body weight or approximately 5 liters. About 55% is blood plasma, while the rest is made up of blood cells. (Pearce, 2006). Blood is a fluid that is very important for humans because it functions as a means of transportation and has many other uses to support life. Without enough blood, a person can experience health problems and can even result in death.

2.2 Blood Type

In general, blood consists of several components. The components of blood include the following (Pandiangan, 2014):

1. Whole Blood (WB), is whole blood (complete blood). Has a volume that varies from 250 ml, 350 ml, and 450 ml. This type of blood is stored in the refrigerator at 2-6oC. WB is divided into three parts, namely fresh blood, new blood, and stored blood. This WB has a lifespan of up to 35 days.
2. Packed Red Cell (PRC), is blood that is deposited. PRC was derived from whole blood which was sedimented during storage. One unit of PRC has a volume of 500 ml. The expiration date of this blood type is the same as whole blood, which is 35 days.
3. Fresh Frozen Plasma (FFP), obtained from the separation of fresh blood by the screening method, then frozen and stored at a temperature of -30oC. so it can last up to 1 year. This type of blood is given to patients with generalized bleeding that cannot be controlled with surgical sutures.
4. Washed Red Cell (WRC), obtained by washing packed red cells two to three times with saline, the remaining plasma is wasted. The weakness of WRC is the danger of secondary infection that occurs during the process and the short shelf life (4-6 hours).
5. Thrombocyte Concentrate (TC), this blood type is given to patients with bleeding cases caused by a lack of platelets. This blood type has an expiration date of up to 5 days.

2.3 Inventory Routing Problem

Inventory Routing Problem (IRP) is an integration between two components including inventory control and vehicle routing where both components are determined simultaneously (Savelsberg et.al., 2006). Unlike in the vehicle routing problem (VRP), where suppliers allocate vehicles to make deliveries according to customer demand, in IRP there are no direct orders from customers (Siswanto et.al., 2011). The supplier must maintain inventory at the customer at a certain level. Suppliers must maintain this inventory level to prevent stocked outs while minimizing costs. The costs that arise here can be in the form of transportation costs, loading and unloading costs, inventory costs, and other costs depending on the characteristics of the existing problems.

The characteristics of the problems discussed in the IRP can vary. Archetti et al. (2018) describes it as follows:

a) Time can be either discrete or continuous
b) Demand can be deterministic or stochastic
c) Some consider inventory holding cost as an objective function but some do not

Although the characteristics raised in the problem are different, all studies must consider inventory and routing as components of the optimization model. According to Coelho et al (2014), research on IRP is relatively new compared to related optimization models such as VRP. There are several variations of IRP that have been developed by researchers which are applied in various fields. In a study conducted by Coelho et al. (2014) to find out the development and application of IRP, the most common application is in maritime logistics, or what is known as ship routing and inventory management.

3. METHODS

In the Inventory Routing Problem with Pickups and Deliveries (IRP-PD) algorithm, a type of goods is generated in the set of transport nodes $\mathcal{N}_{\mathcal{P}}$ and sent to the set of sending nodes $\mathcal{N}_{\mathcal{D}}$. In each period $t \in \mathcal{T}$, each pickup node $i \in \mathcal{N}_{\mathcal{P}}$ produce several products d_{it}. Whereas at each delivery node $i \in \mathcal{N}_{\mathcal{D}}$ consume a certain amount of product d_{it}.

Number of vehicles as much as m and capacity Q leave and return to the depot (*node* 0) in each period $t \in \mathcal{T}$. The depot neither produces nor consumes the product, but can store the product in its inventory. Inventory level I_{it} at each customer node $i \in \mathcal{N}, \mathcal{N} = \mathcal{N}_{\mathcal{P}} \cup \mathcal{N}_{\mathcal{D}}$ in each period $t \in \mathcal{T}$ cannot exceed the maximum inventory limit U_i and must not be below the minimum inventory limit L_i.

Mathematically, based on the notation written in table 1, the inventory routing problem with pickups and deliveries modeling is formulated as follows:

Table 1 Modeling notation of inventory routing problems with pickups and deliveries

SET	
$\mathcal{N}$	Set customer node, $\mathcal{N} = \mathcal{N}_{\mathcal{P}} \cup \mathcal{N}_{\mathcal{D}}$
$\mathcal{N}'$	Set all *node*, including *depot*, $\mathcal{N}' = \{0\} \cup \mathcal{N}$
$\mathcal{N}_{\mathcal{P}}, \mathcal{N}_{\mathcal{D}}$	Set *node* pickup and delivery, dimana $\mathcal{N}_{\mathcal{P}} \cap \mathcal{N}_{\mathcal{D}} = \emptyset$
$\mathcal{A}$	Set *arcs* or *path* (i,j), where $i,j \in \mathcal{A}$
$\mathcal{T}$	Set period
$\mathcal{T}'$	Set period including period 0, $\mathcal{T} = \{0\} \cup \mathcal{T}$
PARAMETER	
d_{it}	The number of products produced at the pickup node $i \in \mathcal{N}_{\mathcal{P}}$, or consumed in the delivery node $i \in \mathcal{N}_{\mathcal{D}}$ in period $t \in \mathcal{T}$
h_i	*Inventory cost per unit in all node* $i \in \mathcal{N}'$
L_i, U_i	Minimum and maximum inventory level at customer nodes $i \in \mathcal{N}$
I_i^0	Initial inventory level on all nodes $i \in \mathcal{N}'$
c_{ij}	*Traveling cost from node to node* j, $(i,j) \in \mathcal{A}$
m	Number of vehicles
Q	Vehicle capacity
VARIABLE	
q_{it}	The number of products picked up at the depot or delivery node $i \in \mathcal{N}_{\mathcal{P}}$, or unloaded in the delivery node $i \in \mathcal{N}_{\mathcal{D}}$ in period $t \in \mathcal{T}$
y_{it}	Binary variable, value 1 when node $i \in \mathcal{N}$ visited in period $t \in \mathcal{T}$, and is 0 if not visited

y_{0t}	Number of vehicles used in period $t \in \mathcal{T}$
I_{it}	Inventory level on all nodes $i \in \mathcal{N}'$ in period $t \in \mathcal{T}$
x_{ijt}	Binary variable, value 1 if path $(i,j) \in \mathcal{A}$ traversed by vehicles in period $t \in \mathcal{T}$, and is 0 if not visited
l_{ijt}	The number of items loaded in the vehicle when passing through the path $(i,j) \in \mathcal{A}$ in period $t \in \mathcal{T}$

Objective Function

$$\min z = \sum_{(i,j)\in\mathcal{A}} \sum_{t\in\mathcal{T}} c_{ij} x_{ijt} + \sum_{i\in\mathcal{N}'} \sum_{t\in\mathcal{T}} h_i I_{it}, \tag{2.1}$$

Constraints

$$\sum_{j\in\mathcal{N}} x_{0jt} - y_{0t} = 0, \qquad t \in \mathcal{T}, \tag{2.2}$$

$$\sum_{j\in\mathcal{N}'} x_{ijt} - \sum_{j\in\mathcal{N}'} x_{jit} = 0, \qquad i \in \mathcal{N}', t \in \mathcal{T}, \tag{2.3}$$

$$\sum_{j\in\mathcal{N}'} x_{ijt} - y_{it} = 0, \qquad i \in \mathcal{N}, t \in \mathcal{T}, \tag{2.4}$$

$$\sum_{i\in\mathcal{S}} \sum_{j\in\mathcal{S}} x_{ijt} \le \sum_{i\in\mathcal{S}} y_{it} - y_{mt}, \qquad \mathcal{S} \subseteq \mathcal{N}, m \in \mathcal{S}, t \in \mathcal{T}, \tag{2.5}$$

$$I_{it} - I_{i,t-1} - d_{it} + q_{it} = 0, \qquad i \in \mathcal{N}_{\mathcal{P}}, t \in \mathcal{T}, \tag{2.6}$$

$$I_{it} - I_{i,t-1} + d_{it} - q_{it} = 0, \qquad i \in \mathcal{N}_{\mathcal{D}}, t \in \mathcal{T}, \tag{2.7}$$

$$I_{0t} - I_{0,t-1} + \sum_{i\in\mathcal{N}_{\mathcal{D}}} q_{it} - \sum_{i\in\mathcal{N}_{\mathcal{P}}} q_{it} = 0, \qquad t \in \mathcal{T}, \tag{2.8}$$

$$I_{i0} = I_i^0, \qquad i \in \mathcal{N}' \tag{2.9}$$

$$I_{i,t-1} + q_{it} \le U_i, \qquad i \in \mathcal{N}_{\mathcal{D}}, t \in \mathcal{T}, \tag{2.10}$$

$$I_{it} \ge L_i, \qquad i \in \mathcal{N}_{\mathcal{D}}, t \in \mathcal{T}, \tag{2.11}$$

$$I_{it} \le U_i, \qquad i \in \mathcal{N}_{\mathcal{P}}, t \in \mathcal{T}, \tag{2.12}$$

$$I_{i,t-1} - q_{it} \ge L_i, \qquad i \in \mathcal{N}_{\mathcal{P}}, t \in \mathcal{T}, \tag{2.13}$$

$$q_{it} \le \min\ \{U_i - L_i\} y_{it}, \qquad i \in \mathcal{N}, t \in \mathcal{T}, \tag{2.14}$$

$$y_{it} \le y_{0t} \le m, \qquad i \in \mathcal{N}, t \in \mathcal{T}, \tag{2.15}$$

$$l_{ijt} \le Q x_{ijt}, \qquad (i,j) \in \mathcal{A}, t \in \mathcal{T}, \tag{2.16}$$

$$\sum_{j\in\mathcal{N}'} l_{jit} + q_{it} - \sum_{j\in\mathcal{N}'} l_{ijt} = 0, \qquad i \in \mathcal{N}_{\mathcal{P}}, t \in \mathcal{T}, \tag{2.17}$$

$$\sum_{j\in\mathcal{N}'} l_{jit} - q_{it} - \sum_{j\in\mathcal{N}'} l_{ijt} = 0, \qquad i \in \mathcal{N}_{\mathcal{D}}, t \in \mathcal{T}, \tag{2.18}$$

$$\sum_{j\in\mathcal{N}} l_{0jt} \le I_{0,t-1}, \qquad j \in \mathcal{N}, t \in \mathcal{T}, \tag{2.19}$$

$$l_{ijt} \ge 0, \qquad (i,j) \in \mathcal{A}, t \in \mathcal{T}, \tag{2.20}$$

$$q_{it} \geq 0, \qquad i \in \mathcal{N}, t \in \mathcal{T}, \qquad (2.21)$$
$$I_{it} \geq 0, \qquad i \in \mathcal{N}', t \in \mathcal{T}, \qquad (2.22)$$
$$x_{ijt} \in \{0,1\}, \qquad (i,j) \in \mathcal{A}, t \in \mathcal{T}, \qquad (2.23)$$
$$y_{it} \in \{0,1\}, \qquad i \in \mathcal{N}, t \in \mathcal{T}, \qquad (2.24)$$
$$y_{0t} \in \mathbb{N}, \qquad t \in \mathcal{T}. \qquad (2.25)$$

The objective function (2.1) is to minimize operational costs which consist of traveling costs and inventory costs during the planning horizon. Constraint (2.2) is the calculation of the vehicle used in each period $t \in \mathcal{T}$ which is equal to the number of paths to the depot traversed by the vehicle. Constraints (2.3) and (2.4) are route construction, where constraint (2.3) is flow conservation constraint, and constraint (2.4) forces the number of exit paths from customer nodes traversed by the vehicle is equal to 1 if the node is visited, this is because the variable y_{it} where $i \in \mathcal{N}$ is a binary variable. Constraint (2.5) is a subtour elimination constraint. Constraints (2.6), (2.7), and (2.8) are definitions of inventory levels in the period $t \in \mathcal{T}$, at each pickup node $i \in \mathcal{N}_{\mathcal{P}}$, *node* delivery $i \in \mathcal{N}_{\mathcal{D}}$ and *depot*. The initial inventory variable across all nodes is defined by a constraint (2.9). Constraints (2.10) and (2.11), as well as constraints (2.12) and (2.13) are inventory level constraints at each delivery node $i \in \mathcal{N}_{\mathcal{D}}$ and *node* pickup $i \in \mathcal{N}_{\mathcal{P}}$. Where the constraints (2.10) and (2.12) limit the inventory level not to exceed the maximum inventory level, and the constraints (2.11) and (2.13) prevent the inventory level from being below the minimum inventory value. Constraint (2.14) limits the number of goods transported or unloaded at each node not exceeding the vehicle capacity and available inventory. Constraint (2.15) is a constraint that limits the number of vehicles used in each period $t \in \mathcal{T}$ must not exceed the available vehicles. Constraint (2.16) limits the amount of cargo on the vehicle not exceeding its maximum capacity when passing through the path $(i,j) \in \mathcal{A}$. Constraint (2.17), (2.18), and (2.19) defines the load in the vehicle. Constraint (2.20), (2.21), and (2.22) prevents the number of loads on trucks, the number of items loaded or unloaded, and the inventory at each node is negative. And the last is the constraints (2.23), (2.24), and (2.25) defining the variable domain x_{ijt} and $y_{it}, i \notin 0$ which is a binary number, and the number of vehicles is a positive integer y_{0t}.

4. RESULTS

In this study, the model has been developed into Inventory Routing Problem Pickup and Delivery (IRP-PD) by considering blood age. The maximum number of vehicles available to carry out pickup and delivery activities is 5 vehicles. The number of hospitals (RS) handled by PMI are 11 hospitals and 5 blood center (BC) cars. Based on the results of running using VBA, the results are presented in Table 2.

In carrying out pickup and delivery activities, a maximum of 5 vehicles is needed per day with different routes for each period (day). With the costs incurred as a result of running the model development, it is much lower than the current pickup and distribution activities.

Table 2. Calculation Results of Model Development

Period (Day)	Number of Vehicle	Number of Node								Distance (Km)	Time (minutes)	Cost (Rp)	Total Cost (per period)
		1	2	3	4	5	6	7	8				
1	1	PMI	RS1	BC1	PMI					12	55	12.000	193.800
	2	PMI	RS2	RS5	BC5	BC4	PMI			32	119	32.300	
	3	PMI	RS9	RS7	RS4	BC2	PMI			64	158	64.300	
	4	PMI	RS11	RS10	RS3	PMI				47	117	47.600	
	5	PMI	BC3	PMI						38	66	37.600	
2	1	PMI	RS1	BC1	BC4	PMI				22	87	22.000	174.500
	2	PMI	RS6	RS3	RS10	BC5	PMI			51	141	50.000	
	3	PMI	RS8	RS11	RS4	BC2	PMI			66	157	64.900	
	4	PMI	BC3	PMI						38	66	37.600	
3	1	PMI	RS1	RS8	RS11	BC5	BC4	PMI		34	142	34.500	104.000
	2	PMI	BC1	BC2	PMI					32	79	31.900	
	3	PMI	BC3	PMI						38	66	37.600	
4	1	PMI	RS1	RS9	BC5	BC4	PMI			30	117	30.400	164.700
	2	PMI	RS7	RS6	RS4	RS2	BC1	PMI		33	140	33.600	
	3	PMI	RS5	RS3	RS10	BC3	PMI			70	164	69.300	
	4	PMI	BC2	PMI						32	58	31.400	
5	1	PMI	RS8	RS11	RS7	BC1	PMI			33	119	32.400	189.200
	2	PMI	RS2	RS1	RS4	RS6	BC4	BC5	PMI	39	167	39.600	
	3	PMI	RS10	RS9	RS5	RS3	PMI			51	141	50.900	
	4	PMI	BC2	BC3	PMI					67	120	66.300	
6	1	PMI	RS1	RS3	RS10	RS11	BC5	PMI		53	165	53.500	136.000
	2	PMI	BC1	BC4	PMI					16	60	16.200	
	3	PMI	BC2	BC3	PMI					67	120	66.300	
7	1	PMI	RS7	RS5	RS2	BC1	BC4	BC5	PMI	43	170	41.400	172.300
	2	PMI	RS6	RS9	RS4	RS3	RS8	PMI		47	157	48.100	
	3	PMI	RS10	BC3	BC2	PMI				83	159	82.800	
												TOTAL	1.134.500

6. CONCLUSIONS

1. This study resulted in an inventory routing problem model for planning blood transportation and distribution scheduling, by giving PMI flexibility regarding the schedule and amount of blood distributed along with the amount of blood that can be transported (pickup) from blood collection points (mobile blood center).
2. Based on the experimental results, the total cost for pickup and delivery activities in 7 periods (7 days) is Rp. 1,134,500. The cost is much lower Rp. 190,800 compared to the costs incurred in PMI's current distribution activities.

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COMPONENTS THAT INFLUENCE THE SUCCESS OF PROJECTS IN START-UP COMPANIES IN SURABAYA

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ABSTRACT

The convenience of the internet is a good thing to introduce businesses to create new business innovations such as technology-based (startups). The types of startups are very diverse, from games, property, trade, insurance to education, each of which has very varied characteristics. This study aims to determine the components of project management that affect startup companies in Surabaya. The method used is a descriptive analysis of the mean and standard deviation distribution. The questionnaire was filled out on 40 respondent consisting of startup owners or the equivalent managerial level. In this study, 28 components are broadly grouped into five: initiation, planning, implementation, control, and closing. The results showed that the variable with a high mean value and a slight standard deviation among 28 variables was the most important or influential. These components are used in running a project at a startup company. Each aspect has essential components. The analysis results show that the essential aspect of the variable has a mean value of 3.95 with a standard deviation of 0.778. This value is obtained from the planning component. This shows that the planning component is the essential variable in the smooth running of a project at a startup company.

Keywords: project management, startup companies, planning, mean, standard deviation.

1. INTRODUCTION

The CHGR research institute projects that the number of technology-based startups (startups) in Indonesia will proliferate, reaching more than 2.000 businesses by 2020. The various startup business sectors in Indonesia, e-commerce and marketplace are the startup sectors that are most in demand by global public investors. Data from the Indonesian Information and Communication Technology Creative Industry Society (MIKTI) in 2019, East Java was in the third position after Jabodetabek and Sumatra with 113 startup companies. Surabaya is one of the cities with the highest number of startup companies in East Java.

The Government of Surabaya provides many facilities to support the formation and sustainability of startups, such as co-working spaces as an office that startup entrepreneurs can use for free. However, in addition to facilities that the government has supported, startups should have a good management system as the key to the success of a business or company to support the progress process. With a good management system, a startup can continue growing and innovating more than ever before.

2. LITERATURE REVIEW

(Teguh & Sudiadi, 2015) project management is a science and art related to each other by leading and coordinating a resource, such as human and material, using a modern management technique to achieve a specified target. The principle of project management is a skill "Tools and Techniques" in activities during the project to meet project requirements and needs. In the process, project management can be divided into five processes: initiation process, planning process, executing process, controlling process, and closing process.

The rapid growth of the internet from year to year has made the business change from being conventional to fast-moving and far more strategic. Therefore, the startup business is becoming more recognized and proliferating every year. And not only abroad, but Indonesia also feels the changes (Kiwe, 2018).

(Kiwe, 2018) states that startups are individuals who form a group to form an organization that is used as a startup company that can produce a product in technology. In today's digital era, the internet has become optimal, so startups must be ready to face the free market in cyberspace that can reach all target markets in expanding market needs with vast and significant expansion. Therefore, startups often disrupt technology on a large scale from the previous conventional model and turn it into a digital form that is expected to be accessible to anyone without any boundaries of space and distance. Things like this are the basis for startups planning a target to trigger growth for

customers who are considered so massive at the beginning of launching (Nandini, 2019).

3. METHODS

The research method used in this research is the descriptive analysis method with a quantitative approach. Descriptive research is research conducted to know the value of independent variables, both on one variable or several (independent) variables, without making comparisons or connecting with other variables (Sugiyono, 2012). Descriptive research is a study that tries to describe an event, symptom, or event in the present (Sudjana & Ibrahim, 2004). A quantitative approach is an approach that uses numbers, starting from data collection, data processing to output or results (Arikunto, 2013).

Based on this understanding, it can be concluded that descriptive research is carried out by seeking information related to the existing phenomena, explaining in detail the goals to be achieved, planning how to approach them, and collecting various kinds of data as material for making reports. In the research conducted, the authors want to know the components of project management that affect startup companies in Surabaya.

This research approach uses a quantitative approach because it uses numbers, starting from data collection, interpretation of the data, and the resulting output. This approach is also associated with research variables that focus on current problems and phenomena with research results in the form of numbers that have meaning.

The population used in this study were 40 resource persons consisting of start-up owners or equivalent managerial levels. The sample used is 40 sources with the condition that the start-up company has been in existence for two years or more and is still running until now. The instrument used in sampling is a questionnaire. The questionnaire contains 28 aspects related to the most influential components.

4. RESULTS

The use of the descriptive analysis method by determining the mean and standard deviation in finding the components that affect the smooth running of the project in a startup company in Surabaya. The questionnaire results were tabulated into a compilation of data, and then a plot diagram was made, which divided the 28 variables into four quadrants.

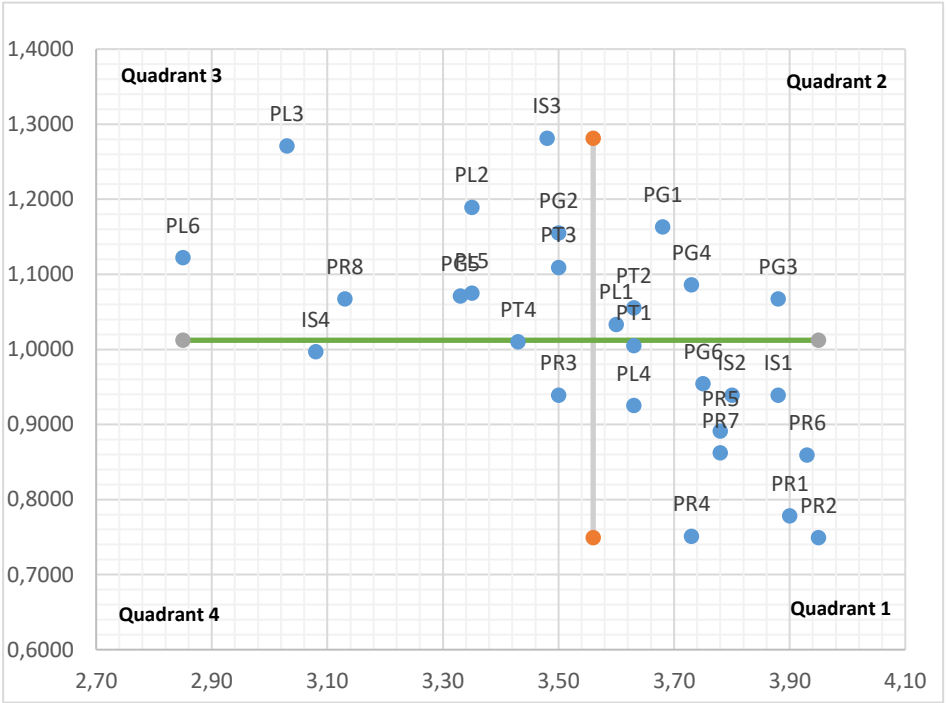

Figure 1. Mean and Standard Deviation Plot Charts

From the results of the plot diagram in Figure 1, it can be seen that the aspects are in each quadrant 1, quadrant 2, quadrant 3, and quadrant 4. Quadrant 1 is a variable that has a high mean value with a slight standard deviation, quadrant 2 is for variables that have a high mean value and also a high standard deviation, for quadrant 3 is a variable with a small mean and high standard deviation, and quadrant 4 is for a variable with a slightly mean and high standard deviation. Therefore, aspects of each quadrant can be grouped as follows:

Table 1. Quadrant Variables

Quadrant 1			
No.	**Variable**	**Mean**	**Standard Deviation**
1.	Initiation Aspect 1	3.88	0.9388
2	Initiation Aspect 2	3.80	0.9392
3	Planning Aspect 1	3.90	0.7779
4	Planning Aspect 2	3.95	0.7494
5	Planning Aspect 4	3.73	0.7506
6	Planning Aspect 5	3.78	0.8912
7	Planning Aspect 6	3.93	0.8590
8.	Planning Aspect 7	3.78	0.8619
9.	Implementation Aspect 4	3.63	0.9251
10.	Control Aspect 6	3.75	0.9541
11.	Closing Aspect 1	3.63	1.0048
Quadrant 2			
No.	**Variable**	**Mean**	**Standard Deviation**
1.	Implementation Aspect 1	3.60	1.0328
2.	Control Aspect 1	3.68	1.1633
3.	Control Aspect 3	3.88	1.0667
4.	Control Aspect 4	3.73	1.0857
5.	Closing Aspect 2	3.63	1.0546
Quadrant 3			
No.	**Variable**	**Mean**	**Standard Deviation**

1.	Initiation Aspect 3	3.48	1.2808
2.	Implementation of Aspect 2	3.35	1.1886
3.	Implementation of Aspect 3	3.03	1.2707
4.	Implementation of Aspect 5	3.35	1.0754
5.	Implementation of Aspect 6	2.85	1.1220
6.	Control Aspect 2	3.50	1.1547
7.	Control Aspect 5	3.33	1.0715
8.	Closing Aspect 3	3.50	1.1094
Quadrant 4			
No.	**Variable**	**Mean**	**Standard Deviation**
1.	Initiation Aspect 4	3.08	0.9971
2.	Planning Aspect 3	3.70	0.9392
3.	Closing Aspect 4	3.43	1.1094

Table 1 to table.4, which has been grouped in quadrant 1 to quadrant 4, shows that the Planning variable has a mean value of 3,95 and a standard deviation of 0,7779. This value comes from Aspects 1 and 2 in planning, namely startup companies in Surabaya always make possible obstacles that will occur during the project before the project runs, and project management planning must be done before the project runs.

5. CONCLUSION

Based on the data from the questionnaire, which was distributed to 40 respondents, the mean and standard deviation of the 28 variables that had been determined were obtained. From the data processing results, it can be concluded that the most influential component in the smooth running of projects in start-up companies in Surabaya is planning. With a mean value of 3,95 and a standard deviation of 0,7779. This shows that planning plays an essential role in running the project in the project management system in a startup company.

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INFORMATION TECHNOLOGY GOVERNANCE AUDIT AT RSUD SIDOARJO HOSPITAL (A REGIONAL GENERAL HOSPITAL OF SIDOARJO REGENCY) USING THE COBIT 2019 FRAMEWORK

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ABSTRACT

RSUD Sidoarjo Hospital has developed information technology solutions but has not been able to assess whether these steps are beneficial and align with the company's strategy.This study aims to obtain measurements, current and expected Information Technology process capabilities and guidelines for aligning Information Technology governance with hospital business strategies. This research method uses the COBIT 2019 framework and using the standard Capability maturity model integration (CMMI) to measures the level of capability with the stages of the assessment activity process.Analyzed 9 domains, those been found significant gaps between the current and expected level of capabilities of RSUD Sidoarjo in 2022. In the sub-domain and IT processes: EDM01, EDM02, EDM03, APO06, APO12, APO13, with gap value 2 and APO01, APO03 with gap value 3, IT management were declared as very not good/ very not optimal, although there was 1 sub-domain that managed to reach level 1 or PERFORMED, namely APO07, still the company stated that it had not implemented the IT Governance implementation process and had not been able to identify IT risks clearly yet. The audit recommendations obtained included: employee development, training in the application of information technology management, developing formal mechanisms (guidelines/policies/procedures) for information security, and defining KPIs for employees.

Keywords: IT, Audit, COBIT 2019, IT Governance

1. INTRODUCTION

In order to improve service quality in the field of health services, RSUD Sidoarjo Hospital had carried out developments in the field of information technology in the areas of software, hardware, and networks. However, the existing problems found were actually obstacles in the governance of infrastructure, security, and application. Seeing the increasingly complex challenges faced by the organization, the need for good governance practices also increases. Previously,infrastructure and application development are carried out only based on user's requests from the service department and rely on the problems that develop at that certain time, hence the application exists, for just in case purposes, in the short term without any further development. This happens because there is no comprehensive infrastructure planning for a long run i.e for the next 5 years. The issue of data security or security for increasing integration

between applications, both internal and external, definitely requires unique data security design and a strong data security fortress. A reliable hospital information system requires information that can provide guarantees for the hospital information system because it involves patient data. When hospital security neglect its information system, it can increase the security risk caused by both external and internal factors. The human resource factor is constrained by a shortage of employees, even current employees also need to increase competence by providing IT-related Training. Considering the management policy side, the strength and capacity of human resources at the RSUD Sidoarjo Hospital is expected to be able to analyze the problems that are priorities to be resolved and strategies to overcome these problems in the implementation of good information technology governance. In order to manage information technology to be more optimal and align to the hospital's business strategy, IT governance at the Sidoarjo Hospital requires an evaluation or audit, especially for infrastructure, security and applications.

Some of the problems that occur include monitoring the condition of the stock of oral drugs and the completeness of medical records, each has an application in its management but does not appear to have a significant improvement impact. The following are data on field findings that support the urgency of conducting the COBIT 2019 Audit:

Table 1.1 : Damage Stock-Dead Stock and Expired Stock of Oral Medicine

Year	Percentage (%) to Total Stock			
	Damage	Dead	Expired	Healthy
2019	10	8	10	72
2020	12	11	8	69
2021	10	11	13	66

Stock of damaged medicine is medicine that is damaged, physically or chemically, while stock of dead medicine is medicine that had been stocked more than 3 (three) months but yet ever been used, while expired stock is medicine that had reached its expiration date. In Table 1.1, it can be seen that the stock of healthy drugs had decreased from year to year, this is certainly worrying because it shows the lack of good forecasting process for purchasing and storing drugs which results in risks in the efficiency of the purchasing budget. Another problem can be seen in table 1.2 as follows :

Table 1.2 : Inpatient Medical Record Completion Time

No	Year	Number of Medical Record Documents	Number of Completed Documents in Such Period		
			1x24 hrs	2x24 hrs	Longer than 3 Days
1	2019	42470	27200	3610	1520
			64%	9%	4%
2	2020	42800	29590	6080	7130
			69%	14%	17%
3	2021	33800	25000	5340	3460
			74%	16%	10%

Filling and completion of inpatient Medical Record (RM) file is carried out by doctors and nurses that shall be submitted to the PJRM room (Medical Record Caretaker Officer) 1x24 hours after the patient leaves the hospital. If the RM file is not complete, then the file will be returned to the respective sections to be completed within the next 1x24 hours. Based on table 1.2, inpatient RM files in 2019 reached 42470 files with the completeness of filling out medical record files not yet reaching 100% (only 77%). The impact of filling in the inpatient RM file that will not interfere with the quality of health services at RSUD Sidoarjo Hospital. Incomplete health information in the inpatient RM file will make it difficult to know the condition or history of previous illnesses and the risk for wrong treatment. Although the speed of filling in medical record completeness is increasing, this is still far from the requirements set in 2018 and 2019 which is to complete the RM file at least 90 percent within 1 x 24 hours. At the end of 2019, the Information Technology Department developed the infrastructure and application of hospital management information systems, this was done to improve the Information Technology asset security system (data/information) and maintain the IT Service Level Agreement (SLA). IT services SLA is an SLA that helps all parties to measure expectations based on clear measurements knowing that the infrastructure and applications do not experience any obstacles in the company's operations. From the SLA data for IT Services at the Sidoarjo Hospital from 2019 - 2021, we know that:

Table 1.3 : IT Service Level Agreement and Revenue

No	Indicator	SLA 2019	Revenue 2019 (IDR mio)	SLA 2020	Revenue 2020 (IDR mio)	SLA 2021	Revenue 2021 *(s/d Nop 2021) (IDR mio)
1	LAN and Internet Services	98,0%	385.785	99,50%	424.547	99,79%	450.000
2	Application Services	99,6%		99,8%		99,91%	

Lunardi et al. (2013), in their research, found that companies that adopt information technology governance practices have increased performance, especially concerning profitability. The effect of adopting information technology governance mechanisms on financial performance is more visible in the year after adoption, not in the year of adoption. Andrianti and Assegaf (2018), in their research, said that the implementation of IT Governance needs to be done to deal with problems such as damage that can result in loss of data so that it can interfere with the company's operational activities, considering that the recovery efforts carried out require a lot of time and resources. Well, it can be seen from the table above that the SLA of LAN and Internet services from year to year always increases, while the target set annually by the Information Technology Sub-section of the Sidoarjo Hospital is 95%., thus, thanks to the implementation of infrastructure and application development, the Information Technology Department succeeded in exceeding the service SLA targets set, it is one of the Information Technology risk mitigation and supports Information Technology governance in Sidoarjo Hospital. This mitigation may reduces monthly maintenance costs and efficiency of HR costs and increase revenue due to higher service quality that makes patients choose RSUD Sidoarjo Hospital when they need healthcare help. and from the table above revenue increase looks significant on year to year. However, an IT

Governance Audit is needed to support this assumption, whether with this strategy the risks of implementing and using Information Technology were previously unknown can be controlled so that it will support the company's business objectives.

This research has two purposes, firstly is to conduct an audit using the COBIT 2019 framework and assess the level of adequacy of information technology risk control so that the inherent risk of implementing and using existing information technology does not interfere with the smooth and continuous operation, business and reputation of the RSUD Sidoarjo Hospital. Secondly is to obtain recommendations for comprehensive management of information technology governance, as well as controlling and aligning them with the hospital's business strategy in order to optimize the benefits of Information Technology investment to further develop the RSUD Sidoarjo Hospital business.

2. LITERATURE REVIEW

Based on the explanation that has been stated previously, this research is a study that discusses the IT governance audit at Sidoarjo Hospital. The output to be produced from this research is an explanation of the current and expected level of IT management capability and recommendations will be given later to IT management to support the company's goals to be even better. The completion of this research cannot be separated from relevant research that has been carried out previously, which serves as study material in solving existing problems.

Table 2.1 : Literature Review

No	Reasearcher	Year	Research	Methods	Result
1	Kasma Septiyana Vira	2019	IT Governance of Electronic Based Government System (SPBE) using COBIT 2019 (Implementation Study in X Government Body).	Design Research Methodology (DRM) type 5 and COBIT 2019	The organization is in maturity level 2 and in the next 5 years it will move to maturity level 3. The recommendations are: Formulation and maintenance of investment security risk mitigation plans, maintenance of available solution component investments. Development of a risk mitigation plan proposal which includes information security, providing input on risk mitigation planning, information and privacy awareness training and programs, integration of information security monitoring with other controls.
2	Sulistyowati Dwi	2020	Information and Data Management of East Java Public Relation and Protocol Beaurau using COBIT 2019	COBIT 2019 and Capability Level Measurement using Capability Maturity Model Integration (CMMI).	Recommendations for data and information management for each selected objective. For each selected objective, the level that will be achieved in the next 5 years is then determined. There are many basic things that need to be addressed, such as the fulfillment of the Standard Operating Procedure (SOP) flow and the flow of handling if a problem occurs. In addition,

					additional matters related to the work function of certain units were added, considering that the addition of units/fields could not be done immediately and had to be adjusted according to the organizational structure determined by the relevant ministry.
3	Oktianatasari Heppy	2017	Audit Tata Kelola Teknologi Informasi Pada PT Pelabuhan Indonesia III (Persero) Menggunakan Kerangka Kerja Cobit 5	COBIT 5 RACI Chart and Median Value to measure IT Capability	Of the 37 selected domains, there were 26 IT domains and processes that managed to reach level 1 (performed) and 11 IT domains and processes that managed to reach level 2 (managed). The level of IT management capability is expected to reach level 3 in 2018, which means that the company has not currently implemented the defined process or failed to achieve the objectives of the process. In this research, recommendations are made that aim to improve process capability in order to achieve the expected level of capability
4	Nistrina Khilda, Talib Abdul bin Bon	2019	Information Security For Hospital Information System Using COBIT 5 Framework	Quantitative method using questionnaire analysis of 86 respondents that use HIS (Hospital Information System) in RS Soreang Bandung Hospital. COBIT 5.	The capability level of Soreang Hospital is at level 1 for the DSS05 domain with L criteria (Largely Achieved) and level 0 for APO13 domains with L criteria (Largely achieved). Improvements are needed for information security at HIS to achieve the Capability level target with fully achieved criteria.
5	Nugroho Heru	2017	Proposed IT Governance at Hospital Based on COBIT 5 Framework	Design Science Research Methodology (DSRM) dan COBIT 5.	Suggest this model to audit Hospital Information System (HIS) by using COBIT 5: APO01,APO02,APO03,APO06, APO07,APO09. BAI02,BAI03,BAI09 DSS01, DSS02, DSS03,DSS06 MEA01, MEA02

Position of previous research on research to be carried out:

a. Researchers will apply COBIT 2019 by previously studying research (1) and (2) in order to get a more comprehensive understanding of COBIT 2019.

b. In research (2), the researcher obtained a complete picture of CMMI and COBIT 2019 and their application in assessing the maturity level of the IT System.
c. In research (3), (4) and (5), researchers gain insight into the application of COBIT 5 to compare it with COBIT 2019. In studies (4) and (5) researchers gain insight into the application of COBIT 5 in the health care industry (RS). and what domains should be used in COBIT 5 to be converted to COBIT 2019, but of course researchers will adjust to the findings of conditions in the field, where Sidoarjo Hospital has only implemented an Integrated IT System starting in 2015.
d. The researcher decided to use the method in research (2), namely COBIT 2019 and CMMI to be applied in the health care industry which in research (4) and (5) used the COBIT 5 Framework.

3. METHODS

The COBIT Framework consists of 5 (five) domains namely Evaluate, Direct and Monitor (EDM), Align, Plan and Organize (APO), Build, Acquire and Implement (BAI), Deliver, Service and Support (DSS), and Monitor, Evaluate and Assess (MEA).

At the stage of determining objectives in COBIT 2019 based on design factors and the COBIT 2019 matrix, the process reference model in COBIT 2019 divides the company's IT governance and management processes into two main process domains, namely governance (EDM) and management (PBRM) but not all organizations have the same or cover all of these processes. The domains that will be examined in the management process are EDM (Evaluate, Direct, Monitor) and APO (Align, Plan and Organize). The current maturity measurement process of the research was carried out to determine the capability level in information technology governance at the RSUD Sidoarjo Hospital. The choice of this domain is intended to get recommendations that are truly focused so that they are able to support the business by using questionnaire to the experts and validate it through the documents checking and interview process.

Next process is the gap analysis stage is measuring the maturity level of IT governance, which is calculating the gap which is the difference between the current maturity level and the expected maturity level. Analysis of this gap is carried out to identify activities and for improvement carried out by the management information system owned by RSUD Sidoarjo so that IT governance can reach the expected maturity level.

At the corrective steps determination stage, an action plan will be drawn up on the evaluation of the various previous stages after going through data collection related to the application of Information Technology in RSUD Sidoarjo Hospital.

The last stage of the process of compiling governance recommendations in accordance with COBIT 2019 is the process of submitting the audit results report, which will deliver an Executive Summary to the interested parties at Sidaorjo Hospital as well as presentation and provision of audit reports along with recommendations for improving Information Technology Governance, in this research the recommendation shall be given but without giving the interested/responsible party that shall execute the action plan.

4. RESULTS

Gap analysis is a process that aims to analyze what is happening between the current maturity level of IT management capability to what is expected by the RSUD Sidoarjo Hospital.

Based on the analysis of the current capability level that has been carried out and identified from the expected IT capability level, there are several gaps in each existing process. Table 4.1 each shows what is happening between the current IT management capability level and the expected IT management level in 2022.

Table 4.1 : Gap Analysis Result As Is (2021) to To Be (expected at 2022)

IT Process		Capability Level		Gap
		As Is	To Be	
Evaluate, Direct and Monitor				
EDM01	Ensure Governance Framework Setting and Maintenance	1	3	2
EDM02	Ensure Benefits Delivery	1	3	2
EDM03	Ensure Risk Optimisation	1	3	2
Align, Plan, Organise				
APO01	Manage the IT Management Framework	0	3	3
APO03	Manage Enterprise Architecture	0	3	3
APO06	Manage Budget and Costs	1	3	2
APO07	Manage Human Resources	2	3	1
APO12	Manage Risk	1	3	2
APO13	Manage Security	1	3	2

Based on the gap level analysis carried out for 2021, there is a significant gap between the current capability level and what is expected by the Sidoarjo Regional Hospital in 2022. The gap in the APO07 IT sub domain and process with a value of 1 indicates that IT management in the IT domains and processes being studied is currently not good/less than optimal to meet the company's medium-term targets. However, even though it has not met the set targets, the sub domains and IT processes have been implemented and have succeeded in achieving the goals of the desired process. In addition, the company also still has enough time until the end of 2022 to improve IT management in the identified IT processes and domains in order to achieve the predetermined level 3.

Meanwhile, gaps in IT sub domains and processes EDM01, EDM02, EDM03, APO01, APO03 APO06, APO12, APO13, with gap values 2 and 3 indicate that IT management in the identified IT domains and processes is stated to be very bad/very bad. not optimal to meet the company's medium-term targets. This also illustrates, apart from not being able to achieve the specified target, the company also does not have or implement the identified IT processes and sub domains or have not been able to achieve the goals of the established process, making it difficult for the company to achieve the set targets. However, to meet the long-term target, at least the gap that occurs in the medium-term target must be minimized (maximum gap = 1), so that in the process the company will find it easier to achieve the desired level of capability (by 2022).

In order to increase the current level of IT management capability so that it is align with the level of IT management capability that has been expected by the RSUD Sidoarjo Hospital, it is necessary to gradually improve the existing IT processes according to priorities. IT sub domains and processes that have the lowest level of capability are given higher priority according to management's request. Therefore, the recommendations that can be given are:

a. Monitoring of IT Governance by internal parties in IT management is carried out to ensure that what has been planned runs as it should.
b. Make documentation regarding corrective action records of any deviations found.
c. Take action or move quickly in terms of planning work programs, investments, financing, and risks, to see how the benefits of using IT as a performance support.
d. Evaluating employee performance and providing training related to the application of information technology risk management to improve HR competencies.
e. Prepare and implement guidelines/policies/procedures related to IT budget management
f. Develop and implement formal mechanisms (guidelines/policies/procedures) related to information security based on business needs that contain organizational structures for information security, access control, and incident management functions.
g. Develop a special knowledge transfer mechanism for employees who experience transfers (job mutation), resign or leave.
h. Plan basic IT training for employees tailored to the needs and job-desk in each field.
i. Define KPIs for employees, where the preparation of KPIs is carried out in coordination with the HR department.
j. Developing information security competencies, especially for the field of work or personnel who will be responsible for managing information security.
k. Carry out awareness programs for all parties who will access the company's information assets.
l. Develop and implement mechanisms (guidelines/policies/procedures) for managing the company's IT assets, including the person in charge and classification of assets, including defining the party responsible for managing IT assets and licenses.

6. CONCLUSIONS

Through the IT Governance Audit using the COBIT 2019 framework by analyzing 9 IT domains and processes, a significant gap was found between the current capability level and that expected by RSUD Sidoarjo in 2022. In the domain and process IT EDM01, EDM02, EDM03, APO06, APO12, APO13, with gap values 2 and APO01, APO03 with gap values 3 indicate that IT management in the domains and IT processes identified is stated to be very poor/very not optimal to meet the company's medium-term targets. Although there is 1 sub-domain and IT process that has successfully reached level 1 or performed, namely APO07, it is stated that the company does not have or yet implement the IT Governance implementation process and has not been able to identify IT risks clearly so that the company is less than optimal in achieving the set targets.

