



MTITS

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Institut Teknologi Sepuluh Nopember

PROCEEDINGS

MOTIP 03

INTERNATIONAL CONFERENCE ON MANAGEMENT OF
TECHNOLOGY, INNOVATION, AND PROJECT

Technology as an Enabler to Survive Post Covid-19

July, 24th 2021



**DEPARTMENT OF TECHNOLOGY MANAGEMENT
INSTITUT TEKNOLOGI SEPULUH NOPEMBER**

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Program Book

The 3rd International Conference on
Management of Technology,
Innovation, and Project (MOTIP 03)

***“Technology as an Enabler to
Survive Post Covid-19”***

July 24th, 2021

Surabaya,

Indonesia

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Program Book

The 3rd International Conference on Management of Technology, Innovation, and Project (MOTIP 03) 2021

“Technology as an Enabler to Survive post Covid-19”

July 24th, 2021

Surabaya, Indonesia

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Agenda

The conference will be held **online** on July 24th, 2021 (Day 3) 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 linktr.ee/motip2020.

Time (GMT+7)	Agenda
08.30-09.00	Opening Welcome Speech from Chair of MOTIP 03, Jerry Dwi Trijoyo Purnomo, M.Si., Ph.D. Opening Speech from Director ITS Postgraduate Program ITS, Professor Dr. Heri Kuswanto
09.00-09.40	Keynote Speech from Associate Prof. Himanshu Shee
09.40-09.50	Break
09.50-11.20	Parallel sessions 1 09.50-10.05: 1 st presenter 10.05-10.20: 2 nd presenter 10.20-10.35: 3 rd presenter 10.35-10.50: 4 th presenter 10.50-11.05: 5 th presenter 11.05-11.20: 6 th presenter
11.20-12.10	Lunch Break
12.10-13.40	Parallel sessions 2 12.10-12.25: 1 st presenter 12.25-12.40: 2 nd presenter 12.40-12.55: 3 rd presenter 12.55-13.10: 4 th presenter 13.10-13.25: 5 th presenter 13.25-13.40: 6 th presenter
13.40-13.50	Break
13.50-14.20	Closing Ceremony and Best Papers Announcement Closing from Dean of SIMT Professor Ir. Nyoman Pujawan, M.Eng., Ph.D., CSCP

Parallel Session Schedule

Session 1

ROOM A Operation Management

Chair : Gita Widi Bhawika S.ST., M.MT.

Assistant : Erwina Adhyarini, S. Pi.

Time : 09.50 – 11.20

Virtual Room Link: <https://zoom.us/j/92732231131>

No	Time (GMT+7)	ID	Author	Title
1	09.50-10.05	6	Ripta Rarung Raska, Raja Oloan Saut Gurning and Niniet Indah Arvitrida	DETERMINATION OF POTENTIAL HUB LOGISTICS BASED ON STAKEHOLDER'S PERSPECTIVE: A CASE STUDY FOR 3PL COMPANY
2	10.05-10.20	7	Ari Primantara and Pujawan I Nyoman	ANALYSIS OF FACTORS AFFECTING LAND TRANSPORTER PERFORMANCE WITH THE SCOR MODEL AND SUPERVISED MACHINE LEARNING METHOD TO IMPROVE SUPPLY CHAIN PERFORMANCE IN THE FERTILIZER INDUSTRY
3	10.20-10.35	8	Aries Pratama Kurniawan and Iwan Vanany	ANALYSIS OF SELECTION OF ALTERNATIVE TRANSPORTATION OF AMMONIA WITH INTEGER LINEAR PROGRAMMING (ILP)
4	10.35-10.50	13	Ilham Cahya Suherman, Daniel Oranova Siahaan and Rahmi Rizkiana Putri	A COMPARATIVE STUDY OF OPTIMIZATION METHODS FOR OPTIMIZING SOFTWARE EFFORT ESTIMATION USING COCOMO II
5	10.50-11.05	15	Mhd. Syarif and Ahmad Rusdiansyah	APPLICATION DEVELOPMENT OF PERIODIC VEHICLE ROUTING PROBLEM FOR PRODUCT DISTRIBUTION IN A GROCERY STORE

6	11.05-11.20	30	Kita Sumanto and Imam Baihaqi	DESIGN OF SUPPLY CHAIN PERFORMANCE MEASUREMENT SYSTEM FOR PT XYZ USING SUPPLY CHAIN OPERATIONS REFERENCE (SCOR) DAN ANALYTICAL HIERARCHY PROCESS (AHP) METHODS
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ROOM B Operation Management

Chair : Bahalwan Apriyansyah, S.T., MBA
Assistant : Indriyanti Nirmalasari, S.T., M.MT.
Time : 09.50 – 11.20
Virtual Room Link:

No	Time (GMT+7)	ID	Author	Title
1	09.50-10.05	31	Indra Permata Kusuma and Erma Suryani	IMPROVEMENT OF LOADING PROCESS FOR BULK FERTILIZER PRODUCTS FROM 50,000 TON BULK WAREHOUSE TO PORT PT. GRESIK PETROCHEMICALS WITH A SIMULATION APPROACH TO REDUCE HANDLING COSTS AND DEMURRAGE COSTS
2	10.05-10.20	34	Eliana Nurhafidah and Ahmad Rusdiansyah	ANALYSIS RESETTING OF BUFFER WAREHOUSE DISTRIBUTION NETWORK STRUCTURE IN PT. PETROKIMIA GRESIK FOR EAST JAVA AREA
3	10.20-10.35	39	Viona Nauvalisya and Tatang Akhmad Taufik	OPTIMIZATION OF AIRCRAFT MAINTENANCE PROGRAM THROUGH EQUALIZED MAINTENANCE PROGRAM
4	10.35-10.50	56	Laili Sulistyarini	THE DEVELOPMENT OF COAL SUPPLIER SELECTION MODEL AND OPTIMIZATION OF COAL SUPPLY IN POWER GENERATION COMPANY
5	10.50-11.05	71	Maria Theresia D Triviananda and Nurhadi Siswanto	COMPARATIVE DEMAND FORECAST USING LINEAR AND NON LINEAR MODEL TO OPTIMIZE OPERATIONAL PERFORMANCE IN FURNITURE RETAILER: A STUDY IN IKEA INDONESIA
6	11.05-11.20	99	Faizah Maulidya Afifah Lutfi and Hera Widyastuti	ANALYSIS PROBABILITY THE USE OF BIKE TO SUPPORT MASS TRANSPORTATION BASED ON COMMUTER TRAIN

ROOM C Operation Management

Chair : Nabila Silmina Hakim, S.T., MBA

Assistant : Indriani Puspitasari

Time : 09.50 – 11.20

Virtual Room Link:

No	Time (GMT+7)	ID	Author	Title
1	09.50-10.05	11	Syaiful Budianto and Mohammad Arif Rohman	ANALYSIS OF INFLUENCE SERVICE PROVIDER FAILURE FACTORS ON E-PROCUREMENT PROCESS IN THE MINISTRY OF AGRARIAN AFFAIRS AND SPATIAL PLANNING/NATIONAL LAND AGENCY
2	10.05-10.20	12	Muhamad Ilham Fadila Ramadhan and Bustanul Arifin Noer	DESIGNING PERFORMANCE MEASUREMENT SYSTEM AT PT XYZ WITH INTEGRATION SWOT BALANCED SCORECARD METHOD AND ANALYTICAL HIERARCHY PROCESS
3	10.20-10.35	17	Yustina Ithrisa	PERFORMANCE MEASUREMENT OF PARTS LOGISTICS AND WAREHOUSE DIVISION USING BALANCED SCORECARD MODEL (CASE STUDY: PT X)
4	10.35-10.50	29	Alwan Gangsar Brilian Putra and Farida Rachmawati	THE INFLUENCE OF WORK SAFETY AND HEALTH SYSTEMS TO QUALITY OF THE BUILDING PROJECTS
5	10.50-11.05	48	Aziz Fauzi and Putu Artama Wiguna	DELAY ANALYSIS AND CONTRACTUAL COMPLETION OF SUTET 500 KV GRATI – TX KALANGANYAR
6	11.05-11.20	50	Naufal B. Pawenang and Niniet I. Arvitrida	SUPPLY CHAIN PERFORMANCE MEASUREMENT MODEL USING SCOR 12.0 IN A COPRA MEAL PROCESSING COMPANY

ROOM D Operation Management

Chair : Prahardika Prihananto, S.T., M.T.

Assistant : Widya Kusumawardhani, S.T.

Time : 09.50 – 11.20

Virtual Room Link: <https://zoom.us/j/94454532130>

No	Time (GMT+7)	ID	Author	Title
1	09.50-10.05	3	Muhammad Shollahudin Nur Anwar	PERBAIKAN SISTEM PRODUKSI UD. INDO PRIMA PLASTIK DENGAN LEAN MANUFACTURING
2	10.05-10.20	20	Ramadhan Fauzi and Pujawan Nyoman	PRODUCTION PROCESS AND RACKING STORAGE SYSTEM DESIGN FOR OPEN TOP CAN (OTC) PT. X PURWOSARI
3	10.20-10.35	28	Ahmad Ardiansyah and Nurhadi Siswanto	LEAD TIME AND COST MEASUREMENT ANALYSIS FOR MAINTENANCE OF PULP AND PAPER MACHINE
4	10.35-10.50	68	Fiqo Tsavandho and Bambang Syairudin	ANALYSIS OF SATISFACTION LEVEL OF CONSTRUCTION SERVICES WITH INTEGRATION METHODS OF SERVQUAL, KANO, IPA, AND HOQ TO MAKE A PROPOSED IMPROVEMENT. CASE STUDY: PT. KARYATIM SURABAYA
5	10.50-11.05	69	M Dian Fahmi and Raden Venantius Hari Ginardi	ANALYSIS OF MEDIA CUSTOMER SERVICE QUALITY TO IMPROVE CUSTOMER SATISFACTION USING CUSTOMER SATISFACTION INDEX METHOD IN ONLINE TRAVEL AGENT (OTA)
6	11.05-11.20	76	Sekar Ayu Kuncaravita, Vita Ratnasari and Fuad Achmadi	THE INFLUENCE OF E-PROCUREMENT AND GOOD GOVERNANCE IMPLEMENTATION TOWARD THE PERFORMANCE OF GOODS/SERVICES IN TEMANGGUNG REGENCY

ROOM E Project Management

Chair : A.A.B. Dinariyana Dwi P., S.T., MES., Ph.D.

Assistant : Sri Wahyuni

Time : 09.50 – 11.20

Virtual Room Link:

No	Time (GMT+7)	ID	Author	Title
1	09.50-10.05	9	Ali Amirrudin Ahmad and Tri Joko Wahyu Adi	ANALYSIS OF BUILDING INFORMATION MODELING (BIM) IMPLEMENTATION IN CONSTRUCTION COMPANIES
2	10.05-10.20	35	Tiffany Erba and I Putu Artama Wiguna	IDENTIFICATION OF AGILE PROJECT MANAGEMENT (APM) RISK IN THE CONSTRUCTION DESIGN PROCESS
3	10.20-10.35	49	Tututwuri Rohmadani and Tri Joko Wahyu Adi	MAXIMUM PRODUCTIVITY ANALYSIS OF LAND USE WITH THE HIGHEST AND BEST USE (HBU) METHOD ON INSTITUTE TECNHNOLGY SEPULUH NOVEMBER COMERSIL LAND, SURABAYA
4	10.35-10.50	53	Samsul Hidayad and I Putu Artama Wiguna	PIPE MATERIAL SELECTION ANALYSIS BY USING ANALYTICAL NETWORK PROCESS (ANP) METHOD FOR UNDERGROUND FLOWLINE CONSTRUCTION PROJECT OF NKT-01 TW GAS WELL IN PT XYZ GUNDIH FIELD
5	10.50-11.05	96	Imam Maulana Arief, I Ketut Gunarta	IMPACTS OF THE COMPANY'S ACTION PLAN ON THE FINANCIAL PERFORMANCE OF PLTGU
6	11.05-11.20	110	Steffanie Charistarindra and Farida Rachmawati	CORRELATION STUDY BETWEEN STRESSOR AND WORKING STRESS OF CONSTRUCTION PROJECT MANAGER IN SURABAYA

ROOM F Data Analytics and Business Management

Chair : Jerry Dwi Trijoyo Purnomo S.Si, M.Si., Ph.D.

Assistant : Titien Eriyanawati

Time : 09.50 – 11.20

Virtual Room Link: <https://zoom.us/j/92294641071>

No	Time (GMT+7)	ID	Author	Title
1	09.50-10.05	14	Hardhian Restu Panca Laksana and Jerry Dwi Trijoyo Purnomo	ANALYSIS OF THE INFLUENCE OF PRODUCT QUALITY, SERVICE, PRICE, AND PRODUCT AVAILABILITY ON PURCHASE DECISION MAKING
2	10.05-10.20	18	Nobel Danial Muhammad and Erma Suryani	VEHICLE TRAFFIC MODELING ON THE JOMBANG- MOJOKERTO TOLL ROAD USING MACHINE LEARNING METHOD AS PREDICTION AND ANALYSIS OF VEHICLE SPEED FACTORS
3	10.20-10.35	41	Romi Purba and Mohamad Atok	ANALYSIS OF BRAND AWARENESS USING TWITTER SENTIMENT ANALYSIS ON LAPTOP PRODUCTS
4	10.35-10.50	51	Yusuf Dimas Hermawan and Mohamad Atok	ANALISA BRAND REPUTATION BERDASARKAN TWITTER SENTIMENT ANALYSIS STUDI KASUS INDIHOME
5	10.50-11.05	55	Jupita Sari Ika Hanugraheni and Dedy Dwi Prastyo	NOWCASTING APPROACH TO ANALYZE FACTORS AFFECTING ONLINE SALES DURING COVID-19 PANDEMIC IN SEVERAL CITIES/REGENCY IN EAST JAVA
6	11.05-11.20	57	Panji Kresno W, Dedy Dwi Prasetyo and Satria Fadil Persada	BUSINESS INTELLIGENCE BASED ON ASPECT BASED SENTIMENT ANALYSIS (ABSA) WITH CONVOLUTIONAL NEURAL NETWORK METHOD ON ONLINE MARKETPLACE PRODUCT REVIEWS

ROOM G Data Analytics and Business Management

Chair : Satria Fadil Persada, S.Kom., MBA., Ph.D.

Assistant : Mizati Dewi Wasdiana, S.Hum.

Time : 09.50 – 11.20

Virtual Room Link: <https://zoom.us/j/96068278018>

No	Time (GMT+7)	ID	Author	Title
1	09.50-10.05	92	Mochamad Arief Hidayat and Wahyu Wibowo	DEVELOPMENT OF MODEL FOR PREDICTING HOUSE SELLING PRICE USING MACHINE LEARNING
2	10.05-10.20	97	Yusuf Widiasmoro and R. Mohamad Atok	THE EVALUATION OF MAPPING ATMs BANK IN SURABAYA AREA BY USING CLUSTER ANALYSIS METHOD
3	10.20-10.35	102	Kevin Naufal Widyadhana and Dedy Dwi Prastyo	CREDIT CARD DEFAULT PREDICTION USING MACHINE LEARNING
4	10.35-10.50	106	Rosi Ana Qolbi, Rosi Ana Qolbi and Rosi Ana Qolbi	CIRCULAR ECONOMY FRAMEWORK IN CIGARETTE FILTER COMPANY (CFC) USING MATERIAL CIRCULARITY INDICATOR (MCI)
5	10.50-11.05	109	Gandhi Muhammad Nuurakbar and Budisantoso Wirjodirdjo	SENTIMENT ANALYSIS OF DISPLACEMENT CAPITAL CITY TO EAST BORNEO PROVINCE IN TWITTER USING NAÏVE BAYES BASED TWO OR THREE CLASSIFICATION

6	11.05-11.20	118/61	Clarissa Amelia Sitorus, R. Mohamad Atok S.Si	IDENTIFICATION IMPACT OF COVID – 19 ON REAL ESTATE STOCK RETURNS USING ARMAX – ARCH/GARCHX METHOD
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Session 2

ROOM H Consumer Behavior

Chair : Reny Nadlifatin, S.Kom., MBA., Ph.D

Assistant : Erwina Adhyarini, S. Pi.

Time : 12.10 – 13.55

Virtual Room Link: <https://zoom.us/j/91682401407>

No.	Time (GMT+7)	ID	Author	Title
1	12.10-12.25	4	Ratih Laksitowati, Satria Fadil Persada and Reny Nadlifatin	FACTORS AFFECTING ENTREPRENEURIAL INTENTION IN INSTITUTION OF TECHNOLOGY STUDENTS XYZ
2	12.25-12.40	5	Fahmi Fahresi	ANALYSIS OF INTEREST IN USING THE PLN MOBILE APPLICATION USING A MODIFIED TAM MODEL
3	12.40-12.55	22	Ahmad Fahriyannur Rosyady	DEVELOPMENT OF THE UTAUT 2 MODEL IN USING MOBILE CUSTOMER APPLICATIONS IN FIXED BROADBAND SERVICE TO IMPROVE CUSTOMER EXPERIENCE (CASE STUDY : MY INDIHOME CUSTOMER)
4	12.55-13.10	36	Dea Sidhi Pratiwi and R. Mohamad Atok	ANALYSIS OF TELKOMSEL CUSTOMER LOYALTY IN GRAPARI TELKOMSEL CIPUTRA SURABAYA USING MIX METHOD
5	13.10-13.25	37	Citra Andriyadi	INFLUENCE FACTORS OF USER EXPERIENCES AND SERVICE QUALITY ON CONTINUANCE INTENTION TO USE FOR MOBILE PAYMENT IN MILLENNIAL GENERATION
6	13.25-13.40	59	Rizka Amelia Rohmah, Satria Fadil Persada and Reny Nadlifatin	THE EFFECT OF SOCIAL MEDIA MARKETING ACTIVITIES, TRUST, CORPORATE IMAGE ON INTEREST IN TRANSACTIONS USING EDC MACHINE AT MERCHANT PT. XYZ
7	13.40-13.55	79	Claresta Dwi Pranindya and Reny Nadlifatin	THE EFFECT OF PERCEIVED EFFECTIVENESS TOWARDS ECONOMIC BENEFIT AND SUSTAINABLE CONSUMPTION OF E-COMMERCE IN INDONESIA DURING COVID-19 PANDEMIC

ROOM I Decision System Analysis

Chair : Gogor Arif Handiwibowo ST., M.MT.

Assistant : Indriyanti Nirmalasari, S.T., M.MT.

Time : 12.10 – 13.55

Virtual Room Link:

No	Time (GMT+7)	ID	Author	Title
1	12.10-12.25	10	R Sunni Nugraha Priadi and Udisubakti Ciptomuyono	IMPLEMENTATION OF AHP AND TOPSIS METHODS FOR NON-SIMULATION ENHANCED OIL RECOVERY TECHNIQUES SCREENING IN "X" AND "Y" FIELDS
2	12.25-12.40	40	Denny Indra Purnama	ANALYSIS OF PITOT PROBE RELIABILITY PART NUMBER 0851HL ON AIRCRAFT AIRBUS A320-200 PT. XYZ USING LIFE DATA ANALYSIS METHODE
3	12.40-12.55	44	Auzan Devara	MULTI-CRITERIA SUPPLIERS SELECTION IN STRATEGIC PARTNERSHIP TO SUPPORT OVERHAUL MAINTENANCE OF TNI AURI AIRCRAFT GTC
4	12.55-13.10	46	Alfian Suban	THE EFFECT OF FLEXIBLE MANPOWER SUPPLY STRATEGY ON DELAY MAINTENACE IN BASE MAINTENANCE DEPARTMENT OF PT. GMF AERO ASIA
5	13.10-13.25	60	Maya Sari	AHP MODEL IN SELECTING E-CATALOGUE GOODS/SERVICES PROVIDERS AT INSTITUTE OF TECHNOLOGY SEPULUH NOPEMBER (ITS) SURABAYA
6	13.25-13.40	73	Much Arif Amrulloh	SELECTION OF ALTERNATIVE IMPLEMENTATION METHODS FOR THE FOUNDATION OF FUEL STORAGE TANKS IN AN EFFORT TO ENHANCE PERFORMANCE
7	13.40-13.55	77	Dede Noviardi and Suparno Suparno	SELECTION OF PRIORITY ROAD INFRASTRUCTURE IN SPECIAL ECONOMIC ZONE (SEZ) THE MANDALIKA USING ANALYTIC NETWORK PROCESS (ANP)

ROOM J Product Development and Innovation Strategy

Chair : Dr. Ir. Tatang Akhmad Taufik, M.Sc.

Assistant : Indriani Puspitasari

Time : 12.10 – 13.55

Virtual Room Link:

<https://zoom.us/j/95086193376?pwd=dnpQbjVhOCtUQTR1dFZkY1Jac1IUZz09>

No	Time (GMT+7)	ID	Author	Title
1	12.10-12.25	24	Bayu Rahmad Azhari and Tatang Akhmad Taufik	STRATEGY FORMULATION OF SMART LOGISTICS DEVELOPMENT IN A NATIONAL LOGISTICS COMPANY
2	12.25-12.40	33	I Gusti Bagus Yogiswara Gheartha and Niniek Fajar Puspita	INNOVATION PRODUCT DEVELOPMENT FROM CORPORATE INNOVATION LAB IN TELECOMMUNICATION INDUSTRY USING IRL AND QFD
3	12.40-12.55	52	Nanang Yulian and Tatang Akhmad Taufik	MARKET ORIENTED INDUSTRIAL SERVICES INNOVATION USING HYBRID QFD AND KANSEI ENGINEERING
4	12.55-13.10	63	Yogo Laksono Baskoro Se and Dr. Ir. Tatang Akhmad Taufik. M.Sc. Ipu	APPLICATION OF BALANCED SCORECARD (BSC) AND STRESS TESTING METHOD FOR STRATEGY FORMULATION IN MAINTAINING BUSINESS SUSTAINABILITY OF PT XYZ (PERSERO)
5	13.10-13.25	80	Sylvia Juniar Susanto	DESIGN OF KAI ACCESS APPLICATION IMPROVEMENT BASED ON USABILITY ASPECTS AND QUALITY FUNCTION DEPLOYMENT (QFD)
6	13.25-13.40	87	Muhammad Hawary Izzaturoby and I Nyoman Pujawan	SELECTION AND RISK ANALYSIS OF GLOBAL LOGISTICS SERVICES

7	13.40-13.55	104	Denny Irawan and Eko Budi Santoso	THE STRATEGY OF DEVELOPING SMART VILLAGES BASED ON CULTURAL TOURISM IN THE LAWAS MASPATI VILLAGES OF SURABAYA CITY
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ROOM K Project Management

Chair : R. Haryo Dwito Armono ST., M.Eng., Ph.D.

Assistant : Agus Dwi Purwolastono, S.E., M.Acc.

Time : 12.10 – 13.55

Virtual Room Link:

No	Time (GMT+7)	ID	Author	Title
1	12.10-12.25	26	Fariz Gilang Wahyu Ansharianto and I Putu Artama Wiguna	MODELING PROJECT CHARACTERISTICS TO PROJECT PERFORMANCE BASED ON TIME COST AND QUALITY IN PT XYZ JABODETABEK USING STRUCTURAL EQUATION MODELING (SEM)
5	12.25-12.40	78	Niken Saraswati and Reny Nadlifatin	IMPROVING PERFORMANCE THROUGH LEADERSHIP STYLE, ORGANIZATION CULTURE, AND COMMITMENT IN IMPLEMENTING DIVISION OF XYZ AGENCY
4	12.40-12.55	81/113	Mohd Walidurrohmah and Effendi	ANALYSIS OF DELAY IMPACT IMPLEMENTATION OF THE CIPUTRA WORLD SURABAYA PHASE 3 PROJECT BASED ON FIDIC MDB HARMONIZED EDITION
3	12.55-13.10	114	Hilma Ayu	WORKLOAD ANALYSIS USING MODIFIED FULL TIME EQUIVALENT (M-FTE) DAN NASA- TLC TO OPTIMIZE PERFORMANCE IN ASSET PROJECT MANAGEMENT OFFICE DEPARTEMENT
2	13.10-13.25	119	Akmilia Aswarini, Satria Fadil Persada, Reny Nadlifatin	INFLUENCE OF WORK ENVIRONMENT, MANAGEMENT SUPPORT, AND JOB SATISFACTION TO EMPLOYEE PERFORMANCE IN CONSTRUCTION PROJECT : A CASE STUDY IN PT. PP (PERSERO) Tbk.
6	13.25-13.40	116	Syafa'Ah Adhiimah, Purwanita Setijanti and Happy Ratna Sumartinah	COMMUNICATIVE ONLINE CO-LIVING PROMOTION STRATEGIES BASED ON MILLENIAL PREFERENCES

7	13.40-13.55	117	Fauzan Ghazy, Purwanita Setijanti and Sri Nastiti N. Ekasiwi	THE EFFECT OF FACADE DESIGN ON CONSUMER PREFERENCES FOR SUSTAINABLE HOUSING
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ROOM L Operation Management

Chair : Mushonnifun Faiz Sugihartanto, S.T., M.Sc

Assistant : Sri Wahyuni

Time :12.10 – 13.55

Virtual Room Link:

No	Time (GMT+7)	ID	Author	Title
1	12.10-12.25	27	Nur Aswan Darwis and Moses L Singgih	IMPROVING THE QUALITY OF PRODUCTION OF POWER TRANSFORMERS USING SIX SIGMA APPROACH IN TANK FABRICATION
2	12.25-12.40	38	Windra Nuswantoro and Abdullah Shahab	DISTRIBUTION PLANNING OF DAIRY PRODUCTS AT UD BUNDA ANI WITH LINEAR PROGRAMMING METHOD
3	12.40-12.55	43	Fajryansya M. Falah and Moses L. Singgih	WASTE REDUCTION IN CONICAL TAPER HEAD BOLT PRODUCTION AT PT. ROLLER WITH LEAN SIX SIGMA METHOD
4	12.55-13.10	83	Citra Dwi Kusumawardani and Putu Dana Karningsih	REDESIGN RAILWAY STAIRCASE WITH MULTI-LAYER QUALITY FUNCTION DEPLOYMENT AND DESIGN FOR MANUFACTURING APPROACH
5	13.10-13.25	93	Erdinanto Ahaddin and Mokh Suf Mokh Suf	KAIZEN QUALITY IMPROVEMENT TO REDUCE INTERNAL DEFECT AT PT XYZ
6	13.25-13.40	86	Yunazzilul Alfarizky	IMPLEMENTATION OF LEAN CONCEPT IN CHANGEOVER PROCESS OF FISH FEED INDUSTRY
7	13.40-13.55	115	Christopher Davito Prabandewa Hertadi and Budisantoso	THE INFLUENCE OF DEMOGRAPHIC AND WORK ENVIRONMENT FACTORS ON THE DYNAMICS OF THE PERSONALITY DEVELOPMENT PATTERN IN THE MANUFACTURING INDUSTRIES COMMUNITY

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ROOM M Risk Management

Chair : Puti Sinansari, S.T., M.M.

Assistant : Titien Eriyanawati

Time : 12.10 – 13.55

Virtual Room Link: <https://zoom.us/j/99547370008>

No	Time (GMT+7)	ID	Author	Title
1	12.10-12.25	2	Ari Setiawan and Eddy Setiadi Soedjono	ANALYSIS OF ENVIRONMENTAL QUALITY BASED ON BIRD HABITAT AT SENSITIVE AREAS OF PT. PHE WMO
2	12.25-12.40	32	Jimmy Restu Soeyandono	VERBAL SAFETY MODELING FOR IMPROVE WORKPLACE SAFETY OF HIGH-RISE BUILDING PROJECTS IN EAST JAWA
3	12.40-12.55	67	Broto Dhegdo Haris Pranoto and Moh Arif Rohman	RISK CONTROL TO PURIFIED WATER SYSTEMS (PWS) USING FAILURE MODE AND EFFECT ANALYSIS (FMEA) AND FUZZY PRIORITIZATION AT PHARMACEUTICAL COMPANY PT XYZ
4	12.55-13.10	70	Tatak Nurwahyudo	MANAJEMEN RISIKO KONTRAK SKEMA CONTRACTOR FULL PRE-FINANCED PADA PROYEK KONSTRUKSI DI INDONESIA
5	13.10-13.25	82	Steve Mario Virdianto and A.A.B. Dinariyana	RISK ASSESSMENT ON THE NEW SHIPBUILDING PROCESS(CASE STUDY THE NAVY HOSPITAL ASSISTANCE SHIP AT PT. PAL INDONESIA (PERSERO))
6	13.25-13.40	85	Heru Subiyantoro	RISK MANAGEMENT TO PLAN CHANGES IN FEEDER VALVE LINE PROJECT AT PT. IPBS BY PT. KAMANJAYA TEKNIK INDONESIA AS CONTRACTOR USING RFMEA

ROOM N Miscellaneous Topics

Chair : Ninditya Nareswari, S. M., M. Sc.

Assistant :

Time : 12.10 – 13.55

Virtual Room Link:

No	Time (GMT+7)	ID	Author	Title
1	12.10-12.25	16	Rr Sekar Kalaksita and Erma Suryani	ANALYSIS OF ACCEPTANCE OF VIDEO CONFERENCE TECHNOLOGY IN A GOVERNMENT INSTITUTION IN EAST JAVA PROVINCE WITH UNIFIED THEORY OF ACCEPTANCE AND USE OF TECHNOLOGY 2 (UTAUT2)
2	12.25-12.40	66	Cindralina Krechen Selly, Satria Fadil Persada and Ellya Zulaikha	ANALYSIS OF THE EFFECT OF INTERIOR DESIGN ELEMENT ON CUSTOMER SATISFACTION AT DAOP 8 RAILWAY STATION
3	12.40-12.55	74	M Pramuaji Tri Saputro and Satria Fadil Persada	ANALYSIS OF COMMUNITY TRUST IN PT PLN (PERSERO) IN THE MIDDLE OF EDITION ISSUE DURING THE COVID-19 PANDEMIC
4	12.55-13.10	84	Winda Amelia Novitasari and Moses Laksono Singgih	ANALYSIS OF THE EFFECT OF SERVICE QUALITY ON CUSTOMER SATISFACTION USING THE SERVQUAL AND IPA METHODS AT BTN SYARIAH SURABAYA
5	13.10-13.25	88	Aryono Aimbarto and Christiono Utomo	SENSITIVITY OF INVESTMENT CRITERION CHANGE OF PROBOLINGGO - BANYUWANGI TOLL ROAD PROJECT
6	13.25-13.40	95	Deninta Widya and Sri Gunani	EVALUATION OF OUTSOURCING EMPLOYEE PERFORMANCE APPRAISAL SYSTEM WITH ALTERNATION RANKING AND BORDA METHOD (STUDY AT BADAN PENGELOLAAN KEUANGAN DAN PAJAK SURABAYA)
7	13.40-13.55	89	Sukamto	APPLICATION SIX SIGMA TO IMPROVE BOTTLENECK IN THE EXPORT WAREHOUSE WORKSTATION IN CARGO HANDLING COMPANY SOEKARNO HATTA AIRPORT

MOTIP 03

THE 3rd INTERNATIONAL CONFERENCE
ON MANAGEMENT OF TECHNOLOGY,
INNOVATION, AND PROJECT

ADVANCING
HUMANITY



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Links

Opening Session

Link Zoom:

<https://zoom.us/j/97404610871>

Meeting ID:

97404610871

Closing Session

Link Zoom:

<https://zoom.us/j/96484388845>

Meeting ID:

96484388845

Parallel Session

Room	Session 1		
	Link Zoom	Meeting ID	Passcode (if any)
A	https://zoom.us/j/92732231131	92732231131	
B	https://zoom.us/j/95646387074	95646387074	
C	https://zoom.us/j/96718733593	96718733593	
D	https://zoom.us/j/94454532130	94454532130	
E	https://zoom.us/j/91355003612	91355003612	
F	https://zoom.us/j/92294641071	92294641071	
G	https://zoom.us/j/96068278018	960 6827 8018	

Room	Session 2		
	Link Zoom	Meeting ID	Passcode (if any)
H	https://zoom.us/j/91682401407	91682401407	
I	https://zoom.us/j/98054703321	98054703321	
J	https://zoom.us/j/95086193376?pwd=dnpQbjVhOCtUQTR1dFZkY1Jac1IUZz09	95086193376	MOTIP3
K	https://zoom.us/j/7475779423	7475779423	
L	https://zoom.us/j/98158993342?pwd=WktrVk11RzVMcHpoVUtsa1dZdHB4QT09	98158993342	
M	https://zoom.us/j/99547370008	99547370008	
N	https://zoom.us/j/94007850817	94007850817	

Abstract Keynote Presentation “Sustaining Post Pandemic COVID-19”



Prof. Himanshu Shee

Victoria University, Australia

COVID-19 pandemic has created havoc on planet earth forcing social distancing, lockdowns and border closure to stop the spread of virus. This has affected communities and businesses significantly. But our understanding is limited how it is different from the earlier crisis such as economic recession, natural disasters (tsunami, flood, drought) and flu that also took lives and affected businesses? Further, it has challenged the businesses and supply chains on their way out to quicker recovery. Question is what those strategies are. Are they really different from the existing ones being prescribed for long time? Have the businesses shifted their focus towards limited, but effective ones? This keynote will address some of those including experiences of Australian businesses. While emerging into future, key role of technologies along the timeline will be discussed.

Parallel Session 1

Room A (09:50 - 11:20)

Moderator:

Category: Operation Management

DETERMINATION OF POTENTIAL HUB LOGISTICS BASED ON STAKEHOLDER'S PERSPECTIVE: A CASE STUDY FOR 3PL COMPANY

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ABSTRACT

PT. ABC is a company engaged in the mining industry. PT. ABC often imports goods for operational needs in Sorowako, South Sulawesi. This study aims to provide an alternative area of logistics hub with the most potential based on the perspective of stakeholders, specifically service providers of 3PL companies, customers of 3PL companies and partners who support the operational activities of 3PL companies. The alternative location proposal are Jakarta, Makassar, Balikpapan and Surabaya. This study used method of Analytical Hierarchy Process (AHP) and feasibility study for financial aspects. Weighting results using AHP method that alternative areas of logistics hub rank. The first is the Jakarta area with a weight of 0.307 and second rank is Surabaya area with a weight of 0.299. Makassar area has a weight of 0.208 and Balikpapan area has a weight of 0.186. Results of calculation projected contract period on 5 years, show that for the Jakarta area Net Cashflow, NPV value is Rp. 107,501,718,390 and for the Surabaya area, NPV is Rp. 334,342,939,515. Percentage of IRR in the Jakarta area is 60.48% while percentage of IRR in the Surabaya area is 127.89%. Analysis of profit and loss projections, showed that location at Jakarta area has a minus gross profit margin in 2025 of -2%. Total GPM (Gross Profit Margin) project is 4.8%. For the Surabaya area, there is no minus margin and total GPM (Gross Profit Margin) during the project period is 9.4%.

Keywords: 3PL company, Logistics hub, feasibility study.

1. INTRODUCTION

The transportation is a serious problem in the global era along with the development of transportation technology. Logistics hub facilities are used in transportation routes, namely in the transfer from one transportation to another (transshipment), merging (consolidation) and break-bulk functions. Logistics hub location problems include hub location facilities, allocating origin and destination points to be used as hubs, and trajectory routes. The other purpose of using a logistics hub is to make efficiency in carrying out goods distribution activities. The distance factor from the logistics hub location to the customer location has its own challenges, especially goods in the form of an effort to reduce transportation costs as small as possible. Cost is the aspect of greatest concern because it is the main factor in determining the selection of a 3PL logistics provider. Therefore, strategic planning is needed in determining the location of the facility in question (Klibi et al., 2010).

In this study, a case study will be taken regarding the determination of logistics hubs for optimizing logistics services where PT. X will act as a third party logistics company (3PL) and PT. ABC will act as 3PL service users. As a 3PL service provider, PT. X proposal facilities for logistics hub solution for operational activities of PT. ABC. The location offered based on existing area of PT. X. The alternative branch locations that will be selected of logistics hubs to support the operational activities of PT. ABC are Jakarta, Surabaya, Balikpapan and Makassar.

According to (Asadabadi, 2018), MCDM has been widely developed to facilitate the selection of alternatives that have many criteria. There are many MCDM methods that can be used in solving logistical problems and site selection, one of which is the use of the Analytical Hierarchy Process (AHP) method. Determining location and logistics problems, AHP has been used in determining the location of industrial development (Ramya & Devadas, 2019), determining the location of Dry Port (Ka, 2011), determining the location of military depots (Lai, 2019) to determining the location of the emergency logistics center (Liu & Zhang, 2011).

Based on these problems, a research is needed to determine the location for the right logistics hub for customers based on predetermined criteria and sub-criteria. Several studies that have been carried out previously to determine the logistics hub of goods transportation using Multiple Criteria Decision Models (MCDM) models such as Analytic Hierarchy Process (AHP) method, Gravity modeling, Agent Based Modeling (ABM), Linear programming, Integer programming and others. However, most modeling uses quantitative methods because they tend to maximize the economic benefits of logistics users and operators by minimizing the costs of using logistics hubs.

In this study, parameters and criteria that influence the determination of the location of the logistics hub will be determined by referring to various previous studies and existing conditions that occur in the field. The selection of logistics hub locations will be determined using the Analytical Hierarchy Process (AHP) method based on predetermined criteria and alternatives. After the location of the logistics hub is selected, an economic analysis will be carried out to determine the feasibility of the business for the development of the logistics hub in the location that has been determined. Based on this, it is hoped that this research can be a solution for choosing a logistics hub location by PT X to support PT ABC's operational activities that meet the company's criteria and are economically feasible to develop.

This study focuses on the logistics hub selection method from PT. X in accordance with criteria desired by PT. ABC to support their operational activities. Therefore, the

formulation of the problem in this study is as follows (1) How to determine potential locations for logistics hubs based on stakeholder perspectives? and the next question is (2) How to analyze a business feasibility study to determine business feasibility based on selected alternative potential locations in order to support the operational activities of PT. ABC?

2. LITERATURE REVIEW

Logistics hub is a place to store goods from abroad or domestic to be consolidated and temporarily stored for a certain period of time. Cargo will then be sent to the final location of cargos. The place for consolidating goods in developed countries is called an Original Equipment Manufacturer (OEM) which is also known as a global hub. Meanwhile, place where original equipment manufacturer (OEM) is located usually called Global Hub and consolidation of cargos approaching the destination country is called Regional Hub. The ideal logistics hub can include transportation, storage, packaging, labeling, and other functions concentrated in one place (Beata, 2008). Multimodal transport can sometimes also be part of a logistics hub. To encourage intermodal transportation for the handling of goods, the Logistics Center should be served by various modes of transportation (road, rail, deep sea, inland waterway, air).

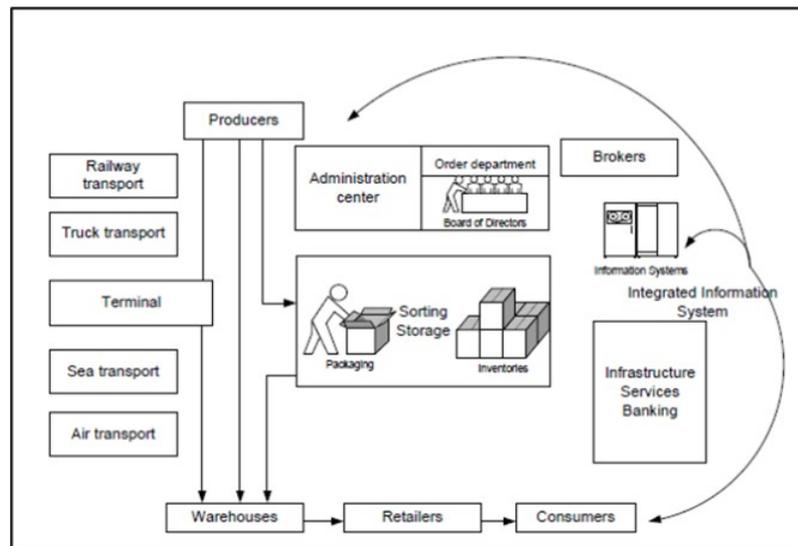


Figure 1. Ideal of Logistics Hub

In general, the determination of logistics hubs can be divided into several categories, depending on their function. Based on geographical location and conditions, logistics hubs can be categorized into (Beata, 2008) :

- International logistics hub
Consists of the highest level of organizational and functional development to function on an extensive international distribution network with global reach.
- Regional logistics center
Generally this type of logistics center is an intermediary cell of regional distribution

- networks and large cities.
- Local distribution center
It is the point of gravity in the local/city distribution network.
 - Industrial distribution centers
Serving only one specific industry or one large company with a range of specialized production products.

Based on the literature study, there are a number of criteria that can be identified as the main factors that influence location to become a logistics hub. Main criteria could be on infrastructure, close to the market area, availability of land, government and industry support and labor needs (Lipscomb, 2010).

Table 1. Criteria, Assumption & Measurement Method

Criteria	Assumption	Measurement Method
Infrastructure	Capacity to move cargo access to modes of transport	Identify highways, railroads, waterways, airports, and intermodal terminals
Close to market	Market reach, one day market reach	Find population within 600 km radius of alternative area
Government and Industry Support	Government support for transportation development and size of regional transportation/distribution industry	Identify regional economic development councils, particularly those with a priority on transportation. Find the number and size (by income or occupation) of local industries.
Availability Area	Land available for transportation logistics development	Identification of vacant land, buildings/land available for redevelopment, etc
Labor Supply	Supply of industrial labor is able to meet the growing transportation developments.	Identify the proportion of a region's workers who have skills for transport jobs.

Determining location of logistics hubs is a complex problem, where decisions are influenced by context, availability of information, and the importance of evaluation criteria (Lee et al., 2009). Therefore, it must be taken based on several criteria supported by quantitative and qualitative data. Multi-criteria models usually allow conflicting criteria to be considered, which the decision maker will then evaluate to establish preferences among possible locations. Among the surveyed papers, which take into account more criteria areas proposed by Lee, Huang & Teng (2009), Ren, et al. (2010) and Tu, et al. (2010).

The formulation of a multi-criteria model usually begins with identifying the most relevant decision criteria. Here the aspects that have been determined can be directly used as

decision criteria. Furthermore, the pre-selected locations will be evaluated for their performance according to their respective criteria. The way the evaluation is carried out depends on the problem-solving technique adopted, which can produce an optimal solution or a good set of alternatives. In this case, the results can also be evaluated and ranked through sensitivity analysis.

This study will use the MCDM method with the AHP approach as a solution in choosing a logistics hub location. This is because AHP is very suitable for handling complex decisions that involve comparisons of decision elements that are difficult to measure.

There are many MCDM methods that can be used in solving logistical problems and site selection, one of which is the use of the Analytical Hierarchy Process (AHP) method. AHP is especially suitable for complex decisions that involve comparisons of decision elements that are difficult to measure. AHP assumes that, when faced with a complex decision, a natural human reaction is to group decision elements according to their general characteristics. In determining a location and logistics problems, AHP has been used in determining the location of industrial development (Ramya & Devadas, 2019), determining the location of Dry Port (Ka, 2011), determining the location of military depots (Lai, 2019) to determining the location of the emergency logistics center (Liu & Zhang, 2011).

AHP is a method developed by Thomas Saaty in the 1970s, where this method uses the human ability to make accurate judgments about problems where there is little aggregation of various factors that can be considered (saaty, 1994).

Table 2. Score Intensity of Interest

Intensity of Interest Description Correlation among components explanation	Intensity of Interest Description Correlation among components explanation	Intensity of Interest Description Correlation among components explanation
1	Equal importance	Both elements are equally important
3	Moderate importance	One element is slightly more important than the other, Experience and judgment support one element a little more than another
5	Strong importance	One element is more important than another, Experience and judgment strongly support one element over another
7	Very strong or demonstrated importance	One element is clearly more absolutely essential than any other element, One element that is strongly supported and dominant is seen in practice
9	Extreme importance	One element is absolutely more important than the other elements. Evidence which supports one element against another has the highest degree of affirmation possible

2,4,6,8	The values between two values of adjacent considerations, This value is given when there are two compromises
Reverse	Reverse If for activity i gets one point compared to activity j, then j has the opposite value compared to i

In this study, AHP analysis will be carried out with the help of Expert Choice software. Expert Choice is a software used to perform systematic analysis, and consideration (justification) of a complex decision evaluation. Expert Choice is used by various business and government agencies in various forms of application, including: alternative selection, resource allocation, quality evaluation decisions, pricing, marketing strategies, acquisition decisions, mergers and others. By using expert choice, it makes it easier for stakeholders in the decision-making process. Based on the Analytical Hierarchy Process (AHP), the use of hierarchy in expert choice aims to organize estimates and intuitions in a logical form. This hierarchical approach allows decision makers to analyze all options for effective decision making.

In conducting business feasibility study, it is necessary to look at various aspects. Each aspect is interrelated with one another so it is necessary to carry out an overall analysis of these aspects. In theory, there are no standard provisions regarding aspects that need to be analyzed, but the more aspects that are analyzed, the better the results will be. The purpose of the financial aspect analysis is to determine the investment plan through calculating the expected costs and benefits by comparing expenses and income, such as the availability of funds, the cost of capital, the ability of the business to repay the funds within a predetermined period of time and assess whether the business will be able to continue to be developed or not. In this study, the aspect of a business feasibility study which is the main topic of discussion is the financial aspect. This is because the alternative logistics hub location owned by PT. X is an existing area to serve existing customers at this time.

3. METHODS

This research is an application in case study related to multi-criteria decision making to choose the most efficient logistics hub for PT. X. The approach taken is rational, systematic and scientific in the decision-making process that will be used in this research to develop main criteria and sub-criteria considered for the logistics hub selection process. Calculating the relative weight or importance of each criterion, it is necessary to create a ranking that is used to select the logistics hub that is deemed capable of meeting the predetermined criteria. This research is expected to help company in determining the location of logistics hub according to the needs of customer.

This research methodology is divided into 4 stages, namely:

- Stage 1: Collecting data (literature study), which includes:
 1. Confirmation of the existing flowchart
 2. Collect supporting documents
 3. User interviews
- Stage 2: Identifying process of interview about logistics hub facility, which includes:
 1. Group discussions with expert users
- Stage 3: Finding logistics hub based on perspective stakeholder, which includes:
 1. Analytical Hierarchy The process of determining the best solution

2. Calculating feasibility financial aspect for logistics hub which higher weighting alternative area

- Stage 4: Making recommendations

After analyzing the selection of logistics hub locations with AHP and calculating business feasibility for each potential area, the next step is to determine the ideal location for the logistics hub based on the research results. At this stage, a study will be conducted on the factors that influence the location determination and the relationship between these factors. The output of this stage is a recommendation for an ideal logistics hub location that can be considered by stakeholders in carrying out operations.

4. RESULTS

There is a main objective, namely selection of best logistics hub location from several alternative locations that have been determined based on the respondent's perspective. Selecting the location, it is necessary to first determine the criteria and sub-criteria that will be used in the calculation. The criteria and sub-criteria used are as follows:

Table 3. Criteria & Sub-criteria AHP

Criteria	Sub-Criteria
1. Time	1.1 Paperworks Actions to check customs facility documents
	1.2 Priority Shipment Provide solutions for special requests by giving priority to delivery of certain goods
	1.3 Number of rejected Material No items are rejected during Customs inspection
	1.4 Acceptance Third party inspection performs inspection of the goods quality system and maintenance, matches the number/model/ as well as a valid certificate with the physical goods.
2. Cost	2.1 Monthly charge A positive approach to the offer of rental of warehouse locations and facilities as well as clear terms and conditions
	2.2 Lifting fees Handling costs offered are at or below market prices, ready to improve unit price/tariff offers, fuel costs, consumption and any costs incurred due to unavailability of lifting and transporting equipment
	2.3 Customs Broker Fee Commercial claims for additional costs from the Customs Clearance process with a good
	2.4 Transport Demurrage and Detention charge Additional operating costs include waiting fees and late fees due to unavailability of heavy equipment, delays in loading containers and availability of Masterlist
	2.5 Packing/repacking Fully compliant SEI packing costs contract requirements
3. Location	3.1 Near to Operation Area The location close to the operating area increases the speed of delivery of goods on schedule

3.2 Near to Seaport/Airport with Infrastructure Support

The location near sea and air ports and the availability of transportation modes increase the ability to expedite the delivery of goods.

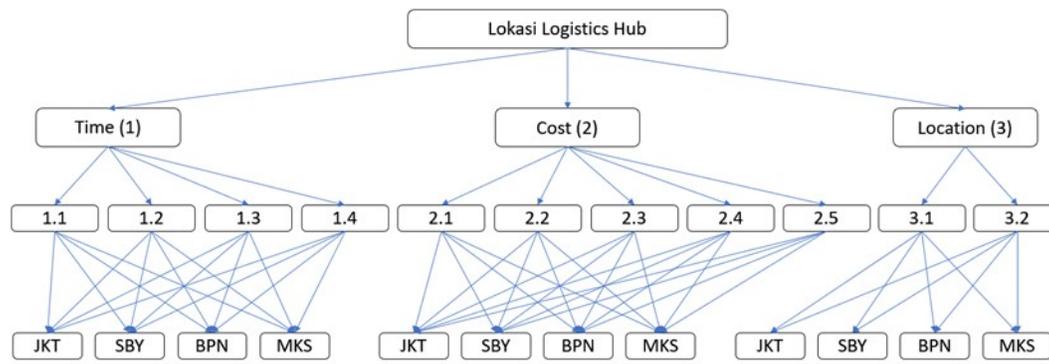


Figure 2. Transportation Mode Selection Hierarchy

The next stage in preparing for the selection of a logistics hub location using the AHP method is the creation of a questionnaire. The questionnaire that will be used in this study will use Google Forms as a tool to make it easier for respondents to provide an assessment of the intensity of interest between criteria and sub-criteria. This research will involve respondents from several stakeholders, including PT X . stakeholders, stakeholders of PT ABC, vendors and partners. In this study, the selection of logistics hub locations using the AHP method will use the help of Expert Choice software to simplify calculations and mitigate errors that may occur.

Based on the analysis that has been done, it can be seen the results of the weighting of each criterion and sub-criteria based on the respondent's assessment. The results of the analysis show that inconsistency of the respondents' assessment is below 0.1 for all criteria and sub-criteria, which means results of the analysis are acceptable.

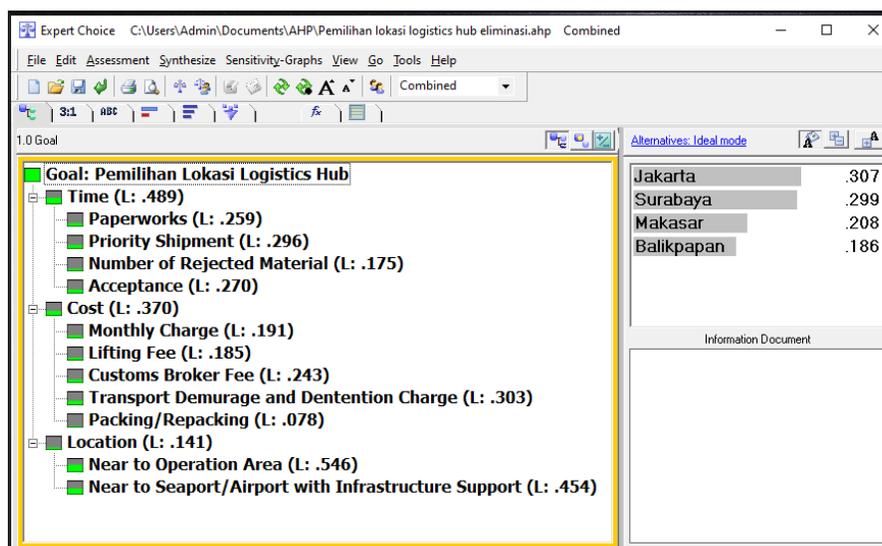


Figure 3. Result of Analysis AHP using Expert Choice Software

The results of the study indicate that the order of weighting for the Jakarta area is more dominant than other areas for logistics hubs. The Jakarta area has a weight that is almost the same as the Surabaya area, where Jakarta has a weight of 0.307 and Surabaya has a weight of 0.299, with a difference of 0.008 points. On the other hand, Makassar and Balikpapan are quite far apart, namely Makassar has a weight of 0.208 and Balikpapan has a weight of 0.186. Based on this, it can be concluded that the recommended logistics hub location based on AHP analysis is in the Jakarta or Surabaya area.

An analysis of the financial aspects need for identification of fixed costs and variable costs is carried out, calculation of depreciation, net cash flow, calculation of feasibility parameters. It is important to calculate the business feasibility study to provide an in-depth analysis, especially the financial aspect, to the managers of PT. X to determine selected of alternative logistics hub locations. The weighting carried out using the AHP method shows an alternative logistics hub area in the first rank, namely the Jakarta area and the second area is Surabaya. In this study, the estimated revenue obtained on the types of services offered by PT. X is as follows :

Table 4. Estimated projection revenue for 5 years contract period

Type of Service	Revenue Estimated	UoM
Vessel Charter	1.508.000.000	Per Months
Local Charges	1.052.795.833	Per Months
Trucking	622.112.500	Per Months
Airfreight	679.266.667	Per Months
Seafreight	526.716.667	Per Months
Dedicated manpower	28.958.333	Per Months
Warehouse Activity	30.966.667	Per Months
Total	4.448.816.667	Per Months

The economic aspect based on net cash flow, it can be seen that the NPV value for the logistics hub location in Jakarta is Rp. 107,501,718,390 and the IRR formed is 60.48%. This is acceptable because $NPV > 0$ and the IRR is above the hurdle rate set by the company, which is 12.5%. In the Surabaya area, the NPV value for the logistics hub area, the NPV value formed is 334,342,939,515 and the IRR formed is 127.89%. If the NPV is > 0 then the project can be accepted, while the IRR can be adjusted according to each decision of the company's management. In this case, the management of PT. X sets the hurdle rate / IRR of $> 12.5\%$. The calculation of payback period, it can be seen that, with an investment value of 2,681,015,048 and a revenue value of 3,385.8 million per year, therefore the payback period is first year. This is based on the strategy of PT. X which utilizes non-asset based so that the investment burden compared to fixed costs is added to the variable costs incurred by the company are still larger.

Table 5. Net cashflow Jakarta Logistics Hub

Cash Flow Statement Logistics Hub Area JKT [Rupiah]					
	2021	2022	2023	2024	2025
Cash Inflow					
Pendapatan	48.936.983.333	53.385.800.000	53.385.800.000	53.385.800.000	57.834.616.667
Total Cash Inflow	48.936.983.333	53.385.800.000	53.385.800.000	53.385.800.000	57.834.616.667
Cash Outflow					
Investasi + Total Fixed Cost + Variable Cost	52.951.833.063	50.270.818.015	50.270.818.015	50.270.818.015	50.270.818.015
Cash from Investing	52.951.833.063	50.270.818.015	50.270.818.015	50.270.818.015	50.270.818.015
Net Increase (decrease) in Cash	(4.014.849.730)	3.114.981.985	3.114.981.985	3.114.981.985	7.563.798.651
Closing Cash Balance	(4.014.849.730)	3.114.981.985	3.114.981.985	3.114.981.985	7.563.798.651

Table 6. Net cashflow Surabaya Logistics Hub

Cash Flow Statement Logistics Hub Area SUB [Rupiah]					
	2021	2022	2023	2024	2025
Cash Inflow					
Pendapatan	48.936.983.333	53.385.800.000	53.385.800.000	53.385.800.000	57.834.616.667
Total Cash Inflow	48.936.983.333	53.385.800.000	53.385.800.000	53.385.800.000	57.834.616.667
Cash Outflow					
Investasi + Total Fixed Cost + Variable Cost	50.296.675.895	47.879.338.480	47.879.338.480	47.879.338.480	47.879.338.480
Cash from Investing	50.296.675.895	47.879.338.480	47.879.338.480	47.879.338.480	47.879.338.480
Net Increase (decrease) in Cash	(1.359.692.562)	5.506.461.520	5.506.461.520	5.506.461.520	9.955.278.187
Closing Cash Balance	(1.359.692.562)	5.506.461.520	5.506.461.520	5.506.461.520	9.955.278.187



Figure 4. Profit n Loss Projection area Logistics Hub Jakarta

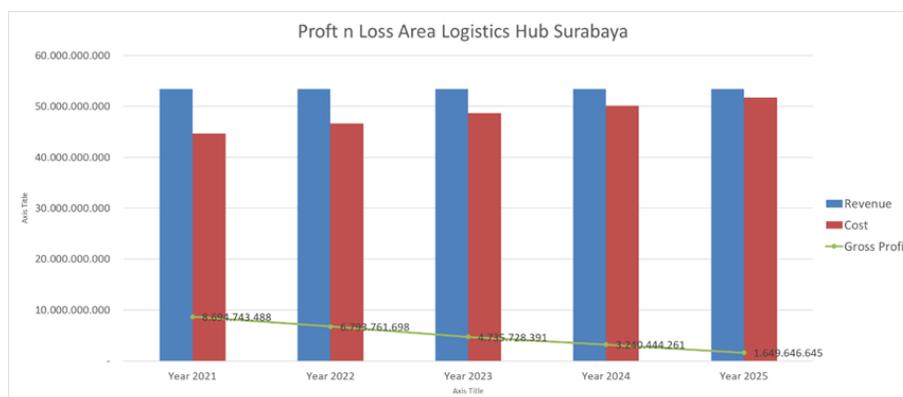


Figure 5. Profit n Loss Projection area Logistics Hub Surabaya

6. CONCLUSIONS

Selection of alternative logistics hub locations based on weighting carried out using AHP method with respondents from PT X, PT ABC and vendor partners. The weighting using the AHP method is condensed into two alternative logistics hub areas, namely first rank is Jakarta area with a weight of 0.307 and second rank is Surabaya area with a weight of 0.299. Makassar area has a weight of 0.208 and Balikpapan area has a weight of 0.186.

Based on calculations that have been made with a projected contract period of 5 years, it shows that for the Jakarta area Net Cashflow, the NPV value is Rp 107,501,718,390 and the Surabaya area, the NPV value is Rp 334,342,939,515. The percentage of IRR in the Jakarta area is 60.48% while the percentage of IRR in the Surabaya area is 127.89%. Day. This shows that logistics hub service project for PT. ABC is feasible because NPV 0, IRR 14% between Jakarta and Surabaya locations. If added to the analysis of profit and loss projections (profit n loss), the data shows that the location in the Jakarta area has a minus gross profit margin in 2025 of -2%. Total GPM over lifetime project is 4.8%. As for Surabaya area, there is no minus margin and total GPM during the project period is 9.4%.

The calculation data from financial aspect shows that the alternative locations for the logistics hub area of Jakarta and Surabaya are worthy of being a logistics hub area to support the operational activities of PT. ABC. This is very relevant considering the geographical conditions and the availability of complete infrastructure in the Java island area.

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ANALYSIS OF FACTORS AFFECTING LAND TRANSPORTER PERFORMANCE WITH THE SCOR MODEL AND SUPERVISED MACHINE LEARNING TO IMPROVE SUPPLY CHAIN PERFORMANCE IN THE FERTILIZER INDUSTRY

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ABSTRACT

Business competition today makes the role of supply chain management increasingly important to support the company's business. In the fertilizer industry, supply chain performance is one of the determinants of the smooth distribution of fertilizers. This study aims to improve the supply chain performance of the fertilizer industry with a new approach, namely combining supply chain performance measurement models using the SCOR Model with Predictive Analytics using Supervised Machine Learning using random forest (RF) algorithms, support vector machines (SVM) and artificial neural networks (ANN) which has been used in previous research for classification in the supply chain field. Supply chain performance measurement show that the supply chain responsiveness attribute is a critical performance attribute with on time orders collection as critical parameter. Then with feature selection, it was found that there were 9 variables that affected on time orders collection, that continued analyze with descriptive and predictive analytic with machine learning classification use Random Forest (RF), Support Vector Machine and Artificial Neural Network algorithms. It was found that the RF algorithm has the best prediction rate with 83.91% accuracy and area under curve (AUC) value of 0.88 (good classification). From the Gini ratio in the RF algorithm, it is found that there are 4 factors that are very significant to the on time orders collection (Qty POSTO, product type, POSTO order date and shipping costs). Recommendations for improvement are made by making a delay prediction model and the proposed new POSTO order flow, which has an impact on the estimated supply chain performance improvement of 136% and the estimated financial savings of Rp 4.37 billion. This research has covered descriptive and predictive stages and can be developed in further research by continuing at the prescriptive stage through optimizing improvement proposals, increasing the analysis period for one year with Realtime data.

Keywords: Supply Chain Performance, SCOR Model, Supply Chain Analytics, Supervised Machine Learning.

1. INTRODUCTION

Supply chain management, including the performance of external partners in it, is important in today's economic developments, because the performance of individual

companies has shifted to supply chain performance, where supply chain performance includes internal and external supply chain activities in order to meet end consumers (Harrison et al., 2004). So that in order to face today's business competition and achieve company goals, organizations must maintain supply chain performance (Van Hoek, 1998; Brewer & Speh, 2000).

This is growing with organizational performance that is increasingly dependent on the performance of external supply chain partners (Chen & Paulraj, 2004), so that the role of supply chain management in order to maintain company performance is an important thing to do (Li et al., 2005; Mentzer et al., 2001). supply chain management as the strategic and systematic coordination of business functions along the supply chain, with the aim of improving the long-term performance of individual companies and the supply chain as a whole (Ketchen & Giunipero, 2004). Supply Chain Management improves performance through the effective use of resources and capabilities with internal and external development which results in coordinated supply chain management (Ketchen & Hult, 2007).

The supply chain also plays an important role in the fertilizer industry. The smooth distribution of fertilizers is related to the supply chain performance of the organization or company (Chandrasekaran & Raghuram, 2014). This is reinforced by the research of Yang et al (2019) on a case study of the imbalance in the world's fertilizer supply which can be improved through the improvement of the fertilizer supply chain. Another case study in a country on the African continent, shows that the role of the supply chain in the fertilizer industry has a significant impact on the success of agricultural products (Gerstenmier & Choho, 2015).

PT Petrokimia Gresik, as a subsidiary of PT Pupuk Indonesia, is a producer of fertilizers, and chemicals for agro-industry solutions, has the responsibility for the smooth distribution of subsidized fertilizers (Kementerian BUMN, 2019). The Government of Indonesia, through the Ministry of Agriculture, has assigned the distribution of subsidized fertilizers to PT Pupuk Indonesia Persero (Kementerian Pertanian, 2020). Subsidized fertilizer for the agricultural sector implementation must pay attention to the right principles, namely the right type, quantity, time, place, price and quality (Kementerian Perdagangan, 2011). Based on the parameters of the success of distributing subsidized fertilizers according to the government regulations above, the success of PT Petrokimia Gresik in distributing subsidized fertilizers is influenced by the company's supply chain performance, as in the case study of the successful distribution of subsidized fertilizers in Nepal is due to good supply chain performance (Panta, 2018).

The supply chain flow of PT Petrokimia Gresik starts from the Inbound Logistics supply chain which consists of the delivery of raw materials from partners until the raw materials are received at the Petrokimia Gresik Port/Terminal for Self Interest (TUKS), then sent to the raw material warehouse and consumed until it becomes a product. ready to sell. The production supply chain flow (Outbound), starting from product receipt at the Gresik Warehouse (Line I), then sent to the Distribution Center (DC)/Line II) or directly to the Buffer Warehouse (GP/Line III). From GP Line III, the product will be picked up by the Distributor to be stored in the distributor's warehouse, before finally being picked up by the final retailer.

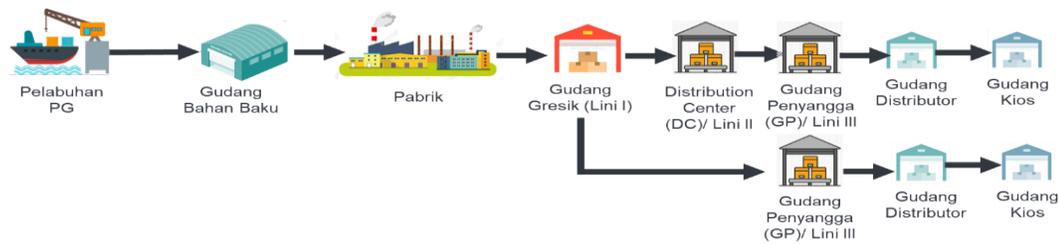


Figure 1. Supply Chain of PT Petrokimia Gresik

With the large number of partners and truck fleets operating in the Java – Bali area, it is a parameter that there is a large movement of fertilizer products in that area. A large fertilizer movement requires good supply chain management. Apart from being seen from the point of view of storage capacity, if we look at the sales target/distribution of subsidized fertilizers for PT Petrokimia Gresik, which is outlined in the Company's Work Plan and Budget (RKAP) for 2020, it appears that the largest sales/distribution target is in the Java – Bali area. Of the total tonnage (quantum) fertilizer sales target of 4,740,276 tons, consisting of 2,943,757 tons (62%) for the Java – Bali area, and 1,796,519 (38%) for the Outer Java – Bali area (Sumatra, Kalimantan, Sulawesi, Maluku, Papua and Nusa Tenggara).

The large capacity of the supply chain network and the high target for distribution of subsidized fertilizers for Petrokimia Gresik in the Java - Bali area, encourage the focus of this research to improve the Outbound Logistics Supply Chain Performance in the Java - Bali Distribution Area. Improving the performance of a system, must begin with measuring the condition of the existing system, this shows the importance of measuring performance or performance for successful supply chain management. Ineffective performance measurement will never reveal what adjustments are needed in the supply chain. Performance improvement, effective collaboration with suppliers and customers to streamline the supply chain is an interactive process. This means that how performance measurement is carried out is very important and is an ongoing process.

Measurement of supply chain performance can be carried out using various methods (Reddy et al., 2019), among others, by using a comparison of company performance contained in key performance indicators (KPIs) related to supply chains (Akkawuttiwanich & Yenradee, 2018; Punia et al., 2019) or can also be done using the Supply Chain Operations Reference (SCOR) Model method in case studies in the manufacturing industry (Okongwu et al., 2015; Lima-Junior & Carpinetti, 2019; Zanon et al., 2019; Mancini et al., 2020). In several studies that have been carried out related to supply chain performance measurement, most of the research focuses on supply chain performance measurement with the next stage in the form of recommendations and suggestions for improvement.

As in other cases, improving process improvements in the supply chain by using predictive analytics using forecasting methods (Pereira et al., 2018; Praveen et al., 2019; Punia et al., 2019). In addition, there is also the application of big data analytics (BDA) to improve supply chain performance (Robmann et al., 2017; Bag et al., 2020). There are many studies that aim to improve the supply chain process carried out using supervised machine learning methods (Cavalcante et al., 2019; Qin & Chiang, 2019; Lauer et al.,

2019; Baryannis et al., 2019; Pereira & Frazzon, 2020; Sharma et al., 2020; Abbasi et al., 2020; Mancini et al., 2020; Cheng et al., 2020). Specifically supervised machine learning can also be applied to several logistics case studies, including 3PL (Third party logistics) case studies (Tufani et al., 2020), Inbound Logistics (Knoll et al., 2016) or repair congestion urban traffic problems (Pandya et al., 2020). Regarding the location of this research, which was carried out in the fertilizer industry (fertilizer industry) PT Petrokimia Gresik, is a new thing that has not been reviewed in previous studies. With the focus area for improvement in the Java - Bali area, this research will begin with measuring the supply chain performance of PT Petrokimia Gresik's Land Transport partners in the Java-Bali area using the SCOR Model.

The results of the performance measurement are knowing one of the critical attributes of the 3 (three) supply chain performance attributes (reliability, responsiveness, flexibility). Then from the critical performance attributes above, an analysis of the factors that influence these attributes will be carried out using Supervised Machine Learning. In this study, Supervised Machine Learning was used with the random forest method, support vector machine (SVM) and Artificial Neural Network (ANN). This is based on several journals that are used as references in this study, the performance of the supervised machine learning random forest method is better in terms of accuracy and AUC value. In other hand, in the specifics of the supply chain topic, the Supervised Machine Learning method that is most often used is Artificial Neural Network (ANN) or also commonly known as Neural Network (NN) and Support Vector Machine (SVM) (Ni et al., 2019).

With 2 (two) considerations on the good level of accuracy in the Random Forest method and the type of method used most on the supply chain topic (ANN and SVM), this study will use the random forest method, support vector machine (SVM) and Artificial Neural Network. (ANN). The results of the classification using Supervised Machine Learning on the random forest method, support vector machine (SVM) and Artificial Neural Network (ANN) will search for the best machine learning method in predicting the performance of Land Transporters. Based on this sequence of steps above, it is hoped that the factors that influence the performance of Land Transporters as part of the PT Petrokimia Gresik supply chain can be identified. With these results, it is possible to make suggestions or alternative suggestions for improvement in order to improve the performance of PT Petrokimia Gresik's Land Transporters.

By considering a number of studies related to previous research, there are many studies on the results of supply chain performance evaluation, which focus on how to determine the best supply chain calculation model and there is also research on how to calculate supply chain performance using one of the measurement models. In this study, there is a difference by measuring supply chain performance with the SCOR Model which is then followed by determining the critical factors that cause the performance. Determination of critical factors is done by using Supervised Machine Learning method. This means that there is a combination of two methods, namely the SCOR Model and Machine Learning in order to improve supply chain performance. In addition, the location of this research is in the fertilizer industry, this can complete the research gap by expanding the field of application of the SCOR Model and Supervised Machine Learning so that it can further enlarge the knowledge base in the field of supply chain performance improvement.

2. LITERATURE REVIEW

According to Gunasekaran, et al., (2004) Supply Chain Management (SCM) has become a major component of the strategy to increase productivity and company profits. This is in line with the role of measuring the performance of the Supply Chain. One of the fundamental aspects of SCM is performance management (performance) and continuous improvement (Pujawan, 2005). According to Sushil & Shankar (2004), an effective performance measurement is one that has the following characteristics: Inclusiveness (measurement of all aspects concerned), Universality (allows comparison under various operating conditions), Measurable (the required data can be measured), Consistency (the measure used is in line with the organization's goals).

The Supply Chain Operations Reference Model (SCOR Model) provides a general framework for the supply chain, with standardized terminology, performance measures that can be used for comparison and provide best practices. The Supply Chain Operations Reference Model can be used as a general model to evaluate, compare positions and implement supply chain software applications. (Huang et al., 2004). One of the main advantages of the SCOR Model is in the definition of a common language of communication between internal business functions and external business functions (Poluha, 2007).

Big Data Analytics (BDA) is a condition where there is data with a large amount, speed and variety of data and exceeds the speed of traditional data processing (Chen & Zhang, 2014). while Business Analytics (BA) is a field of expertise in evaluating the strategic functions of organizations through data-based improvements, statistics, operations analysis, Predictive Modeling, forecasting (Forecasting) and optimization techniques (Russom, 2011). Supply Chain Analytics is a process by which individuals, organizational units, and companies utilize supply chain information through the ability to measure, monitor, forecast, and manage business processes related to the supply chain. (Smith, 2000). Meanwhile, according to (Marabotti, 2003) Supply Chain Analytics is the process of extracting and presenting supply chain information so that it can be used in providing measurement, monitoring, forecasting, and supply chain management. The application of Big Data Analytics and Business Analytics has been widely applied in Supply Chain operations, such as Demand Planning, Procurement, Production and Logistics in order to improve Supply Chain performance and this is commonly referred to as Supply Chain Analytics (Wang et al. , 2016).

Machine Learning is a discipline that includes the design and development of algorithms that enable computers to develop behavior based on empirical data, such as from sensor data databases (Ni et al., 2019). Machine Learning can utilize examples (data) to capture the necessary features of the underlying (unknown) probabilities (Mohri et al., 2018). The random forest algorithm has been widely discussed since Breiman's (2001) article appeared in a machine learning journal. Liaw and Wiener (2002) stated that the random forest was developed by Breiman (2001). Breiman(2001) attempts to improve the estimation process using the bagging method. The random forest method is the development of the Classification and Regression Tree (CART) method, by applying the bootstrap aggregating (bagging) and random feature selection methods. Support Vector Machine(SVM) is a computer algorithm that performs learning to assign labels to objects

(Noble, 2006). The SVM model is a binary classifier labeled training data, finding the hyper-plane that maximizes the margin between the two classes. For multi-class classification problems, a one-on-one approach is used (Hsu & Lin, 2002). The study of Artificial Neural Networks (ANN) or Neural Networks (NNs) was inspired by attempts to simulate biological nervous systems. Analogous to the structure of the human brain, an ANN consists of an interconnected assembly of nodes and directed links. and show how models can be trained to solve classification problems (Tan et al., 2014)

3. METHODS

We use SCOR Model as supply chain performance measurement the continued by descriptive and predictive analytics with supervised machine learning. Calculation of the company's Supply Chain performance is carried out using the SCOR Model at Metrics level 1 for the performance attributes of Reliability, Responsiveness and Agility. Based on SCOR Model result, we get critical supply chain attribute for further analysis. The next step is data preprocessing. this process is aims to eliminate missing data and apply feature selection to existing variables. After that, we do a descriptive analysis on the data and continue with predictive analysis using classification based on supervised machine learning. The machine learning algorithm used in this research is random forest, artificial neural network and support vector machine. The best predictive model of machine learning algorithm is based on Accuracy, Precision, Recall, F-Measure, (ROC Curve - AUC). Then we analyze Critical Factors on Performance Attributes, suggest improvement, calculate estimation increasing supply chain performance and financial impact of improvement

The performance test of the classification results in this study used Stratified sampling 5 fold Cross Validation. Cross Validation is widely regarded as the most reliable way to test Machine Learning performance (Smith & Frank, 2016). The commonly used k fold value is k with values 5 and 10. This value depends on the size of the dataset. If there is any doubt, then you can use k-fold cross validation, with the value of k being 5 or 10 (Brownlee, 2016).

4. RESULTS

After conducting the process of collecting, processing data and measuring supply chain performance with SCOR Model, the results are obtained as shown in the table 1

Table 1. Supply Chain Performance Measurement with SCOR Model

SCOR Performance Attribute	Definition	Company KPI	KPI (%)	Total (%)
	Perfect Order Fulfillment is the percentage of orders	Percentage of product quantity delivered perfectly at destination warehouse (not damaged/defective)	100	

Supply Chain Reliability	that meet product delivery performance with complete, accurate and no Damage Documentation	POSTO Percentage completion in accordance with the service fulfilment deadline (30 days)	96.4	98.2
Supply Chain Responsiveness	Order Fulfilment Cycle Time is the actual cycle time (Cycle Time) achieved consistently to fulfil customer orders	Source Cycle Time and Make Cycle Time based on the KPI achievement of production realization in the period of December 2020	105	71.4
		Delivery Cycle Time is measured based on the timeliness of the first pick-up from the published POSTO (on time orders collection)	37.76	
Supply Chain Flexibility	Supply Chain Flexibility and Adaptability in order	Achievement of KPI "Production Performance" in 2020	98	106.0
	to fulfill an increase in orders is the number of days required to achieve an unplanned 20% increase in quantity	Achievement of KPI "Production Performance" Below the Target in 2020	114	

Based on calculation in table 1, the Key Performance Indicator (KPI) that must be improved on the Supply Chain of PT Petrokimia Gresik is the Delivery Cycle Time with the detail performance parameter is " on time orders collection "

In data mining techniques, the first thing to do before processing the data is to pre-process the data. The first step is to handle missing values. In this study, variables with missing values will be removed from the study. The next step is to perform feature selection to select the predictor variable (X) that will be used to predict the accuracy of the retrieval time. Feature selection is carried out with the aim of knowing whether there is multicollinearity between the independent variables. The method used in selecting predictor variables (Feature Selection) is to use Forward Elimination with the Best First feature, Search direction: forward with the results as presented in Table 2

Table 2. Feature Selection Result

Feature Selection		
	Number of predictor variables (X) before feature selection	Number of predictor variables (X) after feature selection
Predictor Variables (X)	19	9

recapitulation of the Accuracy, Precision, Recall, F-Measure and ROC Curve/AUC values as shown in the Table 4

Table 4. Classification Performance Using Supervised Machine Learning Algorithm

Classification Algorithm	Random Forest	Support Vector Machine	Artificial Neural Network (ANN)
Accuracy	83,91%	81,57%	76,29%
Precision	83,90%	81,50%	75,90%
Recall	83,90%	81,60%	76,30%
Kappa Statistic	0,6478	0,5959	0,4814
ROC Curve/ AUC	0,880	0,789	0,799
F Measure :	83,60%	81,20%	75,9%

Based on Table 4.4, it can be seen that the overall machine learning classification performance parameters generated by the random forest algorithm have the best value, with an average accuracy value of 83.91% and AUC 0.880. The resulting model belongs to the Good Classification category because the AUC value is in the range of 0.8 – 0.9 [44].

4.2 Factor Analysis

After knowing the random forest algorithm is the best classification model, then an analysis of the factors (X1 to X9) to get the most significant factor to predicts the value of the On time orders collection (Y) is carried out. Determination of critical factors based on a decrease in average impurity (Gini importance) with the results as shown in Figure 3

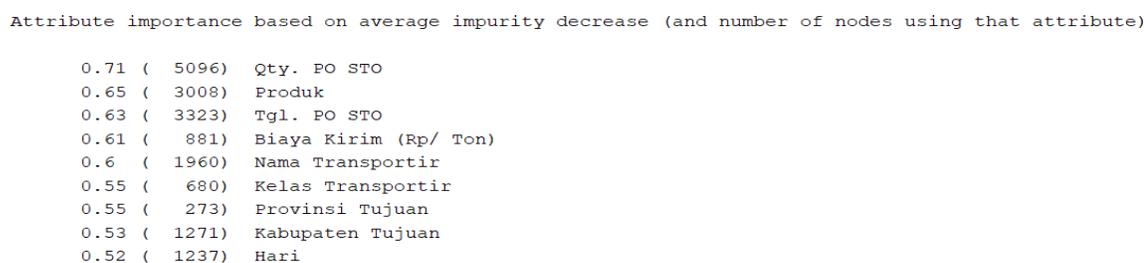


Figure 3. Attribute Importance Based On Average Impurity Decrease (Gini Ratio)

Based on the above analysis, it can be concluded that the critical factors for late performance are (POSTO Quantity), Product, POSTO Date and Delivery Cost (Rp/Ton). Based on the descriptive analysis for the Qty POSTO variable, it can be seen that the greater the quantity of POSTO, the greater the potential for delays in collection by transport partners. It is understandable that the larger the order quantity, the transport partner will dedicate more and more fleets to service. This condition requires a longer coordination time for transport partners.

Based on the descriptive analysis for the Product Type variable, it can be seen that there are several types of products that have a significant proportion of delay compared to

other products. It can be seen that NPK and ZA products have a higher proportion of delays compared to other products. The difference in these services can be analyzed more deeply, how the handling of expenses for ZA and NPK products is practically more difficult than other products, because there is a tendency for the product to harden (cacking). So the process of loading onto the truck will take longer than other products. This has the potential for transport partners to prioritize taking other types of products (Urea fertilizer, SP-36 and Petroganik). Based on the descriptive analysis for the POSTO issue date variable, it can be seen that there is a tendency on certain dates in December 2020 which has a proportionate rate of delay in collection when the order is issued. Based on the descriptive analysis for the Delivery Costs variable, it can be seen that there is a tendency for the smaller the value of the shipping costs (Rp/Ton), and the proportion of delays is greater. This can be analyzed more deeply, determining the evaluation of shipping rates per route of PT Petrokimia Gresik with the estimated realization of costs incurred by Transporter Partners. This is aimed at determining the optimal point of the fare per route with the level of performance of retrieval by partner transporters as expected by PT Petrokimia Gresik.

4.3 Critical Factor Validation

Critical factor validation is carried out in order to validate critical variables, by reclassifying using 4 (four) variables and comparing the results of classification performance between 4 critical variables with existing conditions (9 variables) generated.

Table 5. Classification Performance Comparison

Algorithm	Random Forest (9 Variable)	Random Forest (4 Critical Variable)
Accuracy	83,91%	84,09%
Precision	83,90%	84,00%
Recall	83,90%	84,10%
Kappa Statistic	0,6478	0,6543
ROC Curve/ AUC	0,880	0,894
F Measure :	83,60%	83,90%

The prediction model using 4 critical variables is proven to be able to produce a better classification performance compared to the 9 existing variables

4.4 On Time Orders Collection Predictive Model

In order to estimate the conditions of delay in picking up by land transport partners so that they get better planning, a predictive delay model is made. The results of predictive classification modeling using the random forest algorithm on critical variables are stored in the Weka Model File and generated as shown in Figure 4 below.

```
=== Model information ===
```

```
Filename:      Model Predictive.model  
Scheme:       weka.classifiers.trees.RandomForest -P 100 -I 100 -num-slots 1  
Relation:     DATA TRANSPORT FIX-weka.filters.unsupervised.attribute.Reorder-  
Attributes:   5  
              Produk  
              Tgl. PO STO  
              Qty. PO STO  
              Biaya Kirim (Rp/ Ton)  
              Keterangan
```

```
=== Classifier model ===
```

Figure 4. Random Forest Algorithm Predictive Model

4.5 New Scheme Issuing Orders for Transporters

By having a Land Transporter performance prediction model, in order to improve the company's supply chain performance in terms of responsiveness performance attributes. From the estimation of the level of goodness of the predictive model, it can be calculated that the estimated supply chain performance improvement if applying the proposed Land Transporter ordering scheme is 89.4% or an increase of 136% from the existing condition of supply chain performance on time (37.76%).

6. CONCLUSIONS

Based on the results of the SCOR Model measurement, it is found that the Supply Chain Responsiveness attribute is a critical performance attribute of the PT Petrokimia Gresik Land Transporter Supply Chain, with the company's KPI parameter being the on-time orders collection. It is found that there are 4 (four) variables that affect the on-time orders collection, namely POSTO Quantity (Qty), Product Type, POSTO Date and Delivery Cost (Rp/Ton). The results of the predictive analysis of machine learning classification using the Random Forest, Support Vector Machine (SVM) and Artificial Neural Network (ANN) algorithms, it was found that the Random Forest algorithm model had the best prediction rate with an accuracy rate of 83.81% with an Area value Under Curve (AUC) of 0.88 (Good Classification). On further predictive analysis on the Random Forest algorithm model using the Gini Importance parameter, 4 (four) variables have a very significant effect on the On time orders collection, namely the POSTO Quantity, Product Type, POSTO Date and Delivery Cost (Rp/Ton). These results indicate that descriptive analysis and predictive analysis with classification show the same results. Based on the proposed improvement through the creation of a delay predictive model (in order to improve the on-time orders collection) and the application of the Land Transporter New Ordering Scheme, it is estimated that it can improve the supply chain performance of PT Petrokimia Gresik on the parameter "pick-up time" to 89.4% (or increased by 136% from the existing condition of timeliness of 37.76%). In addition, this improvement is also estimated to have a financial impact in the form of savings in handling costs of Rp. 4.37 billion. This research has covered descriptive and predictive stages and can be developed in further research by continuing at the prescriptive stage through optimizing improvement all significant variable and increasing

the analysis period for one year with Realtime data.

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SCENARIO SELECTION OF THE NEED FOR AMMONIA CARRIER BASED ON MRP WITH INTEGER LINEAR PROGRAMMING (ILP)

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ABSTRACT

Planning for raw material needs is one of the important aspects in the whole series of production processes in the chemical industry sector. Good planning for raw material needs will give management an idea of how much raw material is needed and when it is needed. In addition, with a good material requirements planning, it will be a reference for management on how to meet these needs. PT XYZ is a company in the chemical industry sector which of course requires information on the material needs of raw materials and how to meet the needs of these raw materials. One of the raw materials used in the production process at PT XYZ is ammonia. Ammonia is used in almost all PT XYZ products. The ammonia used can be produced on its own, but in limited quantities, and to cover the shortfall, imports are carried out using ammonia transport vessels. So far, the planning process for raw material material requirements, especially ammonia at PT XYZ, is carried out separately in each unit which has an impact on inaccuracies in the data resulting from the planning of raw material requirements. In addition, planning for import needs so far has only looked at the availability of vessels and has not carried out an evaluation of the impact of selecting the capacity of ammonia carriers on the total costs incurred. This research was conducted to solve the two problems mentioned above. The planning process for the total demand for ammonia raw materials is carried out using the MRP method so that all products using ammonia raw materials can be included in the planning to minimize errors and also include the ammonia production capacity itself. After the total ammonia requirement is known, the lot sizing of the ammonia import will be calculated using the integer linear programming method. This lot sizing will evaluate the scenario of the need for vessels using either a single vessel or a combination of vessels. The evaluation results show that the scenario using a combination of vessels is the best scenario because it provides the lowest total cost compared to the scenario using a single vessel.

Keywords: raw material planning, scenario selection, total costs, MRP, ILP.

1. INTRODUCTION

Production planning plays an important role in the production operations of a company. Production planning will provide an overview to the management of what products will be produced along with the time then what raw materials or components are needed and when they are needed. Good production planning will assist management in making strategies and decisions to achieve the expected targets. Production planning is closely

related to planning for raw material requirements, planning for raw material requirements is an inseparable part of production planning because the availability of raw materials is a key factor in the sustainability of production operations.

XYZ Company as a company with a core business in the chemical industry sector, of course, really needs good and precise raw material planning. With good and precise planning of raw material requirements, the process of procuring raw materials according to plan and the arrival of raw materials on schedule can help ensure the availability of raw materials which is a key factor in the success of production operations at XYZ company.

The planning process for ammonia raw material needs has been carried out by each production unit and will be fulfilled by the internal ammonia production capacity of XYZ company. Due to the limited production capacity compared to the total demand, there is still remaining ammonia requirement that must be met from imports. So far, the planning process for raw material needs for ammonia is carried out separately in each work unit and then the procurement process is carried out by the procurement unit. The impact of this separate planning process is that there is often a need that is not included in the planning of raw material requirements which results in additional procurement which will increase the cost of vessel logistics. In addition, the procurement process for imported ammonia has been carried out only by looking at the availability of vessels. There are two vessels commonly used to transport imported ammonia. Vessel A with a carrying capacity of 5,700 tons of ammonia and vessel B with a carrying capacity of 11,400 tons of ammonia. The selection of this vessel certainly has an impact on the total costs that arise, both in terms of ordering costs and inventory costs. In this study, the best scenario for transporting ammonia using a single vessel or a combination of A and B vessels will be evaluated by considering the total costs incurred.

2. LITERATURE REVIEW

2.1 Material Requirement Planning (MRP)

Material Requirements Planning or abbreviated as MRP is based on dependent demand. Dependent demand is caused by the demand for goods at a higher level. According to Waters (Waters, 2003) determining the amount of dependent demand is basically a simple multiplication process. According to Chase (Chase et al., 2006) calculation of MRP requires some information with three main sources, namely Master Production Schedule (MPS), Bill of Materials (BOM) and Inventory Record.

1. Master Production Schedule (MPS) is a time-based planning that determines when and how much of the final product will be produced by a company (Chase et al., 2006).
2. Bill of Materials (BOM) is a list of all subassemblies, intermediates, parts and raw materials used to make the main assembly indicating the amount required to perform an assembly (Arnold et al., 2008).
3. Inventory Record, according to Tony Arnold (Arnold et al., 2008) when a calculation is made to get the number of items needed, the amount available must be considered.

If described, the information needed in the MRP calculation can be seen in Figure 1. The main outputs or main reports from MRP are the arrival schedule of raw materials, schedule of ordering raw materials and production control.

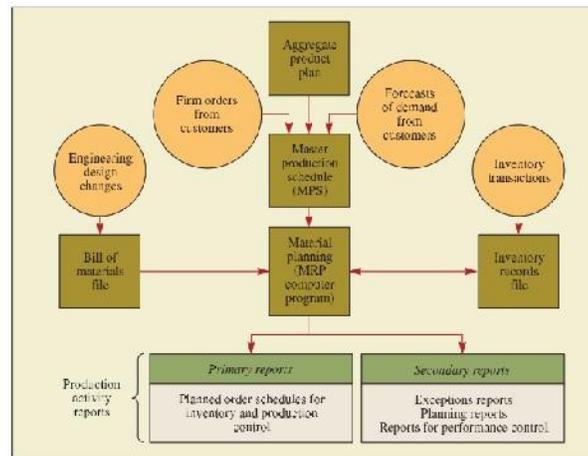


Figure 1. Input Output of the MRP System System

The MRP calculation process according to Isnaini (Ummiroh, 2013) is carried out using the four basic steps of the MRP system, which are as follows :

1. Explosion Process

The explosion process is the process of calculating the gross needs of items at the lowest level.

2. Netting Process

The netting process is a calculation process to determine the amount of net requirements, the amount of which is the difference between gross requirements and inventory conditions.

3. Lotting Process

The lotting process is the process of determining the optimal order size for each product item based on the results of the calculation of net needs.

4. Offsetting Process

The offsetting process is aimed at determining the right time to plan an order in an effort to meet the level of net demand. The required plan is carried out when the required material is reduced by the lead time.

The MRP calculation process can be described as in Figure 2 as follows :

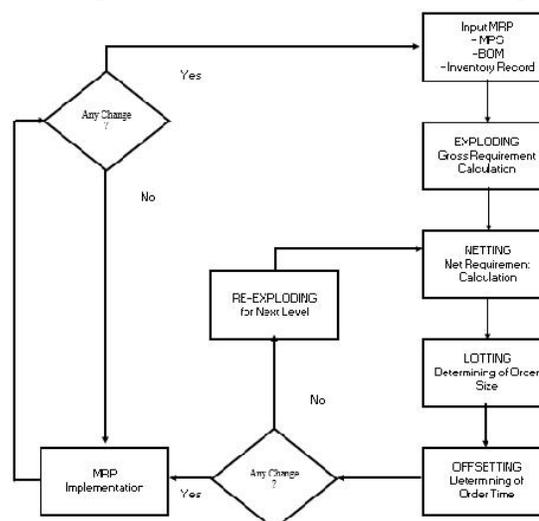


Figure 2. MRP Calculation Process (Panjaitan, 2000)

2.2 Lot Sizing on MRP

According to Tony Arnold and Stephen Chapman (Arnold et al., 2008) a lot or batch is an amount produced together and sharing the same production costs and specifications. In calculating the MRP, the number of items needed to be ordered will be calculated in lots or batches with several approaches as follows (Waters, 2003) :

1. Lot for Lot where the net requirement to be ordered is determined by calculating the MRP for each period or the amount ordered is the same as the required amount.
2. Fixed Order Quantity where the number of orders will always be in the same amount due to limitations in vesselping such as truck loads, container loads, economic order quantity or other quantity approaches.
3. Periodic Orders where orders are made regularly at a certain period with a predetermined amount.
4. Batching Rules using several specific procedures to calculate the best ordering pattern.

Several studies used in this study related to MRP and lot sizing including the research of Yuli Agustriamah (Agustrimah et al., 2020), Adelia Candradevi (Chandradevi & Puspitasari, 2016), Kukuh Anggara (Martha & Setiawan, 2018), Isnaini Ruhul Ummiroh (Ummiroh, 2013) and Togar WS Panjaitan (Panjaitan, 2000).

2.3 Integer Linear Programming

Based on research conducted by Teerawat Thepmanee (Masuchun et al., 2009) MRP has a weakness where problems arise when materials are not available or resources are currently mastered resulting in plans that cannot be achieved. This is because MRP does not take into account capacity constraints and sequence of operations in the calculations. When the schedule is created, it is possible that some materials are needed earlier than planned in the MRP for several reasons. An integer linear programming model to capture the essence of both planning and scheduling was built. The objective function includes planning and scheduling objectives, namely to minimize total inventory costs and order delays. Total inventory cost can be calculated from the total quantity required multiplied by the inventory cost per unit times the material waiting time to be processed to avoid subassembly, or components, or items being processed or prepared too early as intended when generating the MRP.

The general form of Integer Linear Programming is as follows (Lumbantoruan, 2020) as shown in equation (1) and equations and inequalities (2).

Objective Function :

Maximize or minimize

$$Z = c_1x_1 + c_2x_2 + \dots + c_nx_n$$

Constraint Function :

$$a_{11}x_1 + a_{12}x_2 + \dots + a_{1n}x_n = / \leq / \geq b_1$$

$$a_{21}x_1 + a_{22}x_2 + \dots + a_{2n}x_n = / \leq / \geq b_2$$

$$a_{m1}x_1 + a_{m2}x_2 + \dots + a_{mn}x_n = / \leq / \geq b_m$$

$$x_1, x_2, \dots, x_n \geq 0$$

The symbol $x_1, x_2, \dots, x_n (x_i)$ shows the decision variable where for Integer Linear Programming the decision variable is an integer. The number of decision variables (x_i) therefore depends on the number of activities or activities carried out to achieve the goal. The symbol c_1, c_2, \dots, c_n is the contribution of each decision variable to the goal, also called the coefficient of the objective function in the mathematical model. The symbol $a_{11}, \dots, a_{1n}, \dots, a_{m1}, \dots, a_{mn}$ is the use per unit of the decision variable for the limiting resource, or also called the coefficient of the constraint function in the mathematical model.

The symbol b_1, b_2, \dots, b_m indicates the amount of each available resource. The number of constraint functions will depend on the number of limited resources. The last inequality $(x_1, x_2, \dots, x_n \geq 0)$ shows a non-negative constraint.

The traditional approach to solving integer linear programming problems is the branch and bound method. This method is a tedious method and often involves a complex calculation process that can be calculated using several software tools that can be obtained easily.

3. RESEARCH METHODOLOGY

The research methodology used in this study is generally divided into 3 systematic stages as follows :

1. Collecting and processing data to be used in calculating the need for ammonia both gross and clean using the MRP method.
2. Analysis of the results and discussion where the lot sizing fixed order quantity will be calculated using an integer linear programming approach.
3. Conclusions related to the purpose of this study.

This research methodology when described in a flow chart will appear as Figure 3 as follows :

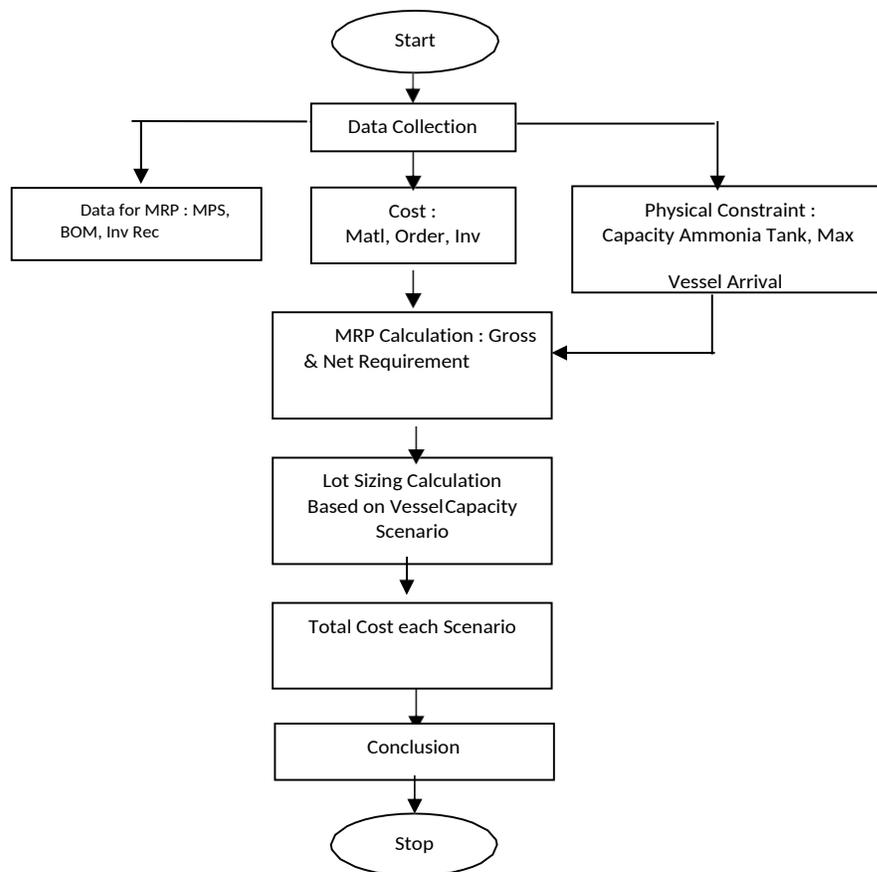


Figure 3. Flowchart of Research Methodology

The lot sizing model used in this study is as follows and table 1 shows calculations :

$$\min(Z) = Q \left(\left(5.700 \left(\sum_{t=1}^{24} x1_{(t)} \right) \right) \left(11.400 \left(\sum_{t=1}^{24} x2_{(t)} \right) \right) \right) + S1 \left(\sum_{t=1}^{24} x1_{(t)} \right) + S2 \left(\sum_{t=1}^{24} x2_{(t)} \right) + H \left(\sum_{t=1}^{24} \left(\frac{I_{(t)} - I_{(t-1)}}{2} \right) \right)$$

Objective Function :

(3)

Subject to :

- Z : Total Costs (USD)
 X1 : Decision Variable Vessel A (5.700 tons)
 X2 : Decision Variable Vessel B (11.400 tons)
 Q : Material Costs (USD/ton)
 S1 : Order Costs Vessel A (USD/vesselment)
 S2 : Order Costs Vessel B (USD/vesselment)
 H : Holding Costs (USD/ton)

Constraint Function :

Tank Capacity Constraint :

$$+ Supply_{(t)} - Demand_{(t)} + 5.700x1_{(t)} + 11.400x2_{(t)} = I_{(t)}$$

$$A \leq I_{(t)} \leq B$$

(4)

Maximum Vessel Arrival Constraint :

(5)

$$x1_{(t)} + x2_{(t)} \leq C$$

(6)

$$x1_{(t)} < D$$

(7)

$$x2_{(t)} \leq E$$

(8)

$$x1_{(t)}, x2_{(t)} \geq 0 ; integer$$

(9)

Subject to :

- t : 1,2,3... 24; Half of Month Period
 A : 36.500 tons, Ammonia Tank Maximum Capacity B :
 6.000 tons, Ammonia Tank Minimum Capacity
 C : 4 units, Maximum Number of Total Vessel Arrival D
 : 2 units, Maximum Number of Vessel A Arrival
 E : 2 units, Maximum Number of Vessel B Arrival I(0) :
 16.764 tons, Initial Ammonia Stock
 Supply(t) : Total Ammonia Production Demand(t)
 : Total Ammonia Consumption

4. RESULTS & DISCUSSION

Based on the results of the MRP calculation of the exploding stage of the ammonia requirement and Lot Sizing of ammonia imports, it can be seen in table 2 and table 3 as follows:

Table 2. Gross Ammonia Requirement

NO	PRODU CT	RAW MATERIAL	JA N		FE B		MAR		APR	
			1 H	2 H	1 H	2 H	1 H	2 H	1 H	2 H
1	A1	Ammonia	11.180	11.180	11.180	8.944	11.180	11.180	11.180	10.434
		CO2	14.456	14.456	14.456	11.565	14.456	14.456	14.456	13.493
2	A2	Ammonia	15.008	15.008	15.008	12.006	15.008	15.008	15.008	14.007
		CO2	19.406	19.406	19.406	15.525	19.406	19.406	19.406	18.113
3	B1	Sulfuric Acid	8.340	8.340	8.340	6.670	8.340	8.340	8.340	7.791
		Ammonia	3.150	3.150	3.150	2.520	3.150	3.150	3.150	2.940
4	B2	Sulfuric Acid	8.340	8.340	8.340	6.670	8.340	8.340	8.340	7.791
		Ammonia	3.150	3.150	3.150	2.520	3.150	3.150	3.150	2.940
5	B3	Sulfuric Acid	4.248	3.688	4.248	2.832	4.248	3.688	4.248	3.398
		Ammonia	4.680	4.056	4.680	3.120	4.680	4.056	4.680	3.744
		CO2	4.320	3.744	4.320	2.880	4.320	3.744	4.320	3.456
		Gypsum	13.824	11.981	13.824	9.216	13.824	11.981	13.824	11.059
6	C	Phosphoric Acid	3.828	638	0	3.445	3.828	128	0	3.445
		Ammonia	2.514	419	0	2.262	2.514	84	0	2.262
		Sulfuric Acid	5.156	859	0	4.640	5.156	172	0	4.640
		ZA	4.290	715	0	3.861	4.290	143	0	3.861
		Urea Prill	195	33	0	176	195	7	0	176
		KCl.	4.095	683	0	3.686	4.095	137	0	3.686
		Ammonia Total	53.580	50.458	52.637	40.393	53.434	50.316	52.980	47.202

Due to the limited space in this paper, the total gross ammonia requirement of company XYZ in 2021 is only displayed for 6 products and until April. The data in table 2 will then be input to the lot sizing calculation using the following scenario :

1. Scenario 1 uses a 5,700 tons vessels
2. Scenario 2 using 11,400 tona vessels
3. Scenario 3 uses a combination of 5,700 ton and 11,400 ton vessels

The total cost obtained from the calculation of each scenario is as shown in table 3 as follows :

Table 3. Comparison of Total Costs of Each Scenario

No.	Scenario	Number of Vessels	Costs (USD)			
			Material	Order	Holding	Total
1	A (5.700 tons)	22 units	57.739.943	4.064.690	18.392.012	80.196.645
2	B (11.400 tons)	11 units	57.739.943	4.047.093	21.391.169	83.178.205
3	Combination A&B	A = 14 units B = 4 units	57.739.943	4.058.291	16.249.756	78.047.990

Based on table 3, we can see that of the three scenarios, the scenario that provides the lowest total cost is scenario 3 using a combination of vessels A and B. This can happen because scenario 3 can optimize both order costs and inventory costs. Whereas in scenario 1 it can only optimize inventory costs but cannot optimize ordering costs. Scenario 2 can only optimize ordering costs but has a big impact on inventory costs biaya.

5. CONCLUSION

This study aims to determine the total need for ammonia which will be used to determine the lot sizing of the needs of the vessel carrying ammonia based on three scenarios. Based on the results of this study, it was found that the transportation scenario using a combination of vessels is the best scenario which provides the lowest total cost. It is expected that raw material procurement planners can use the results of this study in planning the total demand for vessels that will be used to transport ammonia.

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A COMPARATIVE STUDY OF OPTIMIZATION METHODS FOR OPTIMIZING SOFTWARE EFFORT ESTIMATION USING COCOMO II

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ABSTRACT

COCOMO II is a model that can be used to estimate software development efforts and time estimation. Many previous studies used swarm-based algorithms as optimization methodologies, such as Cuckoo Optimization Algorithm, Bat Algorithm, and Particle Swarm Optimization, to optimize COCOMO II parameters and to improve its estimation accuracy. However, no research has yet analyzed the differences in the characteristics and estimated values obtained from the methods used in each of these studies. This research aims to understand the behavior of each optimization method. In this paper, a comparison of three swarm-based algorithms, Cuckoo Optimization Algorithm, Bat Algorithm, and Particle Swarm Optimization is presented. Each method is implemented and tested by using both the NASA93 and the Turkish Project dataset. The different results of the implementation are compared by evaluating their Magnitude Relative Error (MRE) for each project data and their Mean Magnitude Relative Error (MMRE) for each dataset. The results show that all algorithms can give better results than the original COCOMO II in software development effort estimation by optimizing the constant A and B of COCOMO II, but each algorithm has different behavior. Numerous factors affect the behavior and the result of the algorithms in this study case, such as the dataset and the parameter of each algorithm.

Keywords: COCOMO II, Particle Swarm Optimization, Cuckoo Optimization Algorithm, Bat Algorithm

1. INTRODUCTION

Initiation in software development project management is an important phase. According to PMBOK (Project Management Institute, 2008), the purpose of the phase is to determine whether the project is feasible and the company can work on it. One of its activities is to estimate software development effort, time, and cost. Estimation is a crucial process in the initiation phase of software development project management. Estimation helps Project Manager to determine resources and timeline for the software development project. It is a

challenging task that cannot be underestimated because the wrong estimation can lead to project failure. According to a survey in Europe (McManus & Wood-Harper, 2008), 65% of project failure is caused by bad estimation methods.

There is a lot of software development effort and time estimation models that can be used to address this problem such as the Constructive Cost Model (COCOMO) II that commonly used (Barry Boehm, Chris Abts, A. Winsor Brown, Sunita Chulani, Bradford K. Clark, Ellis Horowitz, Ray Madachy, Donald J. Reifer, 2000).

COCOMO II is an estimation model based on regression that can help Software Development Project Manager to estimate effort and cost for developing software projects. COCOMO II is an updated version of COCOMO 81 (Barry Boehm, Chris Abts, A. Winsor Brown, Sunita Chulani, Bradford K. Clark, Ellis Horowitz, Ray Madachy, Donald J. Reifer, 2000; Boehm, Valerdi, Lane, & Brown, 2005; Shekhar & Kumar, 2016). To estimate software development effort, COCOMO II requires Kilo Line of Code (KLOC) and Cost Drivers. There are 22 Cost Drivers, 17 Efforts Multiplier (EM), and 5 Scale Factors (SF), and the values are determined by the project manager. Unlike other methods that only use source line of code as the input for the effort estimation, COCOMO II also considers external factors that influence the project.

Many previous studies used swarm-based algorithms as optimization methodology, such as Bat Algorithm (Amelia Effendi, Sarno, & Prasetyo, 2018), Cuckoo Optimization Algorithm (Parwita, Sarno, & Puspaningrum, 2018), and Particle Swarm Optimization (Langsari & Sarno, 2017), to optimize COCOMO II constant parameters (A and B) so that the estimation accuracy is improved.

Bat Algorithm (BA) is an optimization algorithm developed in 2010 by Xin-She Yang (Yang, 2010). This algorithm is inspired by the behavior of bats that use echolocation as a navigation tool for hunting their prey and traveling around. To find the optimum solution, each bat has a velocity and location to hunt their 'prey', in an iteration, in a solution dimension. In the previous research, Bat Algorithm was able to reach 34.25% of MMRE.

Cuckoo Optimization Algorithm (COA) was published by Rajabioun in 2009 (Rajabioun, 2011). The algorithm mimics the behavior of the cuckoo bird that lays its eggs in other birds' nests. If the nest owner finds cuckoo eggs in the nest, there are two choices: the eggs are discarded or the nest is abandoned. In the previous research, Cuckoo Optimization Algorithm was able to reach 34.20% of MMRE.

Particle Swarm Optimization (PSO) is a swarm-based optimization method inspired by the movement behavior of fish or flocks of birds, introduced by Kennedy and Eberhart in 1995 (Kennedy & Eberhart, 1995). In the previous research, Particle Swarm Optimization was able to reach 34.19% of MMRE.

However, no research has yet analyzed the differences in the characteristics and estimated values obtained from the methods used in each of these studies. This research aims to understand the behavior of each optimization method in the same environment testing. In this paper, a comparison of three swarm-based algorithms, Bat Algorithm, Cuckoo Optimization Algorithm, and Particle Swarm Optimization, are presented. Each method is implemented and tested by using both the NASA93 (Menzies, 2008) and the Turkish Project (Kocaguneli, 2009) dataset. The different results of the implementation are compared by evaluating their Magnitude Relative Error (MRE) for each project data and their Mean Magnitude Relative Error (MMRE) for each dataset.

2. METHOD

In this section, we present a methodology used to implement and evaluate the algorithms. First, we describe the dataset, NASA93 and Turkish Project, used for the experiment. Second, we explain the library and the program we used for the implementation phase. Third, we explain the way we evaluate the result of the implementation phase.

2.1 Datasets

We used the NASA93 dataset and the Turkish Project dataset for the experiment to understand the behavior of each algorithm on a different dataset. Both datasets shared the same characteristics. Both datasets have Project ID, Effort Multiplier (EM) attribute, Scale Factor (SF) attribute, Line of Code (LOC) attribute, and Actual Effort attribute in person-months. The only difference between both datasets is the amount of data. Turkish Project dataset consists of 12 data of projects from 5 different software companies. While the NASA93 dataset consists of 93 data of projects. Table 1 shows the Turkish Project dataset, while Table 2 shows some parts of the NASA93 dataset.

Table 1. Turkish Dataset

ID	EM	SF	LOC	Actual Effort
1	0.350766095	19.92	3000	1.2
2	0.453841835	18.83	2000	2
3	0.647308126	18.68	4250	4.5
4	1.121349587	10.31	10000	3
5	1.084102861	19.28	15000	4
6	0.23786807	8.41	40530	22
7	0.196509112	7.42	4050	2
8	1.083720964	19.73	31845	5
9	0.373383092	27.23	114280	18
10	0.649964747	20.82	23106	4
11	0.225013699	15.36	1369	1
12	0.410914058	19.11	1611	2.1

Table 2. Parts of NASA93 Dataset

ID	EM	SF	LOC	Actual Effort
1	1.04541	11.56	25900	117.6
6	1.04541	11.56	24600	117.6
12	1.04541	11.56	7700	31.2
18	1.04541	11.56	8200	36
24	1.04541	11.56	9700	25.2
32	1.04541	11.56	2200	8.4
36	1.04541	11.56	3500	10.8
42	1.04541	11.56	66600	352.8
48	1.292852	11.56	7500	72
54	0.436221	13.12	20000	72
60	0.505098	13.12	6000	24

66	0.436221	13.12	100000	360
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2.2 Implementation

In this phase, we implemented the optimization methods to optimize A and B constants from the COCOMO II formula. We used the COCOMO II formula as the fitness function. The following are the equations of COCOMO II that we used for the fitness function:

$$E = E + 0.01 \sum_{i=1}^5 E_i$$

(1)

$$PM = (KLOC)^A \Pi^{17} SF$$

(2)

where PM as Person-Month, A is a constant equal to 2.94, KLOC is Kilo Line of Code, EM as Effort Multiplier, B is a constant equal to 0.91, and SF as Scale Factors.

In general, all algorithms work similarly. They start by initializing the parameter and finding the optimal solution, constants A and B, randomly. Then, constants A and B are assigned to Equation 1 and Equation 2 to calculate the effort required for each project in each dataset. If the result of the fitness function is larger than the previous result, the algorithm will find another optimal solution in the next iteration. The algorithm stopped when the iteration reaches its maximum number. For Bat Algorithm and Particle Swarm Optimization, we used Python with MealPy library (Thieu, 2020), while for Cuckoo Optimization Algorithm we used Matlab code (Rajabioun, 2021).

For parameter configuration, each algorithm has its own "best" configuration. Table 1 shows the parameter we used for Bat Algorithm, while Table 2 shows the parameter we used for Cuckoo Optimization Algorithm, and Table 3 shows the parameter we used for Particle Swarm Optimization. These parameters are found by numerous trials and errors.

Table 3. Algorithm parameter configurations

Parameter	Bat Algorithm	Cuckoo Optimization Algorithm	Particle Swarm Optimization
Population	50	50	50
Iteration	1000	1000	1000
Pulse Rate	0.5	n.a.	n.a.
Frequency	[0, 100]	n.a.	n.a.
Lambda	n.a.	2	n.a.
Eggs	n.a.	[2, 4]	n.a.
Max Population	n.a.	10	n.a.
Laying Radius	n.a.	10	n.a.
Cluster	n.a.	3	n.a.
Acceleration	n.a.	n.a.	[2.0, 2.0]
Inertia	n.a.	n.a.	.9

Lower Bound	-10	-10	-10
Upper Bound	10	10	10

2.3 Analysis

After the implementation phase, the accuracy of the estimation of each data project from each dataset, NASA93 and Turkish Project, is analyzed and compared by using Magnitude Relative Error (MRE) and Mean Magnitude of Relative Error (MMRE). MRE calculates the percentage of the absolute error of the estimation while MMRE calculates the average of MRE of all projects in the dataset. Equation (3) and Equation (4) are the equation for calculating MRE and MMRE respectively.

$$MRE = \frac{|Actual\ Effort - Estimated\ Effort|}{Actual\ Effort} * 100 \quad (3)$$

$$MMRE = \frac{1}{N} \sum_{i=1}^N MRE_i \quad (4)$$

3. RESULTS AND DISCUSSION

This research aims to compare the behavior of three algorithms, Bat Algorithm, Cuckoo Optimization Algorithm, and Particle Swarm Optimization, for optimizing COCOMO II A and B constants to minimize its estimation error and increase its accuracy. In this research, we found that all algorithms have better results in effort estimation than the original COCOMO II.

3.1 Experimentation on Turkish Dataset

The results of the first experiment with the Turkish Project dataset show that all algorithms have a 699% better estimation than the original COCOMO II as shown in Figure 1 and Figure 2. Our experiment shows that Bat Algorithm has the smallest MMRE among other algorithms while Cuckoo Optimization Algorithm has the largest MMRE. The results of this experiment are different from the previous works. This is due to the random nature of the metaheuristic algorithm in finding an optimal solution.

Table 4. Turkish Project dataset experiment result

Method	Optimized A	Optimized B	MMRE
BA	4.3908	-0.1830	34.190%
COA	4.4174	-0.1847	34.230%
PSO	4.3961	-0.1838	34.193%

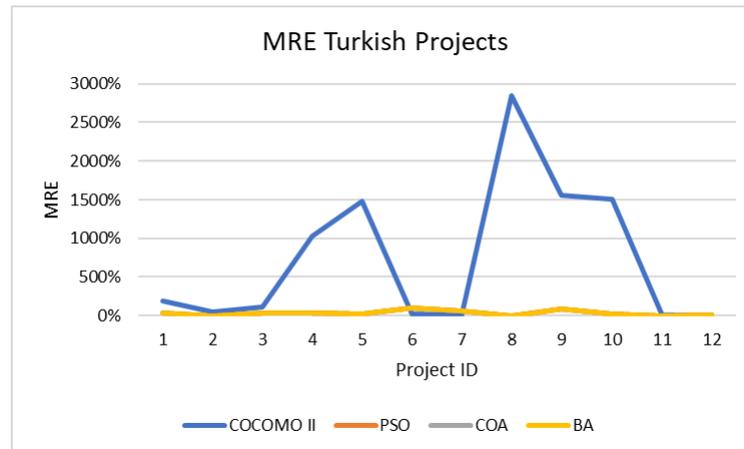


Figure 1. MRE Turkish Project

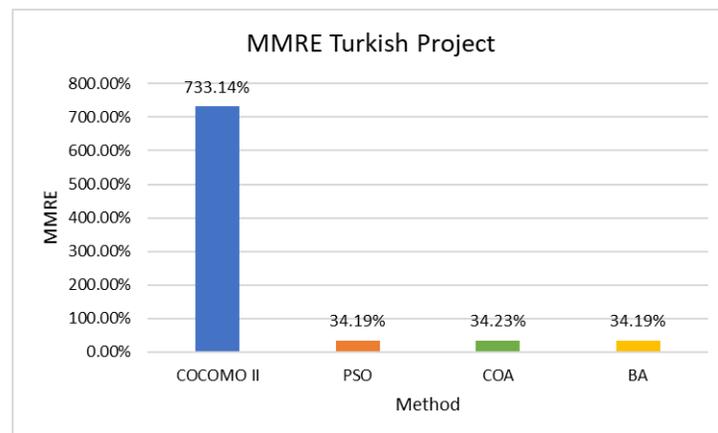


Figure 2. MMRE Turkish Project

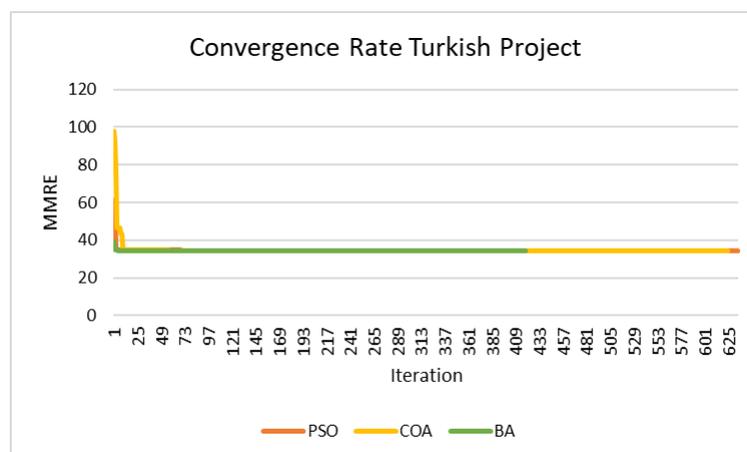


Figure 3. Turkish Project Rate of Convergence Comparison

In this experiment, Bat Algorithm reaches the optimal solution at the 420th iteration, while Cuckoo Optimization Algorithm reaches the optimal solution at the 622nd iteration, and Particle Swarm Optimization reaches the optimal solution at the 635th iteration.

3.2 Experimentation on NASA93

The results of the second experiment with the NASA93 dataset show that all algorithms have 3% better estimation than the original COCOMO II as shown in Figure 4 and Figure 5. The result of this experiment are different from the Turkish Project dataset experiment due to the number of data points and the variety of the data points.

Table 5. Turkish Project dataset experiment result

Algorithm	Optimized A	Optimized B	MMRE
BA	4.1262	0.8537	48.688%
COA	4.1747	0.8451	48.734%
PSO	4.1428	0.8518	48.693%

In this experiment, Bat Algorithm has the smallest MMRE. It reaches the optimal solution at the 326th iteration. Cuckoo Optimization Algorithm has the largest MMRE. It reaches the optimal solution at the 955th iteration. Particle Swarm Optimization reaches its optimal solution at the 965th iteration.

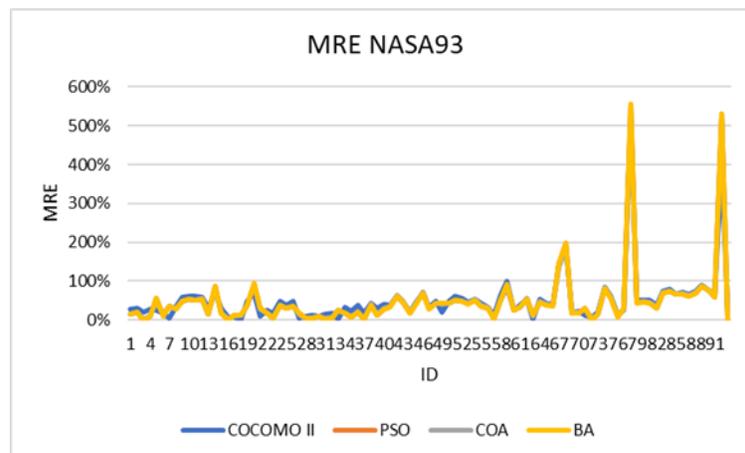


Figure 4. MRE NASA93

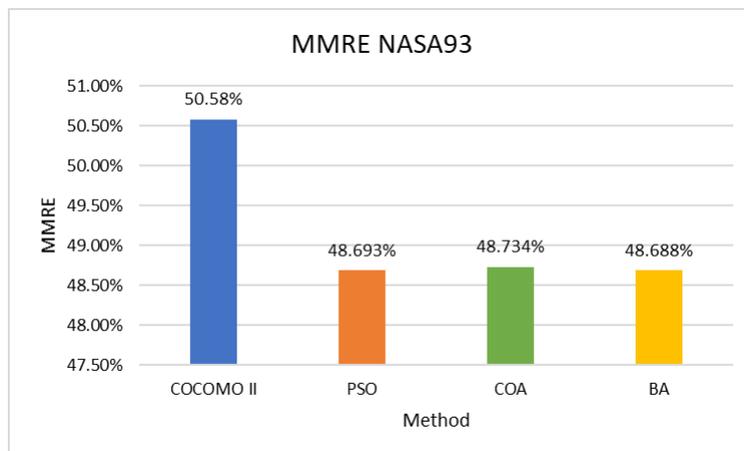


Figure 5. MMRE NASA93

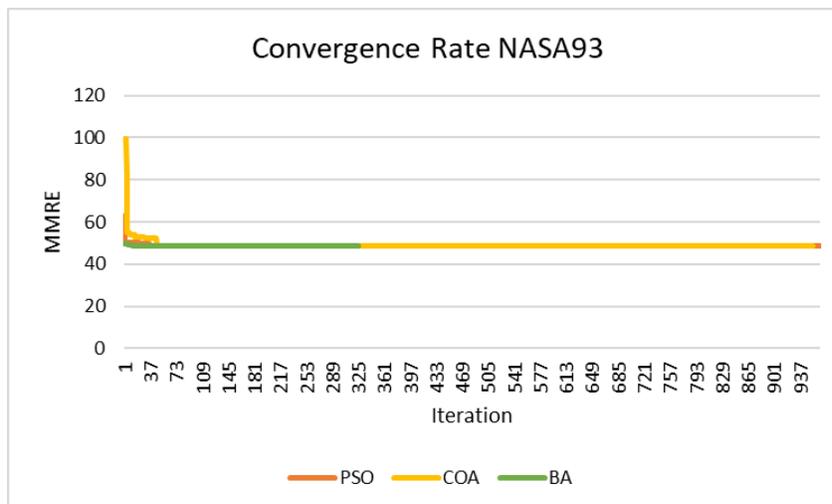


Figure 6. NASA93 Rate of Convergence Comparison

3.3 Analysis

Each algorithm gives a better result than COCOMO II, but each algorithm has a different rate of convergence. It can be affected by the complexity of the optimization problem and the dataset. It can also be affected by the parameter choices for each algorithm. Bat Algorithm has the loudness and pulse rate mechanism to find the global minimum and to limit the local search, so it can reach the optimal solution faster. While both Cuckoo Optimization and Particle Swarm Optimization have a lower rate of convergence because both algorithms are also searching for local optimum. For Particle Swarm Optimization, the global convergence is affected by the inertia value and the constant value for local best. For Cuckoo Optimization

Algorithm, the global convergence is affected by the value of the motion coefficient or lambda parameter.

4. CONCLUSION

This study compared the behavior of three swarm-based metaheuristic algorithms to optimize the A and B constant of COCOMO II to increase its estimation accuracy. Each algorithm is tested using two different datasets, Turkish Project and NASA93. Based on the experiment, all algorithms can give better results than the original COCOMO II in software development effort estimation by optimizing the constant A and B of COCOMO II. In the Turkish Project experiment, all algorithms can reduce the MMRE by 699%. compared to the original COCOMO II. While in the NASA93 experiment, all algorithms can only reduce the MMRE by 3% compared to the original COCOMO II. Each algorithm has a different rate of convergence. In this research, with COCOMO II as the study case, it is shown that Bat Algorithm has a better rate of convergence than other algorithms. Future studies are required to find the correlation between the value of the MMRE and the dataset.

5. ACKNOWLEDGEMENTS

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THE PROTOTYPE APPLICATION DEVELOPMENT BASED ON PERIODIC MODEL VEHICLE ROUTING PROBLEM FOR COMMODITY DISTRIBUTION IN GROCERY STORES NET

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ABSTRACT

Service providers or distribution companies are constantly facing the challenge of providing the best service to customers. The punctual service delivery of goods and accordant the estimated delivery based on the beginning agreement is considered satisfactory. Companies engaged in retail send various types of products to grocery stores when customers order products. The process of purchasing products, payment methods, packaging products, determine vehicle delivery routes to track product shipment, and procedures carried out by utilizing application-based information technology. Currently, the delivery on the next day after the order is processed. However, there are obstacles encountered where customers want to order the product multiple times due to the limited capacity of the grocery store space, so the customer requested their orders not to be sent at once but multiply in a predetermined period when the order process is complete. To resolve this problem, the requirement of a method with the Periodic Vehicle Routing Problem (PVRP) model in managing delivery schedules and determining optimal and efficient vehicle routes using the Google OR-Tools software developed by Google. This study results in a delivery route schedule for the Special Capital Region (DKI) Jakarta area with a total of 60 customers with different coordinate locations based on a combination of visiting days for a period of 6 days from day 1 to day 6 with a route determination process once a week which resulted in a total of 29 routes and found this method more efficient 13.72% of the total travel time for 6 (six) days.

Keywords: Distribution, Periodic Vehicle Routing Problem, Grocery Store.

1. INTRODUCTION

Service providers or logistics companies are constantly facing the challenge of providing the best service to customers. The punctual service delivery of goods and accordant the estimated delivery based on the beginning agreement is considered satisfactory. In addition, from a business perspective, the delivery must be carried out with the lowest possible shipping costs to generate greater profits. Logistics companies are constantly facing the challenge of providing the best service to customers. PT XYZ is a start-up company engaged in retail by utilizing information technology in managing operations. Customers use the application in ordering goods, and the company sends goods from the depot based on the customer's location. The

delivery process is carried out the next day by fulfilling requests at each customer location and delivering goods to different customer places in several cities. The delivery process by classifying orders based on the customer's coordinate location points is currently carried out or commonly called clusters.

One of the problems faced by companies in shipping goods is when customers request that their orders not fulfilled at once, but more than once delivered within a definite time, due to the space capacity owned by customers in the shop cannot accommodate all the goods that ordered previously and also the vehicle has the size in carrying capacity and route selection which are grouped based on the customer's location so that it is not efficient because location are close together but in different sub-districts/districts.

The Vehicle Routing Problem (VRP) is a distribution problem for sending or picking up goods from one customer to another using a vehicle (Toth and Vigo, 2014). Transportation and distribution management is a related aspect in determining vehicle routes, the high operational costs will affect the company's competitiveness and make the quality of service to customers decrease (Munoz, 2018). Each vehicle has a carrying capacity limit as the main obstacle faced when the company has some requests that exceed the vehicle's capacity in one shipment resulted from the customer's multiple shipment requests. The VRP model in considering vehicle capacity is called the Capacity Vehicle Routing Problem (CVRP) (Dantzig, et al, 1959).

The research on VRP capacity continuously changed and evolved with a delivery range planning from one day to m-days affirming that customer visits have a delivery range of t-days and served within a specific frequency Periodic Vehicle Routing Problem (PVRP) (Cordeau, et al, 1997) model. According to Christofides and Beasley (1984), the Periodic Vehicle Routing Problem

(PVRP) is a series of schedules, S , given, where service is consisting series of scheduled days on a predetermined day for the customer. Customers visited every day according to the specified day to

receive the ordered products.

2. LITERATURE REVIEW

2.1. Vehicle Routing Problem (VRP)

VRP is a distribution problem for sending or picking up goods from one customer to another using a vehicle (Toth and Vigo, 2014). According to Christofides, et al. (1979), VRP is a transportation problem in goods distribution to minimize some distribution goals in determining vehicle routes to customers.

According to Moghaddam, et al (2012) explained that VRP is a problem to determine the number of vehicles and routes, where each of the vehicle's starts from the depot/warehouse and traverses along the designated direction to serve a set of customers with a known geographic location and then completes the tour at the same depot. VRP is a complex combinatorial optimization problem, where VRP aims to minimize the required costs, while the determination of costs is closely related to the distance traveled (Mancini, 2015). Euchi, et al, (2020) say that VRP is an integer linear programming scheduling and combinatorial optimization problem that finds the best route on a particular vehicle to visit and supply goods to several customers.

The VRP belongs to the NP-hard problem (Lenstra & Kan, 1981). An appropriate algorithm can be applied to determine the optimal solution in VRP, but it can only find the optimal solution for small-scale problems in a limited time. In other words, the correct algorithm applied to VRP with large-scale data takes a long time with many iterations to determine the optimal solution.

The VRP problem aims to minimize costs in finding distribution routes locations from one depot/warehouse to customers with different amounts of demand (Braysy and Gendreau, 2001). Each customer can only serve by one vehicle in one route

According to Toth and Vigo (2002), the mathematically VRP is expressed in graph $G = (V, A)$ with $V = \{0, 1, \dots, n\}$ which stated the set of nodes that indicates the customer's location and that is $A = \{(i, j) | i, j \in V, i \neq j\}$ edge sets direction represented connecting roads between customer locations. Node 0 indicates the depot/warehouse, which is a place to store vehicles used for distribution and the starting point for a vehicle route. The number of vehicle availability at the depot/warehouse is K on the vehicle capacity to- k is C_k . Each customer has requests as many as d_i .