Audit recommendations in the form of recommendations on improving Information Technology governance at Sidoarjo Hospital which are adjusted to the hospital's business strategic plan comprehensively, among others by evaluating employee performance, providing training related to the application of information technology risk management to improve HR competencies, developing and implementation of formal mechanisms

(guidelines/policies/procedures) related to information security based on business needs that contain organizational structures for information security, access control, and incident management functions. Other recommendations include defining KPIs for employees, developing information security competencies, especially for the field of work or personnel who will be responsible for managing information security and implementing awareness programs for all parties who will access the company's information assets.

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HAZARD IDENTIFICATION AND RISK CONTROL IN ROTARY KILN WITHIN THE CEMENT MANUFACTURING COMPANY

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ABSTRACT

This paper presents the situation of a cement manufacturing sector company. The company has implemented work safety regulations and programs, but the problem of work accidents will always be an unexpected threat. Several aspects of work accidents occur due to unsafe actions and unsafe conditions. A rotary kiln is an area that has a high potential for danger because the process requires high temperatures, chemical reactions, and rotating machines. So in this study carried out identification of hazards and risks that occur and repaired work problems using Hazid Methodology. Used hierarchy of control to provide proposals for risks with a very high level, While the risk matrix determines the risk level mapping. Hazard identification is carried out using Electrical, Mechanical, Physical, Chemical, Biological, Ergonomic, Psychosocial, Environmental hazards, Natural phenomena, Locative. The results of the hazard identification are 25 hazards and 40 risks. There are 35% very low, 20% low, 35% moderate, 5% high, 5% very high at the risk mapping level. The proposed improvement for two risks with a very high level is Co-processing to replace coal with solid waste and replace clinker with fly ash.

Keywords: Rotary Kiln, Hazid Methodology, Risk Matrix, Hierarchy of Control

1. INTRODUCTION

Occupational safety and health are essential for the company because accidents and occupational diseases harm employees and the company both directly and indirectly. Occupational safety and health is an interdisciplinary field concerned with maintaining the safety, health, and well-being of people involved in a job or the workplace. Safety is associated with the physical condition of both mind and body of everyone in the workplace, including workers, contractors, and visitors, which protects them from harm in the form of injury or illness. Safety is concerned with the physical conditions in the workplace and applies to situations where the risk of harm and damage has been eliminated or reduced to a tolerable level (Khan, 2017). Aspects of work accidents in the industry are 88% of industrial accidents caused by unsafe action, 10% of accidents caused by unsafe conditions, and 2% of accidents caused by other factors (Heinrich, 2009)

The company under study is a company engaged in the cement industry. This company is very concerned about safety by continuously improving safety by creating innovative programs to increase employee and contractor awareness of the importance of workplace safety. Based on the researcher's interview with one of the workers and recent research on cement manufacture, Rotary kiln is an area that has many sources of potential hazards. Among other things, there is a combustion process with temperatures reaching 1500 °C. These potential hazards can cause many losses, including explosions, fires, and leaks that result in injury, physical disability, death toll, environmental damage, psychological impacts, and financial losses (Ewais & Bayoumi, 2018).

The kiln is where the sound intensity exceeds the threshold value of up to 88dB. Prolonged exposure to noise over 85dB NAB can cause physical damage and potentially cause hearing loss. Noise pollution has a detrimental effect on human health and environmental quality. In addition, noise interferes with speech communication which risks reducing performance to some extent (Bolaji et al., 2018). Cement production, more precisely in the Rotary Kiln, is a significant contributor to anthropogenic greenhouse gas (GHG) emissions, and therefore cement in the industry is the primary driver of global warming (Wang et al., 2013). The impacts of greenhouse gas emissions include climate change, formation of photochemical oxidants: ecosystem damage, formation of fine particles, and terrestrial acidification (Tun et al., 2021).

This research aims to improve work safety by identifying the hazards that exist in the research area, mapping the level of risk, and selecting the best work accident prevention mechanism. This study uses the integration of the Hazid Methodology, Risk Matrix, and Hierarchy of Control that can be applied to the company. The combination of several methods from various disciplines is expected to solve the problem.

2. LITERATURE REVIEW

Using most of the references from international journals. The literature review describes the literature that is relevant to a study. The literature review then contains a description of the theory of a research result, findings, and materials in research activities. This can then be used as a theoretical basis when conducting research or compiling scientific papers.

2.1 Rotary Kiln

Rotary Kiln is a device used to burn raw meals into a semi-finished material called clinker. It requires the highest consumer of thermal energy in its operation. This equipment requires a continuous input of fuel to facilitate the chemical reactions required for clinker production (Csernyei & Straatman, 2016). Rotary Kiln has the function of burning so that the fed raw meal reacts to become clinker. In the initial planning for the establishment of a factory, the calculation basis is the kiln capacity, while other equipment is adjusted to the kiln design. Other information about the rotary kiln on the object of research is as follows:

- Capacity : 7800 ton/day
- Length : 84000 mm
- Slope : 4% of the length
- Rotation : 3 rpm
- Power drive: 2 x 600 kW

The Rotary Kiln Production Process is Kiln feed entering the kiln through the end of the kiln and then heated by the heat from burning coal in the burner. Due to the kiln slope, the material will move to the other end of the kiln while continuously being heated and rotated. The kiln is rotated so that there is an even distribution of heat on the kiln wall. The inside of the kiln is lined with refractory bricks to reduce the heat load on the kiln walls and minimize radiation heat loss. The rotary kiln is divided into four zones according to the reaction at the temperature at which the reaction takes place. The zones are

a. Calcination zone at 800 -1200 °C
b. Transition zone at 1200 -1400 °C
c. Clinkerization zone at 1400 -1520 °C
d. Cooling zone at temperature 1520 -1290 °C

2.2 Hazid Methodology

Hazid Methodology is a systematic analysis that is critically analyzed by a team in which the operations and processes that are running are assessed to be able to find out the potential dangers of maloperation or malfunction of one tool of equipment and the consequences that arise as a whole (Rivera Domínguez et al., 2021). This method serves to identify hazards that may occur in the workplace. Identify specific hazards with several aspects, namely sources, environmental, physical, and mental overload, surrounding, natural and locative, storage, and administrative. Hazard identification will be carried out in several areas within the company's location.

2.3 Risk Matrix

Risk Matrix is a semi-quantitative assessment tool used to categorize an event risk that decides whether a particular risk is acceptable based on historical statistical data (Duijm, 2015). A risk matrix in mapping risk levels is used to determine and calculate between severity and probability (Luo et al., 2018). Table 2.1 is a risk matrix for determining risk level mapping.

Table 2.1 Risk Matrix

Probability	**A**	**Frequent**	Low	Medium	High	Very High	Very High
	B	**Probable**	Very Low	Low	Medium	High	Very High
	C	**Occasional**	Very Low	Low	Medium	High	High
	D	**Remote**	Very Low	Low	Low	Medium	High
	E	**Improbable**	Very Low	Very Low	Low	Medium	Medium
			1	**2**	**3**	**4**	**5**
			Negligible	**Minor**	**Moderate**	**Major**	**Catastrophic**
			Impact Severity				

Table 2.2 Colour Code Description

Colour	Risk Description	Risk Qualitative Description
Red	Intolerable	Risk must be mitigated; either decrease the probability or relieve consequence
Orange	Unwanted	Unwanted and only accepted when risk reduction is impracticable
Yellow	Tolerable with Control	Acceptable after review and safety measures imposed
Light Green	Reasonable tolerable	Risk reduction is not needed
Dark Green	Tolerable	The risk could be neglected

2.4 Hierarchy Of Control

Risk control is an activity carried out sequentially so that the existing risks are reduced by using a hierarchy. Hierarchy of Control is a sequence in the prevention and control of risks that may arise, consisting of several levels in sequence (Ramadhan, 2017). The following is a sequence of controls according to the Hierarchy of Control.

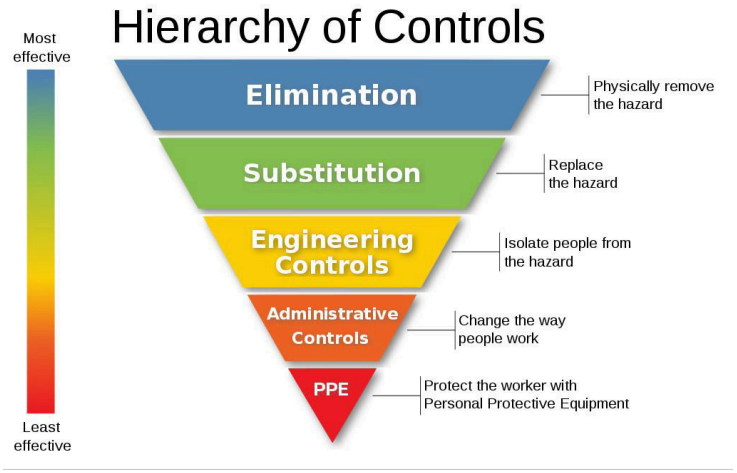

Figure 2.1 The Hierarchy of Control

3. METHODS

The first process that must be carried out in this research is Hazard Identification. In the Hazard Identification Process, researchers use the Hazid Methodology to identify hazards that may occur in the workplace. Identify hazards with several aspects: sources, environmental, physical, and mental overload, surrounding, natural and locative, storage, and administrative.

The following process, namely Risk Assessment, is by conducting risk assessments and mapping according to safety or the impact received on the environment. This risk assessment uses a risk matrix; the steps taken are to determine and calculate between severity and probability. The risk assessment results with a very high-risk level will be given control.

Risk Control is the last process in this research. Risk control will produce output in the form of risk mitigation. The approach used for risk control is the Hierarchy of Control. The results of the previous stage will be analyzed and given improvements based on 5 control hierarchies, namely elimination, substitution, planning, administration, and personal protective equipment.

4. RESULTS

This section presents the results of the research in this paper. The stages for this research are Hazard Identification, Risk Analysis, and Risk Control. The approach used has been described in the previous section.

4.1 Hazard Identification

The first stage in this research is hazard identification. Identification starts from determining the research area and then analyzing the potential hazards contained in that area. The last step is to determine the risk of potential hazards. The risk will be obtained from 10 hazard categories in the Rotary kiln area. Table 4.1 and Table 4.2 below are the results of hazard identification using the Hazid Methodology.

Table 4.1 Hazard Identification Results in Rotary Kiln with Hazid Methodology

Business name: **Cement**	Diagnosis: **Area**	Date: **November 8, 2021**
Area Identification : **Rotary Kiln**	Number of workers: **8**	Economic activity: **Cement Production**
Hazard Category	**Danger (potential source of damage)**	**Risk (consequence of damage)**
Electrical	Electric current	Electrocution resulting in injuries to workers and death
		Explosions that damage equipment and facilities
		Fires that cause financial losses
Mechanical	Kiln Machine	Exposure to the heat of the kiln engine causes blisters on the hands
		Hot dust from the manhole or leaking equipment
		Wedged the rotating kiln machine
		Material or equipment fall
		Collision due to getting pressure from a leaky manhole or equipment
	Apron Conveyor	Pinched hands during the repair
		Scratched by rotating objects during inspection and repair activities
	Hoist Crane	Material transported fall
		Squeezed and scratched by transported material
		Hit by the swing of transported material
Physical	Temperature	skin irritation, blisters, and loss of concentration
	Noise	Noise that can cause hearing loss and headaches
	Radioactive Radiation	Cause genetic disorders and cancer
Chemical	Clinker Dust	Pneumoconiosis, eye & skin irritation, and cancer
	Combustion Emission	Air pollution causes the Greenhouse Effect
	Poison gas	Toxic gas in a confined space that causes suffocation, unconsciousness, and death
	Hot Gas	burns, redness of the skin, blisters
Biological	Bacteria/virus	Decreased immunity and contracting various diseases
	Snake	The snake enters the panel causing damage etc
		Disturbing the comfort of workers
Ergonomic	Workplace design	Falls from heights and limb injuries
		Inhibiting activities
	Work Position	Injuries to limbs
		Struck by material or tools
Psychosocial	Workload	Work results are not optimal and stressful.
	Worker conflict	The team is not solid, causing the work to be unfinished and stressful.
	Career path	Tired and lazy at work
	Personal problems	Negligence at work due to lack of concentration

Table 4.2 Hazard Identification Results in Rotary Kiln with Hazid Methodology (Continuance)

Business name: **Cement**	Diagnosis: **Area**	Date: **November 8, 2021**
Area Identification: **Rotary Kiln**	Number of workers: **8**	Economic activity: **Cement Production**
Hazard Category	**Hazard (potential source of damage)**	**Risk (consequence of damage)**
Surrounding Danger	Material from the cyclone to air	Air quality is declining
		Respiratory disorders
Natural Phenomena	Earthquake	Damage equipment and facilities
	Rain	Corrosion on equipment
	Lightning	Reduced functionality of the equipment
	Tsunami	Fire due to the lightning strike
Locative	Smooth Work Floor	Slip
		Falling from a height
	Scattered tools	Stumble

4.2 Risk Assessment

Risk assessment uses a tool, namely the risk matrix. The steps taken are to determine and calculate between severity and probability. After that, a risk level mapping will be carried out according to the risk assessment results. Figure 4.1 is the percentage of risk level mapping in the Rotary Kiln area.

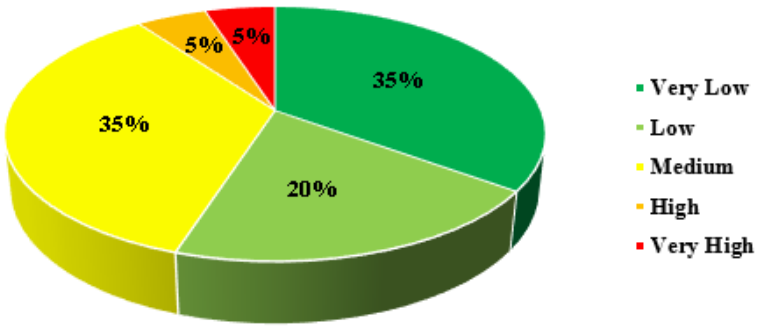

Figure 4.1 Percentage of risk assessment of kiln area

Risks that get a very high level will be suggested improvement. The following are risks that get a very high level:

Table 4.3 Risiko yang memiliki level very high

No	Danger	Risk	Level
1	Combustion Emission	Air pollution causes the Greenhouse Effect	Very High
2	Clinker Dust	Pneumoconiosis, eye & skin irritation, and cancer	Very High

4.3 Risk Control

Risk control is given to reduce or prevent potential hazards that cause losses to the company. Two risks will be given control because it has a very high level. The following is given risk control and a description of the reasons and benefits of the proposed improvement.

- **Combustion Emission**

The proposed improvement is given to prevent the risk of air pollution that causes the greenhouse effect by using **Co-processing as a substitute for coal fuel with municipal or industrial waste**. This risk control uses a Substitution from the Hierarchy of Control because the leading cause of this risk is coal. So that the replacement of coal can certainly reduce air pollution that causes the greenhouse effect, the advantage that the company can get financially is that the company will get compensation from a customer or company which will dispose of the waste, and the replacement of coal will reduce the company's expenses.

- **Clinker Dust**

The manufacture of clinker requires materials that harm health. Besides that, the manufacturing process is also long. Workers exposed to clinker dust can infect Pneumoconiosis, eye irritation, skin irritation, and cancer. The control will be given by **Replacing clinker with fly ash from power plant waste**. The proposed improvements include the substitution from the Hierarchy of Control. Fly ash can replace clinker as the main ingredient for making cement with an appropriate composition. From this material replacement, the company reduced production costs because the long process of making clinker was no longer carried out. In addition, the suggestions given can prevent workers from being exposed to clinker dust which causes adverse health effects.

5. CONCLUSIONS

Work safety regulations and programs at the company have been implemented, but the problem of work accidents will always be an unexpected threat. Therefore, it is necessary to continuously improve safety by making program innovations to prevent accidents and increase employee and contractor awareness of the importance of workplace safety. This study will integrate several methods: hazid methodology, risk matrix, and control hierarchy. The integration is expected to reduce or prevent the impact of potential hazards in the Rotary kiln area. The results of this research are that hazard identification is 25 hazards and 40 risks. There are 35% very low, 20% low, 35% moderate, 5% high, 5% very high at the risk mapping level. The proposed improvement for two risks with a very high level is Co-processing to replace coal with solid waste and replace clinker with fly ash. In addition, periodic maintenance must be carried out to prevent damage to the machine, which adversely impacts the company. The proposed improvements are expected to reduce greenhouse gases released into the atmosphere and prevent respiratory diseases caused by clinker dust.

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PORT SERVICE QUALITY FOR FERRY TRANSPORTATION IN PACIRAN LAMONGAN SEAPORT BY SERVQUAL AND KANSEI ENGINEERING APPROACH

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ABSTRACT

Due to delegation of authority to operate ferry transportation from PT. ASDP to UPT PPR Lamongan and opening of long distances ferry Paciran – Garongkong South Sulawesi that intersects with the Tanjung Perak – Makassar route, it places Paciran Seaport as long distances ferry port along with Tanjung Perak Port. it is needed service quality description given so far to compete and to increase government revenue from the transportation sector. Servqual method has been used to assess the gap of service perceived. While Kansei Engineering has been used to assess customer impression through Kansei words. Multiple Linear Regression is used to identify critical port service levels. The three most important service attributes are Knowledge and the ability of reliable officers to handle arising problems during service (X20), Officers secure customers when getting services and carry out activities in the port (X19) and Officers solve problems quickly and precisely (X17). It is found that customers consider the availability of competent officers in providing service as the most attractive and important matter.

Keywords: Service Quality, Servqual, Kansei Engineering, Port.

1. INTRODUCTION

Through Operational Handover Minutes between the Indonesian Transportation Ministry and East Java Provincial Government, the authorization to operate ferry transportation service in Paciran Seaport has been delegated from PT. ASDP Indonesia Ferry to East Java Provincial Government through UPT PPR Lamongan. Also, the opening of long distances ferry Paciran – Garongkong (South Sulawesi) in early 2021 that intersects with the Tanjung Perak – Makassar route, places Paciran Seaport as long distances ferry port along with Tanjung Perak Seaport.

Considering the lack of experience of UPT PPR Lamongan in organizing ferry transportation, it is needed service quality description given so far as the basis of preparation standard operating procedures by determining the attractive and important service attributes for customers to develop the strategy for Paciran Seaport for improving their service quality of ferry transportation service to compete and increase government revenue from the transportation sector.

Service quality overview is obtained by measuring customers' satisfaction and their importance level of service provided. Satisfaction is a personal feeling of pleasure or disappointment after comparing perceptions/impressions of the performance (or results) of a product and his expectations (Kotler, 2012). Servqual method has been used to measure a level of customers satisfaction by identifying gaps in service quality in terms of 5 (five) dimensions i.e. Tangibility, Reliability, Responsiveness, Assurance, and Empathy (Parasuraman et. al., 1988).

Kansei Engineering is a method that can translate customers' emotional needs into product attribute parameters through engineering (Hartono, 2012). Psychologically, Kansei means a mental state where knowledge, emotions, and sentiments are in harmony (Nagamichi, 2003). It is used to capture the psychological impressions/emotions of customers through Kansei words based on the characteristics of the services listed in the organization's mission and 5 (five) Human Image of Transportation (Lima Citra Manusia Perhubungan).

This research has used the servqual method to identify satisfaction and importance level of customers, Kansei Engineering through Kansei words to identify customers impression/emotions and integration of both methods by multiple linear regression to obtain critical attribute of service.

Thus, this paper has three main objectives. Firstly, to identify the gap between service perceived and expectation of customers. The second objective is to identify Kansei words that represent the emotional needs of the customers and the Kansei words that are affected by the service attributes. Third, to determine the attractive and important service attributes for customers to develop the strategy for Paciran Seaport for improving their service quality.

2. LITERATURE REVIEW

2.1 Servqual

Service quality is a kind of perception of consumption, which is invisible and versatile. It is difficult to evaluate service quality than evaluate products quality (Chen et al., 2007). The Servqual method, developed by Parasuraman et al. (1988) is a technique that can be used for performing a gap analysis of an organization's service quality performance against customer service quality needs. It is the best-known service quality measurement model (Parasuraman et al., 1991). Assessing service quality using SERVQUAL involves computing the gap between expectation and perception statements (Parasuraman, et al., 1985). For each pair of statements, the Servqual score is computed as follows: Servqual score = Perception score - Expectation score

Gogoi (2020) used Servqual to find out the factor which influences customer satisfaction and also tries to check the relationship between customer satisfaction and customer loyalty by identifying the dimensions of service quality leading to customer satisfaction and customer loyalty. Parasuraman et al. (1988) defined SERVQUAL as a compact tool for measuring the number of items to give good validity and reliability values that can be used to provide a better understanding of the expectations and the value obtained by consumers of these services.

2.2 Kansei Engineering

Nagamachi (1995) argues that Kansei Engineering (KE) method can win over the competitive market. KE aims to develop products by converting consumers' feelings into design elements of the product (Namagachi, 1995; Nagamachi & Lokman, 2011). As an ergonomics-based product development technology, KE incorporates customers' emotions and preferences (Kansei in Japanese) with engineering knowledge. According to Nagamachi and Lokman (2011), Kansei refers to the condition in which knowledge, emotions, and passions are unified.

Muafi et. al. (2018) integrated Servqual, Kano Model, and Kansei Engineering to identify attractive and important service attributes then using Quality Function Deployment to close the gap between perceived quality of services and also estimate the existing and future emotional needs of customers. Li et al. (2016) integrated Kansei Engineering and PLS Method to design budget hotel services through establishing the relationships between service categories and Kansei words as well as the relationships between Kansei words and customers' overall satisfaction. These studies indicated that the use of Kansei Engineering not only be applied in the form of tangible products (goods) but also can be effectively applied in the field of services.

Hartono (2012) stated that Kansei Engineering is a superior method compared to other similar methods. First, KE can minimize subjectivity by building a mathematical model of the response of Kansei through the human senses and the external stimulus. Second, KE is also able to optimize other properties that are not visible. Third, KE is known as a quality framework that has the tools and integrated methods. Fourth, KE has a strong ability to accommodate the trend of the 21stcentury, namely hedonistic, pleasure, and individualistic. This is why consumers tend to focus more on the emotional impression than the functional usefulness of the product.

3. METHOD

3.1 Research Design

Firstly, the Service Blue Print of Passenger and Car in Paciran Seaport has been reviewed and is evaluated over Transportation Ministry Regulation No. PM 62/2019 concerning Minimum Service Standards for Ferry Transport. It is identified service attribute into 5 (five) dimensions of servqual as Parasuraman et. Al. (1988) recommendation. It is found 21 service attribute questionnaires for Passengers, 22 service attribute questionnaires for personal cars and 24 service attributes questionnaires for freight cars.

Kansei can be measured indirectly and partially, by measuring sensory activity, internal factors, psycho-physiological and behavioral responses (Harada, 2011; Nagamichi, 2003; Ishihara et. al., 2005; Levy et. al., 2007). Therefore, Kansei words are selected based on the characteristics listed in the organization mission and 5 (five) Human Image of Transportation with a total of 13 vocabularies i.e. Easy (K1), Safe (K2), Convenient (K3), Quick (K4), Responsive (K5), Orderly (K6), Organized (K7), Clean (K8), Skilled (K9), Agile (K10), Friendly (K11), Polite (K12) and Responsible (K13). This was followed by developing a semantic differential (SD) scale using 2 (two) different words with the addition word “Not” for the differentiating meaning of Kansei words.

The survey instrument is a questionnaire consisting of 4 sections: (1) demographic data of respondents (2) assessed service attribute (3) importance level of service attributes (4) Kansei Words arranged on a semantic differential (SD) Scale using two different words (positive words and negative words). A five-point Likert scale, such as “1 = not very important” to “5 = very important” was used to measure the customer satisfaction and importance level of attribute service for servqual analysis. And also used on the Semantic Differential (SD) Scale of Kansei words which describes customers’ impressions.

This research applied a framework that consists of five main steps as shown in **Figure 1**. They include the initial phase, span the semantic space, span the service attribute space, regress Kansei words with the service attribute, and adjusted importance level.

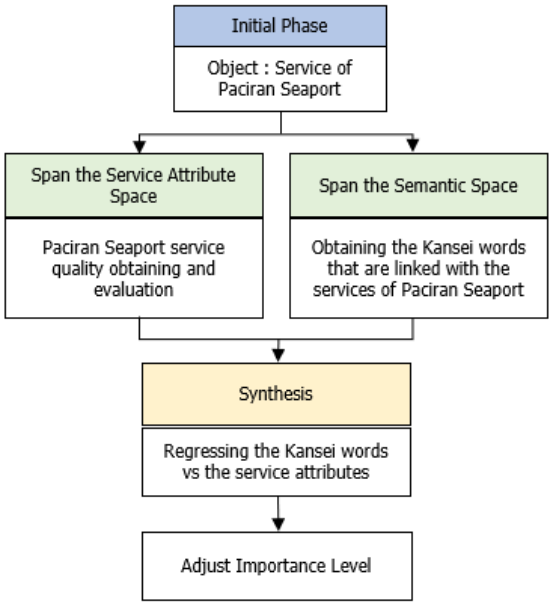

Figure 1. Research Framework

3.2 Data Collection

This paper focuses on Paciran Seaport service for passengers and cars with a research population is Ferry Transportation Customer. Sample on this research was calculated based on the number of customers in 2020 by slovin's equation. Sugiyono (2012), the sample is part of the number and characteristics possessed by the population.

Table 1. The proportion of Passengers Sample on Each Route

Route	Sample	Proportion	Sample Proportion
Paciran – Bawean	99	78%	77
Paciran – Bahaur		22%	21
Paciran – Garongkong		0%	0
Total		100%	99

Table 2. The proportion of Car Samples on each route

Route	Sample	Proportion	Sample Proportion	Proportion		
				Motorcycle	Personal Car	Freight Car
Paciran – Bawean	98	80%	78	45	7	26
Paciran – Bahaur		19%	19	5	1	13
Paciran – Garongkong		1%	1	0	0	1
Total		100%	98	50	8	40

Considering Paciran Seaport customers consist of different destinations/origins, sampling was taken proportionally based on the destination/origin of the customer and according to the type of car (personal car or freight car) as shown in **Table 1** and **Table 2**.

4. RESULTS

Validity and Reliability Test were carried out toward service attributes and Kansei words by using Minitab 18 software. It is found all service attributes and Kansei words meet the minimum requirement of the test.

4.1 Service Quality Evaluation

Gap discussed in this study is Gap 5, which is the perceived service gap by showing the gap between services perceived and expected services by customers (Zeithaml et. al., 1990). The higher negative gap between expectations and customer perceptions means the lower service quality and vice versa. So, it is concluded gap value obtained is subjective, which can be affected by:

1. Customer visits frequency at Paciran Seaport
2. Unavailability of other Seaport as an option for traveling
3. Customer experience using others similar Seaport

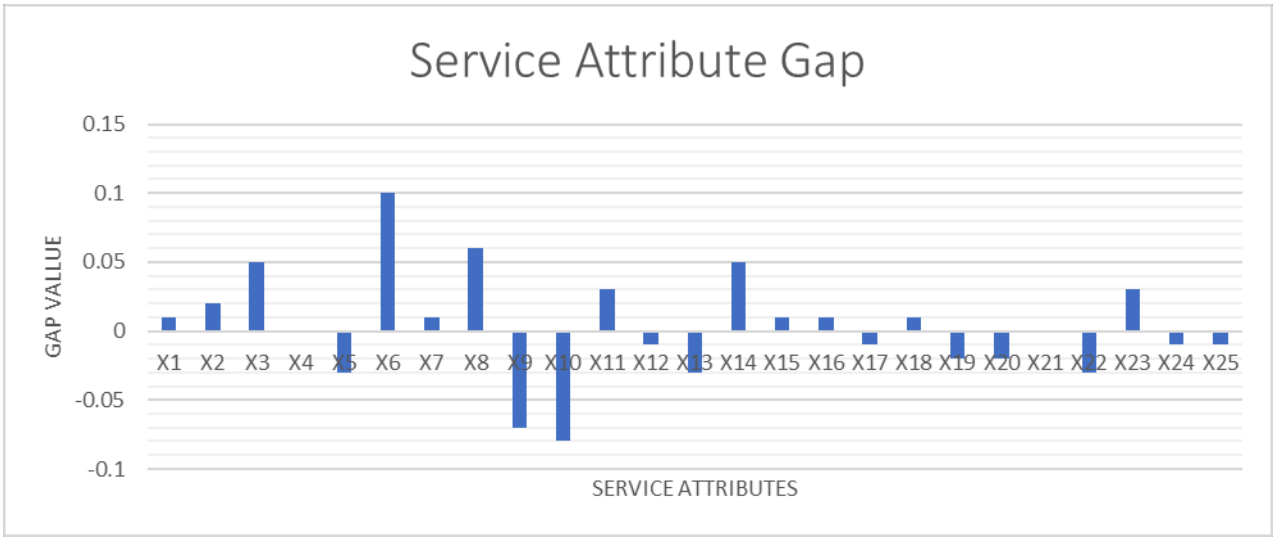

Figure 2. Service Attributes Gap

Passengers and cars service attributes evaluation is carried out by calculating the cumulative gap of all variables in all customer categories (Passengers, personal car, and freight cars). It is found that 11 of 25 service attributes have a negative gap value as shown in **Figure 2**. Negative gap value occurs at each dimension i.e. Tangible dimension 2 of 9 attributes, Reliability dimension 3 of 5 attributes, Responsiveness dimension 1 of 4 attributes, Assurance dimension 2 of 3 attributes, and Empathy dimension 3 of 4 attributes.

4.2 Kansei Engineering Evaluation

As service attributes evaluation, Kansei words evaluation is also carried out by calculating the cumulative gap of all variables in all customer categories (Passengers, personal cars, and freight cars).

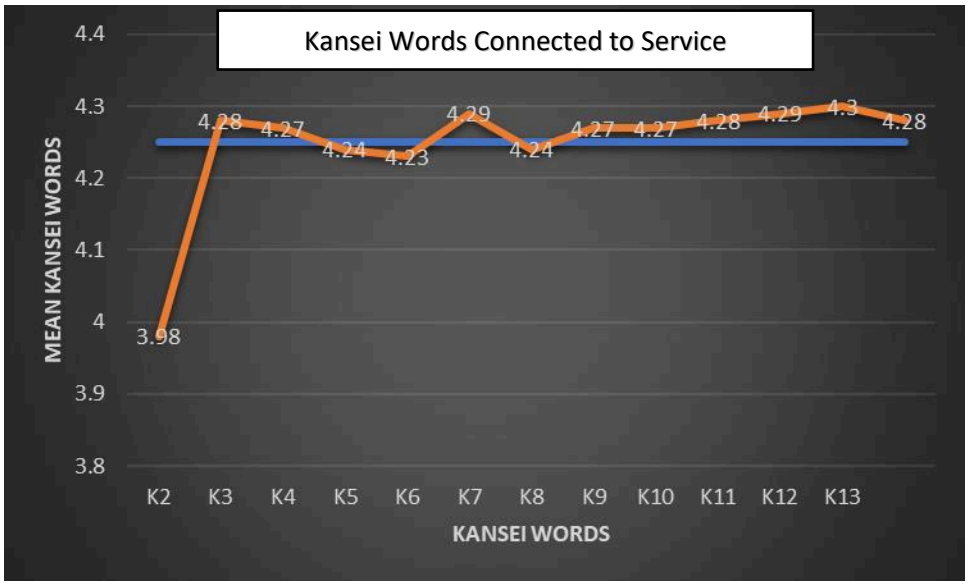

Figure 3. Kansei Words Linked to Service

With cumulative mean Kansei words of 4,25, It is found 4 Kansei words have a value less than cumulative mean Kansei words i.e. Easy (K1), Quick (K4), Responsive (K5), and Organized (K7) as shown in **Figure 3**.

4.3 Multiple Linear Regression

Multiple linear regression was performed using Minitab 18, where Kansei words functioned as dependent variables and service attributes as independent variables. The effects of the independent variable on the dependent variable were evaluated and the final model equation was selected simultaneously with critical test area (1) P-Value < (0.05), the independent variable has a significant effect on the dependent variable (2) P-Value > (0.05), the independent variable has no significant effect on the dependent variable.

Table 3. Prioritized Service Attributes

Var.	Gap	Attribute	Related Kansei Words	Priority
X1	0,01	The appearance of the officers is neat, clean, and polite		
X2	0,02	Informative and interesting information media used	Responsible	
X3	0,05	The ticket counter is safe and comfortable for transactions	Easy, Convenient, Skilled	
X4	0,00	Availability of road signs/markings		
X5	-0,03	Access road and parking lot facilities are in good condition	Clean, Quick	6
X6	0,10	Weighbridge facilities are in good condition		
X7	0,01	The physical building form, its arrangement, and waiting room makes comfort		
X8	0,06	Availability of clean worship places and toilets		
X9	-0,07	Passenger shuttle car for internal transport to the pier is in good and comfortable condition	Clean, Polite	4
X10	-0,08	Clarity and accuracy in providing		7

Var.	Gap	Attribute	Related Kansei Words	Priority
		information		
X11	0,03	Ease access of obtaining information	Skilled	
X12	-0,01	Regularity when there is a queue	Quick, Friendly	5
X13	-0,03	Clarity of service flow in the port		8
X14	0,05	Weighing accuracy of freight cars		
X15	0,01	Officer flexibility when help is needed	Convenient, Quick	
X16	0,01	Availability of officers/Customer inquiries	Polite	
X17	-0,01	Officers solve problems quickly and precisely	Easy, Safe, Convenient, Quick, Agile	3
X18	0,01	Officers make arrangements for potential queues		
X19	-0,02	Officers secure customers when getting services and carry out activities in the port	Easy, Safe, Orderly, Agile, Polite	2
X20	-0,02	Knowledge and the ability of reliable officers to handle arising problems during service	Easy, Safe, Convenient, Quick, Responsive, Orderly, Organized, Clean, Skilled, Agile, Friendly, Polite, Responsible	1
X21	0,00	Polite and friendly service	Convenient, Quick, Skilled	
X22	-0,03	Officers offer assistance when customers need it		9
X23	0,03	Apologies if there are mistakes in the service		
X24	-0,01	Officers respond sympathetically in response to complaints/questions		11
X25	-0,01	Officers give personal attention to customers		10

Table 3 shows Prioritized service attributes based on several affected Kansei words and have the most negative gap. It is found Knowledge and the ability of reliable officers to handle arising problems during service (X20) as the most attractive service attribute with 13 Kansei Words affected.

4.4 Adjusted Importance Level

Service attribute with the higher number of affected Kansei words and have the most negative gap will be prioritized for improvement. First, the score for each attractive service attribute, which is called the "adjusted priority score" was determined. The priority service attribute was given the highest score and normalized. For example, attribute X20 was given a score of 1. Through normalization, the adjusted priority score became 0.167 (= 11 / [1+2+3+4+5+6+7+8+9+10+11]). Second, the importance level is adjusted by multiplying the adjusted priority score and importance level. The greater the adjusted importance level, the more important is the service attribute.

Table 4. Adjusted Importance Level

Var.	Attribute	Priority	Score (1)	Adjusted Priority Score (2) = (1)/$\sum_s$	Importance Level (3)	Adjusted Importance Level (4) = (2)*(3)
X20	Knowledge and ability of reliable officers to handle arising problems during service	1	11	0,167	4,16	0,693
X19	Officers secure customers when	2	10	0,152	4,16	0,631

Var.	Attribute	Priority	Score (1)	Adjusted Priority Score (2) = (1)/$\sum_s$	Importance Level (3)	Adjusted Importance Level (4) = (2)*(3)
	getting services and carry out activities in the port					
X17	Officers solve problems quickly and precisely	3	9	0,136	4,14	0,564
X9	Passenger shuttle car for internal transport to the pier is in good and comfortable condition	4	8	0,121	4,00	0,485
X12	Regularity when there is a queue	5	7	0,106	4,14	0,439
X5	Access road and parking lot facilities are in good condition	6	6	0,091	4,11	0,374
X10	Clarity and accuracy in providing information	7	5	0,076	4,16	0,315
X13	Clarity of service flow in the port	8	4	0,061	4,14	0,251
X22	Officers offer assistance when customers need it	9	3	0,045	4,19	0,190
X25	Officers give personal attention to customers	10	2	0,030	4,19	0,127
X24	Officers respond sympathetically in response to complaints/questions	11	1	0,015	4,19	0,063
$\sum_s$			66			

The result of the adjusted importance level is shown in **Table 4**. It is found service attributes of Knowledge and the ability of reliable officers to handle arising problems during service (X20) is still the most priority to develop port service quality for improvement.

5. CONCLUSION

After collecting and analyzing the data obtained from customers of Paciran Seaport, not all port services are considered to be attractive and significant to their Kansei. Kansei is an emotional feeling felt by customers. Through the multiple linear regression of the Kansei words and service attribute, there were eleven service attributes deemed attractive and important to customer emotional needs. It is found that service attributes in Paciran Seaport do not meet customer satisfaction in five dimensions of servqual.

The three most important service attributes are Knowledge and the ability of reliable officers to handle arising problems during service (X20), Officers secure customers when getting services and carry out activities in the port (X19) and Officers solve problems quickly and precisely (X17). It is found that customers consider the availability of competent officers in providing service as an attractive and important matter. Improvement on those service attributes automatically will affect other service attribute related officer competencies such as Officers offering assistance when customers need it (X22), Officers giving personal attention to customers (X25) and Officers responding sympathetically in response to complaints/questions (X24). This means it improves three-dimensional servqual at once i.e. Assurance, Responsiveness, and Empathy dimensions.

While for improvement in Tangible dimension, Port operator shall concern to the provision of adequate shuttle car for internal transport and access road and parking lots facilities. For Reliability dimension improvement, Port Operator shall be concerned about the improvement of the internal information system.

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FORECASTING MODELS FOR COVID-19 CASES IN INDONESIA

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ABSTRACT

Coronavirus Disease 2019 (COVID-19) is an infectious disease caused by the SARS-CoV-2 virus and was first announced by the World Health Organization (WHO) on December 31, 2019. In addition to the negative health-related impacts, COVID-19 has also had an impact on education and the economy. Given that the economy, health and education are important aspects of a country, it is necessary to plan and formulate policies that are in accordance with current conditions. Decision-making related to planning and policy must be based on the current development of COVID-19 cases in a country. In this study, forecasting related to COVID-19 conditions in Indonesia have been carried out using several methods, such as Exponential Smoothing and ARIMA. Our results show that the majority of variables were suitable in using double exponential smoothing as a forecasting method because it had the smallest error compared to simple exponential smoothing and ARIMA.

Keywords: COVID-19, Forecasting, Model Selection

I. INTRODUCTION

Coronavirus Disease 2019 (COVID-19) is an infectious disease caused by the SARS-CoV-2 virus. The first case of COVID-19 was announced by the World Health Organization (WHO) on December 31, 2019. It started with a report regarding a group of people who were infected with the pneumonia virus in Wuhan, People's Republic of China and continued to spread throughout the world. In most countries in the world, this disease has become a serious threat that makes WHO change its status as a pandemic on the March 12, 2020.

The health impacts caused by COVID-19 are quite dangerous for many people. However, if we look at the case fatality rate (CFR), it is known that in fact many other diseases have a higher mortality rate. The mortality rate of 2% is low when compared to other infectious diseases such as MERS, SARS, Typhus and Cholera as shown in Table 1 below. Its transmissions that makes this virus dangerous so because it's spread quickly from one human to another.

In addition for a problem in health sector, COVID-19 also has an impact on economic problems and education. According to (UNICEF, 2021) it is known that 1 in 3 children in the world cannot access online learning when their schools are closed. Not only that, there are 1.6 billion children affected by school closures due to the COVID-19 pandemic. From an economic perspective, according to data released by the World Bank, it can be seen that almost all regions experienced an economic decline of 2.7% to 7.2%, only East Asia and the Pacific experienced economic growth of 0.5% (The World Bank, 2021).

Given that the economy, health and education are important aspects of a country, it is necessary to plan and formulate policies that are in accordance with current conditions. Decision-

making related to planning and policy must be based on the current development of COVID-19 cases in a country. Therefore, it is very important to know the condition of COVID-19 in a country, at least the country is able to take preventive steps to suppress the spread of the virus between humans.

In this study, forecasting related to COVID-19 conditions in Indonesia will be carried out using several methods, namely exponential smoothing and ARIMA. Proposed method will be chosen based on the smallest error and will be proposed as a method for forecasting COVID-19 cases in Indonesia. It is hoped that knowing the approximate number of COVID-19 cases in Indonesia can facilitate decision making and policy formulation by the government.

Table 1. Comparison of Case Fatality Rates from Several Infectious Diseases

Disease	Type	How to Cure	CFR	References
MERS	Virus	Taking medication, oxygen, etc.	34%	(World Health Organization Regional Office for East Mediterranean, 2021)
Typhus	Bacteria	Get enough rest and drink antibiotics	10%-20%	(Heymann, 2008)
SARS	Virus	Use antibiotics and oxygen, maybe another medication too if needed	11%	(Department of Communicable Disease Surveillance and Response World Health Organization, 2003)
Cholera	Bacteria	Use ORS (Oral Rehydration Solution, give the patient an infusion.	2%-3%	(Nsubuga, et al., 2019)
COVID-19	Virus	Vaccine, 14-days self isolation	2,05% (as of 1 October 2021)	(World Health Organization, 2021)

II. METHODS

A. Variables Identification

The variables used in this study are active cases of COVID-19, recovered cases of COVID-19 and death cases of COVID-19 in each region listed below. The determination of the area used in this study is based on the pareto principle where 80% or more total cases happen in these area. These area are as follows: North Sumatera, West Sumatera, Riau, DKI Jakarta, Banten, West Java, Central Java, DI Yogyakarta, East Java, Bali, East Kalimantan, and South Sulawesi.

B. Source of Data

Data used in this study are secondary data taken from National Agency for Disaster management (BNPB). Although there are other sources like kawalcovid19, data from BNPB is more complete in terms of data per region and updated on daily basis. Daily data collection for COVID-19 is obtained from the following sources: https://datastudio.google.com/u/0/reporting/fda876a7-3eb2-4080-92e8-679c93d6d1bd/page/7ApVB

Table 2. Variables Identification

Region	Variables			Region	Variables		
	Active Cases	Recovered Cases	Death Cases		Active Cases	Recovered Cases	Death Cases
Indonesia	KA	KS	KM	Central Java	KA_JG	KS_JG	KM_JG
North Sumatera	KA_SU	KS_SU	KM_SU	DI Yogyakarta	KA_Y	KS_Y	KM_Y
West Sumatera	KA_SB	KS_SB	KM_SB	East Java	KA_JT	KS_JT	KM_JT
Riau	KA_R	KS_R	KM_R	Bali	KA_BL	KS_BL	KM_BL
DKI Jakarta	KA_DKI	KS_DKI	KM_DKI	East Kalimantan	KA_KT	KS_KT	KM_KT
Banten	KA_BN	KS_BN	KM_BN	South Sulawesi	KA_SLS	KS_SLS	KM_SLS
West Java	KA_JB	KS_JB	KM_JB				

C. Forecasting

1) Simple Exponential Smoothing

Simple exponential smoothing is a forecasting model for data that does not consider trend or seasonality. This model uses a weighted average calculation with 2 variables used, namely the average of the previous data and the current observation data (Brown, 1956)..