VRP programming in linear integer form to minimize the total cost or total distance traveled from the route of distribution of goods/services is as follows (Toth and Vigo, 2002):

$\text{Minimize } z = \sum_{i \in V} \sum_{j \in V} c_{ij} \sum_{k=1}^K x_{ij} \quad (1)$
with constraints:
$\sum_{k=1}^K y_{ij} = 1 \quad \forall i \in V \setminus \{0\} \quad (2)$
This constraint is to ensure that each customer is visited once by one vehicle.
$\sum_{k=1}^K y_{0k} = K \quad (3)$
This limitation is to ensure that there are K-vehicles in operation starting the route from the depot/warehouse.
$\sum_{j \in V} x_{ij} = \sum_{j \in V} x_{jik} = y_{ijk} \quad \forall i \in V, k = 1, 2, \dots, K \quad (4)$
This constraint ensures that each customer will be visited by a vehicle scheduled for that customer.
$\sum_{j \in V} d_i y_{ijk} \leq C_k \sum_{j \in V} y_{ijk} \quad \forall i = 1, 2, \dots, K \quad (5)$
These constraints ensure that the total customer demand in each route does not exceed the vehicle's capacity.
$\sum_{i \in S} \sum_{j \in S} x_{ijk} \leq S - 1 \quad \forall S \subseteq V \setminus \{0\}, S \geq 2, k = 1, 2, \dots, K \quad (6)$
This constraint ensures that there are no sub routes in the existing formulation.
$y_{ijk} \in \{0, 1\} \quad \forall i \in V, k = 1, 2, \dots, K \quad (7)$
This constraint ensures that the decision variable y_{ijk} is an integer
$x_{ijk} \in \{0, 1\} \quad \forall i \in V, k = 1, 2, \dots, K \quad (8)$
This constraint ensures that the decision variable x_{ijk} is a binary integer.
With decision variables:
y_{ijk} = worth as 1 if i is served by the k -vehicle and valued 0 if otherwise.
x_{ijk} = worth as 1 if the k -vehicle from customer i goes directly to customer j and valued 0 if otherwise.

With:

V = Set of nodes

A = Set of directed edges (arc), $\{(i,j) | i,j \in V, i \neq j\}$

c_{ij} = Distance/cost of travel from customer i to customer j

d_i = Number of customer requests i

C_k = Capacity of the k vehicle

K = Number of available vehicles

2.2. Periodic Vehicle Routing Problem (PVRP)

The first PVRP proposed by Beltrami and Bodin in 1974 (Beltrami & Bodin, 1974) aims to allocate customer visits to specific vehicle routes within a certain period while meeting certain service requirements in the form of frequency of customer visits or a predetermined pattern of previous visits.

According to Christofides and Beasley (1984), the Periodic Vehicle Routing Problem (PVRP) is a series of schedules, S , given, where service is consisting series of scheduled days on a predetermined day for the customer. Customers visited every day according to the specified day to receive the ordered products.

$$S_i = \{ s \in S : \sum_{t \in T} a_{st} = f_i \} \quad (9)$$

Where S_i is the schedule chosen for customer i , f_i is the frequency of visits for customer i and a_{st} is 1 if day $t \in T$ includes schedule $s \in S$ and 0 if otherwise.

The implementation of three decisions: choose a schedule for each customer, assign the customer to a vehicle and create a route to take in each time combination period. PVRP is a delivery route schedule planning in days to manage the selected frequencies visit for each customer in meeting demand by minimizing the total cost of the route.

PVRP is a generalization of classic VRP in which vehicles route based on certain time combinations using a predefined schedule that indicates the period when the customer must be visited (Campbell and Wilson, 2014). Planning the PVRP route in m -days requires determining the frequency of visits- f and the combination of visit days- S . Table 1 shows the frequency of visits and 6 (six) visiting days combinations by assuming a constant range between deliveries. The 6- digit sequence in table 1 represents visits day, where 1 indicates a visit that happens on that day and 0 indicates otherwise. For example, if $f = 2$, then the visit combination are on the 1st and 4th days, 2nd and 5th days, or 3rd and 6th days. While the frequency (f) = 3, then the combination of visits is on the 1st, 3rd, and 5th day or the 2nd, 4th, and 6th day.

Tabel 1. Frequency of Visits and Combination of Visit Period for 6 days

Frequency (f)	Visit Combination (S)					
	#1	#2	#3	#4	#5	#6
1	100000	010000	001000	000100	000010	000001
2	100100	010010	001001			
3	101010	010101				
6	111111					

Source: Rusdiansyah and Tsao, 2005

In completing the PVRP, the main objective is to minimize the total optimal travel distance.

According to Chen, et al (2019) PVRP can be formulated as follows:

$$\text{Minimize } z = \sum_{i=0}^n \sum_{j=0}^n \sum_{t=1}^T \sum_{v=1}^k d_{ij} z_{i,j,t,v} \quad (10)$$

With limitations:

$$\sum_{i=0}^n \sum_{j=0}^n z_{i,j,t,v} r_i \leq Q_v \quad i \neq j, v \in V, t \in D \quad (11)$$

This limitation ensures that the minimum total route distance obtained with a constraint on the total number of customer requests fulfilled by the vehicle v must not exceed the vehicle's load capacity.

$$\sum_{v=1}^k z_{i,j,t,v} \leq 1, \quad i, j (i \neq j) \in N, t \in D \quad (12)$$

This constraint ensures that the service provided from customer- i to customer- j on day- t can occur at most once (that is, the frequency of visits between two customers limited to one route on day- t)

$$\sum_{v=1}^k y_{t,v} \leq k, \quad t \in D \quad (13)$$

This limit ensures that the total number of vehicles operating each day is limited to the total number of vehicles that available at the depot.

$$z_{i,j,t,v} \in \{0,1\}, \quad i, j (i \neq j) \in N, t \in D, v \in V \quad (14)$$

This equation $z_{i,j,t,v} = 1$, if the value is 1, indicates that the service is provided from customer- i to customer- j by vehicle- v on day- t of the period and is worth 0 if otherwise.

$$y_{t,v} \in \{0,1\}, \quad t \in D, v \in V \quad (15)$$

This equation $y_{t,v} = 1$, if the value 1 of vehicle- v is delivered to the service customer on day t , and is 0 if otherwise.

with:

d_{ij} = Distance between customers

D = Set of days in service period

T = The number of days in the period

r_i = Demand order

k = Total number of vehicles

Q_v = Vehicle capacity

t = Frequency of days

3. METHODS

3.1. Data Collection

The data needed in this study are as follows:

- Order data from a total of 50 customers in DKI Jakarta with different coordinate locations with the delivery frequency visit to customers for 6 (six) days.
- Requests for orders in kilograms capacity.

3.2. Data processing

1. Determination of Frequency and Combination of Visit

The frequency of visits for each customer sets at 1, 2, 3, and 6 times at one period where visit combination for each frequency referred to table 1.

2. Demand Order Calculation

Calculation of the number of demand order per customer in kilograms based on the frequency of visits per customer in step 1.

3. Time Matrix Calculation

The 6 (six) days time matrix calculation period between the customers and depot.

4. Determination of Vehicle Capacity Vehicle limits determination in kilograms.

5. Data Processing Using Google-Or Tools

The data compilation is processed to find the optimal route using the PVRP model with Google-Or Tools software customized according to the studies needed.

6. Determination of Shipping Routes

The process to find the shortest route in entering each location is made by fulfilling the vehicle capacity constraint on accessing the unregistered area from the previous direction to create a new destination, the process repeats until it gets the optimum solution and stops if all location finds their respective routes.

4. RESULTS

This study uses 50 customers with different coordinate locations in placing orders from the 1st day to the 6th day.

Table 2. Customer in Days

Day	Number of Customers	Total Order Capacity (kg)
1	23	680
2	20	630
3	25	750
4	22	590
5	19	580
6	22	700

After the customer order data is grouped based on the 1st to 6th-day combination visits, it will calculate the time from the depot to the customer and the arranged time between customers in a matrix called the time matrix. Location coordinates depot longitude=106,678, latitude=-6.3336. This time matrix will be used in data processing using Google Or-Tools, and the maximum vehicle capacity is 150 kg.

Periodic Vehicle Routing Problem

Routing Kombinasi Hari

HARI #1

HARI #2

HARI #3

HARI #4

HARI #5

HARI #6

Figure 1. Home Page View

To process the data, click the day button, a new page will appear, and the process will run. After meeting the criteria, the process will stop to get the optimal solution for the delivery route for each vehicle starting from depot/warehouse number-0 to the returned depot/warehouse as follows:

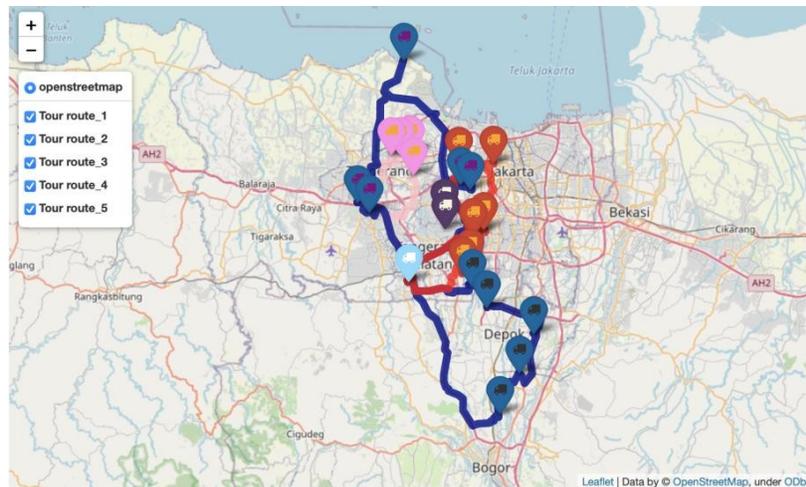


Figure 2. Display of the results of the 1st Day Visit Delivery Route

In Figure 2, the results of the delivery route display from table 2 on the 1st day produce 5 (five) vehicles with travel routes.

Table 3. Display of the results of the 1st Day Visit Delivery Route

Vehicle	Route	Load of the Route (kg)	Duration of the Route (hour)
Route for vehicle 1	Load(0) -> P-50 Load(20) -> P-26 Load(40) -> P-6 Load(20) -> P-27 Load(10) -> P-3 Load(40) -> 0 Load(130)	130	1,72
Route for vehicle 2	0 Load(0) -> P-48 Load(10) -> P-35 Load(50) -> P-45 Load(20) -> P-12 Load(30) -> P-18 Load(40) -> 0 Load(150)	150	1,23
Route for vehicle 3	0 Load(0) -> P-22 Load(30) -> P-42 Load(80) -> 0 Load(110)	110	0,71
Route for vehicle 4	0 Load(0) -> P-40 Load(20) -> P-17 Load(50) -> P-28 Load(40) -> P-38 Load(10) -> P-44 Load(20) -> 0 Load(140)	140	1,98
Route for vehicle 5	0 Load(0) -> P-25 Load(20) -> P-11 Load(20) -> P-2 Load(40) -> P-24 Load(40) -> P-7 Load(20) -> P-1 Load(1) -> 0 Load(150)	150	1,43

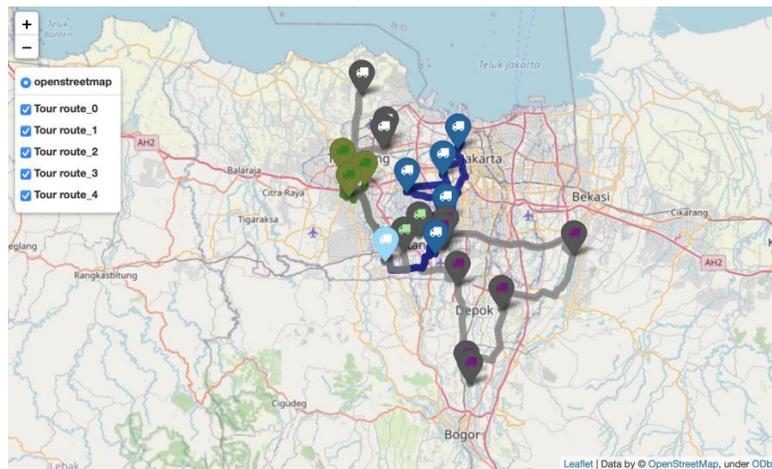


Figure 3. Display of the results of the 2nd Day Visit Delivery Route

In Figure 3, the results of the delivery route display from table 2 on the 2nd day produce 5 (five) vehicles with travel routes.

Table 4. Display of the results of the 2nd Day Visit Delivery Route

Vehicle	Route	Load of the Route (kg)	Duration of the Route (hour)
Route for vehicle 1	0 Load(0) -> P-34 Load(40) -> P-37 Load(30) -> 0 Load(70)	70	0,50

Route for vehicle 2	0 Load(0) -> P-13 Load(60) -> P-44 Load(20) -> P-14 Load(30) -> P-1 Load(10) -> P-25 Load(20) -> 0 Load(140)	140	1,38
Route for vehicle 3	0 Load(0) -> P-30 Load(80) -> P-45 Load(20) -> P-29 Load(40) -> 0 Load(140)	140	1,31
Route for vehicle 4	0 Load(0) -> P-40 Load(20) -> P-39 Load(60) -> P-21 Load(50) -> 0 Load(130)	130	0,94
Route for vehicle 5	0 Load(0) -> P-27 Load(10) -> P-5 Load(20) -> P-50 Load(20) -> P-6 Load(20) -> P-4 Load(40) -> P-19 Load(20) -> P-11 Load(20) -> 0 Load(150)	150	2,31

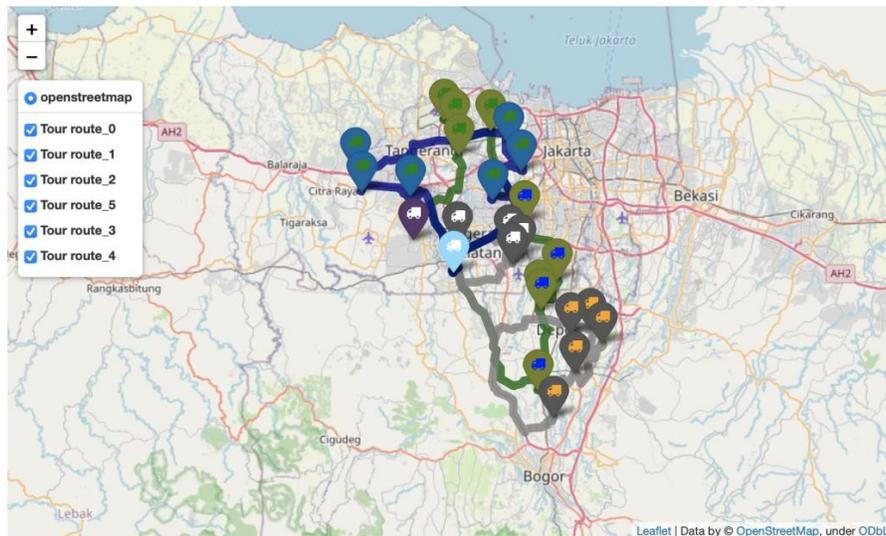


Figure 4. Display of the results of the 3rd Day Visit Delivery Route

In Figure 4, the results of the delivery route display from table 2 on the 3rd day produce 6 (six) vehicles with travel routes.

Table 5. Display of the results of the 3rd Day Visit Delivery Route

Vehicle	Route	Load of the Route (kg)	Duration of the Route (hour)
Route for vehicle 1	0 Load(0) -> P-31 Load(40) -> P-41 Load(50) -> P-27 Load(10) -> P-15 Load(40) -> P-1 Load(10) -> 0 Load(150)	150	1,65
Route for vehicle 2	0 Load(0) -> P-36 Load(20) -> P-6 Load(20) -> P-46 Load(40) -> P-26 Load(40) -> P-50 Load(20) -> 0 Load(140)	140	1,83
Route for vehicle 3	0 Load(0) -> P-49 Load(50) -> 0 Load(50)	50	0,51

Route for vehicle 4	0 Load(0) -> P-20 Load(40) -> P-45 Load(20) -> 140 P-43 Load(40) -> P-18 Load(40) -> 0 Load(140)	1,38
Route for vehicle 5	0 Load(0) -> P-40 Load(20) -> P-8 Load(20) -> P-9 Load(40) -> P-7 Load(20) -> P-44 Load(20) -> P-22 Load(30) -> 0 Load(150)	1,67
Route for vehicle 6	0 Load(0) -> P-16 Load(40) -> P-32 Load(40) -> 120 P-25 Load(20) -> P-11 Load(20) -> 0 Load(120)	0,83

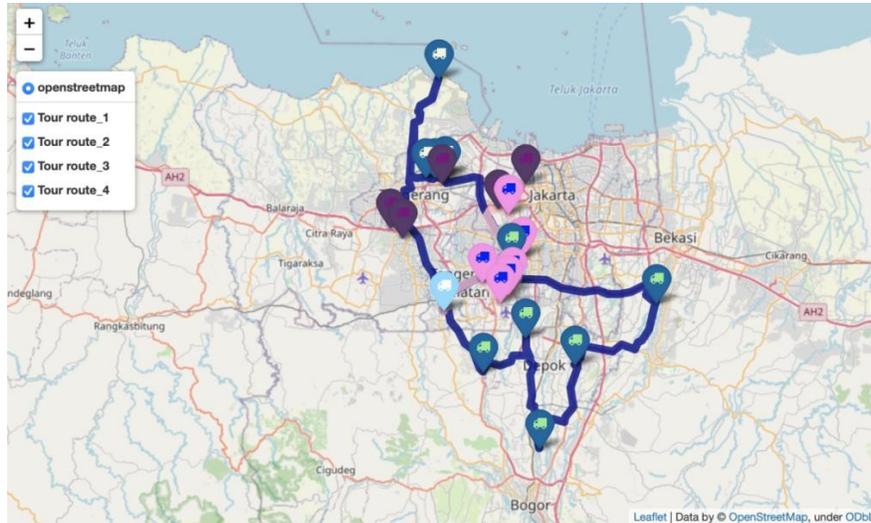


Figure 5. Display of the results of the 4th Day Visit Delivery Route

In Figure 5, the results of the delivery route display from table 2 on the 4th day produce 4 (four) vehicles with travel routes.

Table 6. Display of the results of the 4th Day Visit Delivery Route

Vehicle	Route	Load of the Route (kg)	Duration of the Route (hour)
Route for vehicle 1	0 Load(0) -> P-28 Load(40) -> P-48 Load(10) -> P- Load(50) -> P-45 Load(20) -> 35 P-12 Load(30) -> 0 Load(150)	150	1,7
Route for vehicle 2	0 Load(0) -> P-40 Load(20) -> P-17 Load(50) -> P- Load(40) -> P-14 Load(30) -> 29 P-38 Load(10) -> 0 Load(150)	150	1,33
Route for vehicle 3	0 Load(0) -> P-10 Load(40) -> P-27 Load(10) -> P-50 Load(20) -> P-6 Load(20) -> P-4 Load(40) -> P-1 Load(10) -> 0 Load(140)	140	2,20

Route for vehicle 4	0 Load(0) -> P-37 Load(30) -> Load(20) -> P-19 Load(20) -> Load(20) -> 0 Load(150)	P-25 Load(20) -> 11 P-2 Load(40) -> 44	P- P-	150	1,22
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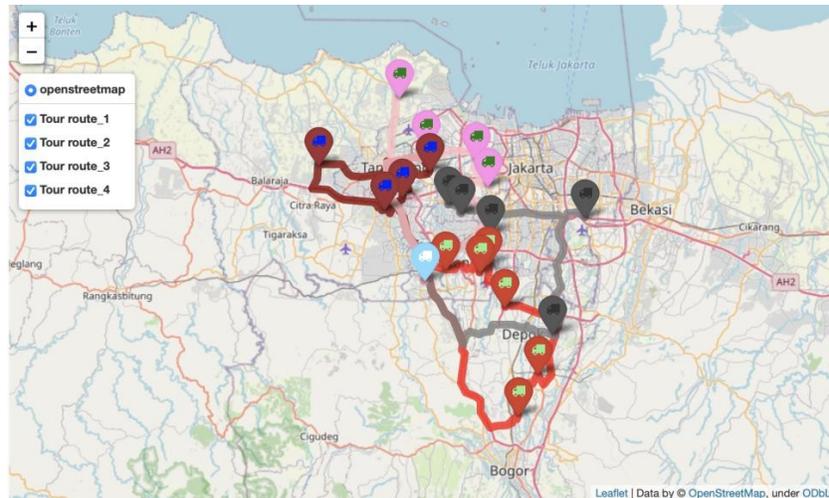


Figure 6. Display of the results of the 5th Day Visit Delivery Route

In Figure 6, the results of the delivery route display from table 2 on the 5th day produce 4 (four) vehicles with travel routes.

Table 7. Display of the results of the 5th Day Visit Delivery Route

Vehicle	Route	Load of the Route (kg)	Duration of the Route (hour)
Route for vehicle 1	0 Load(0) -> P-50 Load(20) -> Load(10) -> P-11 Load(20) -> Load(40) -> 0 Load(150)	P-26 Load(40) -> P-27 25 Load(20) -> P-34	150 1,89
Route for vehicle 2	0 Load(0) -> P-6 Load(20) -> Load(30) -> P-13 Load(60) -> P-1 Load(10) -> 0 Load(140)	P-33 Load(20) -> P-22	140 1,78
Route for vehicle 3	0 Load(0) -> P-40 Load(20) -> P-18 Load(40) -> P-21 Load(50) -> 0 Load(150)	P-47 Load(40) ->	150 1,54
Route for vehicle 4	0 Load(0) -> P3- Load(80) -> P-7 Load(20) -> P-44 Load(20) -> 0 Load(140)	P-45 Load(20) ->	140 1,55

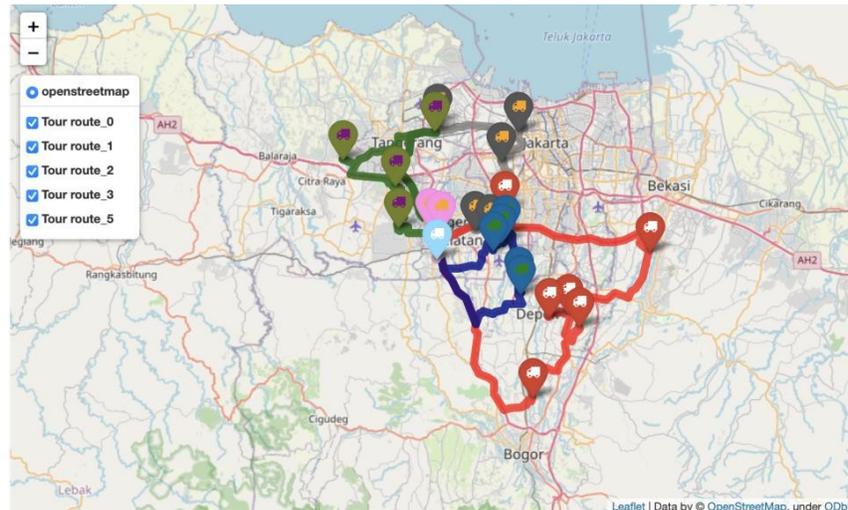


Figure 7. Display Display of the results of the 6th Day Visit Delivery Route

In Figure 7, the results of the delivery route display from table 2 on the 6th day produce 5 (five) vehicles with travel routes.

Table 8. Display of the results of the 6th Day Visit Delivery Route

Vehicle	Route	Load of the Route (kg)	Duration of the Route (hour)
Route for vehicle 1	0 Load(0) -> P-16 Load(40) -> P-37 Load(30) -> P-32 P-150 Load(40) -> P-25 Load(20) -> 11 Load(20) -> 0 Load(150)	150	0,87
Route for vehicle 2	0 Load(0) -> P-50 Load(20) -> P-46 Load(40) -> P-6 Load(20) -150 > P-36 Load(20) -> P-4 Load(40) -> P-1 Load(10) -> 0 Load(150)	150	2,35
Route for vehicle 3	0 Load(0) -> P-45 Load(20) ->P-14 Load(30) -> P-44 P-120 Load(20) -> P-19 Load(20) ->27 Load(10) -> P-41 Load(50) -> 0 Load(150)	120	1,84
Route for vehicle 4	0 Load(0) -> P-49 Load(50) -> P-40 Load(20) ->150 P-9 Load(40) -> P-29 Load(40) -> 0 Load(150)	150	1,36
Route for vehicle 5	0 Load(0) -> P-23 Load(100) -> 0 Load(100)	100	0,29

The results obtained were then compared with the previous method.

Table 9. Results of Comparison of Methods

Days to	Number of Routes		Total Duration of All Routes (hour)	
	Existing	PVRP	Existing	PVRP
1	7	5	8,2	7,07
2	7	5	7,92	6,44
3	8	6	9,11	7,87
4	6	4	7,68	6,45
5	6	4	7,52	6,76
6	7	5	7,66	6,71

6. CONCLUSIONS

From the implementation research, the PVRP method concluded that the Google Or-Tools software applies in route schedules for goods delivery vehicles findings to grocery stalls. The data used are 50 customers from different locations and are grouped based on the request for a combination of visit orders according to the frequency of visits in 6 days. The total of all route periods generated from the 1st to the 6th day is 29, from 29 (twenty-nine) vehicles and a total travel time of 41.3 hours.

The PVRP method produces a total travel time of 41.3 hours, while the company's method produces a full travel time of 47.87 hours. The entire travel time from the proposed model is more efficient with 6 hours 57 minutes compared to the previous method.

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DESIGN OF SUPPLY CHAIN PERFORMANCE MEASUREMENT SYSTEM OF PT XYZ USING SUPPLY CHAIN OPERATIONS REFERENCE (SCOR) AND ANALYTICAL HIERARCHY PROCESS (AHP) METHODS

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ABSTRACT

This study aims to design a Supply Chain Performance Measurement System and implement the system to evaluate the performance of PT XYZ. As the company experiences a decrease in productivity and suffers from losses, a performance measurement needs to be carried out. The results of the design of performance measurement generated 13 Key Performance Indicators (KPIs), which were divided into five core processes of supply chain, namely Plan, Make, Source, Deliver, and Return. The indicators were determined using the Supply Chain Operations Reference (SCOR) method. It was supported by the Analytical Hierarchy Process (AHP) method to determine the weighting of the perspectives and KPIs on a priority scale. The Scoring System was used to measure performance to determine the achievement of KPIs compared to the target set. In addition, a Traffic Light System analysis was carried out to ascertain the performance achievement. Three colors (red, yellow, and green) were used as indicators of achievement. According to the results of the performance measurement in 2019, there were 9 performance indicators with a green score, 2 indicators with a yellow score, and 2 indicators with a red score. Meanwhile, in 2020, there were 11 indicators with a green score and 2 indicators with a red score. This study also provides suggestions to improve the performance of KPIs that belonged to the red and yellow categories.

Keywords: Performance Measurement System, SCOR, AHP, Scoring System and Traffic Light System

1. INTRODUCTION

One of the important activities in supply chain management (SCM) that can support the effort to win the market is the distribution system. Distribution has a significant role in supply chain management, namely delivering products to customers on time. It also has to ensure that the orders are delivered in the right amount and in good condition (Pujawan and Mahendrawati, 2017). In achieving effectiveness and efficiency in distribution activities, performance measurement is necessary, both on the distribution side and the supply chain side.

Competitive pressures in the business world are forcing companies to improve their supply chain activities. Supply chain management has become one of the decision-making

systems and tools used in determining competitive strategies to increase the productivity and profitability of a

company (Taticchi et al, 2010; Gawankar et al, 2013). This is because the system is used to evaluate performance, including many managerial processes such as metric identification, goal setting, planning, reporting, monitoring, and provision of input for improvement (Cai et al, 2009). Evaluation of supply chain performance can be carried out by executing performance measurement to determine the accuracy of process and behavior in the supply chain activities of a company. Performance measurement aims to understand the current execution of supply chain processes so that companies can evaluate supply chain performance simultaneously and continuously (continuous improvement). There is a method that best meets the supply chain management criteria in the broadest and most detailed scope, namely the Supply Chain Operations Reference (SCOR) Model.

PT XYZ is a developing company engaged in the distribution of High-Speed Diesel (HSD). For companies engaged in diesel fuel distribution services, accuracy and speed of delivery become important factors in a business process. During the execution of PT XYZ's operational process, some customers were dissatisfied with the company's services, nearly resulting in the termination of cooperation contracts. The customers were dissatisfied due to various reasons, such as delays in delivery and the inaccuracy of the number of orders received by the customers, which exceeded the loss tolerance limit.

The urgent issues related to the company's business urge PT XYZ's management to immediately improve its business activities. As the company does not want to lose its customers, the company management needs to explore the causes of the various problem in a detailed manner to determine the improvement that needs to be made. To find out the details of the causes of the problems, the company management needs to evaluate the overall business process of the company. In other words, it has to evaluate the company's supply chain process. The establishment of a performance measurement system is considered to be quite effective in providing an overall picture of distribution performance in the supply chain process. In addition, through performance measurement, the company can also find out the aspects that need to be improved to increase business performance.

2. LITERATURE REVIEW

Supply chain can be defined as the overall activity in the integration of business processes, including the provision of raw materials, operational activities of manufacture of products and services, storage, and the process of distribution to customers (Lambert and Cooper, 1998). Supply chain management is a network of many integrated organizations that need each other. As such, they work together to control, monitor, and improve the flow of commodities and information from suppliers to end users (Ballou, 2007). Supply chain management is implemented to improve the long-term performance of a company and the supply chain as a whole, as there is strategic and systematic coordination of traditional business functions within the system (Mentzer, 2001).

Service supply chain is defined as a network of suppliers, service providers, consumers, and other supporting units. It carries out the transaction of resources needed to generate the company's core and support services. One of the types of supply chain systems is a service supply chain dedicated to providing services related to products (Wang et al, 2015). The Supply Chain Management in the service industry must hone its ability to approach

customers by increasing its supply chain channels. In the service supply chain, such ability will include responsiveness, effectiveness, efficiency, and control over services (Kathawala, 2013).

To create an effective and efficient supply chain, a performance measurement system that can evaluate the overall supply chain performance is needed (Blecken and Hellingrath, 2008). Performance measurement must be done to achieve supply chain effectiveness (Kazemkhanlou and Ahadi, 2014). Performance measurement is an important element of effective planning and control in the decision-making process of an organization (Chan et al, 2006). It can provide feedback needed to reveal progress, improve motivation and communication, diagnose problems, improve the fulfillment of customer needs, and achieve the company's strategic goals (Chan, 2003).

Chibba and Horte (2003) state that during the development of supply chain performance measurement, four types of measurements have been successfully formulated to measure the overall performance of supply chain activities, as shown in Figure 1 below:

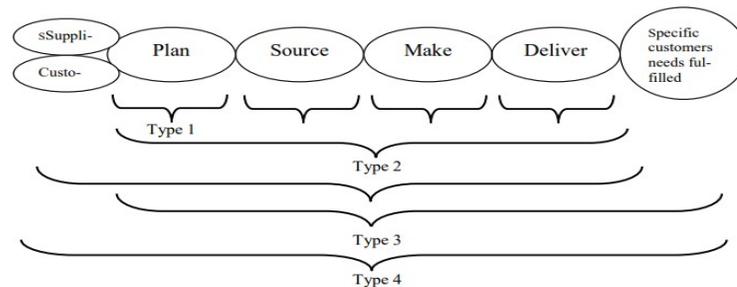


Figure 1. Four Types of Supply Chain Performance Measurement

According to Chibba and Horte (2003), there are 4 types of supply chain performance measurement, namely:

- Type 1: Functional Measures. This measurement is carried out separately on each function or activity within the supply chain process.
- Type 2: Internal Integrated Measures. This type of performance measurement is carried out on all functions or activities within a company, including plan, source, make, and deliver.
- Type 3: One-side Integrated Measures. This type of performance measurement is carried out on all functions or work activities within a company, including its suppliers or customers only.
- Type 4: Total Chain Measures. A performance measurement carried out in full on all work activities of a company. It also includes various company functions, from suppliers to customers. Partner companies are also involved in the effort to jointly make continuous improvements to the supply chain flow.

SCOR Model

The Supply Chain Council (SCC) developed and introduced a supply chain performance framework known as the Supply Chain Operations Reference (SCOR) model.

This method can completely illustrate supply chain. This model was developed to describe the five basic supply chain management processes conducted to meet the customers' needs. There are five basic management processes used in this framework, namely: Plan, Source, Make, Deliver, and Return. Pujawan and Mahendrawati (2017) explain that the SCOR model integrates three main elements, namely: (1) Business process reengineering by capturing the complex processes that are currently happening (as-is) and defining the desired process (to-be), (2) benchmarking by making efforts to obtain the operational performance data of similar companies to determine the company's internal targets based on the best-in-class performance obtained, (3) process measurement by measuring, controlling, and improving the entire supply chain process.

The Supply Chain Council explains that the SCOR model has been developed to describe business activities at all phases to meet customer demands. Based on Version 11.0 of SCOR, the model contains six main management processes, as shown in Figure 2. Plan, describes planning activities related to supply chain operations carried out by balancing demand and supply. Source, procurement of goods and services related to suppliers to meet the demands. Make, in service-based companies, this stage can describe the transfer of products from one process to the next. Deliver, describes activities related to the fulfillment of customers' needs. Return, describes activities related to product return caused by various reasons. Enable, describes supply chain management by involving the handling of the arrangement between planning and execution. In the SCOR model, there are five aspects of performance measurement attributes that can be used to measure supply chain activities, namely reliability, responsiveness, agility, cost, and assets.

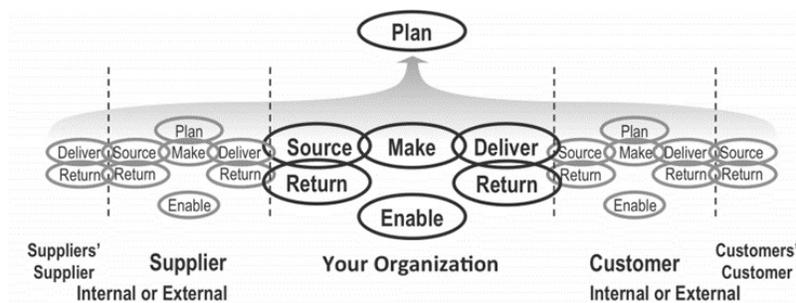


Figure 2. The scope of Supply Chain Process Management in SCOR Model (SCC)

Analytical Hierarchy Process

Analytical Hierarchy Process (AHP) was developed by Thomas L. Saaty in the 1970s as a method that can be used in the decision-making process. This decision-making support model can unravel the problem of qualitative and quantitative multi-factor or multi-criteria elements in a hierarchical manner (Taherdoost, 2017). This structure consists of three levels. Level one is related to goal or target setting, level two is related to criteria, and the third level is related to alternatives. AHP method is used to create a series of alternatives in a decision-making process. It does that by selecting one of the best alternatives based on the overall evaluation results on the qualitative and quantitative factors.

3. METHODS

This study consists of 5 stages, namely Data Collection, Design of Supply Chain Performance Measurement, Supply Chain Performance Measurement and Evaluation, Results of the Design of Performance Measurement, and Conclusions and Suggestions. The following flowchart illustrates the stages of this study:

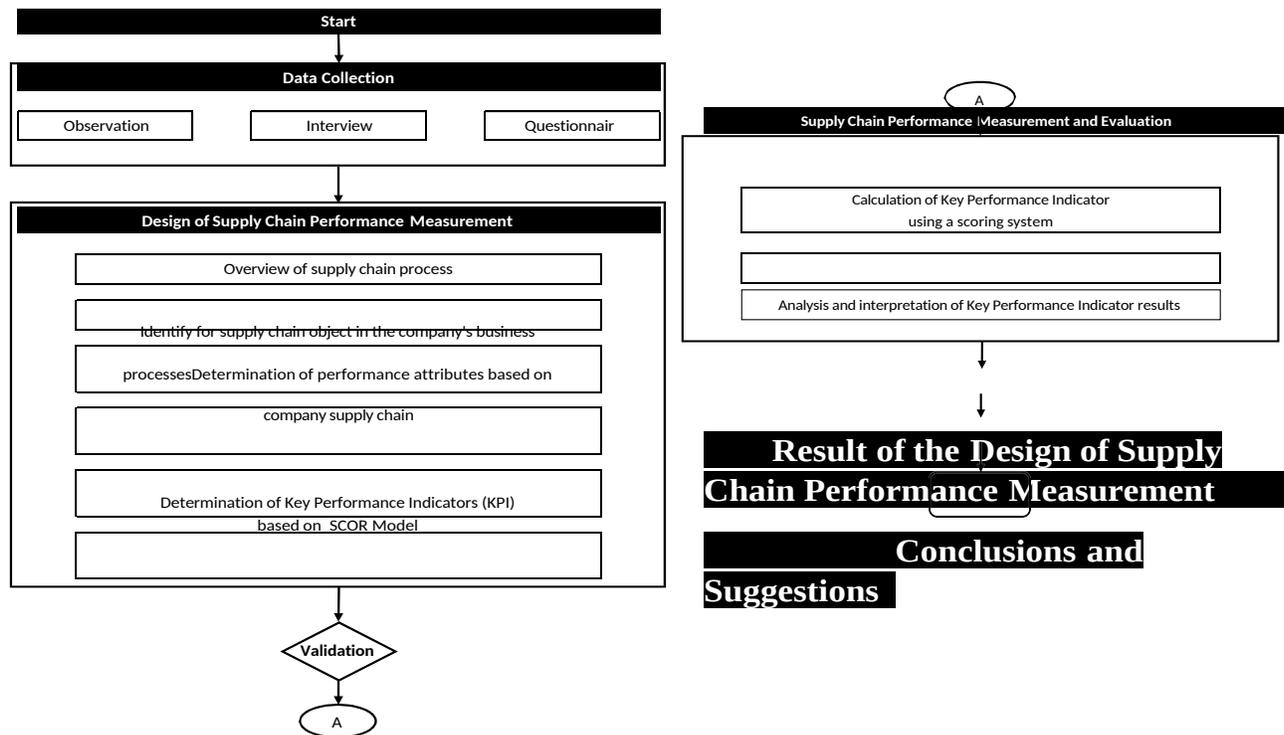


Figure 3. Flowchart of the Study

4. RESULTS

KPIs were identified using the SCOR framework, consisting of five core supply chain management processes, namely Plan, Source, Make, Deliver, and Return. Next, a validation process was carried out to ensure that each performance indicator (KPI) was in accordance with and can be measured in relation to the company's conditions. Performance indicators were determined based on the company's strategy and the existing condition of the company's business processes. 13 valid KPIs were processed in the next stage. Each KPI was weighted to determine the proportion of the contribution of each process, attribute, and performance indicator to the achievement of the company's supply chain performance. The attributes used were Reliability,

Responsiveness, Cost, and Asset Management. In addition, there were 13 performance indicators. This stage was carried out using the Analytical Hierarchy Process (AHP). Pairwise comparison was conducted on each KPI in each process, assisted by a software called Expert Choice.

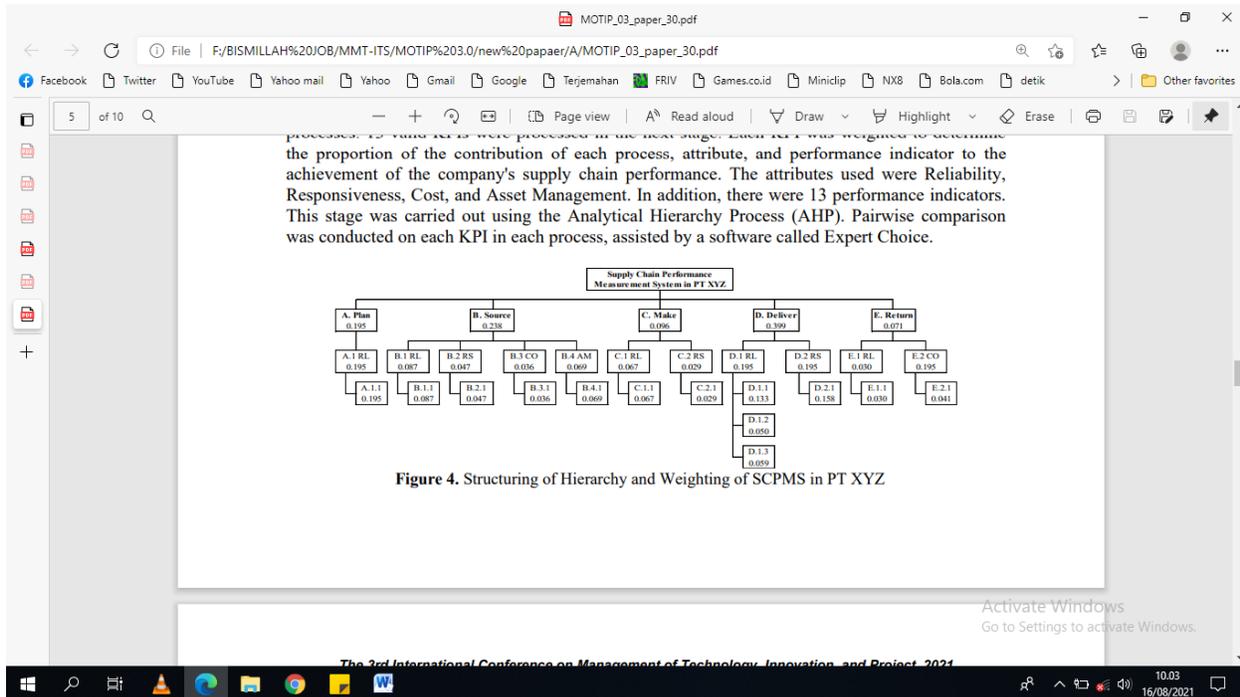


Figure 4. Structuring of Hierarchy and Weighting of SCPMS in PT XYZ

The actual performance measurement process was carried out for each KPI based on the data of each KPI that had been collected. Each indicator was measured every month for 2 full years, namely in 2019 and 2020. Next, the Scoring System and Traffic Light System (TLS) stages were carried out on each performance indicator in Table 1 and Table 2 to determine the score of actual performance achievement against the target set. The Scoring System was needed to equalize the measurement scale of each KPI, which was displayed in percentage (%). The methods used in this measurement were Higher is better, Lower is better, and Zero/One, as explained below:

- Higher is better

$$Score = \frac{Achievement}{Target} \times 100 \% \dots\dots\dots(1)$$

- Lower is better

$$Score = \frac{Target+(Target-Achievement)}{Target} \times 100\% \dots\dots\dots(2)$$

with:

Target = target expected by the company

Achievement = the current score of the company's performance achievement

- The Zero/One method has a scoring system consisting of only two achievements, namely successful and unsuccessful. A successful achievement will net a score of 100%, while an unsuccessful achievement will get a score of 0%.

Table 1. Performance Score of KPI in 2019

Index	KPI	Type	Jan	Feb	Mar	April	May	June	July	Agst.	Sep	Oct	Nov	Des
A.1.1	Forecast Accuracy	Higher is Better	107.51	108.78	106.34	107.38	104.33	96.56	91.91	88.18	109.79	105.75	105.91	100.29
B.1.1	Orders Received with Correct Content	Zero/One	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
B.2.1	Sources Cycle Time	Lower is Better	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
B.3.1	Transportation Costs	Lower is Better	95.33	92.00	94.67	88.67	91.83	96.67	94.80	98.33	96.00	94.00	92.83	95.00
B.4.1	Inventory Turnover	Higher is Better	100.00	106.67	120.00	140.00	126.67	106.67	146.67	153.33	80.00	100.00	100.00	106.67
C.1.1	Product Transferred On-Time to Demand Requirement	Higher is Better	98.56	98.57	98.26	97.62	99.59	99.06	98.14	98.98	98.23	97.32	99.73	101.28
C.2.1	Process Transferring Lead Time	Lower is Better	75.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	25.00	50.00	75.00
D.1.1	Orders Fill Rates	Higher is Better	99.52	100.36	101.93	98.41	99.59	102.5	102.78	99.91	100.64	99.62	101.49	103.24

C.1 .1	Transferred On- Time to Demand Require ment	0.06 7	er is Bett er	6.6 0	6.6 0	6.5 8	6.5 4	6.6 7	6.6 4	6.5 8	6.6 3	6.5 8	6.5 2	6.6 8	6.7 9
C.2 .1	Process Transferring Lead Time	0.02 9	Low er is Bett er	2.1 8	1.4 5	1.4 5	1.4 5	1.4 5	1.4 5	1.4 5	1.4 5	1.4 5	0.7 3	1.4 5	2.1 8
D.1 .1	Orders Fill Rates	0.13 3	High er is Bett er	13. 24	13. 35	13. 56	13. 09	13. 25	13. 63	13. 67	13. 29	13. 39	13. 25	13. 50	13. 73
D.1 .2	% of Orders Delivered In Full	0.05 0	High er is Bett er	5.1 7	5.1 5	5.1 9	5.1 2	5.2 3	5.1 7	5.2 3	5.1 4	5.1 5	5.0 6	5.2 1	5.2 6
D.1 .3	Delivery Performance to Consumer Commit Day	0.05 9	High er is Bett er	5.4 0	5.4 1	5.3 9	5.3 2	5.4 7	5.4 4	5.3 3	5.3 8	5.3 6	5.2 7	5.4 3	5.4 4
D.2 .1	Deliver Cycle Time	0.15 8	Low er is Bett er	15. 80	10. 53	10. 53	10. 53	10. 53	10. 53	10. 53	15. 80	10. 53	10. 53	10. 53	15. 80
E.1 .1	Number of Customer Complaint	0.03 0	Low er is Bett er	0.5 5	0.6 8	1.0 0	- 0.2 5	0.6 3	0.3 8	1.0 9	0.4 1	1.6 5	0.1 7	1.7 1	0.5 5
E.2 .1	Warranty/ Returns Processing Cost	0.04 1	Low er is Bett er	3.4 0	3.5 7	4.1 8	3.6 5	3.4 9	1.8 5	4.5 1	3.5 7	3.1 2	0.9 0	3.4 4	4.6 3

Table 4. Performance Index of KPI in 2020

Index	KPI	Weight	Type	Jan.	Feb.	Mar.	April	May	June	July	Agst.	Sep.	Okt.	Nov.	Des.
A.1.1	Forecast Accuracy	0.195	Higher is Better	19.70	19.18	15.53	15.44	4.41	4.92	-7.22	4.64	-1.81	3.84	2.30	0.68
B.1.1	Orders Received with Correct Content	0.087	Zero/One	8.70	8.70	8.70	8.70	8.70	8.70	8.70	8.70	8.70	8.70	8.70	8.70
B.2.1	Sources Cycle Time	0.047	Lower is Better	4.70	4.70	4.70	4.70	4.70	4.70	4.70	4.70	4.70	4.70	4.70	4.70
B.3.1	Transportation Costs	0.036	Lower is Better	3.40	3.43	3.40	3.37	3.45	3.49	3.70	3.62	3.71	3.60	3.54	3.60
B.4.1	Inventory Turnover	0.069	Higher is Better	6.91	7.07	7.10	7.29	6.71	7.03	7.67	7.67	7.67	7.67	7.67	7.67
C.1.1	Product Transferred On-Time to Demand Requirement	0.067	Higher is Better	6.04	6.18	6.20	6.37	5.86	6.14	6.70	6.70	6.70	6.70	6.70	6.70
C.2.1	Process Transferring Lead Time	0.029	Lower is Better	1.45	2.18	2.18	3.63	3.63	3.63	3.63	3.63	3.63	3.63	3.63	3.63
D.1.1	Orders Fill Rates	0.133	Higher is Better	13.07	13.62	13.55	13.70	12.93	13.55	11.08	13.14	12.31	11.08	14.78	13.30
D.1.2	% of Orders Delivered In Full	0.050	Higher is Better	5.23	5.27	5.30	5.35	5.21	5.56	5.56	5.56	5.56	5.56	5.00	5.56
D.1.3	Delivery Performance to Consumer Commit Day	0.059	Higher is Better	5.39	5.51	5.46	5.53	5.43	5.69	6.21	6.21	6.21	6.21	5.59	6.21
D.2.1	Deliver Cycle Time	0.158	Lower is Better	15.80	15.80	15.80	10.53	10.53	10.53	15.80	15.80	15.80	15.80	10.53	10.53
E.1.1	Number of Customer Complaint	0.030	Lower is Better	0.31	1.64	0.00	0.88	2.25	6.00	6.00	6.00	6.00	6.00	3.00	6.00
E.2.1	Warranty/Returns Processing Cost	0.041	Lower is Better	3.69	4.18	4.39	5.33	6.56	8.20	8.20	8.20	8.20	8.20	6.36	8.20

Evaluation of the company's supply chain performance needs to be carried so that the performance can be controlled and improved continuously. Before that, KPIs that need to be improved must be identified and analyzed using the Traffic Light System. In the Traffic Light System, the color red is used to indicate KPIs that have not reached the target with a score of < 70. The color yellow indicates KPIs that have a score between 70 to 84.99%, which needs to be improved. The color light green indicates KPIs that have reached the target with a score of 85 to 99.99%, which belong to the good category. The color dark green indicates KPIs that have reached the target with a score of 100%, which belong to the very good category.

Table 5. Company Performance Achievement

SC OR Mo del	Ind ex	Score		Perfo rm. Inde x	
		201 9	202 0	201 9	20 20
PL AN	A. 1.1	92. 61	60. 66	18. 06	11. 83
SOU RCE	B.1 .1	100 .00	100 .00	8.7 0	8.7 0
	B.2 .1	100 .00	100 .00	4.7 0	4.7 0
	B.3 .1	94. 02	95. 65	3.3 8	3.4 4
	B.4 .1	100 .00	60. 56	6.9 0	4.1 8
MA KE	C.1 .1	98. 78	100 .00	6.6 2	6.7 0
	C.2 .1	52. 08	100 .00	1.5 1	2.9 0
DELI VER	D. 1.1	100 .00	97. 81	13. 30	13. 01
	D. 1.2	100 .00	100 .00	5.0 0	5.0 0
	D. 1.3	96. 37	100 .00	5.6 9	5.9 0
	D. 2.1	75. 00	100 .00	11. 85	15. 80
	E.1 .1	23. 77	100 .00	0.7 1	3.0 0

RET URN	E.2 .1	81. 92	100 .00	3.3 6	4.1 0
Achievement				89. 78	89. 26

In 2019, based on the Traffic Light System analysis in Table 5, 2 KPIs belonged to the yellow category, namely Deliver Cycle Time and Warranty/Returns Processing Cost. Furthermore, 2 KPIs belonged to the red category, namely Process Transferring Lead Time and Number of Customer Complaints. Meanwhile, in 2020, 2 KPIs belonged to the red category, namely Forecast Accuracy and Inventory Turnover. The overall performance achievement score in 2019 was 89.78, while the overall performance achievement score in 2020 was 89.26. The score of PT XYZ's supply chain performance achievement was in the light green category, indicating that the company's performance had reached the target. However, several KPIs that belonged to the red and yellow categories were still found. As such, additional effort and in-depth evaluation of the performance are needed.

A force majeure caused by the Covid-19 pandemic that ravaged Indonesia has resulted in an inaccurate forecast of the company's product needs. Therefore, the company needs to evaluate the determination of the forecast of its product needs based on the evaluation of historical data, trends of demand, and market changes. As Inventory Turnover has drastically decreased, it is recommended that the company implements a drop shipping system until the customers' need for industrial oil fuel returns to normal. Concerning the Process Transferring Lead Time, the company can replace the equipment used in the transfer of products to maximize machine productivity and shorten lead time. In regard to the Number of Customer Complaints, the company needs to increase customer retention by improving customer service and experience during a transaction. For the indicator of Deliver Cycle Time, improvements can be made by reducing cycle time under certain conditions provided that such action does not incur great costs. Meanwhile, for the Warranty/Returns Processing Cost, the company must identify and reduce the sources of cost waste.

4. CONCLUSIONS

In accordance with the SCOR Model framework, there were five main activities in PT XYZ's supply chain, namely Plan, Source, Make, Deliver, and Return. In the main activities, 13 Key Performance Indicators were identified and divided into four performance attributes of the SCOR Model, namely Reliability, Responsiveness, Cost, and Asset Management. The results of the weighting process showed that there were differences in the level of importance of supply chain activities. The Deliver activity had the biggest weight of 0.399, followed by the Source activity with a weight of 0.238. From the results of the performance measurement implementation obtained in an aggregated manner, it can be seen that the overall performance achievement of the company was in the good category. In 2019, the company's performance achievement was 89.78, while in 2020 it was 89.26. However, several performance indicators still belonged to the red and yellow category, meaning that they did not reach the target set. Thus, the company needs to carry out further evaluations to improve and increase the performance of each supporting indicator of supply chain activities.

This study provides a new perspective for the design of the company's performance

measurement. The design of the performance measurement system conducted by applying the Scoring System and the Traffic Light System can be used as a reference to improve the company's performance in the future. The performance achievements are displayed in the form of numbers and colors (red, yellow, and green), which are easier to understand. The steps needed by the company to ensure that performance measurement can be carried out continuously are: (1) ensuring a good understanding of the benefits of performance measurement carried out by each party involved, in accordance with their roles and functions, (2) appointing a person in charge from the company management who acts as a supervisor of the existing performance measurement system so that the evaluation process of performance achievement can be conducted more easily, (3) and holding two-way discussions in realizing each improvement recommendation.

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Parallel Session 1

Room B (09:50 - 11:20)

Moderator:

Category: Operation Management

IMPROVING THE LOADING PROCESS OF BULK FERTILIZER PRODUCTS FROM A 50,000 TON BULK WAREHOUSE TO THE PORT OF PT. PETROKIMIA GRESIK WITH A SIMULATION APPROACH TO REDUCE HANDLING COSTS AND DEMURRAGE COSTS

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ABSTRACT

The process of loading bulk fertilizer at Petrokimia Gresik is evaluated from the time of loading at the warehouse, the time of delivery from the warehouse of 50,000 tons to the port, the time of loading on the ship, and the amount of demurrage. The high handling costs are since the bulk fertilizer loading process still relies on wheel loaders, dump trucks, and vessel cranes. Problems occur when there are equipment constraints in the loading and delivery process, which causes a queue of ships and an increase in loading times that exceeds the standard time and an increase in demurrage borne by the company. There are four alternatives proposed to reduce the high handling costs and demurrage costs, namely (1) Additional Fleet Transportation; (2) Addendum to the Fleet Agreement; (3) Construction of a conveying system project with a capacity of 500 t/h; (4) Construction of Project Conveying system with a capacity of 1000 t/h. The goal to be achieved is to determine the best alternative scenario to improve the current condition. The bulk fertilizers studied were Phonska Fertilizer, Urea Fertilizer, and NPS Fertilizer. Simulations were carried out using discrete-event simulation methods and assisted with Arena 14.0 software. The simulation results show that the fourth alternative scenario is the Construction of a Conveying System Project with a capacity of 1000 t/h. These alternatives can reduce handling costs by 89.748% per year and reduce overall demurrage costs from the existing condition. Based on the calculation of the Net Present Value (NPV) of Rp. 276,256,856.453,- Return On Investment (ROI) obtained 48.66% and Payback Period (PP) of 3 years one month.

Keywords: Simulation, Arena, Demurrage Cost, Bulk Fertilizer, Handling Cost

1. INTRODUCTION

PT Petrokimia Gresik is the complete fertilizer producer in Indonesia, producing various fertilizers and chemicals for agricultural industry solutions. Over time, the development of national and global economic sectors. Starting from the production of nitrogen-based fertilizers, Petrokimia Gresik has now developed its ability to produce phosphorus-based fertilizers and grow towards the production of compound fertilizers. It can be seen from Figure 1 that between 2018 and 2020, the production capacity of phonska fertilizer, urea fertilizer, and Niphos fertilizer / called NPS fertilizer has increased significantly

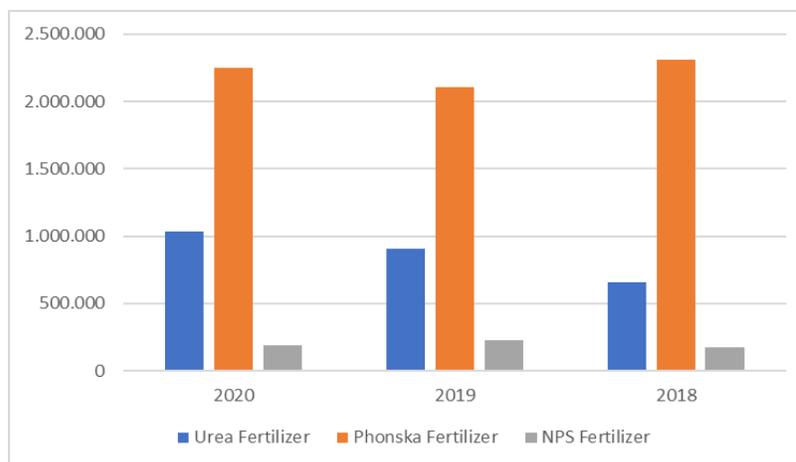


Figure 1 Production of Bulk Fertilizer Th. 2018-2020

Along with a significant increase in production capacity, it automatically requires high handling services and high handling costs. Meanwhile, in 2017 there was an increase of Rp. 48,415/ton or a rise of 14.08% when compared to costs in 2016. It can be seen in table 1.1 where there is a relatively high increase in handling costs from 2017 to 2020.

Table 1 Annual Handling Costs for the 2017-2020 period

Year	Realization of Transportation Via Shipping (Bulk Products)	Loading Price/tons	Loading Annual Fee
2017	623.675	48.415	30.195.225.125
2018	610.665	48.415	29.565.345.975
2019	749.325	48.415	36.278.569.875
2020	839.243	48.415	40.631.949.845
Average/year	705.727	48.415	34.167.772.705

The amount of this cost plus the number of demurrages per year, in Table 2 shows the cost of demurrage, and the cost of loading fertilizer from the bulk warehouse of 50,000 tons to the Petrokimia Gresik Port in 2020 reached Rp. 5,519,250,000 with an average of Rp. 613,250,000 per month. The highest demurrage was in March, and this was due to the high demand for exports during that month, especially Urea. With high demand, the supporting facilities at the Petrokimia Gresik port cannot meet the volume, so the demurrage cost becomes large.

Table 2 Petrokimia Gresik Demurrage Cost in 2020

Month	Number of Ships	Demurrage Case	Day	Demurrage Costs (Rp)
January	3	1	3,70 0	1.526.250.00 0
February	2	0	-	-
March	4	2	5,74 0	2.367.750.00 0
April	4	0	-	-
May	3	1	3,19	1.315.875.00 0
June	3	0	-	-
July	3	0	-	-
August	4	0	-	-
September	3	1	0,21	86.625.000
October	2	0	-	-
November	1	1	0,54	222.750.000
December	1	0	-	-
Amount	33	6	14.3 8	5.519.250.00 0

From the data in Table 1 and Table 2, the company identifies factors that affect the increase in demurrage costs and high loading costs from the 50,000-ton warehouse to the Petrokimia Gresik Port. From these conditions, the most critical factors in the above problems are the lack of adequate structural facilities and dependence on the availability of dump trucks, wheel loaders, and vessel cranes. Many studies related to loading goods in the form of bulk (bulk) have been carried out with various observed conditions. In this research, two criteria become the basis of priority. The priority is to minimize the cost of handling fertilizer from the 50,000-ton Bulk Warehouse to the Petrokimia Gresik Port, and the second priority is to reduce the total demurrage. Typically, ship Berthing rules are still based on the general queuing discipline, namely, first come, first serve. However, ship berthing allocation is dynamic because there are several goals to be achieved. (Umang and Vacca, 2013) conducted research on the port of bulk goods. The Berthing allocation arrangement is made to minimize the ship's service time, minimizing the Berthing time of the vessel at the pier, or minimize the deviation between the berthing schedule and the actual conditions in the field.

Research that has used the simulation method to identify the port's capacity in serving ships was carried out by (Vianen and Lodewijks, 2014). This research uses a methodology that is equipped with a simulation method. Simulation is used to estimate the size of the warehouse by considering several stochastic variations in the time between ship arrivals, ship size, and dry bulk storage time. Identifying and analyzing the loading system directly takes a long time and is quite expensive. It will be easier to study and analyze the loading system on bulk

fertilizer by modeling the system. To study and analyze the loading system directly takes a long time and is quite expensive. To make it easier to study and analyze the loading system, the system is described in a model. This model will represent the loading system.

Furthermore, the analysis of the behavior and characteristics of the loading system and its performance can be carried out through the model using the simulation method. The simulation method has been widely used to solve all kinds of problems. The main advantage of using the simulation method is that experiments with different scenarios can be carried out without affecting daily operational performance.

From this research, it is hoped that alternative scenarios can be developed to improve the current condition, then model these alternative scenarios to obtain minimizing demurrage costs and overcoming high handling costs. Furthermore, the best alternative can be determined from the comparison of Return on Investment (ROI), Payback Period (PP), and Net Present Value (NPV) from the alternative scenario with the reduction of the demurrage that occurs.

2. METHOD

Simulation steps are carried out to be able to develop alternative scenarios and determine the best alternative in an effort to reduce the high handling costs and demurrage costs. Figure 2 shows the simulation steps carried out

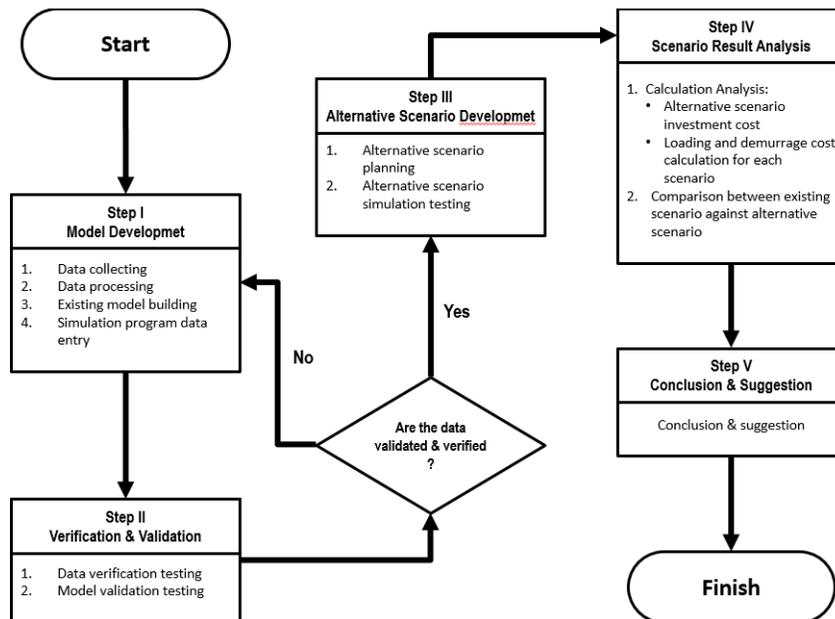


Figure 2. Steps in Simulation Development in the Best Alternative Scenario

Problem identification is made by direct observation on the research subject, namely the Port of Petrokimia Gresik. The observed activity is loading activity, along with problems that occur during loading. The data collected from the data waiting time for the ship before being served, data on the preparation time for loading after the ship docked, data on the preparation time for loading fertilizer in the 50,000-ton bulk warehouse, data on the loading time of fertilizer in the 50,000-ton bulk warehouse, data on the travel time of the 50,000-ton bulk warehouse truck to the Port. , Data on Preparation Time for Loading at the Port, data on

Fertilizer Loading Time at the Port, data on Time for Ship Off. Data collected and processed to determine the distribution of the data. Model validation is done by comparing the model's performance with the existing system's performance under study using statistical tests. A model can be valid if the comparison between the simulation model and the actual model shows no statistically significant difference. Comparison of the simulation model's output with the existing model was performed using paired t-test. After the simulation model has been created, experiments and running simulations are carried out to determine the results of the alternative scenarios developed. The calculation of handling costs and demurrage costs is carried out for each design, from the existing condition to the proposed improvement alternative scenario. Then calculate the investment costs for these alternative scenarios. The best method will be selected based on lowering handling costs and the lowest demurrage costs.

3. RESULTS AND DISCUSSION

3.1 Data Distribution

The data that has been collected will know the characteristics, namely by the distribution equation. Determination of data distribution is carried out on Phonska Fertilizer Bulk Loading Distribution, Bulk Urea Fertilizer Loading Distribution, Bulk NPS Fertilizer Loading Distribution, Ship Waiting Time Before Serving, Loading Preparation Time after Ships docked, Fertilizer Loading Preparation Time in Warehouse, Fertilizer Loading Time in Warehouse, Time Warehouse Truck Trip to the Port, Ship Loading Preparation Time, Fertilizer Loading Time at the Port, Ship Offshore Time, Demmura Data are shown in Table 3.

Table 3 Determination of Data Distribution

No	Data	Distribution Type	Distributi on
1	Bulk Phonska Fertilizer Loading	Triangular	TRIA(1.19e+004, 2.15e+004, 2.57e+004)
2	Bulk Urea Fertilizer Loading	Beta	$3.16e+004 + 1.32e+004 * BETA(0.0383, 0.0284)$
3	Bulk NPS Fertilizer Loading	Weibull	$2.55e+004 + WEIB(1.65e+003, 0.572)$
4	Ship Waiting Time Data Before Service	Normal	NORM(11, 7.11)
5	Data of Loading Preparation Time after Ship Berthing	Gamma	GAMM(0.344, 1.27)
6	Data on Fertilizer Loading Preparation Time in Bulk Warehouse 50,000 Tons	Beta	$0.35 + 0.36 * BETA(1.73, 1.54)$
7	Fertilizer Loading Time Data in 50,000 Tons Bulk Warehouse	Erlang	$0.06 + ERLA(0.000132, 25)$
8	Travel Time Data for 50,000 Ton Warehouse Trucks to Port	Normal	NORM(0.277, 0.026)
9	Loading Preparation Time Data at the Port	Normal	NORM(0.0581, 0.0213)
10	Fertilizer Loading Time Data at the Port	Beta	$0.15 + 0.2 * BETA(1.86, 1.86)$
11	Ship Off Time Data	Exponential	EXPO(0.429)
12	Demurrage Time	Erlang	$0.5 + ERLA(1.54, 2)$

3.2 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. The conceptual model for the loading process at the Petrokimia Gresik port is shown in Figure 3.

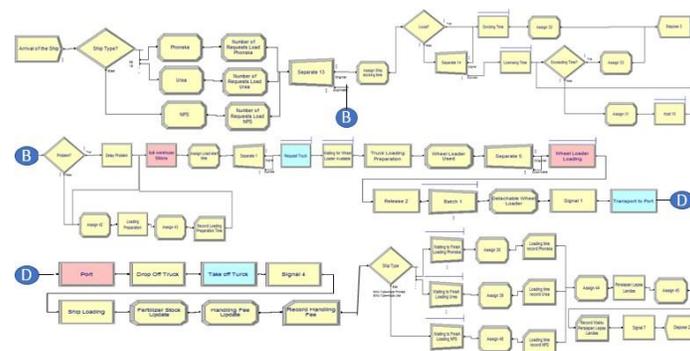


Figure 3 Existing Model of Simulation

3.3 Model Verification

After the existing fertilizer loading process from the 50,000-ton bulk warehouse to the port is simulated, the verification process is carried out first. Verification is carried out to ensure that the model can be run and there are no errors in making the simulation model and inputting the simulation data.

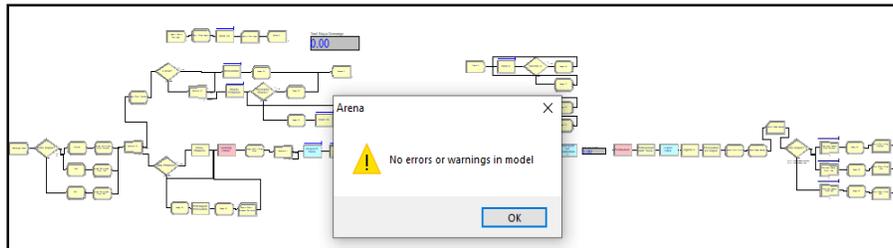


Figure 4 Arena Simulation Verification

From Figure 4, it can be seen that the indication of the simulation software is "No Error or Warning in Model." So from these results, it can be said that the model made has been well verified, and there are no errors in the model.

3.4 Model Validation

Validation is carried out to determine whether the model made is by the actual conditions of the system. Validation is done by comparing the simulation results with primary data in the existing requirements for the desired parameters. A validation test is used to prove that the model made can represent actual conditions (real system). Validation is done by comparing the simulation results with the exact cost using a one-sample t-test. The simulation data is said to be valid if the P-value of the t-test result > 0.05 . Before the one-sample t-test, first, look for the correct number of replications with an initial trial of $n = 25$ replicas. Simulation error (4,519%) relative error (5%), then the number of replications has met the validation requirements. So the number of replicas used is 25 times. The next stage, then to determine this simulation model is valid, is to test the hypothesis with a one-sample t-test. The significance level used is $\alpha = 0.05$. By using one sample t-test in Microsoft Excel, as shown in Table 4 below.

Table 4 Validation Results of one sample t-test

t-Test: Two-Sample Assuming Equal Variances		
	Variable 1	Variable 2
Mean	247,2727273	249,8136
Observations	25	25
Pooled Variance	373,9036495	
Hypothesized Mean Difference	0	
df	48	
t Stat	0,464577386	
P(T<=t) one-tail	0,322167308	
t Critical one-tail	1,677224196	
P(T<=t) two-tail	0,644334616	
t Critical two-tail	2,010634758	

From the above calculation, a P value of 0.322 is obtained, where P value > 0.05, the hypothesis can be said that Ho is accepted or, in other words, there is no significant difference between the existing system and the model system so that the model is said to be valid. So from these results, it can be concluded that there is no difference between the simulation results and the actual conditions, so the simulation can be said to have passed the validation test.

3.5 Identification of Factors Causing High Handling Costs and Demurrage Costs

This identification is described in a Fishbone Diagram, and an FMEA (Failure Mode and Effect Analysis) analysis is carried out to determine the RPN value of each cause. The RPN value in the FMEA (Failure Mode and Effect Analysis) analysis is tabulated in a Pareto diagram. By conducting a Focus Group Discussion (FGD) with parties related to the process of loading bulk fertilizer products, the factors causing the problem were found and mapped in a fishbone diagram, as shown in Figure 5.

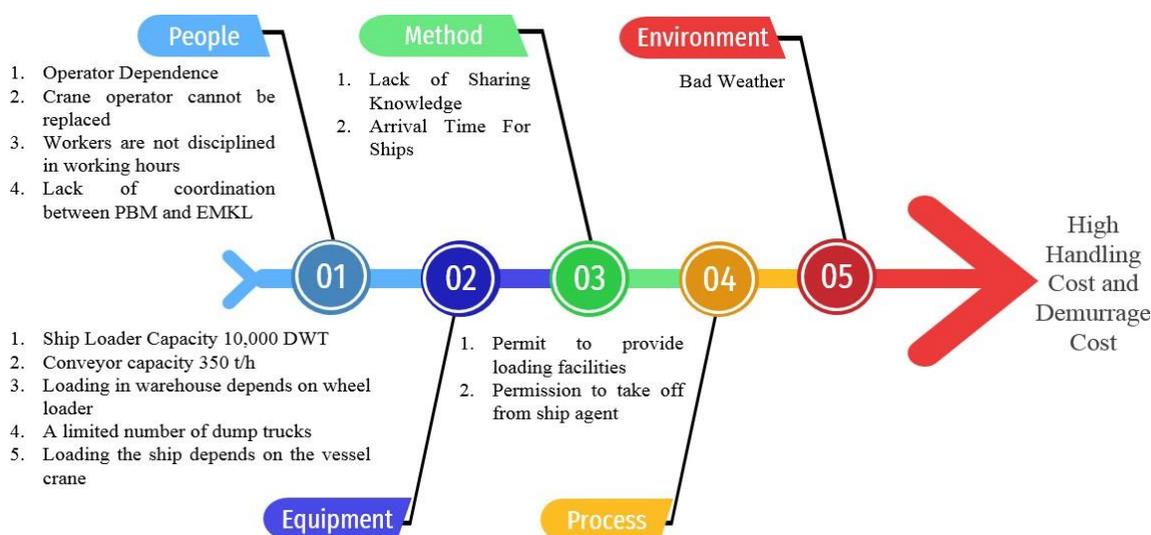


Figure 5 Fishbone Diagram

After obtaining the cause of the fishbone diagram, the next step is to perform FMEA analysis with data obtained from the distribution of questionnaires to determine the value of SOD (Severity, Occurrence, Detection) to determine the value of the RPN (Risk Priority Number).

Table 5. FMEA Analysis

Type of Failure	Cause	Initial	SEV	OCC	DE T	RPN
High Handling Cost and	People					
	Operator Dependence	A	5.4	5	1.6	43.20
	Crane operator cannot be replaced	B	5.6	5.4	2.2	66.53
	Workers are not disciplined in working hours	C	4.4	4	1.4	24.64
	Lack of coordination between PBM and	D	4.6	4.2	2.4	46.37

Demurrage Cost	EMKL					
	Method					
	Lack of Sharing Knowledge	E	6.6	5	3.2	105.60
	Arrival Time For Ships	F	7	5.6	2.8	109.76
	Environment					
	Bad Weather	G	6.8	5.6	4.6	175.17
	Equipment					
	Ship Loader Capacity 10,000 DWT	H	9.4	9.2	9	778.32
	Conveyor capacity 350 t/h	I	8.8	8.8	8	619.52
	Loading in warehouse depends on wheel loader	J	8.6	8.2	8	564.16
	A limited number of dump trucks	K	8.4	8.6	8.4	606.82
	Loading the ship depends on the vessel crane	L	8.6	8	8	550.40
	Process					
	Permit to provide loading facilities	M	6.6	5.4	2.6	92.66
	Permission to take off from ship agent	N	6.2	5	2.8	86.80

From the FMEA analysis shown in Table 5, the next stage will be an analysis using a Pareto diagram, to determine the weighting of the influencing factors, then use the mapping of the factors causing the high handling costs and demurrage costs, grouping with the largest weight and getting the results shown in Figure 6.

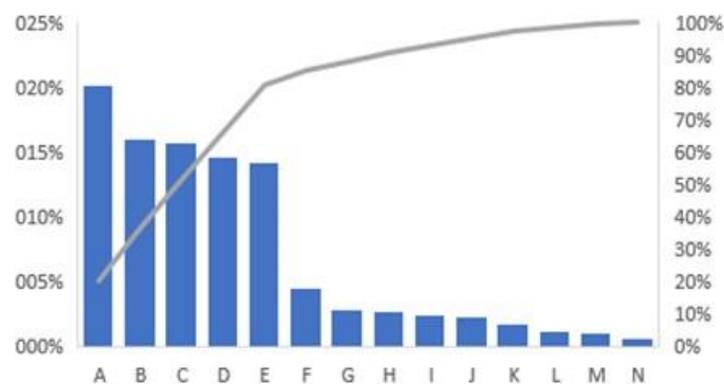


Figure 6 Pareto Chart

3.6 Scenario Development

The development of alternative scenarios needs to be done to reduce handling costs and

demurrage costs at the Petrokimia Gresik Port. The development of this alternative scenario is based on the root causes described in the Pareto Diagram. Several alternative scenarios will be carried out in the simulation. The alternative scenario is chosen by considering lowering handling costs and demurrage costs.

The following are alternative scenarios that arise taking the above into account:

1. Alternative Scenario 1 - Addition of Freight Fleet
2. Alternative Scenario 2 - Addendum to the Fleet Agreement
3. Alternative Scenario 3 - Construction of a Conveying System project with a capacity of 500 t/h
4. Alternative Scenario 4 - Construction of a Conveying System project with a capacity of 1000t/h

3.7 Cost And Benefit Analysis

The next stage is to calculate the Net Present Value (NPV), Return On Investment (ROI), and payback period (PP) of the repair costs of each alternative scenario. Savings from reducing handling costs and demurrage costs due to alternative solutions can be said to be advantages.

Table 6 Comparison of Costs and Savings between Alternative Scenarios

Scenario	Value of Investment	Demurrage Costs (Rp)	Savings (Rp)	Handling Costs (Rp)	Savings (Rp)	Total Savings (Rp)
Existing	-	5.053.125.000		39.872.541.280		
Alternative 1	9.680.000.000	33.000.000	5.020.125.000	39.388.701.080	483.840.200	5.503.965.200
Alternative 2	-	4.180.450.313	872.674.688	36.992.560.277	2.879.981.003	3.752.655.691
Alternative 3	102.171.000.000	0	5.053.125.000	22.283.424.760	17.589.116.520	22.642.241.520
Alternative 4	148.800.000.000	0	5.053.125.000	4.087.752.960	35.784.788.320	40.837.913.320

From table 6 it can be calculated NPV (Net Present Value), ROI (Return On Investment), and PP (Payback Period), so the comparison can be seen according to Table 7 below.

Table 7 Comparison of Cost and Benefit Analysis between Alternative Scenarios

Description	Alternative 1	Alternative 2	Alternative 3	Alternative 4
NPV (<i>Net Present Value</i>)	- 169.910.611.144	- 199.421.186.087	24,005,086,842	276.256.856.453
PP (<i>Payback Period</i>)	∞	∞	6 Tahun 5 bulan	3 Tahun 1 bulan
ROI (<i>Return On Investment</i>)	-309.12%	-	17.06%	48.66%

Based on Table 7 above, the best alternative scenario for improvement is alternative scenario

four improvement by constructing a Conveying System Capacity of 1000 t/h. This is based on the following points: The Net Present Value (NPV) of the 4th alternative scenario is the largest compared to other scenarios with a Rp 276,256,856.453,-. The payback period from alternative scenario 4 is the fastest compared to alternative scenario 1, scenario 2, and scenario 3 with a time of 3 years and one month. Return on Investment (ROI) from alternative scenario 4 is the largest compared to alternative improvements in scenario 1, scenario 2, and scenario three which is 48.66%

4. CONCLUSION AND RECOMMENDATION

Based on the results of the study, the causes of high handling costs and demurrage costs in bulk fertilizer loading can be seen as 80% due to, Limited capacity of the ship loader, which only has a capacity of 10,000 DWT, Conveyor capacity is only 350 t/h, which cannot serve at a high rate, Limited number of dump trucks causing late delivery times, Slow loading process in a warehouse due to dependence on wheel loaders, The process of loading bulk fertilizer onto ships relies on a vessel crane. From the analysis of the causes of the high handling costs and demurrage costs, four alternative scenarios have been developed. Based on the simulation using Arena 14.0 software from alternative scenarios of improvement to reduce high handling costs and demurrage costs, it can be concluded that the alternative scenario of Conveying System Project Development with a capacity of 1000 t/h is the best alternative scenario by reducing handling costs by 89.748% per year and can eliminate overall demurrage costs. From the calculation of the feasibility of investment costs, the net present value (NPV) is Rp. 276,256,856.453,- Return On Investment (ROI) obtained 48.66% and Payback Period (PP) of 3 Years 1 month

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REDESIGNING OF BUFFER WAREHOUSE NETWORK STRUCTURE OF PT. PETROKIMIA GRESIK FOR EAST JAVA DISTRIBUTION AREA

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ABSTRACT

PT. Petrokimia Gresik is one of the fertilizer producers in Indonesia. A reliable distribution system is needed to ensure fertilizers can be accepted by farmers. Buffer warehouse is one of the aspects of the effectiveness of fertilizer distribution to agricultural areas. East Java is the province that has the largest number of buffer warehouses compared to other provinces, which are 75 buffer warehouses. Distributing fertilizer to 75 buffer warehouses requires a large cost, so it is necessary to analyze the redesigning of the fertilizer distribution network to reduce distribution costs. In evaluating and providing recommendations, the P-Median method can be used to determine the location and effective warehouse in distribution. PMedian is the most suitable method in solving this problem because P-Median minimize the number of the shortest distances multiplication with the number of demands from all demand nodes in a network. To determine the number of buffer warehouses that will be selected as intermediate warehouses is based on the lowest distribution costs consisting of warehouse rental costs, warehouse management, loading and unloading, and land transportation. The results obtained are 25 intermediary warehouses to meet demand in the East Java area with a minimum total distribution cost of Rp 221,573,927,100.

Keywords: Minimum Distribution Cost, Buffer Warehouse, P-Median, Subsidized Fertilizer.

1. INTRODUCTION

The government's plan to improve the targeting accuracy of fertilizer subsidies with the application of direct fertilizer subsidies through farmer cards has a significant impact on PT. Petrokimia Gresik. PT. Petrokimia Gresik must transform its business to lower the cost of production so that its products can compete in the free market. In 2020, distribution costs are budgeted by PT. Petrokimia Gresik for region 1 which covers the areas of Java and Bali islands is 22% of the total budget for region 1. The analysis of the redesigning of buffer warehouse network structure is expected to reduce distribution costs and reduce the cost of production as a domino effect. The method used for the analysis of redesigning network structure is P-Median. By doing analysis and evaluation using the P-Median model, it is hoped that an effective number and location of intermediate warehouses will be produced with the lowest total cost of warehouse rental, warehouse management, and land

transportation to reduce distribution costs in line with the decline in the cost of fertilizer production.

2. LITERATURE REVIEW

According to Daskin (2013), the P-Median method is usually used to solve problems where the distance between facilities, demand nodes, and distribution costs have a close relationship, so that the P-Median can be used to maximize benefits by determining the median amount to meet demand in an area, thereby minimizing costs. Meanwhile, according to Hakimi (1964), the P-Median method is used to determine the location to meet demand at the point of need (demand nodes) by maximizing the benefits that would be obtained or minimizing transportation costs by choosing the median with the closest distance between several demand nodes.

The P-Median method is mixed-integer linear programming that uses a binary algorithm so that in its process it produces numbers 0 and 1. According to Daskin (2013), the P-Median method can be used to determine the location of the closest facility to a group of consumers or demand nodes around it. Thus, the output of P-Median is produces the right solution/facility to be used with the most optimal distance to meet the needs or demands of consumers. The objective function of the P-Median method is to minimize the total distribution distance using the following formula:

Inputs :

h_i = demand at point/node to-i

d_{ij} = distance between demand node to-i and warehouse candidate to-j

P = number of facility/warehouse to be placed

Decision variables:

$X_j = \begin{cases} 1 & \text{if placed warehouse candidate to } j \text{ location} \\ 0 & \text{if not} \end{cases}$

$Y_{ij} = \begin{cases} 1 & \text{if demand at node } i \text{ fulfill by warehouse at node } j \\ 0 & \text{if not} \end{cases}$

With the notation previously written, the P-Median problem can be formulated as follows: Minimization

$$\sum_i \sum_j h_i d_{ij} Y_{ij}$$

(2.1)

Constraints:

$$\sum_i Y_{ij} = 1 \tag{2.2}$$

$$\sum_j X_j = P \tag{2.3}$$

$$Y_{ij} - X_j \leq 0 \tag{2.4}$$

$$X_j = 0,1 \tag{2.5}$$

$$Y_{ij} = 0,1 \tag{2.6}$$

Information:

- (2.1) The objective function is to minimize the total demand multiplied by the distance between demand nodes and the nearest facility
- (2.2) Requires the requirement at each demand node to-i to be met by one facility to-j
- (2.3) State that facility P should be located
- (2.4) Connecting the location variable (X_j) and the allocation variable (Y_{ij}). This equation states that the fulfillment of demand at point to-i can only be assigned to one facility at location to-j if the facility is placed at point to-j
- (2.5) and (2.6) standard limitation for integral conditions

Heuristic algorithms can be used in solving P-Median problems which are divided into three types, there are: myopic algorithms, exchange heuristics, and neighborhood search algorithms. According to Daskin (2013), a myopic algorithm is an algorithm construction used to generate the best solution from a random condition. Usually, the myopic algorithm is used to solve the maximum covering problem. It is different from the exchange algorithm and neighborhood search algorithm whose purpose is to change the redundant conditions and will change the problem to a maximum covering problem.

3. METHODS

3.1 Demand and Distance Matrix

The formation of the demand and distance matrix requires two primary data, there are demand data for each demand node and the distance between demand nodes. Demand data is obtained from sales orders or the number of subsidized and non-subsidized fertilizer products that were successfully sold in 2020 at each demand node. Matrix demand and distance is the results of multiplication of demand and distance of each demand node.

3.2 Determining Warehouse Locations and Grouping Warehouses with Neighborhood Search Algorithms

The results of multiplication of demand and the distance of each demand node are summed and the smallest value will be the demand nodes that are selected as intermediate warehouses. Next, grouping the demand nodes with the shortest distance from the median or selected warehouse location to produce groups of demand nodes.

3.3 Determining the Number of Warehouses and Minimum Distribution Costs

Determining of the number of warehouses is closely related to distribution costs, the lower distribution costs, the more efficient distribution network. PT. Petrokimia Gresik has several types of costs as components of distribution costs, including: warehouse rental costs, warehouse management costs, loading and unloading costs, land transportation costs from Gresik to the Median or selected warehouse, and land transportation costs from the median or selected warehouse to demand nodes. From each iteration at the stage of determining the location of the previous warehouse, the total cost of distribution is calculated, then selected the iteration with the lowest total distribution cost so that distribution costs determine the number of medians or efficient selected warehouses.

4. RESULTS

Data processing is carried out using the P-Median method, the first step is to multiply the distance between demand nodes (in kilometers) with the demand for subsidized and non-subsidized fertilizers for each demand nodes (in tons). This data multiplication aims to

include distance variables and quantum demand in calculations and decision-making. The goal of using the P-Median method is to minimize mileage in a distribution network.

The second stage is to determine the location of the buffer warehouse that is selected as the median or intermediate warehouse using a heuristic algorithm, that is the myopic algorithm. The application of the myopic algorithm in location problems is to determine the buffer warehouse that will be used as an intermediary warehouse is to add up the results of multiplying the distance and demand for each demand node. The result of the sum is then referred to as the total enumeration, which is then searched for the smallest value. The smallest value of the total enumeration of each demand node is chosen as the median, or the buffer warehouse is selected as the intermediate warehouse. This study analyzes the redesigning of buffer warehouse network structure at PT. Petrokimia Gresik for East Java distribution area is repeated to find the smallest total enumeration

or iterations of 30 times. Data processing for determining the location of the intermediate warehouse with a total of 30 iterations resulted in 30 medians as the selected intermediate warehouse. This intermediary warehouse will later be used as a transit warehouse that receives supplies of subsidized fertilizers and non-subsidized fertilizers from the Gresik warehouse. The intermediary warehouse is also used to store subsidized and non-subsidized fertilizer products which will be distributed to demand nodes in one neighborhood group.

Table 4.1 Median or Selected Intermediate Warehouse per Iteration

Iteration	Intermediate Warehouse	Warehouse Code	Iteration	Intermediate Warehouse	Warehouse Code
1	Mojokerto 2 - Trowulan	MJK_3	16	Sumenep – Saronggi	SMNP_1
2	Pamekasan - Nyalaran	PMKS_4	17	Sampang - Torjun 2	SMPG_2
3	Madiun - Kaligunting	MDN_2	18	Lumajang 2 - Sumbersuko	LMJG_1
4	Jember - Rambipuji	JBR_1	19	Nganjuk – Pehserut	NGJK_1
5	Blitar GPP - Garum	BLTR_4	20	Magetan – Maospati	MGTN_1
6	Bojonegoro 1 - Baureno	BJN_1	21	Trenggalek	TGLK_1
7	Ponorogo 2 - Balong	PNRG_2	22	Tuban 1 – Jenu	TBN_1
8	Malang GPP - Pakisaji	MLG_4	23	Probolinggo – Paiton	PRBL_1
9	Pasuruan 3 - Pelabuhan	PSRN_2	24	Kediri 3 – Gurah	KDR_2
10	Banyuwangi - Singojuruh	BWI_1	25	Lamongan 3 – Pucuk	LMG_2
11	Bangkalan - Socah	BKLN_1	26	Situbondo 1 – Arjasa	STBD_1
12	Kediri - Ngadiluwih	KDR_4	27	Sidoarjo – Lebo	SDA_1
13	Bojonegoro 4 – Kalitidu	BJN_4	28	Jombang - Gatot Subroto	JBG_1
14	Pacitan - Menadi / Kayen	PCTN_1	29	Probolinggo 2 - Wonomerto	PRBL_2
15	Bondowoso 1 - Tangsil	BDW_1	30	Ponorogo – Badegan	PNRG_3

Meanwhile, to determine another buffer warehouse that will become the neighborhood in one group, the neighborhood search improvement algorithm is used. This algorithm works by finding a buffer warehouse with a minimum distance from the median or selected intermediate warehouse. From the calculation of the minimum distance, neighborhood groups

are obtained which consist of one median or intermediate warehouse and several buffer warehouses. The intermediary warehouse that has been selected in the previous stage will become the supply center for the distribution of subsidized and non-subsidized fertilizers to demand nodes in a neighborhood group.

Table 4.2 Buffer Warehouse Grouping with Neighborhood Search Improvement Algorithm 25th Iteration

Median	Buffer Warehouse	Median	Buffer Warehouse	Median	Buffer Warehouse
MJK_3	JBG_1	PNRG_2	PNRG_1	SMNP_1	SMNP_1
	JBG_2		PNRG_2		SMNP_2
	MJK_1		PNRG_3		SMNP_3
	MJK_3	MLG_1	SMNP_4		
	SDA_1	MLG_4	MLG_2	SMPG_1	
PMKS_1	MLG_3		SMPG_2		
PMKS_4	PMKS_2	PSRN_2	MLG_4	LMJG_1	SMPG_3
	PMKS_3		PSRN_1		LMJG_1
Median	Buffer Warehouse	Median	Buffer Warehouse	Median	Buffer Warehouse
	PMKS_4		PSRN_2		LMJG_2
MDN_2	MDN_1	BWI_1	PRBL_2	NGJK_1	NGJK_1
	MDN_2		BWI_1		NGJK_2
	MDN_3		BWI_3		NGJK_3
	MDN_4	BKLN_1	BKLN_1	MGTN_1	MGTN_1
	NGWI_1		BKLN_2		NGWI_3
	NGWI_2	KDR_4	KDR_4		PNRG_4
JBR_1	JBR_1	BJN_4	TLG_1	TGLK_1	TGLK_1
	JBR_2		BJN_3		TLG_2
JBR_3	BJN_4		BJN_4	TBN_1	TBN_1
BLTR_4	BLTR_1	PCTN_1	BJN_5	PRBL_1	TBN_2
	BLTR_2		BJN_6		PRBL_1
	BLTR_3		PCTN_1	KDR_2	KDR_1
BLTR_4		PCTN_2	KDR_2		
BJN_1	BJN_1	BDW_1	BDW_1	LMG_2	KDR_3
	BJN_2				LMG_1
	TBN_3		STBD_1		LMG_2
					LMG_3

The third stage is the calculation of distribution costs based on the results of grouping buffer warehouses with a neighborhood search improvement algorithm. Distribution costs consist of two types, fixed costs consisting of rental costs and warehouse management, and variable costs consisting of loading and unloading costs and land transportation. Iteration with

the minimum number of distribution costs is the optimal iteration and is chosen as a solution to the problem.

Table 4.3 Distribution Cost Calculation

Rental	Management	Loading Unloading	Transportation	Total
Iteration 15				
7.269.649.032	1.884.300.000	13.464.899.850	212.969.157.296	235.588.006.177
Iteration 20				
9.237.505.032	2.518.236.000	13.439.840.430	199.687.217.365	224.882.798.827
Iteration 25				
11.147.025.432	3.155.904.000	13.427.749.588	193.843.248.081	221.573.927.101
Iteration 30				
12.704.805.432	3.768.516.000	13.427.749.588	193.132.185.463	223.033.256.483

Variables in the calculation of distribution costs have a considerable influence in determining the minimum total distribution costs. The combination of the four variables, there are warehouse rental costs, warehouse management, loading and unloading, and land transportation results in the total distribution costs. The distribution cost calculation that has been done previously concluded that iteration 25 has the lowest total distribution cost compared to other iterations. The iteration with the lowest total distribution cost can be used as the optimal solution in determining the median number or the selected intermediary warehouse.

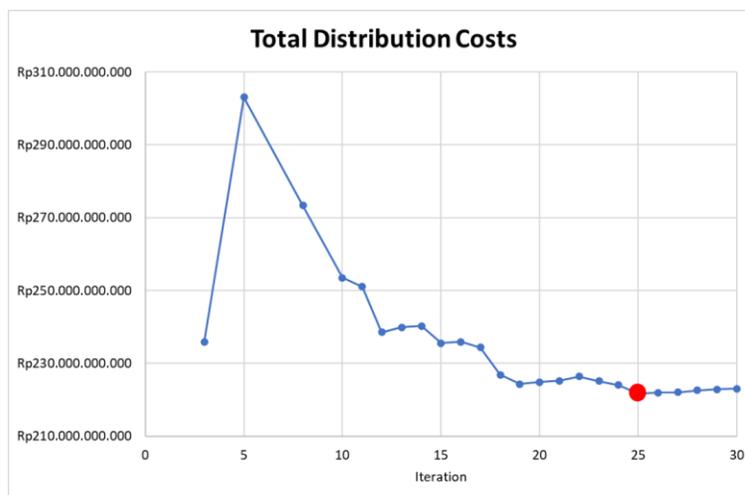


Figure 4.1. Total Distribution Cost Each Iteration

Redesigning of buffer warehouse network structure at PT. Petrokimia Gresik with the P-Median method produces an optimal solution of 25 intermediate warehouses and 25 neighborhood groups. The total distribution costs that need to be incurred by PT. Petrokimia Gresik when redesigning the distribution network by applying the optimal solution using the P-Median method is Rp. 221.573.927.101.

6. CONCLUSIONS

The fertilizer distribution network of existing buffer warehouses in the East Java area currently uses direct shipment, which is direct shipment from the Gresik warehouse to the buffer warehouses in each district. The total number of buffer warehouses in the East Java area is 75 warehouses where the distribution requires a large enough cost, so that it is not effective as seen from the limitations of the types of land transportation used and the existing warehouse capacity that exceeds the need. To anticipate the application of direct subsidies, a business transformation is needed to reduce the cost of production. One of the costs that can be minimized is distribution costs by redesigning network structure.

The appropriate method to overcome the problem of redesigning of buffer warehouse network structure of PT. Petrokimia Gresik for east java distribution area is using the P-Median method with a myopic algorithm approach and a neighborhood search improvement algorithm. The application of the P-Median method with a limitation of 30 iterations results in the 25th iteration being the iteration with the minimum total distribution cost so that the optimal number of intermediary warehouses in the distribution network of subsidized fertilizers and non-subsidized fertilizers in the East Java area is 25 intermediate warehouses. Furthermore, these 25 selected intermediary warehouses will become supply centers for other supply and demand nodes in a neighborhood group. The total distribution cost required by the number of 25 intermediary warehouses is Rp. 221,573.927,101.

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OPTIMIZATION OF AIRCRAFT MAINTENANCE MATERIAL DISTRIBUTION

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ABSTRACT

Aircraft maintenance is one of the important activities that determine the success of aircraft departures. The purpose of aircraft maintenance is to maintain the airworthiness of the aircraft. In 2019, an airline company experienced more than 500 flight delays and 17 of them were caused by material factors. One of the problems that occur in this material factor is the delay in distribution from the Central Warehouse to the Store. Material requirements in the form of wheels, oxygen bottles, and seat covers are needed both during minor and major inspections so that the availability of these three materials needs to be maintained both in the hangar and apron. For the fulfillment of the material on the apron and hangar, the material is sent through the central store (GADC). The material request was obtained on the previous day for fulfillment on the next day. The material needs that are not the same day by day make the ongoing distribution a problem in itself. This is often a complaint by the customer to the company to improve the existing distribution system. One of the problems that are often found in the distribution of this material is the accumulation of vehicles in one of the stores in the hangar or apron. To overcome this problem, this study aims to improve the existing distribution system by using Pickup-and-Delivery Vehicle Routing Problem (PDVRP) in order to obtain an efficient cost and meet material requirements.

Keywords : Vehicle Routing Problem, Material Distribution, Pickup and Delivery, and Maintenance.

1. INTRODUCTION

Aircraft maintenance is one of the most important things to do to maintain the reliability and serviceability of the aircraft. An aircraft is designed to be flown for most of its economic life, then every ground time may be considered as a loss for an airline. Thus, many companies are making various efforts to increase productivity, quality and reduce costs by maintaining maintenance (Miyake and Enkawa, 1999). The maintenance program is required performed by airline for the principal reasons:

- a. Operational: To keep the aircraft in a serviceable and reliable condition.
- b. Value Retention: Minimizing the aircraft physical deterioration to maintain aircraft value.
- c. Regulatory requirements: The aviation authorities regulate the aircraft maintenance in which the aircraft is registered.

The maintenance program selected based on several categories. Maintenance program are

generally divided into three categories, namely:

- Block Maintenance, grouping tasks which require frequent repetition under a letter check (“A”, “C”, & “D” Checks)
- Progressive Maintenance, where each “taskcard” is done based on their respective intervals(also known as day-by-day maintenance). There is no default grouping, but it is still possible to schedule and work on concurrently.
- Equalized Maintenance, a maintenance program that divides the maintenance tasks into smaller packages so it can be completed not only during periodic checks but also can be carried out overnight when the aircraft is not required.

Currently, PT. XYZ uses a Block Maintenance for aircraft maintenance program. This category requires more ground time to perform one package of work. This makes the aircraft cannot perform revenue flight segments during the ground time. Equalized maintenance program selected to reduce ground time by divides the tasks of package into smaller packages and distribute it to another station that still have remaining manhours. The tasks can be performed during the aircraft RON (Remain Over Night).

One common scheduling problem is job shop that allows to process operations on one machine out of a set of alternative machines. Tasks distribution as a job shop scheduling problem solved by the metaheuristic algorithms named Genetic Algorithm. This algorithm developed by John Holland and his collaborators in the 1960s and 1970s. Genetic Algorithm is a model of biological evolution that can solve optimization problems. With this genetic algorithm, schedules were generated in a particular way. The decision management in JSSP distributes the jobs for each machine, selecting one machine among the other alternatives to have a better fitness. With mutation several population and generation, this algorithm can help the distribution issues.

The implementation of Equalized Maintenance Program causes changes in the planning and scheduled to perform C-Check maintenance. The changes can reduce TAT (Turn Around Time) C-Check from 14 days to be 8 days, and this study can be used as a basis for operator to develop the maintenance program subject to the approval of his Regulatory Authority.

2. LITERATURE REVIEW

The aim of maintenance program and planning is to ensure continued airworthiness and continuously maximizing fleet availability and optimizing airlines’ maintenance resources (Delmas, 2015). With a maintenance program that is well developed and assessed, it will be able to increase flexibility in its planning, and this will certainly benefit the airline. In making the maintenance program, each airline refers to the MPD (Maintenance Planning Data) document from the manufacturer. The MPD document is very helpful for airlines in preparing a maintenance program that suits the needs of each airline which is then submitted to the local Airworthiness Authority for approval.

In this study, the maintenance schedule will be determined using a metaheuristic method, namely genetic algorithm. The goal is to solve optimization problems and maintenance scheduling schemes so that the maintenance planning and schedule can be more optimal. At the initial stage, selection criteria will be carried out so that the packages become an equalized. Then the genetic algorithm method is carried out with several

assumptions and criteria that have been set.

Job Shop Scheduling Problem (JSSP) theory explains the problem of scheduling a number of n -jobs on a number of m -machines which aims to minimize certain criteria. The development of this JSSP theory is that each job has a processing sequence, and this is determined through all machines that are fixed and known in advance, known as the Flexible Job Shop Scheduling Problem (FJSSP). This development theory is more complex because the method used is to determine the allocation of a job to be processed from several alternative machines, so it is not just sorting jobs that will be processed on number of machines (Zhang, 2009).

To solve the optimization issue in this study, development of an algorithm for the job-shop scheduling problem, which is based on genetic algorithms performed. Existing literature deals with different methods and tools. The following Table 1. Comparison of Heuristic Method shows the literature of weakness mapping between Genetic Algorithm and other metaheuristic algorithm.

Table 1. Comparison of Heuristic Method

Authors	Title	Method	Literature Review
Baykasoglu et al (2004)	Using Multiple Objective Tabu Search and Grammars to model and solve multi-objective flexible job shop scheduling problems	Tabu Search Algorithm	<ul style="list-style-type: none"> - Too many parameters to define. - The number of iterations can be very large. - The global optimization may not be found, depending on the initial parameter settings.
Bagheri et al (2010)	An artificial immune algorithm for the flexible job-shop scheduling problem	Artificial Immune Algorithm	A relatively new field of research trying to build computational systems inspired by the nature of the biological immune system.
Verma et al (2011)	Solving the Job-Shop Scheduling Problem by using Genetic Algorithm	Genetic Algorithm	Requires many generations to produce optimal values, thus creating a time delay.
Chen et al (2020)	Improved artificial immune algorithm for the flexible job shop problem with transportation time	Hybrid Artificial Immune and Simulated Annealing	<ul style="list-style-type: none"> - Time delay. - More complex because the search is not only from local but also from global.

3. METHODS

3.1 Equalized Maintenance Program

To perform equalized maintenance program, it is important to perform:

- Preparing maintenance packages.
- Scheduling scenarios.

These two activities are important to get an effective maintenance schedule and efficiently. The first step of this study in preparing maintenance packages is reviewing the

Maintenance Program task and split the tasks into several smaller packages. The parameters that should be considered are manhours requirement, tools & equipment, and spare part or materials. Typically, line operation tasks have a lower level of demand than base operation tasks.

After the maintenance packages are formed, continue to develop scheduling scenarios. Main consideration for the maintenance schedule is the tasks distribution between the maintenance phases should be fairly distributed to get ease of resource planning. The following Table 2. Current Implementation of B737-800 Maintenance Program shows the current implementation of B737-800 Maintenance Program by using Block Check Maintenance approach.

Table 2. Current Implementation of B737-800 Maintenance Program

MAINTENANCE EVENT		NO. OF TASKS	MANHOURS	TASK (%)	MANHOURS (%)
<A-CHECK		14	8,75	0,85%	0,19%
ITEMA-CHECK	1A	33	24,21	2,01%	0,53%
	2A	24	12,52	1,46%	0,27%
	3A	32	13,86	1,95%	0,30%
	4A	21	12,40	1,28%	0,27%
	5A	28	16,80	1,71%	0,37%
	6A	33	13,76	2,01%	0,30%
OUT OF PHASE	OOP-A	246	348,27	14,98%	7,63%
	OOP-C	82	96,30	4,99%	2,11%
ITEMC-CHECK	1C	503	406,91	30,63%	8,92%
	2C	48	82,53	2,92%	1,81%
	3C	66	32,15	4,02%	0,70%
CPCP		26	56,46	1,58%	1,24%
STRUCTURE/YEAR TASK	6Y R	128	492,18	7,80%	10,79%
	8Y R	87	685,32	5,30%	15,02%
	10YR	83	635,90	5,05%	13,93%
	12YR	62	594,12	3,78%	13,02%
	F/R	78	937,21	4,75%	20,54%
	YR	48	93,80	2,92%	2,06%
TOTAL		1642	4563,45	100%	100%

Reviewing the maintenance program task and split the tasks into several smaller packages done by Focus Group Discussion with some expert planner. Since maintenance is mandatory for safety and airworthy, it is not possible to reduce the number of maintenance tasks to be accomplished. The only way to be achieved is to change the planning of performing maintenance. Performing the maintenance in a more dynamic way by utilizing

every moment when the aircraft is at another station and have ground time for any reason. Reviewing the tasks by check the interval of tasks, manhours requirement, tool and equipment, and materials.

In this study, it is possible to see the benefits of Equalized Maintenance Program concept. By using block check approach, an aircraft is kept on the ground about 14 days for maintenance in a period of one C-Check, however in the method proposed in this study, the same aircraft can perform the C-Check only for 8 days. This can be achieved only by utilizing every moment, as a maintenance opportunity when the aircraft is on the ground for any reason, especially during overnight. The following Table 3. Proposed Implementation of B737-800 Maintenance Program shows the several tasks of C-Check that have split to smaller packages and moved the packages into Out of Phase-A.

Table 3. Proposed Implementation of B737-800 Maintenance Program

MAINTENANCE EVENT		NO. OF TASKS	MANHOURS	TASK (%)	MANHOURS (%)
<A-CHECK		14	8,75	0,85%	0,19%
ITEM A-CHECK	1A	33	24,21	2,01%	0,53%
	2A	24	12,52	1,46%	0,27%
	3A	32	13,86	1,95%	0,30%
	4A	21	12,40	1,28%	0,27%
	5A	28	16,80	1,71%	0,37%
	6A	33	13,76	2,01%	0,30%
OUT OF PHASE	OOP-A	451	508,18	27,47%	11,14%
	OOP-C	82	96,30	4,99%	2,11%
ITEM C-CHECK	1C	298	247,00	18,15%	5,41%
	2C	48	82,53	2,92%	1,81%
	3C	66	32,15	4,02%	0,70%
CPCP		26	56,46	1,58%	1,24%
STRUCTURE/YEAR TASK	6Y R	128	492,18	7,80%	10,79%
	8Y R	87	685,32	5,30%	15,02%
	10YR	83	635,90	5,05%	13,93%
	12YR	62	594,12	3,78%	13,02%
	F/R	78	937,21	4,75%	20,54%
	YR	48	93,80	2,92%	2,06%
TOTAL		1642	4563,45	100%	100%

From Table 3. Proposed Implementation of B737-800 Maintenance Program above, if the package is divided into smaller packages in OOP-A, the 1C-Check package will be reduced from the previous 503 tasks with total manhours consuming =

406.91 to only 298 tasks with total manhours consuming = 247, 00. There is a reduction of 205 tasks and 159.91 manhours, which will then be divided into 5 small packages to be distributed to 5 outstations (KNO, SUB, BPN, UPG, DPS). Packages distribution is adjusted to the remaining capacity of each outstation. The distribution of the packages can be seen in Table 4. Split Packages per Aircraft below:

Table 4. Split Packages per Aircraft

Operation (Maintenance Packages)	Tasks per Packag e	Total Manhours consume	Total Manhours for simulation
Operation1 (OOP-A1)	38	25,96	26
Operation2 (OOP-A2)	43	31,94	32
Operation3 (OOP-A3)	42	30,09	30
Operation4 (OOP-A4)	45	36,95	37
Operation5 (OOP-A5)	37	34,97	35
TOTAL	205	159,91	160

The capacity planning for each outstation is different depending on the aircraft landing and maintenance is carried out at the station. The following Table 5. Remaining Capacity–5 Machines shows daily remaining capacity for each station. For simulation needs in the program using Genetic Algorithm, the outstation is represented by Machine.

Table 5. Remaining Capacity–5 Machines

	Shift 1	Shift 2	Shift 3	Active person per day	Effective working hours per day	Total Available Manhours per day	Average daily workload	Remaining capacity (MH)
Machine 1	4	4	4	12	7	84	55	29
Machine 2	6	6	6	18	7	126	93	33
Machine 3	2	3	3	8	7	56	24	32
Machine 4	5	5	6	16	7	112	87	25
Machine 5	6	7	7	20	7	140	99	41

3.2 Genetic Algorithm

To get the best optimization of the package's distribution, we need to create a simulation using Genetic Algorithm. To facilitate the simulation, it is necessary to create a parameter matrix based on the data presented above. The following Table 6. Flexible Job-

Shop Scheduling with 5 Jobs, 5 machines and 25 operations shows the matrix input parameters required for the simulation.

Table 6. Flexible Job-Shop Scheduling with 5 Jobs, 5 machines and 25 operations

Job (Aircraft)	Operation (package)	Number of task per package	Total Manhours consume	M1 (29)	M2 (33)	M3 (32)	M4 (25)	M5 (41)
Job1	O1,1	38	26	1	1	1	2	1
	O1,2	43	32	2	1	1	2	1
	O1,3	42	30	2	1	1	2	1
	O1,4	45	37	2	2	2	2	1
	O1,5	37	35	2	2	2	2	1
Job2	O2,1	38	26	1	1	1	2	1
	O2,2	43	32	2	1	1	2	1
	O2,3	42	30	2	1	1	2	1
	O2,4	45	37	2	2	2	2	1
	O2,5	37	35	2	2	2	2	1
Job3	O3,1	38	26	1	1	1	2	1
	O3,2	43	32	2	1	1	2	1
	O3,3	42	30	2	1	1	2	1
	O3,4	45	37	2	2	2	2	1
	O3,5	37	35	2	2	2	2	1
Job4	O4,1	38	26	1	1	1	2	1
	O4,2	43	32	2	1	1	2	1
	O4,3	42	30	2	1	1	2	1
	O4,4	45	37	2	2	2	2	1
	O4,5	37	35	2	2	2	2	1
Job5	O5,1	38	26	1	1	1	2	1
	O5,2	43	32	2	1	1	2	1
	O5,3	42	30	2	1	1	2	1
	O5,4	45	37	2	2	2	2	1
	O5,5	37	35	2	2	2	2	1

Based on matrix Table 6 above, create the structure of datasets. The following below is an example of a dataset that is used as input to genetic algorithm simulation using python.

5 5 1

5 5 1 1 2 1 3 1 4 2 5 1 5 1 2 2 1 3 1 4 2 5 1 5 1 2 2 1 3 1 4 2 5 1 5 1 2 2 2 3 2 4 2 5 1 5 1 2 2 2 3 2 4 2 5