Assume that the data you have is time series data up to t-1 and the value you want to predict is the next data from the time series data (y_t). When the value of y_t is known, then that value can be compared with the forecasting result which is symbolized by $\hat{y}_t$ to get the value of forecasting error $y_t - \hat{y}_t$. So the forecast value for the next period t+1 is

$$\hat{y}_{t+1} = \hat{y}_t + \alpha(y_t - \hat{y}_t) \quad (1)$$

where, $\hat{y}_t$ is the forecasting data at time t, y_t is the observed data at time t and α is the data smoothing factor ($0 < \alpha < 1$)

It can be seen in (1) that the forecasted data is the previous forecasting data plus adjustments for errors (alpha) that occurred in the last forecast. When alpha has a value close to 1, it indicates fast learning (only the latest data affects forecasting results). On the other hand, when alpha is close to 0 it indicates slow learning (historical data greatly affects forecasting) (Shmueli & Lichtendahl Jr., 2016)

2) Double Exponential Smoothing

Double exponential smoothing is a development of the simple exponential smoothing model by including the trend as a consideration in the model calculation. This model uses 2 parameters, namely data smoothing factor or commonly referred to as alpha (α) and trend smoothing factor or commonly referred to as beta (β) where both parameter values are between 0 to 1. Calculation for level or level estimation (parameter α) using double exponential smoothing can be seen below.

$$L_t = \alpha * y_t + (1 - \alpha) * (L_{(t-1)} + b_{(t-1)}) \quad (2)$$

where y_t is the observed data at time t, α is the data smoothing factor; $0 < \alpha < 1$, L_t is the level at time t

Another parameter, β, is used for calculating trend estimates to support data forecasting later. The calculation of the estimated trend can be seen below.

$$b_t = \beta * (L_t - L_{t-1}) + (1 - \beta) * b_{(t-1)} \quad (3)$$

where, b_t is the trend estimation at time t and β is the *trend smoothing factor* ($0 \leq \beta \leq 1$)

So that the calculation of the forecasting results for the DES method can use the combination of (2) and (3) which can be seen below.

$$\hat{y}_t = L_{t-1} + b_{t-1} \quad (4)$$

where, $\hat{y}_t$ is the forecasting data at period t

3) Box-Jenkins Model

The Box-Jenkins model was created by mathematicians George Box and Gwilym Jenkins in 1970. This model is commonly used to forecast many types of problems, from business-related data to future prices. The Box-Jenkins model is generally best suited for short-term forecasts of 18 months or less. In addition, this model offers a fairly high level of stability and a low level of volatility so that it is often the main choice in forecasting (Box, Jenkins, Reinsel, & Ljung, 2015).

In forecasting, the Box-Jenkins model uses 3 principles, namely autoregression, differencing and moving averages. These three principles are known as p, d, q, respectively. These three principles will later be used in Box-Jenkins analysis, or better known as ARIMA (p, d, q).

Autoregressive Integrated Moving Average Model (ARIMA) is a time series forecasting model. Like other quantitative forecasting models, ARIMA uses past and present data to forecast future events. ARIMA is usually used for stationary cases where there is no difference in the mean and variance over time (constant).

In its application, it is very rare for time series data to be stationary because there will be trend and seasonality effects. One thing that needs to be done is to change the non-stationary time series into a stationary time series using differencing. Differencing can help stabilize data by eliminating or reducing trends and seasonality. One way to do differencing is to perform a logarithmic transformation (Hyndman & Athanasopoulos, 2018).

The ARIMA model includes several components, namely autoregression (AR), integrated and moving average (MA). Each of these models has its own meaning as described below.

Autoregression: In the autoregression model, the calculation of the response variable uses a linear combination of the past response variable values. In other words, the autoregression model shows that the model performs variable regression on itself. So that the autoregression model with the order p (AR(p)) can be expressed as follows.

$$y_t = c + \varphi_1 * y_{t-1} + \ldots\ldots\ldots + \varphi_p * y_{t-p} + \varepsilon_t \quad (5)$$

where, y_t is the response variabel at time t, φ_p is the autoregression coefficients, ε_t is the error estimation

Integrated: The integrated component represents the differencing of the data, where as explained above that in making the ARIMA model it is necessary to apply the principle of stationarity. If a data is stationary then the order used is 0 while if the data is not stationary then the order used starts from 1 and so on.

Moving Average: In the moving average model, the estimation of past forecasting errors is used as the basis for calculating this MA model. So the moving average model with the order q (MA(q)) can be stated as follows.

$$y_t = c + \varepsilon_t + \theta_1 * \varepsilon_{t-1} + \ldots\ldots\ldots + \varphi\theta_q * \epsilon_{t-q} \quad (6)$$

Where y_t is the response variabel at time t, θ_q is the moving average coefficients, ε_t is the error estimation

So if we combine differencing with AR and MA models, we will get a non-seasonal ARIMA model which is commonly called the ARIMA model (p, d, q) where p is the order of autoregression, d is the degree of differencing and q is the order of the moving average. The complete ARIMA (p, d, q) model can be stated as follows.

$$y'_t = c + \varphi_1 * y'_{t-1} + \ldots + \varphi_p * y'_{t-p} + \theta_1 * \varepsilon_{t-1} + \ldots + \varphi\theta_q * \epsilon_{t-q} + \varepsilon_t \quad (7)$$

where, y'_t is the *differenced series* at time t, φ_p is the autoregression coefficients, θ_q is the moving average coefficients, ε_t is the error estimation.

III. RESULTS AND DISCUSSIONS

At this stage, forecasting will be carried out on the data that has been collected previously. There are 3 forecasting periods used during forecasting, 46 days (1 November 2021 – 16 December 2021), 77 days (1 October 2021 – 16 December 2021) and 31 days (period 1 July 2021 – 31 July 2021). The first two forecasting periods (77 days and 46 days) are used to predict normal conditions, while the 31 day forecast period is used to forecast second wave conditions. From the results of this forecast, the result with the smallest error will be selected and chosen as the forecasting method for a particular area. This is because each region does not necessarily have the same forecasting method with each other.

A. Simple Exponential Smoothing

As we can see in Table 3, it has been summarized the alpha value of each variable that produces the smallest error from each forecasting time frame. It can be seen that all alpha values summarized in the table above have a value of 0.9 which means that the latest data is more influential than historical data in forecasting.

Furthermore, as we can see from Table 3, it is known that the 77-day forecasting period has an average error rate in the range of 0-2,3%. It can be considered a fairly small amount of forecasting error for all variables. However, when compared to the result of 46-days forecasting

period, the largest error value is only 0,4% and it is certainly makes sense because the longer the forecast period, the greater the uncertainty will affect the forecast result..

Then, as we can see from Table 3 it can also be seen that the error value for the 31-day forecasting time range is greater than the other two time frames (46 days and 77 days). This is related to the many uncertainties aspects when the second wave occurred, it could be due to faster virus transmission or people are starting to disobey the health protocols . As we can see from Table 3, the forecast error is very high when compared to normal conditions where the error rate varies greatly for each variable where the smallest error is 4.64% and the highest is 30,16%.

Table 3. Error Calculation for Simple Exponential Smoothing

Variable	Time Window						Variable	Time Window					
	77 days		46 days		31 days			77 days		46 Days		31 days	
	α	MAPE	α	MAPE	α	MAPE		α	MAPE	α	MAPE	α	MAPE
KA	0.9	0.71	0.9	0.22	0.9	20.15	KA_JG	0.9	0.65	0.9	0.20	0.9	18.20
KS	0.9	1.27	0.9	0.32	0.9	15.29	KS_JG	0.9	1.02	0.9	0.31	0.9	14.90
KM	0.9	1.02	0.9	0.24	0.9	18.54	KM_JG	0.9	0.80	0.9	0.24	0.9	24.38
KA_SU	0.9	1.01	0.9	0.16	0.9	16.59	KA_Y	0.9	0.81	0.9	0.43	0.9	28.37
KS_SU	0.9	2.34	0.9	0.42	0.9	9.13	KS_Y	0.9	1.44	0.9	0.40	0.9	19.33
KM_SU	0.9	1.50	0.9	0.06	0.9	8.31	KM_Y	0.9	1.12	0.9	0.25	0.9	30.16
KA_SB	0.9	0.53	0.9	0.07	0.9	14.36	KA_JT	0.9	0.73	0.9	0.23	0.9	22.15
KS_SB	0.9	1.27	0.9	0.20	0.9	8.25	KS_JT	0.9	1.09	0.9	0.29	0.9	14.50
KM_SB	0.9	1.16	0.9	0.28	0.9	10.12	KM_JT	0.9	0.71	0.9	0.20	0.9	18.12
KA_R	0.9	0.58	0.9	0.16	0.9	12.52	KA_BL	0.9	1.12	0.9	0.24	0.9	16.03
KS_R	0.9	1.02	0.9	0.19	0.9	8.42	KS_BL	0.9	1.83	0.9	0.24	0.9	9.97
KM_R	0.9	1.02	0.9	0.20	0.9	11.07	KM_BL	0.9	2.02	0.9	0.38	0.9	11.33
KA_DKI	0.9	0.49	0.9	0.21	0.9	21.85	KA_KT	0.9	0.70	0.9	0.15	0.9	16.91
KS_DKI	0.9	0.59	0.9	0.26	0.9	22.42	KS_KT	0.9	1.28	0.9	0.22	0.9	8.49
KM_DKI	0.9	0.33	0.9	0.09	0.9	16.12	KM_KT	0.9	1.11	0.9	0.04	0.9	20.86
KA_BN	0.9	0.68	0.9	0.21	0.9	26.04	KA_SLS	0.9	2.32	0.9	0.17	0.9	11.74
KS_BN	0.9	1.06	0.9	0.28	0.9	9.88	KS_SLS	0.9	2.25	0.9	0.35	0.9	4.64
KM_BN	0.9	0.51	0.9	0.06	0.9	10.24	KM_SLS	0.9	1.17	0.9	0.21	0.9	10.01
KA_JB	0.9	0.48	0.9	0.22	0.9	21.78							
KS_JB	0.9	0.71	0.9	0.27	0.9	15.01							
KM_JB	0.9	0.54	0.9	0.21	0.9	22.62							

B. Double Exponential Smoothing

As we can see from Table 4, it has been summarized the beta value of each variable that produces the smallest error from each forecasting time frame. It can be seen that the beta values are more varied with almost all ranges of values for either 31 days, 46 days or 77 days of forecasting.

As we can see from Table 4, it can also be seen that the error values for the 77-day forecasting period is mostly in the 0%-2% and for 46-day forecasting period are mostly under 1%. This shows that this method is quite good when compared to the simple exponential smoothing method, although not all variables have the same conclusion because some variabel have a higher

values such as variables KA, KS, KS_BL,etc. If we look closely, it is similar to the simple exponential smoothing method where a shorter forecasting time span will produce smaller errors than the longer ones.

For a forecasting time span of 31 days, error values are quite high when compared to normal conditions (forecasting period of 77 and 46 days) where the error rate varies greatly for each variable where the error value varies from 1% to 17% due to uncertainty factor in this period.

Table 4. Error Calculation for Double Exponential Smoothing

Variable	Time Window						Variable	Time Window					
	77 Days		46 Days		31 Days			77 Days		46 Days		31 Days	
	beta	MAPE	beta	MAPE	beta	MAPE		beta	MAPE	beta	MAPE	beta	MAPE
KA	0.8	0.89	0.9	0.08	0.9	8.30	KA_JG	0.8	0.63	0.9	0.06	0.3	6.13
KS	0.8	1.50	0.8	0.03	0.9	8.00	KS_JG	0.7	0.08	0.4	0.06	0.4	5.08
KM	0.8	2.08	0.9	0.06	0.9	8.79	KM_JG	0.3	1.56	0.7	0.01	0.4	17.27
KA_SU	0.8	1.84	0.9	0.02	0.9	10.58	KA_Y	0.8	0.90	0.3	0.04	0.9	13.31
KS_SU	0.8	0.43	0.6	0.13	0.7	1.53	KS_Y	0.8	1.28	0.4	0.01	0.7	10.01
KM_SU	0.7	0.09	0.9	0.01	0.1	3.05	KM_Y	0.8	0.30	0.5	0.05	0.7	13.27
KA_SB	0.8	0.38	0.7	0.01	0.6	5.69	KA_JT	0.4	1.16	0.9	0.12	0.9	14.41
KS_SB	0.8	0.04	0.6	0.03	0.1	2.07	KS_JT	0.8	1.67	0.9	0.12	0.9	9.09
KM_SB	0.6	0.12	0.2	0.10	0.4	1.22	KM_JT	0.6	0.82	0.9	0.07	0.9	9.28
KA_R	0.8	0.84	0.3	0.03	0.9	5.34	KA_BL	0.8	1.85	0.9	0.14	0.7	10.40
KS_R	0.6	1.99	0.7	0.04	0.1	1.69	KS_BL	0.3	5.42	0.9	0.16	0.7	6.66
KM_R	0.8	0.04	0.8	0.03	0.1	3.88	KM_BL	0.8	0.95	0.2	0.49	0.1	9.36
KA_DKI	0.4	0.18	0.9	0.01	0.4	4.97	KA_KT	0.8	0.92	0.7	0.02	0.9	9.03
KS_DKI	0.7	0.30	0.6	0.02	0.8	13.79	KS_KT	0.8	1.51	0.9	0.14	0.5	6.43
KM_DKI	0.8	0.18	0.9	0.02	0.8	5.38	KM_KT	0.8	0.75	0.7	0.01	0.5	13.92
KA_BN	0.5	0.03	0.8	0.01	0.4	17.12	KA_SLS	0.4	0.39	0.5	0.02	0.2	7.84
KS_BN	0.6	0.51	0.4	0.09	0.3	6.39	KS_SLS	0.2	0.54	0.7	0.06	0.7	2.74
KM_BN	0.2	0.17	0.3	0.05	0.4	10.13	KM_SLS	0.7	0.07	0.2	0.03	0.3	4.81
KA_JB	0.7	0.05	0.8	0.01	0.8	8.41							
KS_JB	0.8	0.07	0.2	0.02	0.8	7.30							
KM_JB	0.5	0.14	0.3	0.05	0.4	5.21							

C. Box-Jenkins Model

As we can see from Table 5, it is known that ARIMA is suitable for short forecasting periods. It can be seen that the error for the shorter time span (46 days) is smaller when compared to the longer one (77 days). When viewed from the order of the two time spans, almost more than 50% have the same order with each other. This means that a shorter time span does produce smaller errors for the ARIMA method.

Then, as we can see from Table 5,, it is also found that the error value for a time span of 31 days also has the worst error compared to the other two time ranges. This means that the three methods are both not good enough to forecast where the increase in cases occurs quite quickly. However, if you look at it, the ARIMA method itself is better than the double exponential smoothing method in predicting this second wave case where for ARIMA the error is maximum 20% while for simple exponential smoothing is maximum 30% and double exponential smoothing is >30%.

Table 5. Error Calculation for ARIMA

Variable	Time Window						Variable	Time Window					
	77 days		46 days		31 days			77 days		46 days		31 days	
	Order	MAPE	Order	MAPE	Order	MAPE		Order	MAPE	Order	MAPE	Order	MAPE
KA	4,2,3	0.44	4,2,3	0.13	3,2,5	8.68	KA_JG	1,2,2	0.75	1,2,2	0.11	0,2,1	6.17
KS	1,2,1	1.69	1,2,1	0.05	0,2,2	8.97	KS_JG	3,2,3	1.51	3,2,3	0.07	1,1,0	11.57
KM	2,2,2	1.82	2,2,2	0.49	0,2,2	9.80	KM_JG	4,2,2	1.59	4,2,2	0.19	1,2,1	18.76
KA_SU	3,2,4	1.95	3,2,4	0.04	0,2,1	10.69	KA_Y	0,2,1	0.92	0,2,1	0.06	1,2,1	13.85
KS_SU	2,2,2	0.69	3,2,2	0.37	1,2,3	1.30	KS_Y	0,2,1	2.92	0,2,1	0.05	1,1,2	21.55
KM_SU	2,2,2	6.83	0,2,1	0.78	0,2,1	3.14	KM_Y	5,2,4	1.15	3,2,5	0.07	4,2,0	14.54
KA_SB	5,2,2	1.13	5,2,2	0.07	0,2,2	8.10	KA_JT	4,2,5	1.59	4,2,5	0.21	3,2,1	14.98
KS_SB	1,2,3	4.84	1,2,4	0.04	0,2,1	2.57	KS_JT	2,2,3	1.41	2,2,3	0.15	2,2,1	9.52
KM_SB	1,2,2	3.02	1,2,2	0.09	2,2,1	2.33	KM_JT	4,2,4	0.36	4,2,4	0.12	2,2,3	10.92
KA_R	0,2,1	1.11	0,2,1	0.05	0,2,1	6.47	KA_BL	2,2,3	0.82	2,2,3	0.21	0,2,3	11.18
KS_R	0,2,1	2.17	0,2,1	0.11	0,2,1	2.61	KS_BL	0,2,1	5.78	0,2,1	0.29	0,2,1	6.89
KM_R	1,2,3	0.88	1,2,3	0.43	1,2,2	4.16	KM_BL	1,2,3	2.99	1,2,3	0.85	0,2,1	9.40
KA_DKI	0,2,0	0.19	2,2,5	0.05	0,2,2	4.91	KA_KT	0,2,2	1.17	0,2,2	0.08	1,2,2	10.11
KS_DKI	4,2,3	0.30	1,1,1	0.18	0,2,1	14.29	KS_KT	1,2,3	0.63	1,2,3	0.03	0,2,1	6.46
KM_DKI	0,2,1	0.78	0,2,1	0.06	2,2,0	4.96	KM_KT	0,2,1	1.03	0,2,1	0.11	2,2,1	15.97
KA_BN	0,2,1	0.93	1,1,1	0.01	1,1,1	21.28	KA_SLS	2,2,2	0.95	2,2,2	0.10	2,2,1	7.18
KS_BN	1,2,2	0.86	2,1,2	0.13	1,1,1	9.23	KS_SLS	2,2,1	0.84	2,2,1	0.35	3,2,1	3.07
KM_BN	1,1,1	0.08	1,1,1	0.06	0,1,0	10.13	KM_SLS	1,2,1	2.50	1,2,1	0.07	1,2,1	6.88
KA_JB	3,2,3	0.13	3,2,3	0.16	0,2,3	9.53							
KS_JB	1,2,1	1.65	1,2,1	0.04	1,2,1	9.55							
KM_JB	0,2,2	3.10	3,2,3	0.17	2,1,2	8.39							

D. Choosing the best method

As we can see from Table 6, double exponential smoothing method is better for most of the variables in 77 days forecasting period with 24 variables choose double exponential smoothing as the chosen method, followed by simple exponential smoothing with 11 variables and ARIMA with 6 variables. Furthermore, for the 46 days forecasting period, it can be seen that the double exponential smoothing method is also better for most of the variables with 36 variables choosing double exponential smoothing as the best method, followed by ARIMA with 3 variables. This indicates that for the distribution of data in Indonesia under normal conditions it is more suitable to use double exponential smoothing for most of the variables.

Then for abnormal conditions or conditions for example is the occurrence of second waves, the forecasting results will have a fairly high error eventhough the training data covers the initial 1 month of the second wave condition to study its pattern. However, of course it would be better if you have a planning eventhough the forecast error is quite high. As we can see from Table 6, it can be seen that to predict data with a lot of uncertainty, the double exponential smoothing method is more powerful than other methods. It is evident from the 39 variables used in the study, 34 variables choose double exponential smoothing as the best method, leaving ARIMA with 5 variables and simple exponential smoothing with 0 variable that choose them as the best method.

Table 6. Methods Chosen for Each Variables in Each Time Frames

Variable	Time Window			Variable	Time Window		
	77 days	46 days	31 days		77 days	46 days	31 days
KA	ARIMA	DES	DES	KA_JG	DES	DES	DES
KS	SES	DES	DES	KS_JG	DES	DES	DES
KM	SES	DES	DES	KM_JG	SES	DES	DES
KA_SU	SES	DES	DES	KA_Y	SES	DES	DES
KS_SU	DES	DES	ARIMA	KS_Y	DES	DES	DES
KM_SU	DES	DES	DES	KM_Y	DES	DES	DES
KA_SB	DES	DES	DES	KA_JT	SES	DES	DES
KS_SB	DES	DES	DES	KS_JT	SES	DES	DES
KM_SB	DES	ARIMA	DES	KM_JT	ARIMA	DES	DES
KA_R	SES	DES	DES	KA_BL	ARIMA	DES	DES
KS_R	SES	DES	DES	KS_BL	SES	DES	DES
KM_R	DES	DES	DES	KM_BL	DES	SES	DES
KA_DKI	DES	DES	ARIMA	KA_KT	SES	DES	DES
KS_DKI	ARIMA	DES	DES	KS_KT	ARIMA	ARIMA	DES
KM_DKI	DES	DES	ARIMA	KM_KT	DES	DES	DES
KA_BN	DES	DES	DES	KA_SLS	DES	DES	ARIMA
KS_BN	DES	DES	DES	KS_SLS	DES	DES	DES
KM_BN	ARIMA	DES	ARIMA	KM_SLS	DES	DES	DES
KA_JB	DES	DES	DES				
KS_JB	DES	DES	DES				
KM_JB	DES	DES	DES				

IV. CONCLUSION

In this study, we used the number of COVID-19 cases for each region as the variables to build the model. It may provide the information about the estimated number of active cases, recovered cases and death cases for the future. There is no guarantee that the forecasting results will be 100% correct to predict the future, but from the forecasting results that are not 100% correct, preventive measures can be taken by the government. Also, this study suggests that shorter time frame for forecasting is preferred rather than longer ones because from the study above it can be assumed that the less time period is predicted, the better the results obtained.

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AHP-Based Spare Parts' Criticality Assessment and Prioritization for Machine Availability and Reliability: Case Study at PT Solusi Bangun Indonesia Tbk

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ABSTRACT

The importance of maintaining the availability and reliability of machines in cement plants is an obligation for all employees in order to support the cement supply cycle from customer requirements. Machine failure due to unavailable spare parts is a loss for the company, so the need for spare parts availability has an essential role in cement production. In addition, the existence of a target budget cost and the value of spare parts inventory is an essential basis for prioritizing the purchase of spare parts. The existence of multiple criteria in determining the purchase of spare parts causes the need for the Analytical Hierarchy Process (AHP) method to solve these problems. This research aims to prioritize parameters in the purchase of spare parts and the criticality of the production machine process area at PT Solusi Bangun Indonesia (PT SBI). PT SBI management has guidelines when prioritizing spare parts. Critical equipment becomes the most influential parameter in the priority process into spare parts. The Kiln process area is the most critical area for the supply of spare parts to maintain factory availability.

Keywords: Availability, Reliability, AHP, Spare Parts, PT Solusi Bangun Indonesia

1. INTRODUCTION

Nowadays, various industries are doing many things to compete in both local and international markets. Owusu & Arthur explain at their research (2020), company owners, management, and employees recognize that they are responsible for meeting customer needs. To compete and survive in this market competition, companies need to optimize production so the main goal is to prevent the production process from stopping.

Galankashi Et al (2020) define the importance of maintaining the availability and reliability of machines in cement plants is an obligation, especially for all factory employees, to be able to support the cement supply cycle at the request of customers. So with the current highly competitive cement market, cement factories must always be ready to keep their machines healthy so they do not interfere with cement production operations. The existence of a dead machine due to a functional equipment problem causes financial losses due to the cessation of the production process. The longer the engine is off, the longer the cement production operation will stop so that the financial loss will increase. Moreover, if this causes a cement factory to be unable to meet

customer needs, it can cause a loss of market share. If this happens, it is a significant loss both in terms of finance and trust in the company because it has lost many customers.

In the past two years, PT SBI Tuban has suffered substantial financial and moral losses due to unplanned stops, namely the first case in the cement production process in the Cement Mill area and Kiln area due to the absence of spare parts. Spare parts that should be available are not in the warehouse, so the machine stop duration is getting longer. Maintaining the availability of spare parts dramatically affects the reliability and performance of the cement production plant machinery. However, it is necessary to maintain a budget for spare parts purchases because companies need to run their business effectively and efficiently.

Carssten (2013) explain that it is necessary to maintain the value of warehouse inventory to maintain the turnover of spare parts and minimize the slow movement of spare parts. From the previous, we can conclude that it is necessary to maintain the availability of spare parts to support the smooth operation of the cement plant. However, there are restrictions on costs for purchasing spare parts and the value of spare parts inventory. Thus, the assessment and prioritization of spare parts is a problem that needs to be researched so that the management of PT SBI Tuban can have guidelines in deciding the purchase of spare parts. In order to maintain the availability and reliability of the factory while maintaining the budget so that it is not excessive and keeping the spare parts inventory value below the target. To determine the criteria assessment and spare parts prioritization at PT SBI Tbk, Analytical Hierarchy Process (AHP) method is used to see which areas need priority.

Saaty (1990) introduce that The AHP method is used to choose conflicting criteria. These existing criteria will be processed with the AHP method to produce one of the desired alternatives. Nurhidayat (2013) explain that working principle of AHP is the simplification of a complex problem that is not structured, strategic, and dynamic into separate parts for later indexing in a hierarchy. Then the level of importance of each variable is given a numerical value subjectively about the relative importance of that variable compared to other variables. From these various considerations, a synthesis is then carried out to determine the variables that have a high priority and play a role in influencing the results of the system. The AHP method was used in this study because it is practically suitable for the cement industry, because it accommodates the opinions of experts in practice in the field. In practice, there are several different points of view from the experts which will be tried to be compromised in this AHP method.

2. LITERATURE REVIEW

Research has been conducted by Carssten (2013) to analyze the assessment of the cement factory in managing the inventory of spare parts in the warehouse. What needs to be done to manage spare parts efficiently is to classify them according to the criticality of the cement manufacturing process. Data collection can be done by conducting surveys and questionnaires to employees. Respondents as resource persons are employees from the finance, maintenance, supply chain, and production departments, so various perspectives on this spare parts inventory can be seen. From the study results, it was found that the things that affect the value of the spare parts inventory in the warehouse are the cost of obtaining spare parts and the time required for the arrival of spare parts from the purchasing process. The effect of these spare parts on the effectiveness of the factory production process is because when there is a problem in a machine, there is no spare parts supply, the longer the machine stops time. The most significant factors causing the spare parts inventory value are the ignorance of the cement factory management which needs a priority to be purchased, and the lack of synergy between productions, namely maintenance, operation, finance, and supply chain-related to the production plan.

A critical analysis of the cement production area has been carried out at a Cement factory in India by Chaudhary, Tripathi, & Shankar (2019). The main goal of this research is employees can focus on prioritizing to improve performance from the point of view of analysis, availability and maintainability. This research was conducted by collecting data on the Mean Time Between Failure (MTBF) and Mean Time To Repair (MTTR) of the factory and then conducted a correlation test to find the distribution of data from MTBF and MTTR and their parameters. The results of this study found. The Kiln area is critical in terms of availability, and the Cement Mill area is critical in maintainability, as indicated by low MTTR data. With these three findings, it is hoped that management can make it easier to maintain maintenance.

Okpal and Yelebe (2016) make a Prediction of failures that occur in cement plants with the analysis carried out has been made by finding engine stop data. This prediction is carried out accurately so that the failure time can be synergized with machine maintenance so that preventive maintenance carried out by the team can reduce the frequency of machine failure. Variations in failure that occur in the machine were studied by regression analysis using the r-square method and its correlation with linear regression analysis and the Weibull model's prediction method. This study found that two machines were predicted to fail, which was 55% of the overall engine stops, namely BE01 and BE02. So that by getting critical machine priority data, it can improve the MTBF and MTTR values

The AHP application has been used by Antosza and Ratnayakeb (2019) to prioritize the selection of parts related to an automotive manufacturing plant's performance in Warsaw, Poland. The stages of the research are as follows: making a hierarchical structure of the priority of spare parts, then using the Saaty scale and comparing comparisons, then conducting AHP analysis and calculating priority weights after finding the priority ranking results, illustrated in the form of analytical analysis. In this research, the assessment criteria are divided into two main aspects: maintenance and logistics. The sub-criteria used are price, delivery time, storage, spare parts provider, all of which are incorporated in the logistics side. Then for the maintenance side, which consists of categories, replacement of spare parts, replacement of spare parts, types of failure due to spare parts, frequency of machine failure in these spare parts, and workers' qualifications.

PT SBI has two-line cement process production. Each line have many area process production. Figure 1 shows the whole cement production process at PT SBI. Cement production starts from area Quarry to manage raw material for making cement and then through ten areas before ending at Dispatch area for delivery to the customer.

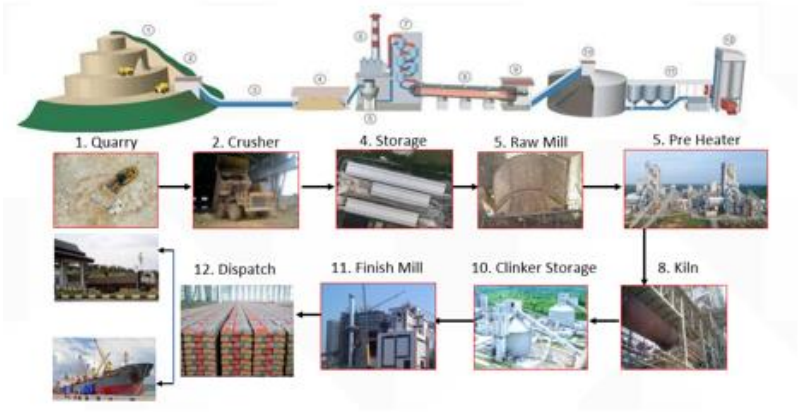


Figure 1. Area process production at cement industries
(Marrel, 2014)

3. METHODS

In this research methodology chapter discusses the research method, the data needed, the steps taken in the research, the data collection method and the expected results. It is illustrated as in Figure 2 below.

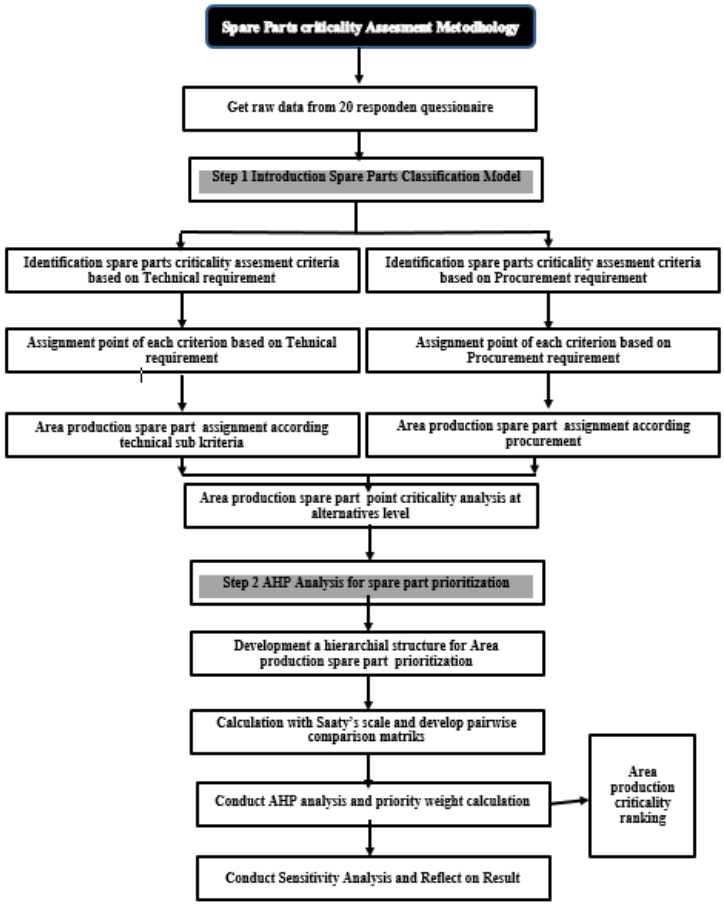


Figure 2.Criticality assessment and prioritization approach methodology

Based on Figure 2 above, the following step is conducted for the spare part criticality prioritization. The main goal of this methodology is to make area production criticality analysis based on spare part requirements.

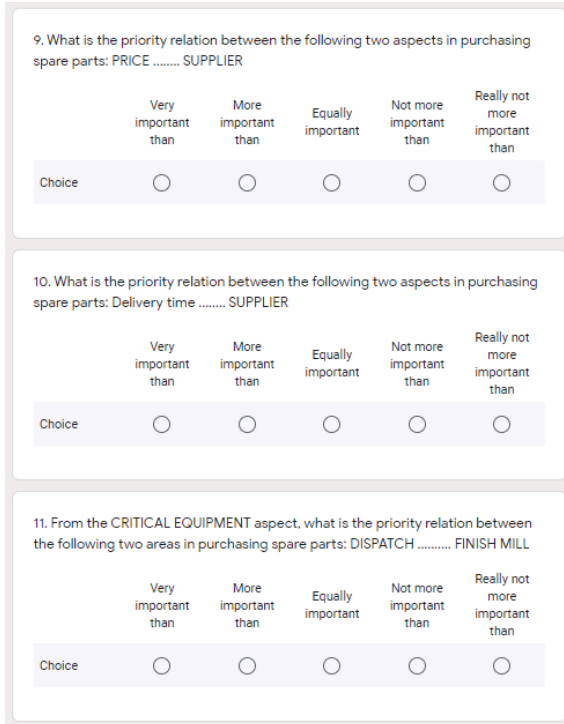
- Identification of the spare parts' criticality assessment criteria, based on the technical, finance and procurement requirements,
- Give a point for each criterion, based on the technical requirements
- Give a point for each criterion, based on the procurement requirements
- Give a point for each criterion, based on the finance requirements
- Area production spare part requirement assessment, according to the technical criteria
- Area production spare part requirement assessment, according to the procurement criteria
- Area production spare part requirement assessment, according to the finance criteria
- Final weighing of area production spare part requirement
- Identification of area production spare part criticality.

From Table 1 below, spare part criticality is divided into three criteria, Technical, Procurement and Finance criteria. Within Technical criteria, the following criteria proposed are Critical Equipment, Flexibility Part, and Complexity Part. Within Procurement criteria, the following criteria proposed are Delivery Part and Supplier. Within Finance criteria, the following criteria proposed are Price Part, Frequency Requirement and Warranty.

Table 1 Spare Part Criteria

Criteria	Sub Criteria	Sub Criteria Description
Technical	Critical Equipment	This criterion shows for which machine category the spare parts are mainly used. Machine category A means that this machine is very important for the production process performance, when machine A down whole production process will be down. The highest points are assigned to the spare part that is mainly used for very important machines
	Complexity Part	This criterion shows how difficult and complex the design a spare part is and that there is a need to have special method and tools in the spare parts production process. The complexity of the spare parts' design will also have an influence on the total failure elimination time and finally, on the criticality of the spare parts. The highest points are assigned to spare parts with high levels of complexity and the lowest points are assigned to the least complex spare parts.
	Flexibility Part	This criterion shows how practise spare part can use into various ewuipment. The highest point are spare parts can be utilize in some equipment, so team just should prepare a few tipe of spare part which can be install in many equipment. The lowest point are spare parts just can be install into one equipment, can not install to the other equipment.
Procurement	Supplier	This criterion shows how supplier make an effect for spare part reliability and availability. Some times if spare parts have customize design, just a few supplier who able to delivery spare parts. The highest points are spare part just a less supplier able to supply. The lowest points are spare part able to supply by many supplier (Common spare part)
	Delivery Part	This criterion shows how much time requirement from spare part order until the parts came to customer. The highest points are spare part need one year long from ordering part until came to customer. The lowest points are spare part need one week from ordering part until came to customer
Finance	Frequency Requirement	This criterion shows how often spare parts used by machine, its related with how often part of equipment should be replaced. The highest point are spare parts often taken from warehouse for equipment replacement. The lowest point are spare parts never or rarely taken from warehouse for equipment replacement.
	Warranty	This criterion shows how supplier give a guarantee for their spare part. The highest points are spare part have warranty at least five years. The lowest points are supplier can not give a warranty to their spare part.
	Price Part	This criterion shows how spare part cost The company sometimes does not want to buy a spare part because the cost is very high. At the same time, there are many less important spare parts in the storage, which are not needed The highest points are assigned to the spare part that has the highest cost, the lowest points are spare part with the lowest cost.

This research using primary data, by directly providing to data collectors not through intermediaries or in the form of answers to the results of distributing questionnaires. Questions were asked to 20 people involved in the factory production process every day so that they are experts in the cement production process of PT SBI. Figure 3 below is a questionnaire that has been given to respondents. Figure 3 shows the questions addressed to respondents in filling out questionnaires by selecting the available answers for each pairwise comparison.



9. What is the priority relation between the following two aspects in purchasing spare parts: PRICE ..... SUPPLIER

	Very important than	More important than	Equally important	Not more important than	Really not more important than
Choice	○	○	○	○	○

10. What is the priority relation between the following two aspects in purchasing spare parts: Delivery time ..... SUPPLIER

	Very important than	More important than	Equally important	Not more important than	Really not more important than
Choice	○	○	○	○	○

11. From the CRITICAL EQUIPMENT aspect, what is the priority relation between the following two areas in purchasing spare parts: DISPATCH ..... FINISH MILL

	Very important than	More important than	Equally important	Not more important than	Really not more important than
Choice	○	○	○	○	○

Figure 3.Assesment quessionaire of pairwise comparison

Table 2 below presents area production spare parts, which most critical process like cement production at PT SBI as alternatives of AHP calculation. Four primary area production at PT SBI are Raw Mill, Kiln, Finish Mill, and Dispatch. Every area production has each characteristic from the spare part requirement side, as technical, finance or procurement criteria. The final result of this methodology is that most criteria have the most significant weight and area production, which significantly affects the spare part requirement for equipment availability.

Table 2 Area process production as alternatives at AHP calculation

Area process production	Area process production description
Raw Mill	The initial milling process of the material with the aim of reducing the size of these raw materials to have a diameter of 100 mm. Then the product that has been ground is in a smooth condition dialirkan oleh penyaring udara
Kiln	The stages of burning the material until it melts at a certain temperature according to the standard of the machine so that a chemical process occurs for the formation of semi-finished raw material properties
Finish Mill	The final grinding process of all cement-forming elements so that the output has become a complete cement
Dispatch	The process of packing finished cement into bags to be ready for distribution to customers

Figure 4 below shows the hierarchy of spare parts criticality with the AHP calculation process. The purpose of calculating AHP is defined by calculating the priority of spare parts to support cement production operations. The criteria in the AHP are divided into three parts, namely

technical, finance and procurement aspects. Sub-criteria are defined by critical equipment, the flexibility of spare parts, and the complexity of parts that are part of the technical criteria. The next sub-criteria are delivery part and suppliers are part of the procurement criteria. The final sub-criteria are prices, frequency of requirements and warranty are part of the finance criteria. The cement production machine area as alternative in the AHP calculation process is the Raw Mill, Kiln, Finish Mill, and Crusher areas.

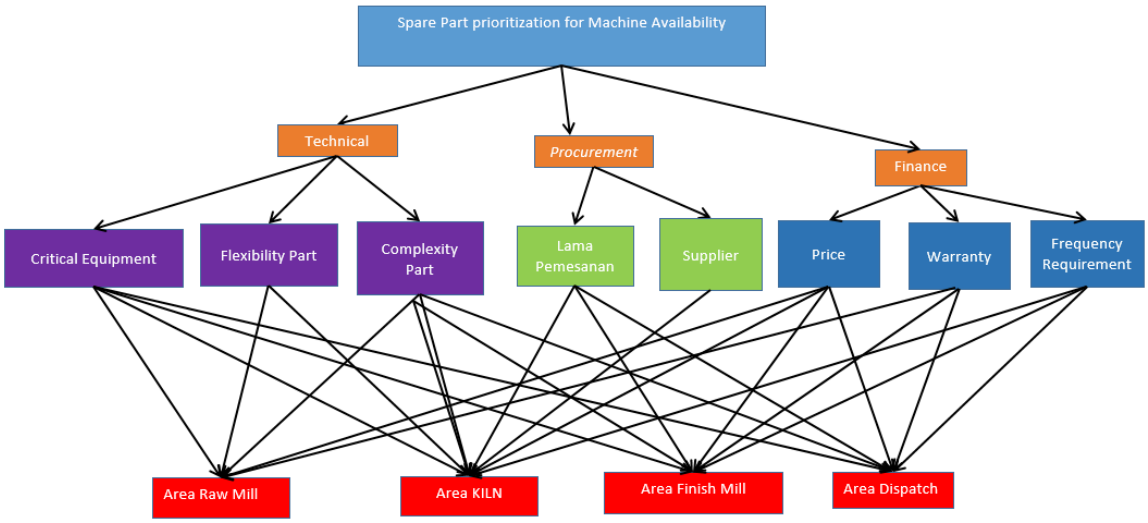


Figure 4.Hierarchial structure for prioritization

4. RESULTS

Table 3 below shows spare parts 'criteria rank, which has a significant effect on keeping equipment available. Critical equipment has the most priority when PT SBI management decides which criteria spare part will be ordered. Supplier criteria have moss fewer essential criteria than the other criteria.

Table 3 Spare part Criteria priority rank result

Criteria	Weight	Priority
Critical Equipment	0.309	1
Price	0.203	2
Delivery Time	0.124	3
Frequency Requirement	0.112	4
Flexibility Part	0.109	5
Complexity Part	0.07	6
Warranty	0.042	7
Supplier	0.031	8

Table 4 below shows the final result of the AHP calculation for prioritizing the criticality of PT SBI spare parts, with the Kiln area being the first priority with a weight value of 1.513, then followed by the Dispatch area with a weight value of 1.507, third place is the Finish Mill area with a weight value of 1.488. Then ranks last, Raw Mill area with a weight value of 1.478. The following Figure 4 shows the final result of the criticality sequence of PT SBI's cement production area to the need for spare parts from technical, finance and procurement aspects.

Table 4 Area cement production priority rank result

Alternatives	Weight	Priority
KILN	1.513	1
DISPATCH	1.507	2
FINISH MILL	1.488	3
RAW MILL	1.478	4

Table 5 below shows the results of the consistency ratio for the sub-criteria, the aspect of the warranty looks very consistent with a smaller value than the other aspects, which is 0.067. Other sub-criteria show values below 0.1 so that all are consistent.