1

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5 5 1 1 2 1 3 1 4 2 5 1 5 1 2 2 1 3 1 4 2 5 1 5 1 2 2 1 3 1 4 2 5 1 5 1 2 2 2 3 2 4 2 5 1 5 1 2 2 2 3 2 4 2 5
1
5 5 1 1 2 1 3 1 4 2 5 1 5 1 2 2 1 3 1 4 2 5 1 5 1 2 2 1 3 1 4 2 5 1 5 1 2 2 2 3 2 4 2 5 1 5 1 2 2 2 3 2 4 2 5
1
5 5 1 1 2 1 3 1 4 2 5 1 5 1 2 2 1 3 1 4 2 5 1 5 1 2 2 1 3 1 4 2 5 1 5 1 2 2 2 3 2 4 2 5 1 5 1 2 2 2 3 2 4 2 5
1
5 5 1 1 2 1 3 1 4 2 5 1 5 1 2 2 1 3 1 4 2 5 1 5 1 2 2 1 3 1 4 2 5 1 5 1 2 2 2 3 2 4 2 5 1 5 1 2 2 2 3 2 4 2 5
1
```

The first line represents the number of jobs, the number of machines and the maximum number of operations that the machine can perform in parallel. Then, there is one line per job. The first number in the row represents the number of activities or operations for this job. The second number (that we will calling $k \geq 1$) corresponds to number of combination that machines can perform the operations. Then find k pairs corresponding to the number of the machine and the duration that takes the operation, then the data for the second activity.

The steps taken for this Genetic Algorithm method using Python version 3.9.0 are as follow :

1. Input default parameters namely :
 - a. 5 Jobs
 - b. 5 machines
 - c. Machine(s) can process 1 operation at the same time.
2. Input additional parameter : population size.
3. Input additional parameter : maximum generation.
4. Perform the initial population, which corresponds to total population size.
5. Perform selection.
6. Perform random : mutation based on mutation probability (0,100) ; permutation probability (0,100) ; move probability (0,100)
7. Python will determine the efficient time for each input parameter. The parameters are population size and maximum generation.
8. Python will check if generation > maximum generation, otherwise generation = generation+1.
9. Program will continue until the generation = maximum generation.
10. If the final condition is met, the program stops and the result is the best solution in all generations.
11. Perform another simulation with different input parameter values on the population size and maximum generation.

4. RESULTS

4.1. Optimization of Task Distribution and Manpower Utilization

The simulation was carried out 6 times on different population size and maximum

generation. Based on modelling on Python version 3.9.0, the effective tasks distribution for 5 jobs (aircrafts), 5 machines (outstation) and 25 operations (maintenance packages) are 8 days. The processing time for each simulation is different. The following Figure 1. Simulation Result using Python shows the result of running various population size and maximum generation.

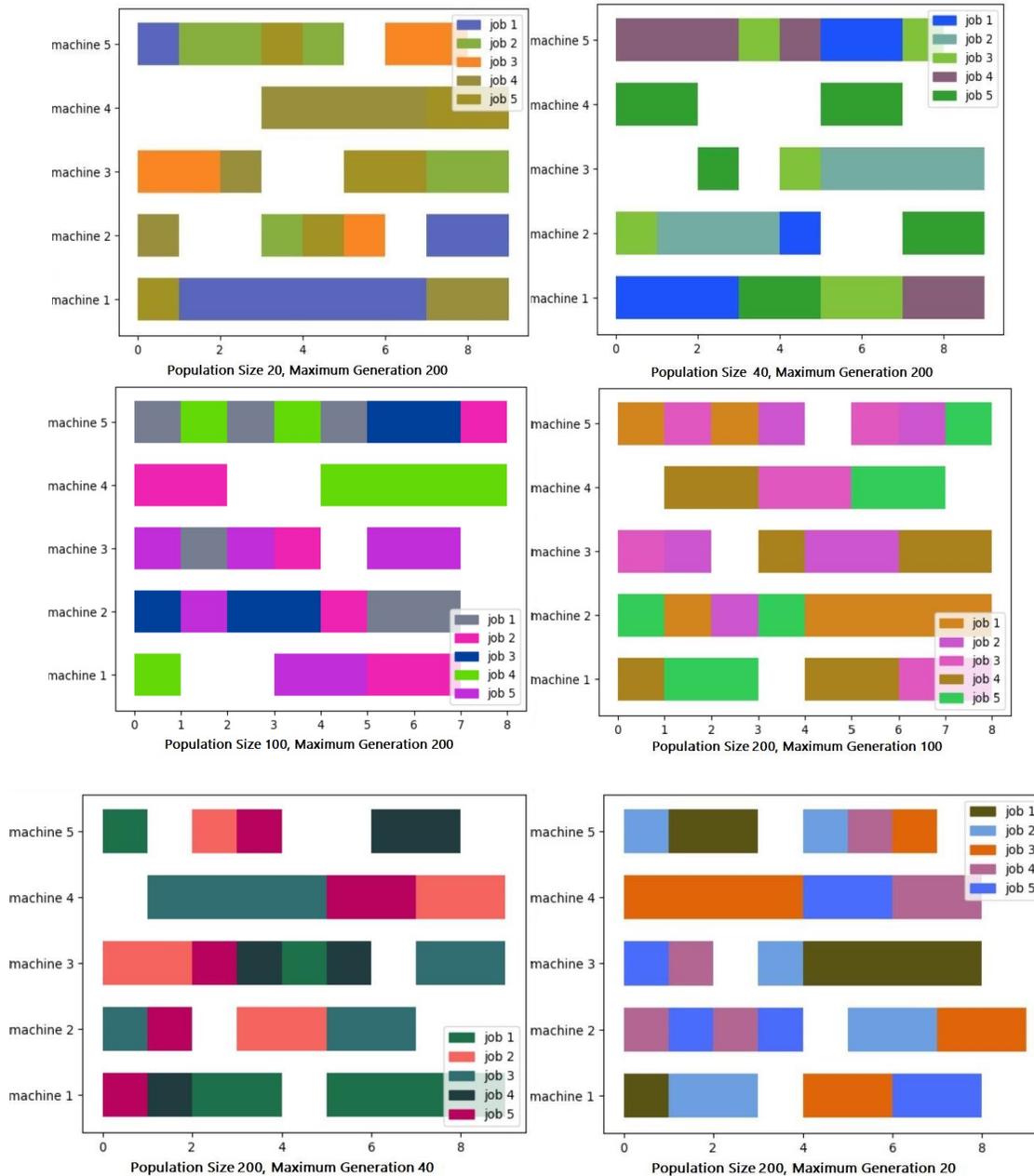


Figure 1. Simulation Result using Python

After determining the proposed parameters to improve the efficiency of maintenance program implementation, Genetic Algorithm is carried out using the

parameter values to

determine the resulting efficiency values. Performed using Python, the following values were obtained in Table 7. Task Distribution of 5 Job, 5 Machines, 25 Operations below.

Table 7. Task Distribution of 5 Job, 5 Machines, 25 Operations

Population Size	Maximum Generation	Total Processing Time	Result
20	200	8.3858486 seconds	9
40	200	9.1493656 seconds	9
100	200	32.948059 seconds	8
200	100	53.9232359 seconds	8
200	40	22.881088197 seconds	9
200	20	12.4684624 seconds	9

4.2. Proposed Improvement of Maintenance Program

The efficiency value of each aircraft registration is after the package divided into smaller packages in OOP-A, total maintenance program that will be carried out by base maintenance (at main base station) to be 1006 tasks (61,27%) with total manhours consuming = 3952,97 (86,62%), from previous 1211 tasks (73,75%) with total manhours consuming = 4112,88 (90,13%). The following Table 8. Comparison of Task Distribution shows the efficiency value obtained is 12,48%.

Table 8. Comparison of Task Distribution

Current Implementation of Maintenance Program B737-800		Line Maintenance ↑ 12,48 %
Total Line Maintenance Maintenance Program	Total Base Maintenance Maintenance Program	
431	1211	
450,57	4112,88	
26,25%	73,75%	
9,87%	90,13%	
Proposed Implementation of Maintenance Program B737-800		Base Maintenance ↓ - 12,48 %
Total Line Maintenance Maintenance Program	Total Base Maintenance Maintenance Program	
636	1006	
610,48	3952,97	
38,73%	61,27%	
13,38%	86,62%	

6. CONCLUSIONS

The optimization of manpower utilization and task distribution that is part of equalized maintenance program, is performed using Genetic Algorithm method on 5 Boeing B737-800 aircraft registrations. By calculating scheduled maintenance using this algorithm, it can be concluded that with 100 total population and 200 generation, vice versa declared more efficient for 5 jobs, 5 machines, and 5 operations with score 8, while 20 and 40 total population and 200 generation, vice versa had efficiency score 9. By implementing the equalized method, maintenance downtime for C-Check can be reduced significantly up to 6 days at main base station. Equalized Maintenance Program implementation with tasks distribution to several outstation more efficient than the aircraft maintenance performed only at main base station. The result of this study can be used as a reference for the planning department in determining and planning maintenance program. Several days reduction on the main base station which is replaced by maintenances at 5 outstation using remaining manhours, will optimize production utilization and increase aircraft availability so that aircraft can perform revenue flight segments.

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DEVELOPMENT OF COAL SUPPLIER SELECTION MODEL AND OPTIMIZATION OF COAL SUPPLY IN POWER GENERATION COMPANY

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ABSTRACT

The coal switching strategy was chosen as one of the effective way to reduce electricity production costs for power generation company. This strategy is carried out by switching the coal used with the lower caloric value coal so that fuel costs are lower. This strategy requires the company to find new supplier for new coal specifications. Due to the important role of supplier in both operational and strategic roles, making supplier selection process is a challenge. In addition, coal calorie mixing arrangements are also important to meet operational reliability and cost-saving strategies. The company must determine the allocation of coal ordered per calorie for each supplier on a monthly basis in such a way as to minimize costs but still meet requirements. This study develops a supplier selection model using the Analytic Hierarchy Process (AHP). Linear programming as an optimization method is used to solve the problem of optimizing the coal supply allocation for each period. The results showed that AHP can help decision makers to choose the appropriate supplier based on the specified criteria. Optimization of calorie mixing using a linear programming results in lower coal costs compared to using the company's existing methods.

Keywords: supplier selection, AHP, linear programming.

1. INTRODUCTION

Today's business competition in power generation companies is getting tighter. They are competing to provide electricity at lowest cost so that they can get prioritization to operate in the maximum capacity. Based on financial report of power generation company in Indonesia, fuel cost accounts for 60% of production cost. Reducing fuel cost can have a major impact on overall production cost.

Coal switching is one of strategy chosen to provide lower production cost by switching coal used from higher caloric value to lower caloric value. Lower caloric value coal has lower price so that it can directly contribute to reduce production cost. With the new coal specifications, a new supplier is needed.

Coal suppliers play important roles both in operational and strategic aspects. Their

reliable supplies can ensure the coal availability that have direct impact to the operational reliability. They also become company's strategic partners in reducing production costs which have an impact on the company's competitive advantage. High dependencies on coal suppliers as operational and strategic partners makes the selection of coal suppliers cannot be seen from price criteria alone. According to Chen and Chao (2012) supplier selection is a decision-making process that involves multi-criteria decision making. The Analytic Hierarchy Process (AHP) is a popular multi-criteria decision-making method used in supplier selection. AHP has the ability to accommodate both quantitative and qualitative criteria (Taherdoost and Brad, 2019). In this study, AHP is used in the supplier selection process, because it can accommodate complex criteria and the preferences of decision makers.

After the supplier is selected, coal supply allocation is another aspect to be considered to reduce costs. The company needs several types of coal which are mixed together to meet specifications that match the engine. Every month, they have to determine the allocation of coal ordered each type in such a way as to minimize costs but still meet requirements.

In this study, researchers built a model of selecting coal suppliers as well as optimizing coal supply allocation for each type each supplier. Supplier selection is done using Analytic Hierarchy Process (AHP) method. The supplier selection process consists of establishing criteria, criteria weighting, and assessing bids. Selected suppliers will be the input of optimization model. This model was developed using linear programming method.

2. LITERATURE REVIEW

Supplier selection is the activity of identifying, evaluating, and contracting with suppliers (Taherdoost and Brard, 2019). In supply chain management, supplier selection is the process of determining the appropriate suppliers who are able to provide goods/services with the right quality, right price, on time, and on time quantity (Singh *et al.*, 2012). Steps in supplier selection include identifying potential suppliers, collecting information from suppliers, supplier offers, and evaluating offers (Bhatt, 2016).

Stevic (2017) conducted a literature study on criteria in supplier selection. The results of the study mentioned that the main criteria used in the selection of suppliers by the researchers include financial parameters, quality, and delivery (Stevic, 2017). These criteria can be divided into more specific sub-criteria if needed (Stevic, 2017).

The process of selecting suppliers between one company and another company is different so that companies are faced with various options to determine the right method according to the product, expectations, criteria, and type of industry (Jain and Singh, 2020). To ensure fair competition between potential suppliers, Cheaitou et al (2018) stated that companies should use multiple criteria in the evaluation and selection process. This is in line with previous researches that classify the problem of selecting these suppliers as Multi Criteria Decision Making (MCDM) (Gencer and Gu, 2007); Setiyaningsih, 2015; Jain and Singh, 2020; Singh *et al.*, 2012; Chen and Chao, 2012; Bhatt, 2016; Parthiban et al., 2012; Taherdoost and Brard, 2019; Zhao and Guo, 2014).

Analytic Hierarchy Process (AHP) is popular MCDM method used for supplier selection (Govindaraju et al, 2015; Mostafa and Sharifi, 2012). Analytic Hierarchy Process (AHP) is developed by Thomas L. Saaty. AHP can convert subjective judgments into weights and ratios that are used as the basis for decisions (El-Sawalhi, Eaton and Rustom, 2007). AHP

decomposes complex problems into a hierarchy and assesses the relative importance of each criterion and compares alternatives for each criterion in order to obtain priorities or rankings of existing alternatives (Govindaraju et al, 2015).

Multi sourcing issues require companies to determine optimal supply allocation for each supplier. The goal is to minimize costs or maximize profit or in other words this problem is an optimization problem. According to (Scott *et al.*, 2015) optimization methods that can be used include Linear Programming (LP), Goal Programming (GP) for problems with multiple objectives and multiple criteria, as well as other methods such as MCDM.

Linear programming is a mathematical technique used to optimally allocate limited resources to meet demand (Chase & Jacobs, 2006). Linear programming is widely used and accepted in various industries because it is able to provide detailed information related to operations and able to optimize the process to reduce costs (Chase & Jacobs, 2006).

3. METHODS

The object of research used in this study is one of the power generation company in Indonesia. Data related to research is obtained directly (primary data) as well as data from related parties (secondary data). The research is divided into 2 (two) major stages, supplier selection and optimization of coal supply allocation. Supplier selection is done by using AHP and optimization of coal supply allocation is done by using linear programming method. Here is the flow of process diagrams for supplier selection using AHP.

The process of selecting suppliers is carried out based on the stages in the AHP. First is define the objective, construct the hierarchy of the criteria, make the pairwise comparison matrix, establish the criteria, then consistency test. After got the weight of each criteria, the next step is assessing the bid using scoring method.

After obtaining the coal supplier, the coal supply optimization process is performed. Company requires 4 (four) types of coal supplied by different suppliers. Each type is supplied by one supplier. The four types of coal are mixed to produce coal with the desired specifications. The composition of the mixture must be determined in such a way as to minimize costs but still meet requirements. Product mixing problem approach with linear programming method is used to solve this problem. The model run using LINGO *software*.

- Decision Variables

X_{ij} = Volume of coal type supplied by supplier i for month to j

where

i = supplier 1, supplier 2, supplier 3, supplier 3

j = month 1, month 2, month 3, ... month 12.

- Objective Function:

$$\text{Min } Z = \sum_{i=1}^{j=12} (C_{ij} X_{ij})$$

$$K_{min} \leq \frac{\sum_{i=1}^4 K_i X_{i12}}{\sum_{i=1}^4 X_{i12}} \leq K_{max}$$

- Subject to:

1. Calorific value to be achieved

$$K_{min} \leq \frac{\sum_{i=1}^4 K_i X_{i1}}{\sum_{i=1}^4 X_{i1}} \leq K_{max} \quad K_{min} \leq \frac{\sum_{i=1}^4 K_i X_{i2}}{\sum_{i=1}^4 X_{i2}} \leq K_{max}$$

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·
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(2)

2. Total permissible sulfur

$$\frac{\sum_{i=1}^4 T_{S_i} X_{i1}}{\sum_{i=1}^4 X_{i1}} \leq T_{Smax}; \frac{\sum_{i=1}^4 T_{S_i} X_{i2}}{\sum_{i=1}^4 X_{i2}} \leq T_{Smax} \dots \frac{\sum_{i=1}^4 T_{S_i} X_{i12}}{\sum_{i=1}^4 X_{i12}} \leq T_{Smax} \quad (3)$$

3. Monthly coal demand

$$\sum_{i=1}^4 X_{i1} \geq V_1; \sum_{i=1}^4 X_{i2} \geq V_2 \dots \sum_{i=1}^4 X_{i12} \geq V_{12} \quad (4)$$

4. Total volume contracted

$$X_{1min} \leq \sum_{j=1}^{12} X_{1j} \leq X_{1max}; X_{2min} \leq \sum_{j=1}^{12} X_{2j} \leq X_{2max}; X_{3min} \leq \sum_{j=1}^{12} X_{3j} \leq X_{3max}; \\ X_{4min} \leq \sum_{j=1}^{12} X_{4j} \leq X_{4max} \quad (5)$$

5. Suppliers supply capability

$$X_{1j} \leq Cap_1; X_{2j} \leq Cap_2; X_{3j} \leq Cap_3; X_{4j} \leq Cap_4 \quad (6)$$

6. Non negativity

$$X_{ij} \geq 0 \quad (7)$$

4. RESULTS

Supplier selection is done to determine 1 (one) best supplier that will supply coal type 4200 kcal/kg. Based on the results of weighting criteria, it is known that companies focus more on coal quality criteria compared to other criteria. From the coal quality criteria, the sub criteria of calorific value and sulfur content have the two largest weights. Calorific value is important because it has a direct impact on the generating machine, while sulfur content has a direct impact on the environment and there are regulations that must be complied.

Selected supplier has coal quality that is not the best compared to other suppliers. On the other hand, supplier A has excellent organizational management and good mine operations so as to boost the total score obtained. In addition, selected supplier is able to offer competitive prices.

Optimization is performed to determine the amount of supply for each type of coal by each supplier. Optimization of supply allocation of each supplier is done with linear programming model and solution obtained from running the model on LINGO software. The result shows that the total cost obtained from the optimal solution is IDR 2,535,749 million. When compared to the cost that generate from existing method that is IDR 2,598,392 million, the possible saving is IDR 62.65 billion or 2.4%.

5. CONCLUSIONS

The conclusions of the research on the development of supplier selection models and optimization of coal supply arrangements are as follows:

1. Coal supplier selection model has been built using AHP model as well as supplier assessment by scoring method. This supplier selection model has been able to determine the coal supplier with the appropriate specifications and the best price.
2. Optimization model using linear programming to determine the allocation of coal supply of each supplier / type of coal has been designed and can be run on Lingo software and produce optimum global solutions.
3. Optimization generates potential savings of 62.6 Billion or approximately 2.4% of the planned coal procurement costs.

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COMPARATIVE DEMAND FORECAST USING LINEAR AND NON LINEAR MODEL TO OPTIMIZE OPERATIONAL PERFORMANCE IN FURNITURE RETAILER: A STUDY IN IKEA INDONESIA

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ABSTRACT

This study was done to define the most suitable forecasting method for furniture retailer like IKEA Indonesia. This needs to be done to avoid overstock and shortage due to shift of trend on demand from market. Four demand forecast methods were used to do the experiment. The source data was sales history from 2014-2019 to forecast 2019 and 2020 of IKEA Indonesia. The simulation is done for 14 product areas in IKEA. Sampling method is using purposive sampling based on some criteria such as data completion, product category, and growth indexes. The four models used were ARIMA, SARIMA, and ETS and neural network (NN). The accuracy level of each method will be measured using 3 measures, mean absolute percentage error (MAPE), mean absolute error (MAE) and root mean squared error (RMSE). The lead of each forecasting was 6, 12, 26 and 52 weeks to define the ideal length of forecasting for every PA. The result of this study showed that every product area in IKEA Indonesia had different method of forecasting and ideal lead of time to achieve the most accurate result. The purpose of this study was to give input for furniture retailer the accurate model and lead for each PA based on the nature of products.

Keywords: Furniture retailer, Forecasting method, SARIMA, ARIMA, ETS, NN.

1. INTRODUCTION

The ability to understand customers' behaviour has become very important for businesses to be able to drive efficient operational achievement. The need for accuracy of demand prediction is increasingly considered as the key of success for enterprises to have most effective operational process. According to Danese & Kalchschmidt (2011) several decisions related to operation and financial are based on forecast of future demand. Thus, some enterprises consider forecast as important process for them to be able to have guidance on activities and decision making.

There are many type of enterprises that rely on forecast as their operational and financial planning. One of them is retailer industry. Retailer industry is often seen as one

of the industry with the most seismic condition due to the rapid change of customers' demand. According to Pantano (2014) retailers' ability to predict trends in turbulence and frequent change of customers' demand is the key issue of business success. Prediction of future demand is the base for several decisions in operation for retailers. In volatility market, high consumer valuation of the product, and an intensity of market competition, accurate forecast is valuable and important for the business. Yan & Ghose (2009) revealed that there is significant improvement in profit with the increase of forecast accuracy. This then emphasizes the importance of forecast accuracy for retailers. The sequence processes in retailers including spending decision is unquestionably based on the forecast. Thus, forecast accuracy takes critical role towards retail businesses.

IKEA Indonesia, as one of the franchisee group of Inter IKEA System BV and one of the furniture retailers in Indonesia was established in 2014. Along the journey in Indonesia, IKEA expands to reach more people in Indonesia by opening 1 ecommerce unit Cibitung, 1 small store Sentul in 2019 and 2 normal size store with capacity of 11,000 m³ for each store in November 2020 and 2021. By the end of 2021 IKEA Indonesia will grow into 3 normal size stores, 1 customer fulfillment unit and 2 small size stores. With the growth of the channels in Indonesia, it is expected that IKEA is able to translate customers' need into accurate demand supply to minimize inefficiency both in operational and financial investment such as overstock structure, capacity and operational cost. By 2021 IKEA Indonesia is going to have additional 2 normal size stores with 11,000 m³ capacity.

The model of forecasting used by IKEA is ARIMA and it is applicable for all ranges. Meanwhile the performance forecast is calculated using mean absolute percentage error (MAPE) in weekly basis. Having the same system of forecasting as global, IKEA Indonesia also uses ARIMA as the model and MAPE as the performance controller. Currently the demand forecast accuracy in IKEA Indonesia is < 85% and the overstock level is 40% of total stock. This study will focus on defining the right model of forecasting to accommodate IKEA in catering customers' demand in Indonesia. There are 4 models that is used to do experiment in the forecasting process of IKEA Indonesia.

2. LITERATURE REVIEW

Forecasting is a process to predict future trend using combination of dimensions and variables. According to Biegel (1999) forecasting is an activity to estimate the future demand of products in certain period of time. Forecasting owns certain characters and principals. Arnold and Chapman (2004) defined the main character of forecast as forecast is always wrong. Forecast is built based on historical data, expectation and assumption. Thus the error is predictable and unavoidable. However, they added that the error level should be measurable to define the confidence level of the forecast against the actual demand. Agrawal and Schorling (1996) emphasized that the accuracy of demand forecast brings critical impact in a profitable retail operation. Poor forecast accuracy impacts the stock position in either shortage or overstock which will have direct reflection in uncompetitive position in retail market and revenue.

Forecast is a combination of techniques, system, managerial approaches and measurement (Mentzer and Bienstock, 1998). Earlier, Armstrong (1987) claimed that in forecasting process there are 4 main pillars. Those are forecasting method, data available,

uncertainty analysis, benefits and result. This study will define the most accurate approach or model of forecasting for every product area for a furniture retailer.

2.1 ARIMA and Seasonal ARIMA (SARIMA) Model

Autoregressive Integrated Moving Average (ARIMA) is an optimal version of Box and Jenkins (1970). According to Brockwell and Davis (2016) there are 3 linear filters in ARIMA approach; Integration (I), autoregressive (AR) and moving average (MA). There are 2 models of ARIMA which are non-seasonal and seasonal model. The non-seasonal model of ARIMA (p, d, q) is the combination of previous observation (p), differencing (d), and previous error (q). A non-seasonal model of ARIMA can be described as below

$$(1 - \phi_p B - \dots - \phi_p B^p)(1 - B)^d y_t = c + (1 + \theta_1 B + \dots + \theta_q B^q) \varepsilon_t$$

The non-seasonal model can be extended into seasonal model of ARIMA (p, d, q) (P, D, Q)^s

Where (p, d, q) is the non-seasonal model

(P, D, Q) is the seasonal model

s is the seasonal length

In general the seasonal model of ARIMA (p, d, q) (P, D, Q)^s can be expressed as below:

$$\Phi_p(B) \Phi_p(B^s) (1 - B)^d (1 - B)^D y_t = \theta_q(B) \Theta_Q(B^s) \varepsilon_t$$

$$\Phi_p(B) = 1 - \phi_1 B - \phi_2 B^2 - \dots - \phi_p B^p$$

$$\Phi_p(B) = 1 - \phi_s B^s - \phi_{2s} B^{2s} - \dots - \phi_{ps} B^{ps}$$

$$\theta_q(B) = 1 - \theta_1 B - \theta_2 B^2 - \dots - \theta_q B^q$$

$$\Theta_Q(B) = 1 - \theta_s B^s - \theta_{2s} B^{2s} - \dots - \theta_{Qs} B^{Qs}$$

Where:

s is seasonal length (3 months, 4 months, 6 months, 12 months, etc)

B is the back shift operator defined by $B^k y_t = y_{t-k}$

ε_t is the sequence of white noise with 0 mean and constant variance

$(1-B)^d$ and $(1-B^s)^D$ are the non-seasonal and seasonal factors

2.2 Exponential Smoothing

According to Makridakis et al., (1998) the exponential smoothing method is a relatively simple but a robust model in forecasting. The model is quite famous and being used by a lot of business for demand forecasting technique. Exponential smoothing is also known as well-performed forecasting method compares to the more sophisticated methods. According to Hyndman et al., (2002) exponential smoothing was first introduced by Holt in 1957 and Winters in 1960. In their journal Hyndman et al., (2002) showed that exponential smoothing, including the linear method is an optimal forecast from innovation state space models. Furthermore, Hyndman, & Athanasopoulos (2018) defined Holt and Winters method as the combination of forecast equation with 3 components of smoothing equations. It is defined as ℓ_t is one for the level, b_t is one for the trend, s_t is one components for the seasonal corresponding to $\alpha, \beta^*,$ and γ . Also is used to define number of season within the year for example quarterly = 4 or yearly = 12. m

In Hyndman & Athanasopoulos (2018) there are two variations of Holt-Winters method. The variations is defined based on the difference of the nature of the seasonal.

1. Additive method is the method that fits to the situation where seasonal variation is

$$\begin{aligned} y_{t+h|t} &= \ell_t + hb_t + S_{t+h-m(k+1)} \\ \ell_t &= \alpha(y_t - S_{t-m}) + (1 - \alpha)(\ell_{t-1} + b_{t-1}) \\ b_t &= \beta^*(\ell_t - \ell_{t-1}) + (1 - \beta^*)b_{t-1} \\ s_t &= \gamma(y_t - \ell_{t-1} - b_{t-1}) + (1 - \gamma)s_{t-m} \end{aligned}$$

an absolute and stable terms in the series in observation and equation (Hyndman Athanasopoulos, 2018). The series is adjusted by subtracting the seasonal component with the seasonal component will be max zero. The equation for additive method is stated as below:

k is the integer part of $(h - 1)/m$ that ensures the estimates of seasonal indices used for forecasting is a data that comes from final year of the samples.

Weighted average between seasonally adjusted observations $(y_t - S_{t-m})$ with the non-seasonal forecast $(\ell_{t-1} + b_{t-1})$ for time t .

Weighted average of seasonal index is shown in $(y_t - \ell_{t-1} - b_{t-1})$

Seasonal index of the same season from last year data (m time periods)

Seasonal component is often formulated as $S_t = \gamma^*(y_t - \ell_t) + (1 - \gamma^*)S_{t-m}$

If the S_t substituted from the smoothing equation above we will get

$$S_t = \gamma^*(1 - \alpha)(y_t - \ell_{t-1} - b_{t-1}) + [1 - \gamma^*(1 - \alpha)]S_{t-m}$$

With $\gamma = \gamma^*(1 - \alpha)$ and the restriction is $0 \leq \gamma^* \leq 1$ which can be translated to

$$0 \leq \gamma \leq 1 - \alpha$$

2. Multiplicative method is a method where seasonal variation is changing proportionally in the series. In this method the seasonal component is stated in percentages and the series is seasonally adjusted by having through divided by the seasonal component. In certain period of time, the seasonal component will be defined approximately as sum of m (Hyndman & Athanasopoulos, 2018).

The equation of multiplicative method is as below:

$$\begin{aligned} y_{t+h|t} &= (\ell_t + hb_t)S_{t+h-m((k+1))} \\ \ell_t &= \alpha \frac{y_t}{S_{t-m}} + (1 - \alpha)(\ell_{t-1} + b_{t-1}) \\ b_t &= \beta^*(\ell_t - \ell_{t-1}) + (1 - \beta^*)b_{t-1} \\ s_t &= \gamma \frac{y_t}{(\ell_{t-1} + b_{t-1})} + (1 - \gamma)s_{t-m} \end{aligned}$$

According to Makridakis, et, al. (1998) exponential smoothing is a method which initially implemented without referring to a statistical framework. This then brings other approaches to be the device for certain selection problems. However, with the method that is revealed by Holt and Winters, the components of exponential smoothing can be used as the statistical framework. Prediction validation is one such approach. The validation sample is used to evaluate the forecasting capacity of a method with a criterion such as the mean absolute percentage error (MAPE).

2.3 Neural Network Models (NN)

Hyndman & Athanasopoulos (2018) mentioned that neural network (NN) is a forecasting methods that is based on simple mathematical models of the brain. NN method allows complex linear and nonlinear relationships between the response variable and its predictors. An illustration of NN model can be found Hyndman & Athanasopoulos (2018)

along with an explanation on the underlying dynamics. Neural network is the overview of how neuron works where the input/ predictor from the data base and the output layer will be the result/ the forecast.

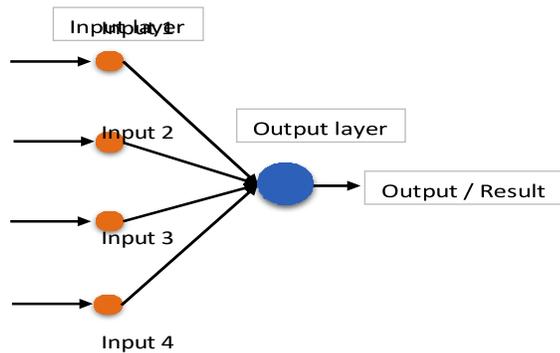


Figure 1.4 Linear Regression on Neural Network
Source: Hyndman & Athanasopoulos (2018)

The above overview shows direct connection from input to output and there is no additional hidden components in between the input and output layer. Figure 1.3 shows neural network model in linear regression version with four predictors or input. The simple model where the output is the base layer and the output or result will be the forecast is equal to linear regression. The combination of input factors or nodes (X) and the weighted linear (W) will result as the output prediction or forecast. The equation for the above overview is as below

Where:

W_1, \dots, W_m is the weighted linear in the layer

X_1, \dots, X_m is the input nodes or factor

$X_i = 1$ as the bias or fake attribute

However, if we add 1 hidden layer in between input and output the neural network method become nonlinear. The nonlinear version of neural network can be seen as below image.

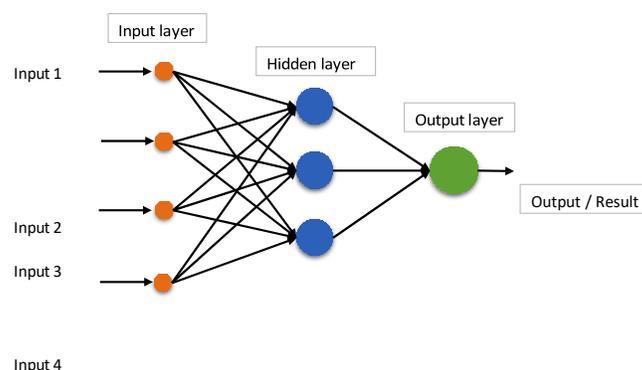


Figure 1.5 Nonlinear Regression on Neural Network
Source: Hyndman & Athanasopoulos (2018)

The above overview is known as multilayer feed-forward network (Hyndman & Athanasopoulos, 2018). In multilayer feed-forward network, every nodes receive input from the previous layer and the output from those nodes are data for the next layer. The input on every layer is combined to weighted linear combination which later will be facing another modification of nonlinear function before become result or output. In nonlinear neural network when we add j as the hidden neuron as shown in figure 1.3, the equation will be as below

$$Z_j = b_j + \sum_{i=1}^m w_{i,j} x_i$$

In the hidden layer, nonlinear function such as sigmoid is added to give input for the next layer.

$$S_z = \frac{1}{1 + e^{-z}}$$

The function is added to reduce the effect from inputting extreme value in the layer. Thus, it potentially will give a more robust result on the method. The parameter of the weight is sometimes limited to avoid the layer becoming too large. To restrict the weight the decay parameter is used and it is often to be set equal to 0.1.

2.4 Accuracy Measurement

The deviation between actual value vs forecast value is the error level of a forecasting. The equation below gives an overview of accuracy measurement in forecasting

$$e_t = Y_t - F_t$$

Where

Y = Actual value of transaction in certain period of time

F = Forecast value in certain period of time

e = is the error or deviation between actual value vs forecast value in certain period of time (t)

Harvey (1988) mentioned there are three common standard measurement to calculate forecast accuracy. Those measurement are MAPE (Mean Absolute Percentage Error), MAE (Mean Absolute Error) and RMSE (Root Mean Squared Error). The three measures are most common to be utilized as standard measures for calculating forecast accuracy and will be used in this study. To have an overview of the most frequent used measures, table 1.1 shows studies that using those measurement. This paper will use the frequent appears and those are MAPE, MAE and RMSE.

Table 1.1 Forecast Error Measures

Zhang & Qi (2005)	Co & Boosarawongse (2007)	Ali, et al (2009)	Danese & Kalchschmidt (2011)	Degiannakis, et al (2018)	Ren, et al (2020)
MAPE	MAPE	MAPE	MAPE	MAPE	MAPE

MAE	MAE	MAE			MAE
	MSE			MSE	MSE
RMSE	RMSE	RMSE		RMSE	

RMSE or Root Mean Square Error is a forecast measurement which based on the deviation of forecast vs actual, squared then divided by the number of data. The formula of RMSE is as below

$$RMSE = \sqrt{\frac{\sum_{t=1}^n (A_t - F_t)^2}{n}}$$

Where:

A_t = Actual data

F_t = Forecast

n = number of data

\sum = total of value

MAPE or Mean Percentage Absolute Error is a measurement that based on the error percentage of the absolute deviation between actual vs forecast. Currently IKEA Indonesia uses MAPE as the base of accuracy measurement of forecasting. The formula of MAPE is as below

$$MAPE = \frac{\sum_{t=1}^n \left| \frac{A_t - F_t}{A_t} \right| * 100\%}{n}$$

Where:

A_t = Actual

F_t = Forecast

n = number of data

The error in MAPE is absolute number so regardless the error is minus, MAPE still shows positive percentage of error.

MAE or Mean Absolute Error is the simplest way of measuring error in a forecast. MAE is the average deviation of actual vs forecast. The formula of MAE is as below

$$MAE = \frac{\sum_{t=1}^n |A_t - F_t|}{n} \qquad \sum_{i=1}^n W_i X_i = W \cdot X$$

Where:

A_t = Actual

F_t = Forecast

n = number of data

3. METHODS

The design of this study will be quantitative – descriptive. The choosing of quantitative – descriptive is because this study will define the most suitable forecast

method in retail furniture by retrieving history data of 2014-2018 for 14 types of PA and apply it in each method to forecast 2019-2020 sales. Then using 2019-2020 actual sales data to be the valuation of accuracy. The type of demand forecast method is chosen from the robust methods that are used during crisis situation in the past.

The technique of sampling used in this study is purposive sampling. According to Sugiyono (2016) non probability sampling is a technique of sample taking where every aspect in the sampling cannot get the equal opportunity to be samples. There were some criteria set on the purposive sampling for this study such as missing data, range changes, minus sales indexes, and slow moving PA. The criteria was based on impact and phenomenon of the product type of IKEA Indonesia. Final sample data taken were 14 product areas out of 182 PA from actual sales data from 2014 – 2020.

The data analysis steps followed Ozcan (2005) where a forecast application is divided into 5 major steps. Ozcan (2005) defined the breakdown detail of forecast steps as below:

1. Defining purpose of the experiment. The experiment was done to define what model of forecast most suitable for each PA and in which length of interval.
2. Establishing time horizon. The nature of time horizon is the increase of time horizon will result in decrease accuracy level. The period taken for this experiment was 6, 12, 26 and 52 weeks of forecasting
3. Selecting models. This experiment used 4 models (ARIMA, SARIMA, ETS, and NN). The tools were chosen to do experiment were Minitab and Matlab.
4. Conducting experiment in each model by following the steps required for each model such as data transformation, differential, data smoothing, data training,
 - ARIMA: Plotting → Box-cox transformation → ACF → Differencing (if data is not stationer) → ACF, PACF → Trial to define parameters → P-Value and Ljung box checking → forecast experiment with 6, 12, 26 and 52 lead → accuracy measurement using RMSE, MAPE, and MAE
 - SARIMA: Plotting → Box-cox transformation → ACF Differencing (if data is not stationer) → ACF, PACF → Seasonal differencing → Seasonal ACF, PACF → Trial to define parameters → P-Value and Ljung box checking → forecast experiment with 6, 12, 26 and 52 lead → accuracy measurement using RMSE, MAPE, and MAE
 - ETS: Data plotting → smoothing constant defining → choosing models based on data plotting (multiplicative/ additive) → forecast experiment with 6, 12, 26 and 52 lead → accuracy measurement using RMSE, MAPE, and MAE
 - ANN: Data transformation → Data transpose → Data trial and testing → Regression checking → forecast experiment with 6, 12, 26 and 52 lead → accuracy measurement using RMSE, MAPE, and MAE
5. Determining accuracy and concluding.

4. RESULTS

The result of the study shows that every product area had different most robust forecasting model and lead. The criteria of robust was measured by the lowest RMSE, MAPE and MAE. The validation of accuracy was against the actual sales of 2019. The forecast final parameter of ARIMA and SARIMA *P-Value* <0.00 while the control from

Table 1.3 Forecast experiment result 2020 (pandemic situation)

Product Area	Models	Lead					
		6 lead 2020			6 lead 2019		
		RMSE	MAPE	MAE	RMSE	MAPE	MAE
Chest of drawer	SARIMA (0,1,1)(0,1,1) ¹²	230.72	39%	221.59	132.19	15%	110.76
	ANN backpropagation	365.04	27%	229.77	54.08	4%	34.04
Bathroom small furniture	ARIMA (1,1,1)	84.21	4%	57.20	107.26	8%	98.87
	SARIMA (1,1,1)(1,1,1) ¹²	137.25	5%	90.21	124.06	10%	122.61
	ANN backpropagation	80.92	5%	52.90	48.55	3%	31.74
Kitchen wall organisers	SARIMA (1,1,1)(1,1,1) ⁵	17,516.19	131%	16,981.00	2,148.90	13%	1,782.57
	ANN backpropagation	3,160.21	18%	2,316.16	1,228.97	7%	900.73
Chairs incl covers, folding	ARIMA (1,1,2)	388.88	13%	354.74	238.66	12%	219.86
	SARIMA (0,1,1)(0,1,1) ⁴	535.08	19%	487.11	284.31	15%	259.91
	ANN backpropagation	386.84	9%	338.18	171.93	4%	150.30
Toys for small children	ANN backpropagation	2,448.63	25%	1,371.40	783.56	8%	438.85
Floor lamp	ARIMA (1,1,1)	59.80	6%	49.07	166.78	17%	131.98
	SARIMA (1,1,1)(1,1,1) ⁶	73.73	9%	64.91	140.58	15%	110.95
	ANN backpropagation	57.93	7%	45.65	107.59	13%	84.77
Duvet covers	ANN backpropagation	113.38	9%	93.15	27.94	2%	17.45
Pots and cooking acc	ANN backpropagation	339.77	7%	282.21	388.31	8%	322.52
Food containers	ARIMA (1,1,1)	837.83	9%	692.99	1,082.62	11%	818.42
	SARIMA (1,1,1)(1,1,1) ⁹	1,005.45	10%	805.98	1,170.01	11%	847.31
	ANN backpropagation	1,609.17	19%	1,137.10	506.81	5%	408.36
Dinnerware	ANN backpropagation	2,244.38	13%	1,843.85	1,553.80	9%	1,276.51
Vases, bowls and accessor	ANN backpropagation	935.95	26%	861.78	719.96	20%	662.91
System cabinet	ANN backpropagation	321.35	18%	190.27	303.50	17%	179.70
Bathroom accessories	ANN backpropagation	941.42	15%	836.26	502.09	8%	446.01
Accessories for baby	SARIMA (1,1,1)(1,1,1) ⁶	6,717.16	53%	6,471.27	1,688.26	17%	1,257.98
	ETS additive	8,101.85	62%	7,291.68	1,607.61	17%	1,495.77
	ANN backpropagation	5,724.34	28%	2,851.71	1,022.20	5%	509.23

6. CONCLUSIONS

Refer to Table 1.2 SARIMA (0, 1, 1)(0, 1, 1)¹², ANN backpropagation was most accurate for chest drawers. While ARIMA (1, 1, 1), SARIMA(1, 1, 1)(1, 1, 1)¹², and ANN backpropagation were robust for bathroom small furniture. SARIMA (1, 1, 1)(1, 1, 1)⁵ and ANN backpropagation were suitable for kitchen wall organizer. On the other hand ARIMA (1, 1, 2), SARIMA (0, 1, 1)(0, 1, 1)⁴, and ANN backpropagation were robust for dining chair incl covers. Toys for small children was only robust when forecasted using ANN backpropagation. While for floor lamp the product was more stable and not sensitive as ARIMA (1, 1, 1), SARIMA (1, 1, 1)(1, 1, 1)⁶, and ANN backpropagation were relevant for the product. Duvet covers, pots and cooking, dinnerware, vases and bowls, system cabinet, and bathroom accessories were product area where only ANN backpropagation was resulting accurate forecast. While for food containers ARIMA (1, 1, 1), SARIMA (1, 1, 1)(1, 1, 1)⁹, and ANN backpropagation were most accurate. The last one was accessories for baby with SARIMA (1, 1, 1)(1, 1, 1)⁶, ETS, and ANN backpropagation were suitable. The result showed that ETS only accurate for 1 PA and ANN backpropagation was most accurate for almost all PAs. All of the models above were the model with lowest error measurement.

Every PA had their own model of forecasting to achieve robust forecasting. There was

different results shown in table 1.2 when robust models were used to forecast 2020 (refer to table 1.3). This then can be reference for future study where there were phenomenon of demand changing of furniture in Indonesia during pandemic situation. It was not coping all type of product areas which means the buying power of customers was still strong but their preference and demand moved to different product areas during

pandemic. Some product areas *like chest of drawers, kitchen wall organizer, toys for small children and accessories for baby* showed significant difference in term of errors. The errors increased significantly. This showed that there was a demand change from market that data history and robust forecast models during normal condition were not relevant anymore to be used during pandemic for some PA. This to give overview for operation and sales team in furniture retail business to do assessment and built the forecast not only based on the history data. On the other hand, product areas like *bathroom small furniture, kitchen accessories, dining chairs, floor lamp, duvet covers, pots & cooking accessories, food containers, dinner ware, vases & accessories, system cabinet, bathroom accessories* both data 2015-2019 and forecast models were still relevant. This then brought interesting phenomenon why for some product areas data history of 2015-2019 were still relevant along with the models but not for some others product areas.

For time horizon of forecasting, each product area were owned different time horizon of forecasting to be able to achieve robustness but based on the result of the experiment referred to table 1.2, the results were most accurate when the time horizon was 6-12 weeks for forecasting. For reporting purposes MAPE is still acceptable. However, for operational purpose, in term of capacity preparation, sales planning or sales steering strategy, considering that RMSE shows the quantity of error and the weighting of each error in every week or time interval is recognized, RMSE is more suitable and relevant for operation especially supply chain team in IKEA Indonesia.

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ANALYSIS PROBABILITY THE USE OF BIKE TO SUPPORT MASS TRANSPORTATION BASED ON COMMUTER TRAIN

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ABSTRACT

A sustainable transport system became one of the embodiments of an environmentally friendly city. One way to do this is by choosing a more eco-friendly transportation system, such as trains and bicycle. During the COVID-19 pandemic, cycling has become a trend in Indonesia and even throughout the world. To attract public interest in using bicycles as a station access mode, a better understanding is needed and following the characteristics of a commuter train passenger to knowing the associated correlates. The method used in this research is the distribution of questionnaires using the Stated Preference technique. Primary data is then processed using binary logistic regression to obtain probability values. The probability of using a bicycle are affected by age, 2-wheels vehicle ownership, and frequency of use the commuter train with a probability value is 11%.

Keywords: bicycle, commuter train, probability, binary logistic regression

1. INTRODUCTION

Increasing the use of motorized vehicles can cause congestion. The Surabaya city government has made many efforts to reduce congestion, some of them are widening roads and built the frontage road. But, Hymel (2019) stated that wider highways increase traffic speeds and reduces the time cost of driving, thereby inducing additional vehicle travel. Another effort by the Surabaya city government to reduce congestion is to develop public transportation services. To increase people's desire to move from private vehicles to public transportation modes, the city government held school buses, Suroboyo Bus, and Joyoboyo Terminal Revitalization. However, the operation is still not optimal. This can be seen from the lack of passengers who use these facilities to meet their needs as public transportation.

Currently, sustainable construction is being heavily publicized. One of them is an environmentally-friendly transportation system. Sulistyono et al (2011) mentions A sustainable transportation system is a transportation system that can accommodate as much accessibility as possible with a minimum of negative impacts. A sustainable transportation system is also one of the manifestations of an environmentally friendly city. One way is to choose a more environmentally friendly means of transportation, such as trains and bicycles. During the

COVID- 19 pandemic, cycling has become a trend in Indonesia and even throughout the world. The increase in bicycle sales doubled when compared to the months before the pandemic (Sukmana, 2020).

Based on the official website of the Surabaya city government, "Bangga Surabaya" not only provide Bike Sharing Gowes services, but the Surabaya Transportation Office will also provide bicycle parking facilities. The location is also at several strategic points in the city of Surabaya. Among them are transportation nodes and other public transportation, government offices, parks, parking buildings, terminals, bus stops, and public facilities. For the first stage, the Surabaya Transportation Office has prepared 25 bicycle parking locations spread across several points in Surabaya. The facility can be used as a feeder for commuter train users.

From related problems about sustainable transportation and congestion, it is necessary to do research that can be a recommendation in optimizing the feeder system. Research related to the analysis of the probability of using bicycles as a support for mass transportation based on commuter trains at Gubeng Station. This research uses binary logistic regression analysis to get the probability value of commuter train passengers who will use bicycles.

2. LITERATURE REVIEW

Button and Rietveld (1999) concluded rail transport is an environmentally friendly alternative to the use of the plane or the car for a broad range of occupancy rates and technologies used. Few Studied have explored willingness to move from motor vehicles to train. The factors that affect willingness to move are age, gender, income, ticket prices, travel intent, and travel time (Nurdiansyah and Widyastuti, 2015; Soimun and Widyastuti, 2018; Leliana and Widyastuti;2019). Rietveld (2000) mentions one of the reasons why the train is often not chosen as an alternative journey related to the accessibility of the railway station. Both at the end of the house and the end of the travel activity, people face the problem of how to get to the railway station. Kager et al. (2016) had opinion cycling and public transport can have a symbiotic relationship forming a hybrid, distinct transport mode, which should be reflected in transport planning. Bicycles are one means of transportation that can soften the rigid nature of public transportation and accommodate various needs and individual travel situations. Souza et al (2017) concluded in the Netherlands, the use of bicycles is used as feeder transportation in addition to being the main transportation. The system has proven successful in facilitating round trips for commuter train users in terms of distance traveled. According to Keijer and Rietveld (2000), for train passengers who want to contribute to realizing sustainable transportation, they can use several alternatives, namely renting bicycles available at the railway station, having two bicycles to park at the origin and destination railway stations, and bicycle is taken with train. Several major cities in Indonesia support sustainable transportation by building bike lanes and bike-sharing facilities. Ummah (2019) concluded that Indonesians still have difficulty implementing cycling transportation due to several factors, namely the lack of bike lanes, lack of public awareness of healthy and environmentally friendly transportation, limited access to cycling, the level of safety for bicycle users because motor vehicle users use bike-only lanes, as well as the weather in Indonesia that tends to be hot. Sherwin and Parkhrust (2010) mentions that increased use of bicycles in urban environments could be achieved by combining bicycle and rail

transportation. Weliwitiya et al. (2019) have examined the influence of demographic variables, station characteristics, and built-in environments in improving bicycle access to Station. This study was conducted to determine the probability of using bicycles as a support for the train in Surabaya. The following section outlines the method adopted in this research.

3. METHODS

The methods used in this research include problem identification, problem formulation, literature study, questionnaire preparation, sample size determination, data collection (primary and secondary data), and data analysis. Identification of the problem is the initial stage carried out in this study. At this stage the determination of the problem is carried out, the road conditions in Surabaya are increasingly congested and air pollution is getting worse every year. Literature study is the search and collection of references in research that is used as a theoretical basis at each stage of the research. Calculation formulas and the results of previous research are collected, which will later be used as a reference in conducting research. Making a questionnaire using a preference statement technique (Soimun and Widyastuti, 2018).

Determine the number of samples using the Slovin formula (Taherdoost, 2016). The population in this study is the number of passengers on the Surabaya – Pasuruan roundtrip commuter train in 2021 as many as 19,119 people (PT. Kereta Api Indonesia Daop 8 Surabaya). To determine the number of samples used with the following calculations:

$$n = \frac{N}{1 + Ne^2}$$

Where,

n : minimum number of samples

N : total population of commuter train passengers

e : error margin = 10% (the maximum error that can be tolerated)

$$n = \frac{19119}{1 + 19119 \times 0,1^2}$$

$$n = 100 \text{ sample}$$

To anticipate the occurrence of invalid data, then taken > 100 samples. In this study, the total number of samples was 116 respondents.

Data collection was carried out by distributing questionnaires and direct interviews with commuter train passengers. Interviews were conducted at Gubeng Station Surabaya and on commuter trains. From the questionnaire survey results and interviews, the next stage is the analysis of general characteristics, socioeconomic, and commuter train passenger travel characteristics in the form of descriptive analysis of personal data of passengers obtained from interview surveys on respondents. The data include gender, age, level of education, occupation, income (based on Surabaya minimum wage in 2021 amounting to Rp. 4,300,479,-), number of family dependents, number of motorized vehicle ownership, origin and destination of travel, train station of origin and the destination, the purpose of the trip, the frequency of use of the commuter train, the mode used when going to and leaving the station, and costs incurred when going to and leaving the station.

Binary logit regression analysis is used to determine the probability percentage of respondents willing to use bike sharing facilities. In addition, binary logit regression analysis can also determine the factors that can influence respondents to be willing to use bike sharing

facilities. To estimate the probability value of using bike-sharing facilities, it can be calculated using the following formula (Soimun and Widyastuti, 2018; Leliana and Widyastuti, 2019):

$$\text{Logit } (p) = \ln[p/(1-p)] = \beta_0 + \beta_1 X_1$$

Where: $\beta_0 + \beta_1$ = Binary data is the dependent variable with two responses, willing to use bike sharing facility (0) or not willing to use bike sharing facility (1). (X) = Is an independent variable the influence factor in the availability use the bike-sharing facilities. After this calculation

is complete, the exponential value (exp) is obtained, which will be used to calculate the estimated probability value using the formula (Soimun and Widyastuti, 2018; Leliana and Widyastuti, 2019) as follows:

$$P = \frac{\exp^{\text{logit } (p)}}{1 + \exp^{\text{logit } (p)}}$$

Determination of the influencing factors between the independent and dependent variables can be determined by comparing the significant value, namely if the value of sig. < α , with a tolerance value of $\alpha = 5\%$. Then the variable affects, but if the value of sig. > α then the variable does not affect. The implementation of the binary logistic regression calculation is carried out using the SPSS program.

Using the stepwise method when running in SPSS programs. This stepwise method is used when we have many independent variables. Marija (2006) stated this stepwise method will automatically eliminate independent variables that are not statistically significant. The steps that must be taken are to formulate a hypothesis:

1. H_0 = there is no relationship between the independent variable and the dependent variable
2. H_1 = there is a relationship between the independent variable and the dependent variable

The control of the results of this analysis is to pay attention to the aspect of Sig (Pvalue) < 0,05:

1. Reject H_0 if sig. (Pvalue) > 0,05
2. Accept H_1 if sig. (Pvalue) < 0,05

The conclusions that can be drawn from this test are:

1. If H_0 accepted, suggested there is no significant relationship between the variables
2. If H_0 rejected, suggested there is significant relationship between the variables

If we have analyzed the significance of each variable, then look at the goodness of fit of the logistic regression model equation whether it has met the requirements to interpret the dependent variable (Y) or not. Some of the conditions that must be considered in the goodness of fit are:

1. Sig. Omnibus Test (Pvalue < 0,05) Hypothesis:
 H_0 = Independent variables simultaneously do not affect the model
 H_1 = Independent variables simultaneously affect the model
2. Sig. Hosmer and Lemeshow Test (Pvalue > 0,05)

H_0 = The logistic regression model is unable to explain the relationship between variables

H_1 = The logistic regression model is able to explain the relationship between variables

4. RESULTS

The result of data processing can be obtained information base on the result of calculations with the path analysis model as follows.

A. Characteristics of Respondents

Demographic Data

Demographic data consists of gender, age, and education. The survey results show that women dominate commuter train users by 54% and men by 46%. The age of commuter train users is 19-30 years (45%) and the minimum is >55 years (2%). The level of education commuter users is obtained at the undergraduate level (45%) and the least at the elementary level (1%). The distribution of respondent's demographic data can be seen in **Table 1**.

Table 1. Demographic Characteristics of Respondents

Variable	Code	Description	Percentage
Gender	1	Man	46%
	2	Woman	54%
Age	1	< 19 years old	7%
	2	19 - 30 years old	45%
	3	31 - 45 years old	33%
	4	46 - 55 years old	12%
	5	> 55 years old	2%
Level of Education	1	Elementary	1%
	2	Junior High School	2%
	3	Senior High School	43%
	4	Diploma	10%
	5	Bachelor	45%

Socioeconomic Data

Socio-economic data consists of the respondent's current occupation, monthly income, number of family dependents, 4-wheels vehicle ownership, and 2-wheels vehicle ownership. The survey results show that jobs for commuter train users are private sector (39%) and the least is state-owned companies (2%). The income of commuter train users is obtained at the most by the minimum wage (40%) and at least > the minimum wage (21%).

Table 2. Socioeconomic Characteristics of Respondents

Variable	Code	Description	Percentage
----------	------	-------------	------------

Occupation	1	Not Working	7%
	2	Students	26%
	3	Civil Servants	7%
	4	Private sector	39%
	5	State-owned Companies	2%
	6	Housewife	10%
	7	Self-employed	5%
	8	Others	6%
Monthl y Income	1	< Minimum wage	39%
	2	Minimum wage	40%
	3	> Minimum Wage	21%
Number of Family Dependant s	1	No one	59%
	2	1 person	14%
	3	2 person	7%
	4	> 2 persons	20%
4-wheels vehicle ownershi p	1	No one	72%
	2	1	25%
	3	2	1%
	4	Others	2%
2-wheels vehicle ownershi p	1	No one	11%
	2	1	45%
	3	2	25%
	4	Others	20%

The number of family dependents is obtained at most no dependents. The number of family dependents obtained at the most did not have family dependents (59%) and the least had family dependents as many as 2 people (7%). The number of 4-wheels ownership commuter train users is obtained at the most not having 4-wheels vehicles (72%) and having at least two 4-wheels vehicles (1%). 2-wheels ownership is obtained at most having one 2-wheels vehicle (45%) and at least don't have 2-wheels vehicle (11%). The distribution of respondent's socioeconomic data can be seen in **Table 2**.

Travel Characteristics Data

The travel characteristics data consists train station of origin and the destination, the purpose of the trip, the frequency of use the commuter train, the vehicle when towards and leaving the station. The survey results show that the commuter train users travel intention is mostly for recreation/tourism (41%) and the least is for other categories such as going to the hospital (2%). The frequency to use the commuter trains is the largest in the uncertain category, in one year no more than 3 trips (36%) and the fewest who use commuter trains once a month (4%). The vehicle used when getting to the station is mostly private motorbike (61%) and the least is online taxi (3%). The mode used when leaving the station are mostly private motorcycle (32%) and the least are private cars and public transportation (7%). The distribution of respondent's travel characteristics data can be seen in **Table 3**.

Table 3. Travel Characteristics of Respondents

Variable	Code	Description	Percentage
Purpose of The Trip	1	Working	15%
	2	Family Business.	26%
	3	Destination	41%
	4	Study	16%
	5	Others	2%
Frequency of Use the Commuter Train	1	Weekend	23%
	2	Weekday	7%
	3	Once a week	16%
	4	Once a month	4%
	5	Uncertainly	36%
	6	Others	14%
Vehicle Towards the Station	1	Walking	5%
	2	Ojek Online	21%
	3	Taxi Online	3%
	4	Motorcycle	61%
	5	Private Cars	5%
	6	Public Transportation	5%
Vehicle Leaves the Station	1	Walking	10%
	2	Ojek Online	25%
	3	Taxi Online	20%
	4	Motorcycle	32%
	5	Private Cars	7%
	6	Public Transportation	7%

B. Analysis of The Availability Using Bike Sharing Facilities Based on Characteristics

The survey results obtained as many as 116 respondents. Of the total sample availability using bike-sharing facilities, 75 respondents or 65% are willing to use bike-sharing facilities. The remaining 41 respondents or 35% are not willing to use bike-sharing facilities.

Analysis of the availability using bike-sharing facilities based on the characteristics with multivariate testing, where all the variables are inserted parallel to determine correlations relationship between the independent variable and the dependent variable. Mardhiati (2018) stated this modeling aims to obtain a consisting model of several independent variables that are considered the best to predict the occurrence of the dependent variable. Dependent variable (availability to using bike-sharing facilities) and independent variable (gender, age, level of education, occupation, income number of family dependents, number of motorized vehicle ownership, the purpose of the trip, the frequency of use of the commuter train, the vehicle when towards to and leaving the station, and cash rent). The results of the binary logistic analysis can be seen in **Table 4**.

Based on the binary logistic analysis results in table 4, step 3 shows that there are three variables whose values are sig. (P-value) < 0.05, i.e., age, 2-wheels vehicle

ownership, and frequency. The next analysis is to check the goodness of fit, it can be seen in **Table 5** and **Table 6**. Based on the Omnibus Test of Model Coefficients results on table 5, step 3 revealed that logistic regression results are known to be sig. $0.042 < 0.05$, which means that the independent variables simultaneously affect the model.

Based on the Hosmer and Lemeshow Test results on table 6, step 3 revealed that logistic regression results are known to be sig. $0.272 > 0.05$, which means that the independent variables are able to explain the model.

According to the table 4, The massive influence is indicated by the value of Exp (B) or also called Odds Ratio (OR). The independent variable of age has a large OR value than the other variables. This means that the availability to use bike-sharing pays more attention to age than the other variables.

Table 4. SPSS Results from Multivariate Binary Logit Regression

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1 ^a	Frequency	.301	.117	6.656	1	.010	1.352
	Constant	-2.057	.616	11.149	1	.001	.128
Step 2 ^b	2-wheels vehicle ownership	-.569	.240	5.629	1	.018	.566
	Frequency	.307	.121	6.392	1	.011	1.360
	Constant	-.676	.828	.666	1	.414	.509
Step 3 ^c	Age	.498	.250	3.974	1	.046	1.646
	2-wheels vehicle ownership	-.735	.261	7.917	1	.005	.480
	Frequency	.325	.126	6.630	1	.010	1.384
	Constant	-1.595	.958	2.772	1	.096	.203

a. Variable(s) entered on step 1: Frequency.

b. Variable(s) entered on step 2: 2-wheels vehicle ownership.

c. Variable(s) entered on step 3: Age.

Table 5. Omnibus Test of Model Coefficient from SPSS

		Chi-square	df	Sig.
Step 1	Step	7.241	1	.007
	Block	7.241	1	.007
	Model	7.241	1	.007
	Step	6.065	1	.014

Step 2	Block	13.306	2	.001
	Model	13.306	2	.001
Step 3	Step	4.149	1	.042
	Block	17.455	3	.001
	Model	17.455	3	.001

Table 6. Hosmer and Lemeshow Test from SPSS

Step	Chi-square	df	Sig.
1	5.122	4	.275
2	15.671	8	.047
3	8.734	7	.272

The B value is the natural logarithm, also known as the slope value, a constant or regression coefficient used by the Y equation. The positive and negative values in this B value are the level of relationship or influence with the availability of commuter train passengers to use bike sharing facilities. For example, the age variable has a B value of 0.498. This figure implies that the older the age (X), the probability of availability (Y) will increase by 0.498 times. Because the regression coefficient is positive, it can be said that age (X) has a positive effect on the probability of using bike-sharing. From table 4, the following equation is obtained.

The results of the logit equation are then entered into the probability calculation formula.

$$\text{Logit}(p) = \ln \frac{p}{1-p}$$

$$\text{Logit}(p) = \beta_0 \pm \sum_{k=1}^p \beta_k X_k$$

$$\text{Logit}(p) = -1,595 + (0,498)_{\text{Age}} + (-0,735)_{2\text{-wheels ownership}} + (0,325)_{\text{Frequency}}$$

$$Y = -1,595 + (0,498)_{\text{Age}} + (-0,735)_{2\text{-wheels ownership}} + (0,325)_{\text{Frequency}}$$

$$Y = -1,595 + 0,498 - 0,735 + 0,325$$

$$Y = -1,507$$

$$\text{Logit}\left(\frac{p}{1-p}\right) = Y$$

$$\text{Logit}\left(\frac{p}{1-p}\right) = -1,507$$

$$p = \frac{\exp(y)}{1 + \exp(y)}$$

$$p = \frac{\exp(-1,507)}{(1 + \exp(-1,507))}$$

$$p = 0,181 \approx 18\%$$

From the calculation, it can be seen that people with age <19 years category, who don't have 2-wheels vehicle, and travel every day have probability as 18% (logit p) of using a bicycle as support for mass transportation based on commuter train. Continued processing based on variable data to get the average value of the probability level of users of bike-sharing facilities. The results of the processing are shown in **Table 7**.

Table 7. Probability Level Results

Number of Respondent	Age	2-wheels ownership	Frequency	Logit P	Probability
1	2	2	2	-1,42	0,195
2	2	2	6	-2,07	0,112
3	3	3	2	-2,31	0,091
4	2	2	4	-2,07	0,112
5	2	2	4	-2,07	0,112
6	2	2	4	-2,07	0,112
7	2	3	4	-2,80	0,057
8	2	2	4	-2,07	0,112
9	2	2	2	-2,07	0,112
10	3	2	3	-1,57	0,172
11	4	4	6	-2,54	0,073
12	2	2	2	-2,07	0,112
13	3	3	4	-2,31	0,091
14	2	1	4	-1,33	0,208
15	5	1	6	0,16	0,540
⋮	⋮	⋮	⋮	⋮	⋮
116	2	4	4	-3,54	0,028
Total					13,098
The Average Value of the Probability					11%

From the results of table 7, it is obtained that the average of all probabilities of using a bicycle as support for mass transportation based on a commuter train is 11% (the average of all probabilities).

6. CONCLUSIONS

From the interview survey results of commuter train users at Gubeng Station, 116 respondents were found. Of the 116 respondents who stated their willingness to use bike sharing facilities, 65%. From the probability analysis results with the help of the SPSS program, the result is a large percentage of the probability of commuter train passengers who will use bicycles as a transit mode at Gubeng Station is 11%. The factors that influence the characteristics of respondents in the availability of using bicycles as a mode of transit at Gubeng Station are age, 2-wheels ownership, and frequency. The older of the age, the probability of availability will increase. A growing number of 2-wheels ownership, the probability of availability will

decrease. More frequently of using commuter trains, the probability of availability will increase.

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Parallel Session 1

Room C (09:50 - 11:20)

Moderator:

Category: Simulation and Optimization

FACTORS THAT INFLUENCE THE SERVICE PROVIDER FAILURE IN E-PROCUREMENT PROCESS IN THE MINISTRY OF AGRARIAN AFFAIRS AND SPATIAL PLANNING/NATIONAL LAND AGENCY

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ABSTRACT

The providers selection for consultants works is carried out through electronic procurement (E-Procurement). To discover the consultant service providers failure and factors which influenced the failures in the e-procurement is important. The failure factors used based on literature review are planning and management, policy and regulations and technology standard. Partial Least Square (PLS) is analytical method for model fit assessment between the failure factors which is suitable for this research. The primary data is obtained by distributing questionnaires to consultants who have been participating in the e-procurement process at the Ministry of ATR/BPN Regional Office of East Java. The purpose of this study are to discover and find the most dominant factors that influence the failure of contractor or consultant service providers in electronic procurement. Planning and management factors have positive value but do not have significant effect on technology standard factors (1.291). It means that the worse planning and management value, the more inefficient standard technology in e-procurement will be. The technology standard factors has positive value and significant influence on policies and regulation factors with value 3.230. In addition, policies and regulation factors have positive influence on auction failure in consulting project with value 1.098.

Keywords: Construction, Failure Factors, Partial Least Square, Electronic Procurement (Eprocurement).

1. INTRODUCTION

The government goods and services procurement system are activities that take advantage of advances in information and communication technology through the government's electronic procurement system (e-Procurement). The auction of goods and

services electronically (e- procurement) will increase transparency, improve the efficiency level of the procurement process, support the monitoring and audit process and also fulfill the need for real time access to information. Thus, clean and good government in the procurement of government goods and services will be created and turned to healthy competition among businesses.

In practice, several problems occurred in e-procurement, one of which is the failure to participate in the auction of goods and services at the ministry of ATR/BPN East Java regional office. Auction failure is an event that results in re-evaluation, resubmission of bidding documents, termination of the process or auction/selection/re-election declared by the ULP, PA/KPA working group or the minister/institution leader.

Based on several procurement failures experienced by auction partners in the e-procurement process, further analysis is needed for the causes of this failures. There are various of failure caused by service providers. There are various causes of failure by service providers. The factors causing the failure studied were investigated based on literature review, namely Planning& management, Policy and regulations, and Technology standard.

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 identification of the most dominant factors causing failure. Modeling the relationship between factors based on substance theory. The expected results of this study are to identify influenced failure factors of consultant service providers in electronic auctions, understand the most dominant causes of failure, and beneficial for stakeholders in order to anticipate losses occurrence sooner in e-procurement activities at the ministry of ATR/BPN East Java regional office.

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

- Identify the factors that can affect the failure of service providers in e-procurement activities.
- Knowing the relationship between the factors causing the failure of the auction and how much influence it has on the failure of the auction in the ministry of ATR/BPN East Java Regional Office.

2. RESEARCH FRAMEWORK

2.1 Electronic Procurement of Goods and Services (E-Procurement)

The interaction between the government and the community in the process of procuring government goods and services requires an optimal, effective, and efficient service system. E- Procurement is the procurement of goods and services carried out using information technology and electronic transactions in accordance with the provisions of the legislation (Abidin, 2011). The benefits of the existence of E-Procurement are not only for agencies, especially in the ministry of ATR/BPN East Java Regional Office as well as system developers themselves, but also for providers of goods and services and the general public who want to know the process of procurement of goods and services to the government that can be accessed openly With E- Procurement, procurement providers get higher bid prices and

simpler administrative processes, while goods and services providers can expand business opportunities, create healthy business competition, open up business opportunities for anyone and reduce administrative costs. (HandRelevanto, 2009 in Nightisaba *et al*, 2009).

2.2 E-Procurement Failure

E-Procurement Failure is an event that results in re-evaluation, resubmission of bid documents, termination of the process or auction/selection/re-election. Failing to bid will result in activities or programs not being able to be implemented, delays in the implementation of goods/services procurement activities, and delays in the implementation of work so that it will affect the absorption of the budget (Hapsari, 2017). Failed auction is one of the risks in a process of procurement of goods and services. If a procurement of goods/services is declared to have failed, a re-auction will be conducted.

2.3. 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).

$$r_{xy} = \frac{n \sum_{i=1}^n x_i y_i - \sum_{i=1}^n x_i \sum_{i=1}^n y_i}{\sqrt{n \sum_{i=1}^n x_i^2 - \left(\sum_{i=1}^n x_i\right)^2} \sqrt{n \sum_{i=1}^n y_i^2 - \left(\sum_{i=1}^n y_i\right)^2}}$$

r = Product moment correlation coefficient, X= Score for each question/ Variable ,

Y= Total score,

N= Number of respondents in the study.

2.4. 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.

2.5. PLS (Partial Least Square) Method

Partial Least Square (PLS) which is one of the alternative methods of model estimation for Structural Equation Modeling (SEM), where PLS is made to overcome the limitations of the SEM method such as missing values, not normally distributed and can be used on a smaller number of samples with a number of samples at least 30 to 100 (Hair *et al*, 2010). The advantage of using PLS is that it can determine the complexity of the relationship between several variables and their indicators. Primary data obtained through distributing questionnaires will be analyzed using PLS analysis.

3. RESEARCH METHODOLOGY

3.1. Data Collection Methodology

This study uses several tests and methods to determine the most dominant factor causing the failure of construction/consulting service providers to participate in e-procurement at the Ministry of ATR/BPN Regional Office of East Java. The tests used are: Validity Test, Reliability Test, and Frequency Analysis. The methodology used is Partial least square.

In obtaining the main data of this study using a questionnaire survey method. According to Singarimbun & Effendi (1995: 3) 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, in which the questionnaire itself contains questions or statements related to the research objectives. Questionnaire data will be used as a measuring tool 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 (on a measurement scale).

In this study, questionnaires will be given to partners who provide Consultant services within the Ministry of ATR/BPN Regional Office of East Java, and the procurement committee for construction services/consultants to obtain primary data. services at the Ministry of ATR/BPN East Java regional office.

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 that influence the failure to participate in e-procurement and which factors have a major influence on the failure of this auction.

Partial Least Square (PLS) which is one of the alternative methods of model estimation for Structural Equation Modeling (SEM), where PLS is made to overcome the limitations of the SEM method such as missing values, not normally distributed and can be used on a smaller number of samples with a number of samples at least 30 to 100 (Hair et al, 2010). The advantage of using PLS is that it can determine the complexity of the relationship between several variables and their indicators. Primary data obtained through distributing questionnaires will be analyzed using PLS analysis. 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 following is the Path Model Model in SEM with partial least square PLS in this study as follows:

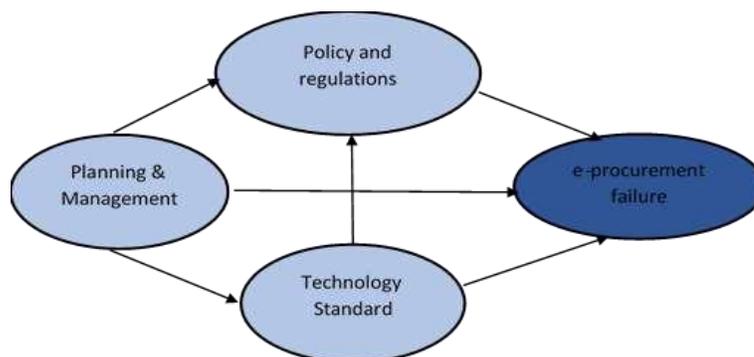


Figure 1. Theoretical framework for the cause of e-procurement failure

The model has three exogenous latent variables (independent variables), namely X1, X2, and X3 with one endogenous latent variable (dependent variable), namely E-Procurement Failure. With a description of each independent variable, namely, X1= Planning & Management, X2= Technology Standard, X3= Policy and Regulations, and X4= E-Procurement Failure. Variables X1, X2 and X3 were measured by 20 indicators in a formative manner. While the E-Procurement variable is measured by three indicators reflectively.