Table 5. Consistency ratio for the sub-criteria

Sub Criteria	*CR*	Remarks
Critical Equipment	0.089	Consistent
Frequency Requirement	0.089	Consistent
Flexibility Part	0.09	Consistent
Complexity Part	0.091	Consistent
Delivery Part	0.09	Consistent
Price Part	0.09	Consistent
Warranty	0.067	Consistent
Supplier	0.09	Consistent

Sensitivity analysis shows an illustration of transparency in the prioritization process to determine the correlation between criteria, sub-criteria, and alternatives. The figure below shows the sensitivity analysis of the criteria compared to the production process area as an alternative.
From Figure 5 below, it can be seen that the bar chart describes the overall effect of technical, finance and procurement criteria on the prioritization of PT SBI spare parts purchases. At the same time, the line diagram describes the weight results per individual production process area. In the line diagram, the Dispatch area appears to have a higher weight value than the others, especially on the criteria for ordering time and part complexity. This indicates that the ordering time and part complexity criteria are essential for this Dispatch area. However, overall, the sub-criteria for ordering time and part complexity is not entirely essential factors in the availability of spare parts for the reliability of factory machines. The sub-criteria for critical equipment is the most critical

factor in maintaining factory machines' reliability compared to other factors. So that when prioritizing the purchase of spare parts, it is necessary to examine the spare parts to be purchased which will be installed in the machine. If the machine dies, the entire production process will stop or not. If face several production areas applying for the purchase of spare parts, it is necessary to research the origin of the area that proposes to purchase spare parts. The dispatch area becomes the most critical area to maintain the availability of spare parts compared to other areas because it has the biggest influence on factory reliability compared to other areas

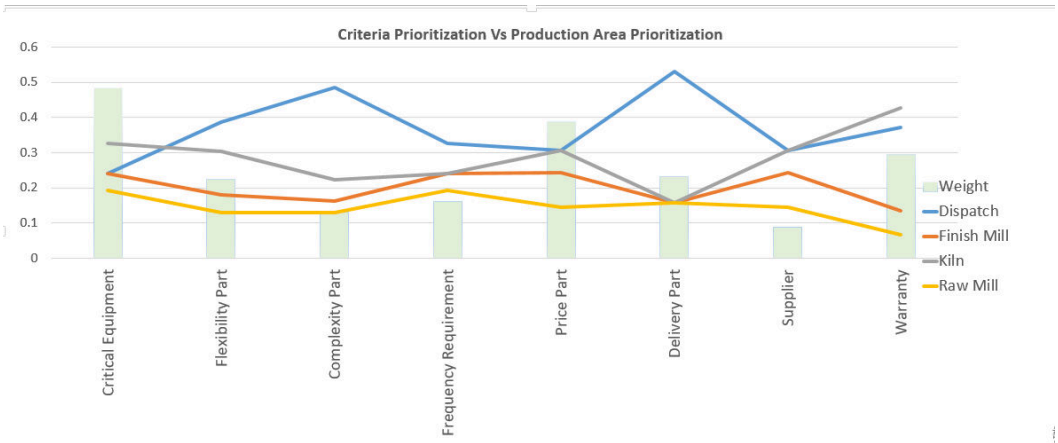


Figure 5. Sensitivity Analysis Criteria Prioritization vs Area Prioritization

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5. CONCLUSIONS

In closing the discussion, these conclusions and suggestions given as a comparison can be drawn, ultimately providing future improvements. Based on the research objectives and the results of the research above, it can be concluded that the most influential criterion on the prioritization of spare parts at PT SBI is the critical equipment aspect with a weight value of 0.309, in the second rank is the price aspect with a weight value of 0.124, the delivery time aspect of the goods occupies the third position with a weight value of 0.124, followed by frequency requirements aspect in the fourth position with a weight value of 0.112, the flexibility aspect of the part occupies the fifth position with a weight value of 0.109, then the aspect of the complexity occupies the sixth position with a weight value of 0.07, then the warranty of the part is ranked seventh with a weight value of 0.042, and the vendor-supplier aspect is ranked the most bottom with a weight value of 0.031.

The most critical work area criteria based on the prioritization of spare parts at PT SBI is the Kiln area, with a weight value of 1.513. Followed by the second rank of the Dispatch area with a very slight difference in weight value, with the first rank being the weight value of 1.507, the third place being the Finish Mill area with the weight value is 1.488. The Raw Mill area occupies the last position with a weight value of 1.478.

Based on the results of the analysis and conclusions above, some suggestions can propose area PT SBI management in purchasing and prioritizing wood spare parts should pay attention to the weight of the spare parts parameter criteria because each criterion has a different weight. That way, the company can combine these criteria in prioritizing the selection of spare parts to be purchased. Choosing the proper parameter criteria when prioritizing spare parts will make

purchasing spare parts more effective and efficient so that budgets can be arranged more quickly and the inventory value of warehouse storage is not high.

When PT SBI management faces conditions from several work areas proposing to purchase spare parts at the same time and at the same time the spare parts budget is limited, then the results of this study in the form of a criticality sequence of work areas can be used as a basis for making decisions on which area spare parts which will be purchased first. So that the purchase of spare parts that are right on target will not interfere with the cement production process at PT SBI, and there will be no potential loss of cement customers in the future.

In the future, if there are new criteria or sub-criteria relevant to the company or by the new company policy, the company can change the criteria and sub-criteria currently used. PT SBI can use AHP analysis to solve other multi-criteria problems as a decision support tool, apart from prioritizing spare parts.

For further research, researchers can use other criteria by the policies of each company. In addition, to reduce the subjectivity of respondents' assessments, significantly reduce the inaccuracy and uncertainty of respondents in mapping their perceptions into numerical figures, researchers can also use other methods to support decision making, such as the fuzzy AHP method.

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ANALYZING FACTORS THAT INFLUENCE HOME BUYING OF MILLENNIAL GENERATION

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ABSTRACT

Housing is a basic needs for everyone. As a place to live, housing make a person's live more stable and become to be an investment. Millennial generation has contribute to purchase intention about residential property. The supplies were contradicted with the demand as millennial needed. The purpose of this research is to study factors influencing housing purchase intention of millennial generation. The sample consists of 100 millennial that lived in Surabaya. The data were analyzed using Structural Equation Modeling (SEM). The result, which is obtained based on SEM analysis there are 3 variables have significant effect to purchase intention. There are financial, location and motivation had effect to purchase intention.

Keywords: Purchase Intention, Millennial Generation, Structural Equation Modeling (SEM).

1. INTRODUCTION

Housing is important thing as the basic needs for everyone. As a place to live, housing must be able to provide comfort for the user. Based on Real Estate Indonesia (2020) there is potential need for buying residential properties although some people no need to buy now. Buying a house is a complex decision involved many aspects. According to Heriyati et al. (2021) feng shui, brand reputation and financial has an impact to purchase decision. Various other studies conducted by Kurniawan et al. (2020) mention about some important factors that influence housing purchase decisions such as structural attributes, location and financial. Based on Rachmawati (2019) there is price has contributes to purchase decision. In addition, motivation and personal values also effects home purchase decision making process (Nurarong and Punnakitikashem, 2018).

Population growth has increase every year. Population in Indonesia is dominated by millennial generation (BPS, 2021). Millennial generation defined as a group of generations between 25 until 40 years old. The large proportion of millennial generation towards the working age shows that millennial generation has a big contribution to the housing demand. So, this study will analyze feng shui, brand reputation, financial, location, structural attribute, price, motivation and personal values factors on millennial purchase intention towards housing. The results of this study are expected to contribute marketing strategy and develop home demand.

2. LITERATURE REVIEW

According to Utomo & Noormega (2020) millennial generation describe that a group connected with technology and creativity. Millennial born between 1982-1997. This generation has characteristic of open, creative, informative and productive communication. Research on millennial generation is something that needs to be done because its large population and need strategy to offer products and service to influence the intention to buy (Heriyati, 2021). Kotler & Keller (2018) defined purchase intention is consumer behavior when the consumer is stimulated by external factors and comes along to decide on purchase based on their personal characteristics and processes decision making.

The factors influence to purchase intention based on studies before are fengshui, brand reputation, financial, location, structural attribute, price, motivation and personal values. Fengshui is an ancient chinese art of arranging buildings, objects and space in an environment to achive harmony and balance (Petra, 2009). According to Heriyati et al. (2021) brand reputation is a professional manner, good quality and services. The other variable is financial, it is personal ability to get income, credit and payment method (Kurniawan et al., 2020). Based on Sastra & Marlina (2006) describe the property location near public transportation and public facilities. Structural attribute about private space, large of building and number of room is structural characteristic (Kurniawan et al., 2020). Purchase intention also defined by price, which is value indicator (Tjiptono, 2008). Psychology aspect there are motivation and personal values is another aspect about purchase intention (Nurarong & Punnakitikashem, 2018).

Conceptual framework for this research can be described as follows:

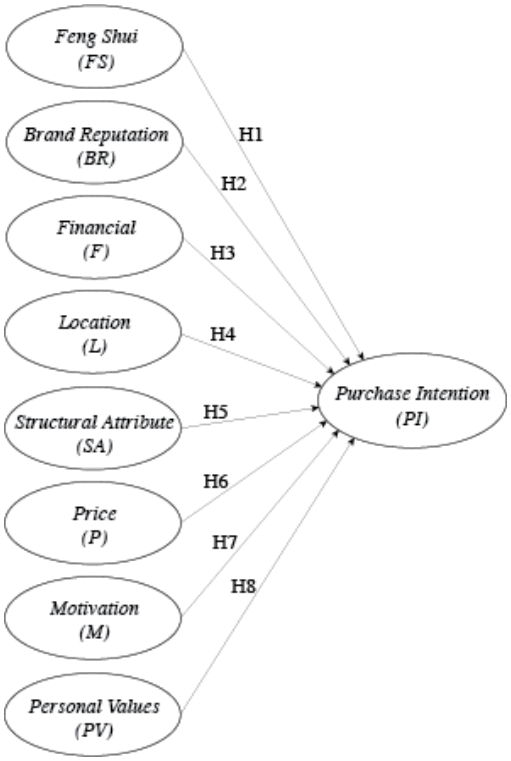

Figure. 1. Conceptual Framework

The research hypotheses in this study are:
H1: Feng shui has significant effect to purchase intention.
H2: Brand reputation has significant effect to purchase intention.
H3: Financial has significant effect to purchase intention.
H4: Location has significant effect to purchase intention.
H5: Structural attribute has significant effect to purchase intention.
H6: Price has significant effect to purchase intention.
H7: Motivation has significant effect to purchase intention.
H8: Personal value has significant effect to purchase intention.

3. METHODS

This purpose of this research is to examine the relationship between feng shui, brand reputation, financial, location, structural attribute, price, motivation and personal value as independent variables and purchase intention as dependent variable. The convenience sampling method is used in this research. The sample consists of 100 millennial generation in a great Surabaya. The data was collected by survey questionnaire.

Data will be analyzed using SEM-PLS through several stages of analysis outer model and inner model. Outer model consists of validity test and reliability test. The validity test performed to ensure all instruments are valid as they has loading factor more than 0.5 (Hair, 2018). The reliability test conducted to ensure all variables are reliable with minimum cronbach's alpha and composite reliability value of 0.7 (Hair, 2018). Inner model to examine structural model. The final step is path coefficients to prove the hypothesis framework. A hypothesis of positive correlation accepted if it has a significant value of less than 0.05.

4. RESULTS

The construct validity test results show that all instruments in this study are valid as they have loading factor more than 0.5. All variable must have cronbach's alpha and composite reliability more than 0.7 (Hair, 2018). The result of this study on Table 1 below.

Table 1. The Result of validity and Reliability test

No	Indikator		Loading Faktor	Cronbach's Alpha	Composite Reliability
1	Financial (F)	F1	1.000	1.000	1.000
2	Location (L)	L1	0.716	0.816	0.880
3		L2	0.892		
4		L3	0.849		
5		L4	0.750		
6	Structural Attribute (SA)	SA1	0.950	0.876	0.941
7		SA2	0.935		
8	Price (P)	P1	0.946	0.859	0.934
9		P2	0.925		
10	Motivation (M)	M3	1.000	1.000	1.000
11	Purchase Intention (PI)	PI1	0.841	0.788	0.876
12		PI2	0.870		
13		PI3	0.802		

Table 2 shows that result that the location has the strongest influence on purchase intention with the lowest p-value 0.007 followed by financial (0.010) and motivation (0.050). Meanwhile, the other two factors, structural attribute and price do not significantly influence the purchase intention as their significant value of more 0.05.

Table 2. The Result of validity and Reliability test

Keterangan	R^2	T Statistics	P-Values	Conclusion
Financial → Purchase Intention	0.258	2.593	0.010	Significant
Location → Purchase Intention		2.684	0.007	Significant
Structural Attribute→ Purchase Intention		0.909	0.363	Not Significant
Price → Purchase Intention		0.452	0.651	Not Significant
Motivation → Purchase Intention		1.962	0.050	Significant

Location is one of the factors that has a significant effect to purchase intention of millennial generation. It affirms the results of previous studies stated that location influences housing purchase decisions (Kurniawan, 2020). The result of the study claimed that residential product are offered by development of integrated public transportation mode and close to public service. Financial is the second one that influence to purchase intention. This finding confirmed studies by Heriyati et al. (2021) that found the significant influence of financial factor on the housing purchase decision. This financial refers to income of someone. The last factor has significant effect to purchase intention is motivation. Motivation orientated about desire of individuals to have residential properties.

6. CONCLUSIONS

This study conducted to find out influence of location, financial and motivation toward millennial's purchase intention. In the context of location is security system, distance to the public services and public transportation. In the scope of financial, millennial must have stable income to get properties. The last variable is motivation, that is about psychological factor that influencing residential property purchase intenton. The individual desire to own residential property arises. This study recommends about focusing marketing strategies on the factors influence the millennial housing purchase intention. Property developers should create residential products that meet millennial needs, since millennial has a major contribution to housing demands in Indonesia. Indicator of financial is about income. Strategic location can be recommendation for property developer. The last is motivation about desire individual to have residential property.

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THE EFFECT OF VISUAL COMPLEXITY AND CONTEXTUAL RELEVANCE ON WEB ATTRACTIVENESS, TRUST, AND ONLINE PURCHASE INTENTION ON COMPANY WEBSITES

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ABSTRACT

When facing the demands of consumer needs and the rapidly growing wave of digitalization, the company's website is the right communication medium to use to reach consumers more broadly in this process. The development of competitors in designing the appearance of the company's website poses a challenge for companies to be able to design attractive displays and be able to present relevant information so as to increase web attractiveness and consumer trust to make online purchases. This study examines the effect of visual complexity where a number of elements with a certain level of complexity can be an influence on the cognitive and emotional aspects of humans and contextual relevance where the connection between the delivery of information included in advertisements is in accordance with the content, this is also a tool used to compete more effectively on the market. the appearance of the company's website on web attractiveness where the ability of the website is felt to be able to provide benefits to individuals and trusts, where trust or consumer expectations that the stall can fulfill the promised commitment using the MANOVA test analysis technique, then linked to online purchase intention of consumers using multiple regression tests. This study used a 2 x 2 factorial design and used a random assignment technique to 160 participants. The study was initiated by conducting a pre-test and manipulation test to ensure that participants understood the stimuli that had been prepared from the manipulation. In the main effect, it was found that the results of using high type of visual complexity resulted in high web attractiveness and trust. And in contextual relevance, it is found that there are differences in web attractiveness and trust. Website display that displays a display that has information linkages between images and descriptions will result in higher web attractiveness and trust. In addition, the research found that web attractiveness and trust have a positive effect on online purchase intention.

Keywords: visual complexity, contextual relevance, web attractiveness, trust, online purchase intention, MANOVA, multiple linear regression.

1. INTRODUCTION

Website is one part of the company's communication media where information related to products and services is contained in it. In this case the company acts as a provider of products and services. Also, all transactions that occur will be handled alone. The presence of the company's website in Indonesia has been around for a long time, which is growing day by day and getting a

positive response. This is marked by the company's incessant presence, collaborating, growing rapidly, and relying on electronic transactions as well as the demands from consumers for the presence of electronic services from the company. The positive response given by the community is driven by the increasingly incessant promotion of various electronic-based companies so as to shape the behavior of searching for information electronically. This electronic business competition is interesting because in 2016 the Indonesian government has issued a roadmap targeting online transactions to reach 130 million dollars by 2020. The use of a good marketing strategy puts the company in the right position in the competition for electronic transactions, and can be an example for other companies in developing marketing strategies on their websites. In addition to good conditions, the presence of many websites that implement the same strategy creates a new problem for marketers to attract the attention of consumers. Empirical studies find that the situation will be complicated for marketers, if other marketers also apply the same marketing strategy. Another strategy that can be used to differentiate from other company websites is to manage the content of the website. Management of the content of the website cannot be separated from the company's role in presenting information related to products and services which are the main material of the offer. By processing the visual display, it will have an effect on increasing the effectiveness of the advertising strategy that has been set (Kewen, 2016). Differences in processing the visual appearance of the website will provide differences in the level of effectiveness of advertising in the process of attracting consumer attention which has an effect on the process of consumer evaluation (Reber et al, 2004). In processing the visual display, of course, the company needs to pay attention to the guidelines and policies that apply both from within the company itself and the laws that apply in the country where the company is located. In this development, many companies are processing the composition of the visual appearance of their website in accordance with applicable policies. From this processing, consumers find there is a uniformity of each website. Indirectly, consumers are asked to evaluate the quality of each website according to what information they can understand. With the uniformity between websites, it will be difficult for companies to stand out and attract the attention of consumers to stop and evaluate further the products and services offered by the company based on the visual appearance displayed.

2. LITERATURE REVIEW

2.1 Visual Complexity

Visual complexity is a visual characteristic of advertising images with different understandings of advertising messages (Donderi, 2006). In addition, according to Tuch et al., (2009) and Geissler et al., (2006) visual complexity is also described as a number of elements with a certain level of complexity that can affect human cognitive and emotional aspects, such as satisfaction, memory, and job performance. Several studies on visual complexity found that ads using visual complexity strategies resulted in a more positive ad performance in attracting consumers' attention as in the research of Pieter et al., (2010) where design complexity such as shape, image, and arrangement can give stimuli to consumers to pay more attention to advertising.

2.2 Contextual Relevance

Contextual relevance is the delivery of information in related content (Guitart & Hervet, 2017). According to Anthony (2014) contextual relevance is explained as the relationship between the delivery of information included in advertisements according to the content, this is also a tool used to compete more effectively. In addition, according to Stammerjohan and Coulter (2005) contextual relevance is described as a tool that can increase the effectiveness of advertising because of the links inherent in it. Studies on contextual relevance state that the placement of content-related

product ads can increase the effectiveness of the persuasion effect compared to ads that are not content-related (Maile & Fleck, 2011). The application of contextual relevance in online media or on websites can have a significant impact on the response of target consumers who are targeted by marketers, because the function of contextual relevance is as a trigger and is part of the application of complexity theory (Reetika et al., 2005; Cox and Cox, 1988)

2.3 Web Attractiveness

Web attractiveness is defined as everything that is attached to a website that can attract the attention and preferences of each consumer's buying process (Orth & Wirtz, 2014). Attractiveness itself is defined as the ability of a website that is felt to be beneficial to individuals (Mayo & Jarvis, 1981). The more the website is able to meet consumer needs, the more attractive the website will be and will increase the likelihood that it will become a choice again for consumers. Another study states that attractiveness refers to the perception that arises in the minds of consumers regarding the availability of elements attached to the website so that the website is worthy of competition (Jones et al., 2000). From the understanding of experts, web attractiveness is defined as consumer perception of the effects attached to the website and is felt to be able to attract consumer attention.

2.4 Trust

Trust is defined as consumer expectations that the store can fulfill its promised commitments (Eastlick et al., 2006). Trust also refers to the depth and certainty of feelings based on inconclusive evidence. One's trust can be seen when faced with uncertain and risky situations. Research finds that uncertainty and risk are necessary conditions to reveal the value of trust (McKnight & Chervany, 2002). According to Golbeck (2005) trust is defined as a commitment to an action based on the belief that one's future actions will produce good results. Consumers can be said to believe if they already have confidence that in the future the results of the actions taken will have a good impact. From the understanding of experts, it can be concluded that trust is the tendency of consumers to believe in the ability, integrity, and trustworthiness of other parties.

2.5 Online Purchase Intention

According to Cyr (2008) online purchase intention is defined as a form of consumer desire to buy goods or services from the website. In the study it was stated that online purchase intention is the final consequence of various cues given to e-commerce consumers (Cyr et al., 2009). With a variety of cues or stimuli given can change consumer attitudes to do something. According to Hsiao et al., (2011) online purchase intention is defined as the possibility that consumers plan or are willing to buy certain products or services in the future through online media. According to Spart and Singh (2004) purchase intention is defined as a conscious plan or consumer's intention to purchase a product. This means that online purchase intention is the intention of consumers to purchase products through online media. From the understanding of the experts, it can be concluded that online purchase intention is the tendency of consumers to plan or be willing to buy products from online stalls in the future.

2.6 MANOVA

This MANOVA test is used to test whether each factor affects the group of related variables. MANOVA assumes that each dependent variable has the same variance for all group categories (Ghozali, 2012: 90). MANOVA can be used in two main conditions, the first condition is when there are several correlated dependent variables, but the researcher only wants one overall test on

these variables compared to doing several individual tests. The second condition is when the researcher wants to know how the independent variable affects the pattern of the dependent variable.

2.7 Multi Linier Regression

According to Suharso (2009) multiple linear analysis is used to test the effect of several independent variables on one dependent variable on an interval scale. According to Sugiyono (2008) multiple linear analysis is used to predict how the value of the dependent variable changes if the value of the independent variable is increased or decreased (3.1). This analysis involves two or more independent variables between the dependent variable (Y) and the independent variable (X1, X2, and X3). This method is used to find out how strong the relationship between several independents together is on the related variables which are then expressed in the formula. Sugiyono (2008) formulates multiple linear regression analysis as follows:

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 \quad (3.1)$$

Where:
Y = Intention to shop online
α = Constant
β_1, β_2 = Regression Coefficient
X_1 = Web Attractiveness
X_2 = Consumer Confidence
The questionnaire is prepared with a Likert scale from 1 to 5, then the constant value is considered reasonable if $1 \leq 5$ (positive value)

3. METHODS

The approach used in this research is a quantitative approach. The quantitative approach is a research approach that uses statistical figures to help explain, describe, and answer research problems (Curwin & Slater, 2002). In this research can be categorized as a type of causality research. Causality research is a type of research whose main objective is to obtain evidence regarding a causal relationship between the independent variable (which affects) and the dependent variable (which is influenced) (Malhotra, 1993). This research also uses experimental research methods. Experimental research is research that collects information from respondents by asking several questions through a questionnaire so that later it can describe various aspects related to the manipulation presented (Faenkel & Wallen, 1990). In this study, to be able to measure the level of agreement or disagreement of participants in assessing statements related to web attractiveness, trust, and online purchase intention, the Likert Scale was used. The Likert scale used in this study uses 5 Likert Scale

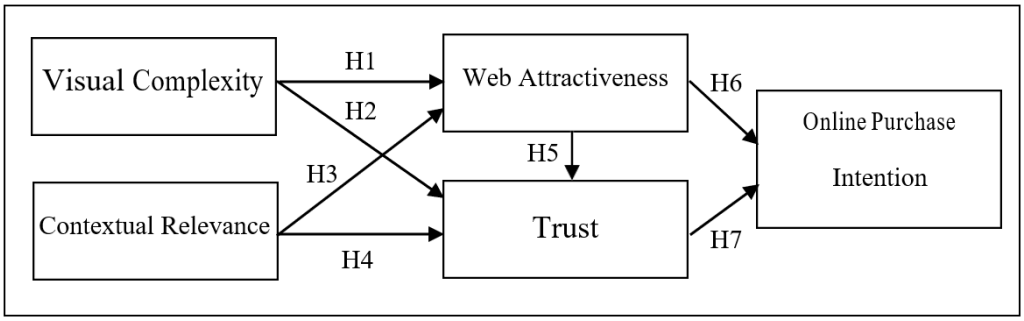

Figure 1. Conceptual Framework Schematic

The technique in the sampling process uses stratified random sampling with a proportional sampling approach. This sampling was done by distributing questionnaires based on five Likert scales. The technique in the sampling process used stratified random sampling with a proportional sampling approach.

Table 1. Likert Scale Estimation

Mark	Estimation Scale		Explanation
	Criteria	Code	
1	Strongly agree	STS	Respondents strongly disagree with the statement because it is not in accordance with the circumstances felt by the respondent
2	Agree	TS	Respondents consider the statement does not match the situation they feel
3	Neutral	N	Respondents assume that the statement does not know how he or she behaves, so it is possible that the "don't know" option facilitates the respondent's confusion about the statement
4	Do not agree	S	Respondents consider the statement to be in accordance with the situation they feel
5	Strongly Disagree	SS	Respondents strongly agree with the statement because it is in accordance with the perceived situation

4. OUTCOMES

4.1. Validity and Reliability Test

The results of the study are described according to the results of the acquisition based on the participants' answers to the questionnaire that has been given. Participants' answers are raw data that will be processed, measured for validity and reliability, and analyzed using statistical programs.

Table 2. Factor Test Analysis, Validity Test, and Dependent Variable Reliability Test

Variabel Dependen		Corrected Item to Total Correlation	Cronbach's Alpha
Web Attractiveness	WA1	0,415	0,752
	WA2	0,500	
	WA3	0,608	
	WA4	0,645	
	WA5	0,559	
	WA6	0,267	
	WA7	0,316	
Trust	T1	0,499	0,843
	T2	0,638	
	T3	0,730	
	T4	0,700	
	T5	0,685	
Online Purchase Intention	OPI1	0,662	0,902
	OPI2	0,686	
	OPI3	0,822	
	OPI4	0,796	
	OPI5	0,821	

4.2 Multivariate Test

In this section, it will be tested whether there are differences in the dependent variable together in the group of independent variables. If the multivariate test produces a significance value of $F < 0.05$ ($\alpha = 5\%$), it can be concluded that there are differences in the dependent variable together in the group of independent variables. The following are the results of the multivariate test for the effect of the interaction between visual complexity and contextual relevance.

4.2.1 Main Effect

Testing with multivariate analysis of variance obtained the results of the main effects that have been summarized Table 3.

Table 3. Main Effect Test

Variable	Web Attractiveness			Trust		
	Mean	F	Sig.	Mean	F	Sig.
a. Visual Complexity						
High	26,99	7,269	0,008	16,64	0,305	0,582
Low	25,39			16,38		
b. Contextual Relevance						
Relevance	26,61	2,283	0,133	17,04	4,788	0,030
Irelevance	25,73			15,97		

5. OUTCOME AND DISCUSSION

Regarding the results of the main effect, it displays a different significance value and calculated F value in each variable. Based on Table 3, it can be concluded that the results of testing the hypothesis of this study

5.1 Hypothesis 1 : The Effect of Differences in Visual Complexity on Web Attractiveness and Trust

Based on the results of the study, it can be seen that the different types of visual complexity have different effects on Web Attractiveness and on consumer confidence in the website. These results are based on the results of testing using MANOVA which shows that there is a significant difference in the main effect of visual complexity on Web Attractiveness and consumer trust in the website. Thus, hypothesis 1 and hypothesis 2 can be **accepted**.

5.2 Hypothesis 2: The Effect of Contextual Relevance Differences on Web Attractiveness and Trust

Based on the results of the study, it can be seen that the different types of contextual relevance have different effects on the attractiveness of the stalls and consumer confidence in the website. These results are based on the results of testing using MANOVA which shows that there are significant differences in the main effects of contextual relevance on Web Attractiveness and consumer confidence in the website. Thus, hypothesis 3 and hypothesis 4 can be **accepted**.

5.3 Hypothesis 3: Relationship between Web Attractiveness and Trust

The results of the study using a simple linear regression test resulted in the finding that web attractiveness can positively affect trust. This means that the higher the Web Attractiveness of consumer trust on the website will also be high. And vice versa if the Web Attractiveness is low, the consumer's trust in the website is getting lower as well. This finding is supported by the findings of Orth & Wirtz (2014) which found that the more the website is able to meet consumer needs, the more attractive the website is and will increase the likelihood that it will be a choice again for consumers. Research also reveals that with the availability of elements that can meet consumer needs, perceptions that arise in the minds of consumers can be formed. The emergence of the perception that the webiste can meet consumer needs can increase consumer trust.

5.4 Hypothesis 4: Relationship between Web Attractiveness and Online Purchase Intention

The results of tests conducted using multiple linear regression show that consumer trust has a positive and significant effect on online purchase intention on the website so that hypothesis 7 is **supported**. This result is supported by Hong and Cho (2011) who found that the trust perceived by consumers is important in determining online purchase intentions. Evaluation of the consumer's trust on the stimuli received can shape the consumer's response to do something. In the research of Gupta et al. (2009) found that the consumer's perspective on trust can determine the final purchase decision between buyers and sellers.

6. CONCLUSIONS

This study used a 2 x 2 factorial design and used a random assignment technique to 160 participants. The study began by conducting pre-tests and trials to ensure that the participants understood the stimuli that had been prepared. In the main effect, it was found that the use of high-type visual complexity resulted in higher web attractiveness and trust. As well as on contextual relevance, it was found that there was a difference between the attractiveness and trustworthiness of the web. Website views that display views that have informational linkages between images and descriptions result in higher web attractiveness and trust. In addition, in the study, it was found that the attractiveness of the web and the positive influence of trust on online purchase intentions.

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SUPPLIER RELATIONSHIP MANAGEMENT MATURITY LEVEL ASSESMENT: CASE STUDY PT PJB UNIT PEMBANGKITAN GRESIK

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ABSTRACT

Supply chain management plays an important role in supporting the performance of a company, including companies in the power generation industry. Relationships with suppliers as one of the stakeholders in the supply chain management business process need to be managed properly and effectively in the Supplier Relationship Management (SRM) program in order to provide benefits for the company. The SRM program is implemented in several activities, namely Supplier Segmentation, SRM Governance, Supplier Performance Management, Supplier Development, and Risk Management. Several studies were conducted with the big theme of SRM with various perspectives and focuses, including the preparation of information system architecture as the ultimate research goal, the value the company wants to achieve through SRM implementation, and segmentation based on the process capability index. In practice, several companies have not implemented an effective SRM program, so that suppliers are still managed in response to deviations from performance targets. This SRM research was conducted using a qualitative method by obtaining SRM implementation level data based on implementation measurement instruments compiled by researcher based on literature review and validated by experts. This study aims to evaluate the effectiveness of the implementation of the SRM program, to then be used as the basis for the formulation of the SRM program to be recommended to power generation companies. Implementation measurement shows that Supplier Selection and Segmentation and Risk Management have the lowest results, so they need to be developed. With the formulation of the recommended SRM program, the SRM program can facilitate and make the process more effective between the company and its suppliers. So that it can improve the quality and performance of the company through constructive collaborative relationships with suppliers.

Keywords: supplier relationship management measurement, segmentation, srm activity

1. INTRODUCTION

The supplier as one of the stakeholders for PT PJB plays an important role in achieving key performance indicators for PT PJB, especially the Unit Pembangkitan Gresik. Good supplier performance will be able to help the Supply Chain Management Division to meet the service level of meeting material needs, the Maintenance Division to meet the maintenance program targets, and from the Operations Division to meet the generation unit readiness and reliability targets. So

overall, good performance from suppliers will make a positive contribution to the achievement of key performance indicators of PT PJB Unit Pembangkitan Gresik.

With the important role of Supply Chain Management in supporting the achievement of the performance of the generation unit, the aspects in it need to be managed and planned properly, including the Supplier Relationship Management program. But on the other hand there are conditions where there is no systematic Supplier Relationship Management program including supplier segmentation, Supplier Relationship Management Governance, Performance Management, Supplier Development and Risk Management, so this study has the interest of proposing a Supplier Relationship Management program in order to increase the effectiveness of supplier management implementation.

2. LITERATURE REVIEW

Mettler & Rohner (2009), Supplier Relationship Management (SRM) is a comprehensive approach that aims to improve cooperation (business relationship level), coordination (process level) and communication (information systems level) between companies and suppliers in order to increase efficiency and overall success continuously by collaboration and improving quality, safety and innovation. Researchers including Stuart (1993), Dyer & Ouchi (1993), Ellram & Edis (1996) and Wong (2002) provide empirical evidence in their respective studies which can be concluded that partnership can be a core competency and a source of competitive advantage. Thus it is necessary to change the relationship with suppliers into a collaborative and long-term relationship. Larson & Kulchitsky (2000) state that stronger relationships in the form of Supplier Relationship Management can improve supplier performance in terms of lead-time execution. Meanwhile, Martin & Grbac (2003) highlight the benefits of Supplier Relationship Management in terms of increasing supplier responsiveness and loyalty to the company.

Deloitte (2015) in its publication explains that there are four effective Supplier Relationship Management program activities, namely Supplier Segmentation, Governance, Supplier Performance Management, and Supplier Development. Supplier segmentation is the process of categorizing suppliers based on certain criteria to develop an effective Supplier Relationship Management program, Pujawan & Mahendrawati (2010). Pujawan, I N., and Mahendrawati Er. in his book Supply Chain Management 3rd Ed, based on the level of importance of the material and the difficulty of obtaining material, they grouped suppliers into non-critical suppliers, bottleneck suppliers, leveraged suppliers, and critical strategic suppliers.

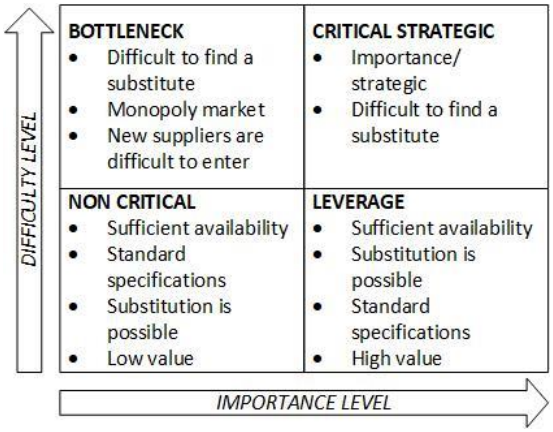

Figure 1. Supplier Segmentation

Supplier Relationship Management Governance is a series of activities to place Supplier Relationship Management in stages at every line and level, so that there is a more structured and

effective relationship. Rantonen (2017), in Supplier Relationship Management Governance, a mature governance structure encourages value creation through collaboration.

To manage supplier performance, the supplier's performance must first be measured. Park et al. (2010) stated that the specific purpose of Supplier Relationship Management is to build a two-way performance management system that is proactive and produces continuous improvement for suppliers. Supplier performance management is a series of arrangements and continuous monitoring of commercial or operational actions that have been mutually agreed with suppliers. Supplier performance management must also be able to identify deviations from the minimum performance criteria that have been agreed in advance and document in supplier performance assessments. Supplier Performance Management in its operational activities is able to encourage increased fulfillment of goods in terms of timeliness, quality of goods, and prices.

Supplier development can also be an incentive for suppliers, because by increasing their performance capabilities, suppliers can also create value for other customers and increase their competitiveness against competitors. Wagner (2006), states that supplier development is one of the important activities in Supplier Relationship Management. Fogg (2009), that risk management is a series of processes of recognizing risks and efforts to maximize the possibility of certain risks and the impact on the company in this case the supply chain manager if the risk actually occurs.

Literature 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.

Correspondingly, the references should be listed based on alphabetical order of the first author's last name. See examples at the end of these guidelines.

3. METHODS

This research was conducted using a qualitative research method where primary data was obtained from semi-structured interviews with executors and decision makers in the Supply Chain Management business process and other related business processes. Heriyanto (2018), a study conducted with qualitative methods has the characteristics of a study that aims to explore and tell the experience of someone involved in an incident. For this reason, the research steps are arranged as shown in the following figure.

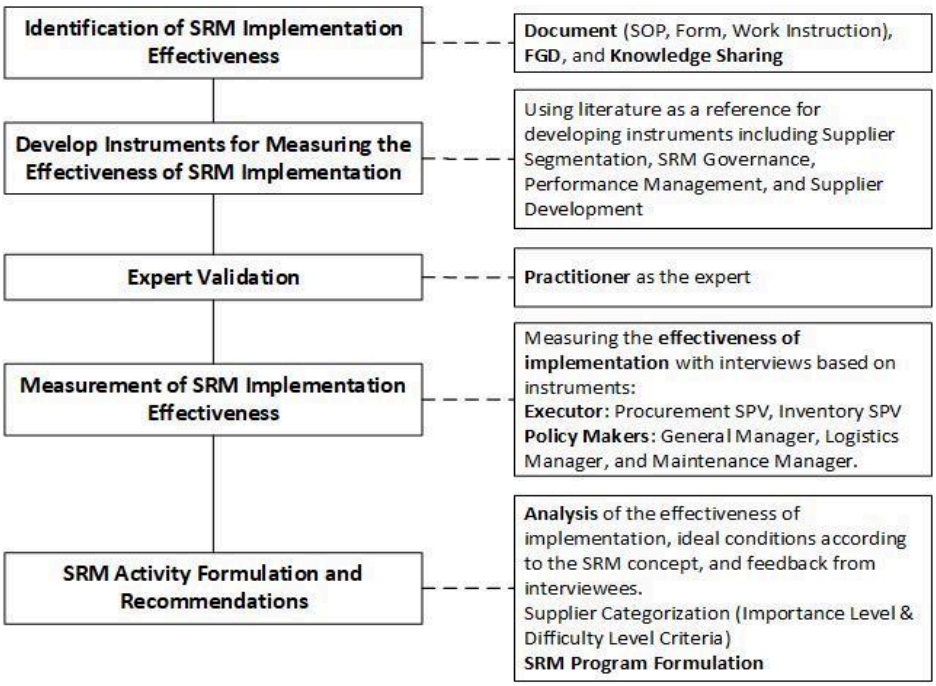

Figure 1. Step of Research

The first stage of this research is to identify the implementation of Supplier Relationship Management at PT PJB Unit Pembangkitan Gresik. At this stage, information and data are needed on how the Supplier Relationship Management is managed, along with the existence of the organizational structure, the mechanism for managing programs and activities, and supplier development activities. The information and data are obtained from company sources in the form of work instruction documents, standard operating procedures, supplier performance appraisal forms, and company performance contracts. In the next stage, the instruments are prepared that will be used as the basis for measuring the effectiveness of the implementation of Supplier Relationship Management at PT PJB Unit Pembangkitan Gresik. The measurement instrument developed in the form of a maturity level related to the effectiveness of the implementation of the Supplier Relationship Management program at PT PJB Unit Pembangkitan Gresik. This measurement instrument is composed of themes in the Supplier Relationship Management program, namely supplier segmentation, Supplier Relationship Management Governance, supplier performance management, supplier development, and risk management. The third stage is expert validation of the Supplier Relationship Management measurement instrument. The purpose of expert validation at this stage is to ensure that the Supplier Relationship Management measurement instrument that has been compiled can produce the information and data needed in this study. With the right information and data through expert validation, it is hoped that the right Supplier Relationship Management program can be formulated to be implemented at PT PJB Unit Pembangkitan Gresik.

Measurement of the Supplier Relationship Management implementation will be carried out using a semi-structured interview method based on the instrument for measuring Supplier Relationship Management implementation effectiveness. The purpose of the semi-structured interview method is to explore information and data on the implementation of the Supplier Relationship Management program which includes supplier segmentation, Supplier Relationship Management Governance, supplier performance management, supplier development and risk management, along with constraints, benefits, and values desired from the Supplier Relationship

Management program at PT PJB Unit Pembangkitan Gresik. Eisenhardt (1989) in Ha (2015) states that 'analyzing data is at the heart of building theory from case studies'. Therefore, this is the most difficult and important step in any research. In this study, data collection techniques in the form of semi-structured interviews with executors and policy makers at the company strongly support the analysis process. In the literature review section on activities in the Supplier Relationship Management program, it is a step to understand and identify important activities in order to obtain a Supplier Relationship Management program capable of increasing the effectiveness of implementation.

The Supplier Relationship Management program will be formulated based on the supplier categorization that has been carried out previously by taking into account the feedback provided by the executors and implementation policy makers at the stage of measuring the effectiveness of the implementation of Supplier Relationship Management. So that the Supplier Relationship Management program that is formulated is adjusted to the criteria in each supplier category

4. RESULTS

Based on the preparation of the Supplier Relationship Management measurement instrument and expert input at the expert validation stage, the measurement instrument includes the following themes and sub-themes. The theme of Supplier Selection and Segmentation is indicated through the sub-themes of supplier selection criteria, selection methods and supplier search techniques, and supplier categorization. Meanwhile, the theme of Supplier Relationship Management Governance is indicated by the sub-themes of the organizational structure of Supplier Relationship Management, Supplier Relationship Management, and management support for Supplier Relationship Management. Furthermore, the Supplier Performance Management theme is indicated through supplier performance monitoring, supplier performance assessment KPIs, reward and punishment and contract management. The next theme, namely Supplier Development, can be measured through the sub-themes of supplier development programs, feedback from suppliers, and proactive efforts to prevent problems. While the last theme, namely risk management, is divided into three sub-themes, namely internal risk, external risk, and supply chain risk in the COVID-19 pandemic.

The indicators in the sub-themes are measured on a scale of 1 to 5, where at each level a description of the conditions, attachments/supporting documents, and opportunities for improvement are given. So that it can provide a valid description of the implementation of Supplier Relationship Management at PT PJB Unit Pembangkitan Gresik. Attachments or supporting documents are documentation that can provide validation or support for the description of the previously described level criteria. Meanwhile, the opportunity for improvement is the opinion or expectation of the resource persons on development opportunities in each theme or sub-theme so that they can improve performance in the implementation of Supplier Relationship Management.

Table 1. Result of Measurement

Theme		Sub Theme		Result
T1	Supplier Selection and Segmentation	1.1	Supplier Selecting Criteria	4
		1.2	Supplier Selection dan search	5
		1.3	Supplier Categorization	3
T2	SRM Governance	2.1	SRM Organization	4
		2.2	SRM Governance	5
		2.3	Managerial Support	4

T3	Supplier Performance Management	3.1	Supplier Performance Monitoring	4
		3.2	Supplier KPI	5
		3.3	Reward and Punishment	5
		3.4	Contract Management	3
T4	Supplier Development	4.1	Supplier Development	4
		4.2	Supplier feed back	5
		4.2	Proactive efforts to prevent problems	4
T5	Risk Management	5.1	Internal Risk	4
		5.2	External Risk	3
		5.3	Supply Chain Risk by COVID-19 Pandemic	2

Based on the measurement results in Table 1 and Table 2, the Risk Management theme is the theme with the lowest measurement results. The Risk Management theme has three sub-themes, namely Internal Risk, External Risk and Supply Chain Risk in the COVID-19 Pandemic. Internal risk has been well managed in the implementation of Supplier Relationship Management at PT PJB Unit Pembangkitan Gresik, which is indicated by the existence of risk mapping in business processes through Hazard Identification Risk Assessment and Risk Control (HIRARC), ICOFR, and Monitoring of the Work Plan and Budget Unit (RKAU)). Monitoring RKAU is an important aspect of risk identification in the implementation of Supplier Relationship Management, because it is carried out regularly every month involving the fields of logistics, maintenance, and engineering. However, RKAU monitoring is not specifically part of the Supplier Relationship Management program.

On the external risk side, it has only been carried out to identify, measure and mitigate risks, while management and monitoring have not been carried out fully because they involve suppliers who are outside the full control of the company. Meanwhile, supply chain risk in the COVID-19 pandemic is carried out at the identification and measurement stage. These two things are done to determine the scenario of the procurement process in the form of avoiding or accepting risks that have the potential to occur.

The second theme that needs to be improved is Supplier Selection and Segmentation which gets a measurement result of 4.00. If identified based on the sub-theme, then the supplier categorization becomes the sub-theme with the lowest value, this indicates that there is no supplier categorization based on certain criteria and is used as the basis for decision making and the preparation of the Supplier Relationship Management program.

Table 2. Theme Result of Measurement

Theme		Result
T1	*Supplier Selection and Segmentation*	4,00
T2	*SRM Governance*	4,33
T3	*Supplier Performance Management*	4,25
T4	*Supplier Develoment*	4,33
T5	*Risk Management*	3,00
Average		3,98

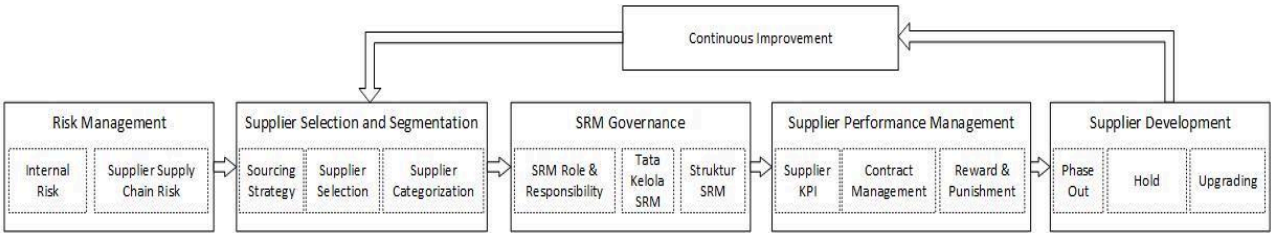

Figure 1. SRM Framework Proposed

Based on the results of the identification and measurement of risks from the internal and supply chain sides, activities and sub-activities are determined in the next theme, namely Supplier Selection and Segmentation, which consists of sub-themes of sourcing strategy, supplier selection and supplier categorization. Furthermore, Supplier Relationship Management Governance is organized into three sub-themes, namely Supplier Relationship Management Role and Responsibility, Supplier Relationship Management Governance and Supplier Relationship Management Structure. The next theme is Supplier Performance Management which consists of sub-themes Supplier Key Performance Indicator, Contract Management and Reward and Punishment.

Based on the results of performance measurements in the previous theme, activities were carried out on the Supplier Development theme which consisted of three sub-themes, namely phase out for suppliers who had poor performance and could not be maintained, then hold for suppliers who showed average performance and tended to be stable, and upgrading for suppliers who can contribute more through a better cooperation scheme with the company.

6. CONCLUSIONS

The Supplier Relationship Management program which is formulated based on the identification and evaluation of the measurement results of the implementation of Supplier Relationship Management at PT PJB Unit Pembangkitan Gresik is able to provide a broader perspective in managing relationships with suppliers based on risk management in the supply chain, so that it has the possibility of improving the quality of relationships between companies. and suppliers that will have an impact on the company's overall performance in achieving the company's performance contracts. This is in line with the research results of Mettler & Rogner (2009), where the purpose of Supplier Relationship Management is to facilitate and make the process more effective between the company and its suppliers. So in general, Supplier Relationship Management aims to improve the quality and performance of the company through constructive collaborative relationships with suppliers.

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Prediction Of Product Defects in Production Lines With Recurrent Neural Network(RNN) And Bayessian Optimization Approach as Optimization Models:

Case Study of PT XYZ

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ABSTRACT

To maintain product quality, the company must control product quality every day. One way to control product quality is to reduce the presence of defective products, identify the main factors causing them and take corrective actions as the next step. PT XYZ has taken quality control measures by conducting root-cause mapping and action plans to reduce the number of product defects. Still, the number of product defects continues to increase. This results in longer production times and higher costs. To reduce the number of product defects, a prediction of the number of product defects and the factors that affect them will be made using machine learning using product defect data from 2016 – 2021 to predict future defects. The primary machine learning model that will be used is the Recurrent Neural Network (RNN) with its architecture, namely the Gated Recurrent Unit (GRU). The reason for choosing this model is because of the Recurrent Neural Network (RNN) because it is simpler and faster when the training iteration process takes place. It has a memory that contains temporal information from the input data, making it suitable for problems regarding time series. In addition, Bayesian Optimization is used to determine the best parameters for the Recurrent Neural Network (RNN) model. So that a model can be obtained that gives better accuracy results. The results of this study are in the form of documents using the Recurrent Neural Network (RNN) model with its architecture, namely Gated Recurrent Units (GRU) and its optimization model, namely Baesiyyan Optimization, to determine the number of product defects in the future. The results of using the GRU and GRU models with Bayesian Optimization prove that the results of the GRU model tend to be quite good, it can be seen from the MAE, and RMSE values at 3556.4 and 7806, respectively, compared to data testing or validation carried out in the field or using original data. . The results of the Optimization of the GRU model using bayesian Optimization obtained each parameter, namely: activation function = eLu, Number RNN Layers = 12, Dropout = 0.0, Number Units = 64 and Learning Rate = 0.001. The above parameter testing found that the MAE and RMSE values were better than the Normal GRU, which were 1608 and 2046, respectively. From these results, the GRU with the Bayesian Optimization model will be selected to continue for future prediction data.

Keywords: Machine Learning, Defect Product, Recurrent Neural Network (RNN), Gated Recurrent Units (GRU) ,Bayessian Optimization

1. INTRODUCTION

Product quality is an essential requirement that companies must meet to produce goods and services to achieve customer satisfaction. There are 9M that directly affect the quality of products and services, namely: Market (market), Money (money), Management (management), Man (human), Motivation (motivation), Material (Material), Machines, and Mechanization (machinery and mechanization), Modern Information Methods (modern information methods), Mounting Product Requirements (production process requirements)[1]. Companies must carry out product quality control every day to maintain quality products. One way to control product quality is to minimize product defects, identify the factors, and take corrective action as the next step.

PT. XYZ is a company engaged in manufacturing plastic packaging. There are five processes carried out at PT XYZ: Blow Molding, Injection Molding, Stamping, Printing, and Assembly. At each cycle, quality control is carried out by PT XYZ by paying attention to product records. The quality division has carried out quality control measures with root-cause mapping and action plans to reduce product defects. In addition, the quality division also routinely conducts audits by recording problems in each process. However, based on historical data collected, the number of product defects increases. From the beginning of January 2021 to June 2021, the number of product defects touched 1400 pcs, or every month the average percentage increase was up to 8%. The high number of defective products produced requires the quality division to conduct strict sampling checks and rework unsuitable product components. It impacts the length of processing time. This proves that the level of effectiveness of quality control is still far from being effective.

In maximizing quality control, PT XYZ can see the prediction of the number of defects in the future and what factors will affect it. One way to find out is to automate data analysis with machine learning. According to Russel & Norvig, machine learning can be defined as the application of computers and mathematical algorithms adopted utilizing learning that comes from data and produces predictions in the future [2]. ne of the surveys conducted by Algorithm on 750 companies that implement machine learning stated that as many as 38% answered that machine learning helps reduce costs. As many as 37% can provide accurate customer information [3]. This proves that machine learning can produce data to support the decision-making process.

To support the need for planning for making good machine learning, data and the use of the correct model are needed to provide accurate results. The model used is the Recurrent Neural Network (RNN) method with its optimization model, namely Bayesian Optimization, to provide the best parameters. The advantage of the Recurrent Neural Network (RNN) method is that the RNN model has a memory that contains temporal information from the input data, making it suitable for time-series problems [4]. RNN has also been extensively researched for time-dependent data analysis [5]. The choice of Bayesian Optimization was based on one of the studies to predict product defects in Injection Molding, which gave an increase in model accuracy of up to 11% [6]. Machine Learning will be carried out to predict the number of product defects at PT XYZ by using data from the company in the future.

The results of this study are in the form of documents using the Recurrent Neural Network (RNN) model with the Gated Recurrent Unit (GRU) architecture along with its optimization model, namely Baesiyyan Optimization to determine the number of future product defects and the factors that influence it. It is hoped that the results of this research can be used by PT XYZ companies in the same field for similar applications and as facts to support other research activities.

2. METHODS

2.1 Data Gathering

In this study, the data gathering process is divided into two sources. The first type is sourced from the company's excel local drive data with time dimensions from 2016 - to 2018. The second type is sourced from SQL Server with time dimensions from 2018 - to 2021. From these two data sources, the data will be combined using Microsoft Excel to become one unit with the time dimension from 2016 to 2021.

2.2 Data Pre-Processing

The processing is carried out from all the data obtained to be consistent and integrated. The output of the Pre-Processing stage itself is data ready to be modeled using GRU and Bayesian Optimization.

2.2.1 Data Cleaning

The data cleaning process is carried out to clean the data so that all attributes and data columns are consistent. The purpose of data cleaning is to ensure that there are no outliers in the data that can worsen the model quality. From this research, several treatment plans that will be carried out in the data cleaning process include changing the NAN value to zero, eliminating data duplication, and deleting unnecessary columns.

2.2.2 Data Transformation

In the data transformation process. Some of the treatments carried out are aggregating from the beginning. The column is divided by machine. The date and shift will be changed to per date because it relates to the main objective, namely forecasting based on time series data. The output of the data transformation is that the placement of each column is correct, and the contents of each column are by the data type of that column.

2.2.2 Feature Engineering

Some of the activities of feature engineering are looking at the series plot of the original data and choosing which columns to target features and which columns not to use. The output of the feature engineering process is that the data is just running or is ready to enter the model development stage; besides that, the information is also prepared to be split into training data and testing data.

2.2.2 Data Splitting & Normalization

The data splitting stage is carried out to ensure the data is divided clearly for the training and testing process. In this study, the training data distribution is 80% and testing 20%; the total information is 2182 rows. The data will also be normalized to ensure that the data distribution can be uniform—normalization calculation using the Min-Max formula in equation 1 [7].

$$x' = \frac{x - min\ (x)}{max(X) - min\ (x)} \quad (1)$$

2.3 Model Development

After being divided into training data and testing data, the training data will be processed for model making. The model used is Recurrent Neural Network (RNN) with its architecture, namely Gated Recurrent Units (GRU). The GRU functions are taken from the Tensorflow library

and hard. The output of this stage is that a benchmark model is obtained to be compared with the optimization model.

2.3.1 Gated Reccurent Unit(GRU)

After being divided into training data and testing data, the training data will be processed for model making. The model used is Recurrent Neural Network (RNN) with its architecture, namely Gated Recurrent Units (GRU). The GRU functions are taken from the Tensorflow library and hard. The output of this stage is that a benchmark model is obtained to be compared with the optimization model [8]. An illustration of the GRU method can be seen in Figure 1

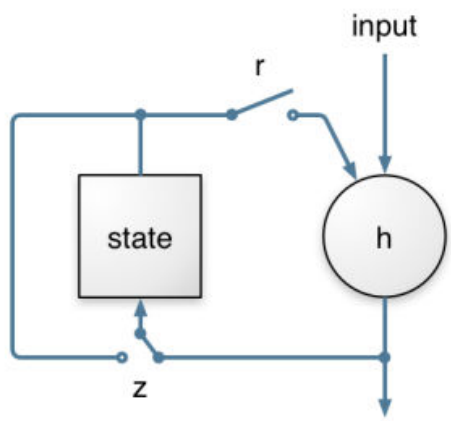

Figure 1 GRU Method

In the GRU method, there are two gates, namely the reset gate 'r' and the update gate 'z,' used to form the hidden state 'h.' The update gate is used to determine how much past (previous) information should be kept. At the same time, the reset gate is used to decide how much past information to delete and determine how to combine the new input with the past (previous) information. Equation 2, Equation 3, and Equation 4 below are the formulas in the GRU method.

1. Update Gate

$$zt = \sigma g\ (Wz\ xt + Uz\ ht{-}1 + bz) \quad (2)$$

2. Reset Gate

$$rt = \sigma g\ (Wr\ xt + Ur\ ht{-}1 + br) \quad (3)$$

3. Hidden State

$$ht = (1 - zt\ ) \circ ht{-}1 + zt \circ \sigma h\ (Wh\ xi + Uh\ (rt \circ ht{-}1\ ) + bh) \quad (4)$$

In the model the author randomly determines these parameters as the benchmark model, with the model specifications as below:

• Activation Function = ReLU
• Units = 64
• Drop out = 0.2
• Dense Unit = 1
• Epoch = 20
• Optimizer = adam

• Learning rate = 0.1

2.4 Model Optimization

After randomly benchmarking the GRU model from determining parameters, the next step will be to optimize the model parameters using Bayesian Optimization. The parameter information that has the minor validation loss will be obtained.

2.4.1 Bayessian Optimization

Bayesian Optimization is often used in machine learning to adjust the hyperparameters of a given well-performing model in the validation dataset [9]. To select the hyperparameters from subsequent experiments, one can optimize the expected increase (EI) over the current best yield over the bound Gaussian process (UCB) [10]. Bayes's rule uses prior priors to calculate possible posteriors. Bayesian Optimization is referred to as a representation of the Bayes' rule and is represented in Equation 5

$$P\,(score \mid hyperparameters\,) \qquad (5)$$

The Bayesian method works by considering the results of the previous iteration. Therefore, the optimal point is much more optimal than the sampling of the random parameter. Several parameters will be tested, namely Activation function, Number RNN Layers, Dropout, Number Units, and Learning Rate. Each parameter is determined by the range of numbers or types being tested. The following is an explanation of each parameter:

- **Activation Function**
  In the activation function, there are five types of parameters to be tested, namely ReLu, TanH, Linear, SeLu, and Elu. The process makes the neural network non-linear.
- **Number rnn layers**
  The number of layers to be tested is in the range of 0 - 12
- **Dropout**
  The Dropout that will be tested is in the number 0 – 0.99. The number of outputs that will be generated in the learning process.
- **Num_units**
  Several units are to be tested on numbers 0 – 64. Amount of memory to be used
- **Learning Rate**
  Learning rate ranges 1e-2, 1e-3, 1e-4.

And a trial will be carried out 3 times in the implementation of the trial.

2.5 Model Selection & Evaluation

After knowing the information on using the best parameters, the next step is to apply these parameters to retrain data using the training and testing data shared earlier. The output of this process is that we know the MAE and RMSE values of each model. The MAE method is generally used to check the estimation of the error value in forecasting. The MAE formula can be seen in Equation 6

$$MAE = (1/n) * \Sigma|y_i - x_i| \qquad (6)$$

In measuring the prediction model's performance, the Root Mean Square Error (RMSE) calculation method is used, which is the value of the root of the average value of the error that has been squared. A low RMSE value indicates that the predicted value (output) is close to the variation in the actual value (target). The RMSE formula can be seen in equation 7.

$$RMSE = \sqrt{1/n \sum (yi - \hat{y}i)^2} \quad (7)$$

Comparison will also be seen from the graph plot of the two model models close to the testing data line; the model is undoubtedly good. Otherwise, if the training data results move away from the testing data, the model is less accurate. This model will be used to predict defective products in the future**.**

3. RESULTS & ANALYSIS

The result of the model selection is that we compare the two models that have been developed and then choose the smallest MAE and RMSE.

3.1 Model GRU

In the normal GRU model, the difference between train loss and validation loss is quite different, but as the iteration process or epoch increases, both train loss and validation loss tend to decrease significantly. The use of Learning rate is 0.01. Detailed images of the results of the GRU model train and validation loss model can be seen in *Figure 2*.

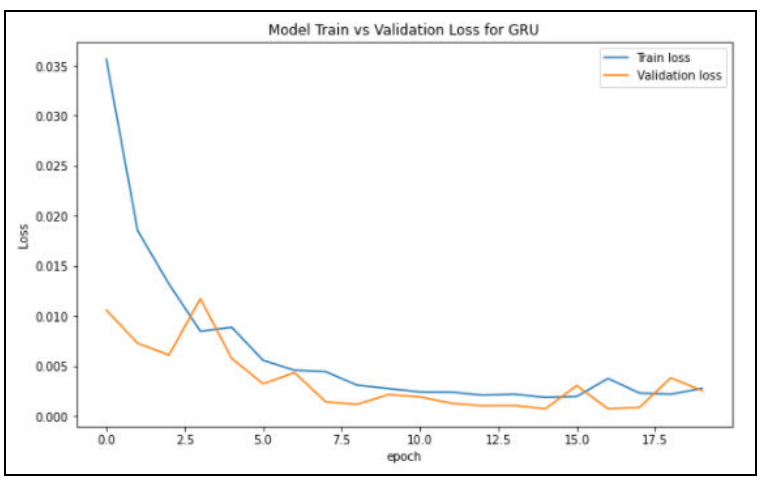

Figure 2 Train Loss vs Validation Loss Model GRU

In the iteration experiment on the GRU model, of the 20 iterations tested, the smallest train loss and validation loss numbers touch the numbers 0.0022 and 0.0007, respectively. The iteration process can be seen on Figure 3

```
Epoch 1/20
88/88 [==============================] - 6s 38ms/step - loss: 0.0357 - val_loss: 0.0106
Epoch 2/20
88/88 [==============================] - 3s 35ms/step - loss: 0.0185 - val_loss: 0.0073
Epoch 3/20
88/88 [==============================] - 3s 32ms/step - loss: 0.0132 - val_loss: 0.0061
Epoch 4/20
88/88 [==============================] - 3s 31ms/step - loss: 0.0085 - val_loss: 0.0117
Epoch 5/20
88/88 [==============================] - 3s 33ms/step - loss: 0.0089 - val_loss: 0.0057
Epoch 6/20
88/88 [==============================] - 4s 42ms/step - loss: 0.0056 - val_loss: 0.0032
Epoch 7/20
88/88 [==============================] - 4s 46ms/step - loss: 0.0046 - val_loss: 0.0043
Epoch 8/20
88/88 [==============================] - 4s 42ms/step - loss: 0.0044 - val_loss: 0.0014
Epoch 9/20
88/88 [==============================] - 3s 33ms/step - loss: 0.0031 - val_loss: 0.0012
Epoch 10/20
```

Figure 3 Iteration Process Model GRU

In the test data and prediction results of the GRU Model, as long as the graph of the predictive data plot tends to follow the test data plot or the original data, there are several days that affect the prediction results, namely on days 100 - 140, causing GAP which makes GRU's performance less good. Detailed pictures can be seen on *Figure 4*.

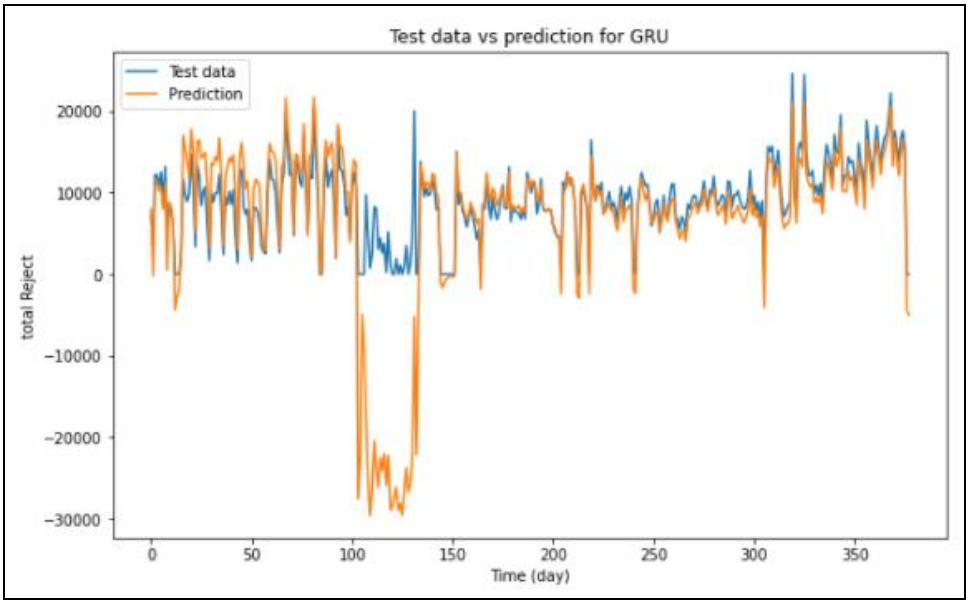

Figure 4 Test Data vs Prediction Model GRU

RMSE and MAE results from the GRU Model can be seen in *Table 1*

Table 1 MAE & RMSE Score GRU Model

Formula	Score
MAE	3356
RMSE	7806

3.2 Model GRU with Bayessian Optimization

The test results of the Bayesian optimization model can be seen in *Table 2*. From the 3 trial results, the best parameter results are in trial 1, namely: activation function = eLu, Number RNN Layers = 12, Dropout = 0.25, Number Units = 7 and Learning Rate = 0.01. In trial 1 it has a score of 6.94853, then in trial 2 it has a score of 0.0014 while in trial 3 it has a value of 0.01390.

Table 2 Trial Model GRU Bayessian Optimization

Parameter	Trial 1	Trial 2	Trial 3
Activation Function	elu	Linear	TanH
Number RNN Layers	12	11	9
Dropout	0.25	0.16	0.58
Number Units	7	17	1
Learning Rate	0.01	0.01	0.01
Score Total	6.94853	0.0014	0.01390

In the GRU model with bayessian optimization, the difference between train loss and validation loss is much better. The increasing number of epochs will be in line with the decreasing train loss and validation loss. Detailed figire can be seen in

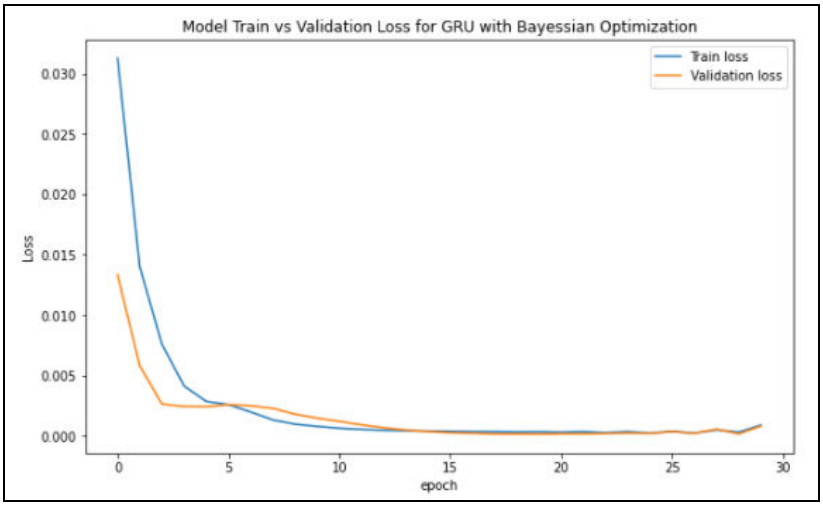

Figure 5 Model Train vs Validation Loss with Bayessian Optimization

In 50 iteration experiments carried out on the Bayessian optimization train loss model and the smallest validation loss, each touched the numbers 0.0122 and 0.0009. These results are better than the GRU model, which only touch the numbers .0022 and 0.0007, respectively. A snippet of the iteration process of the Bayessian optimization GRU model can be seen in *Figure 6*.

```
Epoch 1/50
88/88 [==============================] - 3s 18ms/step - loss: 0.0313 - mean_absolute_error: 0.1335 - val_loss: 0.0133 - val_mea
n_absolute_error: 0.0908
Epoch 2/50
88/88 [==============================] - 1s 16ms/step - loss: 0.0140 - mean_absolute_error: 0.0907 - val_loss: 0.0058 - val_mea
n_absolute_error: 0.0571
Epoch 3/50
88/88 [==============================] - 1s 17ms/step - loss: 0.0076 - mean_absolute_error: 0.0675 - val_loss: 0.0026 - val_mea
n_absolute_error: 0.0405
Epoch 4/50
88/88 [==============================] - 1s 16ms/step - loss: 0.0041 - mean_absolute_error: 0.0491 - val_loss: 0.0024 - val_mea
n_absolute_error: 0.0425
Epoch 5/50
88/88 [==============================] - 1s 17ms/step - loss: 0.0029 - mean_absolute_error: 0.0401 - val_loss: 0.0024 - val_mea
n_absolute_error: 0.0422
Epoch 6/50
88/88 [==============================] - 1s 17ms/step - loss: 0.0026 - mean_absolute_error: 0.0374 - val_loss: 0.0026 - val_mea
n_absolute_error: 0.0429
Epoch 7/50
88/88 [==============================] - 1s 16ms/step - loss: 0.0020 - mean_absolute_error: 0.0320 - val_loss: 0.0025 - val_mea
n_absolute_error: 0.0439
Epoch 8/50
88/88 [==============================] - 1s 17ms/step - loss: 0.0013 - mean_absolute_error: 0.0262 - val_loss: 0.0023 - val_mea
n_absolute_error: 0.0434
Epoch 9/50
88/88 [==============================] - 1s 17ms/step - loss: 9.7487e-04 - mean_absolute_error: 0.0226 - val_loss: 0.0018 - val
_mean_absolute_error: 0.0388
Epoch 10/50
88/88 [==============================] - 1s 17ms/step - loss: 7.9564e-04 - mean_absolute_error: 0.0204 - val_loss: 0.0015 - val
_mean_absolute_error: 0.0351
Epoch 11/50
88/88 [==============================] - 1s 17ms/step - loss: 6.3546e-04 - mean_absolute_error: 0.0183 - val_loss: 0.0012 - val
_mean_absolute_error: 0.0318
```

Figure 6 GRU Model Literacy Process with bayesian optimization

In the comparison of testing tests, we can see the plots for each of the testing data and the prediction data do not experience a significant difference, the movement of the average prediction plot has followed the movement of the testing data. Detailed picture of test data and prediction of GRU model with bayessian optimization can be seen in *Figure 7*.

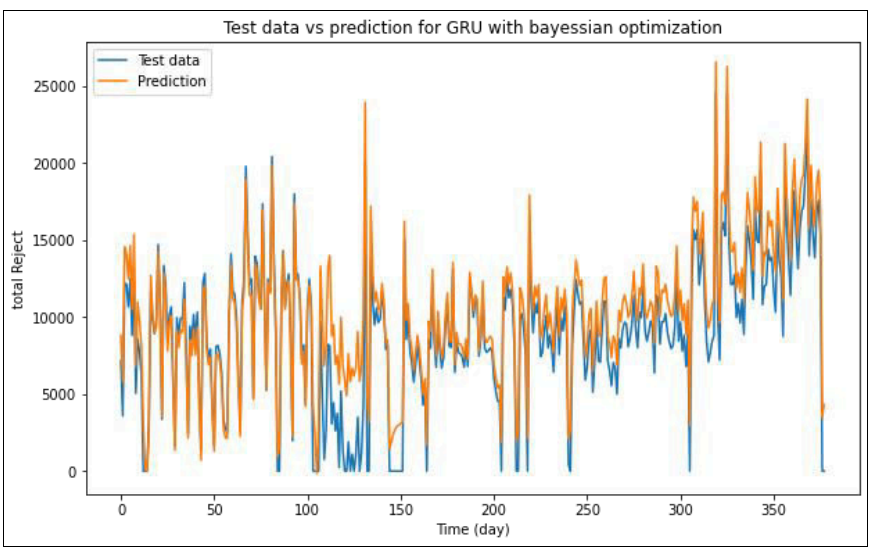

Figure 7 test data and prediction Model GRU with bayessian optimization

RMSE and MAE results from the GRU Model with bayessian Optimization can be seen in *Table 3*

Table 3 MAE & RMSE Score GRU Model with Bayessian Optimization

Formula	**Score**
MAE	1608
RMSE	2046

3.2 Model Selection & Evaluation

From the test results of the two models in the *Table 4*, it is found that the GRU with Bayessian optimization model has MAE and RMSE values which are much smaller than the MAE and RMSE scores of the normal GRU model. From these results, the next step is to carry out a multi-step forecasting process in accordance with the company case study

Table 4 Comparison of MAE dan RMSE of each model

Model	MAE	RMSE
GRU	3356	7806
GRU with Bayessian Optimization	1608	2046

4. CONCLUSIONS

In general, the stages carried out in this research include gathering data sourced from local excel and SQL Server, pre-processing or processing the data that has been obtained, model development, model optimization, model selection and ending with model implementation. The main purpose of this study is to determine the total number of defective products that occur in the company PT XYZ in the future. In conducting this research there are lessons learned by researchers. The following are the lessons learned:

1. Model development is carried out with the aim of being able to accurately predict the future. The results of the prediction data can be used by PT XYZ and researchers as a reference for conducting further studies. Then proceed with model optimization to get the best model obtained using the Bayessian optimization method, then iterate several parameters to get the best parameters. So that the model can be continued for data prediction for the next 30 days starting from January 1 - 31, 2022. The results of data analysis and data prediction are as follows:
    a. The trend of defective product data from 2016 to 2021 is very volatile, some certain periods such as in May-June can be very down because the average production process stops because there are big holidays. Then followed by September – December, the cumulative trend of data tends to increase because the production process is also busy in these months. Some of these periods can be said to experience seasonal data.
    b. The results of the GRU model tend to be quite good, as can be seen from the MAE and RMSE values at 3556.4 and 7806, respectively, compared to testing or validation data carried out in the field or using original data.
    c. The results of the optimization of the GRU model using bayessian optimization obtained each parameter, namely: activation function = eLu, Number RNN Layers = 12, Dropout = 0.0, Number Units = 64 and Learning Rate = 0.001. From the above parameter testing, it was found that the MAE and RMSE values were better than the Normal GRU, which were 1608 and 2046, respectively. From these results, the GRU

with Bayessian Optimization model will be selected so that it can be continued for future prediction data.

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OPTIMIZATION OF THE UTILIZATION OF WIDE BODY AIRCRAFT HANGAR BASE MAINTENANCE SLOTS USING THE INTEGER PROGRAMMING METHOD

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ABSTRACT

The global trend for wide-body aircraft maintenance in the Asia Pacific area is growing as the area offers lower labor costs and a wider workshop capacity. At the same time, turn-around-time (TAT) and logistical factors such as spare parts are proved to be very challenging these days. This study aims to maximize the available hangar slots to fulfill the heavy maintenance of wide-body aircraft based on a case study of Maintenance, Repair, and Overhaul Organization (MRO) hangar slot availability at PT. XYZ in Indonesia. Optimization is done through integer programming using two stages of modeling. The first model determines the placement of aircraft in hangar slots and the second model determines the scheduling of all accommodated aircraft. The results of the first modeling show that Hangar 3 of PT. XYZ is able to accommodate 41 aircraft in a year period with total utilized days of 97.58% for 3 slots. The second model shows the order of aircraft maintenance in each slot with reduced delay penalty, where it will save revenue of up to 29.47%.

Keywords: Optimization, Aircraft Maintenance, Integer Programming, Allocation, Scheduling.

1. INTRODUCTION

Wide-body aircraft account for 20 percent of the global fleet but represent more than 44 percent of MRO spending as aircraft are more maintenance-intensive and more complex. Based on the Airline Maintenance Cost Executive Commentary published by IATA in January 2021, it is observed that the expenditure for MRO in 2019 was USD 81.9 billion. This is equivalent to 10.3% of the total operating costs of an airline. Flight fleet growth shifts to Asia and other developing countries, and so MRO spending will also migrate to these regions. MRO demand in the Asia Pacific, China, and India in 2028 will more than double that of North America (Wyman, 2018).

The cost of aircraft maintenance consists of the cost of labor and material. Several influential parameters in maintenance include the number of aircraft, age of the aircraft, flight hours, number of flights, and aircraft maintenance program that contains a list of jobs, maintenance intervals, estimated manhours, and materials. Heavy maintenance is one type of maintenance that requires a long time, a large workforce, as well as sufficient equipment due to the complexity of the work. The maintenance slot availability is one of the crucial issues for an MRO in capturing market needs.

This research is based on the case study of wide-body aircraft base maintenance in PT. XYZ PT. XYZ is the biggest aircraft maintenance provider in Indonesia that has a hangar capacity to

accommodate 3 wide-body aircraft at once. The discrepancy that is often experienced is that the hangar capacity is not properly utilized where the number of incoming customers can not be obtained optimally. In some cases, the loss due to late fees has also been a detriment to the revenue that should have been obtained.

The objective of this study is to maximize the available hangar slots to meet customers' demands. Optimization is done through the approach of integer programming by two models. The first model determines the placement of aircraft in the hangar and the second model determines the scheduling of all aircraft that can be accommodated. The study is limited to wide-body aircraft maintenance and major types of maintenance carried out by base maintenance such as C-Check, D-Check/Overhaul, or special maintenance with a ground time of more than 2 days.

2. LITERATURE REVIEW

In the context of optimization, Gavranis and Konzanidis (2015) offer an appropriate algorithm to solve aircraft maintenance scheduling problems to maximize the availability of aircraft in a military aircraft fleet.

Qichen Deng (2019) conducted a study related to optimizing aircraft maintenance schedules. The optimization carried out discusses the inspection intervals and the details of the work required by using the dynamic programming model formulation method.

Van der Weide (2020) discusses the problem of long-term scheduling of heavy maintenance by incorporating an element of uncertainty in the duration of checking and daily use of aircraft (daily utilization) and offers a genetic algorithm methodology that can generate robust and efficient C-Check schedules for heterogeneous aircraft fleets.

Minimization of total maintenance costs is studied in the research of Sriram and Haghani (2003) where the maintenance scheduling problem was formulated as a multi-commodity integer network flow model to minimize the total cost of maintenance checks of type A-Check and type B-Check.

3. METHODS

3.1. Construction of Model

This study is conducted by collecting and processing data from PT. XYZ. The subject of this research is the Integer Programming model to solve hangar slot optimization problems in the Base Maintenance area. The main data is obtained from the Marketing Department and Base Maintenance Department of PT. XYZ that consist of:

1. Company airline data.
2. Types of maintenance carried out in hangar 3.
3. Maintenance duration standard of PT. XYZ.
4. The target time for completion is based on a partnership contract that has been signed by both parties.
5. Late fines based on the cooperation contract for any maintenance carried out in hangar 3.

Two types of modeling will be used in this study. The first modeling was made to determine the acceptable allocation of aircraft to perform maintenance in the hangar slots. Mathematical modeling of aircraft placement in hangars maintenance slots involves several factors that need to be determined beforehand, such as decision variables, objective functions, and constraints. The second model deals with the scheduling of each aircraft in each hangar slot in order to minimize the cost of delays in completing maintenance. The workflow of research to construct both models is shown in

Figure 1. This paper is using integer programming with Branch and Bound method, and LINGO 19.0 software as a tool to help to solving the formula model.

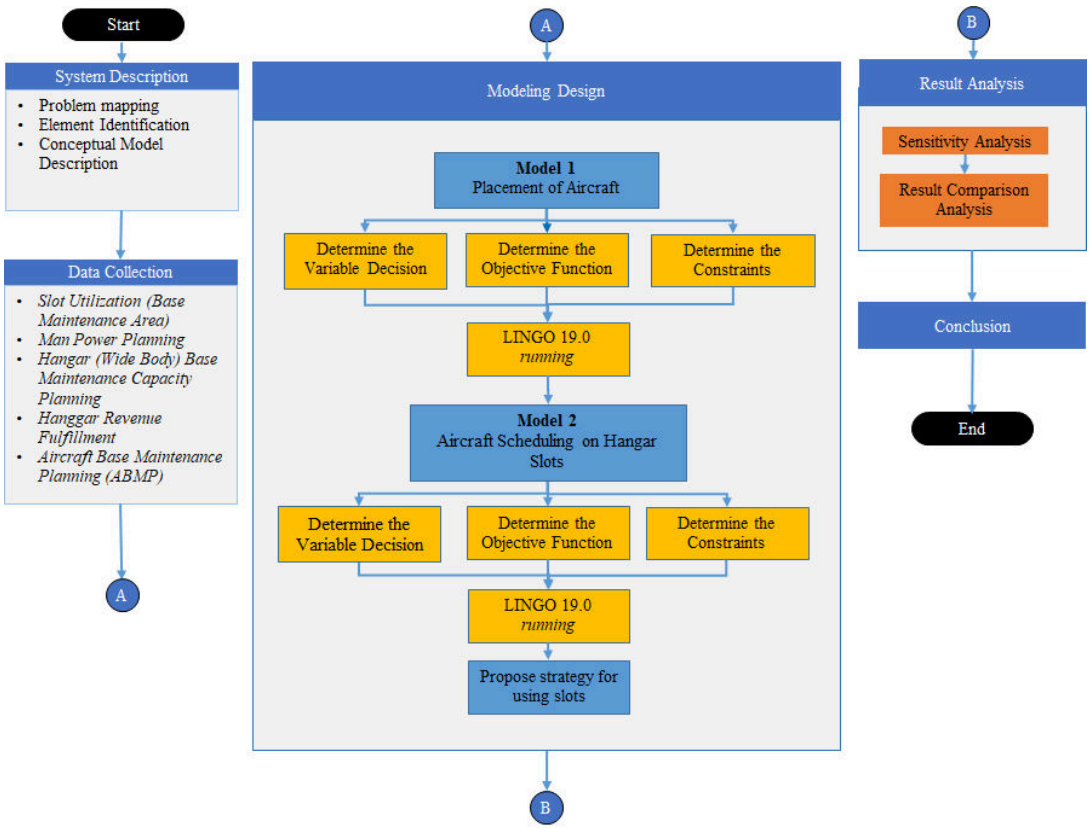

Figure 1. Research Workflow

3.2 Model 1 (Placement of Aircraft)

The objective function of Model 1 is to minimize the deviation from the amount of time provided by each maintenance hangar slot where *j* represents the existing hangar slots. As for hangar 3, the index values of *j* are 1, 2, and 3. A variable added to determine the capacity of the unused hangar slots.

$$Minimize \sum_{j=1}^{n} (d_j^- + b.d_j^+)$$

Model 1 has two constraints, the first constrain is the availability of maintenance time where hangar 3 has a capacity of only 3 slots and each slot has the availability that has been blocked for several activities such as hangar rejuvenation, ceremonies, facility repairs, etc as shown on Table 1. The constraint is formulated as follow:

$$\sum_{i=1}^{m} \alpha_i X_{ij} + d_j^- - d_j^+ = B_j \ \ |j = 1, \dots, n|$$

The second constraint is the availability of a maintenance slot where only one aircraft is undergoing maintenance on a hangar slot. The constraint is formulated as follow:

$$\sum_{j=1}^{n} X_{ij} \leq 1 \quad |i = 1, \dots, m|$$

With this formula, it can be interpreted that every aircraft that is accepted for maintenance will only experience one maintenance.

Table 1. Slot Availability of Hangar 3 in 2020

Slot 1	Slot 2	Slot 3
330 Days	330 Days	330 Days

3.3 Model 2 (Aircraft Scheduling on Hangar Slots)

The objective function of Model 2 is to minimize late maintenance costs where the index β_{ij} represents the penalty cost due to the late completion of aircraft maintenance *i* in slot *j* where the unit is USD per day. Meanwhile, the number of days of late completion of aircraft *i* in slot *j* will be written in the variable d_{ij}. For m_j, it is defined as the number of aircraft to be served in slot *j*.

$$Minimize \sum_{j=1}^{n} \sum_{i=1}^{m_j} \beta_{ij} d_{ij}$$

Model 2 has three constraints, the first constrain is the maintenance completion time limit where the formula is created to avoid penalties due to lateness. W_{ij} is the target day for aircraft maintenance completion *i* in slot *j* in the hangar. While t_{ij} indicates the time required for maintenance of aircraft *i* in slot *j*.

$$X_{ij} + t_{ij} - d_{ij} = W_{ij} \; |j = 1, \dots, n \; ; \; i = 1, \dots, m_j|$$

The second constrain is the maintenance conflict of an aircraft with another aircraft where the formula will pair one aircraft with all other aircraft. The third constrain is the limitation of starting time for maintenance of an aircraft.

$$X_{rj} \geq \sum_{i=1}^{r-1} t_{ij}(1 - Y_{ir}) + \sum_{i=r+1}^{m_j} t_{ij} Y_{ri} \; |j = 1, \dots, n \; ; \; r = 1, \dots, m_j|$$

Where X_{rj} represent the start of maintenance r in slot j, Y_{ir} is binary variable with a value of 1 if the maintenance of r precedes the maintenance of aircraft i. Y_{ri} is binary variable with a value of 1 if maintenance of aircraft i precedes maintenance of aircraft r. Then, r is the index of the plane that is part of i.

4. RESULTS

4.1 Result of Model 1

The results of running Model 1 (placement of the aircraft) can be directly obtained by utilizing LINGO software as shown in Table 2.

Table 2. Result of Model 1 (Placement of Aircraft)

Index	Slot 1	New Variable	Maint. Duration (Days)	Slot 2	New Variable	Maint. Duration (Days)	Slot 3	New Variable	Maint. Duration (Days)
1	X131	X11	42	X52	X12	30	X23	X13	21
2	X141	X21	45	X72	X22	14	X33	X23	25
3	X221	X31	45	X152	X32	14	X63	X33	15
4	X241	X41	45	X172	X42	8	X93	X43	10
5	X261	X51	6	X252	X52	8	X103	X53	9
6	X331	X61	39	X272	X62	40	X113	X63	15
7	X401	X71	34	X282	X72	40	X163	X73	30
8	X471	X81	10	X302	X82	12	X183	X83	20
9	X511	X91	20	X322	X92	41	X193	X93	20
10	X521	X101	20	X342	X102	39	X203	X103	35
11				X372	X112	14	X213	X113	29
12				X532	X122	35	X233	X123	35
13				X552	X132	35	X293	X133	30
14							X413	X143	
15							X433	X153	
16							X453	X163	
17							X483	X173	
18							X543	X183	
	Utilized Slot:		306	**Utilized Slot:**		330	**Utilized Slot:**		330

It can be concluded from 56 aircraft with the type of maintenance needed, hangar 3 can optimize the available slots in a year by accommodating as many as 41 aircraft with the maximum selected type of maintenance. From the results obtained, Slot 1 will receive as many as 10 aircraft by utilizing 306 days of the available slot. For Slot 2, 13 aircraft will be received by utilizing 330 days of available slots for aircraft maintenance. While Slot 3 will receive as many as 18 aircraft by utilizing 330 days of slot availability in that year.

4.2 Result of Model 2

The results of Model 2 show the optimal value of the aircraft scheduling in the hangar slots as shown in Table 3.

Table 3. Result of Model 2 (Aircraft Scheduling on Hangar Slot 1)

Order Number	Aircraft Index	Start (day)	Maint. Duration (day)	End of Maint. (day)
1	51	0	6	6
2	81	6	10	16

Order Number	Aircraft Index	Start (day)	Maint. Duration (day)	End of Maint. (day)
3	91	16	20	36
4	101	36	20	56
5	71	56	34	90
6	61	90	39	129
7	11	129	42	171
8	31	171	45	216
9	41	216	45	261
10	21	261	45	306

Table 4. Result of Model 2 (Aircraft Scheduling on Hangar Slot 2)

Order Number	Aircraft Index	Start (day)	Maint. Duration (day)	End of Maint. (day)
1	42	0	8	8
2	52	8	8	16
3	112	16	14	30
4	32	30	14	44
5	22	44	14	58
6	12	58	30	88
7	82	88	12	100
8	122	100	35	135
9	132	135	35	170
10	102	170	39	209
11	62	209	40	249
12	72	249	40	289
13	92	289	41	330

Table 5. Result of Model 2 (Aircraft Scheduling on Hangar Slot 3)

Order Number	Aircraft Index	Start (day)	Maint. Duration (day)	End of Maint. (day)
1	10	0	8	8
2	8	8	8	16
3	11	16	8	24
4	17	24	9	33
5	7	33	12	45
6	4	45	10	55

Order Number	Aircraft Index	Start (day)	Maint. Duration (day)	End of Maint. (day)
7	9	55	10	65
8	12	65	12	77
9	15	77	21	98
10	14	98	23	121
11	2	121	24	145
12	13	145	24	169
13	1	169	28	197
14	5	197	24	221
15	6	221	30	251
16	3	251	25	276
17	16	276	25	301
18	18	301	29	330

In Slot 1, the plane with the index 51 becomes the first order of scheduling, followed by the index 81 in the second order in Slot 1, and so on. Likewise with Slot 2 and Slot 3.

In calculating the optimization of late fees, the scenario with similar conditions between research and non-research is developed. The number of aircraft in the same scenario received 41 aircrafts with similar composition in each slot. However, non-research data will not use the second modeling (scheduling). The order of aircraft maintenance in this condition was randomly generated using the randomization method to represent the conditions before the study. This condition is compared with 41 aircrafts which are sorted according to the results of the second modeling (scheduling). The result is model can saving the revenue around 29.47%.

Table 6. Result of Model 2 to represent the comparison of penalty cost with model and without model.