4. RESULTS AND DISCUSSION

4.1. Instrument Test of Research

After validity test and instrument reliability research completely done, the result of validity test in table 1 and reliability test in table 2 shows that correlation values from three variable research above 0.220 and Cronbach alpha value more than 0.7 so that the instrument is valid and reliable (Arikunto, 2006).

Table 1. Research Instrument Validity Test Results

No	Indicator	Mean Value	Correlation	Result
X1: Planning and Management				
1	Project team qualification	3.84	0.924	VALID
2	Overhead cost project	3.62	0.799	VALID
3	Determining accuracy workproject	3.65	0.803	VALID

4	Site project identification failure	3.71	3,74	0.879	VALID
5	Prediction error of cost fluctuation	3.66		0.880	VALID
6	Lateness of attendance	3.72		0.883	VALID
7	Requirement of minimum equipment	4.04		0.934	VALID
X2: Technology Standard					
8	Framework standard	3.68	3.49	0.767	VALID
9	Electronic procurement system	3.68		0.873	VALID
10	Update content and information	3.69		0.815	VALID
11	Relevant content or information	3.51		0.843	VALID
12	The system accuracy feature in evaluation process	3.37		0.841	VALID
13	The slow system response from LPSE	3.29		0.773	VALID
14	Availability of software and hardware	3.63		0.773	VALID
X3: Policy and Regulations.					
15	Conformity of laws or regulation regarding to policies with technological changes	3.47	3.54	0.897	VALID
16	Own coherence policy	3.63		0.789	VALID
17	Procurement process in accordance with applicable regulations	3.37		0.881	VALID
18	Time allotted	3.74		0.847	VALID
19	There are strict legal sanctions related to fraud	3.44		0.901	VALID

20	Conqueror announcement and alternative conqueror not suitable to SPSE format.	3.63	0.875	VALID
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Table 2. Reliability Instrument Test Result

Variable	Cronbach's Alpha
Policies and regulations	0.933
Procurement Failure	0.892
Planning and management	0.948
Technology standard	0.914

4.2. The Description of Research Variable

Based on Table 1, only one indicator that has 4 for mean value variable indicator result which means the value is not really high. The highest mean value is planning and management that has value of 3.74. On the other hand, standard technology and policies and regulation are equal which have 3.49 and 3.54, respectively.

4.3. PLS Analysis Result (Partial Least Square)

a) Linearity Assumption Test

In Partial Least Square (PLS) analysis, there is an assumption which has to be fulfilled which is linearity. The relationship between variables has to be linear. The linearity assumption using Curve Fit method is the condition where the relationship between variables is linear if one of the variables fulfilled these following possibilities: (1) significant linear model (sig linear model < 0.05), (2) non-significant linear model and whole model which possibly non-significant (sig linear model > 0.05). Test result shows in Table 3. Linearity assumption fulfilled because the relationship value has significant value which is more than 0.05.

Table 3. Linearity Test Result

Variable	Sig Model Linier	Result
Policies and regulations	0.000	linier
Planning and management	0.000	linier
Technology standard	0.000	linier
Procurement Failure	0.000	linier

b) Goodness of fit Model Measurement Test (Outer Model)

Table 4. Composite Reliability Test

Variable	Composite Reliability
Policies and regulations	0.947
Planning and management	0.957
Technology standard	0.932
Procurement Failure	0.932

Composite reliability test result shows that the value more than 0.7 which means all the construct meet the composite reliability criteria.

c) Goodness of fit Model Structure Test (Inner Model)

The Q2 has range value of $0 < Q2 < 1$, the closer to 1 means better model result. Table 5 shows the result of goodness fit value or determination coefficient (R2) from two endogenous variables.

Table 5. Goodness of Fit Value (R-Square)

Influence from	for	R-Square
Planning and management	Policies and regulations	0.600
Planning and management	Procurement Failure	0.469
Planning and management	<i>Technology standard</i>	0.040

Table 4.10 shows that R-square value of construct policies and regulation is 0.600 which means policies and regulation explained by determinants of planning and management constructs with 60% while the rest is influenced by other factors that are not included in this study. Technology construct is 0.040, which means that the Technology standard is explained by the determinants of the planning and management construct of 4% while the rest is explained by other factors not included in the modeling. The Auction Failure construct has an R-square value of 0.469 which means that the Auction Failure is explained by the determinants of the planning and management construct of 46.9% while the rest is explained by other factors not included in the study. In the PLS model, the goodness of fit assessment is known from the Q-Square value, the higher the Q-Square value, the more fit the model can be with the data. From Table 4.10 it can be calculated the value of Q2 as follows:

$$Q^2 \text{ value} = 1 - ((1-0,600) \times (1-0,040) \times (1-0,469)) \\ = 0.7961$$

Based on calculation above, 0.7961 for Q^2 value which means the diversity of research data could be explained by structural model is 79.61 % while the rest can be explained by other variables besides the modeling. Also from this result, the structural model of this study has a good goodness of fit value.

d) Calculation Model Test Result (Outer Model)

Outer loading value (for reflective indicator) shows weight in each indicator to gauge each latent variable. Indicator with the biggest outer weight or outer loading means dominant. Table 6 shows

all indicators latent variable shaper have loading value more than 0.5. It means that the measurement fulfilled convergent validity requirement with statistic value more than table value (t-statistic 1.96) and p-value < 0.05. It also concluded that all indicator significant to the latent variable.

Table 6. Variabel Endogenous Formation Indicator Test Result

No	Indicator	Outer Loading	t-statistic	P-Value
X1: Planning and Management				
1	Project team qualification	0.924	49.456	0.000
2	Overhead cost project	0.799	9.446	0.000
3	Determining accuracy workproject	0.803	10.375	0.000
4	Site project identification failure	0.879	23.253	0.000
5	Prediction error of cost fluctuation	0.880	30.886	0.000
6	Lateness of attendance	0.883	31.965	0.000
7	Requirement of minimum equipment	0.934	65.296	0.000
X2: Technology Standard				
8	Framework standard	0.767	12.873	0.000
9	Electronic procurement system	0.873	27.075	0.000
10	Update content and information	0.815	16.792	0.000
11	Relevant content or information	0.843	20.678	0.000
12	The system accuracy feature in evaluation process	0.841	25.24	0.000

13	The slow system response from LPSE	0.773	8.592	0.000
14	Availability of software and hardware	0.773	8.964	0.000
X3: Policy and Regulations.				
15	Conformity of laws or regulation regarding to policies with technological changes	0.897	34.645	0.000
16	Own coherence policy	0.789	17.345	0.000
17	Procurement process in accordance with applicable regulations	0.881	30.335	0.000
18	Time allotted	0.847	12.893	0.000
19	There are strict legal sanctions related to fraud	0.901	26.531	0.000
20	Conqueror announcement and alternative conqueror not suitable to SPSE format.	0.875	25.971	0.000

e) Structural Model Test Results (Inner Model)

The main test of the structural model (inner model) is to test the hypothesis in the research. Hypothesis testing is done by t test (t-statistic) at each track direct effect partially. The results of the complete analysis, contained in the results of the smart-PLS analysis, can be seen in table 7 below. The following table presents the results of testing the direct influence hypothesis:

Table 7. Results of Endogenous Variable Formation Indicators Test

Hypothesis	Coefficient Path	T-Statistic	P Values	Result
Planning and management -> Policies and regulations	0.645	5.668	0.000	SUPPORTED
Planning and management -> Standard Technology	0.201	1.291	0.099	UNSUPPORTED

Standard Technology -> Policies and regulations	0.319	3.230	0.001	SUPPORTD
Policies and regulations -> E-Procurement failure	0.216	1.098	0.136	UNSUPPORTED
Planning and management -> E-Procurement failure	0.356	2.176	0.015	SUPPORTD
Standard Technology -> E-Procurement failure	0.295	2.221	0.013	SUPPORTD

According to Hartono (2004), a significant measure of hypothesis support can be detected by using a comparison between t statistics and t-tables. If the t-statistics value is higher than the t- table value, it can be interpreted that the hypothesis is supported. As for the t-statistics, it can be seen in table 7 above, while for the t-table value, at the 95% confidence level (alpha 5%), the t- table value for the two-tailed hypothesis is 1.96 so that it can be stated that the hypothesis is supported when the value of t-statistics 1.96. Based on testing goodness of fit to the outer structure models and models above, then the full image of the model shown as below :



Figure 3. Outer and Inner Model Evaluation Result.

Thus the results of the hypothesis test can be presented as follows:

- H1: The implementation of better planning and management will be followed by policies and regulations. The results of the analysis show that testing the direct influence between planning and management on policies and regulations, the inner weight coefficient value is 0.645, with a t-statistic value of 5.668, and a p-value of 0.000. Because the value of t statistic > 1.96 , and p- value < 0.05 , then there is a significant direct influence between planning and management with policies and regulations. Thus the first hypothesis can be proven. Considering that the inner weight coefficient is positive, it indicates that the relationship between the two is positive. That is, the better the implementation of planning and management, the better the level of policy and regulation.
- H2: The implementation of better Planning and Management will be followed by better technology standards. The results of the analysis show that testing the direct influence between planning and management on technology standards, the inner weight coefficient value is 0.201 with a t-statistic value of 1.291, and a p-value of 0.099, because the t-statistic value is < 1.96 , and p-value > 0.05 , then there is an insignificant direct effect between planning and management with technology standards. Thus the second hypothesis cannot

be proven.

- H3 : The implementation of better technology standards will be followed by better policies and regulations. The results of the analysis show that testing the direct influence of technology standards on policies and regulations, the inner weight coefficient value is 0.319, the t-statistic value is 3.230, and the p-value is 0.001. Since the t-statistic value is > 1.96 , and the p-value is < 0.05 , there is a significant direct effect between technology standards and policies and regulations. Thus the third hypothesis can be proven. Considering that the inner weight coefficient is positive, it indicates that the relationship between the two is positive. That is, the better the application of technology standards, the better the level of policy and regulation.
- H4: The implementation of better policies and regulations will be followed by a lower auction failure rate. The results of the analysis show that testing the direct influence of policies and regulations on auction failure, the inner weight coefficient value is 0.216 with a t-statistic value of 1.098, and a p-value of 0.136. because the value of t-statistic < 1.96 , and p-value > 0.05 , then there is an insignificant direct effect between policy and regulation on auction failure. Thus the fourth hypothesis cannot be proven.
- H5: The better the implementation of planning and management will be followed by a lower auction failure rate.. The results of the analysis show that testing the direct influence between planning and management on auction failure, the inner weight coefficient value is 0.356, with a t-statistic value of 2.176, and a p-value of 0.015. Because the t-statistic value is > 1.96 , and the p-value is < 0.05 , there is a significant direct effect between planning and management with auction failure. Thus the fifth hypothesis can be proven. Considering that the inner weight coefficient is positive, it indicates that the relationship between the two is positive. That is, the better the implementation of planning and management, the better the auction failure rate.
- H6: The better the application of technology standards, will be followed by a lower auction failure rate. The results of the analysis show that testing the direct effect of technology standards on auction failure, the inner weight coefficient value is 0.295, the t-statistic value is 2.221, and the p-value is 0.013. Because the t-statistic value is > 1.96 , and the p-value is < 0.05 , there is a significant direct effect between technology standards and auction failure. Thus the sixth hypothesis can be proven. Considering that the inner weight coefficient is positive, it indicates that the relationship between the two is positive. This means that the better the application of technology standards, the better the auction failure rate.

5. CONCLUSIONS

The findings factors that influence the service provider failure in e-procurement process show that :

- a) Implementation of planning and management directly increase policies and regulations in the Ministry of ATR/BPN East Java Regional Office.
- b) Implementation of planning and management cannot improve technology standards in the Ministry of ATR/BPN East Java Regional Office.
- c) Implementation of technology standards directly increase policies and regulations at the Ministry of ATR/BPN East Java Regional Office.
- d) Implementation of policies and regulations cannot improve the rate e-procurement

failure in the Ministry of ATR/BPN East Java Regional Office.

- e) Direct implementation of planning and management cannot improve the rate of e-procurement failure in the Ministry of ATR/BPN East Java Regional Office.
- f) Implementation of technology standards directly increase the rate of e-procurement failure at the Ministry of ATR/BPN East Java Regional Office..

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DESIGNING PERFORMANCE MEASUREMENT SYSTEM PT XYZ WITH INTEGRATION SWOT BALANCED SCORECARD METHOD AND ANALYTICAL HIERARCHY PROCESS

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ABSTRACT

PT. XYZ is a manufacturing company which produces in cigarettes filter, that is committed to produce certainly qualified products in East Java. Cigarettes filter works as smoke filter, and also for additional flavor to the cigarettes. With many innovations in this filters, continuous improvement is one of the methods that company will applied. The intense of competition will push manufacturing companies to increase their performance continuously. In the process, PT XYZ only focuses on financial decision in their performance measurement. The weakness of focusing to financial decision only is they cannot cover intangible asset such as employee's loyalty, human resources quality, and customer relationship. this will affect the company's vision, which is "to become a world class player", hard to achieve because world class company needs measurement in intangible asset as well. This study aims to design a performance measurement system at PT XYZ based on their vision and mission. The method used in designing this performance measurement system was integrated SWOT-Balanced scorecard (SWOT-BSC). The performance measurement in this research was also supported by Analytical Hierarchy Process (AHP) to determine the weight between perspectives and Key Performance Indicator (KPI). This research gave 8 strategic targets and 8 KPI based on interview and questioners to PT XYZ's top management. Overall, the company current performance is 6.38 which stand in yellow zone from OMAX-traffic light measurement. This means, PT XYZ has not reached the target and still needs an improvement to achieving the target.

Keywords: Performance measure system, cigarettes filter, SWOT-BSC, AHP.

1. INTRODUCTION

Along with the increasing demand for cigarettes in Indonesia, the demand for cigarette filters will also increase. Cigarette's filter has a function to filtrate CO and as additive flavor. With many innovations that can be applied in cigarettes filter, the filter company should increase their performance by continuous improvement.

PT XYZ is cigarettes filter manufacturer located in East Java. PT XYZ uses *make-to-order* in their business process. It starts with customer request filters design following their

cigarettes mock up, after that trial with research and development team, continue with mass production if customer approved by latest R&D samples and other negotiations. The benefit with this method is PT XYZ can accept any filter specification from their customer regarding their cigarettes. However, since the specification needs variety materials, the company needs time to fulfill their materials. Since some of the materials are imported, it takes long lead times and affects the production and the shipment to the customer. The material availability and shipment delay can make the industrial performance down. Industrial performance is appraisal of a company started from order received until after sales progression (Quezada, et al., 2019). In the process, PT XYZ only uses one method to appraisal their performance with financial perspective. This method was good when applied in small company/startup company because of its easiness. However, since PT XYZ is one of the big manufacture filter cigarettes company in East java and has been applied ISO9001:2015, financial perspective cannot stand up on their own. Many factors such intangible asset, employee satisfaction and waste management system became less visible. Moreover, when there is budget that over or under from what has been planned, the top management sometimes cannot provide a well strategic planning. Hence, to improve PT XYZ performances apart from financial perspective, PT XYZ will use balanced scorecard integrated with SWOT to improve their performance.

Balanced scorecard (BSC) is method that works with qualitative, quantitative, comprehensive, responsive and adaptative (Rangkuti, 2011). BSC can help a company analysis from 4 perspective with long term result and involving internal and external parties (Kaplan, et al., 1996). However, according to Rangkuti 2011, BSC sometimes misleads with strategy, caused by non-initial analysis. Therefore, an internal and external analysis needed first using SWOT method to help performing initial strategy. Although SWOT method can help initial analysis, this method cannot be applied as final strategy. Oreski, 2012 said SWOT analysis gives bias result to management for making decision. Therefore, this integrated method will help giving better strategic because it will lead to lagging and leading indicators also with cause-effect in performance indicator (Rangkuti, 2011). After integrated SWOT-BSC method is finished developing strategic target and indicator key performance, the next is calculating every element using hierarchy process with Analytical hierarchy process (AHP). AHP will provide top management in PT XYZ to decide prioritize elements in every aspect in objective, and comprehensive (Saaty, 2008). Moreover, this research was conducted with objective matrix (OMAX) which can help productivity based on KPI with metric consolidation of current performance (Balkan, 2011). Further, will be symbolized with traffic light system. The research problems that are examined in this study are:

1. How to designing performance appraisal in PT XYZ with integrated SWOT-BSC in every aspect of company?
2. How are the result and implementation to the company in PT XYZ after measured by indicatorsthat has been approved?

2. LITERATURE REVIEW

2.1. Business Prospect and Cigarette Filter Industry Prospect

The business process of PT XYZ is a B2B (business to business) process based on make to order or market orientation that produces cigarette filters for use on PT. XYZ cigarettes as well as for cigarettes produced by other companies. The cigarette filter

manufacturing industry is a growing industry in Indonesia. With many small cigarettes company and expandable, they will continue to developing filters with many innovations to attract customer. Moreover, this development is due to the growing demand for cigarettes in the Indonesian market or for export. SWOT

SWOT is a method for evaluating internal processes which include strengths and weaknesses, as well as externals which include opportunities and treats (Bonnici, 2015). This process is used to analyze problems that occur in the company based on these factors. Futhermore, this method will giving optimum combination between strategies that will help in strategic decision (Rauch, 2007).

SWOT is cannot be a final strategy decision. The strategy that generated still bias because there is so many options that makes top management ambiguous with, they decisions (Oreski, 2012). Therefore, a combination with balanced scorecard will sort these strategies based onperspective that will makes top management more easily to choose critical strategy (Rangkuti, 2011).

2.3 TOWS Matrix

TOWS matrix is a strategy that results from a combined analysis of strengths, weaknesses, oportunities, and threats. This matrix describes how external oportunities and threats with internal strengths and weaknesses produce four alternative strategies that can be taken (Novanda, 2015). Same as SWOT analysis, these TOWS matrix is not a final strategy, but helps the formulation of strategies in analyzing the factors contained in the SWOT.

2.4. Balanced Scorecard

Balanced scorecard (BSC) is a method used to measure company performance that was introduced by Robert S Kaplan and David P Norton at Harvard Business School in 1992. The balanced scorecard is a set of measures that allows a senior manager to get a quick but comprehensive view of the business including financial measures, that contain the results of programs that have been implemented to complement financial measures and operational measures regarding internal processes, customer satisfaction, and innovation of work measures (Rangkuti, 2011).

2.5 SWOT Research Questionnaire

SWOT research questionnaire is a questionnaire used to formulate strategic planning and to determine strategic priorities (Rangkuti, 2011). The purpose of this questionnaire is to analyze and classify internal and external factors that affect the company's business, analyze the driving factors, map out strategies based on mapping, and see possible policy alternatives based on oportunities and threats along with alternative solutions.

2.6 Analytical Hierarchy Process (AHP)

AHP method is a measurement method that uses a hierarchical pair-wise comparison using a priority scale (Dekrita, et al., 2018). Decision making is carried out from the top management to obtain performance weight against the level of importance from each perspective, metric group, and KPI (Saaty, 2008). Furthermore, the weight for decision making calculation for all top management is being equalized because all management members have contribution with identical, contributory, shared and support.

2.7 OMAX and Traffic Light System

Objective matrix (OMAX) is a partial productivity measurement system developed to see productivity in every part of the company developed by Dr. James L Riggs in the 1980s (Avianda, et al., 2014). The OMAX measurement method uses weights to get the total productivity index value (Balkan, 2011). Therefore, each KPI will be divided according current score. The traffic Light System is a symbol that is used as a categorization of the value of a performance measurement indicator that requires improvement or not. Green light means that every indicator in good condition, yellow means some indicators need to be improve, and red means the indicators need to be improve as good as possible, or the company will lose more revenue.

3. METHODS

3.1 Problem Identification

Problem identification started with analysis from PT.XYZ's vision and mission, annual reports, and current financial report. Later, validation and verification were done using questioners and interviews to top management.

3.2 Field dan Literature Study

Field research was needed to know vision and mission of the company, current management appraisal process, and respondent who will be interviewed and fill the questioners. Literature study was needed for theory and concepts in this research such as SWOT, balanced scorecard, analytical hierarchy process and objective matrix.

3.3 SWOT Analysis

The beginning to design management appraisal in PT XYZ is using SWOT-BSC development tool/interview. This method performed with focus group decision with top management from each department in PT XYZ. The main of this analysis was to support balanced scorecard strategy decision to be more accurate and identified strategic target into each balanced scorecard perspective. The breakdown to became each perspective comprises such as financial: sales revenue, ROI and operational cost. For customer: new business relation, goods return, customer complain. For Business internal: production capacity, and man power. For learning and growth: training for employees, turn over intention and human resources competency.

3.4 Forming Strategy

Forming strategy was created from SWOT analysis with Matrix TOWS. This matrix is calculated based EFAS and IFAS from questioner SWOT. Moreover, the strategy that was in this matrix also based on company's vision and mission.

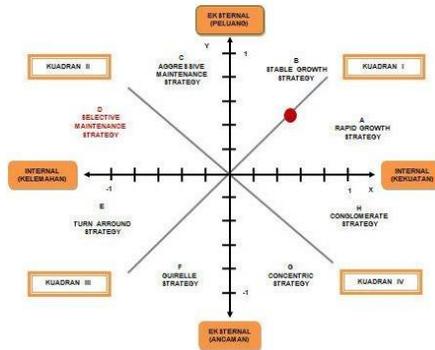


Figure 1 matrix tows

3.5 Strategic Target Decision

Strategic target was obtained from figure 1 that had been translated to balanced scorecard perspective such as financial perspective, customer perspective, business internal perspective, and learning and growth perspective. The chosen strategic was strategic that could solve issues in decision and follow with vision and mission of the PT XYZ.

3.6 Key Performance Indicator Decision

Key performance indicator (KPI) is the most important in this study. The elements that had been chosen should be specific and measured. This KPI should be verified and allowed with top management to make sure there was no secret formulas from company that could leak to public in this study. Moreover, this indicator is fixed by the highest score between indicators from questioners.

3.7 Forming Hierarchy with BSC Perspective

Forming hierarchy with BSC perspective was to grouping indicators based on appraisal measurement using analytical hierarchy process (AHP). Subsequently, each of indicator from KPI, strategic target and BSC perspective were given weight for choosing which indicator is more priority to be solved according to respondent decisions.

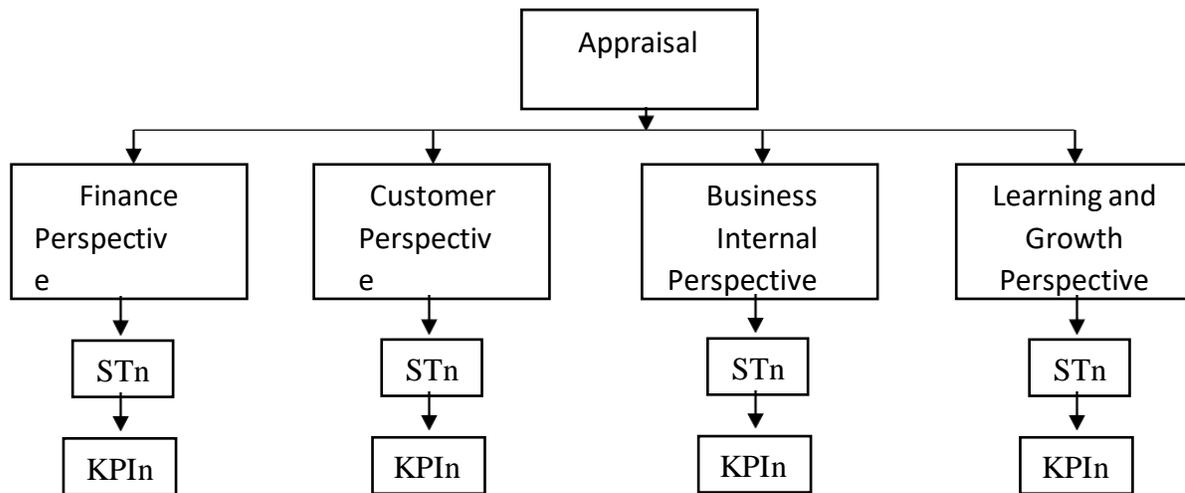


Figure 2 hierarchy of final appraisal

3.8 OMAX and Traffic Lights

OMAX and traffic lights in this study was used to compare the achievement between last year and current achievement based on KPI analysis and to discuss what the best strategy in every aspect. Moreover, traffic light system is a signal to each KPI whether it should be maintained or fixed.

3.9 Summary

Summary was final result from this study. Results started from SWOT analysis until

traffic light system was presented and implemented to PT XYZ with FGD, as well as recommendation to maintain KPI that had been already good, and fix what should be improved. RESULTS

Designing performance appraisal started from interview with top management. The interview based on vision and mission of PT.XYZ. Moreover, the interview also aligned with cascading to all top management since all BSC system will be deployed equality.

4.1 Questioner SWOT research

This questioner was distributed to top management with indicators based on vision-mission, interview, and annual reports. These questioners should be a basic for analysis strategic information and which strategy PT XYZ will aim with Internal Factor Analysis Strategy (IFAS) and External Factors Analysis Strategy (EFAS) (Bonnici, 2015). The results came with IFAS 1.39 and EFAS 1.13. These scores then plotted to matrix TOWS to acknowledge quadrant PT XYZ strategy among aggressive (quadrant I), turn-around (quadrant II), defensive (quadrant III), or diversification (quadrant IV). Afterwards, the table acknowledge that the strategic PT XYZ deployed now is aggressive. It means PT XYZ can get opportunity with strength that they have. One of the supremacies that PT XYZ has is distinctive competence and cost leadership in East Java compared to another competitor.

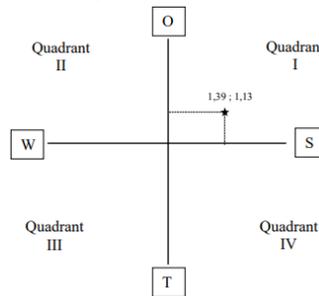


Figure 3 Strategy aims of PT XYZ

4.2 Strategic Target Determination

Strategic target determination explained from matrix TOWS to each perspective of balanced scorecard. Moreover, considering the strategic as well from vision mission of PT XYZ and strategic issue that happened in company. Therefore, not all aggressive strategic being deployed to this determination. The results came with 8 strategic targets, and all of them was approved by management

Table 1. Strategic Target of PT XYZ

No	Perspective	Strategic Target	Approved
1	Financial	Increasing company revenue	Yes
2		Decreasing operational cost	Yes
3	Customer	Increasing number of customers	Yes
4		Decreasing customer goods return	Yes
5	Business Internal	Increasing machines productivity	Yes
6		Developing more innovation product	Yes
7	Learning and	Human resource quality improvement	Yes
8	Growth	Increasing employee satisfaction	Yes

From table 1, all top management are equality contributed based on their specialty to follow each strategic target. The approved strategic, based on analytical hierarchy process calculation using expert choice to help determine which strategic is priority according to its weight. In this study, company decided increasing revenue is more priority, and increasing number customer is less priority. However, less priority does not mean company will exclude it from their target. Moreover, all this strategic target will be applied in PT XYZ company to support current situation.

4.3 Key Performance Indicator Determination

Key performance indicator (KPI) is determined from strategic targets. KPI is the most critical success to company since it will be a decision-making tool to measure performances and evaluate current situation to achieve vision and mission. This method is cascading from current strategic target because all of top management give contribution with identical, contributory, shared and support. The following KPI are sales revenue, budget efficiency, return product number, production capacity, innovation product, employees training, active customer number and decreasing under quality products. These KPI are harmonic with business strategic goals which are sustainability development, product innovation, market penetration and K3 implementation. Hence, this KPI will not dilute each other with baseline target. Similar with strategic target, the approval of KPI based on analytical hierarchy process calculation using expert choice to help determine which KPI is priority according to its weight. The most priority KPI is return product number while the less priority KPI is budget efficiency.

4.4 OMAX Traffic Lights

OMAX traffic lights help to determine total productivity index. This calculation based on last year achievement, this year achievement and target on scale 1-10. The green light indicates that KPI is already archive the target, and they should maintain it in good condition, yellow light means that KPI is close to target and still needs improvement to achieve the target, the last is red light which means it is far away from target and even bellow last year achievement. Current achievement KPI analysis in PT XYZ is yellow lights. It means that there are so many improvements PT XYZ should do to archive the target in 2021 by continuous improvement.

Table 2. OMAX-Traffic light summary result

No	Key Performance Indicators	2019	2020	Traffic Lights
1	Sales Revenue	9.484 billion	9.544 billion	Yellow
2	Budget Efficiency	88 %	93 %	Green
3	Return Product Number	6 cases	6 cases	Red
4	Production Capacity	818 million	900 million	Yellow
5	Innovation Products	3 units	5 units	Yellow
6	Employee's Training	2 units	3 units	Yellow
7	Decreasing Under Quality Products	9 complains	7 complains	Yellow
8	Active Customer Number	47 customers	50 customers	Green

4. CONCLUSIONS

Designing and implementation strategic targets and key performance indicator have been implemented successfully in PT XYZ. 8 strategic targets and 8 key performance indicators were coming from this analysis and approved by PT XYZ to applied in the company. Moreover, it is in line with current business target which is product innovation, sustainability development and market penetration. Moreover, it will help company recent ISO 9001:2015 to full fill management system and supporting company vision “becoming a world class player”. Furthermore, PT XYZ will deploy those strategic targets and KPI with one-by-one depends company situation.

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PERFORMANCE MEASUREMENT OF PARTS LOGISTICS AND WAREHOUSE DEPARTMENT USING BALANCED SCORECARD MODEL (A CASE STUDY FOR HEAVY EQUIPMENT INDUSTRY)

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ABSTRACT

Starting from the weakening of the construction sector due to Covid-19 pandemic at the end of 2019 to early 2020 also had an impact on the growth of heavy equipment providers companies. The company strives to maintain its existence by optimizing the performance of each division that supports the company's profits. In order to achieve these efforts, a measurable assessment is needed to see performance improvements in each division. The object of this research is the parts logistics and warehouse at the heavy equipment industry. The method used in this research is to design a performance measurement system with a balanced scorecard approach. Determination and preparation of criteria or KPIs based on the results of discussions and priority weighting by stakeholders using the ANP method. Financial perspective is a perspective that must be prioritized by the company with a weight of 0.546931. Several alternatives are provided in accordance with the prioritized KPIs as a recommendation to improve KPI performance.

Keywords: Supply Chain Management, Balanced Scorecard, Performance Measurement, Logistics and Warehouse Management.

1. INTRODUCTION

Infrastructure development in Indonesia currently has made the domestic construction sector experience a significant increase. According to data compiled by the BPS, the total company value completed by construction companies in the period 2016, 2017 and 2018 respectively was Rp. 1009 trillion, Rp. 114 trillion and Rp. 1271 trillion. This is a positive signal not only for construction companies but also for heavy equipment supply companies.

The company's optimism to expand its business to support the need for heavy equipment for construction companies in the context of infrastructure development will have an impact on the intense business competition among heavy equipment supply companies. However, the heavy equipment industry has increasingly experienced a weakening due to

Covid-19 virus pandemic. In order to improve its performance, the company continues to optimize after-sales services, which is known as the need for service and spare parts.

One of the logistical and warehousing constraints is the problem of product availability and transportation. Product availability and transportation are very influential on waiting times. The right decision for this problem will greatly affect the effectiveness of waiting times as a form of company commitment to customers. In order to achieve these goals and objectives, reliable and measurable performance is needed so that weaknesses and strengths can be identified to face future challenges.

In this study, a performance measurement model will be designed to measure the performance of the parts logistics and warehouse section with a case study at the heavy equipment industry. The performance measurement model based on the balanced scorecard model developed by Kaplan & Norton (2000) with the basic concept measurement from four perspectives such as financial, customer, internal business processes and learning and growth.

2. LITERATURE REVIEW

Performance Measurement System (PMS) is described as the overall set of metrics used to measure the efficiency and effectiveness of an action (Neely, 2005; Shepherd & Günter, 2011). Melnyk et al., (2004) revealed that metrics and performance measurement systems are important elements in translating the vision, mission, and strategy of the organization. These three elements are closely related and must be designed properly to meet the basic needs of measurement activities, namely evaluation, education, and problem solving. Ip et al., (2011) show the importance of a performance measurement system in a supply chain management (SCM) to understand the strengths, weakness, current performance, and the size and natural gaps of the supply chain between strategic objectives. Gunasekaran et al., (2004) is formed a framework by considering four aims processes in supply chain activities i.e. plan, sources, make/assemble, and delivery/customer. Bigliardi & Bottani (2014) generally classify the most frequently adopted indicators to measure supply chain (SC) performance into six groups of metrics, i.e. customer service, finance and marketing, innovation and learning, internal business, supplier performance, and transport and logistics. Cuthbertson & Piotrowicz (2011) classifies size into three groups, i.e. cost, quality, and delivery. Then they found four important metrics measured in SC such as availability, lead times, backorders, and on-time deliveries.

Yüksel & Dağdeviren (2010) used a BSC approach that was integrated with the fuzzy-Analytical Network Process (ANP) technique to find the correlation between strategic objectives and performance measures, as well as identify and determine the weighting of various perspectives to develop a system with more effective measurement results, as well as determine interrelationships between different factors and give weighting to the most important factors. Performance measurement in the logistics section is considered by Angappa Gunasekaran & Kobu (2007) as one of four key competencies, the other three key competencies are positioning, integration and agility.

Based on the sampling frame conducted by Chia et al., (2009) on a population survey in logistics, manufacturing and retail, financial indicators occupy the most important position. The BSC model usually considers the existence of financial indicators (Cagnazzo et al., 2010). The word “balanced” is an interesting fact that the system must be balanced by combining

financial and non-financial measures (Kanji, 2002). Nine Steps to Success is a disciplined, practical and proven approach to developing a strategic planning and management system based on the balanced scorecard. The following are nine steps taken to implement the balanced scorecard-based performance measurement developed by the Balanced Scorecard Institute: (1) Assessment, (2) Strategy, (3) Strategic Objectives, (4) Strategy Mapping, (5) Performance Measures, (6) Strategic Initiatives, (7) Performance Analysis, (8) Alignment, (9) Evaluation.

The Analytical Network Process (ANP) is a qualitative, multi-attribute decision-making approach that provides structured communication to address business problems. ANP is a decision-making method, and the most comprehensive framework capable of explaining

interdependence relationships, reflecting dependencies as quantitative outcomes and simultaneously providing feedback within and between element groups (Bhattacharya et al., 2014). The ANP model has two parts: firstly, the control hierarchy or the goal network and the criteria that control the interactions within the system, secondly there are so many sub-networks that influence between the elements of the problem and each one controls the other's criteria. The ANP technique will be appropriate to apply by considering the complexity of the existing problems (Aliakbari Nouri et al., 2019). Yüksel & Dagdeviren (2007) explain the steps of solving problems using the ANP method: (1) constructing the model, (2) making a comparison matrix, (3) checking inconsistency ratios, (4) forming a supermatrix, (5) selection of the best alternative.

3. METHODS

A performance measurement model will be designed to measure the performance of the parts logistics and warehouse section with a case study at the heavy equipment industry. In this section, the steps in designing the balanced scorecard-based measurement model will be shown. The first step is the data collection stage which is carried out by direct observation using interview or direct discussion techniques and questionnaires to the respondents (experts/stakeholders). Primary data obtained from questionnaires as many as three types: (a) questionnaire weighting the importance of criteria. To see the level of importance between criteria, (b) criteria dependency relationship questionnaire. To determine the dependency relationship between criteria and sub-criteria, (c) Key Performance Index (KPI) importance weight questionnaire. To see the level of importance between KPIs. Secondary data, obtained from literature studies related to the topic of measurement in the supply chain, model balanced scorecard, ANP method, and logistics and warehouse management.

In this study, a group discussion forum (FGD) and questionnaires will be carried out, i.e. data collection by asking questions both orally and writing to respondents with the method of gathering stakeholders in one table (online forum) to agree on a size decision. What is needed in measuring performance with the balanced scorecard method in the logistics and warehouse division. The next step is to design a BSC measurement model starting with the preparation of KPIs. In this research, the proposed criteria is based on the combination of various criteria from various journals. KPI proposal are prepared based on the journal belonging to (a) (Angappa Gunasekaran & Kobu, 2007), (b) (Keebler & Plank, 2009), (c) (Reefke & Trocchi, 2013), (d) (Meena & Thakkar, 2014), (e) (Papakiriakopoulos & Pramatari,

2010), (f) (Frazelle, 2002).

The next step is the KPI weighting is carried out based on the KPI results that have been selected from the various KPI proposals provided. The KPI weighting process is carried out by pre-selected respondents. This is done with the aim of ranking KPIs that have the largest and smallest contribution to the organization. Furthermore, this ANP weighting data is completed with the help of Super Decision Software. These weights will be used to calculate the score of each KPI in the BSC. The last step is to analyze the data that has been obtained. Based on the analysis and discussion, it can be seen the criteria that need to be improved so as to improve the performance of the logistics and warehouse department in particular and the company's overall performance. This information can make it easier for the company to know the actions that need to be taken as an effort for continuous improvement.

4. RESULTS

The BSC approach generally uses four perspectives in measuring its performance. The four perspectives are related to financial and non-financial (customer, internal process, and learn and growth) perspectives. The data required in the application of this BSC method are as follows: (1) Financial Perspective. The data required for performance measurement from a financial perspective are: Increased Inventory Level; Increased Inventory Turnover Ratio (ITO); Improved Transportation Cost Efficiency; and Increased Utilities of Space/Capacity. (2) Customer Perspective (Customer). The data required are: Improved Product Availability; and Accelerated Lead Time. (3) Learning and Growth Perspective. The data required are: Improved Employee Training; and Improved Issuing Skills. (4) Internal Process Business Perspective. The required data are: Improved Receiving Process; Improved Binning Process; Improved Assessment Process; and mproved Maintenance Process. The following Table 1 will show the KPIs of each strategic target grouped in each perspective as well as the description and formulation of each KPI.

Table 1. Logistics and Warehouse KPIs

Perspective	Dimension	Strategic Goals	No KPI	Indicator	Formulation	Target
FINANCIAL	Cost	Making savings efforts to reduce department expenses	F1	Inventory Level	Total shipment quantity (Q) \geq Product sales (S)	Lower is Better
			F2	Inventory turn over ratio	COGS / Sales	Lower is Better
			F3	Transportation	Total shipping cost + Total picking & packing cost	Lower is Better
	Utilization	Optimizing the effectiveness of inbound and outbound channels and storage cost efficiency	F4	Space utilization/capacity	% space usage / total space capacity	Higher is Better
CUSTOMER	Overall Customer Satisfaction	Maintaining good relationship with customers	C1	Availability Product	(Total listed items - the number of items that are not met) %	Higher is Better
			C2	Lead Time	Total time of the pick-up process	Lower is Better
LEARN and GROWTH	Motivation Management	Ensuring improvement of work competence and skill improvement of all employees	L1	Average annual training time per employee	Total number of training employee / total number of employee	Higher is Better
			L2	Issuing rate	(Number of items taken / number of hours of pick-up) %	Higher is Better
INTERNAL PROCESS BUSINESS	Inventory Accuracy Control dan Stock	Improve logistics and warehousing performance productivity	B1	Percentage of perfect receiving	(No. of good receive - No. of defect receive) / (Total items receiving) * 100%	Higher is Better
			B2	Percentage of perfect binning	(No. of correct placed - No. of incorrect placed) / (Total items placed) * 100%	Higher is Better
			B3	Percentage of assessment	(physical condition of defective goods / total number of items in stock notes) * 100%	Higher is Better
			B4	Inventory Maintenance	Minimum days of maintenance	Higher is Better

The relationship between perspectives and between KPIs in perspectives is shown in Table 2.

Table 2. Matrix Relationship

Cluster	Node	Innerdependence	Outerdependence
Perspective	KPI	-	-
Financial	F1	-	-
	F2	-	-
	F3	-	-
	F4	F1, F2, F3	-
Customer	C1		F1, F2, F3, F4
	C2	C1	F1, F2, F3
Learn and Growth	L1	-	F3
	L2	-	F3
Internal Business Process	B1	-	F3, F4, C1
	B2	B1	F3, C1, C2
	B3	B1, B2	F3, C1
	B4	B1, B2, B3	F4, C1

After knowing the relationship between the criteria, an ANP model will be made for this research with the help of Super Decision software as shown in Figure 1. In the ANP model, clusters and nodes are used. Clusters describe variables and nodes describe strategic objectives used in measuring the performance of the balanced scorecard. The relationship that occurs is in the form of inner dependence and outer dependence.

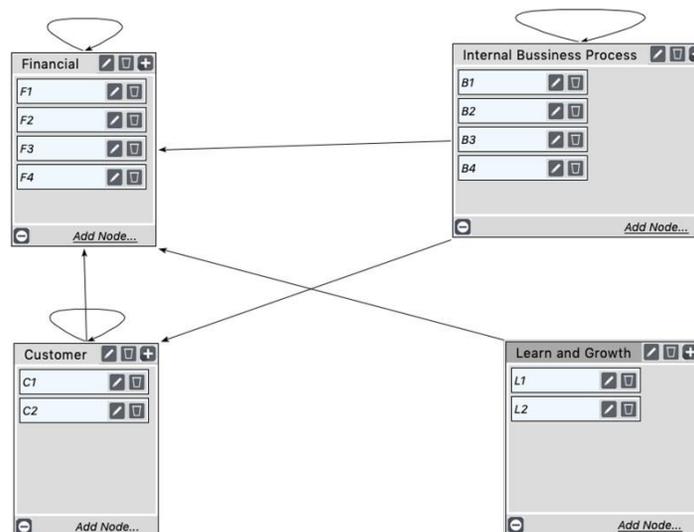


Figure 1. ANP Model

Table 3 shows the results of questionnaire processing and priority weighting on pairwise comparisons of local cluster perspectives in measuring company performance. The weighting results will be validated with its inconsistency index. The value of the inconsistency ratio must be less than or equal to

0.10. The weighting results show that the financial perspective is a perspective that must be prioritized by the company in an effort to improve the company's performance with a weight of 0.546931. The inconsistency index shows a value of 0.05156 which states that the answers to the respondent's questionnaire are quite consistent.

Table 3. Perspectives Weighting Results with Super Decision Software

Perspective	Weight
Financial	0,546931
Customer	0,344545
Internal Bussiness Process	0,108525
Learn and Growth	0

The results of the calculation of the ANP weighting of each KPI are shown in Table 4. It can be seen that there are several strategic objectives that are quite influential on the department's performance measurement. These strategic objectives are highly prioritized to improve departmental performance. This can be seen from the percentage of several performance criteria which when accumulated will reach 92 percent, while the accumulation of other criteria only reaches 8 percent.

Based on Table 4, it is known that the highest weighting is KPI F3, F4, F1 and C1 and the perspective that has the highest weight is the financial perspective.

Table 4. KPI Weight Calculation Results with ANP Method

KPI	Weight per KPI (%)	Weights per Perspective (%)
C1	0,06111	6%
C2	0,00096	
F1	0,08514	92%
F2	0,04823	
F3	0,69266	
F4	0,09283	
B1	0,00278	2%
B2	0,01114	
B3	0,00513	
B4	0	
L1	0	0%
L2	0	

The interaction weight value is obtained from the management's preference as an expertise. ANP calculations and supermatrix preparation are carried out using Super Decision software. The results of the weighting between perspectives show that the financial perspective is bigger than other perspectives (customer, internal business process, and learn and growth).

Transport Indicators related to destination supply chain to meet customer needs in the right way, at the right price and at the right time. If the choice of transportation mode is done correctly, the efficiency and effectiveness of shipping costs can be reduced so that the selling price of the product can compete in the market, this company's transportation indicator has the highest weight of 0.69266. The second position is occupied by the space/capacity utilization indicator which has a weight of 0.09283, this indicator has the effect of reducing the company's goods storage costs while paying attention to the quality of the stored goods. In the third position is occupied by the inventory level indicator with a weight of 0.08514, this indicator benefits the company if it is managed properly while keeping inventory without spending a lot of upfront budgets or compromising customer satisfaction. The fourth indicator is occupied by product availability with a weight of 0.06111, this indicator has a direct influence on customers because of the company's commitment to always meet market demand.

Table 5. Performance Improvement Alternatives

Improvement Alternatives	Weight
Employee Skill Training	0.053331
Workshop on Logistics and Warehousing	0.559094
Workshop on Intermodal Selection	0.387575

In order to continuously improve the performance of the logistics department and warehouse. Then, several alternatives are provided in accordance with the results of the priority KPIs as shown in the Table 5. This alternative is also a recommendation so that companies can focus more on improving and improving KPIs which are the priority of the logistics and warehouse department.

The overall priority of each alternative is calculated through the synthesis process and the result is to provide workshops for employees involved in logistics and warehouse departments with the highest score of 0.559094. Workshops related to logistics and warehouses should be given more often to employees so that they are always updated and get the latest insights from the application of creative and innovative techniques in managing company logistics and warehouses.

6. CONCLUSIONS

Based on the results of research analysis and interpretation of the data carried out, it can be concluded that the results of the calculation of the ANP questionnaire show the KPIs that have the greatest weight in measuring department performance are as follows: Transportation; Utilization Space/Capacity; Inventory Level; and Product Availability. By prioritizing KPIs, the Logistics and Warehouse department can choose the top priorities that are considered important for performance measurement, and focus more on implementation and achieving targets. Based on the four KPIs with the highest weight, several alternatives are recommended that can help the company focus on improving the performance of these KPIs. Workshop on logistics and warehousing occupies the top position.

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THE INFLUENCE OF WORK SAFETY AND HEALTH SYSTEMS TO QUALITY OF THE BUILDING PROJECTS

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ABSTRACT

Work safety is basically an important requirement for every human being to survive from various dangers in various ways. In general, projects with poor quality products have a higher chance of injury. The construction company needs to improve the safety and health systems to maintain and improve the quality of a better project. So there is a relationship between improving the safety and health systems in increasing the quality implementation of construction projects. The purpose of this study was to identify factors that affect the safety and health systems with quality in the implementation of building construction projects. Factor analysis was used to analyse data from interviews and questionnaires to 71 respondents who work in high-rise building construction project companies in Surabaya. The results showed that there were 5 main factors of work accidents that affect the quality of the project. There are 3 main factors from factor analysis, namely humans, systems and procedures, and than environment. The research is expected to provide input for business actors in the field of construction projects, especially for contractors in implementing a safety and health systems with quality building construction projects in Indonesia in order to produce zero accidents to get high-quality projects.

Keywords: Safety and Health Management Systems, Work Accidents, Rework, Project Quality, Building Construction.

1. INTRODUCTION

Infrastructure development is one of the main aspects in support of national development. The rate of economic growth can not be separated from the availability of physical infrastructure such as public buildings, highways, airports, transportation, electrical systems and others, which can be efficiently is an important factor that ensures the effectiveness of the economy, because it is very helpful in determining the location of economic activity. During its development, the construction industry had the records of accidents that take a lot of casualties, but a dangerous job just considered normal and often escape our attention.

Until now, it is still often neglected, especially in the implementation of public works development with simple building construction, this is indicated by the high number of work accidents in construction operations, the workforce in the construction services sector covers about 7-8% of the total workforce in all sectors and accounts for 6.45% of GDP in Indonesia.

The number of work accidents in East Java is still quite large. Nationally, the number of work accidents for 2015 reached 105,182 cases with the number of workers who died as many as 2,275 people. Meanwhile, the East Java Manpower and Transmigration Office noted that in the first

three months of 2015, the number of work accidents was 2,180 peoples, then the second three months as many as 3,099 peoples and the third three months as many as 5,113 peoples.

From various evaluation results of work accidents so far, it can be seen that several factors have caused accidents, both those that have resulted in fatalities and injuries due to the absence of construction engineering experts and the use of appropriate implementation methods, weak supervision of construction implementation in the field, not yet fully implement the existing regulations concerning safety and health, weak supervision of the implementation of safety and health, lack of quality and quantity of availability of personal protective equipment, socio- economic and cultural environmental factors of workers and lack of discipline of workers in complying with provisions concerning safety and health. The safety and health management systems is an inseparable part of the labor protection system and for construction service work it can reduce and avoid the risk of moral and material losses, as well as the safety of humans and the surrounding environment.

According to Alzahrani et al. (2013) work accidents in construction projects can cause losses related to workers, equipment damage and wasted material due to the accident. To prevent work accidents, a safety and health management systems is needed that regulates and can be a reference for consultants, contractors and construction workers. Thus, the workforce feels safe and comfort to do their job, as construction companies have protected their safety and health and provided guarantees if an accident occurs due to work, then indirectly it raises the workers 'confidence which motivate them to work well. This makes construction projects that can later support the improvement of the quality of construction projects in the development process. According to Harris and McCaffer (2013) where quality is the main part of a product or service that allows it to meet the owner's special requirements or needs.

The construction company will indirectly necessarily improve safety and health systems to reduce the occurrence of accidents that can interfere with the performance of the workers so that workers would be motivated to do his job properly and indirectly the quality of a construction project increased with good quality. This implies that there is an indirect relationship between improving safety and health with improving the quality of the results of construction projects, therefore the authors conducted an analysis of this. With the aim of knowing what factors affect the safety and health systems and quality in high-rise building construction projects.

2. LITERATURE REVIEW

2.1 Safety and Health Systems

Safety and health systems is a system used to manage safety and health aspects within the organization or company as a whole in risk control that ensures the creation of a safe, efficient, and productive workplace by implementing a management system to achieve effective results in preventing accidents and their effects. other harmful. From several theories about the factors that cause accidents, there are five factors that cause work accidents, namely

humans, the environment, equipment, processes, systems and procedures.

2.2 Project Quality

Quality is the totality of a form and characteristic of a product or service that meets the needs or requirements imposed on it directly or indirectly. This means that what are the requirements of a product or service can be fulfilled in totality. In general, quality has two main aspects, namely product characteristics that meet customer demands and are free from deficiencies.

To get a good quality, it is necessary to have a plan that involves these two main aspects. In getting good quality, you must take the right, systematic approach, and approach with a statistical basis to solve quality problems that sometimes come from special causes (because of the operator or tool) and general causes (which are the responsibility of the management).

2.3 Previous studies

In the study of Hammarlund and Josephson (1991) linking production errors with site management. Therefore, John Wanberg (2013) revisited the topic, identifying defect origins as production-based 54%, site management-based 34%, and work-based 20%. Correspondingly, other authors have identified poor communication as a cause of rework, claiming that a lack of understanding of end-user requirements leads to the breakdown of Love and Edwards (2004). One author briefly cites procurement delays as a cause of rework Arain et al. (2004), while other researchers claim that rework most often results from job changes by Sun and Meng (2009). The results of John Wanberg's (2013) research show two relationships: the level of recorded injury is positively correlated with rework and the level of first aid is positively correlated with the number of disabilities. The authors conclude that projects with poor quality performance have a higher probability of injury. Opinion-based data support this finding, which suggests that there is a relationship between perceived safety on the project and perceived construction quality.

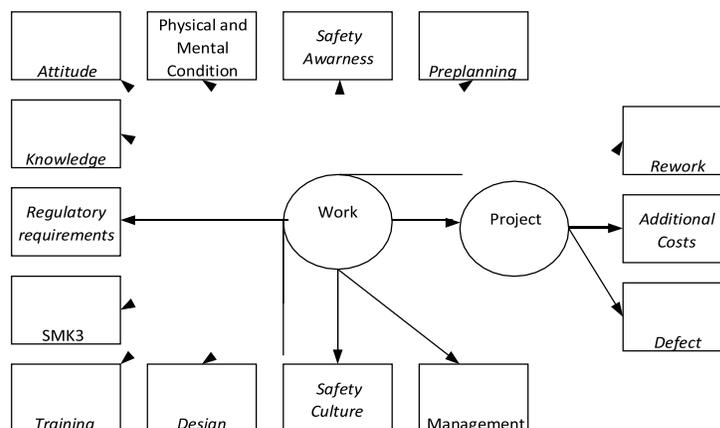


Figure 1. Schemes Framework

3. METHODOLOGY

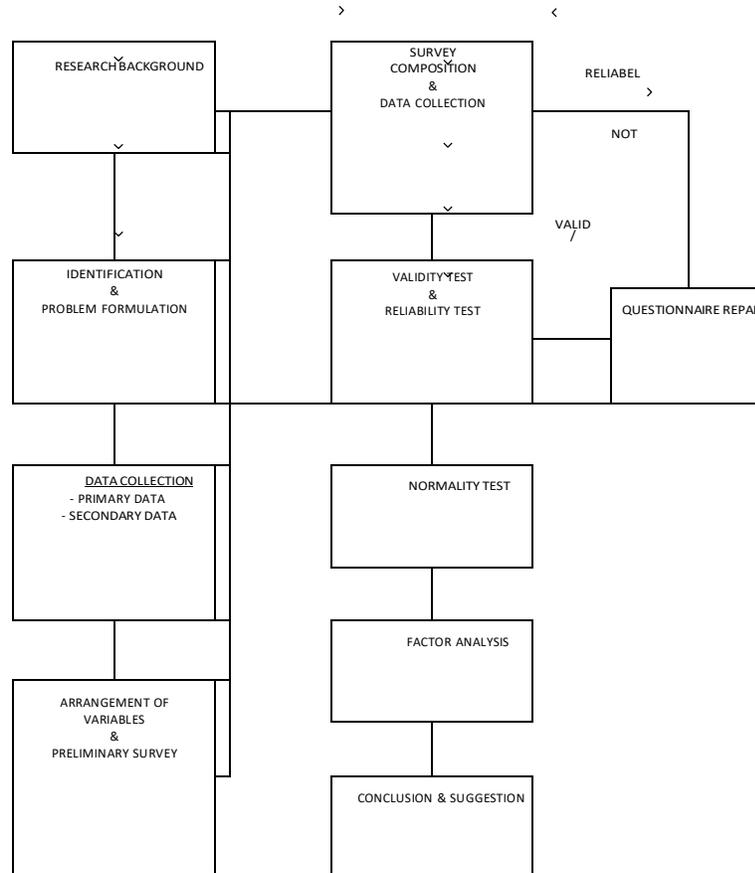


Figure 2. Research Flowchart

3.1 Data collection method

The approach uses descriptive quantitative method, where solving problems by describing the object of research at the time of the current state based on the facts as they are, then analyzed and interpreted, shaped in the form of surveys and studies developments. This study is a survey technique using an online questionnaire.

The population in this study is a service company or contractor with experience in the construction of high-rise buildings in Surabaya with a minimum of 5 floors. The sample in this study were safety and health workers who worked at companies in the contractor sector. The sampling method used in this study is a simple random sampling technique, which is a sampling technique where the sample is taken simply.

According to Hair et al. (2010) the number of samples is at least 5 times the number of

indicators, therefore, the researchers set the minimum number of respondents needed to be 70 respondents. In selecting respondents who are considered capable of providing opinions and thoughts related to experience and profession. The respondents who will be used are staff, supervisors, managers and directors of the safety and health section.

3.2 Data Analysis Technique

Good and appropriate data used in research is data that has a normal distribution. Testing the normality of the data in this study will be carried out using the Kolmogorov-Smirnov test. Decision making in the Kolmogorov-Smirnov test is obtained from a significant value greater than 0.05, then the data distribution is declared normal by Wahana Computer (2005). Detect by looking at the spread of data on the diagonal axis of the normal graph P-P Plots of Regression Wiratna (2015).

Factor analysis is a method for analyzing a number of observations in terms of interkorelasinya, to establish whether the apparent variations in the observation may be based on a number of basic categories fewer than that appeared in the observation Suryabrata, (1995). Process according to factor analysis Santoso (2005) is to find a relationship between a number of variables are mutually independent from one another, so that it can be made of one or more sets of fewer variables than the number of initial variables.

4. RESULT

4.1 Respondent

The research survey was conducted by means of questionnaires distributed to staff, supervisors, managers and directors of the safety and health section of service providers/contractors who carry out high-rise building construction projects in Surabaya. From a total of 83 questionnaires distributed, 71 questionnaires were returned. Respondents consisted of

24 staff, 37 Supervisor, 8 Managers and 2 Project Director of company service providers / contractors who carry out construction projects building high-rise building in Surabaya, most respondents have experience of working in the construction field for less than 1 years by 21% (15 people), 1-5 years by 62% (44 people), 6-10 years by 17% (12 people) and none of the respondents had more than 10 years of experience.

The research object is the project of construction of high-rise buildings in Surabaya, which has a number of characteristics with minimal floor 5 floors. The number of floors of building projects that have been handled by construction experts as respondents in the study are 18% (13 peoples) have experience handling building projects with 5-10 floors, 42% (30 peoples) with 11-20 floors and 39% (28 peoples) with the number of floors > 20 floors.

4.2 Research Variable

This study consisted of the independent variable, namely work accidents and the dependent variable, namely the quality of construction projects. Identification of factors affecting the results of workplace accidents is based on literature review, there are 27 factors. Of the 27 factors obtained 11 factors that are very influential on work accidents. While the results of the identification of factors that affect project quality based on the literature study

there are 3 factors.

Table 1. Variables and Factors in Research

Variable	Factor
Work Accident (X)	Safety Awareness
	Preplanning
	Physical and Mental Condition
	Attitude
	Knowledge
	Regulatory Requirements
	Safety and Health Management Systems
	Training
	Safety Culture
	Management
	Design
Project Quality (Y)	Rework
	Additional Costs
	Defect

From a questionnaire about the factors that influence of work accidents, the total score of the respondents with the highest value stated a large level of influence of 56.34% on the 11th question point about design. Meanwhile, the total score of respondents with the highest value stated that the level of influence was very large at 40.85% on the 7th question point regarding the safety and health management systems. That means there are 2 factors, namely the design and the safety and health management systems which will be more dominant in influencing the occurrence of work accidents.

Meanwhile from a questionnaire about the factors that affect the quality of the project, the total score of the respondents with the highest value stated the level of great influence of 35.21% on the 2nd question point about additional costs. Meanwhile, the total score of respondents with the highest value stated that the level of influence was very large at 14.08% on the 1st question point about rework. That means there are 2 factors, namely additional costs and rework which will more dominantly affect the quality of the project.

4.3 Statistical Test

There are 2 kinds of statistical test, they are validity and reliability test. From the data of 71 respondents, there were 4 respondents who showed data errors so that the data analyzed were 67 respondents. The level of confidence used in the item validity test in this study was 95% with the number of respondents (N). In the validity test, the critical correlation coefficient obtained from the distribution table r using $df = (n-2) = 67 - 2 = 65$. With a significance level of 5%, then the Table r is 0.252. An item is said to be valid if the significance level is below 0.05 or has a correlation coefficient above 0.252, Wiratna (2015).

Validity of the test results showed that all variables are valid because the calculated r value which is greater than the r -table, which is 0.252. Therefore, data from all variables can be included in the research data analysis.

In this study, the reliability test was measured using the alpha coefficient or cronbach's alpha. The reliability of the existing variables is based on the value of the resulting alpha coefficient. According to Sekaran (2003) the closer to 1.0 the reliability coefficient, the better an instrument. If the reliability coefficient is less than 0.60 it is considered bad, in the range of 0.70 it is considered sufficient, and if it is greater than 0.80 it is considered good. Validity of the test results showed the value of the Cronbach alpha coefficient of all variables is greater than 60%. Therefore, it can be interpreted that all data obtained through the questionnaire is reliable so that it can be included in the subsequent analysis.

4.4 Data Analysis Test Results

The normality test in this study was carried out using the Kolmogorov-Smirnov Test technique with the provisions of the data being said to be normal if the significance of p (Asymp. Sig.) > 0.05 . Table 2 below shows that test results data normality by Kolmogorov-Smirnov Test showed significant value of p (Asymp. Sig.) Of greater than 0.05, which amounted to 0.077 at

0.006 ariabel the variables X and Y . Value of significance p (Asymp . Sig.) which is greater than

0.05 indicates that the data is normal.

Table 2. Normality Test Results

VARIABLE	Statistic Value	P-value	Significance Level
Work Accident (X)	0.898	0.077	0,05
Project Quality (Y)	0.814	0.006	0,05

The initial stage in factor analysis is the KMO test and the Bartlett's Test is carried out to find out whether the factors in the study are valid or not, at this stage the KMO and Barlett's Test numbers must be above (0.5).

Table 3. KMO and Barlett's Test Results

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0,775
Bartlett's Test of Sphericity	Approx. Chi-Square	42,297
	Df	55
	Sig.	0,000

Table 3 above shows that the KMO and Barlett test scores are 0.775 with a significance value of 0.000, because the figure is already above 0.5 and the significance is far below 0.05 ($0.00 < 0.05$), then the existing variables and samples can actually be analyzed using factor analysis. Based on the test results Measure of Sampling Adequacy could be seen that there are 11 factors that have a value of $MSA > 0.5$ and all the factors meets the criteria.

And that eleven of these factors have a communal value above 0.5, so all the factors of the independent variables can be tested using factor analysis further. Furthermore, based on Table 4 can we know the value of safety awareness factor is 0.638, meaning 63.8% of the variations in the amount of one factor can be explained by factors formed. Likewise, the explanation for the value of the following factors. Provided that the greater the communalities value of a factor, the closer it is to the factors formed by Santoso (2012).

Table 4. Communalities Analysis Results

Communalities		
	Initial	Extraction
Safety Awareness	1,000	0,638
Preplanning	1,000	0,831
Physical and Mental Condition	1,000	0,662
Attitude	1,000	0,741
Knowledge	1,000	0,670
Regulatory Requirements	1,000	0,569
SMK3	1,000	0,734
Training	1,000	0,712
Safety Culture	1,000	0,822
Management	1,000	0,635
Design	1,000	0,872

Extraction Method: Principal Component Analysis.

The next process of factor analysis is testing Total Variance Explained. According to Santoso (2012), explains that the Total Variance Explained table describes the number of factors formed. Then it must be seen that the eigenvalues must be above one. If it is below one, then there are no factors formed.

Table 5. Test Results Total Variance Explained

Total Variance Explained			
Co	Initial Eigenvalues	Extraction Sums of Squared Loadings	Rotation Sums of Squared Loadings

mpo nent	Total	% of Variance	Cumulat ive %	Total	% of Variance	Cumulat ive %	Total	% of Variance	Cumul ative %
1	5,545	50,406	50,406	5,545	50,406	50,406	3,115	28,317	28,317
2	1,271	11,550	61,956	1,271	11,550	61,956	2,702	24,560	52,876
3	1,071	9,735	71,691	1,071	9,735	71,691	2,070	18,815	71,691
4	0,738	6,709	78,399						
5	0,572	5,202	83,602						
6	0,518	4,706	88,308						
7	0,469	4,265	92,573						
8	0,306	2,779	95,353						
9	0,255	2,315	97,668						
0	0,144	1,309	98,976						
11	0,113	1,024	100,000						
Extraction Method: Principal Component Analysis.									

Table 5 can we know that there are three factors that form, because with 1 to 3 factor eigenvalues figure is still above 1 is 1.071. Yet for all 4 digits eigenvalues factor is below 1, which is 0.738, so the factoring process stops at three factors alone. The next stage is to determine the dominant items in each of these components. It can be seen from Table 10 that shows the distribution of the three research items that form factor. Component Matrix consists of items that formed the beginning of the factor.

At first, the extraction is still difficult to determine the items included in the factor dominant for almost the same correlation value of some items. To overcome this, then the rotation is able to explain the distribution of factors that are clearer and more evident. In this study, the rotation used was the varimax method with Kaiser Normalization. From the results of rotated component matrix, the distribution of the existing factors can be described as follows:

- **FACTOR 1:** Consists of five factors, among others, the first factor comes from the safety awareness factor with a loading value of 0.538. Furthermore, it comes from physical and mental condition factors with a loading value of 0.742. Next comes from the knowledge factor with a loading value of 0.762. The last two factors in factor 1 are regulatory requirements, while the last factor comes from the Safety and Health Management Systems.
- **FACTOR 2:** Consists of four factors, among others, the first factor comes from the preplanning factor with a loading value of 0.892. Next comes from the training factor with a loading value of 0.719. The last two factors in factor 1 are management factors, while the last factor comes from the design.
- **FACTOR 3:** Consists of an attitude factor with a loading value of 0.824, while the second factor is a safety culture with a loading value of 0.836.

4.5 Discussion

Normality test which shows that the variable X data spreads normally while the variable Y does not spread normally. Then the correlation analysis between the independent variable (work accidents) and the dependent variable (project quality) was carried out.

To determine the effect of the independent variable (work accident) on the dependent variable (project quality), then the data processing is carried out with the SPSS program.

The results of data processing have gone through validity and reliability tests, the results of the tests show that the data is valid and reliable, then further data analysis can be carried out.

Based on the research conducted by the author, it can be explained that the factors that influence work accidents in Building Construction Projects are Safety Awareness, Preplanning, Physical and Mental Conditions, Attitude, Knowledge, Regulatory Requirements, Safety and Health Management Systems, Training, Safety Culture, Management and Design.

The most dominant factor influencing work accidents, factors originating from one factor groups with the highest eigenvalue. Factors that affect the most dominant workplace accidents in Building Construction Projects include safety awareness, physical condition, knowledge, regulatory requirements, and the latter safety and health management systems.

While most dominant factor affecting the quality of the project comes from the descriptive test score of respondents with the highest value stated the level of great influence / strong amounted to 35.21% at points 2nd question about additional charges. While the total score of respondents whose highest value stated the level of influence is very large / very strong at 14.08% at points 1st question about reworking. That means there are two factors: the extra cost and work to be more dominant in influencing the quality of the project.

5. CONCLUSIONS

Based on the research that has been described before regarding to the effects of workplace accidents on the quality of the project. Significant factors that directly affect the work accident on a construction project based on the analysis of factors which come from the first factor with the highest eigenvalue include safety awareness, physical condition, knowledge, regulatory requirements, and the safety and health management systems. While the significant factors that directly affect the quality of projects based on the results of descriptive test on the score of respondents with the highest value stated the level of great influence / strong amounted to 35.21% and the level of influence is very large / very strong at 14.08% is extra charge and re-employment.

So that with the existence of a safety and health systems, zero accident can be achieved in every company so that it does not have an impact on the cost and time of project work. And the workers feel safe and calm in doing their work, this is because the company has paid attention to their safety and provides guarantees if an accident occurs due to work, indirectly the workers will work to do a good job and indirectly the quality of a construction project suffers good quality improvement.

Future studies can build on this research paradigm in a number of ways. First, the advice on the method of factor analysis showed three factors divider which makes the independent variables divided into X1, X2, and X3, proceed with multiple regression analysis in order to determine the extent the relationship between the independent variable and the dependent variable. Similarly, can be developed and applied to construction projects other than building construction projects, such as roads, bridges and other infrastructure buildings.

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DELAY ANALYSIS OF SUTET 500 KV GRATI – TX KALANGANYAR PROJECT

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ABSTRACT

The implementation of the SUTET 500 kV Grati – TX Kalanganyar Construction and Procurement Project experienced a delay in the project completion time from the time specified in the contract, which is until December 30th, 2020. However, until the end of the contract, the progress of the new project completion could be completed by 52.1034% of total scope of work. The research method used was analysis of project delays by literature study and reviewing project documents. Testing the relevance of the factors causing delays by means of a Forum Group Discussion (FGD). Analysis of the main factors causing project delays was done by conducting questionnaires and calculations using the TOPSIS method. Respondents were personnel who are directly involved with the project from the owner, contractor, and supervisory consultant. The results of this study indicate that the main factors causing delays in project completion sequentially are the project implementation time is not in accordance with the project schedule, financial difficulties by the contractor, Owner's failure to coordinate land use/handover, unplanned funding of project activities properly (according to funding at the contractor), and negligence/delay by subcontractors.

Keywords : Project delay, SUTET, TOPSIS method.

1. INTRODUCTION

The SUTET 500 kV Grati – TX Kalanganyar Construction Goods and Services Procurement Project which connects GITET Grati in Pasuruan district to GITET Kalanganyar Sidoarjo with a total of 140 towers that pass through 3 (three) areas, namely Pasuruan city, Pasuruan district, Sidoarjo district. The objective of this project is to increase the reliability and stability of the system when there is a contingency of N-2 SUTET Paiton – Grati and Grati – Krian, especially when the Paiton PLTU is operating at its maximum.

The SUTET 500 kV Grati – TX Construction Procurement Project for Construction of Goods and Services began with the signing of the Letter of Agreement No. 077.PJ/KON.02.01/UIP JBTBI/2017 dated June 20th, 2017 with a duration of work execution time of 720 (seven hundred twenty) calendar days or until June 10th, 2019. However, there are obstacles that cause having extra time which is stated in addendum III which is until

December 31, 2019, and addendum V which is until December 30, 2020. The research in this paper aims to analyze the main causes of project completion delay of the SUTET 500 kV Grati – TX Kalangnyar Construction Goods and Services Procurement project.

The benefit that can be obtained from the research in this paper is to find out the main factors that cause delays in the completion of the SUTET 500 kV Grati - TX Construction Procurement project which can be used as consideration in future decision making to be able to complete the project according to the project completion time. in the employment contract.

2. LITERATURE REVIEW

2.1 Extra High Voltage Transmission Line (SUTET) Project

PERMEN ESDM No. 18 of 2015 divides power lines (transmission line) based on the electrical power delivered, which is divided into five namely SUTR, SUTM, SUTT, SUTET, and SUTAS. The electricity distribution medium used is in the form of a wire with the voltage increased to 500 kV with the aim of reducing wasted electrical energy due to being converted into heat energy when passing through a conductor between load centers that are very far away so that electrical energy can be distributed efficiently (Adiputra, et al, 2014).

The construction of the transmission lines in Indonesia continues to increase the length of the line every year. Referring to RUPTL PT. PLN (Persero) 2019-2028, in 2011 the total transmission network in Indonesia was 36,550 kms and increased to 52,605 kms in October 2018. Likewise for the 500 kV SUTET transmission line, which increased from 5,052 kms in 2011 to 5,143 kms in 2015. 2018. The stages of transmission network construction generally consist of 3 (three) stages, namely the Pre-construction Stage, Construction Stage, and Post-construction Stage as follows:

- a. Pre-Construction Stage
 - Determining the location of the tower site
 - Surveying the location of the tower site
 - Making land acquisition for tower site
 - Selecting a contractor
- b. Construction Stage
 - Procurement of civil and electro-mechanical materials
 - Tower foundation work
 - Tower erection work
 - Cable pulling (stringing) work
 - Commissioning
- c. Post Construction Stage
 - Handover
 - Warranty period

2.2 Project Delay

Some previous research results are not related to the main factors causing delays in transmission line projects such as those carried out by Trisanto and Wiguna (2012) which state that the aspect of the incomplete payment of compensation for land or plants passed by right of way of transmission line (ROW) is the highest risk in the construction project of the SUTT transmission line, followed by weather conditions such as rain, wind, and so on for a long time

causing delays incompleting work. In contrast to Karnia's research, et al (2020) stated that the change/addition of the number of towers was the highest factor causing delays in the 150 kV PLTP Karaha - GI Garut transmission line project, followed by the lack of human resources, delays in PLTP construction, inaccurate initial investigations/surveys and delays in previous work. Goutom et al (2020) stated that the main causes of delays in the completion of transmission line projects in Australia are transmission line ROW problems, frequent changes in transmission lines, difficulty in accessing tower locations, weak communication and coordination of parties in the project, late payments. Research by Nundwe and Mulenga (2017) states that the main causes of delays in the completion of transmission line projects in Zambia are poor weather conditions, poor financial management by contractors, late imports of materials, irregular subcontractor payments, planning scheduling or resource management skills. the bad one. Kalebuka, et al (2018) confirms previous research that the main causes of delays in the completion of transmission line projects in Zambia are due to the influence of rain on construction activities, types of bids and awards in tenders (lowest bids), difficulties in project financing by owners, delays in approval of major changes in the scope of work. by the owner, and late payment progress. Banobi, et al (2019) mentions the causes of delays in the completion of transmission line projects in developing countries, namely inadequate allocation of funds, delays in material and equipment delivery, poor cost management planning, vandalism, incomplete supply of materials sets. difficulties in project financing by the owner, delays in approval of major changes in the scope of work by the owner, and delays in payment of progress. Banobi, et al (2019) mentions the causes of delays in the completion of transmission line projects in developing countries, namely inadequate allocation of funds, delays in material and equipment delivery, poor cost management planning, vandalism, incomplete supply of materials sets. difficulties in financing the project by the owner, delays in approval of major changes in the scope of work by the owner, and delays in payment of progress. Banobi, et al (2019) mentions the causes of delays in the completion of transmission line projects in developing countries, namely inadequate allocation of funds, delays in material and equipment delivery, poor cost management planning, vandalism, incomplete supply of materials sets.

3. METHODS

3.1 Research Method

The type of research carried out is a case study, where research is carried out on the object of study in depth and the results can be used as a reference to handle similar cases. In this study, the object under study is the SUTET 500 kV Grati – TX Kalanganyar Construction Goods and Services Procurement project.

The stages of the research carried out are in accordance with Figure 1 below.

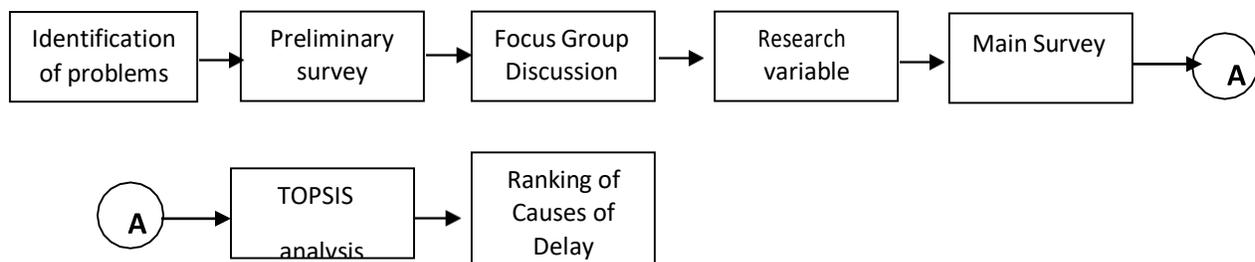


Figure 1. Research flow

3.2 Relevance Test

The preliminary survey was conducted through a review of project documents and using several previous studies (Proboyo, 1992; Trisanto and Wiguna, 2012; Karnia, et al, 2020), the initial variables were compiled into the initial research draft. The relevance test was carried out by means of a focus group discussion (FGD) on the initial research draft to find out the initial variables relevant to the SUTET 500 kV Grati – TX Kalanganyar Construction Goods and Services Procurement project. The results of the focus group discussion on the initial research draft were used as variables in the study. Respondents in the focus group discussion consisted of Owners, Consultants, and Contractors.

3.3. Data collection

The study used review documents to analyze work items that are delayed and determine the factors that cause delays in these work items. Furthermore, interviews were conducted with the parties (owner, contractor, consultant) to confirm the results of the review document and determine the research variables in the form of factors causing project delays. Next, look for data on the factors causing project delays as input for the weighting analysis by conducting questionnaires to the parties directly involved in project implementation.

3.4 Data Analysis

The data and the value of the questionnaire results was analyzed by using the TOPSIS method. The results of the TOPSIS method analysis were in the form of determining the main factors causing project delays and the weighting of these factors as the cause of project delays.

4. RESULTS

Based on the relevance test to the initial research draft, it was determined that there were 53 factors that caused the delay in the SUTET 500 kV Grati – TX Kalanganyar Construction Goods and Services Procurement project which was grouped into 6 aspects.

Table 4.1 Causes of Delay in the Procurement of Goods and Construction Services Project SUTET 500 kV Grati – TX Kalanganyar

No	Cause of Project Delay	Code
Organizational and Managerial Aspects		
1	Inaccurate reporting of work progress for supervisors	A1
2	Project execution time is not in accordance with the project schedule	A2
3	Lack/no competence of field implementers (contractors)	A3
4	Lack/no competence of field implementers (PLN)	A4
5	PLN's failure to coordinate land transfer/use	A5
6	Not yet designated as a priority project by PLN	A6
Planning and Scheduling Aspects		
7	PLN's very tight project schedule	B1
8	Contractor's work sequence plan that is not well organized/integrated	B2
9	PLN's work plan that changes frequently	B3
10	Wrong and inappropriate construction methods/work execution	B4
11	Determination of unequal working hours	B5
Financial and Economic Aspects		
12	Increase in the price of civil materials, tower structures and materials 4other ocal due to inflation	C1

13	The increase in the price of stringing materials and other imported materials due to fluctuations in the value of foreign exchange	C2
14	Error in calculating RAB (unit price and work unit price)	C3
15	Project funding was hampered due to late advances/terms from PT. PLN	C4
16	Funding of project activities that are not well planned (appropriate funding in contractors)	C5
17	Financial difficulties by contractors	C6

Table 4.1 (continued)

No	Cause of Project Delay	Code
Cultural and Environmental Aspects		
18	There are issues by NGOs to the population local regarding the dangers of a transmission line	D1
19	The payment of compensation for land/plants passed by the transmission line (ROW) has not yet been completed	D2
20	Temporary cessation of work due to national holidays, traditional ceremonies, religious ceremonies and so on	D3
21	Work stop orders by local government authorities pemerintahan	D4
22	Conflicts between regions traversed by transmission lines	D5
23	Permits from local government authorities to carry out work have not been issued/constrained	D6
24	Special permission from local residents for transmission lines that pass through customary/religious land	D7
25	Permits to carry out work are difficult to obtain from local residents	D8
26	Lack of public awareness of the rules and benefits of SUTET	D9
Design Aspects and Work Documents		
27	The process of calculating and making working drawings by contractors takes a long Time	E1
28	The shop drawing has not been approved by PT PLN as the owner of the job	E2
29	Design changes by PT PLN	E3
30	The scope of the design by PT PLN is not complete	E4
31	Changes in the scope of work at the time of implementation	E5
32	The technical specifications required by PT PLN in the RKS are not in accordance with field conditions	E6
33	Inadequate number of workers/according to existing work activities	E7
34	Dependence of the contractor on the sub-contractor	E8
35	Delays/delays by sub contractors	E9
36	There is a strike of workers / laborers	E10
37	There is riot/riot, war	E11
38	Unavailability of access for materials, equipment and workers to the site	E12
39	Unavailability of resources for civil works and working water on site	E13
40	The condition of the soil structure at each work location requires different methods and times of foundation work	E14

41	Local labor productivity is low and not up to expectations	E15
42	Work accidents for high work	E16
Physical Aspects and Job Inspection System		
43	The process of testing and evaluating material test from the owner is not relevant	F1
44	A lengthy work permit approval process	F2
45	The bureaucratic way of inspection and control of work by PLN	F3
46	Damage to equipment during use at locations that take a long time to repair	F4

Table 4.1 (continued)

No	Cause of Project Delay	Code
47	Incomplete material in the field for tower structure and stringging works	F5
48	Theft/loss of tower structure materials and stringging	F6
49	Inadequate technical personnel for certain jobs that require expertise	F7
50	Incompatibility of materials in the field with the specifications required by PT. PLN in RKS	F8
51	There is a defect in the work so that it does not match the specifications and technical Requirements	F9
Aspects of Nature and Weather		
52	Weather conditions such as rain, wind, and so on for a long time cause work to be Hampered	G1
53	The existence of natural disasters such as earthquakes, landslides, and so on causes work to stop	G2

The data on the causes of delays in Table 4.1 were conducted by questionnaires to 22 respondents consisting of 8 owners, 8 consultants and 6 contractors. The results of the questionnaire analyzed using the TOPSIS method obtained 5 (five) main factors causing delays in the SUTET 500kV Grati - TX Construction Procurement project, according to Table 4.2.

Table 4.2 Ranking of the Main Causes of Delays in the Procurement of Goods and Services Construction Projects for SUTET 500 kV Grati – TX Kalanganyar

Rank	Cause of Project Delay	Preference Value
1	Project execution time is not in accordance with the project schedule	0.90021117
2	Financial difficulties by contractors	0.86276879
3	PLN's failure to coordinate land transfer/use with preferential values	0.83495110
4	Funding of project activities that are not well planned (difficulty in funding in contractors)	0.82106201
5	Negligence/delay by sub contractor workers	0.80120817

The final result of this study showed that the project implementation time was not in accordance with the project schedule to be the first cause of delays in the SUTET 500 kV Grati - TX Kalanganyar Construction Goods and Services Procurement project. Therefore, it was necessary to increase control over the work schedule by the parties to maintain the time of execution of work in accordance with what has been planned. Then improved communication regularly by the parties.

From the results of this study, the authors recommend several actions to be taken to complete on time, including contractors so that they can start work according to the agreed schedule, consult subcontractors who have good contracts and can be managed properly by projects that have been approved. From the owner's point of view, in order to be able to submit ROW lines on time, always monitor the progress of work so that they can provide a written warning to the contractor if the deviation of work progress is greater than 20% of the planned s-curve, and provide delays to the contractor if in the future unable to complete the agreed scope of work.

5. CONCLUSIONS

The factors causing the delay in the Procurement of Goods and Construction Services Project for SUTET 500 kV Grati – TX Kalanganyar are 53 factors which are grouped into 7 aspects of delay causes. These aspects are organizational and managerial aspects consisting of 7 factors, planning and scheduling aspects consisting of 5 factors, financial and economic aspects consisting of 6 factors, cultural and environmental aspects consisting of 9 factors, design aspects and work documents consisting of 16 factors, the physical aspect and the work inspection system consist of 9 factors, and the natural and weather aspects consist of 2 factors.

The results of this study indicate that the main factors causing delays in project completion sequentially are the project implementation time is not in accordance with the project schedule, financial difficulties by the contractor, Owner's failure to coordinate land use/handover, unplanned funding of project activities properly (according to funding at the contractor), and negligence/delay by sub contractors,.

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SUPPLY CHAIN PERFORMANCE MEASUREMENT USING SCOR IN A COPRA MEAL PROCESSING COMPANY

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ABSTRACT

Performance measurement is the process of collecting and analyzing information related to the performance of individuals, groups, or organizations. Performance measurement is very helpful for companies to determine the performance of the company's supply chain in achieving organizational goals. To find out where PT JKL's supply chain operations lack, it is necessary to measure supply chain performance. Supply chain performance measurement can be done by using the SCOR model. This study aims to measure supply chain performance by utilizing the SCOR model. This study will apply the SCOR supply chain performance measurement to a copra meal processing company, namely PT JKL. A business mapping process will be carried out in accordance with the SCOR model, then it will be continued with supply chain performance measurement. The metrics that will be used to measure PT JKL's supply chain performance will focus on SCOR Performance Measurement Level 1 and 2. From the mapping of existing business processes at PT JKL, nine Level-1 SCOR Performance metrics are found that can be used to measure the company's supply chain performance. From the results of performance measurement for the 2018-2020 period, PT JKL has achieved the company's supply chain strategic targets. However, there are some aspects that still need to be improved on specifically on the company's internal-facing side.

Keywords: Performance Measurement, Supply Chain, SCOR Model, Copra Meal Processing Industry

1. INTRODUCTION

Performance Measurement, according to Behn (2003) is the process of collection and analyzing information related to the performance of individuals, groups or organizations. Performance measurement is very helpful for companies, groups or individuals because they can find the value of the performance of measurements assist in achieving organizational goals.

Lapide (2015) states that assessing an organization's financial accounting performance is certainly important in assessing whether the organization is in good health or not. However, this is not enough to measure the company's supply chain performance. To respond to the shortcomings in traditional accounting methods for measuring supply chain performance in an organization, various performance measurement approaches have been developed, such as the Balanced Scorecard & SCOR Model from the Supply Chain Council.

Although various supply chain models have been proposed, most of them

emphasize inventory management and distribution logistics. As mentioned earlier, strategic decision making is very important in supply chain management, which requires a framework model that can serve as an industry standard. Huang et al. (2005) mentioned that the SCOR model is present as an industry standard that enables next-generation supply chain management. The SCOR contains descriptions of management process standards, a framework for relationships between standard processes, standard metrics for measuring process performance, management practices that result in best-in-class performance, and alignment of standards with software features and functionality. The latest version of the SCOR model is version 12.0 which was released in 2017. SCOR has also been used in several supply chain performance measurement studies in various industrial sectors, including Shoushtari et al. (2011) for the chicken meat supply chain, Bukhori et al. (2015) for the chicken slaughterhouse, Putri et al. (2018) on poultry industry, Wibowo & Sholeh, (2017) on building construction projects, Anggraeni & Hermana (2010) on bottle cap manufacturer, Moazzam et al., (2018) for dairy industry, Waaly et al. (2018) on leather tanning industry, Wahyuniardi et al. (2017) on the leather shoes industry Erni (2013) and Lemghari et al. (2018) in the automotive industry. Azmiyati & Hidayat (2017) on elevator manufacturing, (Boxy et al. (2020) for the framework of vanilla value chains, Sarjono et al. (2017) for a distribution company, Ikasari et al. (2020) for lithium battery manufacturing and Kusri et al. (2019) for leather MSMEs.

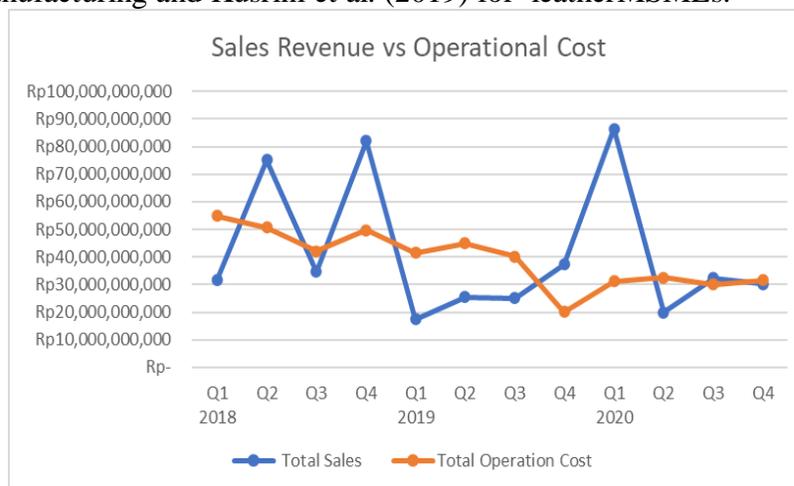


Figure 1 – Sales Revenue vs Operational Cost

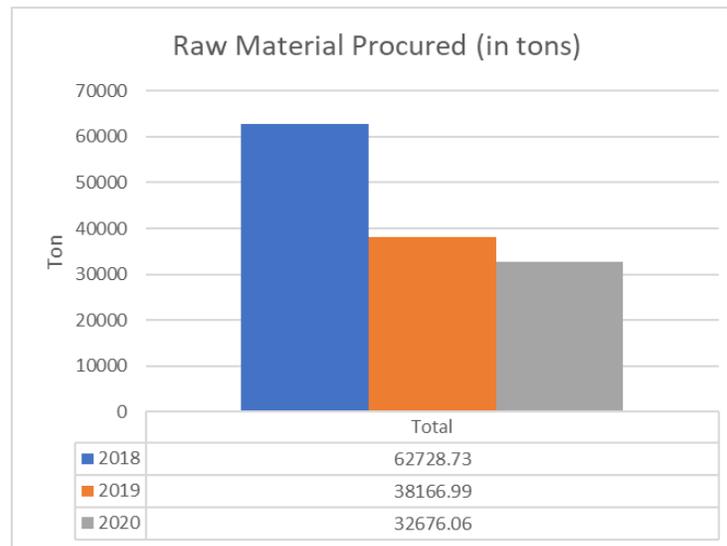


Figure 2 – Procured raw material (in tons)

PT JKL is a copra meal processing company. PT JKL is a strategic business unit of a major poultry feed manufacturers in Indonesia. As seen in Figure 1, in the last three years, operations in PT JKL is under major problem. Although Operation Cost keeps going better, sales in 2018 until 2020 is on a huge fluctuation with 2019 being the worst year of all. On the sourcing side, as seen in Figure 2, there's a huge drop in raw material procured from 2018 to 2020. These two symptoms suggest there is a problem in PT JKL's supply chain. However, it is difficult to pinpoint the problem. So far, PT JKL has never assessed its supply chain process, yet its performance. Thus, the company has difficulty to determine where the problem lies, and how to fix it. Measuring PT JKL's supply chain performance may facilitate the company's work in finding the problem.

This research has three goals in mind. First goal is to create a supply chain performance measurement model for PT JKL. Secondly, to measure and evaluate supply chain performance of PT JKL. Third, to provide a basis for making supply chain performance improvement recommendation for copra meal processing company, which is PT JKL.

2. LITERATURE REVIEW

Supply chain management, according to the definition from the Global Supply Chain Forum (quoted from Lambert & Cooper (2000)), supply chain management is the integration of business processes from primary suppliers to final customers that provide products, services and information that add value to customers and other stakeholders. Today, more and more relationships are managed across the supply chain. The supply chain is not a business chain with relationships between businesses, but a business network and relationships. Supply chain management offers the opportunity to capture integration and management synergies within and between companies. Supply chain management manages the overall excellence of business processes and represents a new way of managing business and the relationships between members in the supply chain.

Good supply chain management requires a change from managing individual processes to an integration of activities into the core supply chain processes. Traditionally, the processes

upstream to downstream of the supply chain interact as unconnected entities that receive information flows at specific times. According to Croxton et al. (2001) the key for a successful implementation of supply chain managements are:

- Executive support, leadership and commitment to change.
- An understanding of the level of change required.
- Agreement on supply chain management vision and key processes.
- Commitment of resources and empowerment needed to achieve the goals that have been set.

According to Fawcett & Magnan (2008) there is ten advantages in performing supply chain management, both from Customer-face and Company-focused. These advantages are:

Table 1. Advantages of supply chain management according to Fawcett & Magnan (2008)

<i>Customer-faced</i>	<i>Company-focused</i>
<ol style="list-style-type: none"> 1. Increase response speed on the customer side 2. Provide more consistent on-time delivery 3. Improve customer satisfaction 4. Shorter order fulfillment lead time 	<ol style="list-style-type: none"> 1. Reduce the cost of procurement of goods 2. Better asset utilization 3. Ability to cope with unexpected events 4. Reduce inventory cost 5. Increase productivity 6. Reduce costs

Another model that is often used is the SCOR Model from the Supply Chain Council. The advantage of the SCOR model is that this model is a reference model specifically created for the Supply Chain. Many studies have been carried out on the use of the SCOR model to measure supply chain performance, among others, Shoushtari et al. (2011) for the chicken meat supply chain, Bukhori et al. (2015) for the chicken slaughterhouse, Putri et al. (2018) on poultry industry, Wibowo & Sholeh,(2017) on building construction projects, Anggraeni & Hermana (2010) on bottle cap manufacturer, Moazzam et al., (2018) for dairy industry, Waaly et al. (2018) on leather tanning industry, Wahyuniardi et al. (2017) on the leather shoes industry Erni (2013) and Lemghari et al. (2018) in the automotive industry. Azmiyati & Hidayat (2017) on elevator manufacturing, (Boxy et al. (2020) for the framework of vanilla value chains, Sarjono et al. (2017)for a distribution company, Ikasari et al. (2020) for lithium battery manufacturing and Kusriani et al. (2019) for leather MSMEs.

Based on the APICS (2017) definition, supply chain operational reference (SCOR) is a model that provides methodologies, diagnostic tools and measurements that help organizations make improvements in the supply chain. The SCOR model was established in 1996 and is

regularly updated to adapt to changes in supply chain business practices. SCOR remains a powerful tool for evaluating and comparing supply chain activity and performance. SCOR provides a unique framework that links business processes, metrics, best practices, and technology into a unified structure to support communication among supply chain partners and to improve the effectiveness of supply chain management and related supply chain improvement activities.

The SCOR model has been developed to describe the business activities associated with all phases of fulfilling customer demands. The model itself contains several tabbed sections and is organized around the six main management processes of Plan, Source, Make, Deliver, Return and Enable. By describing supply chains using process block building, the model can be used to describe very simple or very complex supply chains using general definitions. As a result, different industries can be linked to describe the depth and breadth of almost any supply chain. The model has successfully described and provided the basis for supply chain improvement for global projects as well as local supply chain projects.

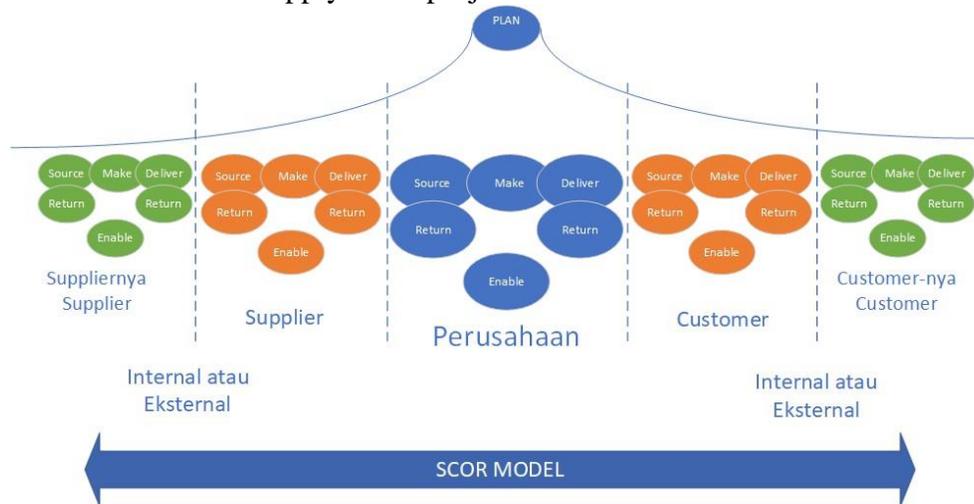


Figure 3. SCOR Model

In Figure 2, the SCOR process range includes all customer interactions, all material transactions, from suppliers to customers to customers, including transactions for equipment, supplies, spare parts, bulk products, software, etc. And all market interactions to fulfill customer orders. SCOR does not attempt to describe every business process or activity.

The advantage of the SCOR model is that this model can be applied to any industrial sector, especially in the manufacturing industry with varying degrees. Table 2 shows some of authors that used SCOR in their research.

Table 2. Research Regarding SCOR

Author	Tahun	Intisari Penelitian
Shoushtari et al.	2011	SCOR Application on poultry industry
Bukhori et al.	2015	SCOR Application on poultry industry
Putri et al.	2018	SCOR Application on poultry industry
Wibowo & Sholeh	2016	SCOR Application on building construction project

Anggraeni & Hermana	2010	SCOR Application on bottle cap manufacturing
Moazzam et al	2018	SCOR Application and risk management in dairy industry
Waaly et al.	2018	Mix of SCOR and AHP on tanning industry
Wahyuniardi et al.	2017	SCOR application on leather shoemaking
Erni	2013	SCOR application on automotive component manufacturing
Lemghari et al.	2018	SCOR application on automotive component manufacturing
Azmiyati & Hidayat	2017	SCOR application on elevator manufacturing
Boxy et al	2020	Creation of SCOR Framework for vanilla supply chain
Sarjono et al.	2017	SCOR performance measurement on distribution company
Ikasari et al	2020	SCOR performance measurement on lithium battery manufacturing
Kusrini et al.	2019	SCOR performance measurement on sugar manufacturing
Putri et al.	2019	SCOR literature review using journal review
Delipinar & Kocaoglu	2016	SCOR literature review to find research gap on SCOR
Ntabe et al.	2015	SCOR literature review for environmental impact of supply chain
Georgise et al.	2012, 2017	SCOR application literature review for developing country

3.METHODS

The data collection process begins with mapping the existing business processes in the field. Business process mapping will be carried out by means of in-depth interviews with stakeholders in the company. The purpose of the interviews is to conduct business process mapping aims to maximize the communication process between researchers and stakeholders in order to obtain detailed information from each stakeholder. The business processes that occur will be cross-checked with the processes in the section in the SCOR guide. After that, the results of the interview will be compared with the existing processes in SCOR Processes so that the business process flow is in accordance with SCOR.

Quantitative data collection was carried out simultaneously with the in-depth interview process with stakeholders. The data that will be collected is company data from January 1, 2018 to December 31, 2020. The data collected is in the form of production operational data, sales

and company financial data. The process of mapping the business process and collecting field data is estimated to take less than one month. These data mostly can be obtained through PT JKL's ERP system.

After the process has been mapped successfully, a supply chain measurement model will be created. The supply chain measurement model that will be used will use the existing supply chain measurement framework in SCOR performance. After mapping out which attributes will be measured, the process of measuring PT JKL's supply chain performance can be started.

The measurement data collection will be taken from the PT JKL ERP system. Data taken from the company's ERP system will be processed in order to meet the measurement process contained in the SCOR performance guidelines. In addition to data from the PT JKL system, this research will also use data from the finance & accounting department to meet data needs that require a financial point of view from PT JKL.

In the analysis and discussion phase, the results of business process mapping and supply chain performance measurement are processed and scrutinized for analysis. At this stage, it will be identified whether the condition of the company's supply chain is in accordance with the strategic goals that have been determined by the company. The research results will be compared with the company's strategic goals and the historical development of the company's supply chain performance. From this analysis, the identification of weak points in PT JKL's supply chain process will be carried out. The results of this study are expected to be the basic basis for PT JKL in carrying out the repair process and as a reference for measuring supply chain performance for industries similar to PT JKL.

4. RESULTS

In accordance with the results of the description of the identified business processes, process mapping will be carried out to determine processes and/or information from each stakeholder. Based on interviews with PT JKL's management, the production strategy uses Made- To-Stock. It aims to reduce customer order's overall fulfillment time. Reduction of lead time from the customer side is important because it reduces the overall cost related to transportation for in- bulk purchases. In addition, the chosen made-to-stock strategy aims to anticipate local purchases, which buys in smaller quantity but with more frequent and larger number of customers.

Table 3. SCOR process mapping based on as-is condition

PROCESS P	S		M		D	
Level 1 (Tipe Proses)	P- PLAN	S- SOURCE	M- MAKE	D- DELIVER		
Level 2 (Kategori iProses)	sP1 Plan Supply Chain	- sS1 Source Stocked Products	- sM1- Make Stocked Products	sD1 Deliver Stocked Products	-	

sP2 - Plan Source
sP3 - Plan Make
sP4 - Plan Deliver

The results of measuring PT JKL's supply chain performance can be seen in table 4.
Table

4 records the performance measurement of five performance attributes, namely reliability, responsiveness, agility, cost and asset management efficiency.

Table 4. PT JKL Supply Chain Performance measurement

Performance Attribute	Level-1	Level-2	2018	2019	2020	Remark
Reliability	RL 1.1 - Perfect Order Fulfillment		100%	100%	100%	
Responsiveness	RS. 1.1 - Order Fulfillment Cycle Time		42	42	59	Days
	RS2.1 - Source Cycle Time		49	46	34	Days
	RS2.3 - Deliver Cycle Time		2	1	1	Days
Agility	AG. 1.1 - Upside Supply Chain Adaptability		11%	11%	11%	
	AG. 1.2 - Downside Supply Chain Adaptability		17%	17%	17%	

Cost	CO.1.1 - Total Supply Chain Management Cost	Rp 41.83M	Rp 39.267M	Rp 36.447M	In Indonesian Rupiahs
	CO.1.2 - Cost of Goods Sold	Rp 219M	Rp 115,7M	Rp 171,2M	In Indonesian Rupiahs
Asset Management Efficiency	AM.1.1 - Cash-to-Cash Cycle Time	38	32	26	Days
	AM.1.2 - Return on Fixed Asset	-0.18	-0.52	-0.23	
	AM.1.3 - Return on Working Capital	-0.08	-0.19	-0.18	

5. CONCLUSIONS

The SCOR model is a good and effective reference for measuring the supply chain performance of a company including copra meal processing companies by conducting research with diagnostic methods for measuring supply chain performance to help companies make real improvements to their supply chain processes.

Based on the analysis of supply chain performance measurement using SCOR, PT JKL has achieved the company's strategic goals on the external-facing side. This is shown in the reliability value of 100% in 2018 to 2020. On the responsiveness side, there is an increasing trend of order fulfillment duration. However, after measuring the Level-2 responsiveness metric, PT JKL has faster sourcing times and faster delivery times.

Based on the analysis of supply chain performance measurement using SCOR, the internal-facing side of PT JKL gives a value that tends to be negative. In terms of cost, PT JKL's TSCMC has decreased costs, which is a good sign. The fluctuating COGS value tends to be influenced by macro factors which were initially bad as time went on, it seemed to improve. Asset Management is clearly seen that the condition of PT JKL requires a thorough improvement. Although PT JKL's CTCCT is getting faster, RoFA and RoWC still show a negative ratio. There is a need for a more comprehensive inspection and improvement so that the RoFA and RoWC ratio values of PT JKL return to a positive value.

This research has some limitations. The limitations that arise during this research should be discussed and included in future researches.

The analysis used in this analysis only includes the SCOR Reference Model based on the supply chain business process (Process) and Performance Attributes (Performance), and not based on the Analysis of Best Practices (Practice) and Organizational Design (People) in the SCOR Model, and this research only measuring performance attributes on level 1 and level 2 SCOR metrics, and does not measure performance attributes on level 3 SCOR metrics. There are limitations related to benchmark data. SCOR should use external benchmarks in order to know the relative position of the company and be able to perform gap analysis. In this study,

there are difficulties in finding benchmark data for similar companies so that external benchmarking and gap analysis cannot be carried out for PT JKL's SCOR Performance results.

The return aspect is not discussed in this study because PT JKL does not return raw materials or accept returns for finished goods. If there is research with the same condition on other similar companies in the future, it is hoped that it can also discuss the return aspect comprehensively.

The enable aspect is not discussed in this study because the use of ERP from PT JKL has not been able to cover all business processes at PT JKL. It is hoped that further research can cover the enable aspect comprehensively.

Metric AG1.3 Overall Value at Risk was not included in this study. This is because PT JKL does not yet have a comprehensive supply chain risk management so that the Overall Value at Risk measurement cannot be carried out. Further research is expected to be able to measure the Overall Value at Risk.

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Parallel Session 1

Room D (09:50 - 11:20)

Moderator:

Category: Operation Management

PRODUCTION SYSTEM IMPROVEMENT UD. INDO PRIMA PLASTIK WITH LEAN MANUFACTURING

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ABSTRACT

UD. Indo Prima Plastik is a company engaged in the processing of plastic waste into non-food grade household products. Some processes add value to the production process, and some processes are not value-added or waste. The objective of this research is to reduce or eliminate non-value-added processes by lean manufacturing. The urgency to conduct this research is waste reduction will reduce production costs and time so that it will increase productivity. The company's leaders choose lean manufacturing because the company's leaders want to reduce processes that are not value-added but do not want to make significant overhauls, and production continues despite system changes in the company. The initial stage will be value stream mapping as a control path map so that all production activities will be well described and carry out an identification and elimination system to eliminate activities that are not following the company's achievements. The final process will be an FMEA system for problem-solving. The results showed that the three critical wastes were Delay and Waiting, Unnecessary Motion, and Inappropriate Processing. The root causes of critical waste are the skills and abilities of employees and a shortage of materials for production.

Keywords: lean manufacturing, VSM, Big picture mapping, RCA

1. Introduction

Manufacturing is a production system with a complex production planning model and control system to meet mass production needs. The lean method aims to reduce variations by eliminating waste (requires rework, unnecessary processing steps, movement of materials or people, waiting time, overstocking, and overproduction), which is considered any action that does not add value to the product or service and provides the highest quality, lowest cost and shortest lead time.

UD Indo Prima Plastik is a company engaged in the manufacturing industry whose products are non-food household appliances (i.e., bucket, broom, tin, basin). In its production process, the company uses plastic waste product materials as a medium for raw materials because the value of the material price is more affordable and more accessible to obtain than using pure plastic seeds. UD Indo Prima Plastik was founded in the 90s to coincide in the Menganti - Gresik area, starting from a lathe and machine workshop business on a home scale and has grown to this day into a trading business for plastic products. Consumers consist of sales agents, wholesale markets, traditional markets, retailers - collectors, and SMEs, and until now, the market coverage starts from the island of Java and outside Java.

2. Lean Implementation

There are four essential factors to consider to implement the lean concept: committed and integrated management, involvement of organizational members, training and education of organizational members, and awards and appreciation. The assumptions lean: committed management, employee engagement, training & education, awards & recognition, and communication between members (Achanga, 2006).

3. Big Picture Mapping & Value Stream Mapping

Big picture mapping is a media tool used and functioned to make it easier to find a picture of a specific process as a whole. Big picture mapping will make it easier to identify the possibility of the emergence of waste in the value stream process (Hines dan Taylor, 2000):

- Customer Requirements identify and analyze the type and number of products ordered by consumers, when the product is needed, and the capacity capable of one delivery.
- Information Flow describes and explains how the flow of information obtained from consumers to suppliers contains, among other things, forecasting of products to be produced and needed by consumers and information if there is a cancellation to suppliers.
- Physical flow describes the physical flow in the form of materials or products, the time required for craft, inventory and inspection conditions, cycle times for each part and total production and transfers between sub-components, operational time at each workstation in a day, the number of inspection at each point, and the number of workers at each workstation.
- Linking Physical and Information Flow connects the information flow and physical flow with arrows containing information on the schedule used and work instructions.
- Complete Map from complementary map/information flow and physical flow by adding lead time and value added time under the flow drawing section.

Value stream mapping provides direction and visualizes processes that can provide value and those that do not add value, identify waste, problems that occur, and how to prevent, disseminate information, and others on how a product produced starting from the flow from suppliers / raw materials to consumer's value stream mapping consist of three main components (Nash dan Poling, 2008) namely:

- Process production flow describes a process flow from raw materials to finished goods to consumers.

- Communication/information flow of various types and models of information flow regulates and control the production process flow.
- Timelines & travel distance show the length of time for each process from the lead time and cycle time and the distance from each process or area.

4. Analysis

4.1 Process

The production processes start from mixing the main and additional materials and coloring if needed. The process continues in a plastic injection molding machine and check the quality before the product enters the warehouse and send to the consumer.

- Process of purchasing main and additional materials from suppliers for purposes in the production process so that there is no engine shutdown and waiting for material; in this process, the material will not be processed directly; some will enter the warehouse. The purchased material will be checked for initial conditions whether it is suitable / still has product defects (the presence of rubber, dirt, and metal).
- The washing process aims to separate dirt and metal that is still attached to the material to better the processing process.
- A drying process is needed if the condition of the plastic material is in a dry condition of less than 10% to facilitate the following process, but if the plastic condition is under the wishes, it will proceed to the destruction process.
- The process of crushing plastic material into smaller pieces so as not to damage the components in the inject molding machine and speed up the plastic melting process.
- The mixing process will make it easier for the material to mix well and add a coloring process if needed.
- The finished material will continue to the production machine so that if the final product is not suitable, then the product will be reused as additional material in the initial process.
- The final product will go to the warehouse for packaging and calculations to record the product.
- The final products are ready to consumers; if the product is defective/damaged during the shipping process, the consumer will be given a quality policy where the damaged goods can be exchanged for new goods/discounted prices according to the number of damaged products. Moreover, the damaged product will be reused as additional material in the initial process.

The production process takes place 24 hours per day, in 2 work shifts, every day throughout the year except for holidays and specified holidays and 34 employees. Value Stream Mapping (VSM) shows a more detailed description of all types of activities that add value to the production process. VSM itself is a tool in lean theory that has a function to describe a production system by sequencing the physical process flow and the information flow involved. VSM can facilitate the identification and analysis of all activities that have the potential to cause waste, the length of time required for each process, as well as the relationship between physical flow and information flow in the production process as follows:

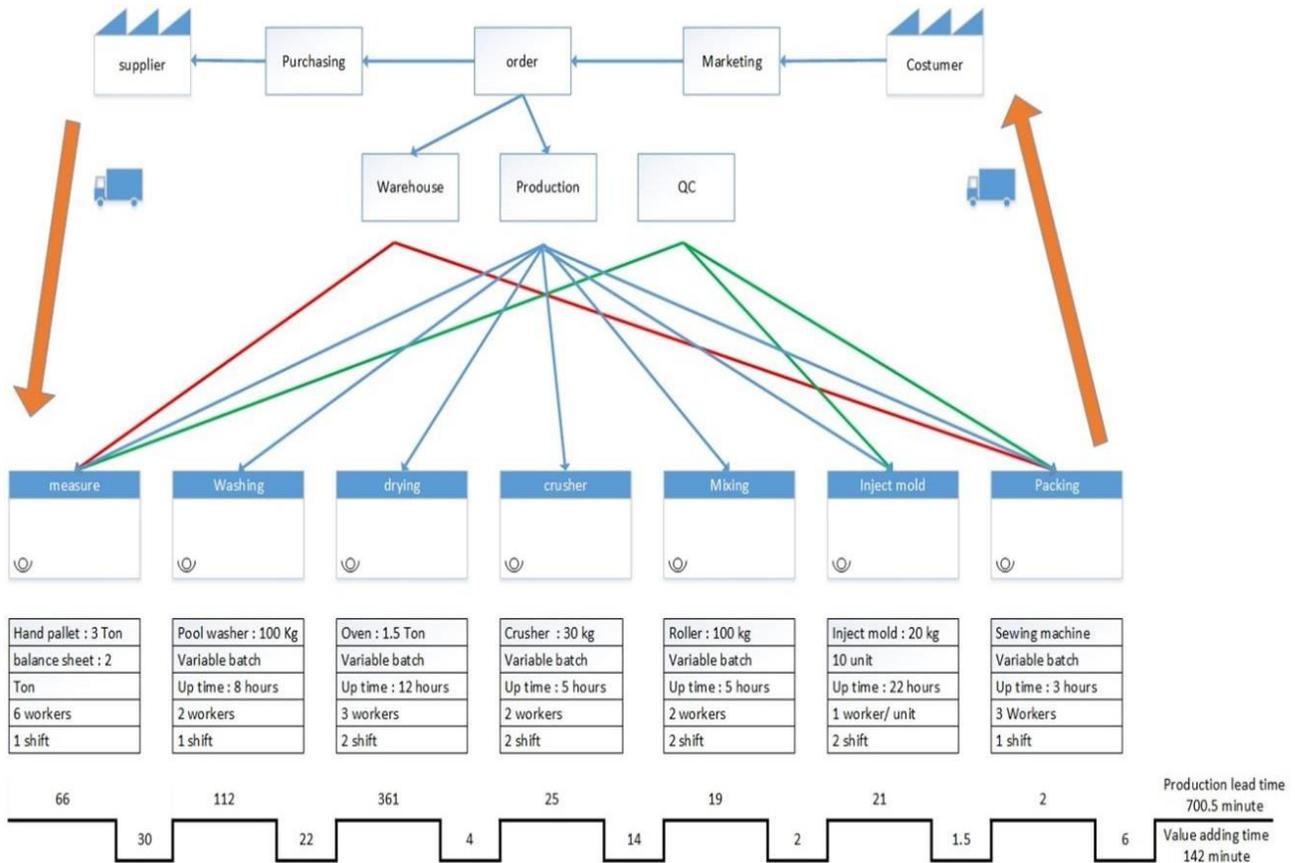


Figure 2. VSM Diagram of the Production Process

4.2 Activity Identification and Categorization

From the observations, each activity in the production process will be explained to find out how the waste that occurs in the production process, then the classification process will be carried out in the category of operation (O), transportation (T), inspection (I), storage (S), and delay (D). These activities are also categorized based on their function towards value-added, namely the category of value-added activity (VA), non-value-added activity (NVA), or necessary but non-value-added activity (NNVA). The following are the results of categorizing the types of activities in the production process.

Table 1. Activity process

Procees	Activity	Time	O	T	I	S	D	VA	NNV A	NV A
Measure	Unload pack	45		v					45	
	Tracing	6			v			6		
	To warehouse	30				v			30	
	To washing	5		v					5	

4.3 Identification of Critical Waste

Several respondents carried out filling the waste weighting questionnaire as the party responsible and understood the production process at UD. INDO PRIMA PLASTIK, namely:

- Respondent 1: Director
- Respondent 2: Plant Manager
- Respondent 3: Head of Production

Tabel 2. Rank respondent

Waste	Rank respondent		
	1	2	3
Defect	7	6	7
Over production	6	7	6
Inventory	4	5	5
Inappropriate processing	3	3	2
Transportation	5	4	4
Delay & waiting	1	1	1
Motion	2	2	3

Tabel 3. Waste Rank

Waste	Ranking							Total	Weight (%)
	1	2	3	4	5	6	7		
Defect						1	2	4	4.8
Overproduction						2	1	5	5.9
Inventory				1	2			10	11.9
Inappropriate processing		1	2					16	19.0
Transportation				2	1			11	13.1
Delay & waiting	3							21	25.0
Motion		2	1					17	20.3
Value	7	6	5	4	3	2	1	84	100 %

4.4 Failure Mode and Effect Analysis (FMEA)

After the analysis process has been carried out and then found various factors causing the root of the problem that can cause waste to appear, it is necessary to reconsider sorting out the root causes of problems that significantly impact the production process. The FMEA method used in this study is helpful in determining the root cause of the problem, which is considered to have a critical level so that it will make it easier to carry out the improvement process in the process and be more accurate in suppressing waste in the company.

Table 4. FMEA

Waste	Problem	S	O	D	RPN	% RPN
Inappropriate Processing	Trial process to change product/material	1	5	8	40	1.10
	Poor condition of raw materials	6	3	6	108	2.96
	Color measuring tool is not precise	5	5	7	175	4.80
	Lack of suitable aids	4	4	4	64	1.75
	The concentration of employees is disturbed	7	5	8	280	7.67
	Employee conditions at work	6	3	8	144	3.95
	Negligence of officers	7	6	8	336	9.21
	Machine setup and operation	8	6	8	384	10.52
Delay & Waiting	Product safety stock is lacking	9	7	8	504	13.81
	Not have material from supplier	9	4	9	324	8.88
	Have not got the material from the supplier yet	9	4	1	36	0.99
	Delay in delivery of raw materials by suppliers	9	4	1	36	0.99
	Delaying goods to other customers	6	4	5	120	3.29
	Absent employee	9	3	7	189	5.18
	Production schedule is not suitable	7	3	1	21	0.58
	Employees lack other skills	2	2	7	28	0.77
	The machine did not cover the production rate	9	2	9	162	4.44
	Effect of weather on company mobility	2	2	8	32	0.88
	Employee performance is not good	9	3	8	216	5.92
	Customer confirmation	1	2	1	2	0.05
Unnecessary Motion	Operating standards are considered to complicate	7	2	8	112	3.07
	Officers are busy with other matters	7	3	8	168	4.60
	Limited access to storage locations	6	2	7	84	2.30
	Material storage access limitations	6	2	7	84	2.30
total					3649	100

1. Inappropriate Processing

- The color measuring tool is not precise
 - Using a digital balance and doing it in the form of a measure in the form of units (grams/scope)
- Employee concentration while working is disturbed
 - Avoiding conditions that allow employees to congregate (playing mobile phones, eating/drinking, sharing components/tools in repairing machines, joking, conspicuous clothing, especially among employees, jewelry)
 - Conducting regular employee monitoring processes
 - Make the environment as comfortable as possible so that employees can feel at home at work
- Employee negligence
 - Make a sequence of work processes before execution
 - Re-checking parts / stages
 - Reducing the workload of employees following the limits of ability / using

employees who are more suitable in overcoming problems that arise

- Machine setup and operation
 - Reset every replacement of a different material/product to be created
 - Ensure the condition of the machine and measuring instruments and engine motion components in a neutral condition for each component during calibration
 - Always check the history of the machining process running

2. Delay & Waiting

- Lack of product safety stock
 - Perform the production data collection process every month / based on the calculations used by the company.
 - Expand the required production lines and reduce the production rate whose sales are declining / less desirable
 - Product priority division
 - Prioritize primary buyers over secondary ones
- Have not received materials from suppliers
 - Make purchases more / often as a medium to lure suppliers into choosing to sell their products to the company
 - Purchase with a slightly higher price offer than the standard price/company target
 - Purchasing of materials if the price drops as stock storage/guarding in case of scarcity at some point (if possible)
 - Provision of new warehouse/storage land
- Employee absent
 - Take a light approach, especially if it is felt that the employee's performance is not too bad, and give a firm warning if the employee cannot give a wrong reason, especially those who are often absent
 - Assist if employees absent have a heavy burden and can be accounted for (accidents, operations, disasters, relatives die)
 - Approach employees to understand what is going on because employees are an essential asset in the company
- Machine capacity does not cover the production rate
 - Check whether the condition of the machine and production components are in the excellent and prime condition / require maintenance
 - Use products according to the type of machine and its capacity
 - Improve the condition of raw materials for production if the results used do not increase the impact but decrease the quality
- Employee performance is not good
 - Carry out more regular supervision in the field
 - Reduce employee workload/use employees with abilities that match the workload
 - Give rewards to employees as an increase in work morale
 - Check whether the work environment is suitable for employees at work

3. Unnecessary Motion

- Officers are busy with other matters
 - Divide the work sequence of officers

- Division of employee work schedule and work process
- Reduce/eliminate the part that employees feel incapable/insufficient in taking care of the job

For continuous improvement in the future, the company can apply the 5S method as a part of the improvement process within the company. 5S is one form of a system to reduce/reduce waste and help optimize productivity by creating an orderly, neat, and systematic workplace. The term 5S comes from the Japanese language known as an abbreviation of:

- Seiri (Sorting)

Identify and sort out the unnecessary parts of the work area by leaving only the necessary parts. The company has a variety of production machines that are used, but in some models, some units have components that do not match, to minimize the company can resell/transfer the function, this will help the company if the company has 1 type of machine with the exact specifications and similar brand. The company will benefit in terms of spare parts if the purchase is in large quantities and makes it easier to repair if a machine is damaged and there are no spare parts; technicians will easily take from machine parts that are not operating as a temporary alternative.

- Seiton (Setup)

It is a form of structuring activity that means that materials and equipment in the work area must be arranged systematically and sequentially to make it easier to use to become more efficient and more accessible if the items used are lost and can be identified quickly. This can be done by placing supporting materials and equipment on parts of the rack that are easily accessible and easily accessible. In its application, the company is still unable to apply it properly due to the lack of land requirements, making it possible for employees to have to carry out a search process from one section to another, not to mention if there are employees who need tools as soon as possible but forget to return them to their original place so that the goods/tools may become lost. As a solution, the company can move the machine parts/machine parts that mix to an arranged place so that it is easier to provide free space in the placement of other components and the company looks more organized and organized

- Seiso (Cleaning)

The purpose of self-cleaning is to remove dust and dirt and keep the workplace clean and unobstructed. All workers in the company are required to implement it, and it is helpful to facilitate the production process in the company and make people aware of cleanliness and tidiness in the work area by applying it every week/month. Meanwhile, for each part of the work station, workers must make every change of work shift so that they will not be burdened by unsanitary working conditions when changing employees. Carrying out the cleaning process regularly and consistently will make the area in the work area easier, tidy, clean, and efficient. It seeks to create awareness of environmental cleanliness and clean living habits.

- Seiketsu (Standardization)

It is a standardization process that follows the standards or rules that have been set by the

party that handles the standards and quality of goods/services. With the implementation of the standardization pattern that has been made, employees can work according to the procedures and rules that have been made so that workers will be more skilled at work and not speed up work process time and be more skilled at work efficiency. In practice, the company still does not have optimal work standards in determining operational time in production. This occurs due to a lack of harmony in operations, such as high cases of absent employees and employees leaving the workplace to hamper the production rate when orders are piled up from customers. Some employees are often late for the morning/evening shift, resulting in the production being delayed and the machine idle due to the absence of a guard operator. The company's solution can provide warnings such as when the distribution of salaries/wages of workers is carried out individually and face to face without being distributed directly so that the leadership can find out the cause and purpose of the shortage made by the employee or vice versa if the employee can meet the production target in each month will be given rewards in the form of salary increases / additional facilities/point deductions if an error occurs, this will provide additional encouragement for employees to comply with company rules.

- Shitsuke (Habit)

In this case, the company must make how the 5S program that has been made into a corporate culture must be carried out continuously. For this, the company is required to continue to carry out the previous sequence of actions to become a work culture that is obeyed in the work environment so that the system will automatically run itself, and employees will feel ashamed if they do not implement it.

5. Conclusion

From the weighting results, it is known that three critical wastes among seven wastes by applying the Lean concept, the waste with the highest weight is Delay and Waiting at 25.0%, Unnecessary Motion at 20.5% and Inappropriate Processing at 19.0%. There the three critical waste categories described above, the root causes of the problems that are prioritized are the skills and abilities of employees that affect the emergence of processing errors and repetition, less than optimal employee conditions that have an impact on the production process, shortage of production materials due to problems with suppliers and handling of the company in storing and managing materials, the number of absent employees and the company's ability to carry out readiness to meet product needs for customers. The practical implication of this research is a change in the way employees work so that the proposed waste reduction can occur. Company leaders need to show new ways of working, supervise and provide incentives so that new ways of working become a habit. Recommendations for improvement proposed for waste problems that arise within the company can be in the form of;

1. Application of 5S (seiri, seiton, seiso, seiketsu, shitsuke).
2. Improved performance with improved quality control, better inspection standardization, better supervision, and improved communication and information relations within the company
3. Good inventory management by making additional warehouses if when material

prices are lower, the company can make its stock without combining it with production stock

4. Improving working relationships within the company's scope of work (suppliers, employees and leaders, and superiors)

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PRODUCTION PROCESS AND RACKING STORAGE SYSTEM DESIGN FOR OPEN TOP CAN (OTC) PT. X PURWOSARI

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ABSTRACT

PT. X Purwosari factory is a manufacturing company engaged in the food industry (milk processing). Purwosari factory has a project to deliver open top can (OTC) supplies to the Cicurug factory. During the project, the Can Making department faced several problems. First is the production output was below the target from October 2020, and second is there are many cases found about expired OTC in the racking area. The purpose of this study is to identify the main cause of the problems and create a proper plan to solve all of them. The methods used to analyze the problem is Lean Six Sigma (DMAIC) by creating current state value stream mapping (VSM), and the Lean principle used to solve the problems. As for the racking area, a suitable racking system must be designed. After all of the problems were solved, the last step is to create a future state VSM. The result of this research is reduction of non-value added time (NVAT) from several process like distribution lead-time reduction with installing new machine, and the effect from the implementation of new racking system. The total of NVAT reduction from all of the process is 60% from NVAT at current condition.

Keywords: Supply chain, value stream mapping, warehouse management, Lean manufacture.

1. INTRODUCTION

Product that meets the specifications and quantity demanded by the customer is a matter that must be fulfilled by the manufacturing company. Because customer satisfaction is the main factor for the company to develop its business. But to fulfill all of that is not an easy task, because there are always problems that arise in the field. Some of the examples of problem factors that often arise in manufacturing activities in companies to fulfill all requests from buyers, ranging from the number of defective goods, the number of goods that are not fulfilled on time, and many more.

PT. X Purwosari factory is one of the manufacturing companies engaged in food. The main products produced at the Purwosari factory are dairy products such as ultra-high temperature milk, liquid milk, and condensed milk. Besides that, Purwosari factory is one of several branch factories which produces its own cans or commonly known as open top cans (OTC) for the condensed milk packaging. Currently Purwosari factory is running a project to meet the demand of OTC at the Cicurug factory which has been

running since October 2020. The OTC will be produced by the Purwosari factory and distributed by land from Purwosari to Cicurug. During the implementation of the project, the Can Making department faced several problems. The main problems faced are as follows.

- In accordance with Figure 1. the graph of production results from October to December 2020 below, the number of OTC produced by the Can Making department is below the predetermined target.



Figure 1. Target vs Actual Output 2020

- Another problem faced by the Can Making department is the inefficient use of storage racking, causing some OTC pallets to be stored for a long time.

Therefore, we need a study using value stream mapping to analyze the current OTC production flow in the Can Making department of the Purwosari factory and apply improvements to any existing waste or problems. Value stream mapping is a Lean tool that is very useful for manufacturing companies in identifying all the problems that occur in their manufacturing sector. Problems that occur in the manufacturing sector are often interpreted as waste (King & King, 2015). By utilizing value stream mapping, companies can easily see where the waste is occurring in the flow map of all their manufacturing activities, as well as simplify the decision-making process to do some improvement.

2. LITERATURE REVIEW

Voehl et al (2014) define the concept of Lean as an effort that focuses on identifying and eliminating all kinds of waste that occur in the company. Some examples of efforts in the Lean concept such as zero inventory, line balancing, reducing waiting time, and others. The Lean concept also has several tools such as overall equipment effectiveness (OEE), 5S (sort, set in order, shine, standardize, and sustain), Kanban, value stream mapping, and others. In the Lean principle, there are several metrics that are commonly used as key performance indexes (Chaple & Balkrishna, 2017), such as.

- Lead-time, the time spend at some process from start to finish.
- Value added time, time spent to provide value to the product.

- Non-value added time, time spent in a process but does not add value to the product.
- Cycle time, a period of time between repetitions of the same process.
- Takt time, the frequency of time required to make one product.

Wijaya (2010) states that Six Sigma is a method with the aim of preventing defects and reducing the level of variation in the products that offered to customers. Besides being able to maintain the level of customer satisfaction, the use of Six Sigma can also help companies reduce unnecessary costs in each of their business processes. According to Pyzdek (2003), there are many methods that can be used to apply Six Sigma, but there are five basic steps that need to be implemented first before using other methods. The five steps are called DMAIC, which stands for define, measure, analyze, improve and control. DMAIC is a method of Six Sigma that is used as a methodology to create problem maps with the aim of making improvements. The following is a further explanation regarding DMAIC according to Krishnan and Prasath (2013), can be listed below.

- Define: make a problem statement, set goals, and benefits
- Measure: collect initial data from the problem
- Analyze: determine the root cause and the goals of performance improvement
- Improve: create some workable solutions
- Control: describe validation methods to monitor and maintain the system

Basically the Lean concept and the Six Sigma DMAIC method have different individual properties. However, Mandahawi et al (2012) stated that when the two concepts are combined, it would become a philosophy that strong enough to give an improvement to a series of process. Because these two things complement each other, the Lean concept dominated by a qualitative approach, while the DMAIC method dominated by a quantitative method. Lean and Six Sigma have been widely implemented in several industrial fields. In its implementation, Lean and Six Sigma have been proven to provide a high level of improvement in terms of cost, quality, and process time improvements.

According to King & King (2015), waste is known as an activity that is not important or not needed. Therefore, waste elimination needs to be carried out in every industrial sector. There are seven type of waste that includes, Overproduction, Inventory, Defect, Transportation, Waiting time, People Movement and Process. Yuvamitra et al. (2016) explained that one of the lean tools that can be used to help identify and eliminate waste is Value Stream Mapping (VSM). The way VSM works is to make a detailed picture of the production process from the current state and create a picture of the future state after applying the Lean concept. The purpose of using VSM in general is to reduce the time required for the process of receiving orders from customers, product production time, and product delivery time to customers (Chaple & Balkrishna, 2017).

3. METHODS

The Six Sigma DMAIC method used in this research to help the identification process until implementation of the compiled solutions. This research was carried out in

the sequence of DMAIC method from Define stage to Control stage. Here is the detail of each stage from this research.

- **Define:** this stage objective is to collect information related to the problems that are currently being faced. There are various ways that can be done in order to collect this information, one of which is by conducting interviews with the management at the Purwosari factory. The purpose of this interview is to find out what factors support the implementation of this project, as well as to find out what problems were encountered in the process of implementing the project.
- **Measure:** this stage objective is to collect the initial data needed in this study. The collection was carried out through two methods, direct observation and interviews with Can Making department personnel. Observations made by researchers were carried out by calculating the time of each process manually with a stopwatch for several processes and recording information related to the capacity of the production machine. Next, the researcher conducted a brief interview with the Can Making department personnel for .
- **Analyze:** this stage objective is to create a VSM Current state from the current conditions in the existing work environment in the Can Making department based on the data that has been obtained previously. The function of the current state VSM is to find out the location of the problem or other waste that was not obtained during the initial interview in the define stage, and to find out the location and causes of problems or other waste that was not seen before. In addition to making the current state VSM, the researcher also designed the racking storage flow, which was made based on the existing storage process flow. The purpose of making the storage flow is to provide a detailed description of how forklift operators carry out the OTC pallet storage and retrieval process.
- **Improve:** this stage objective is do a brainstorming and discussions with management to think about solutions to implementing any steps that can be taken to improve any existing problems according to the Lean concept. In addition, a flow system for OTC storage systems in racking also being designed. The system aims to make it easier for operators to carry out the process of storing and retrieving OTC pallets by utilizing the FEFO principle and selecting storage racks and collecting data automatically. After getting several solutions and design of racking storage systems, the next step is to create a future state VSM to get an overview of the entire OTC production process after every problem has been resolved.
- **Control:** this stage objective is to organize a training for the Can Making department personnel to support the realization of all solution implemented on future state VSM. So that the problems that occur in the Can Making department can be resolved properly.

4. RESULTS

Purwosari factory is one of the branches that has a Can Making department. This makes the Purwosari factory able to fulfill its own demand of cans for packaging purpose. Meanwhile, for several other branch factories that do not have a Can Making

department, in order to meet the needs of cans packaging, they must make purchases through a third party (supplier) who can provide the needed cans for packaging.

4.1. DEFINING THE PROBLEM AND COLLECTING DATA

Currently the Purwosari factory is running a project to deliver OTC supply to meet the demand from the Cicurug factory. According to the Can Making department management, several things were considered for carrying out this project, like the production capacity occupation which is only used about 40% and the OTC price produced by the Purwosari factory is cheaper than the OTC price offered by the supplier. During the implementation of the project, the Can Making department management encountered some problems, first is the production output was always below the target for several months. In addition, the management also added that there is a problem in the racking area, that expired OTC products are often found. After obtaining basic information regarding the current problem, the next step is to collect data. The method used for data collection includes measuring the time of each process manually with a stopwatch, and conducting interviews with several personnel to obtain additional information needed.

4.2. CURRENT STATE VALUE STREAM MAPING

The use of value stream mapping (VSM) in analyzing and repairing problems is very large and can be applied to almost all industrial sectors. Based on the data collected in the previous stage, the current state of the VSM from the Can Making department's production sector can be described as shown in the image 2 below. The VSM shows the flow of information and the flow of goods that occur as a whole in the Can Making department and has been completed by the data obtained previously.

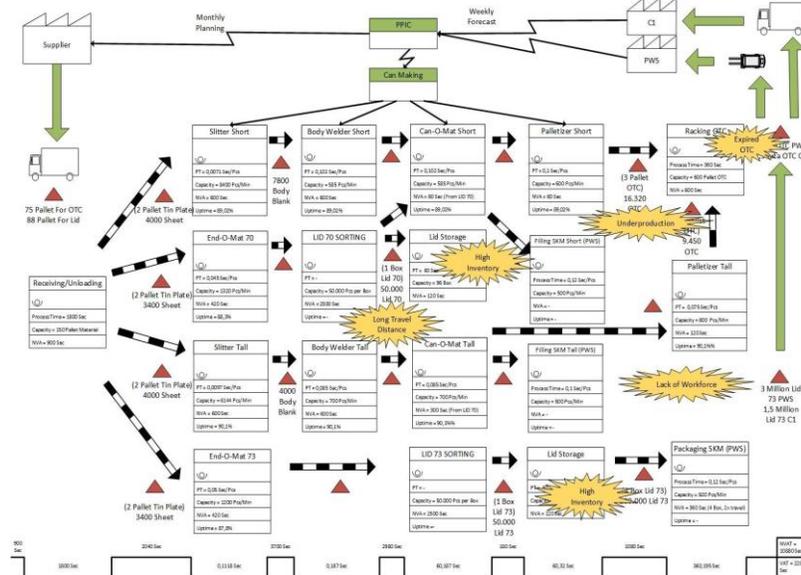


Figure 2. Current State Value Stream Mapping

The description of the problems seen in the current state value stream mapping

above can be rewritten as follows.

- **Underproduction**

Through the results of the discussion, the management said that breakdowns in production machines were the main cause of the low OTC production rate. The high case of jamming on the welder machine is the main factor in the occurrence of breakdowns and its often caused by the condition of the raw materials that does not have a correct specification (defects).

- **Expired OTC**

Based on the results of discussions with the management, five main problems that have a considerable influence were taken as the cause of this problem. Some of these problems include the following.

- Lack of operator knowledge regarding the age of the product taken.
- There is no proper SOP in selecting products for storage or retrieval.
- There is no detailed information about the location of the rack.
- There is no tracker that can show the location of OTC pallet

- **Lack of Workforce**

According to the discussion, the management said that the number of personnel in the Can Making department had not increased since the addition of a new OTC production line until the project implementation of the OTC delivery to the Cicurug factory. This causes the Can Making department to be difficult and unresponsive in handling several cases of problems that arise such as machine breakdowns, or slow movement of goods that occur in the Can Making department.

- **High Inventory**

According to the results of the discussions that have been carried out, there are five main factors that greatly influence this problem. Some of these problems can be described as follows.

- The operator does the feeding process of Lid 70 for the COM machine and feeding Lid 73 for the filling machine manually.
- Lid 73 production results still have to be accommodated in the storage area first.
- The Lid 73/70 production target is higher than the OTC can production target.

- **Long Travel Distance**

To move a single box of Lid 70 from an EOM machine to a COM short, it takes about one minute. Meanwhile, the time needed to move a single box of Lid 70 from EOM to COM takes about five minutes. Based on the results of the discussion, it can be seen that the main cause of this problem is the layout of the EOM 70 machine that does not match the layout of the two production lines of OTC, which require Lid 70 at the same time.

4.3. FUTURE STATE VALUE STREAM MAPPING