	Penalty Cost (KUSD)			
	SLOT 1	SLOT 2	SLOT 3	Total
With Model	8.162	13.194	17.944	39.300
Without Model	13.199	16.202	26.320	55.721

4.2 Comparison to Manual Method

The optimization of the capacity of each hangar slot can be summarized as follows:

1. Among 56 potential customers who will utilize the maintenance facilities in hangar 3 of PT. XYZ, the proposed model capable to absorb 73.21% of aircraft maintenance demand which is slightly larger than the current method performed by PT. XYZ where only a total of 30 aircraft can be absorbed in 2020.
2. The available time (in days) provided by hangar slots in that year reaches 79.09% because at that time there was a hangar renovation project in addition to the time that had been allocated for hangar maintenance.

3. Based on the available days to be used, this method is able to achieve the utilization of hangar slots up to 97.58% which is higher than the manual method being used where the utilization of available slots is at 75.05%.
4. To compare the penalty cost, randomization method applied for the non research data. The result of comparison is the penalty cost reduce until 29.47% than the non-research data (without model).

The comparison can also be seen in Table 7 which describes the comparison between the results of the study and the manual method that was currently used.

Table 7. Comparison of Proposed Model to Manual Method

	With Model	Without Model
Utilized slot days (3 slots)	966 days	743 days
Optimization	97.58%	75.05%
Number of aircraft handled	41	30
	73.21%	53.57%
By the similar scenario with the model		
Penalty Cost	USD 39,300,000	USD 55,721,000
	It's saving around 29,47% revenue during that time	

6. CONCLUSIONS

Based on research on optimization of base maintenance hangar slots utilization for wide-body aircraft at PT. XYZ, it can be concluded that:

1. The integer programming method in operations research is able to optimize the availability of hangar slots both in terms of aircraft placement and maintenance scheduling for each aircraft in its hangar slot.
2. The first model solves the problem where the limitations of hangar slots can be optimized in the absorption of the existing market for aircraft maintenance. The availability of hangar slots can be utilized up to 97,58%. This value can be considered as an increase in revenue based on the number of accommodated aircraft by the hangar slot.
3. The second model serves an optimum maintenance sequence in terms of maintenance duration that eliminate delays due to an extent in maintenance completion. Compared with the data in 2020, the second modeling is able to eliminate the loss in revenue due to late fees which reached 29.47% at that time.
4. The developed mathematical model used is quite computationally efficient and can be easily implemented on a desktop PC by using the LINGO 19.0 program in less than 1 minute to solve the problem.

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DETERMINATION OF OPTIMUM LOCATION OF PUBLIC ELECTRIC VEHICLE CHARGING STATIONS USING SPATIAL ANALYSIS METHOD

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ABSTRACT

The Public Electric Vehicle Charging Station (SPKLU) is one of the facilities whose existence is very vital for the community today and in the future. This is due to the increasing trend in the use of electric vehicles both in the world and in Indonesia. The main cause of the increasing use of electric vehicles is the start of public awareness of environmentally friendly vehicles because there are no emissions produced from the machine, so they are more environmentally friendly. On the other hand, Surabaya City is the city with the highest population density ranking in East Java Province. Most of the people of Surabaya City are motorized vehicle users. This causes the need for SPKLU, especially in the city of Surabaya, to increase. Because of the community's dependence on SPKLU. SPKLU must be located close to the community environment, both residential and urban environments. This research was conducted to determine the best location that would be recommended to be used for the construction of the SPKLU. The recommended area for SPKLU development is based on the weighted overlay method that is run in ArcGIS based on the weights obtained using the Analytical Hierarchy Process (AHP) method. In carrying out planning to determine the optimal location of SPLKU using Geographic Information System (GIS). The method used is Weighted Overlay by giving weight to the class in each criterion. Weights also consider the level of importance by using the Analytical Hierarchy Process (AHP) method. Then the process stage uses a model builder to get an optimal SPLKU establishment location plan. The results of the location are divided into three classes. Based on weighting on the criteria made widely obtained with a less than the optimal class of 16,486 Ha. For a fairly optimal class of 5,165 ha. While the class is very optimal, which is 11,641 ha.

Keywords: Spatial Analysis, Spatial MCDM, AHP, GIS

1. INTRODUCTION

In general, the advantage of using electric vehicles is that there are no emissions from the engine, so they are more environmentally friendly compared to vehicles that use fuel oil (BBM). According to data from the Central Statistics Agency, the increase in the use of vehicles that use fuel can increase CO2 levels is one of the main causes of the effect of greenhouse effect which will have an impact on global warming (BPS, 2020). In addition, it is predicted that oil reserves in Indonesia will decrease and run out in 2030. The fossil-based energy crisis can be exacerbated by its use in other sectors, for example in the industrial sector, the household sector & others. On the other hand, electric vehicles as a way out of dependence on the use of fuel will give hope for the energy security of the Indonesian nation and will of course be equipped with a capable SPKLU in the future.

The Public Electric Vehicle Charging Station (SPKLU) is one of the facilities whose existence is very vital for society today and in the future. This is due to the increasing trend of using electric

vehicles both in the world and in Indonesia (BPS, 2020). Currently, the level of absorption/acceptance of electric vehicles in Indonesia is still not significant, one of the reasons is the limited availability of SPKLU so it will be difficult for electric vehicle users to charge their vehicles.

As stated above, the absorption of electric vehicles in Indonesia is still low. One of the main causes is the unavailability of sufficient SPKLU in various areas, especially in the city of Surabaya. It was recorded that in August 2021, there were only 3 SPKLU units in East Java (PLN, 2021).

The establishment of the SPKLU of course requires various considerations. Some of them are the area of the establishment, access to roads, access to electricity lines, and distribution of electric vehicle users. In this case, the area needed to build an SPKLU is larger than a gas station. This is because an electric vehicle on average takes 2-3 hours to fully charge the battery, in contrast to a gas station where refueling activities can only take 5-10 minutes.

In order to provide optimal SPKLU facilities, a model is needed that can support the decision to establish SPKLU in potential areas. The establishment by considering the factors that support the establishment. Determining the best location can use a method with clear spatial information. So that the optimal area can be visualized clearly and informatively. So that this research will use a Geographic Information System that can model the decision using various considerations, then it can be displayed visually in the form of a map that can describe the actual location of the plan.

2. LITERATURE REVIEW

GIS & Decision Support

As mentioned earlier, the main purpose of GIS is to provide an analysis of support for spatial decision-making. GIS's ability to support spatial decisions can be analyzed in the context of the decision-making process. There are several frameworks for the analysis of decision-making processes. One of them is the decision-making process that can be arranged from three main phases, namely intelligence (is there a problem or opportunity to change?), design (what are other options?), and choice (what is the best alternative?). Malczewski, J. (1999) explains from one of the contents of the book "The new science of management decision" by Simon (1960), that the three stages of decision-making (as in Figure 1) do not have to follow the predetermined stages. So, there is a possibility at every point in the decision making it is necessary to loop back to the previous phase. Malczewski (1999) gives examples such as someone being able to develop some alternative plan at the design stage but may not be sure if that specific plan meets the requirements for decision making. It requires the work of additional intelligence. Thus, the process can run backward adjusted to the needs of decision-making analysis. Each stage of the decision-making process requires a different type of information.

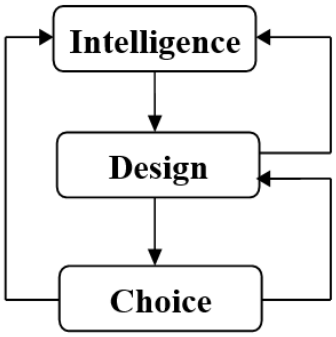

Figure 1. Three stages of the decision-making process

Multi Criteria Decision Process

The Multi-Criteria Decision Process (MCDM) involves a set of alternatives evaluated based on conflicting and non-commensurate criteria. Criteria are considered general terms that include the concept of attributes and objectives. In this analysis, MCDM can be distinguished into MADM (Multi-Attribute Decision Making) and MODM (Multi-Objective Decision Making). MADM and MODM problems further categorize single decision-making problems and group decision-making problems. The two categories are still divided into deterministic, probabilistic, and fuzzy decisions. Deterministic decision problems assume that the data and information needed are known with certainty and that there is a known deterministic relationship between the decision and the consequences of the decision. The probabilistic analysis deals with situations with uncertainties regarding the scope of the problem and the relationship between decisions and their consequences. And probabilistic analysis imposes uncertainty about randomness. Probabilistic analysis is also considered suitable for considering the inaccuracies of information involved in decision making and most use fuzzy decision analysis in its identification and analysis. Keep in mind that conventional MCDM techniques have largely entered the spatial realm in the sense that they regard spatial homogeneity as a region of study (Malczewski, 1999). As a result, there is a need for explicit representations of geographical dimensions in MCDM analysis.

In general, MCDM problems involve six components. First, a goal or set of decision-making objectives involved in the manufacturing process and with its preferences relating to evaluation/assessment criteria.

Second, decision-makers or groups of decision-makers are involved in decision-making along with their preferences with respect to evaluation/assessment criteria. Third, a number of evaluation/assessment criteria (objectives and/or attributes) are based on alternative evaluations of decision-makers actions. Fourth, an alternative set of decisions, i.e. decisions or action variables. Fifth is the uncontrolled set of variables. Sixth set the outcomes or consequences associated with each pair of alternative attributes. The relationship between the elements found in the MCDM can be shown in Figure 1. The central element of this structure is a decision matrix consisting of a set of rows and columns. This matrix is the result of decisions for a set of alternatives and assessment criteria. The column structure consists of levels that represent decision-makers, their preferences, and evaluation/assessment criteria. This element is organized in a hierarchical structure. The most common level is the goal. At this level, the final state that you want to produce from decision-making activities is determined first. Complex decision problems usually involve a number of decision-makers (interest groups).

A decision-maker can consist of a single person/actor or a group of people, such as a corporate organization. A decision requires an analysis of the value of the impact effect of a decision that is

often characterized by unique preferences with respect to the relative importance of criteria based on alternative decisions to be evaluated. Preferences are usually expressed in the weighting set for evaluation criteria. Criteria are assessment standards or rules for testing desired alternative decisions. The problem of multiple criterion decisions involves a set of goals, a set of attributes, or both. An objective is a statement of the desired state of a spatial system.

Basically, a spatial multi-criteria decision problem involves a set of geographically defined alternatives (from a real event) that are the choices of one or more alternatives made (in accordance with the desired purpose) relating to the group/set of evaluation/assessment criteria. Alternatives are defined geographically in the sense that the results of analysis (decisions) depend on the spatial arrangement of the observed object. In GIS terminology, an alternative is a collection of points, lines (polylines), and area objects (polygons) that are used as criterion values. Conventional MCDM techniques accumulate spatial homogeneity within the area of study undertaken. This assumption is clearly unrealistic in many decisions situations because evaluation criteria vary across space/spatial (Malczewski, 1999). The spatial multicriteria analysis is a significant beginning of conventional MCDM techniques due to the involvement of further processable geographical components. Unlike conventional MCDMs, multi-criterion spatial analysis requires data on the value of alternative criteria and their geographic location (Gunarta, 2013). Data is processed using GIS and MCDM techniques to obtain information to make a decision. Thus, integration between both spatial techniques and MCDM Spatial multicriteria decision analysis can be considered as a process that combines and converts geographic data (input) into a resulting decision (output). The MCDM procedure determines the relationship between the mapping input and the mapping output. Procedures that are carried out involve the utilization of geographical data, decision-making preferences, as well as the manipulation of data and preferences in accordance with the rules of the decision that has been determined. This technique combines multi-dimensional information and geographic data into unidimensional alternative decision values. An important aspect of the spatial multicriteria analysis is that it involves evaluating geographic events based on the values of criteria and decision-making preferences that relate to a number of evaluation criteria. This means that analysis depends not only on the geographic distribution of the observed event/object (attribute) but also on consideration of the values involved in the decision-making process. Thus, there are two very important considerations for spatial multicriteria analysis: (1) GIS's ability to obtain data, storage, search, manipulate/engineer, and analyze data, (2) MCDM's ability to combine geographic data and decision-maker preferences into unidimensional values of alternative decisions (output). The sheer number of factors needed to identify and consider spatial decision-making and the extent of the interrelationships between the factors involved causes difficulties in decision-making. The difficulty is that in attempting to obtain data and process data in order to obtain information to make a decision, the complexity of the problem may require processing at a rate that exceeds the cognitive abilities of a decision-maker. The combination of GIS capabilities with MCDM techniques provides support in all stages of decision making, such as analytical intelligence, design, and decision-making process phases.

Decision-making is a process. It involves a sequence of activities that begins with the introduction of decision issues and ends with recommendations. The quality of decision-making depends on the order in which the activity is performed. There are a number of alternative ways to organize the sequence of activities in the decision-making process, Malczewski (1999) provides a framework for the analysis of spatial multicriteria decisions as shown in Figure 2.

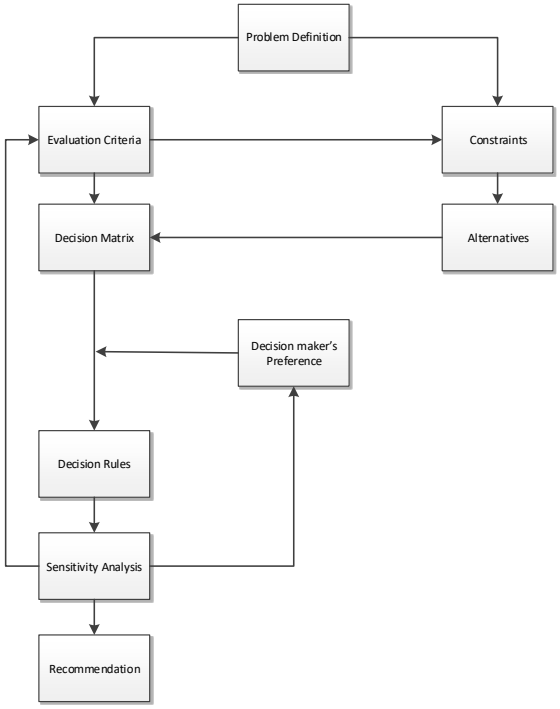

Figure 2 Framework for Spatial Multicriteria Decision Analysis

3. METHODS

A study requires the research methods that can be known direction of the research activities. Method is a systematic way of working with the purpose of facilitating the activities of collecting, processing and in the presentation of data and assist in problem solving. In this chapter will explain the steps (flowchart) done in research so that research can be run in a systematic way. The stages in this study can be seen in Figure 3. The following is an explanation of the flowchart research.

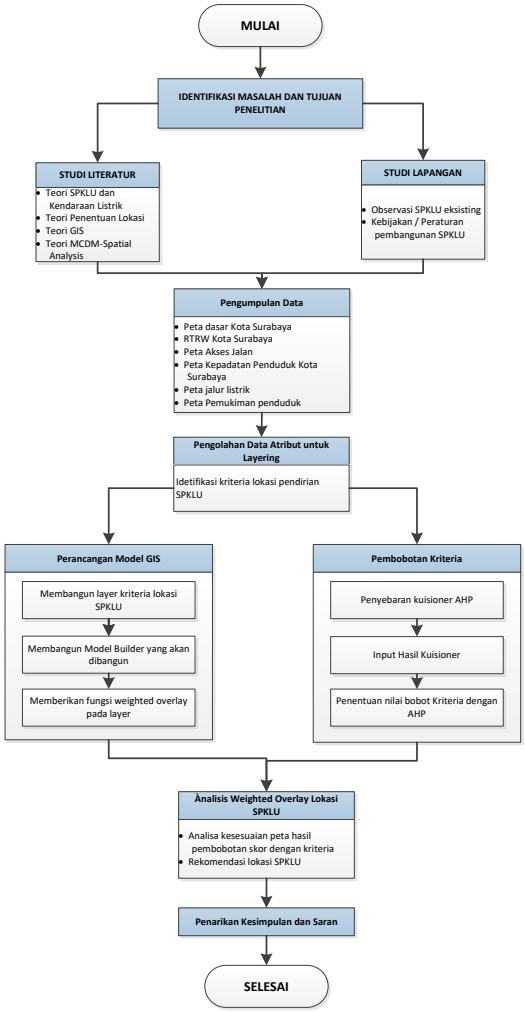

Figure 3. Research Flowchart

The research stage in the data collection process is divided into 2, namely spatial data and the Analytical Hierarchy Process (AHP). The first is spatial data, spatial data has location information so that it can represent the position of information. The spatial data used in this research are the Surabaya City Base Map, the Surabaya City Spatial Plan (RTRW), the Surabaya City Road Network Map, the Surabaya City Population Density Map, the Surabaya City Power Line Map, and the Surabaya Residential Map. The source of the spatial data used is from the RBI map and from the Surabaya City Development Planning Agency (Bapeko).

The data that has been obtained must be adjusted to the Indonesian National Standard (SNI) regarding the construction of SPKLU or government regulations that are passed down in the form of laws or regulations below which regulate the specifications regarding the location of the establishment of SPKLU.

Second, the data used is Analytical Hierarchy Process (AHP) data. AHP data is obtained by conducting interviews with experts and consumers of electric vehicles. Then the calculation is carried out with the AHP calculation application.

The method of collecting data on the weighting criteria used in the AHP is a purposive sampling from 6 to 10 experts (expert judgment) in the field of urban planning, technology, and journals related to the research topic.

For expert criteria in conducting Focused Group Discussion (FGD) experts who have knowledge/expertise in the field of electric cars with a minimum of 6 years experience. Then it is done again with experts who have knowledge related to urban spatial analysis with a minimum of 6 years experience. Because this criterion will guide researchers in selecting the right expert (having competence). Apart from experts, FGDs were also conducted on consumers of electric vehicles. The FGD is planned to be carried out from November to December 2021.

Next to the data processing stage. Processing data using a spatial data processing application, ArcGIS ArcMap. The ArcMap application used is version 10.5. The processing stages use the weighted overlay method where weight is given to each criterion used. The stages of processing are arranged into a model called the model builder. The result of processing is an area with 3 classes, namely the optimum area for establishing SPLKU, quite optimum, and less than optimum.

4. RESULTS

AHP calculations are used as data to perform the Weighted Overlay process. The AHP calculation is used to obtain data on the level of importance between each of the criteria used. The AHP calculation, in this case, uses the AHP Calculator belonging to Business Performance Management Singapore (BPMS). Where the results of the AHP calculator will produce criteria of interest or it can be called the Influence Rate. The degree of influence has a total of 100% divided by the number of criteria used in this case. However, the level of importance may vary according to the level of importance of each criterion.

Furthermore, calculations are carried out on the AHP Calculator application so that the value of the importance of each criterion can be known. The number of comparisons between criteria, in this case, is 10 comparisons. For a comparison between the features presented in the Figure 4.

	1	2	3	4	5
1	1	5.00	0.33	7.00	3.00
2	0.20	1	0.11	0.33	0.20
3	3.00	9.00	1	7.00	5.00
4	0.14	3.00	0.14	1	0.33
5	0.33	5.00	0.20	3.00	1

Figure 4. Comparison Between the Features

The importance value of each criterion is presented in Figure 5 However, it is important to note that in assessing the level of importance between criteria, it is necessary to pay attention to the level of consistency or Consistency Ratio which is a comparison between the Consistency Index (CI) and the Random Index (RI). If CR <= 0.10 (10%) it means that the user's answer is consistent so that the resulting solution is optimal. The consistency ratio, in this case, is 7.1% and is included in the optimal category because it is below 10%.

No	Cat.	Priority	Rank	(+)	(-)
1	Distance from the Road	26.8%	2	10.9%	10.9%
2	Distance from the Power Line	3.6%	5	1.5%	1.5%
3	Distance from the Settlement	50.7%	1	17.6%	17.6%
4	Regional Spatial Plan (RTRW)	6.1%	4	2.6%	2.6%
5	Population Density	12.8%	3	4.1%	4.1%

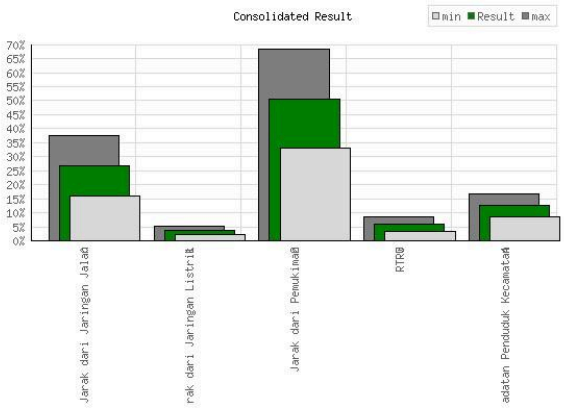

Figure 5. The Importance Value of Each Criterion

The processing stage uses the weighted overlay method by giving weight to each criterion used. This processing will produce areas with certain weights that have been grouped into classes based on the resulting weights. However, for processing, it is necessary to enter the influence value or the importance value of each criterion. The importance value is obtained from processing using AHP in the previous chapter. Then fill in the scale values for the classes in each criterion. For the scale value itself, it has a range of values from 1-9 and there is a restricted option where the option is to assign a weight provision of 0 to the class given the option.

Table 1. Weight for each Criteria Use for Weighted Overlay Processing

Parameter	Value	Class	Description	Influence	Scale Value
Regional Spatial Plan	1	CBD	Trading Facilities	6,21%	7
			Office Facilities		
			Industry and warehousing		
			Trade and services		
	2	Settlement	Settlement		9
	3	Public Facilities	Instalation Facilities		3
			Sport Facilites		

Parameter	Value	Class	Description	Influence	Scale Value
			Educational Facilities		
			Worship Facilities		
			Social Facilities		
			Terminal Facilities		
			Public Facilities		
			Cleaning Facilities		
			Public Health Facilities		
			Public Facilities of The Society		
			Green Open Space		
	4	Government	Governmental Facilities		Restricted
			Military Facilities		
	5	Agriculture	Rice fields		3
			Pond		
			Tegalan		
	6	Protection	Mangrove		Restricted
	7	Electrical Facilities	High Voltage Air Ducts		7
			PLN Substation		
	8	Waters	Boezem		Restricted
			Rawa		
			River		
			Shrubbery		
Population Density	1	< 150 jiwa/ha		14,41%	1
	2	150 - 400 jiwa/ha			2
	3	> 400 jiwa/ha			3
Distance from the Power Line	1	< 300 m		3,63%	9
	2	300 - < 600 m			7
	3	600 - < 1000 m			5
	4	1000 - < 1500 m			3
	5	> 1500 m			1
Distance from the Road	1	< 1 Km		24%	9
	2	1 - 2 Km			7
	3	2 - 3 Km			5
	4	3 - 4 Km			3
	5	> 4 Km			1
Distance from the Settlement	1	< 250 m		51,64%	9
	2	250 - < 1000 m			5
	3	1000 - < 2000 m			4
	4	2000 -< 4500 m			3
	5	> 4500 m			1

The results of the weighting process using the weighted overlay method as shown in the Figure 6 The optimal regional results are divided into three classes, namely very optimal, moderately optimal, and less than optimal. With each in brown, green, and blue.

MAP OF DETERMINATION OF OPTIMUM LOCATION
OF PUBLIC ELECTRIC VEHICLE CHARGING STATIONS

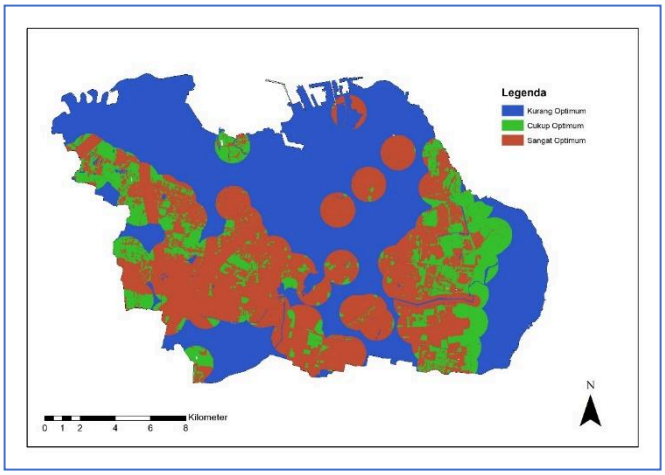

Figure 6. The results of the weighting process using the weighted overlay

The model builder made in processing data displayed in the Figure 7

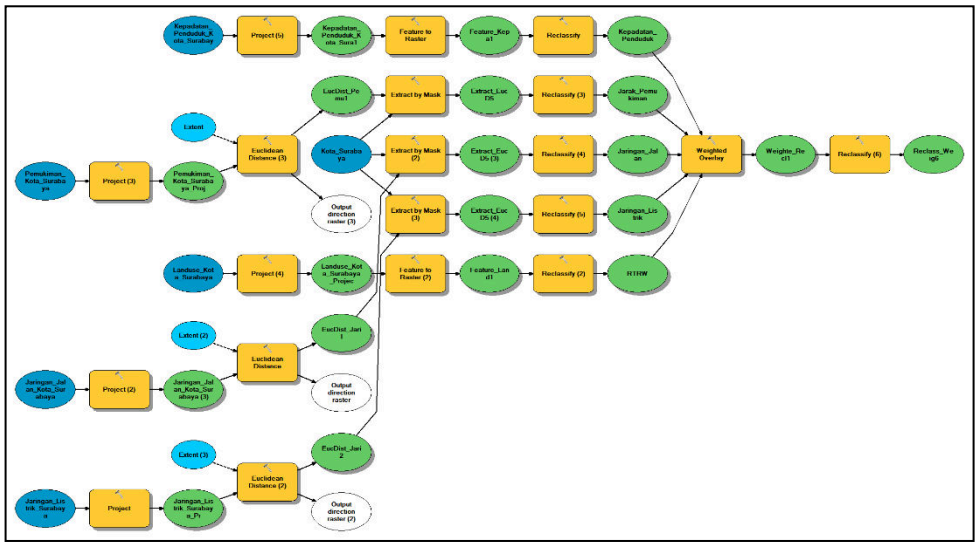

Figure 7. The Model Builder use for The Processing

The broad calculation of weighted overlay results based on the division of the three classes is as follows:

Less than optimal	: 16.486 Ha
Moderately optimal	: 5.165 Ha
Very optimal	: 11.641 Ha

6. CONCLUSIONS

In carrying out planning to determine the optimal location of SPLKU using Geographic Information System (GIS). The method used is Weighted Overlay by giving weight to the class in each criterion. The weight also considers the level of importance by using the Analytical Hierarchy Process (AHP) method. Then the process design uses Model Builder to get the optimal SPLKU establishment location plan.

The results of the location are divided into three classes. Based on weighting on the criteria made widely obtained for a less than the optimal class of 16,486 Ha. For the optimum enough class of 5,165 ha. While the class is very optimal at 11,641 ha.

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OPERATION PERFORMANCE MEASUREMENT IN FINISHED GOOD WAREHOUSE OF COFFEE PRODUCTION COMPANY

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ABSTRACT

This paper takes one of Bali's coffee producers, Banyuatis Company, as the study case of this research. Due to the increased coffee production, the number of goods being managed, and the expansion of market by opening a new distribution point, Banyuatis finished goods warehouse is required to manage warehouse operations effectively. Performance evaluation is one of the methods to control the effectiveness of a warehouse. Henceforth, this research proposes the warehouse performance evaluation in order to understand the current warehouse performance which leads to warehouse effectiveness and efficiency improvement. The warehouse key performance indicators (WKPIs) are first investigated based on study literature and sorted through expert judgment to identify the basic metrics and significant indicators: order lead time, inventory space utilization, physical inventory accuracy, order fill rate, and stockout rate. Then, the warehouse performance evaluation was conducted following by the analysis on insufficient warehouse performance using root cause analysis (RCA), the 5-Whys. The findings show the inventory space utilization identified as the inadequate performance and the main reasons are (1) forecasting issues, (2) no standard operational procedures (SOP) to handling returned products, and (3) the absence of stock allocation management.

Keywords: Warehouse performance measurement, Warehouse Key Performance Indicator (WKPI), Root Cause Analysis (RCA), 5-Whys Analysis

1. INTRODUCTION

In today's competitive business conditions and customer-oriented, companies continue to change their business operations dynamically to enhance overall performance, including warehouse performance. A good warehouse performance will improve quality performance, delivery time, customer satisfaction, and reduce cost in the logistics system (Kusrini, Novendri, et al., 2018). In order to understand the warehouse operation performance, a company required to do the measurement, assessment or evaluation to understand the performance of a warehouse, potential issues, and opportunities for improvement.

Before measuring the warehouse's performance, identifying the indicators used as measurement instruments must be done first and one of the common measurements is Key Performance Indicator (KPI). However, determining the correct KPI to evaluate the performance is challenging includes specific KPIs for the warehouse. Different indicators in each warehouse are likely to happen for many reasons. Some examples are the objective of the measurement (required for long or short-term decision making), the measurement methods, the category of the

warehouse systems (distribution center, fulfilment center, cross-doc platforms), the main activity of the warehouse (picking, shipping, storage), and the measurement tools (statistical, simulation, analytic) (F. H. Staudt, Alpan, Mascolo, & Rodriguez, 2014).

Generally, there are two types of warehouse key performance indicators (WKPI), namely indirect performance indicators and direct performance indicators. Indirect performance is complex because they relate to soft metrics like value-added logistics activity, customer perception, and flexibility. Meanwhile, direct indicators refer to hard metrics or quantitative indicators. This type of indicator is commonly easy to measure because it is directly related to warehouse operations, such as order cycle time, picking accuracy, and labor cost.

This paper takes Banyuatis as coffee producer in Bali as a study case. The company has future plans to expand the Banyuatis coffee market, especially in the Bali area, by inviting the cooperation of their business partners as distribution points. Even though the Banyuatis coffee distribution is still in local scale, the production of this product keeps rising every year. Thus, creates number of items to be manage are risen, now and in the future. Therefore, Banyuatis needs a control system to monitor the efficiency and effectiveness of the warehouse operations to deliver the products in the right time, right quantity, and right place.

Based on the background, this research aims to suggest regarding the warehouse performance assessment in terms of efficiency as a control system, by using study literature performed by F. Staudt et al., (2015) as the basis to formulating the indicators and metrics. Then, the evaluation performance measurement in Banyuatis finished good warehouse based on the significant warehouse key performance indicators is performed. The inadequate warehouse performance is then analyzed through the Root Cause Analysis (RCA), 5-whys analysis, to evaluate and discover the possible reasons for insufficient performance.

The object in this research is limited to the finished good warehouse of Banyuatis that manage the manufactured item at the upstream position and measure direct indicators only. This research is expected to present the current warehouse performance based on significant WKPI by performing warehouse evaluation, and describe possible causes of insufficient warehouse performance so it can be used as the input for companies to improve the warehouse efficiency by conducting RCA using 5-whys analysis with tree diagram.

2. LITERATURE REVIEW

Warehouse Process

Warehouse define as a planned space for the storage and handling of goods and material (Emmett, 2005). It may have different activities according to product specification, customer requirements, and service levels offered (Staudt et al., 2015). The form of a warehouse might be different, but the basic process of a warehouse remains the same. Frazelle (2002) stated that the fundamental processes or activities consist of receiving, put away, storage, order picking, and shipping, as shown in Figure 1.

Performance Measurement

Performance measurement is used to evaluate, control the overall business operations, measure and compare the performance of different organizations both within and outside of the organization (Ishaq Bhatti & Awan, 2014). A clear performance measurement definition can help managers go in the right direction and focus on what matters (Moullin, 2007). The result of performance measurement is a performance indicator, which is generally expressed by a number and a unit of measurement (Franceschini et al., 2019).

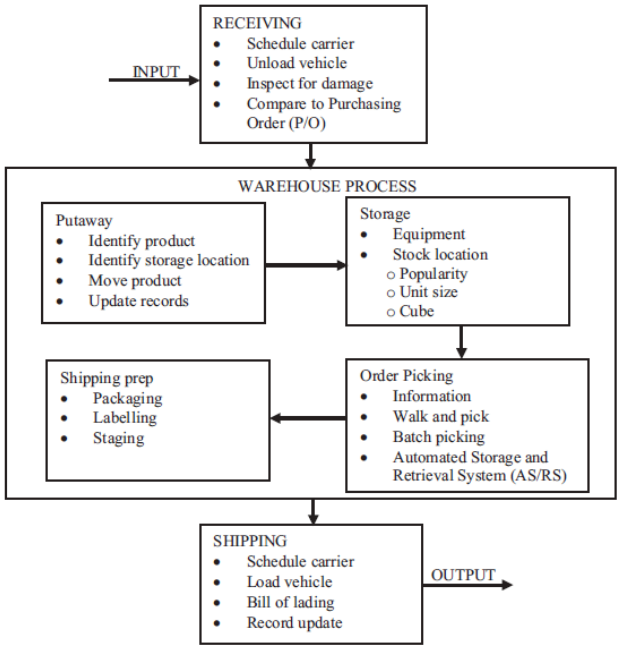

Figure 1. Warehouse Activity (Frazelle, 2002)

Key Performance Indicator

A key performance indicator is a target-style quantitative management indicator obtained by setting, sampling, calculating, analyzing the key parameter of input and output ports of a process within the organization, and measuring the performance of the entire process (Wen et al., 2012). By measuring the performance of the whole process regularly means monitoring the enterprise's performance to keep the process under control. KPI can be used to identify poor performance and the improvement potential (Lindberg et al., 2015).

There are several key indicators used around the world to measure the performance of the warehouse. The homework for a manager logistic is to identify the most appropriate measurement tools with their company's objectives. Some lists need to undertake to discover the right tools, such as: understand the business and strategy, decide on the objectives, understand which KPIs are likely to assist in meeting the objectives, align the KPIs to others within the company, ensure that everyone works towards achieving targets – nominate KPI owners (Richards, 2014).

5-Whys Analysis

This method is used to investigate deeper to find the true root cause of a failure that can be pursued by questioning "why" continuously. This method was firstly introduced by Taiichi Ohno in 1988 in the base of Toyota Production. The original purpose of this method was for worker in Toyota assembly lines, individually, to think deeper than they normally do to explore possible contributing factors when undesirable outcome occurs (Latino et al., 2020). The procedures of this method are listed below and the Figure 2.2 present the mechanism of 5 whys method:

- Step 1: Asking "why" five times to the unwanted occurrence/ failure
- Step 2: Each "why" might lead to another direction of asking "why"
- Step 3: All "why" should be confirmed through other method

3. METHODS

This study is performed according to the steps and procedures presented in Figure 2 to measure the warehouse performance based on KPI. The steps in this research will be started from a preliminary study, followed by data collection, warehouse performance evaluation, data analysis, and closure.

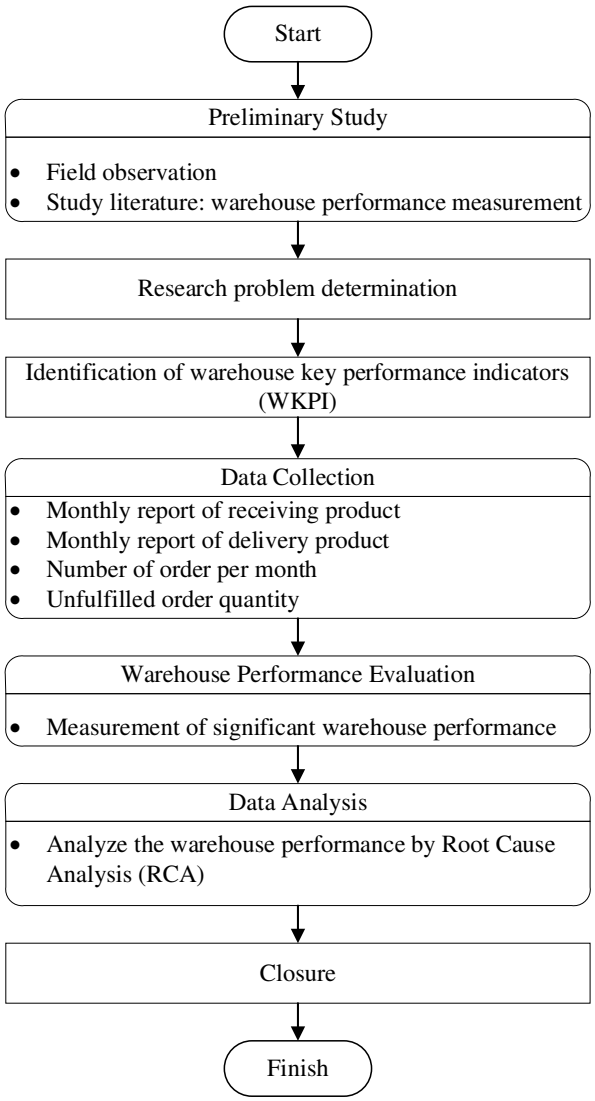

Figure 2. The Flowchart of Proposed Research Methodology

Preliminary Research

To begin with, the study literature and field observation will be conducted to strengthen the base of the preliminary study. In this part, the research problem is determined, which is an assessment of warehouse performance in terms of efficiency. The object of this research is Banyuatis coffee company, the instant coffee producers in Bali. The type of the warehouse is finished good warehouse, that distribute the finished good products to distribution point in Singaraja, Denpasar, Negara, and Mataram.

Data Collection

The data used in this research is sourced from the company through the person in charge in Banyuatis finished good warehouse, the warehouse manager, inventory control manager, production manager, and production manager assistant. The data required to conduct the warehouse performance measurement classify as below:

a. Monthly report of receiving product,
b. Monthly report of delivery product,
c. Number of orders per month and,
d. Unfulfilled order quantity.

Warehouse Performance Evaluation

The performance measurement of Banyuatis finished good warehouse will be evaluated based on the significant KPI sourced from WKPI introduced by Staudt et al. (2015). Firstly, the basic metrics are served by digging down the needs of the warehouse using observation to construct the warehouse indicators based on activity, and deep discussion with the person in charge. Hence, it generates a complete list of metrics specifically used for warehouse assessment that is presented in Table 1 According to a deep discussion with the warehouse person in charge, the significant WKPI including order lead time, inventory space utilization, physical inventory accuracy, order fill rate, and stockout rate selected as significant indicators due to the growth of production volume in the last five years.

Data Analysis

In this part, the performance will be analyzed using problems and causes analysis or Root Cause Analysis (RCA) tools to discover the causes of insufficient warehouse performance adhere to performance standards. The 5-whys with tree diagram analysis will be presented to give a better visualization of the problems and the cause. The reason to conduct this further analysis is to get a better outlook by identifying the ultimate cause of insufficient performance to improve warehouse efficiency.

4. RESULTS

Performance Evaluation Result

In this section, the warehouse performance evaluation is discussed. Since warehouse performance evaluation is the first assessment method in Banyuatis warehouse, insufficient data are found. Therefore, some data are relied on expert knowledge, random sampling, and data availability at the moment.

a. Order Lead Time

Order lead time define as the required time from a customer from issuing an order until it arrives. The delivery activity in finished good warehouse in Banyuatis is not directly sent to end customers but to distribution point in Singaraja, Denpasar, Negara, and Mataram. The average order lead time is around two to three days, according to the availability of the ordered product.

$$= \frac{\text{The average time between the customer ordering and the customer acceptance}}{\text{Number of orders delivered}}$$

$$= \frac{48 \text{ hour}}{1 \text{ order}} = 2 \text{ days/order}$$

Table 1. WKPIs Metrics

Dimension	WKPI	Polarization	Formula	Target
Time				
T-1	Receiving time	Min	Time between the supply arrival and the instant when products is unloaded/ Number of pallets unloaded	1 minutes/ trolley
T-2	Order lead time	Min	Time between the customer ordering and the customer acceptance of the product/ Number of orders delivered	2 day/ order
Productivity				
P-1	Inventory space utilization	Max	Average space occupied by inventory (m^3)/ Total warehouse inventory capacity (m^3)	85%
Cost				
C-1	Transportation cost	Min	Sum of all activity costs that the warehouse has in charge (Rp)/ Total of revenues from sales (Rp)	Rp 10,000,000
Quality				
Q-1	Physical inventory accuracy	Max	Number of pallets unloaded + number of pallet stored + number of pallet move during replenishment) ×number of pallets with inaccuracies between the physical inventory and the system/ Number of pallet unloaded + Number of pallets stored + Number of pallet move during replenishment	99%
Q-2	Storage accuracy		Number of pallets stored in the proper location (nb/month)/Number of pallets stored (nb/month)	97%
Q-3	Order fill rate	Max	Number of orders delivered complete on first shipment (nb/month)/Number of order shipped (nb/month)	99%
Q-4	Stockout rate	Min	Number of products that are not available in stock when the customers make an order/ Sum of the items processed by the warehouse with items in process in picking and shipping activities	5%
Q-5	Return rate	Min	Returned product (nb/month)/ total number of sold product (nb/month)	10%

Selected significant warehouse indicators

b. Inventory Space Utilization

Managing inventory utilization is important, especially for a limited space warehouse. The inventory utilization indicators measure the rate of space employed by storage in the warehouse by comparing the average space occupied by inventory to total warehouse inventory capacity. The total warehouse inventory capacity in finished good warehouse in Banyuatis is 49.3 m^3 and the average space occupied is 40 m^3.

$$= \frac{\text{The average space occupied by inventory } (m^3)}{\text{Total warehouse inventory capacity}}$$

$$= \frac{40\ m^3}{49.3\ m^3} = 81\%$$

c. Physical inventory accuracy (%)

The physical inventory accuracy measures the difference between the actual number and the system in percentage expression. Based on the calculation, the average physical inventory accuracy is 99.9%, with average inaccuracies around 0.96 kg/month, and the average number of receive and delivery items is 144,620 kg/month. The data of managed items and inventory accuracies are presented in Table 2.

Table 2. Number of managed item and physical inventory accuracies

Month	Managed items in the warehouse (Kg)			Inaccuracies inventory (Kg)	Physical inventory accuracy
	Receive	Delivery	Managed items		
April	55,249.78	61,201.23	116,451.01	0.00	100%
May	56,515.77	52,526.45	109,042.21	0.00	100%
June	60,836.53	60,190.54	121,027.07	2.20	99.9%
July	59,321.56	59,184.86	118,506.42	3.35	99.9%
August	53,238.08	54,083.26	107,321.34	0.20	99.9%
September	60,226.81	55,145.55	115,372.36	0.00	100%
Average (Kg/ month)			114,620.07	0.96	99.9%

d. Order Fill Rate

Delayed delivery is sometimes found in warehouse activity due to various reasons. For example, in this company, part of the order might delay because it reached the truck's maximum capacity in terms of weight or volume. Consequently, the delayed product will be sent together with the next order. According to the data in September 2021, the delivered number of orders is 55,145.55 kg/ month. Meanwhile, the number of orders delivered on the first shipment is 54,342.75 kg/ month. Therefore, the percentage of the order fill rate is 98.5%.

$$= \frac{\text{Number of orders delivered complete on first shipment (nb/month)}}{\text{Number of order shipped (nb/month)}}$$

$$= \frac{54{,}342.75\ \text{Kg/ month}}{55{,}145.55\ \text{Kg/ month}} = 98.5\%$$

e. Stock Out Rate

Stockout or out-of-stock is an event when the ordered products are unavailable in stock. In this case, stockout are rarely occurs. Production division always tries to produce unavailable items even takes a longer time to be deliver. Some products that fast moving and needs harder machine adjustment to manufacture are produced in large quantity. Therefore, stockout rate is relatively low. According to the data in Table 3, the average stockout rate is 0.5 %.

Table 3. Number of unavailable stock and stockout rate performance

Month	Unavailable stock (Kg)	Managed items	Stockout rate
April	1,294	116,451.01	1.11%
May	580	109,042.21	0.53%
June	394	121,027.07	0.33%
July	876	118,506.42	0.74%
August	305.5	107,321.34	0.28%
September	0	115,372.36	0.00%
Average	***574.9***	***114.620.07***	***0.50%***

5-Whys Analysis

In order to enhance the warehouse performance, the cause of the problem is need to be identified prior to improvement process. According to warehouse performance measurement presented in Table 4, the insufficient warehouse performance is inventory space utilization with 81% and the target is 85%. This means the rate of space occupied by storage is not fully maximize yet. Therefore, RCA method has been carried out to dig deeper the possibility cause of inadequate inventory space utilization, employed 5-whys with tree diagram analysis.

Based on the 5-Whys analysis presented in Figure 3, the proximate cause of low inventory space utilization is the company failed to maximize its storage space. This analysis reveals two possible answer and all of the expert agree that stockpile on the floor and storage located in packaging area instead of warehouse is the reason or inappropriate storing place.

The overproduction occurs because of there is no forecasting activity in production planning, since it is fully based on target. Meanwhile the other storage used to store the premium products that actually does not need larger space, and properties from marketing division also filled the storage space. Thus, happened since no stock allocation management and SOP to keep the properties from marketing division. Additionally, there is a free space inside the warehouse that fit to put a rack to store more product vertically. Instead of adding the rack, the space used to store returned product and creates another stock pile. Since there is no clear SOP how and when to handle the returned products, then returned products are compiled in a large quantity at the empty area before returned to production to be demolished or reprocessed.

Table 4. Overall performance measurement result

Dimension	WKPI	Polarization	Result	Target
Time				
T-2	Order lead time	Min	2 days/ order	2 days/ order
Productivity				
P-1	Inventory space utilization	Max	81%	85%
Quality				
Q-1	Physical inventory accuracy	Max	99.9%	99%
Q-3	Order fill rate	Max	98.5%	99%
Q-4	Stockout rate	Min	0.5%	1%

Insufficient WKPI

At this stage, it is expected that the reason for low inventory space utilization due to several ultimate cause, no forecasting in production planning, there is no stock allocation management, and there is no detailed SOP for returned product. The clear options that emerged as available to improve inventory space utilization performance as mentioned in this analysis above were listed below and explained in the following paragraph:

- employed appropriate forecasting method in production planning,
- stock allocation management based on FSN (fast-moving, slow-moving, and non-moving) analysis and,
- creating SOP to handling returned products and storing marketing division properties.

6. CONCLUSIONS

Due to the result of the study, important to realize that warehouse is a partially significant facility in the production company. The benefit and losses of warehouse depends on how the company assumes the role of the warehouse and how it performed. This study explained the warehouse performance evaluation based on KPI sourced from warehouse current activities and previous study, then measure the performance through the significant indicators. The concept of WKPI provide indicators of specific area that need to improve or fix through the performance measurement. Thus, allows the managerial team to achieve sufficient controls of the warehouse effectively. Additionally, the application of the 5-whys analysis with tree diagram provides the problems identification for inadequate performance in specific indicators and strengthen the analysis on what definite area need to be fixed as illustrated in this research.

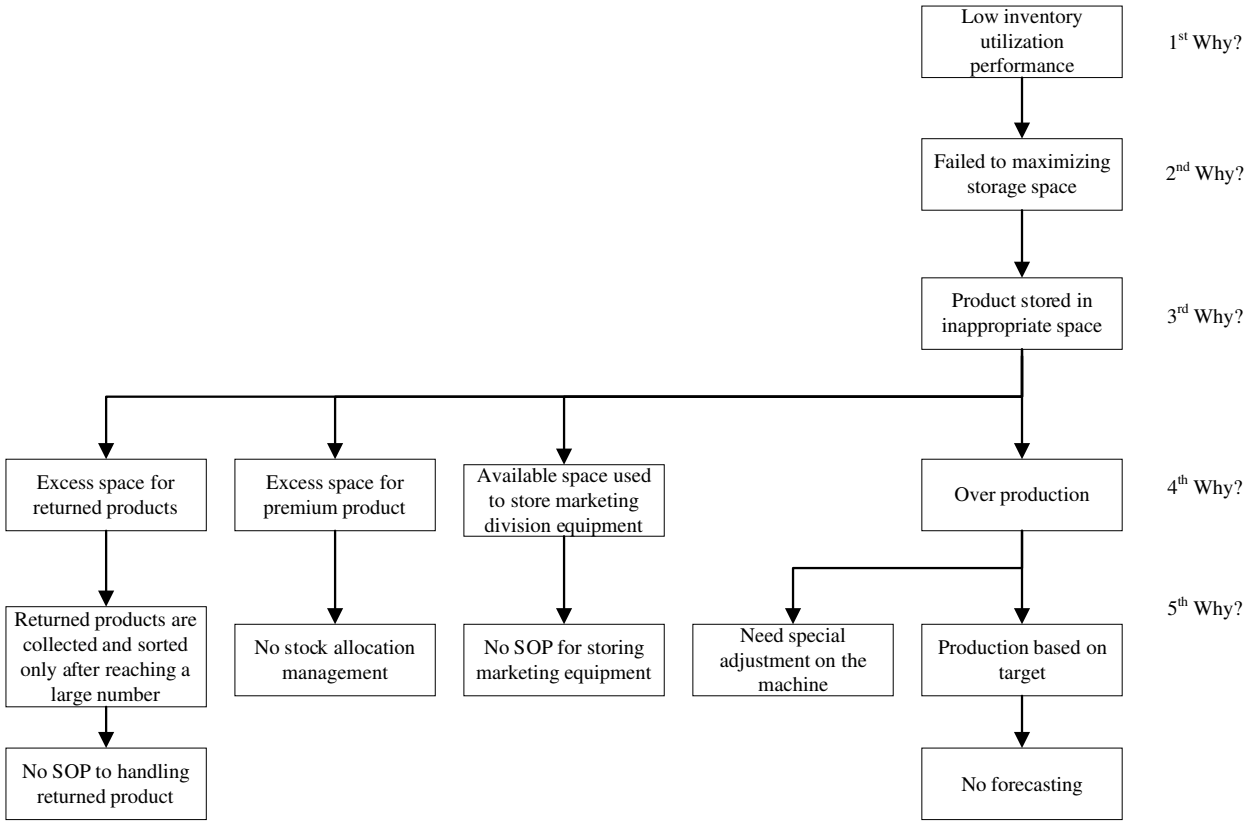

Figure 3. RCA with 5-whys tree diagram of low inventory utilization

Based on the research, it can be concluded that:

- Based on warehouse operations, there are 9 WKPI as the basic metrics in Banyuatis finished good warehouse and 5 of it selected as the significant indicators. There are order lead time, inventory space utilization, physical inventory accuracy, order fill rate, and stockout rate.
- According to warehouse performance measurement on significant WKPIs, it is revealed that the overall operations in Banyuatis finished good warehouse is excellent. Even though, the inventory space utilization indicators show failed to achieve the target with 81% utilized, where the target is 85%.
- The RCA through 5-whys analysis then employed to understand the root cause for insufficient inventory space utilization. The result expected that no forecasting process in production planning, no stock allocation management, and no SOP to handle returned product are the ultimate causes for low utilization in inventory space.

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STRATEGY ANALYSIS OF DEALING WITH THE COVID-19 PANDEMIC ON FREIGHT FORWARDING SERVICES: A CASE STUDY ON FREIGHT FORWARDING SERVICE COMPANY

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ABSTRACT

Freight forwarding or goods delivery transportation management services that using multimodal system plays a very large role to the export-import activities, because it provides benefits for the country. PT Lintas Bangsa Internasional (LBI) is a business engaged in freight forwarding that provides goods delivery services in the form of custom clearance, door to port, door to door either through land, air, or sea transportation. The existence of the Covid-19 pandemic has affected this business because several importer-exporter countries have been applying a lockdown policy which has an impact on the business continuity of PT Lintas Bangsa Internasional (LBI). The strategy formulation requires the identification of the company's internal and external strategic factors with a strategic planning by using the EFE and IFE methods, the IE Matrix and the SWOT Matrix. Then the results are processed using the QSPM Matrix. From the analysis results, the selected strategy with the largest TAS value is the product development strategy with the acquisition of TAS 6.02, aggressive strategy of 5.98, and market penetration strategy of 5.86. Thus, the alternative strategy chosen by PT LBI is the product development strategy. The product development strategy recommends: developing IT-based by giving it to customers so they can check the position of goods in real time; the creation of a website as well as social media and business to business as a marketing medium for PT LBI; and the entire billing and payment system is carried out electronically to reduce human interaction during Covid-19.

Keywords: Freight Forwarding, EFE, IFE, IE, SWOT, and QSPM.

1. INTRODUCTION

In December 2019 there was an outbreak of Coronavirus Disease or known as Covid-19 which was transmitted from human to human with wide spread to various countries so that several protocols were carried out to prevent the wider spread of the virus, one of which was by reducing human interaction (Susilo, et al, 2020). The first Covid-19 was reported in Indonesia on March 2, 2020, the spread occurred due to transmission from people who have traveled to countries that have been infected and infect other humans.

The Covid-19 pandemic has greatly impacted the decline in the field of exports and imports nationally because several countries have locked down which has resulted in delays in the delivery of goods and documents needed for these exports and imports. The number of factories that stopped

their production due to no one placing orders again, and the existence of Large-Scale Restrictions (PSBB) caused a decline in company performance. According to Suyono (2007), freight forwarding plays a very large role in export-import activities because it provides benefits for the country. Freight forwarding is a management service for all activities needed to carry out the delivery, transportation and receipt of goods using multimodal transport either by land, rail, sea, and air in handling imports or exports.

PT. Lintas Bangsa Internasional (LBI) is a company engaged in the field of freight forwarding or export-import management services covering all goods delivery activities using multimodal. PT. Lintas Bangsa Internasional (LBI) was founded in 1999 which is engaged in export-import goods delivery services with services including custom clearance, door to port, door to door either through land, air, or sea transportation. PT. LBI serves its customers in the transportation of goods/cargo in all different shapes and sizes, including raw materials, production equipment (factory machines), construction equipment (heavy equipment), electronic goods, and chemicals. The type of transportation served can be in the form of domestic transportation (where the seller and buyer are both in Indonesia) or transportation abroad, where the place of the sender or recipient is domiciled.

In 2020, the shipper countries have experienced a lockdown, resulting in delays in the delivery of goods and documents needed for the release of delayed goods, the existence of Large-Scale Restrictions (PSBB) also causing a decline in the company's performance in shipping goods. What is meant by a decrease in company performance is the limited processing of documents and the release of goods at Customs, TPS (Container Terminal) and business partners (shippers and trucking entrepreneurs). Also, PT. Lintas Bangsa Internasional (LBI) has difficulty finding ships and containers due to scarcity and shipping prices which are very expensive/higher than the usual price.

By looking at the uncertain conditions in this Covid pandemic, PT. Lintas Bangsa Internasional (LBI) in order to maintain the survival of the company requires the right strategy from strategic management. According to Erislan (2018), strategic management plays an important role in making decisions in running the company in anticipating any changes that occur, providing direction for achieving company goals, activities related to work carried out effectively and efficiently, so that they can be more profitable than companies that do not implement strategic management. Good strategic management can formulate the right strategy by looking at the problems and opportunities that exist. The method used in this research is strategic management planning by using SWOT (Strength, Weakness, Opportunity, Threat) and QSPM (Quantitative Strategic Planning Matrix) methods. From the results of this analysis, it can be determined the company's position and the right basic strategy for business development.

2. LITERATURE REVIEW

Juwono (2012) conducted research entitled "Analysis of Strategic Management of a Franchise Company (Franchise) Case Study in Mcdonald's Fast Food Restaurant". This study uses a SWOT analysis (Strengths, Weaknesses, Opportunities, Threats) to determine the company's position in October-December 2011. From the research results, the Mcdonald's franchise business unit had implemented the right management strategy, obtained from the EFAS (External Factor Analysis Summary) of 3.00: IFAS (Internal Factor Analysis Summary) is 2.65, so that it is in square 1, which supports the aggressive strategy. It is recommended to maintain the strategy and be able to improve the management strategy to become the market leader in their field. The advantages of this research using a market mix and financial statements. The weakness of this research is in decision making as this study only utilized the SWOT method in the decision-making process.

Mirzakhani, Parsaamal & Golzar, (2014) "Strategy Formulation With SWOT Matrix: A Case Study Of An Iranian Company" Research study on Pishgaman Sanat Taha company engaged in manufacturing namely GPS tracking solutions, tracking websites and servers, access control systems, designs, and manufactures RFID based systems, license plate detection systems, image processing solutions, smart home systems with international modern technology. The value of EFE is 2.88 and IFE is 2.7, then it is in the second square, namely *aggressive strategy* that must be applied to the company. The results of the IE matrix analysis state that there are good conditions for the company under study, SO strategy in the SWOT matrix is introduced as a suitable solution for company status. The market influence was selected as the most important strategy using the QSPM method. The advantage of this research is that the QSPM matrix will produce a more accurate analysis than the SWOT because QSPM is the final stage of strategy formulation analysis in the form of selecting the best alternative. From the QSPM matrix, it can be seen that the *TAS (Total Attractiveness Score*) value is the highest, which is the most suitable alternative strategy to be implemented. Lack of accuracy in processing and time-consuming.

Phi, Giang and Le, Dung (2020), "Strategic Responses of The Hotel Sector To COVID-19: Toward A Refined Pandemic Crisis Management Framework" discusses the long-term impact of the COVID-19 pandemic on hotels which requires revising, innovating, and changing business by responding and analyzing strategies in the hotel sector. The result of this study is a map of the concept of pandemic management in hotels, namely emergency transformation, business innovation, services changes, health & safety measures, negative impact, recovery strategies and government policy. In doing so, hotel managers still need to follow government policies by maintaining social distancing, quarantine, and lockdown. The hotel management strategy resulted in three proposals, namely, first, hotel managers need to ensure cash flow when income drops and save financial resources properly. Secondly, they need to make a priority list of hotel expenses and cut costs that are less important. Third, they need to develop hotel-sized communication technology and government support. The advantage of this research is that the hotel business can imitate the application of concepts and strategies for business continuity. The drawback of this research is that the data used were hotel data in the UK; thus, it needs to be studied so that it can be applied in other parts of the country and there are additional uses of other methods.

Of the three previous studies, the connection with the current research uses the IFE (Internal Factor Evaluation), EFE (External Factor Evaluation) method, the application of health in preventing COVID-19, IE (Internal-External), SWOT (Strengths, Weaknesses, Opportunities, Threats) and QSPM (Quantitative Strategic Planning Matrix).

3. METHODS

The method used in this study is strategic management planning using the SWOT (*Strength, Weakness, Opportunity, Threat*) and QSPM (*Quantitative Strategic Planning Matrix*) methods. SWOT analysis is a systematic identification of factors to formulate an integrated strategy between the company's internal and external environment (Rangkuti, 2018). From the results of this analysis, it can be determined the company's position and the right basic strategy for business development. This basic strategy was further developed through the integration of a combination of SW internal factors (strengths and weaknesses) with OT external factors (opportunities and threats) which resulted in the formulation of alternative strategy formulations. Furthermore, this study utilized the QSPM method to decide on the strategic planning that will be used based on the previously identified internal and external key success factors.

4. RESULTS

This research resulted in the following stages: the external environment of PT. LBI are economics, law and politics, technology, demographics and social and competitors; in the internal environment of PT. LBI is in the form of finance, marketing, management, R&D, resources in the external environment (threats and opportunities) and internal environment (weaknesses and strengths), formulation of the factors in the questionnaire, data processing of the questionnaire results to the owner of the company PT. LBI, formulation of EFE, IFE, data processing into IE matrix, matching in SWOT matrix, decision making using QSPM matrix. The following are the results of the formulation of EFE and IFE.

Table 1. EFE Matrix

No	External Environmental Factors			
	Opportunity	Weight	Rating	Rating
1	High demand for exports and imports	0,09	4	0,36
2	The market share in the territory of Indonesia is still quite wide	0,09	4	0,36
3	All-online technology for document creation and payment systems	0,09	3	0,27
4	Collaborating with fellow ALFI members	0,09	4	0,36
5	The development of e-commerce companies	0,07	3	0,20
6	The faster process of developing logistics facilities in Surabaya and Gresik areas	0,09	4	0,36
7	The location of many logistics support facilities in the form of a transportation system (trucking)	0,09	4	0,36
	Threat			
1	Exchange rate fluctuates	0,07	2	0,14
2	The existence of a marketing system technology	0,07	2	0,14
3	Lack of updates to the company's online document and financial system	0,05	1	0,05
4	There was a delay in delivery due to the Covid-19 pandemic	0,05	1	0,05
5	More and more competitors in the same field	0,07	2	0,14
6	Government policy to increase fuel and toll rates	0,05	1	0,05
7	The price of each means of transportation is different	0,05	1	0,05
	Total	1		2,89

Table 2. EFE Matrix

No	Internal Environmental Factors			
	Strength	Weight	Rating	Rating
1	Company with more than 20 years experience in business	0,09	4	0,36
2	The price offered is cheaper with satisfying service	0,07	4	0,20
3	Serving custom clearance, door to door, door to port,	0,09	3	0,36
4	On time in delivery	0,07	4	0,27
5	Good financial processing	0,07	3	0,14
6	Implementing the 5M health protocol in preventing Covid-19	0,07	4	0,27
7	Have loyal customers	0,09	4	0,36
	Weakness			
1	No promotion on social media, website	0,07	2	0,14
2	The structure and position in the company is not clear	0,05	2	0,05
3	Most of the work is done manually, not online regarding document and financial matters.	0,07	1	0,14
4	Management has not facilitated career advancement	0,07	1	0,14
5	The target market is still narrow, only in Kalimantan, Jakarta, Surabaya, Gresik	0,07	2	0,14
6	The decision maker in the company is still held by one person, namely the President Director	0,07	1	0,14
7	The absence of marketing personnel who are quick to find new customers	0,07	1	0,14
	Total	1,00		2,84

After weighting and rating the EFE, the data obtained on the total external matrix score of 2.89, which means that PT LBI already has a good response both in taking advantage of external opportunities and avoiding threats faced by the company. As for IFE, the data obtained on the total internal matrix score of 2.84 which means PT. LBI already has good internal strength in overcoming the weaknesses faced by the company.

IFE calculation results at PT. LBI is 2.84 on the other hand the result of PT. The LBI is 2.89. On the x-axis of the IE matrix, the total IFE values weighted from 1.0 to 1.99 indicate a weak internal position; values 2.0 to 2.99 are calculated again; on the other hand, the value of 3.0 to 4.0 is considered strong. Similarly to the y-axis, the total seeded EFE values from 1.0 to 1.99 were considered low values; values 2.0 to 2.99 are calculated again; on the other hand, the value of 3.0 to 4.0 is considered large. This analysis has a scale of 100 to 400 on each axis (David, 2016). This value is entered in the IE matrix which can be seen in Figure 1.

TOTAL OF EFE SCORE		TOTAL OF IFE SCORE: 4 HIGH	3 MEDIUM	2 LOW	1
	HIGH	4 I GROW AND BUILD	II GROW AND BUILD	III HOLD AND MAINTAIN	
	MEDIUM	3 IV GROW AND BUILD	V HOLD AND MAINTAIN	VI HARVEST AND DIVESTITURE	
	LOW	2 VII HOLD AND MAINTAIN	VIII HARVEST AND DIVESTITURE	XI HARVEST AND DIVESTITURE	1

Figure 1. IE Matrix.

The results of the IE matrix are obtained if PT. LBI is located in quadrant V listed by industry which is interpreted as hold and maintain (David, 2016). So it can recommend the strategy of PT. LBI has two strategies in the form of a market penetration strategy, namely increasing the number of sales force and publicity efforts by launching a new campaign, namely digital marketing; Reducing the intensity of face-to-face contact with potential customers during the Covid-19 condition by utilizing technology; Establishing better cooperation with ALFI can find more potential consumer opportunities. And the product development strategy is developing IT-based by giving it to customers so they can check the position of goods in real time; The existence of a website as well as social media and business to business as PT LBI's marketing media: And all billing and payment systems are carried out electronically to reduce human interaction during Covid-19.

In the SWOT analysis, the criteria for the EFE matrix and IFE matrix have been grouped into four parts consisting of opportunities and threats from external factors, as well as strengths and weaknesses from internal factors. After creating a SWOT matrix, the next step is to choose an alternative strategy on the SWOT matrix by determining the x and y axes. Determining the x-axis is obtained from the total IFE score of 2.84 and the y-axis is obtained from the total EFE score of 2.89. From the total IFE and EFE scores, a SWOT quadratic matrix reference point will be formed to determine the position of PT. LBI. So it can recommend the strategy of PT. LBI, can be seen in Figure 2.

Based on the SWOT analysis the company can take advantage of its internal strengths to take advantage of the opportunities for alternative strategies recommended for PT. LBI aggressive strategy: Marketing development, because the old experience can be a greater opportunity to find potential new customers; Maintaining and improving a service quality to retain loyal customers; Developing a market share and logistics transportation system into the digital era with the support of all ALFI members, the existence of the E-Alfi Application.

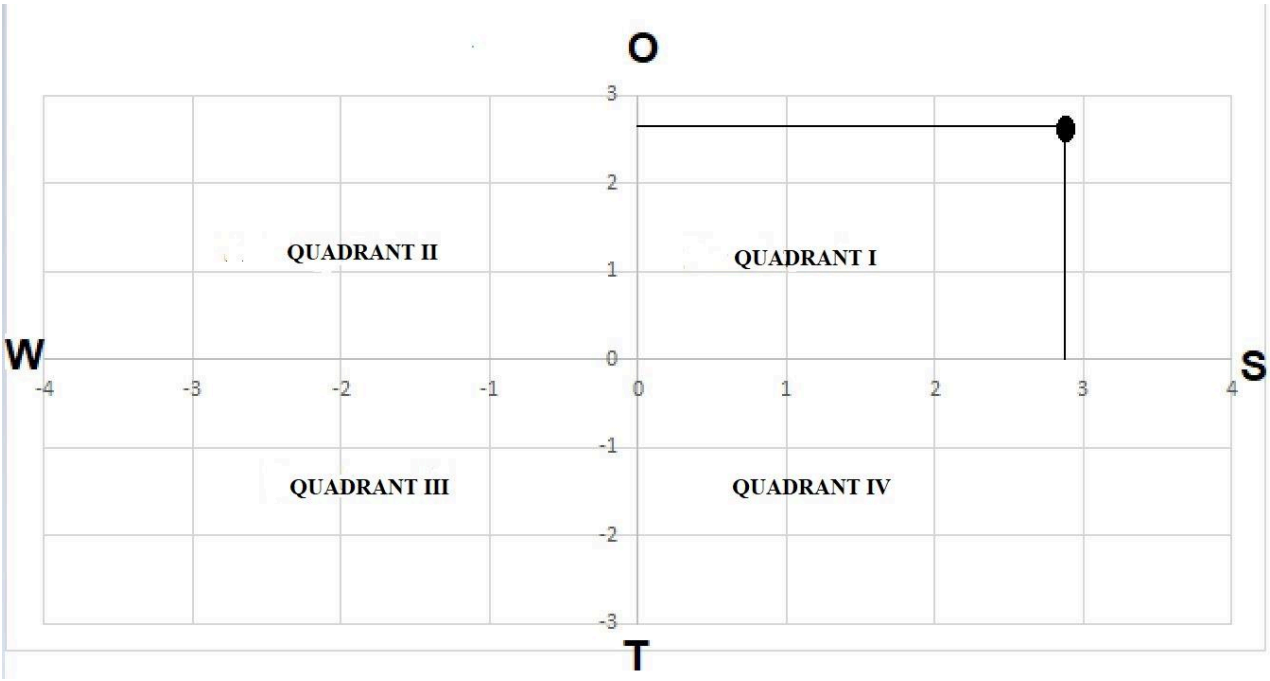

Figure 2. SWOT Quadrant Matrix PT. LBI.

In the results of the calculation of the QSPM matrix PT. LBI can be seen that the strategy with the highest TAS value is obtained in the product development strategy with a TAS of 6.02 followed by an aggressive strategy of 5.98 and the last order is the market penetration strategy of 5.86. So that the alternative strategy of PT. The chosen LBI is the product development strategy.

The strategy management formulation process is not said to end when the industry simply decides what strategy to pursue. The industry is still obliged to translate the strategy formulation into strategic action. Therefore, the industry must be able to implement the strategies that have been obtained efficiently so that the industry can reach its goals optimally.

6. CONCLUSIONS

From the results of data processing and analysis that has been carried out, it can be concluded that external environmental factors have high opportunities for export and import demand, wide market share, online technology, as well as a transportation system (trucking) that supports the threat of exchange rate fluctuations, the marketing system has not maximum, lack of online system updates, delays in delivery due to the Covid-19 Pandemic, more competitors in the same field, government policies to increase fuel and toll rates, prices for each means of transportation are different, and there are more and more competitors in the same field. The strength of the internal environmental factors of PT. LBI is a company with more than 20 years of experience, the price offered is cheaper with satisfactory service, serving door to door, door to port, custom clearance, timely delivery, the company manages finances well, implements the 5M health protocol in preventing Covid-19, and have loyal customers. The weakness is that there is no promotion on social media, there is no website, the structure and positions within the company are not clear, the work is still mostly done manually, there is no online administration system, decisions in the company are still held by one person, namely the President Director, and there is no marketing staff. fast to find new customers. Based on the QSPM analysis of PT. LBI has a strategy with the highest TAS score obtained in the

product development strategy with a TAS of 6.02 followed by an aggressive strategy of 5.98 and the last order is the market penetration strategy of 5.86. So that the alternative strategy of PT. The chosen LBI is the product development strategy. The product development strategy recommends: Developing IT-based by providing customers so they can check the position of goods in real time as well as the creation of websites and social media and business to business as PT LBI's marketing media. The entire billing and payment system is carried out electronically to reduce human interaction during Covid-19.

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PROBABILISTIC PIT GROWTH PREDICTION MODEL ON CONCRETE BRIDGE GIRDER USING HIDDEN MARKOV MODEL

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ABSTRACT

All infrastructures become deteriorated over time, which result in degradation of total performance. This deterioration is characterized by pit or local damage, mainly in reinforcement material of the concrete bridge. Currently, the pit growth prediction models were employed by statistical approach using classical reliability and Montecarlo simulation. However those methods encounter NP hard problem when a lot of data is applied or more than two categories of the pit growth is classified. This paper proposed an advanced stochastic method to predict pit growth condition using Hidden Markov Model (HMM). HMM is used to represent the dynamic process of pit growth by updating information of chloride distribution along the concrete surface and traffic load over the bridge. In this model, the pit growth states are classified into safe, early growth, intermediate growth and failure conditions. Likelihood of this model is maximized using expected maximization (EM) method. To validate the model, three simulated bridges were used as case study. The result shows that the proposed model not only can be used to predict the probability of pit growth condition but also can predict the deterioration lifetime of reinforced steel in girder. Furthermore the output of this model can be utilized to plan bridge maintenance strategy, as well as bridge deterioration early warning system.

Keywords: Bridge, Maintenance, Corrosion; Pit; Crack, Hidden Markov Model.

1. INTRODUCTION

Bridge as an infrastructure of transport facilities is classified into several types based on structural model and materials used. These facilities, mainly in concrete bridge become deteriorated over time due to chemical, physical, biological and mechanical processes. In Schije (2003), Suresh (1998) and Jones (1992) are considered that corrosion and fatigue as the main constituent on reinforced concrete deterioration. The corrosion process usually is characterized by electrochemical reaction which affect to material heterogeneous. In aggressiveness environment,

the corrosion of steel in reinforced concrete mainly induced by chloride, Liu and Wayer (1998). Meanwhile, steel corroded under environmental exposure mostly characterized by pitting corrosion or local damage, Jones (1992). In contrary, the pit growth in reinforced concrete which generated by fatigue as result of repetition loading such as traffic, Din (1971).

Probabilistic model prediction of pit growth of structural element such as aluminum, titanium and steel alloy material have been done by several researcher. The probability model of pit growth to crack nucleation was proposed by Harlow and Wei (1998). The foremost probabilistic model for pitting to fatigue crack growth was proposed by Kondo (1989), and further discussed by Chen et.al (1996). The model improvement, considering the comprehensive methodology in seven stages of corrosion fatigue life was proposed by Shi and Mahdaven (2001). An analytical first order reliability method and Monte Carlo simulation to considered uncertainty is proposed in this model improvement. Probabilistic lifetime assessment of simple supported concrete girder under coupled corrosion-fatigue mechanism was proposed by Bastidas (2009). In this work, mechanism of corrosion-fatigue is divided into corrosion initiation and pit nucleation, pit to crack transition, and crack growth. The robustness is evaluated using classical reliability and Monte Carlo simulation. The result of this work, total corrosion-fatigue lifetime, is classified into safe and failure category.

As mentioned previously, the probability prediction model of corrosion-fatigue life were proposed using classical method. However, in classical reliability approach, the total probability output of this model is can only be classified into two catagories (fail-safe). Previous method also encounter NP hard problem when a lot of data is applied or more than two categories of states is classified.

Meanwhile, more than 84000 bridges in Indonesia are need to be maintained every year. The maintenance strategy is determined by its performance which visually assessed based on the condition of concrete damage. Four scale rating is performed in this assessment and reported in Indonesia Bridge Management System.

The objective of this research is to proposed an advanced stochastic model to predict pit growth condition. The output of this model is used as supplement information to plan bridge maintenance strategy. The proposed model used Hidden Markov Model (HMM) as prediction model, because the nature of concrete pit growth are nonlinear and dynamic.

2. LITERATURE REVIEW

The mechanism of transition from pit corrosion to fatigue crack in concrete girder, by considering chloride and traffic induced corrosion and fatigue respectively, is shown in fig.1. The corrosion mechanism in this case is divided into three stages : corrosion initiation, corrosion at start and corrosion growth. Corrosion initiation in induced by chloride as a function of time using Fick's second law of diffusion (Tuutti, 1993). Cover thickness, chloride diffusion coefficient, chloride concentrations at cover depth at life cycle time are considered as corrosion initiation. Corrosion rate at the start of corrosion propagation depends on water-cement ratio and cover, (Vu.Kat ,2005). It is suggested that during corrosion propagation period, corrosion rate reduced by time. This is due to rush products reduced the diffusion of the iron ions away from the steel surface. Pit is the result of an electrochemical process governed by corrosion, depend on a ratio between pitting and uniform corrosion depth (Jones, 1992).

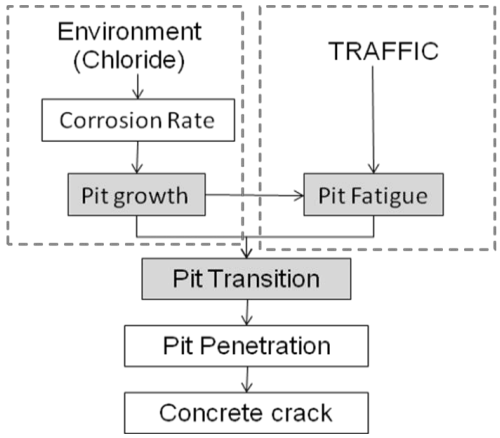


Figure 1. Pit induced by coupled of Chloride and traffic factors

The fatigue crack growth rate is estimated using Paris-Erdo-gan law where crack size depends on the number of cycles, the alternating stress intensity factor, and material constant. and Lovegrove (1971) reported experimental values of those constants corresponding to medium and long crack growth stage.

Based on the previous studied, Bastidas *et al* (2009) proposed empirical model of transition between pit growth and fatigue which the mechanism is represented in mathematical equation. Nevertheless, on his works, the classical approach namely Monte Carlo simulation and classical reliability is used to compute life time of the pit. Furthermore, the result of simulation is classified using a simple approach into normal and failure condition. The advantage of this model is more suitable when used to predict the pit with a limited number of bridge data. However, the drawback of this model lacked information about correlation between inputs with an output, transitional of the pit in time sequence and hard classification in large number data. Moreover, this method encounter NP hard problem when much data is applied or more than two categories of the pit is classified.

Based on the limitation of current model, an advanced probability method of pit growth prediction is proposed using Hidden Markov Model (HMM). HMM can represent dynamic correlation between input and output in transitional and emission probability. Furthermore, HMM is able to classified more than two category of pit. Therefore, the output of this model not only can be used as basis information for maintenance strategy, but also as bridge early warning system .

3. METHODS

3.1 Model Architecture

The proposed model use HMM as Prediction model. HMM is used as man model, because HMM can capture and represent the nature of pit growth which follow nonlinear and dynamic process. Figure 2 shows that HMM is used to predict the temporal probability of corrosion pit conditions (Zk) based on initial conditions (Z_0) and updated field observation data, namely: chloride conditions (x_k) and traffic loads (y_k). The prediction $P(Zk|Zk\text{-}1)$ and updating process $P(Zk|xk,yk)$ in the proposed model will automatically increase the accuracy of the model.

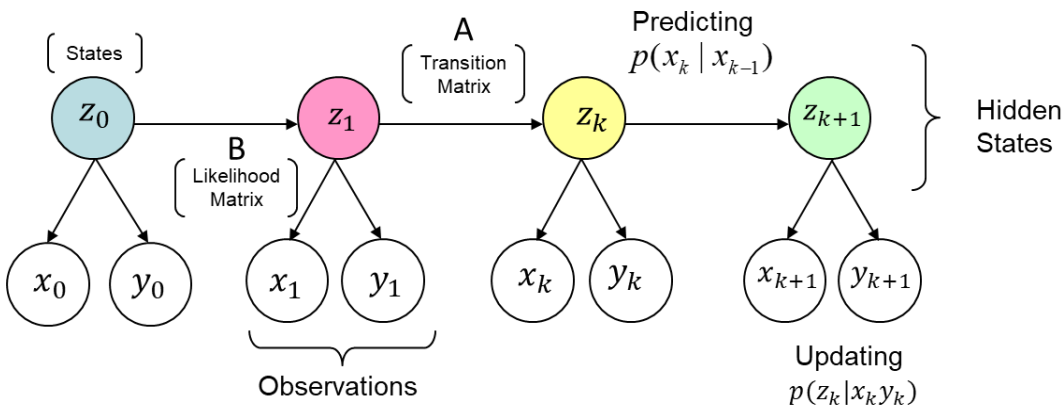


Figure 2. proposed HMM Architecture model

In this study, chloride at surface and traffic load are taken as factors that affect to deterioration of the pit in bridge girder. The basic model of the pit induced by chemical and mechanical processes, which considered are:

a) the pit growth as a result of the chemical process (d_p) governed by corrosion (i_{corr}) with respect to time can be written as (Bastidas, 2009; Jones,1992):

$$d_p/d_t = 0.0116.\alpha.i_{corr}(t) \quad \text{.....(eq.1)}$$

b) the fatigue pit growth as a result of physical process (d_a) or fatigue (f) induced by traffic with respect to time, or called as fatigue crack growth, can be written as:

$$da/dt=C_p[\Delta K_{pit}(t)]^m.f(t) \quad \text{.....(eq.2)}$$

Where ΔK is the stress intensity factor, Cp and m are materials constant which those values are reported in Din and Lovegrove,(1971).

3.2 State Value of Pit

System of discrete Markov process is considered to any time as being in one of a set of |S| discrete states, s_1, s_2,… $s_{|S|}$. In this model, the discrete state of pit is classified into two states, namely failure condition if the pit reaches greater than or equal 0.5d (where d is diameter of steel) and normal condition if otherwise. The state definition divided into four discrete states (|S|=4) with view to give the warning in maintenance strategy during pit propagation. The states definition is divided by the following criteria:

a) State 1, s_1 = safe condition or no pit happen yet: if pit ≤ initial pit.
b) State 2, s_2 = early growth: if initial pit ≤ pit < 0.2d.
c) State 3 , s_3= intermediate growth: if 0.2d ≤ pit < 0.5d
d) State 4, s_4 = failure condition: if pit ≥ 0.5d

3.3 Maximum Likelihood

The goal of learning parameters is to find the parameter of Transition probability matrix and likelihood probability matrix by maximizing the log-likelihood of sequence of state value of (X_k). To get complete model of HMM, the likelihood of parameter θ is maximized by following function:

$$ML_\theta = \text{argmax}_{A,B} \sum_{\vec{z}} Q(\vec{z}) \log \frac{P(\vec{x},\vec{y},\vec{z};A,B)}{Q(\vec{z})} \quad \text{.....(eq.3)}$$

3.4 Model Inference

The goal of inference of HMM is to evaluate the conditional probability Distribution Function (PDF) to calculate the pit growth probability where observations O={x,y} assumed as statistical independent. Forward procedure is performed in this calculation. Computation of pit growth probability for each time step t= [1….T] is divided in three induction steps, as follows:

1) Initiation, computation at time t=1 in state $z_{1(i)} \in |S|$ with initial probability $\pi_{(i)} \in |S|$ and actual observation $O_1=\{x_1, y_1\}$ where $x_1 \in |U|$ and $y_1 \in |V|$, written as :

   $\alpha_1(i)= \pi_i b_{jkl}(O_1)$, where : $1 \leq i \leq |S|$; $1 \leq k \leq |U|$; $1 \leq l \leq |S|$

2) Induction, computation at time t=[1,2,…,T-1] in state $z_{t+1(j)} \in |S|$ with state $z_{t(i)} \in |S|$ times transition matrix A={a_{ij}} times emission matrix B={b_{jkl}}with respect to actual observation $O_{t+1}=\{x_{t+1}, y_{t+1}\}$ where $x_{t+1} \in |U|$ and $y_{t+1} \in |V|$, written as :

   $$\alpha_{t+1(j)} = \left[\sum_{i=1}^{T-1} \alpha_t(i).a_{ij} \right] b_{jkl}(O_{t+1})$$, where: $1 \leq j \leq |S|$; $1 \leq k \leq |U|$; $1 \leq l \leq |S|$

3) Termination, computation of the pit probability by summation α_t at time t=[1,2,…,T-1]

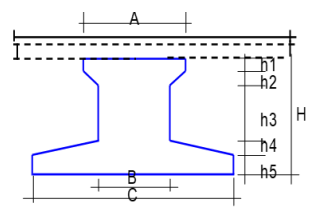
   $$P(O|\theta) = \sum_{i=1}^{T} \alpha_t(i)$$, where: $1 \leq i \leq |S|$

4. MODEL IMPLEMENTATION

This section presents application of proposed model. Prior probability of pit growth states, chlorine condition along the concrete surface, and traffic load condition are generated by simulation data. The girder properties for simulation were given in Table 1.

Table 1. Bridge Girder Properties

No	Bridge Code	H	h1	h2	h3	h4	h5	A	B	C
		Unit in Centimeter (Cm)								
1	B-1	200	15	15	110	35	25	120	20	70
2	B-2	185	12.5	12.5	115	25	20	105	20	60
3	B-3	200	15	15	110	35	25	120	20	70



The chloride at surface and traffic are determined as factors induced pit. Information about chloride at surface estimated based on simulation. Traffic and chloride at surface data are given in Table.2.

Table 2. Traffic and Chloride at Surface (Cs) Data

No	Traffict data		Cs (kg/m3)
B1	250	LHR/year	N(7.35;0.5)
B2	200	LHR/year	N(10.2;0.5)
B3	610	LHR/year	N(10.2;0.5)

Figure 3. (a) Average Daily Traffic Data (b) Chloride at Surface Data.

Given 3 simulated bridges data, the parameters of beam properties and input govern bridge deterioration are collected. Using equation (1) and (2), corrosion initiation is calculated by considering the value of concrete cover (c) is 4 mm, the chloride diffusion in the concrete (D_{cl}) follows lognormal distribution with mean 16.25 mm2/year and covariance 35%, and time for 80 years. Since chloride concentration at surface and chloride diffusion rate are uncertain, a Monte Carlo simulation is utilized to calculate chloride diffusion. After corrosion initiation, initial

corrosion and corrosion rate are calculated using study in Vu Kat (2005). Sequential probability of corrosion rate for each state $P(x_t)$, $x_t \in (u1,u2,u3,u4)$, is classified based on observation discretization shown in table 3.

Table 3. Observation discretization

Corrosion Rate (μA/cm2) 1st Observation state (i)		Traffic (average daily traffic/ADT) 2nd Observation state (Fi)	
1	c_1=0 , (No corrosion)	1	f_1 < 250ADT
2	0 < c_2 ≤10	2	250ADT ≤ f_2 <500ADT
3	10 < c_3 ≤20	3	500ADT ≤ f_3 < 750ADT
4	20< c_4 ≤50	4	750ADT≤ f_4

Given complete data, maximum likelihood is performed using equation 3. Transition matrix and emission matrix were derived using lagrangian approach. The result of transition matrix, $P(z_{t(j)}|z_{t+1(i)})$ where t=1….T-1 for T=120 years, i=4,j=4, $z_t \in \{s_1 \ldots s_4\}$, and the result of emission matrix, $P(x_{t(k)},y_{t(l)}|z_{t(j)})$ where t=1…T for T=120 years, j=4,k=4,l=4, $x_t \in \{u_1 \ldots u_4\}$, and $y_t \in \{v_1 \ldots v_4\}$, $z_t \in \{s_1 \ldots s_4\}$are presented in Table 4 and Table 5 respectively.

Table 4. Transition Matrix Probability of Pit $P(z_{t+1(i)}|z_{t(j)})$

	sj=1	sj = 2	sj = 3	sj = 4
si = 1	0,93	0,07	0	0
si = 2	0	0,89	0,11	0
si = 3	0	0	0,92	0,08
si = 4	0	0	0	1

Table 5. Emition Matrix Probability Pit given Observations $P(x_{t(k)},y_{t(l)}|z_{t(j)})$

Probability No pit, $P(:,:,s_1)$

	$u_{k=1}$	$u_{k=2}$	$u_{k=3}$	$u_{k=4}$
$v_{l=1}$	0.532	0.423	0.005	0
$v_{l=2}$	0	0.034	0.0036	0
$v_{l=3}$	0	0	0	0
$v_{l=4}$	0	0	0	0

Prob. Propagation level1, $P(:,:,s_2)$

	$u_{k=1}$	$u_{k=2}$	$u_{k=3}$	$u_{k=4}$
$v_{l=1}$	0	0	0	0
$v_{l=2}$	0	0.268	0.548	0.001
$v_{l=3}$	0	0.0001	0.1789	0.0028
$v_{l=4}$	0	0	0	0

Prob. Propagation level2, $P(:,:,s_3)$

	$u_{k=1}$	$u_{k=2}$	$u_{k=3}$	$u_{k=4}$
$v_{l=1}$	0	0	0	0
$v_{l=2}$	0	0	0	0
$v_{l=3}$	0	0	0.4482	0.2665
$v_{l=4}$	0	0	0.0015	0.2538

Prob. Failure, $P(:,:,s_4)$

	$u_{k=1}$	$u_{k=2}$	$u_{k=3}$	$u_{k=4}$
$v_{l=1}$	0	0	0	0
$v_{l=2}$	0	0	0	0
$v_{l=3}$	0	0	0	0
$v_{l=4}$	0	0	0	1

5. RESULTS

In this section, the proposed HMM model is applied to classify pit given traffic and corrosion condition. Figure 3 shows the model output of probability of pit lifetime for the three simulated bridges.

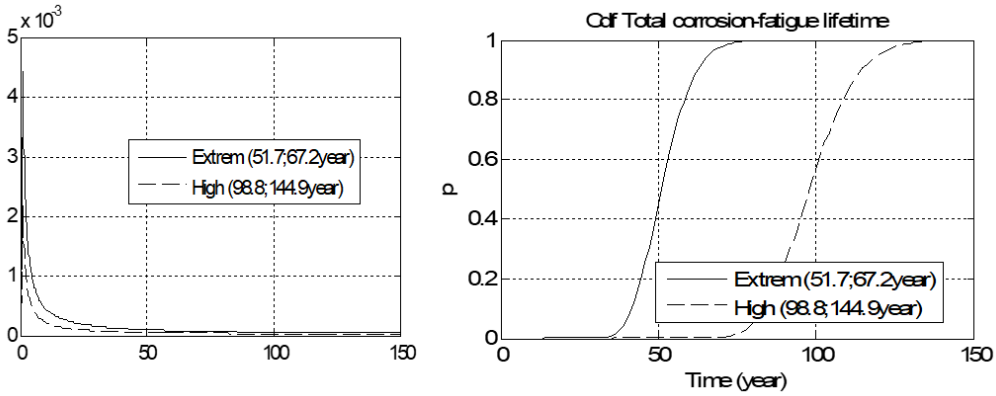


Figure 3. HMM simulation result

The result shows that failure condition is lognormal distribution with parameter mean and standard deviation for B-1 bridge (37,47), B-2 bridge(57,58), B-3 bridge (32,38), B-4 bridge (33,42) and B-5 bridge (39,51). Figure 4 describes the analysis of crack of bridge given the Pit condition for every bridge. It can be seen that bridges B-1, need to be maintained or repaired after 40 years. the probability of bridge crack in states 4 is above 80%. On the other hand, Bridge B-2 need to be maintained or repaired due to crack after 60 years. Based on the result, the maintenance strategy can be set for every bridge, so that the bridge can perform its function optimally.

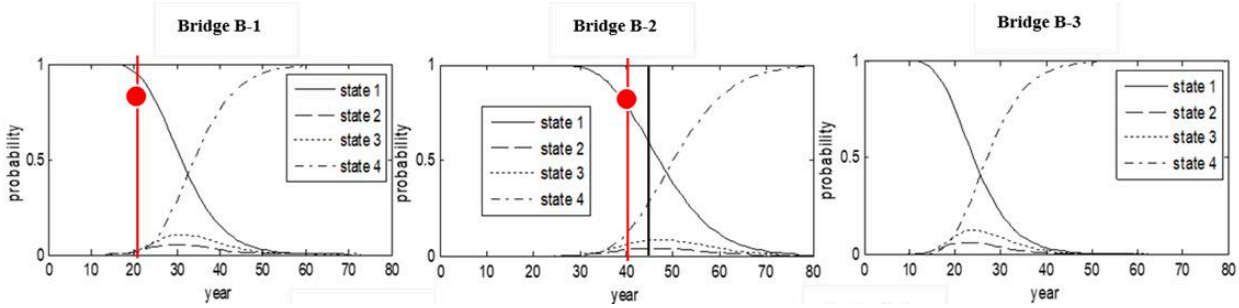


Figure 4. Analysis of Crack given.

6. CONCLUSIONS

Illustrated by given example, the proposed Model can be used as model to predict probability of pit growth condition induced by coupled action of corrosion and fatigue processes. The proposed model also can predict the deterioration lifetime of reinforced steel in girder that reflects the uncertainty. Lack of information from the previous model, namely the relationship between observations and the pit as output, the transitional probability in dynamical systems can be explained explicitly in this model. Moreover, information of the pit growth is also provided by this model so that it can be used in decision making for maintenance strategy. This model is under development. Therefore the research which involve other factors related tor the crack and pit development need to be added to improve the accuracy of the model

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SUPPLY CHAIN RISK MANAGEMENT USING ANP FMEA AND MACTOR METHOD

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ABSTRACT

Supply chain risk has a high chance of happening to frozen food products and is a major challenge in ensuring safety and quality. Frozen food can become contaminated during receiving, handling and storage, production, and distribution. Thus, collaboration of different stakeholders is required to implement effective measures. This study aims to identify risks using the ANP (Analytical Network Process) method, carry out risk control using the WFMEA (Weighted Failure Mode Effect Analysis) method, and mitigation strategies using the MACTOR (Matrix of Alliances and Conflicts: Tactics, Objectives and Recommendations) methods in X companies. There are 3 main criteria and 13 sub-criteria that cause supply chain risk. The results of the study with WFMEA obtained that the highest priority is the risk of handling and storage with a WRPN value of 196.3. And based on the FMEA the highest sub-criteria in the handling and storage criteria is the handling and storage flow that is different from the SOP. So that the mitigation strategy is carried out based on the risk of equipment contamination, weak communication and technical skills, and carelessness in maintaining cleanliness.

Keywords: ANP, FMEA, MACTOR, frozen food.

1. INTRODUCTION

According to WHO (2015), foodborne diseases cause 600 million cases and 420,000 deaths annually. The most common cause of foodborne illness is diarrheal disease due to antimicrobial resistance (WHO, 2021). One of the researcher stated that the spread of antimicrobial resistance also often attacks shrimp, so they are easily infected with white feces disease (Khamesipour et al., 2014). X Company (name changed due to company privacy) is a perishable product company engaged in the frozen food processing industry and dried anchovy. Lala's company produces 17 kinds of frozen food products (based on shrimp and fish), which forces the supply chain actors to handle them optimally. A fairly long supply can be seen in Figure 1. Thus, the problem that occurs is the weakness of the chain seen by actors in handling it. As a result, there have been several complaints from customers regarding the quality of taste that are the cause in the supply chain, such as: risks when receiving supply, handling and storage, production, and distribution. Based on an interview with one of the experts at the X company, the different taste qualities are caused by several factors, but the most important factor is the bacteria content in it.

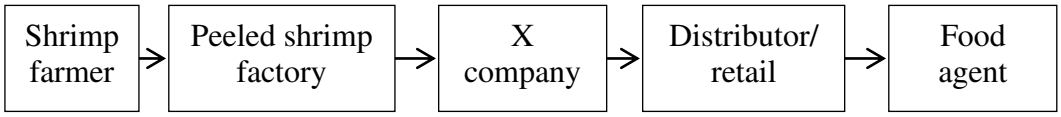

Figure 1. X Company's supply chain model

In handling, shrimp food products have a higher level of vulnerability than fish products. Because, the shrimp product to be processed is still in the form of frozen peeled shrimp, without preservatives, so it is easy to be contaminated with pathogenic bacteria. Meanwhile, the fish products to be processed are already in the form of surimi. In the processing, surimi is mixed with a cryoprotectant which contains sucrose, sarbitol, and sodium tripolyphosphate (STPP). Cryoprotectants protect surimi from protein dehydration thereby preventing protein coagulation (Fahrizal et al., 2018). However, in contrast to shrimp, shrimp contain large amounts of free amino acids that contribute to microbiological spoilage (Eddin & Tahergorabi, 2017; Yassoralipour et al., 2013). Therefore, in handling, the gelling properties of surimi make it a good candidate for seafood-based products (Eddin & Tahergorabi, 2017).

Based on the problems that occurred, it can be seen that it is important to carry out supply chain risk management for frozen food products to be better. Some researchers say that food supply chain risk management can be carried out from various perspectives, namely: risk identification, risk assessment, decision analysis, and risk mitigation (Ge et al., 2016). Thus, the researchers identified and evaluated based on 3 clusters, namely: problems that occurred in Lala's company, influential actors in supply chain activities, and risk factors that influenced.

Hosseini (2013) conducted a research on supply chain risk analysis of food products using the fuzzy Analytic Network Process (ANP). Where in his research analyzes the best alternative as risk management, but does not consider risk improvement plans as a mitigation strategy. In addition, there is also research from Anugerah et al. (2021) which analyzes the risk of the palm oil supply chain using the Failure Mode Effect Analysis (FMEA) method. In his research only assess what risks are the most dangerous without planning a mitigation strategy. Therefore, this research will carry out supply chain risk management by conducting risk identification, risk analysis, and mitigation strategies. The advantage of analyzing the ANP method in supply chain risk management is to show that each risk can interact with other clusters (risks) and their subfactors (Saaty & Sodenkamp, 2008). However, the ANP method cannot determine the failure rate of risk control criteria and parameters, so it is necessary to integrate it with the FMEA method. The results of FMEA analysis can help identify and correct failure modes that have a detrimental effect on the system (Liu et al., 2013). By knowing the adverse criteria, the mitigation strategy that will be carried out is by using the MACTOR method. The MACTOR method seeks to assess power relations between actors and study the convergence and divergence with respect to the number of positions and associated goals. The aim is to study the role of actors in a system by analyzing the interrelationships between them (Isabel & Perez, 2021).

2. LITERATURE REVIEW

The Pacific white shrimp Litopenaeus vannamei is an economically important shrimp species in the world, especially in the Southeast Asian region (Wang et al., 2015). However, these shrimp can be seriously affected by various pathogenic bacteria, such as white spot syndrome virus and vibrio bacteria (Han et al., 2015; Restrepo et al., 2018). One of the causes of pathogenic bacteria is the excessive use of antibiotics in livestock, thereby increasing antibiotic residues (Thornber et al., 2019). Therefore, the integrity of the cold chain must be maintained from the

processing, transportation, handling and storage phases, to the way it is used by consumers (Chaudhuri et al., 2018). The cold chain is a supply chain (SC) of perishable products, which protects various kinds of products from contamination (Bishara, 2006; Chaudhuri et al., 2018). Thus, it is hoped that food policy standards can provide assurance that food does not harm consumers. To provide safe and reliable products, every member of the supply chain must recognize risks both within and outside their network. So, it is necessary to identify and evaluate supply chain risks ultimately implementing a risk mitigation plan to minimize food wastage (Ali et al., 2019; de Oliveira et al., 2017; Khan & Burnes, 2007).

Fazli et al. (2015) analyzed the supply chain risk of crude oil products using DEMATEL-ANP. The results obtained only know the most important risks from the ranking order, not from the results of risk control parameters. Wu & Hsiao (2021) evaluated risks in the frozen food supply chain using FMEA. However, in his research only the level of risk failure was obtained without making a mitigation plan. So, for now the proposed research plan is to identify and analyze risks using the integration of the ANP-FMEA method. With this integration, the results obtained are in the form of risk control priorities based on the reciprocal relationships that occur. Later, the risk priority will be carried out by a mitigation plan as a supply chain risk management effort. Risk mitigation is carried out using the MACTOR method, to determine the role of each actor who plays a role in the supply chain.

3. METHODS

This research is a case study conducted on the Lala company in Indonesia, which produces frozen food. The marketing risk variable is determined by considering previous research that has been verified in the field. After the identification process, the next step is to conduct a risk assessment and risk control using the WFMEA method. Then, an assessment of the actor's power relationship was carried out using the MACTOR method.

3.1 Identification and analysis using the Analytic Network Process (ANP) method

The ANP model used in this study refers to the model (Dag, 2007; Lee et al., 2012) with the following formula and steps:

a. Model construction and problem structuring
b. Perform a weighting assessment on pairwise comparisons
c. Create a pairwise comparison matrix

$$A = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{3n} \end{bmatrix} \quad (1)$$

d. Calculation of element weights (eigenvector value)
e. Calculation of the value of the consistency ratio
f. Calculation of consistency ratio

$$CR = \frac{CI}{CR} \quad (2)$$

Where:

λ_{max} = Maximum eigen value
CI = Consistency Index
CR = Consistency Ratio
IR = Index Random
n = the number of elements compared

g. Make a supermatrix
h. Best alternative choice

3.2 Risk Assessment Using Failure Mode Effect Analysis (FMEA) Method

The FMEA model used in this study refers to the model (Rahmatin et al., 2018). The size of the assessment of each component is the severity value = 1-10, the greater the severity value, the higher the severity level, the occurrence value = 1-10, the greater the occurrence value, the higher the chance of failure in the process, detection value = 1- 10, the greater the detection value, the lower the reliability level of detecting failures in the process. The highest RPN value will be a priority for improvement. RPN formula with the following formula:

RPN = S x O x D (3)

Where:

S = severity
O = occurance
D = detection
RPN = risk priority number

3.3 Risk Control Assessment with Weighted Failure Mode Effect Analysis (WFMEA) Method

The integration of the ANP-FMEA method used in this study refers to the Tanjung & Asti (2019) model with the following formula:

WRPN = $RPN_n \ x \ f(W_i)$ (4)

Keterangan :

$f(W_i)$ = nilai bobot
RPN = risk priority number
WRPN = Weighted Risk Priority Number

Table 1. Risk categories based on WRPN (Tanjung & Asti, 2019)

Output value	Risk Category	Risk Control
0-30	Low	acceptable
31-60	Currently	avoid
61-180	High	
181-252	Very high	not acceptable
253-324	Critical	
>324	Very critical	

3.4 Mitigation of Risk Using MACTOR Method

The risk mitigation strategy used in this study refers to the Bendahan et al model Bendahan et al. (2004) with the following formula and steps:

a. Determine the actor
b. Determine the goals to be achieved
c. Determine the strategy that will be carried out to achieve the objectives
d. Determine the influence between actors on a scale of 0-4 (0 = if actor i does not affect actor j; 1 = if actor i has less influence on actor j; 2 = if actor i has a large effect on actor j; 3 = if actor i has a greater influence on actor j; 4 = J if actor i has a major influence on actor j)
e. Determine the influence of actors on an issue

f. Assessing the direct and indirect relationship between 2 actors.

g. Matrix to determine the effect in general and the correlation coefficient. This is obtained by summing the respective rows and columns of the MIDI matrix, such as equations 5 and 6

$$I_a = \sum_b \left(MIDI_{a,b}\right) - MIDI_{a,a} \quad (5)$$

$$D_a = \sum_b \left(MIDI_{b,a}\right) - MIDI_{a,a} \quad (6)$$

Where:

I_a = Indirect influence of the actor a

D_a = Direct influence of the actor a

$\sum b$ = The sum of the results of the subtraction of actors a and b

$MIDI_{a,b}$ = The direct and indirect relationship of actors a and b

$MIDI_{a,a}$ = The direct and indirect relationship of the actor a

h. Assessment of the strengths of each actor

$$r_a = \left(\frac{\left(I_a - MIDI_{a,a}\right)}{\sum b(I_a)}\right) x \left(\frac{I_a}{(I_a + D_a)}\right) \quad (7)$$

Where:

r_a = Actor coefficient

I_a = Indirect influence of the actor a

D_a = Direct influence of the actor a

$\sum b$ = The sum of the results of the subtraction of actors a and b

$MIDI_{a,a}$ = The direct and indirect relationship of the actor a

4. RESULTS

4.1 Risk Identification Assessment Results with the Analytic Network Process (ANP) method

In processing data using the ANP method, the identification of risks is obtained based on the problems that occur and the actors who play a role. So that it will find out which risk alternatives affect supply chain risk in the risk factor cluster. Table 2 is the result of the weight of each sub-criteria and criteria. However, because the ANP method aims to identify risk, and risk factors are alternative criteria, the next step is to assess risk factor criteria and sub-criteria. With the ANP method, the results of the supply acceptance sub-criteria are 0.28453, the handling and storage sub-criteria are 0.41860, the production process sub-criteria are 0.20240, and the distribution sub-criteria are 0.09447.

Table 2. Weight of Criteria and Sub-criteria with ANP Method

Criteria	Sub-criteria	Weighted of Sub-kriteria	Weighted of Kriteria
Problem	Incompatibility of means of transportation	0.14293	0.273
	Equipment contamination	0.36013	
	Continuity of fluctuating supply quality	0.27963	
	Product storage is not guaranteed	0.21731	
Actor	Shrimp Farmers	0.08305	0.359
	Peeled Shrimp factory	0.30839	
	X company	0.42109	
	Distributor/retail	0.11361	
	Food agent	0.07386	
Risk Factor	Supply Acceptance	0.28453	0.368
	Handling and storage	0.41860	

Criteria	Sub-criteria	Weighted of Sub-kriteria	Weighted of Kriteria
	Production process	0.20240	
	Distribution	0.09447	

4.2 Risk Factor Assessment Results Using the Integration of Failure Mode Effect Analysis (FMEA) and Analytic Network Process (ANP) Methods

In table 3, the risk factor assessment is carried out using the FMEA method. The FMEA method is used to determine the priority of risk factors based on the value of the risk priority number (RPN), which in this study uses a scale of 1-10 as an assessment. Based on the processing results from the FMEA method, the following results are obtained:

Table 3. Risk Assessment With the Integration of FMEA and ANP Methods

No	Risiko Factor	Risk Variable	S	O	D	RPN	Total RPN
1	Supply acceptance	Lack of quality standard checking	7	7	5	245	551
		Lack of education and manpower from QC department	6	5	6	180	
		Unpredictable weather	8	3	3	72	
		Continuity of fluctuating supply quality	6	3	3	54	
2.	Handling and storage	Use of inappropriate storage technology	7	3	5	105	469
		Lack of keeping storage clean	7	4	5	140	
		Different handling and storage flow from SOP	8	4	7	224	
3	Production process	Lack of technical skills education	5	6	3	90	521
		Lack of maintaining the cleanliness of the production environment (both tools and the surrounding environment)	3	2	6	36	
		Inefficient production process	5	3	5	75	
		Lack of effective communication	8	5	8	320	
4.	Distribution	Lack of availability of transportation facilities	8	2	6	96	378
		Poor packaging system	3	3	8	72	
		Use of non-standard transportation	9	1	5	45	
		Long hauling distance	10	1	9	90	
		Delivery time uncertainty	5	3	5	75	

Table 4. Risk Evaluation and Risk Control

Kluster	Kriteria	Weighted (ANP)	RPN	WRPN	Rank	Pengdalian Risiko
Risk Factor	Supply acceptance	0.28453	551	156.8	2	Avoid
	Handling and storage	0.41860	469	196.3	1	Not acceptable
	Production process	0.20240	521	105.5	3	Avoid
	Distribution	0.09447	378	35.7	4	Acceptable

From the results of data processing in tables 3 and 4, it is explained that the priority of repair or risk control is in handling and storage with a WRPN value of 196.3. Thus, the mitigation

plan will be carried out on those that have a mitigation value in the risk control column. In addition, mitigation is also based on the highest value of the handling and supply sub-criteria using the FMEA method.

4.3 Risk Mitigation With MACTOR Method

The first step that needs to be prepared is to build a table of "actors" and "planned goals". Mitigation strategies are carried out because there is a potential for equipment contamination. The identified actors and objectives can be seen in table 5 and table 6

Table 5. Identified Actors

Actor		Actor		Actor	
A_1	Finance	A_5	Production	A_9	Peeled shrimp factory
A_2	HRD	A_6	Admin & inventory	A_{10}	Distributor/retail
A_3	R&D	A_7	Purchasing & marketing	A_{11}	Food Agen
A_4	QC	A_8	Shrimp Farmer		

Table 6. Objectives Identified

O_j	Objectives
O_1	Cleaning equipment with warm water, chlorine and disinfectant
O_2	Clean the floor and the surrounding environment (especially in the production room)
O_3	Carry out strict supervision of the way employees work (especially production and storage)
O_4	Technical and medical research on employees
O_5	Proper sewage system
O_6	Use of appropriate production machines
O_7	Upgrade knowledge related to sanitation
O_8	Sort first grade and second grade raw materials correctly

The results obtained with the MACTOR method are the level of influence of dependence between actors, mapping of actor convergence, mapping of actor divergence, and conclusions:

1. Degree of Influence and Dependence Between Actors

Table 6. Direct and Indirect Influence Between Actors

	A_1	A_2	A_3	A_4	A_5	A_6	A_7	A_8	A_9	A_{10}	A_{11}
Li	136	74	104	98	96	81	86	52	59	0	0
Di	43	33	79	75	92	97	50	38	69	109	101

In table 6, it is known that the actor who has direct and indirect influence with the highest score is finance (A1) with a value of 136. Meanwhile, the actor who has direct or indirect dependence (Di) on other actors is production (A5). with a value of 109. The greater the value, the higher the level of dependence on other actors

2. Mapping of Actor Convergence and Divergence

In Figure 2 (actor convergence graph), it is explained that the red line is the link between the existence of a very strong force against several actors including A4 (QC) and A5 (production).

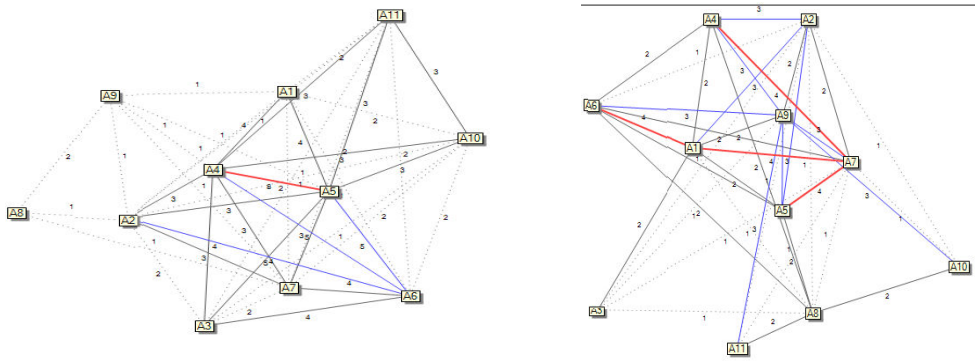

Figure 2. Actor Convergence and Divergence Mapping Chart

The divergence of one actor shown in Figure 2 explains that A7 (purchasing & marketing) against A4 (QC), A5 (production), A1 (finance), and A6 (admin & inventory) have different interests related to the goals that have been set.

6. CONCLUSIONS

Based on the risk analysis in the frozen food industry supply chain, it can be concluded that there are 4 risk factors and 16 identified risk variables. The four risk factors are the risk of receiving supply, handling and storage, production process, and distribution. The most critical risk of the 16 risk variables is handling and storage risk with the highest WRPN value of 196.3. And the results obtained with the MACTOR method are finance which has the highest influence and must synergize with R&D (A3), QC (A4), and production (A5) because they have the same goal.

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SOCIO-TECHNICAL ANALYSIS OF SMALL RETAIL DIGITAL TRANSFORMATION IN INDONESIA

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ABSTRACT

The use of digital technology adopted by modern retail disrupts the existence of conventional small retailers. Unicorn startup is bringing modern retail systems to conventional small retailers such as warung. This system is expected to make the warung have better performance. The fact that the warung business model is uniquely different from modern retail requires an analysis of the impact of digitalization. The analysis of the impact of digitalization on a small retailer has not been done before in this case. The research applied Socio-Technical System (STS) theoritical lens. Interviews were conducted with warung's partners using the purposive method. Data analysis was carried out by codification on Nvivo to look for the findings of the research. Socio-technical mapping corresponding on impact of digitalization and managerial implication is presented at the result of the research.

Keywords: digitalization, digital transfomation, retail, small-medium size enterprise, socio-technical system

1. INTRODUCTION

The data presented by Asosiasi Penyelenggara Jasa Internet Indonesia (2019) indicates that the internet has become a common necessity, and the retail sector must begin to transform processes and ways of thinking digitally (Khare, Khare, & Baber, 2020). Modern large retailers that exist today have exclusive digitalization systems such as supply chain networks, standardized operations, and management that make them more efficient, effective, and profitable. However, this is the opposite for conventional small retailers such as warungs. A technology startup unicorn called Warung Pintar (warpin) is transforming warung with the same digitalization, services, distribution networks, and integrated systems as exclusive modern retailers do.

Ideally, with the digitalization provided by warpin to cover the weakness of the warung compared to modern retail, they should have better performance than conventional warung, because the system provided by warpin that has been mentioned is sufficient for the warung to have a better improvement. The fact happened to warpin partners did not go well as expected. Some warpin partners have less than optimal performance, such as the low frequency of purchasing goods at the warehouse, expired goods in the shop inventory, the profit has not reached the target, until contract termination as partners.

Most of the research to analyze the effect of digitalization on an organization focuses on explaining only one aspect such as technology, which causes other problems to arise when digitalization is implemented. Research conducted Gawankar, Gunasekaran, & Kamble (2020), Bienhaus & Haddud (2018), and Bag, Wood, Mangla, & Luthra (2020) which only focuses on

technology adoption in the supply chain and procurement of goods has resulted in the individual aspects of adopting technology that have not been properly identified. Research conducted by Nasiri, Ukko, Saunila, & Rantala (2020) analyzes the shortened process due to digitalization resulting in a new job structure. Li, Su, Zhang, & Mao (2017) and Bonanomi, Hall, Staub-French, Tucker, & Talamo (2019) adopting information technology for people who are not proficient at using it, the problem that arises is underutilization. Research findings by Eller, Alford, Kallmünzer, & Peters (2020), explain that the digital transformation process is a socio-technical process. Various studies that lead to inconsistencies and contradictions with the aim of digitalizing to increase effectiveness, efficiency, and profitability make another approach is needed. To overcome the weakness of the approach carried out by previous research, the Socio Technical System (STS) approach was chosen to analyze the digitalization phenomenon more comprehensively.

The condition of warpin partners, which is currently not in line with the goal of digitalization to improve performance, has become an interesting open problem to study in the field of small retail transformation, where the resources they have are not as good as modern retail. Digitalizing warung or small retail is not just about using technology from analog to digital Mergel, Edelmann, & Haug (2019), but considering other aspects of resources that need to be studied (Cichosz, Wallenburg, & Knemeyer, 2020). Research in the field of digitalization is mostly in mature companies or Small and Medium-sized Enterprises (SMEs) on a large scale, even though digitalization is not only exclusively for large and mature organizations, micro-enterprise can also participate and adapt to the flow of industry 4.0 (El Hilali, El Manouar, & Janati Idrissi, 2020). Morover, the type of micro-enterprise like warung has a unique business model compared to others in term of small retail. Therefore, this research aim to analyze the impact of digitalizing small retail or warung in terms of structure, tasks, people, and technology aspects contained in the STS component.

2. LITERATURE REVIEW

STS is a system that identifies and seeks joint optimization to optimize two systems together, namely: a technical system with the aim of maximizing task fulfillment and a social system which goal is to maximize the quality of the user's work system. From these two components comes the optimization of work between the system and the user (Bostrom & Heinen, 1977).

STS has two work systems, namely social and technical. A technical system consists of the processes, tasks, and technology needed to convert inputs into outputs. The social system consists of people (attitude, skills, values), relationships between people, organizational structural authority, and performance appraisal.

Structure is defined as organizational elements such as communication systems, authority, occupation, and workflows (Malatji, Von Solms, & Marnewick, 2019; Kim, Chan, & Gupta, 2016). Structure can also mean the way of making decisions, the method of implementation of a project (Hartl & Hess, 2019). These attributes include normative dimensions, values, norms, user expectations, and behavior (Hester, 2014).

According to Kim, Chan, & Gupta (2016) and Malatji, Von Solms, & Marnewick (2019), technology in the STS component refers to a knowledge or methodology and tools that can be applied to work. Research conducted by Hartl & Hess (2019) suggests that the infrastructure for designing, building, and implementing is an important attribute in the technology component.

The process or task in the STS component is an activity or process that must be carried out to achieve a goal of the organization (Hester, 2014; Kim, Chan, & Gupta, 2016). An activity is

carried out by people with the support of other social components such as government regulations and organizational structures (Malatji, Von Solms, & Marnewick, 2019).

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An actor or people is a person or group in an organization who carries out a task to gain profits and achieve organizational goals (Kim, Chan, & Gupta, 2016). An actor can also be a user of a system and has an impact on a process being carried out (Hester, 2014; Malatji, Von Solms, & Marnewick, 2019). Actor who carry out an activity or task must have the appropriate capability according to the type of work in order to carry out the task more optimally (Hartl & Hess, 2019).

3. METHODS

This research used a multi-case analysis method which is carried out by selecting cases that are considered important according to the researcher (Creswell & Creswell, 2018). Interview questions were prepared based on literature review on socio-technical topics that had been done and developed over the session of the interview. Interviews were conducted with semi-structured and open-ended answers.

The research conducted in Banyuwangi Regency of East Java. Interviewee in this study are shop owners who have joined as warpin partner. Partners have at least carried out business activities before joining as warpin partner, such as opening conventional stall, grocery stores, and other forms of small businesses. Interviews were also conducted with employees of the company at the branch office.

The process of coding and organizing data by computer software (NVIVO) to obtain a theme or pattern from the data. Pattern matching is done by analyzing the themes and matching them with the attributes of the STS components in the literature review, or called theoretical dialogue for theoretical development.

This study is a multi-case study with different interpretations for each case. Cross-case synthesis is carried out to draw conclusions from several findings in the case studied in order to be able to interprete and describe the findings in general. The flow of the analysis methodology shown at figure 1.

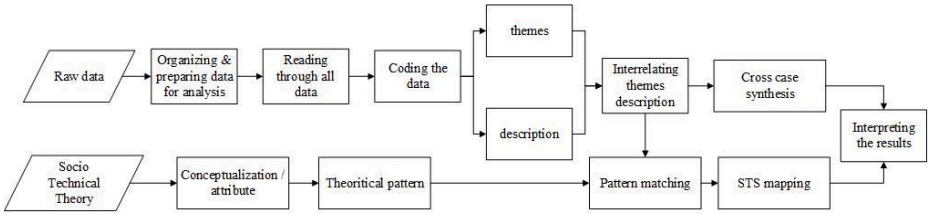

Figure 1. Data Analysis Methodology

4. RESULTS

4.1 Demographics

The demographics of warpin partner respondents shown in Table I. Partner's job represents work before becoming a partner. Location categorization is needed because the distribution of the location of the warungs affect the buying interest of consumers in the surrounding environment. Two company employees interviewee was obtained, they were the warehouse manager and merchant acquisition.

4.2 Data Analysis

Coding is carried out in a sentence that can be reflected in a code for organized analysis. The data coding process was carried out repeatedly in order to obtain the insight. The process to get the optimal code starts from open coding to theme analysis. Open coding has been done by obtaining 349 codes. Decreasing the codes by cutting down the redundants and overlapping codes has been done and obtained 304 codes. Finally the codes reached out 18 themes that reflected the result by obtaining the research descriptive and insight. The Following subsections is discussing the descriptive results.

Table 1. Partner's Demographics

Partner	Age	Job	Revenue (rupiah)	Locations
Partner 1	32	Employee	3.100.000 - 4.000.000	Downtown & residential
Partner 2	26	Employee	2.100.000 - 3.000.000	public , main street, & downtown
Partner 3	28	Job seeker	3.100.000 - 4.000.000	Residential & tourism
Partner 4	51	Small business	2.100.000 - 3.000.000	Residential
Partner 5	25	Housewife	1.000.000 - 2.000.000	Residential
Partner 6	21	Student	1.000.000 - 2.000.000	Main street & downtown
Partner 7	53	Small Business	1.000.000 - 2.000.000	Pedesaan
Partner 8	22	Housewife	1.000.000 - 2.000.000	Pedesaan & public

4.3 Results

The research conducting individual, cross-case, and socio-technical analysis, we provide a narrative and complementary summary of research results. The coding that has been done is mapped on the STS component has been carried out and can be seen in Figure 2. The narrative of the result can be read in the following section.

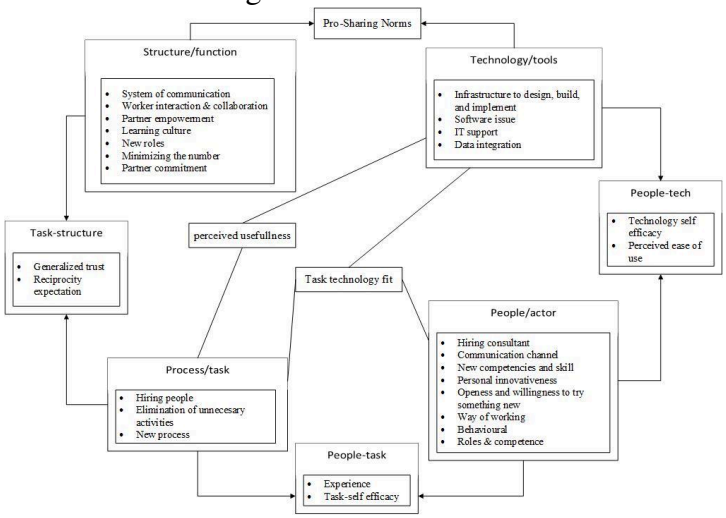

Figure 2. Socio-Technical Mapping

4.3.1 Partners' Motivation

Each partner has a different motivation to join as a partner. The three main reasons are self-motivation, personal circumstances, and seeking opportunities.

Self-motivation comes from the partner's desire for entrepreneurship and digital transformation. Personal circumstances come from the economic factors of an individual who wants to make profit from partnering with warpin. The opportunity was taken by partners because they saw opportunities such as a strategic location to build a business, the lack of competitors around, and government offers.

4.3.2 Partners' Advantages

The benefits of being a partner are: getting rewards, saving on expenses, product delivery, product price margins, time efficiency, operational effectiveness, productivity, operational ease, guidance, and increasing revenue.

Partners get benefits in the form of facilities from warpin such as free shipping for e-procurement through the mobile application. Delivery of this product is location-based upon registration as a partner. Warpin staff has been done geotagging to mark the delivery points.

The product delivery has a significant impact on partners' operations and profitability. Partners can save on procurement costs, time efficiency, and work effectiveness that have an impact on the productivity of partners' personal activities without leaving the house to procure consumer goods.

Partners also obtain a guidance and training for partners who are low technology literation. Warpin staff will come or contact partners if needed. At the and, Joining warpin partners will be able to increase revenue. Ways to get an increase in income include getting points or shopping vouchers, saving on procurement costs, and margins from warehouses that are competitive compared to modern retail.

4.3.3 Warpin's Infrastructure

Warpin has infrastructure in the form of hardware, software, and products or called facilities from Warpin. All these facilities are obtained when it has been approved as a warpin partner. Hardware in the form of a stall containing a tv, refrigerator, cctv, smart tablet, barcode scanner, and internet modem. Software in the form of an application for procuring goods, financial, and point of sales. Products are consumer goods for sale and digital products such as digital vouchers. All of those facilities were free as long as the partner follow the rule of procuring in the warehouse instead of other supplier, or the facilities and partnership will be terminated.

4.3.4 Technical And Operational Changes

A significant change from conventional warung to warpin from is from the technical and operational aspects of the warung. Warpin procured goods electronically without leaving the house and leaving the shop. Warpin has operational standards to procure goods. Partners can also track ordered items through the app. Partners can also record revenue and expenses electronically in the provided application.

4.3.5 Changes in Attitudes and Ways of Thinking

The changes experienced according to partners include being more motivated, eager to learn and grow, leadership and skills, and having an entrepreneurial way of thinking. According to the partners, the benefits obtained motivate them to continue operating warung. The technology supported by warpin makes partners efficient in terms of procurement of partner goods and services. The price of products purchased from the warpin warehouse has a large profit margin compared to procuring independent goods. Partners are also equipped to distinguish between personal money and business money.

Partners have a more organized mind in managing warung. Being a good decision maker and know how the product will be made. Partners become productive because of not leaving household activities. Partners are also aware that technology adoption helps develop their entrepreneurial activities.

4.3.6 Individual Strategics

Partners have manners to develop their warung so that they have good profits and loyal customers. Each individual has their own way of doing it. For eight partners in this study, we found ways such as consumer-oriented strategies, improving facilities, product innovation, strategies with the internet, product-based, and financial management.

For consumer-oriented partners, partners do this by providing comfortable, good, friendly service, giving discounts, and providing stock of goods according to partner market needs.

There are innovative partners by providing added value for semi-finished products into products that are ready for consumption by consumers. Packaged products purchased from the warpin warehouse are processed into value added products with profit margins.

For tech-savvy partners, they do online marketing by sending promotions to social media. Active on the internet is one way of promotion to potential consumers. Some of them are looking for strategies to increase the number of consumer visits on the internet.

An important strategy is to manage business financial flows. Not buying a lot of stuff to fill inventory is a good strategy for some of them. Prioritizing the turnover of goods rather than waiting for the expiration date in the inventory.

4.3.7 Obstacles And Challenges

The challenges and obstacles which come form technology are mostly hardware that does not function or meet the needs of partners. The data displayed in the application is not the same as the product that arrived. Such as ordering a certain amount and what is received is not consistent. CCTV and barcode scanners that are not in accordance with the operational capacity of the shop make the hardware underutilization.

Challenges and barriers that come from individuals are like technology stuttering caused by partners who are not active users of smartphone technology. Partners prefer to record stall financial transactions manually.

The product challenge is regarding the availability of product variants that are inconsistent with partner requests, so partners carry out independent procurement of goods like conventional warung.

External challenges arise, one of which is due to the COVID-19 pandemic which has made the policy of not leaving the house resulting in fewer shop visitors. Partners also face the challenges of socio-cultural structures. Conventional stalls that are jealous of partners feel that their existence is impedence, making partners want to move locations but the process of requesting to move location takes time.

4.3.8 Partner's Interrelationship

Warpin partners which are spreaded in various places and create a community of warpin partners have a positive impact on shop owners. Relationships between partners are also established to develop each other by improving their respective warung.

They created messaging group for partners to share knowledge or motivate each other regarding improving warung. This creates a learning culture between partners. Partners learn from other partners how to make their warung more improved.

The partners also gather together at the warpin warehouse or somewhere to just build a relationship. This indirectly makes warpin create a community under the term of digitizing warung. A strong community will generate strong support to improve the image of MSMEs rather than modern retail

4.3.9 Relationship between Company and Partner

As a partner, the company has a relationship with its partners. In contrast to organizations that have a structural relationship. Warpin conducts training and guidance so that warpin partners have high motivation to develop warung. Warpin runs supervision and services to partners if they need assistance. Warpin also facilitates the relationship between partners by becoming a mediator connecting the warpin community to share knowledge about warung development. All this is done so that warpin and its partners have a reciprocal relationship.

4.3.10 Warpin's Mission

The merchant person explained that Warpin has a mission to the wider community regarding micro-economy. Warpin was originally a conventional distributor of consumer goods. warpin gives the idea that by supporting warungs to shorten the supply chain network will provide more profit for warungs. Warpin stimulates warung that look conventional to become stalls that have better appearance of their consumers by providing facilities such as internet networks, iconic colors, electronic devices, and systems that have been developed by Warpin. The system built includes a blockchain system for optimization of the warpin supply chain network, mobile applications, big data technology and other frameworks that enhance a working environment more leverage than conventional distribution. This system makes the operational work of companies and warung more efficient.

4.3.11 Relationship Among Job, Location, Strategics, and Revenue

Classification is done by classifying based on the revenue range of partners by asking which factors from the elements of location and strategy affect revenue. All partners except partner 5 have the same strategy regarding improving facilities. All partners except partner 4 have the same strategy regarding consumer orientation.

The highest revenue range is obtained by partners 1 and 3. These partners have a similar strategy compared to other partners, namely product-based. This partner only has a different internet-based strategy that has been implemented by partner 3. The locations of partner 1 and 3 also similar, namely being in residential areas. Partner 1 is in the city center while partner 3 is at a tourist location. This contribute a question to be answered wheter the warung is in residential locations and located in city centers or tourist locations with product-based, consumer-oriented, improving facilities, and internet-based strategies can obtain higher revenue than the case of other partners. However, this needs to be studied further because there are other factors that can influence it.

According to work or experience factors, it cannot be concluded that the experienced or knowledgeable and highly educated guarantee to have a warung with a high revenue range. The highest revenue range can be achieved by work or experience as a private employee compared to those who have never worked. This indicates that warung that have good profits are not influenced by individual characteristics itself. There are several factors such as the location of the shop, the condition of the surrounding area, the motivation to develop the shop, and so on in order to have a shop that is profitable.

4.4 Discussion

It was found that the warpin implementation phase contained three stages of warpin system adoption in Banyuwangi. These phases are pre-adoption, on process adoption, and post adoption. The pre-adoption phase is where warpin launched its partnership system for the first time in Banyuwangi and was accepted by new partners who join. The on process adoption phase is when the acquisition of partners has reached a certain amount for the company to be able to sustain and

run the business model continuously. Post-adoption period warpin had problems regarding the increasing number of partners but the volume of procurement of goods did not meet their performance expectation.

Warpin began to adjust its business model, which initially provided facilities as the main driver to only being a goods distribution partner. Warpin also restructured its organizational members. All of this is done in order to achieve efficiency in the company's performance in terms of finance and warehouse inventory. New partners if needed can rent facilities. This is a solution for the company because it does not overspend for potential partners, and is good for partners because they do not need to maintain the assets given. The lack of budget for these facilities can reduce expenses and at the same time the company can also acquire new potential partners.

Some of the findings in this study are also supported by other researchers regarding the findings of socio-technical analysis. The structural component shows that new roles are found that shop owners not only maintain but operate the digital services provided. This is supported by Blumberg, et al. (2019) that digitalization has the potential to create new jobs. Warpin established a system of communication between warpin and its partners to strengthen each other. It is also found by Hartl & Hess (2019) that digitalization changes the communication patterns of organizations and increases awareness of change. Digitalization of warung also has an impact on reducing the business process of procurement of goods as it is being done by Xiang, Archer, & Detlor (2014) which aims for efficiency. The digitalization of warung forms a community that encourages each other to move forward. Worker collaboration and interaction is also stated by Chhim, Somers, & Chinnam (2017) that collaboration has a positive relationship to the formation of knowledge. This collaborating community will form a learning culture. When all learn from each other how to grow, the function of warpin is only to supervise so that its partners remain sustainable. Hadid, Mansouri, & Gallear (2016) said that increased partner performance can improve company performance.

In the process/task component, Digitalization forms a new process in its operations. This is supported by Blumberg, et al. (2019), that each digitalization will lead to a new process. When a new process emerges, the type of job an operator is required to do is required. Partners who have difficulty in operating technology need other people. This agrees with Hartl & Hess (2019) that experienced people are needed to operate new jobs. This is because conventional processes have been eliminated and replaced with more efficient ones as said by Xiang, et al. (2014) to develop business processes must shorten a process. Such as shortening the procurement process for shortened partners.

The people component that has been found in this study is also supported by other researchers. The established way of working makes partners more organized. This is supported by Gong, Yang, & Shi (2020) which states that digital transformation changes the way people work. Despite the age of the partners who have difficulty running the shop's operations, the shop owner also recruits other people to operate. Research by Hartl & Hess (2019) also requires someone with experience in transition. Digitization also causes someone to have the initiative for product innovation. It is supported by Krotov (2015) that a successful adoption process is driven by product innovation. To get a good technology adoption process, between partners and warpin have a way to interact as it is said Nograšek & Vintar (2014), communication has changed through digital since the digitization process. However, this process has an impact on certain behavioral patterns such as resistance and technological stuttering caused by age. This is in line with what was done by (Durkin, Mulholland, & McCartan, 2015).

In the technology component, the most significant thing is about technology support. Hartl & Hess (2019) stated that technology infrastructure must be updated frequently in order to keep up

with trends and remain competitive. This is in line with warpin which continues to update its application so that the process for partners remains optimal. Data integration problems or software issues experienced by several partners are also consistent in the research of Saleem, et al. (2015) that better integration will increase efficiency and trust in social systems. The problem with underutilization of partners is consistent with the research of Chhim, Somers, & Chinnam (2017), that IT does not directly affect the utilization of processes to support operations and replace analog processes, but according to the needs of partners.

6. CONCLUSIONS

Digitalization affects warpin partners in several aspects such as individual partners, work and social structures, the use of more advanced technology than conventional warung, and more effective and efficient operational processes.

For managerial implication, it will become better than procuring equipment facilities for partners, a technology to help warpin branding is more needed to attract consumers that the products needed are located at a partner location for convenience. Similar to location based app, This can be interesting for warpin if it builds a system where partners are marked with locations in the application and the availability of goods on a partner can be seen by potential customers. This will encourage unused devices such as Point of Sales (POS) to be used and digitization is at the next stage. The use of POS will also make partners and companies more data-driven and use big data to improve performance in terms of procurement. The consumer-based strategy will also align with warpin's mission of expanding the reach of partners.

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