A series of discussions and brainstorming have been carried out with management and supervisors to discuss more detail about the problems that occur and to develop several solutions that can be applied to resolve some of the problems that have been encountered. The causes of some of the problems that have been found are caused by raw materials that are defective, there is no system that helps the process of data entry

and selection of racking location, machine layout that is not suitable, workforce planning that are not appropriate, and work-in-process (WIP) production target is higher than products than the final product. Several solutions have been developed through a brainstorming process that has been conducted with the management. After getting the solution, the next step is to create a future state value stream mapping (VSM) which has proposed several solutions that were prepared previously. In creating a future VSM, there are steps that must be done first. The first step is to find the Takt time, here is the calculation of the Takt time needed to make one OTC canned product.

$$\text{takt time} = \frac{\text{total available time (Sec in One Week)}}{\text{Demand (Pcs in One Week)}} = \frac{604.800 \text{ Sec}}{4.500.000 \text{ Pcs}} = 0,1344 \text{ Sec/Pcs}$$

If the Takt time value is greater than the processing time on one of the machines, then this indicates a bottleneck in the production process by that machine. The comparison between takt time and time in each process has been carried out and there is no visible bottleneck in the entire production process of the Can Making department. The future state VSM used for comparing the Takt time can be seen on figure 3 below.

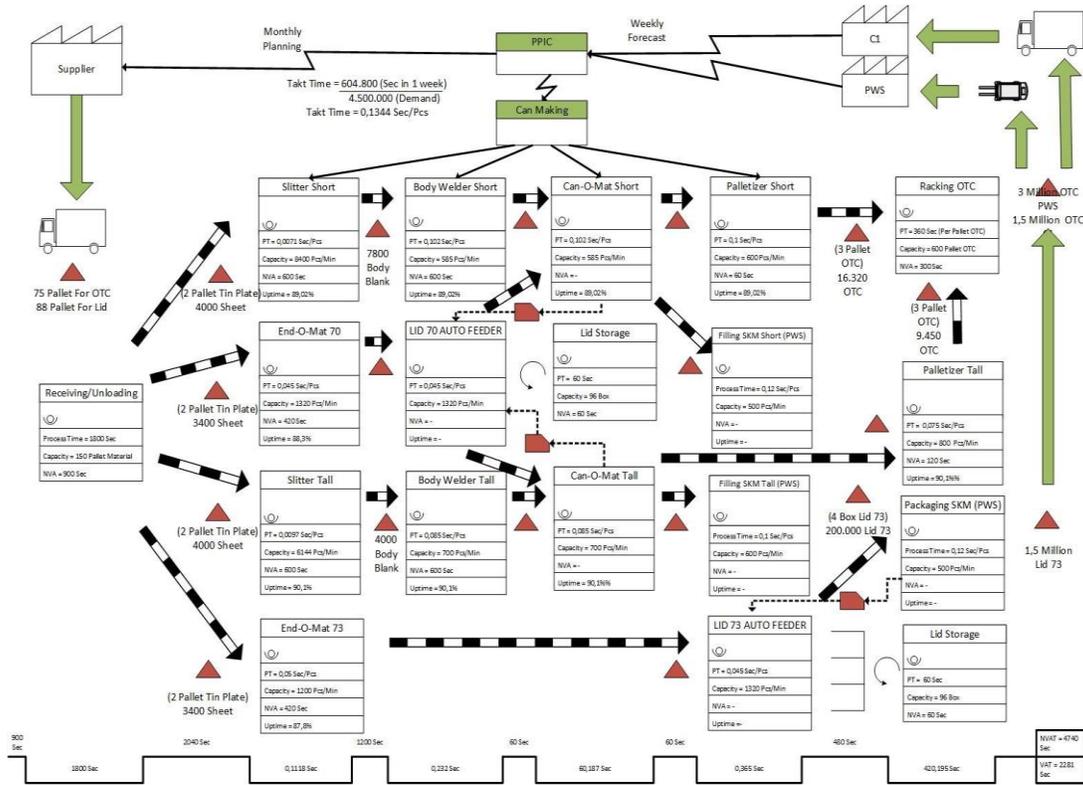


Figure 3. Future State Value Stream Mapping

The results of the implementation of several solutions to overcome the existing problems resulted in a decrease in the value of NVAT in the entire production process. Those solution consists from visiting the supplier production site to do audit and problem identification, designing a racking storage system, and installing new auto Lid feeder machine. The detail information from those solution can be seen below.

- **Visiting the Supplier**

Purwosari factory has a quality management (QM) team that in charge for maintain the quality of material input and product output. To solve the problem related with defective material, Purwosari factory should send a QM team to visit the supplier work place in order to do audit and inspection to help the supplier identify and solve the problems occurred from their work place in order to help them achieve better production output.

- **Designing the Racking Storage System**

Right now, the whole process related with stashing OTC into the racking from data entry,

racking slot selection, and selecting OTC retrieving location still done manually. Therefore, a system that can help support and facilitate operators to help implement the correct procedures for stashing and retrieving OTC on storage racking is needed. The proposed system to overcome this problem is in the form of an application design that can be integrated through several communication tools such as computers and smartphones. In addition, this application for racking is equipped with QR code technology that can make it easier for forklift operators to simplify the final checking process before the OTC can pallet is loaded into the truck. The procedure of retrieving OTC using the help of the system shows that the series of processes carried out are easier and more efficient, so that the OTC taken will always have the oldest age and the potential for expired products will decrease drastically.

- **Installing Auto Lid Feeder Machine**

Auto Lid feeder is a machine that can help the End-O-Mat (EOM) machine to distribute Lid to Can-O-Mat (COM) machine. This auto Lid feeder can also help EOM to adjust production speed if one of the production line has stopped working, so Can Making department can avoid Lid overproduction. Installing this machine can help Can Making department to solve three problems at once: high inventory and long travel distance by distributing Lid directly into COM or filling department, lack of workforce by allocating the job desk of Lid sorting operator into auto Lid feeder machine operator and backup for emergency maintenance.

The results of the application of several solutions to overcome the existing problems resulted in a decrease in the value of NVAT in the entire production process. The reduction of NVAT from the whole production process inside Can making department is 60%, with the comparison from the current state VSM and future state VSM in table 1 below.

Table 1. VAT and NVAT Comparison

Description	VAT	NVAT
Current State VSM	2.281 Second	10.880 Second
Future State VSM	2.281,1 Second	4.740 Second

4.4. PROVIDE TRAINING FOR CAN MAKING DEPARTMENT PERSONNEL

In order to be able to implement some of the solutions that have been prepared previously, several approaches to convey these solutions to the Can Making department personnel need to be carried out. The approach method that is quite suitable and easy to do for Can Making department personnel is to create a small forum and provide training through short presentations to show how to properly implement these solutions. The short presentation that will be made will contain an explanation regarding each solution that will be implemented, who will play a role in implementing the solution, and how to implement and maintain the solution implemented later.

5. CONCLUSION

Based on the results and discussions that have been carried out, we obtained few conclusions. The solutions that implemented on the future state VSM are able to solve all of the problems faced by Can Making department. Thus the NVAT from the whole production processes can be reduced around 60% from the current condition which can give Can Making department a great benefit. The designed racking storage system can be effective to help the operator to do data entry, choosing a racking location, and also choosing a correct OTC to pick up based on the age of that OTC.

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LEAD TIME AND COST MEASUREMENT ANALYSIS FOR MAINTENANCE OF PULP AND PAPER MACHINE

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ABSTRACT

PT XYZ is company who provide the pulp and paper industry services. The service business lines which provides services with a flexible and fit-for-purpose concept, one of which is serving efficient maintenance as needed. At PT XYZ, incoming maintenance orders are treated as projects. These projects are managed by a product engineer who monitors the project from the start of the process until the project reaches the customer. Product engineers monitor the process using excel and a tool called Proffa. This program manages the scheduling and recapitulation of materials, time and costs of the entire project. In its implementation, the tools used are more focused on the integrated project recording system. For the whole project management process, this tool is able to present information without predicting errors. If there is a shift from the initial schedule due to the uncertainty of tasks resulting from the inspection, the product engineer cannot see and monitor how long it will take to accurately increase the time because the additional work is not always done sequentially. The research was conducted using the method of earned value management along with earned schedule. This method provides practitioners with a clear and numerical method for measuring project performance and allows managers to ask critical questions about the actual progress of the project. The expected result of this research is to have accurate tools to measure the cost and duration of the project and to predict the lead time for roll maintenance projects or pulp and paper machine supporting components.

Keywords: Earned Value, Earned Schedule, Duration Measurement, Lead Time Prediction

1. INTRODUCTION

PT XYZ is company who provide the pulp and paper industry services. The service business lines which provides services with a flexible and fit-for-purpose concept, one of which is serving efficient maintenance as needed. At PT XYZ, incoming maintenance orders are treated as projects. These projects are managed by a product engineer who monitors the project from the start of the process until the project reaches the customer. Product engineers monitor the process using excel and a tool called Proffa. This program manages the scheduling and recapitulation of materials, time and costs of the entire project. In its implementation, the tools used are more focused on the integrated project recording system. For the whole project management

process, this tool is able to present information without predicting errors. If there is a shift from the initial schedule due to the uncertainty of tasks resulting from the inspection, the product engineer cannot see and monitor how long it will take to accurately increase the time because the additional work is not always done sequentially. Maintenance processes are characterized by high variability, due to the uncertainty about the status of the machine to be maintained. The activities to carry out are set according to the engine arrival conditions and the needed type of intervention. Management of such a variable process is, hence, one of the most important challenges that the systems have to face in supporting the management. To get work-in-progress (WIP) information from the shop floor (accurate and up-to-date information about the (physical) parts constituting engines and components, regarding both their localization, their identification data such as part number, serial number, quantity, job order, etc.) and their processing status is of great importance. The systematic availability of such information allows the enterprise to have an improved control on work order and process activities.

PT XYZ most received the uncertainty maintenance workscope since the workscope can be developed after the first inspection. Unfortunately, there is no system yet to focus on project measurement or controlling. Consequently, project manager manage it manually and can be missed control the project since they only focus on the execution after the inspection, not to capture all the progress preproject. The aim of this project is to create suitable project measurement tool to make this activity become easier, to analyze project performance in term of cost controlling, lead time inuncertainty project.

2. LITERATURE REVIEW

This research propose earned value and earned schedule method to create suitable project monitoring, in order to create the extension tools for the existing system. Earned value uses some parameters to control project performance, such as planned value, budget at completion, earned value, actual cost, and percentage of completion (Haghighi, 2013). Figure 1 shows the earned value graphical representation.

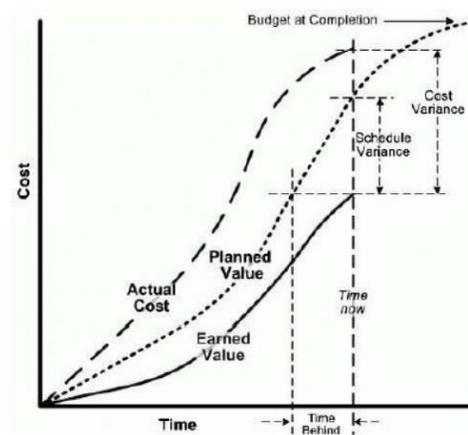


Figure 1. EVM Graphical Representation (Haghighi, 2013)

Although Earned Value Management represents a significant contribution to project management, from its earliest development and adoption limitations were apparent (Fleming, 1988). Experience and further research have shown that while EVM methods for cost are reliable (Fleming & Koppelman, 2003), schedule metrics are not as robust. Among the problems are schedule metrics expressed monetary terms, the lack of reliable metrics for projects whose duration has exceeded the baseline end date, and the unreliability of EVM schedule calculations in the latter stages of a project (Bill Mowery, 2012).

The concept of Earned Schedule is relatively simple: derive a time based measurement of schedule performance by comparing a project's Earned Value today (Actual Time, AT) to

$$ES = t + \frac{EV - PV_t}{PV_{t+1} - PV_t}$$

the point on the Performance Measurement Baseline (Planned Value curve, PV) where it should have been earned. The difference between AT and PV represents a true time-based Schedule Variance, or in Earned Schedule notation, SV (t) (Bill Mowery, 2012). Earned schedule is calculated by formula:

Where t is the number of time increments where $EV \geq PV$. PV_t is the value of PV at the last full performance period and PV_{t+1} is the value of PV at the end of partial performance period. The combination of earned method and earned schedule will be used in this research along with 5 aircraft engine maintenance study cases.

3. METHODS

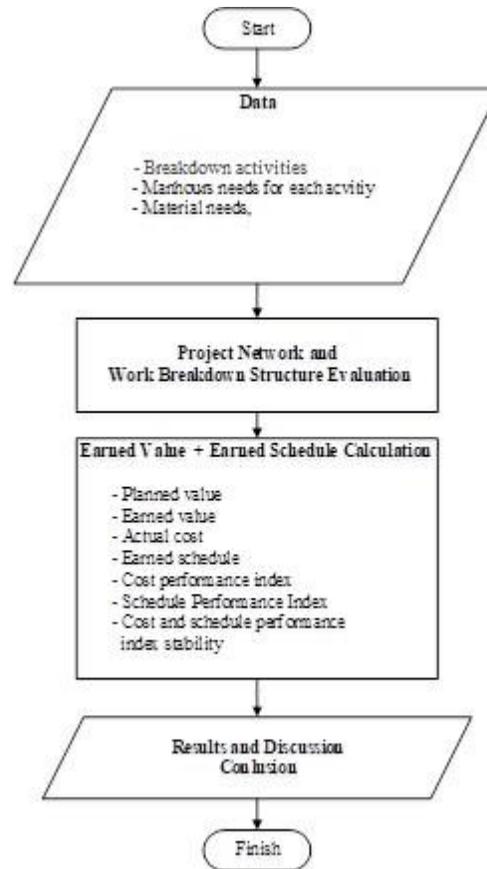


Figure 2. Method of Research

3. RESULT

Suction Roll Proj No. 410291

Analysis Report

Prepared by: [name of Product Engineer]

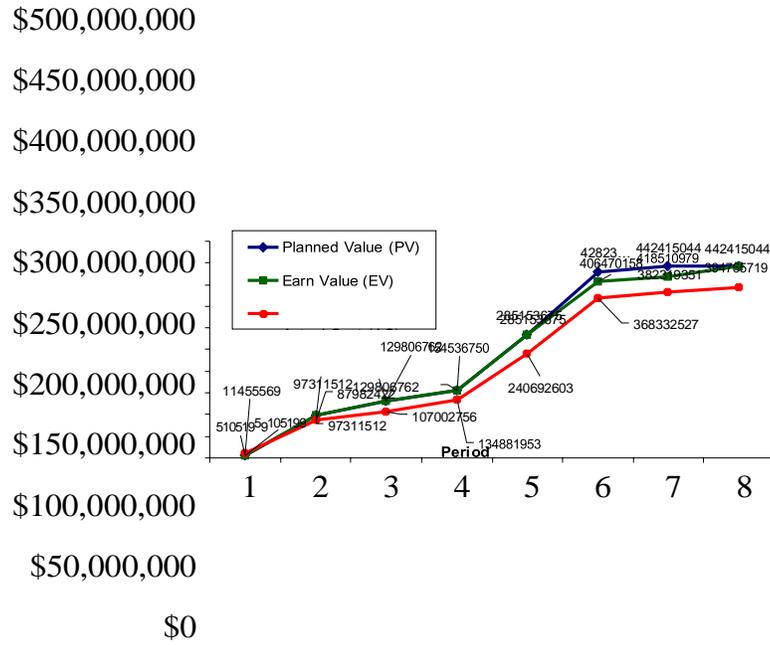
Summary:

Date: [date of reporting]

[put highlight of this report]

Period:

APU A



Planned Value (PV) or Budgeted Cost of Work Scheduled (BCWS) -

Roll Incoming: 4 Mar 2020

WBS	Task Name	Total Budgeted Cost (IDR)	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7
1	10 2000 SHIP Shipment unloading	1,423,052.00	1423052						
2	20 2130 INSP Cover Inspection	711,526.00	711526						
3	25 2060 MANW Prep and disassembly	2,970,621.00	2970621						
4	30 1050 LATH Lathe	25,528,980.00		25528980					
5	40 2020 DRIL prep for cover drilling	59,058,120.00		59058120					
6	50 1180 GRIT Prep and grit blasting	7,619,213.00		7619213					
7	60 1170 CEME Cementing	10,800,430.00			10800430				
8	70 5120 HEAT PU/Composite oven Man	5,494,175.00			5494175				
9	120 1140 PUCV PU-covering	16,200,645.00			16200645				
10	130 1200 HEAT PU/Composite oven	13,186,020.00				13186020			
11	145 5105 LATH Lathe Man	11,543,968.00				11543968			
12	180 5106 DRIL Multispindle drill Man	217,694,875.00					130616925	87077950	
13	195 1030 GRND Roll grinding	46,934,828.00						46934828	
14	200 5104 GRND Cover grooving Man	9,073,192.00						9073192	
15	210 5102 BALA Balancing Man	8,483,191.00							8483191
16	220 2070 MANW Assembly	2,846,104.00							2846104
17	240 2130 INSP Cover Inspection	1,423,052.00							1423052
18	250 2010 SHIP Shipment packing/loadi	1,423,052.00							1423052
Total Budgeted Cost (USD)		440991992	5105199	92206313	32495250	24729988	130616925	143085970	14175399
Cumulative Planned Value (PV)			5105199	97311512	129806762	154536750	285153675	428239645	442415044
			1.157662518	22.06650319	29.43517441	35.04298327	64.66187146	97.10825883	100.3226934

Actual Cost and Earned Value

Cumulative Actual Cost (AC)	11455569	87982422	107002756	134881953	240692603	368332527	382319351
Cumulative Earned Value (EV)	5105199	97311512	129806762	154536750	285153675	406470158	418510979

Project Performance Metrics -

	1	2	3	4	5	6	7
Cost Variance (CV = EV - AC)	-6350370	9329090	22804006	19654797	44461072	38137631	36191628
Schedule Variance (SV = EV - PV)	0	0	0	0	0	-21769488	-23904066
Cost Performance Index (CPI = EV/AC)	0.45	1.11	1.21	1.15	1.18	1.10	1.09
Schedule Performance Index (SPI = EV/PV)	1.00	1.00	1.00	1.00	1.00	0.95	0.95
Estimated Cost at Completion (EAC)	989543050.68	398714835.91	363520033.86	384904310.06	372232657.95	399615302.14	402856270.70

Schedule Performance Index (SPI = EV/PV)
Estimated Cost at Completion (EAC)

Earned Schedule -

	1	2	3	4	5	6	7
Earned Schedule	1.0000	2.0000	3.0000	4.0000	5.0000	5.8479	5.9320
Schedule Variance (SV(t))	0.0000	0.0000	0.0000	0.0000	0.0000	-0.1521	-1.0680
Schedule Performance Index (SPI(t))	1.00	1.00	1.00	1.00	1.00	0.97	0.85
Estimated Time at Completion	1.00	1.00	1.00	1.00	1.00	0.97	0.85
Estimation Completion Date	29-Apr-21	29-Apr-21	29-Apr-21	29-Apr-21	29-Apr-21	30-Apr-21	9-May-21

4. CONCLUSION

The project management system currently in use can only show jobcard status features, material consumption, and manhours with a separate menu. Jobcard status can indicate jobcards that have not been worked, are being worked on, and have been worked on. The material consumption shows the status of the part that has been installed into the engine, and the actual manhours are obtained after the jobcard has been barcoded. The project manager needs to aggregate the information required for reporting himself and needs to get the actual cost values. Manual calculations cannot be obtained directly in real time and take time to calculate, while one project manager manages 4 to 5 projects at a time. The estimated completion of the lead time and costs if in the middle of the project there is a workscope upgrade, finding, or

implementation of other work priorities cannot be determined directly by the project manager through existing tools. This can cause the project manager to have difficulty providing forecasts for the completion date as well as estimating total costs in the middle of the project. There are several benefits that can be stated from the goals of project data processing using the earned value and earned schedule methods as follows:

1. Assist in realistic project planning
2. Able to measure the accuracy of cost and duration directly
3. Able to make project managers anticipate risks early
4. Can be used as iteration and review material for future projects

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ANALYSIS OF SATISFACTION LEVEL OF CONSTRUCTION SERVICES WITH INTEGRATION METHODS OF SERVQUAL, KANO, IPA, AND HOQ TO MAKE A PROPOSED IMPROVEMENT. CASE STUDY: PT. KARYATIM SURABAYA

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ABSTRACT

As a developing country, infrastructure development in Indonesia is the main focus to be prioritized. The quality of the construction service industry can be reflected by the results of its work on time, quality, compliance with specifications, and work safety procedures. PT. Karyatim Surabaya has become one of the players in the construction service business that prioritizes service quality. The problem faced by the company is that there is still a low level of satisfaction, and the company wants to find out the input from their customers so far. 21 service attributes are used as indicators in the questionnaire include five dimensions of service quality as tangible, empathy, responsiveness, reliability, and assurance. The Measurement of customer satisfaction level was carried out using the Service Quality, Importance Performance Analysis, Kano Model, and House of Quality (HOQ) methods. This research was conducted on company clients total of 28 respondents since 2020. As the result of the integration of Servqual, Importance Performance Analysis, and Kano Model, there are three prioritized service attributes for improvement. The three priority attributes are "Storage of materials" has the Must Be category, "The presence of company representatives" has the Must Be category, and "Communicates project progress periodically". From the analysis of the House of Quality, there are steps to improve services at PT. Karyatim Surabaya such as "Creating a WhatsApp group between users and internal management as a communication platform", "Creating a material warehouse and zoning of similar materials in the same zone", "Material monitoring by logistics and warehouse personnel", "Implementing 5R", "Improving the competence of supervisory personnel", and "Recruiting supervisors who are already good on the managerial".

Keywords: Servqual, Model Kano, Customer Satisfaction, Importance Performance Analysis, House of Quality, Construction.

1. INTRODUCTION

As a developing country, Indonesia's major priority should be infrastructural development. Infrastructure is the primary pillar in many economic sectors. The construction service business must constantly be able to give the finest service to its customers. The

construction services industry's quality may be seen in the outcomes of its work on time, level quality, conformance with specifications, and safety procedures. It has been the main focus of construction businesses to maintain their own competitiveness in the construction services industry sector.

PT. Karyatim Surabaya has been one of the private construction companies in Surabaya since 2012. The company is engaged in general contractor services. Company experience such as office construction, office renovation, interior design, residential renovation, residential development, and mechanical electrical building. PT. Karyatim Surabaya always prioritizes the quality of work and trust for sustainable business continuity. The main goal of the company is to be the first choice of the clients by contributing to each client that exceeds what the client expects. The success of the company can be known from the satisfaction of the company's clients.

From 2020 until now, the company's clients who have cooperated with PT. Karyatim Surabaya are 28 clients. Problems arise when conducting preliminary studies related to customer satisfaction with the company's services. Initial studies were conducted to find out how the level of customer satisfaction by giving questions related to satisfaction with 5 indicators of satisfaction. From 17 samples of respondents obtained that the average score of customer satisfaction was 2.94 where the score still does not meet the maximum customer satisfaction indicator.

Table 1. Title of table 1

Score	Very Dissatisfied	Dissatisfied	Quite Satisfied	Satisfied	Very Satisfied
Response	1	2	3	4	5
1		✓			
2				✓	
3				✓	
4		✓			
5			✓		
6			✓		
7				✓	
8			✓		
9		✓			
10				✓	
11			✓		
12		✓			
13			✓		
14			✓		
15		✓			
16			✓		
17			✓		

Therefore, PT. Karyatim Surabaya should seek input from its service users how the level of customer satisfaction with the service from PT. Karyatim Surabaya is more in-depth and what exactly their desires are more specific. So that the corrective steps carried out by PT. Karyatim Surabaya will be more effective and on target. And to know the level of customer satisfaction, it is necessary to know the dimensions that affect customer satisfaction that are strongly related to the quality of services provided.

2. LITERATURE REVIEW

2.1 Service Quality

Servqual is a compact scale selection but has a high level and truth 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.

2.2 Importance Performance Analysis

This technique was first described by Martilla & James (1977) in their article "Importance-Performance Analysis" published in the Journal of Marketing. In this technique, respondents were asked to assess the level of interest in various attributes of the company's services. Importance Performance Analysis and Servqual are two instruments for researching the quality and satisfaction of consumers in the service industry developed from year to year. Importance Performance Analysis is a procedure to show the relative importance of various attributes to the performance of an organization or company. Basically, IPA combines the measurement of dimensions of satisfaction and importance into two grids, then both dimensions are plotted into them. The value of importance is plotted as a vertical axis and the satisfaction value as a diagonal axis using the average score contained in the dimension of importance and satisfaction as the center of line cutting. Look at to Figure 1.

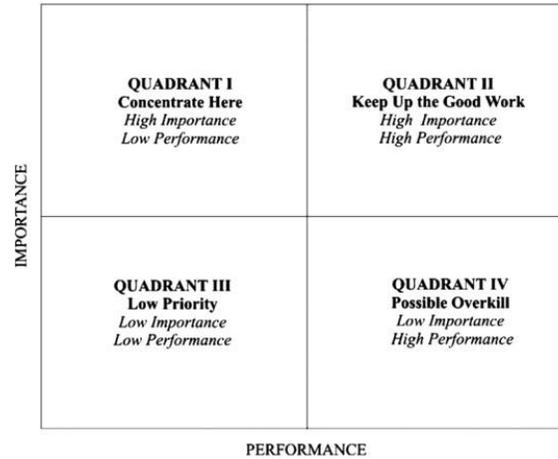


Figure 1. Importance Performance Analysis

2.3 Kano Model

The Kano model was developed by Dr. Noriaki Kano. The Kano model aims to categorize the attributes of products or services that are able to satisfy the needs of customers. Kano divides 3 desired attributes that can affect customer satisfaction, namely the Must be requirements category. If this category is not fulfilled, then the customer will feel dissatisfied, but if this category is a category that has been considered by the customer to be the proper category, then the fulfillment of this category will not increase customer satisfaction. Category One Dimensional requirements (expected attributes). In this category, customer satisfaction is directly proportional to the quality of service provided. The higher the performance of the service provided, the higher customer satisfaction. This category is a category that is always demanded by customers. Attractive requirements category (attributes that can improve customer satisfaction). This category is the service criteria that has the most influence on customer satisfaction if given. This category becomes competitive by service owners and products with similar competitors.

There are two kinds of questions in questionnaires: functional questions and dysfunctional questions: Chen et al., (2021)

1. Functional question: "Quality of work results to appropriate technical specifications"
2. Dysfunctional question: "The quality of the work on technical specifics is not appropriate"

To analyze and improve relevant quality factors, the coefficient of customer satisfaction has been proposed by Matzler and Hinterhuber in Chen et al., (2021) as a reference index. With this coefficient, it can be seen the spread of data that occurs. The suggested modifications in this study, with the following formula: Suh et al., (2019)

$$Satisfaction\ increment\ index\ (SII) = \frac{(A + O)}{(A + O + M + I)}$$

$$Decreasing\ dissatisfaction\ index\ (DDI) = \frac{(O + M)}{(A + O + M + I)}$$

The SSI column means that consumer satisfaction increases if consumer demand is

met. The DDI column means that customer satisfaction decreases if consumer demand is not met. Furthermore, the results of the calculation are processed into scatterplot diagrams and adapted the results of any service attributes that fall into the category of attractive, one-dimensional, must-be, and indifferent.

2.4 House of Quality

The tool used to use the QFD structure is a house-shaped matrix, called the House of Quality. In short, the House of Quality matrix seeks to convert the voice of the customer directly to the technical requirements or technical specifications of the resulting product or service. The organization will strive to achieve the specification targets produced by benchmarking with competitor companies.

3. METHODS

1. Identification Phase

Researchers took a research approach, consisting of Preliminary Studies, and Library Studies. From this research approach, a Problem Formulation, Variable Identification, and Population was created.

2. Data Collection Phase

Researchers created a questionnaire based on the attributes of variables research results from early studies. The questionnaire was then translated into Google Form to facilitate the spread of the questionnaire. The population of questionnaire distribution was based on customer data of PT. Karyatim Surabaya in 2020. The results of this questionnaire were then conducted validity test and reliability test, to ensure the questionnaire and questionnaire results can be processed at a later phase.

3. Data Processing Phase.

The questionnaire results were then processed using 4 methods, namely the Servqual method to measure customer satisfaction based on five dimensions, the Kano model method to categorize service attributes, the Importance Performance Analysis (IPA) method to get conformity between the performance of service providers and customer desires, and the House of Quality method to get priority improvement proposals.

4. Analysis Phase.

The results of data processing were then analyzed to get conclusions on the entire study. The proposed improvements were then discussed with the company's internal management to decide which improvements could be implemented by the company.

4. RESULTS

4.1 Service Quality

From the results of the analysis of the answers of respondents, both perception and expectations, so as to look for gaps in all attributes in the five dimensions of Service Quality, the calculation of gap values with the following formula: Satisfaction (Gap) = Perception (Reality) – Expectations (Expectations). The results of the Servqual gap calculation are shown as shown in Table 2. From the table shows that there are 6 service attributes that have a negative gap, among them are the attributes of the alignment of the scope of the project with contracts, storage of materials carried out, the expertise of project workers in using equipment in the field, the identity of project workers in the field, the presence of on-site company

representatives, and communicating the progress of the project periodically.

Table 2. Gap Analysis Service Quality

No	Service Attributes	Expectations	Reality	Gap	Number of Respondents	N
Dimensions of Reliability						
	Conformity of work results to technical specifications	.50	.71	.21	8	2
	Ability to complete at agreed time	.11	.32	.21	8	2
	Implementation of work procedures and instructions in completing the project	.61	.79	.18	8	2
	Cost suitability with the resulting product	.29	.46	.18	8	2
Dimensions of Assurance						
	Maintenance guarantee and quality assurance of the material used	.39	.43	.04	8	2
	Service level after completion	.43	.54	.11	8	2
	Implementation of monitoring and quality control of projects on a scheduled basis	.50	.57	.07	8	2
	Suitability of the scope of the project with the contract	.39	.96	0.43	8	2
	Services that make clients feel safe when transacting	.18	.39	.21	8	2
Dimensions of Tangible/Visible						
	Material storage implemented	.43	.36	0.07	8	2

No	Service Attributes	Expectations	Reality	Gap	Number of Respondents	N
	Availability of work equipment during the agreed project period	.36	.43	.07	8	2
	Project worker's expertise in using equipment in the field	.00	.93	0.07	8	2
	Identity of project workers in the field	.32	.82	0.50	8	2
Dimensions of Empathy						

Services provided by the project's human resources in communicating both verbally and in writing	.43	.46	.04	8	2
Level of trust in follow up communication	.61	.68	.07	8	2
Presence of on-site company representatives	.64	.93	0.71	8	2
Communicate project progress periodically	.57	.04	0.54	8	2
Dimensions of Responsiveness					
Speed in delivery	.57	.68	.11	8	2
Level of knowledge of company representatives	.25	.39	.14	8	2
Responsiveness in following up on requests	.61	.68	.07	8	2
Rework/repair frequency during project execution	.50	.54	.04	8	2

4.2 Importance Performance Analysis

From figure 4.4 by performing an importance performance analysis method, it appears that there are 3 service attributes that are the priority of PT. Karyatim Surabaya, to be fixed, namely service attributes numbers 10, 16, and 17. These attributes consist of storing materials carried out, the presence of on-site company representatives, and communicating project progress on a regular basis. For more details, data processing Importance Performance Analysis and number descriptions in Figure 2.

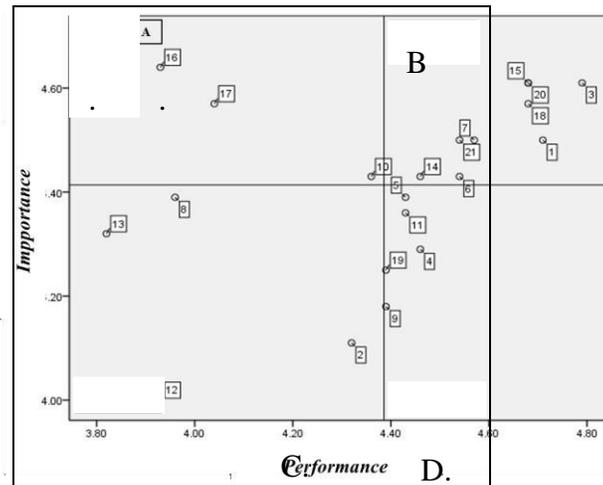


Figure 2. Results Importance performance Analysis

4.3 Kano Model

The answers from respondents were divided into 5 categories, namely attractive, one-dimensional, must-be, indifferent, reverse and questionable. But in the Better and Worse Analysis method, if there are reverse and questionable categories, then the answer is ignored. It can be seengrouping service attributes based on the Better and Worse Analysis method in table 3.

Table 3. Kano Model

o						otal	etter	orse	esult
				8		8	.71	.70	ne Dimensional
				3		8	.71	.61	ne Dimensional
				8		8	.68	.82	ne Dimensional
				2		8	.54	.57	ne Dimensional
				6		8	.61	.82	ne Dimensional
	3					8	.64	.43	ttractive
		1				8	.46	.71	ust be
				8		8	.75	.79	ne Dimensional
				3		8	.61	.54	ne Dimensional
0		4		0		8	.46	.86	ust be
1		0		2		8	.46	.79	ust be
2					0	8	.32	.54	ust be
3	5					8	.61	.25	ttractive
4				6		8	.68	.64	ne Dimensional
5				4		8	.64	.61	ne Dimensional
6		3		1		8	.43	.86	ust be
7				6		8	.61	.79	ne Dimensional
8		5				8	.32	.82	ust be
9				8		8	.71	.64	ne Dimensional

0				8			8	.75	.79	ne Dimensional
1				1			8	.57	.54	ne Dimensional

4.4 House of Quality

From the Quality Function Deployment Analysis, the results of priorities that must be considered by the management of PT. Karyatim Surabaya when carrying out improvement measures. These priorities were based on the attributes in How's Customer Requirements, and the priority on the improvement steps in What's Technical Response. as seen in Figure 3. House Of Quality.

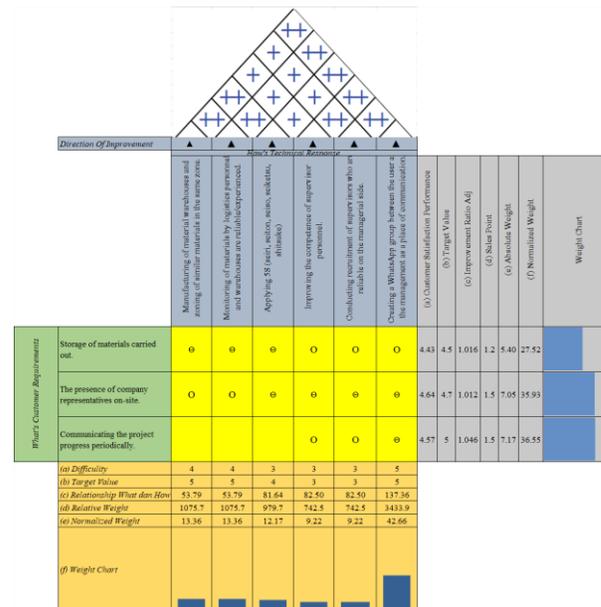


Figure 3. Results House Of Quality

Based on Figure 4, the priority of improvement measures based on customer satisfaction are as follows:

1. Communicating the project progress periodically.
2. The presence of company representatives on-site.
3. Storage of materials carried out.

While the priority of improvement measures based on Technical Response are as follows:

1. Creating a WhatsApp group between the user and the management as a place of communication.
2. Manufacturing of material warehouses and zoning of similar materials in the same zone.
3. Monitoring of materials by logistics personnel and warehouses are reliable/experienced.
4. Applying 5R.
5. Improving the competence of supervisor personnel.
6. Conducting recruitment of supervisors who are reliable on the

managerial side.

5. CONCLUSIONS

From Servqual's analysis, the results found that there were 6 service attributes that had a negative gap. This means that PT. Karyatim Surabaya performance can still not fully satisfy its customers. The attribute with the order of the highest Gap values was "The presence of on-site company representatives" with a Gap value of -0.71, "Communicating project progress periodically" with a Gap value of -0.54, "Identity of project workers in the field" with a gap value of -0.50, "Storage of materials carried out" with a gap value of -0.07, "Expertise of project workers in using equipment in the field" with a gap value of -0.07, and "Suitability of the scope of the project with a contract" with a Gap value of -0.43.

From the Importance Performance Analysis analysis, it can be stated that there are three service attributes that were in the region of quadrant A and need to get priority to be improved, namely: "Material storage implemented", "The presence of company representatives on-site", and "Communicating project progress periodically".

From kano model analysis, there were 2 service attributes that fall into the attractive category, there were 13 service attributes that fall into the one-dimensional category, and there were 6 service attributes that fall into the must be category.

From the integration of Servqual, Importance Performance Analysis, and Kano Model obtained 3 service attributes that were a priority to be improved. The three attributes have the following order of priority:

- a. Material storage implemented has a Must Be category and has a Normalized Weight value of 36.55%.
- b. The presence of on-site company representatives has a Must Be category and has a Normalized Weight value of 35.93%.
- c. Communicate the progress of the project periodically has a category of One Dimensional and has a Normalized Weight value of 27.52%.

From the House of Quality analysis, there were improvement measures for services at PT. Karyatim Surabaya, with the order of priority starting from the highest as follows:

- a. Creating a WhatsApp group between the user and the management as a place of communication and having a Normalized Weight of 42.66%.
- b. The creation of material warehouses and zoning of similar materials in the same zone and having a Normalized Weight value of 13.36%.
- c. Monitoring of materials by logistics personnel and warehouses who are reliable / experienced and having a Normalized Weight value of 13.36%.
- d. Applying 5R and having a Normalized Weight value of 12.17%.
- e. Improving the competence of supervisor personnel and having a Normalizing Weight value of 9.22%.
- f. Conducting recruitment supervisors who have been reliable on the managerial side and having a Normalized Weight value of 9.22%.

From the results of focus group discussion with PT. Karyatim Surabaya management, it has been concluded that there are 5 strategies that can be immediately implemented into a work program to improve services, namely:

a. The work program for technical response "Creating a WhatsApp group between the user and the management as a place of communication" is to ask for approval from the user to be involved in WhatsApp group discussions. Supervisors must report work plans in the form of to-do-list into the group, supervisors must report progress in the form of documentation into the group, and the site manager must report progress in the form of weight values into the group.

b. Work program for technical response "Creation of material warehouses and zoning of similar materials in the same zone" is logistics personnel make plotting zones of materials and similar materials in the layout and then submit them to supervisors and site managers.

c. Work program for technical response "Monitoring materials by logistics personnel and warehouses are reliable/experienced" is logistics personnel make material monitoring books in and out.

d. Work program for technical response "Applying 5R" is site manager personnel conducting morning briefings to deliver work plans, potential hazards, as well as 5R instructions. Supervisors conduct 5R monitoring 1 hour before the day's work ends, and supervisor personnel report documentation of the final work location into WhatsApp groups.

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ANALYSIS OF MEDIA CUSTOMER SERVICE QUALITY TO IMPROVE CUSTOMER SATISFACTION USING CUSTOMER SATISFACTION INDEX METHOD IN ONLINE TRAVEL AGENT (OTA)

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ABSTRACT

Since the confirmation of COVID-19 in 2020, many people who have planned their business trips or holidays in advance, have had to do a refund or reschedule due to the pandemic situation that occurred. One of the online applications that is invaded by the people to make refunds and reschedules is Traveloka. Due to the spike that occurred, many users admitted that they had waited for more than 90 days according to Traveloka regulations but had not yet received the desired refund. Of course, many users have relied on and had direct contact with Traveloka customer service in the past year during this pandemic. This can be seen on Traveloka social media such as Twitter and Instagram, many users have complained that their refunds have not been completed after waiting for more than 90 days. In this way, Traveloka must be able to provide the best service so that it can still be an OTA that is favored by its users. This study aims to analyze Traveloka customer satisfaction using a questionnaire based on the attributes of customer satisfaction or service quality (SERVQUAL) which has 5 dimensions, namely physical or tangible, reliability, response (responsiveness), assurance (assurance) and empathy. (Empathy). There are 22 statement items from a total of 5 dimensions. However, in this study only 17 statement items were used, because the Tangible dimension was not used because there was no form from Traveloka's call center and Twitter. The questionnaire was distributed to 96 respondents who matched the criteria, namely those who had ordered flight tickets using the Traveloka application or website and had direct contact with Traveloka customer service call centers or Twitter in the last one and a half years (starting from November 2019). This study produces an average value that is obtained through the results of respondents who filled in a Likert Scale of 1-5 on a distributed questionnaire and analyzed using Importance Performance Analysis and the Customer Satisfaction Index. Then, the results of the analysis compared, which items are the most interested and considered important by customers and which should be improved and then used as recommendations to improve Traveloka customer service. The results obtained from this study are that customers are satisfied with traveloka's customer service and there are managerial implications that Traveloka can implement as a consideration in developing the right strategy to maintain and provide the best quality of service.

Keywords: Online Ticket Agency, Customer Satisfaction Index, Customer Service, Traveloka, SERVQUAL.

1. INTRODUCTION

In the modern era that already relies on information technology, many service providers are utilizing information technology to provide their services through the internet or online. This is also done by online ticketing service providers or commonly referred to as OTA (Online Ticket Agency). In addition to selling online ticketing products, online *ticketing* service providers also use applications or websites that can be used to serve customers who want to buy tickets online. While many customers love and praise online ticketing services, many customers have difficulties or questions about features on the app, travel, baggage, ticket cancellations, and other issues. Customer service activities become very important, because it is one of the services that are directly connected to customers therefore, this service needs to be managed professionally. Because of the company's success, especially in the field of services, depending on its ability to meet the needs and further to satisfy customers. Customer satisfaction is determined by the quality of the desired service so that quality assurance becomes the top priority and serves as a benchmark for the company's competitiveness excellence. To get an overview of customer satisfaction, it is necessary to know the meaning of service quality (Supranto, 2001). Quality of service is something complex consists of five elements, namely physical (*Tangible*), Reliability (*Reliability*), Response (*Responsiveness*), Certainty (*Assurance*) and Empathy (*Empathy*). All businesses that have a focus on consumers need a customer *service* team as a major part of the form of service to consumers who simultaneously represent the business in front of consumers. How well the quality of customer *service* personnel will directly determine the level of satisfaction of the customers.

Since the pandemic caused by COVID-19, many customers who have booked their travel tickets or booked hotels for business or leisure purposes, have been forced to *refund* or reschedule. This is based on government regulations that prohibit people from traveling during the pandemic period in March 2020 where the pandemic began to strike the world. This certainly has an impact on Traveloka as an online ticket service provider that is favored by many people. Customers flocked to request refunds and rescheduled from February 2020 to Traveloka where this request increased 10-fold from the time before the pandemic, so that Traveloka's customer *operations* team serves up to thousands of requests for assistance every minute, either by phone, application, social media or other channels, this was revealed by Dionisius Nathaniel CMO of Traveloka. Customers feel that the service provided to them is not good it is conveyed on Traveloka's social media page that is invaded by customers. Based on this problem, the improvement of service for customers' needs to be improved so that customers remain loyal using Traveloka conducted a survey by disseminating questionnaires containing questions about customer experience during interacting with *Traveloka's customer service* on Twitter and also *call centers* using questionnaires based on customer satisfaction attributes or service *quality* (SERVQUAL).

Based on this problem, the service improvement for customers' needs to be improved so that customers remain loyal to Traveloka. In this study, research was conducted to find out and provide information about what media services are most in demand and which should be improved among the 2 services provided by Traveloka, namely Traveloka's *call centers* and Twitter. The social media observed and researched in this study is Twitter owned by Traveloka which is used to interact with its customers, because it has a mutual reply feature that can be

done continuously and can be viewed more easily through Traveloka's Twitter page. Furthermore, in this study, a survey was conducted by disseminating questionnaires containing questions about customer experience during interacting with Traveloka's *customer service* on Twitter and also *call centers* using questionnaires based on customer satisfaction attributes or service *quality* (SERVQUAL).

2. METHOD

2.1 Customer Service

Customer Service means customer service. i.e., serving before the customer buys a product, serving during the purchase process, and serving after purchase. All that the goal is for customer satisfaction, and so that customers can get certainty about a product, both price certainty and product information. *Customer service* itself is the vanguard in a company that is referred to here is the most important spearhead for a company in building a vision of customer satisfaction mission. Through *customer service* the company can know and provide positive precepts to customers and also through *customer service* companies can provide expectations of what the customer's goals are.

2.2 Online Travel Agent (OTA)

Online travel agent is a travel agent that serves as a medium of promotion and online sales through the website. Online travel agent website is a website managed by OTA that distributes and facilitates bookings to tourism business providers.

2.3 Customer Satisfaction Index (CSI)

According to Aritonang (2005), CSI is used to know the level of customer satisfaction of the overall use of services by looking at the level of importance of the attributes of products / services. The steps to calculate the magnitude of CSI are:

1. Specifies the Mean Importance Score (MIS). Determine the average interests of each consumer.
2. Create Weight Factors (WF) This weight is a percentage of the PER-attribute MIS value against the total MIS of all attributes.
3. Creating Weight Score (WS) This weight is a multiplication between WF and average satisfaction level or Mean Satisfaction Score (MSS)
4. Determining the Customer Satisfaction Index

There are 5 criteria of CSI value above 50 percent CSI then it can be said that service users are satisfied otherwise if the CSI value below 50 percent eat service users have not been said to be satisfied.

Table 1 Customer Satisfaction Index Criteria

Index Value	Customer Satisfaction Index Criteria
81 – 100	Very Satisfied
66 – 80	Satisfied
51 – 65	Quite Satisfied
35 – 50	Dissatisfied
0 – 34	Not Satisfied

2.4 Importance Performance Analysis (IPA)

Importance-Performance Analysis (IPA) is a descriptive analysis technique introduced by John A. Martilla and John C. James in 1977. According to (Ruhimat, n.d.) , Importance Performance Analysis (IPA) method is an easy application technique to set the attributes of the level of interest and the level of implementation itself that is useful for the development of effective marketing programs. This method aims to measure the relationship between consumer perception and the priority of improving the quality of products/services known as quadrant analysis (Coggan & Ph, 2010). The results of the measurement of IPA will be grouped into Quadrants which will be able to know the reality and expectations of customers and the improvements that need to be made.

2.5 Respondents

At this stage, the first preparation made to collect data is to determine in advance the number of populations and samples taken, in this study using sampling techniques using the Lemeshow formula. The population in this study is women and men who are Indonesian citizens (Indonesian citizens) of productive age (18 years to 60 years) and located in Indonesia. The population in this study is everyone who has known and ever done transactions through Traveloka. The number of samples taken in this study uses the Lemeshow formula, which is used because this is an unknown or infinite number of populations. After finding how many data samples are needed then then conduct the design of questionnaires to be disseminated, in the design of questionnaires tailored to what attributes will be assessed to know customer satisfaction in customer service. The dissemination of this questionnaire was conducted to collect the required data with a predetermined number of respondents, which amounted to 96 respondents. The distribution of questionnaires in this study was conducted online with google forms by sharing questionnaire links to customers who use traveloka application. And the form of statement in this questionnaire is a closed questionnaire.

The questionnaire preparation on the research is based on respondents who are users of Traveloka application which is a company engaged in the tourism sector. At this stage, questionnaires are conducted which are then distributed to respondents. The questionnaire used contains several questions that each indicator will then be filled out by the respondent. The questionnaire in this study used the Likert scale in his assessment. The scale is worth 1 to 5. The questionnaire results were obtained by knowing that of the 113 respondents obtained as many as 61.1% of respondents were Male and the remaining 38.9% were women. The number of male respondents resulted in 44 people and 69 female respondents. Meanwhile, from 113 samples of respondents obtained as many as 40.7% of respondents have an age range of 15-25 years, 44.2% of respondents aged between 26 to 40 years, and 15% of respondents aged over 40 years.

Variables	n	Percentage (%)
Gender		
Male	44	61.1 %
Female	69	38.9 %
Age		
15-25 years	46	40.7%

old 26-40 years	50	44.2%
old > 40 years old	17	15.0%

3. RESULT

The method used in collecting data by using questionnaires as survey techniques. The questionnaire model used is a closed model. While the type of questionnaire used is using an online questionnaire created using google form with the number of questions as many as 17 questions. The questions made next are based on case studies. In this study, a sample of 120 respondents was obtained in total, which was then only used by 113 respondents who were known to have used Traveloka.

Data Validity Test

The table above is the output of validity test on each variable calculated using SPSS software, where the calculated r value in the table above if it is worth more than the table r value then considered valid. It is known that the table r value in the data with N amounts to 113 data and the significance level of 0.01 is 0.2167.

Factor	Pearson Correlation		Rtable	Conclusion
	Reality	Expectations		
RL1	0.301	0.754	0,2167	Valid
RL2	0.630	0.843	0,2167	Valid
RL3	0.541	0.859	0,2167	Valid
RL4	0.351	0.828	0,2167	Valid
RL5	0.295	0.543	0,2167	Valid
RS1	0.803	0.742	0,2167	Valid
RS2	0.487	0.731	0,2167	Valid
RS3	0.796	0.708	0,2167	Valid
RS4	0.451	0.595	0,2167	Valid
A1	0.558	0.772	0,2167	Valid
A2	0.636	0.781	0,2167	Valid
A3	0.572	0.804	0,2167	Valid
A4	0.597	0.809	0,2167	Valid
E1	0.483	0.612	0,2167	Valid
E2	0.594	0.725	0,2167	Valid
E3	0.644	0.827	0,2167	Valid
E4	0.718	0.775	0,2167	Valid

Can be seen in the table, based on the output *correlations* known calculated r value (Pearson Correlation value of all indicators with the Total value of each indicator) is greater than r table so that the data is said that all data on reliable variables is valid. Whereas when looking at the value of Sig. (2-tailed) for the relationship or correlation of each item with a Total RL of < 0.05 and Pearson Correlation is positive, then all

items are valid.

3.1 Data Reliability Test

A questionnaire can be said to be reliable if the answer of the reponden to the statement has consistent results over time. The reliability of the answers will affect the consistency of the answers tested repeatedly on different samples. The method used in this study uses Cronbach Alpha which is processed using SPSS software. Reability Test can be done using SPSS program with the following criteria:

1. If the Cronbach Alpha value \geq the Rtable then the data in this study is said to be reliable
2. If the Cronbach Alpha value $<$ the Rtable then the data in this study is said to be unreliable.

Reliability Statistics

Cronbach's Alpha	N of Items
.892	17

It is known that the Value of *Cronbach's Alpha* in the Reality variable is 0.892. The value is then compared with the table r value, which in the table r, at signification 0.01 with a test of 2 sides and the amount of data (n) = 113, then the table r obtained by 0.2167. Since the value $r = 0.892 > r \text{ table} = 0.2167$ it can be concluded that the items studied are reliable.

Reliability Statistics

Cronbach's Alpha	N of Items
.911	17

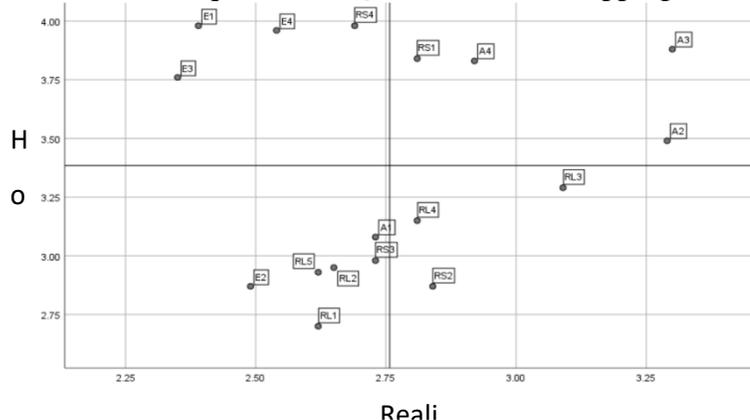
Meanwhile, it is known that the value of *Cronbach's Alpha* in the Variable Expectation is 0.911. The value is then compared with the table r value, which in the table r, at signification 0.01 with a test of 2 sides and the amount of data (n) = 113, then the table r obtained by 0.2167. Since the value $r = 0.892 > r \text{ table} = 0.2167$ it can be concluded that the items studied are reliable.

3.2 Analysis of Performance Interest Level with Importance Performance Analysis (IPA) Method

The IPA method is used to measure the relationship between consumer perception and the priority of improving the quality of products/services, also known as quadrant analysis.

Quadrant analysis divided into four quadrants that include the first quadrant's top priority,

the second quadrant maintains performance, the low priority of the third quadrant and the redundant quadrant. Quadrant IPA mapping can be seen in Figure X.



3.3 Satisfaction Level Analysis with the Method of Customer Satisfaction Index (CSI) Measured user satisfaction levels in this study using the CSI method. To see the results of the analysis of satisfaction calculation with CSI method will be described in the table as follows.

Variabel	Mean Importance Score (MIS)	Mean Satisfaction Score (MSS)	Weighting Factors (WF)	Weighted Score (Wsi)
RL1	2.62	2.70	5.59	15.09
RL2	2.65	2.95	5.65	16.68
RL3	3.09	3.29	6.59	21.69
RL4	2.81	3.15	6.00	18.89
RL5	2.62	2.93	5.59	16.38
RS1	2.81	3.84	6.00	23.02
RS2	2.84	2.87	6.06	17.39
RS3	2.73	2.98	5.82	17.36
RS4	2.69	3.98	5.74	22.84
A1	2.73	3.08	5.82	17.94
A2	3.29	3.49	7.02	24.50
A3	3.30	3.88	7.04	27.32
A4	2.92	3.83	6.23	23.86
E1	2.39	3.98	5.10	20.29
E2	2.49	2.87	5.31	15.25
E3	2.35	3.76	5.01	18.85
E4	2.54	3.96	5.42	21.46

Table 2 CSI Result

WT	CSI	
338.81	67.76168125	Satisfied

The results of the analysis applied by CSI amounted to 113 respondents the level of patient satisfaction with the services provided by Traveloka was 67.76168125 so that it was rounded up to 0. 68. This indicates that Traveloka's customer service quality is categorized as satisfied. In this study, users who interacted with Customer Service were satisfied with the services provided by Traveloka.

4. DISCUSSION

4.1 Managerial Implications

These managerial implications can not only be used by Traveloka directly but can be managerial implications for similar Online Travel Agents such as Tiket.com and PegiPegi in devising the right strategies to maintain and provide the best quality of service.

4.2 Managerial Implications of Importance Performance Analysis (IPA)

Based on the results of ipa calculations that are then grouped into Quadrants obtained the result that in quadrant I can be seen in table X needs to be improved and improved to make customers loyal, attributes located in quadrant II are attributes that need to be maintained.

4.3 Managerial Implications of Customer Satisfaction Index (CSI)

The results of the Customer Satisfaction Index analysis showed that the value of customer satisfaction index to traveloka customer service is 67.76 percent which can be interpreted that customer are satisfied with the service provided. Therefore, customer service at Traveloka Online Travel Agent improves service performance in all dimensions of services provided ranging from complaints to product offers by Traveloka. By improving the performance of the best service, Traveloka customer satisfaction can be increased in the following year.

5. CONCLUSION

5.1 Kesimpulan

Based on the research that has been done based on the objectives obtained the following conclusions:

1. Based on data collection using Google form as a data source and conducted online dissemination, 120 respondents with 113 respondents have used Traveloka and data processing using *Customer Satisfaction Index* and *Importance Performance Analysis* obtained CSI test results that are 67.76 which belongs to the category of Satisfied, and the test results using IPA produce several dimensions in quadrant I need to be improved to increase customer loyalty.
2. From the results of the research conducted obtained that the results of research on Traveloka customer service shows call centers to be the main choice for customers to

submit complaints because they feel faster to follow up on complaints that have been submitted.

3. Recommendations given to Traveloka Online Travel Agents based on research that has been done, namely, in quadrant I where customer expectations or interests are high but in terms of reality is still low as in, *Call center* dimensions and *twitter* admin can provide product information and reports clearly to customers (RS4), , Dimension *Call center* and *twitter* admin Traveloka is able and understand customer requests (E1), Dimension *Call*

center and *twitter* admin Traveloka can repeat the request well and correctly orally or in writing, to convince customers that their request has been in accordance with the wishes (E3) recommendations provided is to provide knowledge through education or certification to customer service so that the service is on target and does not cause new problems. Dimension Availability of adequate service hours (E4) must be evaluated there is the availability of service hours to be added to meet the needs of customer complaints services are increasingly due to this pandemic.

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THE INFLUENCE OF E-PROCUREMENT AND GOOD GOVERNANCE IMPLEMENTATION TOWARD THE PERFORMANCE OF GOODS/SERVICES IN TEMANGGUNG REGENCY

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ABSTRACT

Referring to Presidential Regulation No. 16 of 2018, the activities of procurement of goods and services in Indonesia can be carried out online, the implementation of these regulations is reflected in the e-procurement program that has been implemented both in the central government and in local governments. The purpose of this study is to analyze and evaluate the effect of the implementation of eprocurement on the performance of procurement of goods/services and to analyze and evaluate the effect of the principle of good governance on the performance of procurement of goods/services in the procurement of goods and services in Temanggung Regency. This study uses a quantitative method with a survey approach to see how much influence the independent variable has on the dependent variable. The independent variable in the study is e-procurement and the principle of good governance, while the dependent variable is the performance of the procurement of goods/services. The data analysis technique used to determine the effect of the variables observed in this study is the Partial Least Square (PLS) component-based Structural Equation Model (SEM). The test results between the electronic procurement variable and the principle of good governance on the performance of the procurement of goods and services resulted in an R2 value of construct Y (performance of goods and services procurement) of 0.757 indicating that 75.7% of the variable performance of procurement of goods and services was influenced by electronic procurement and the application of the principle good governance.

Keywords: e-procurement, good governance, procurement of goods/services performance.

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1. INTRODUCTION

The process of goods and services procurement is an important activity for a country, both procurement of goods and services in the public sector and procurement of goods and

services in the private sector. Several efforts to create quality public services have been carried out by the Government of Indonesia, one of which is by issuing regulations on the use of technology and information in the public service sector, and we called it electronic government/e-gov. The policy is contained in the national strategy for developing e-government through Presidential Instruction Number 3 of 2003, which is the legal basis and shade for technical implementation in electronic government (Swadesi, 2017). Furthermore, these efforts are incorporate into regulations and addressed by all public agencies from the central government to the regional level. The regulation is contained in Presidential Regulation of the Republic of Indonesia Number 16 of 2018 concerning Government Procurement of Goods/Services. The process of procuring goods and services is always associated with acts of Corruption, Collusion, and Nepotism (KKN) (Udoyono *et al.*, 2016).

The opportunity for corruption in procurement is very large, considering the large budget. Research results from the Directorate of Research and Development of the Corruption Eradication Commission revealed that around 30% of corruption cases handled were related to the problem of procurement of goods and services with a loss of almost one trillion rupiahs (Islami, 2017). Electronic Government is one solution to overcome the corruption problems in public services implementation, Electronic Government aims to improve the delivery of information and services to public sector institutions (Adjei-Bamfo, Maloreh-Nyamekye and Ahenkan, 2019). E- government itself aims to improve the delivery of information and services to public sector institutions to achieve better governance (Bonsón *et al.*, 2012). The function of e-government itself is explained by several experts from developed and developing countries that e-government increases citizen involvement in the decision-making process and makes government more transparent, accountable, and effective to improve the quality of service delivery (Boateng, 2013; Osei-Kojo, 2017).

Since the public sector is concerned with people's welfare, it may tend to pursue sustainable issues compared to the private sector. Governments can take the lead in stimulating sustainable supply chain management in the marketplace, by demanding environmentally and socially responsible products and services from suppliers, who in turn tend to offer them to other customers in the market (Walker and Brammer, 2012). In fact, the implementation process of e-procurement still has weaknesses and obstacles, such as lack of financial support, several agencies and service providers who are more comfortable with the previous system (conventional procurement), lack support from top management, lack of ability and knowledge about e-procurement. e-procurement and system security guarantees that are not yet qualified (Gunasekaran *et al.*, 2009). It is hoped that the implementation of e-procurement in the Temanggung Regency Government can improve services in the field of procurement of goods and services and the realization of Good Governance.

Officially, the implementation of e-procurement in Temanggung Regency has been carried out since 2012 with the spirit of creating effectiveness, efficiency, accountability, transparency and creating healthy competition between partners.

Table 1 Realization of Temanggung Regency Government Expenditure by Type of Expenditure(thousand rupiah), 2014-2019

Purchase Type	2014	2015	2016	2017	2018	2019
	2	2	2	2	2	2

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Direct Purchase	427 119 269 .58	608 419 098.38	772 179 544.26	139 915 380.22	605 366 259.49	695 370 779.64
Employee Purchase	40 080 982 .28	39 338 729.40	45 519 696.94	20 182 088.48	80 088 353.74	101 188 591.90
Goods and services purchase	188 614 495 .22	248 741 874.87	279 987 740.63	97 734 380.53	339 506 112.23	371 349 373.00
Capital Purchase	198 423 792 .08	320 338 494.11	449 672 106.69	21 998 911.21	185 771 793.52	222 832 814.74

Source: Temanggung in Figure 2018

Based on observations made at the Temanggung Regency Government, the performance of the procurement of goods and services is still relatively low. This can be seen from table 1.1 where in 2017, the realization of government spending in the goods and services expenditure sector decreased drastically from previous years, but in 2018 and 2019 it has started to improve, which means that there has been an increase from the previous year. Allegedly in 2017, there was a decline due to organizational restructuring where the office for the procurement of goods and services had just been moved and made into an integrated office to make it easier for goods and services procurement activities in the Temanggung Regency environment, and there were indications which later resulted in a decline. This is what makes procurement performance of goods and services not too stable, it can be seen from the phenomenon of employees where not all employees have a strong commitment to the performance of the procurement of goods and services. One example is that there are still some employees who have weak abilities in carrying out work so that targets cannot be completed on time.

In addition, there were still irregularities in the selection process for the company winning the auction, such as the committee selecting the winning company with the lowest bid value, while the highest bid was not evaluated. However, when looking at table 1.1 which has increased in 2018 and 2019 the researcher feels the need to cross-check several informants and also sources because the researchers did not find any quantitative data. Some interesting things, although in 2018 - 2019 it has improved, it turns out that there are still some findings in the implementation of the Temanggung Regency development project. These findings include non-compliance with the specifications paid, termination of project

contracts, construction that is not on time. The source was obtained by the researchers from the results of interviews with Mrs. Indah Cahyani, Member of Commission B DPRD Temanggung Regency. Because of these things, the performance of the procurement of goods and services of the Temanggung Regency Government can be affected by the e-procurement system. Several other factors are also suspected to affect the performance of the procurement of goods and services, including leadership, compensation, coordination, work culture, work discipline, formal education, work facilities, quality of human resources, human resource planning, job competence, organizational culture, supervision, attached, and so on.

Within the Temanggung Regional Government, several efforts have been made to apply the principles of good governance. One of them is by implementing an e-procurement system in the procurement of goods and services within the Temanggung Regency. However, based on the results of initial observations made in the field of procurement of goods and services in Temanggung Regency, the application of good governance principles seems to be still very weak. This is due to the improvement of the bureaucratic system that has not been carried out following the demands of the community. Based on the problems described above and considering the importance of solving the Performance of the Procurement of Goods and Services, the authors feel the need to conduct this research.

2. LITERATURE REVIEW

2.1 Procurement of goods and services

The procurement of goods and services in Indonesia has been regulated in Presidential Regulation No. 16 of 2018. According to Presidential Decree Number 16 of 2018. Procurement starts from planning, preparation for procurement, delaying, implementing contracts, and handing over goods/services. In general, the process of procuring goods and services is carried out through an auction/tender. However, there are several processes for procuring goods/services that are carried out directly or by appointment to partners, which means that the institution procures goods/services directly to partners without going through an auction/tender. Usually for some special work.

2.2 Electronic Procurement

According to Bonson (Bonsón *et al.*, 2012), e-procurement is a procurement process that refers to the use of the internet as a means of information and communication. The procurement of goods and services for the e-procurement system utilizes communication and information technology facilities that are used to support the electronic public tender process. E-procurement is not a single application but consists of many different tools, de Boer *et al.* (de Boer, L., Harink, J. and Heijboer, 2001) have identified and described six forms of e-procurement applications. The list is as follows: e-sourcing, e-tendering, e-informing, e-reverse auctions, e-MRO, web-based enterprise resource planning, and e-collaboration. However, many interpret electronic procurement as a comprehensive process from the procurement of goods and services starting from the initial process to the payment process that is carried out electronically. However, specifically, the definition of electronic procurement according to (Surabaya Mayor Regulation No. 8 of 2008) is a government goods/service procurement system that includes a web-based computer program to facilitate a series of procurement processes for goods/service providers including Electronic tendering and electronic selection.

2.3 Good Governance

Good governance is basically a concept that refers to the process of achieving decisions and their implementation that can be accounted for together. Good governance is a prerequisite for every government to realize the aspirations of the people to achieve the goals and ideals of the nation. UNDP defines good governance as a synergistic and constructive relationship between the state, the private sector, and society. The nine main principles of good governance include Participant, Rule of law, Transparency, Responsiveness, Consensus orientation, Equity, Efficiency and effectiveness, Accountability, and Strategic vision. These nine principles are the most important part of every public policy determination, implementation, and accountability within the framework of good governance (Hokayem and Kairouz, 2014).

2.4 Previous Research

Before this research, several studies related to the implementation of e-procurement and good governance have been conducted on the performance of the procurement of goods/services. First, research conducted by Adriana and Yasa (Adiana and Yasa, 2018) examines the Effect of Electronic Procurement on Good Governance in the Bali Provincial Government. This study uses the method used with technical data analysis using Partial Least Square (PLS) component-based Structural Equation Model (SEM) to analyze the direct and indirect effects between electronic procurement variables, employee commitment, procurement service quality, and good governance in the Bali Provincial Government. . Based on the results of data processing, the results showed that there was a positive and significant effect on the e-procurement system, employee commitment, and the quality of procurement services on good governance in the Bali provincial government. Second, research conducted by Jasman and Patra (Hamka, Patra and Jasman, 2019) with the title "The Influence of the Implementation of Good Corporate Governance on Financial Performance (Case Study at PT. Unilever Indonesia for the period 2010 - 2017)". The research method carried out by the researcher is descriptive statistical techniques and regression analysis. The results of the study indicate that: (1) Independent Commissioners have no significant effect on financial performance.

(2) Institutional have a significant positive effect on financial performance. (3) Managerial has a significant positive effect on financial performance.

3. METHODS

The research methodology used in this study uses quantitative research methods. The population in this study were employees of the goods and services sector who already had a certificate of procurement of goods and services from the Temanggung Regency government. According to data from the Center for Policy Development for the Procurement of Public Goods/Services, the population of employees who have certificates for the procurement of goods and services is 285 people. The sample of this study amounted to 160 respondents who were taken from the population of certified employees of goods and services procurement and service providers who use goods and services procurement services. This study uses data collection techniques with questionnaires distributed to respondents.

3.1 Validity and Reliability Test

Things that need to be considered before conducting research, must understand the instrument used to collect data, first test the instrument, to determine the level of validity and reliability.

3.1.1 Validity Test

A validity test was conducted to measure the suitability of the research model based on the measured variables. The test criteria are CR greater than 0.7; FL is greater than 0.6; and an AVE of at least 0.5. If all the questionnaire variables meet the criteria, then the factors or variables in this study have adequate validity.

3.1.2 Reliability Test

The definition of reliability can refer to an understanding that the instrument to be used can clearly measure something that is measured consistently over time. To measure reliability, it is stated that if the intercept value (constant) is greater than 0.6 then the variable is statistically reliable.

3.2 Data Processing

The data processing in this study used the PLS-SEM method. SmartPLS software is used to assist the data analysis process. The completed questionnaire was then processed using the PLS- SEM (Partial Least Square-Structural Equation Modeling) method. Data analysis using the PLS- SEM method consists of 2 (two) stages of testing, namely testing the outer model and the inner model.

3.2.1 Evaluation of the Measurement Model (Outer Model)

At the data processing stage, an evaluation of the measurement model (outer model) was carried out to assess the validity and reliability of the model. In the outer model, there are two types of indicators, namely reflective indicators, and formative indicators. Testing the external model with reflective indicators with several kinds of tests, including internal consistency reliability, and convergent validity. Internal Consistency Reliability, evaluation of internal consistency reliability was done by checking Cronbach's alpha and composite reliability. The test criteria are Cronbach's alpha and composite reliability values greater than 0.7. Convergent Validity, Convergent validity evaluation is done by checking the Average Variance Extracted (AVE) value. The test criteria is the AVE value is greater than 0.5. And the Outer Loading value is greater than 0.7.

3.2.2 Evaluation of the Measurement Model (Inner Model)

The inner model according is a structural model that describes the causal relationship between latent variables that is built on the substance of the theory (Abdillah, 2016). After going through the stages of evaluating the measurement model, the researcher then evaluates the structural model (inner model). This stage is carried out after the previous stage, namely the evaluation of the measurement model showing good quality. At the evaluation stage of the measurement model, several kinds of tests will be carried out, including (a) Coefficient of Determination (R^2), R^2 value 0.75; 0.50; and 0.25 respectively indicate substantial (strong), moderate, and weak (Henseler, Ringle and Sinkovics, 2009), (b) f-square effect (f^2), f^2 value 0.02; 0.15; and 0.35 respectively indicate weak, medium and large effects (Cohen. J, 1988), (c) Cross-validated redundancy (Q^2) A Q^2 value of more than 0 (zero) indicates that the model has accurate predictive relevance to certain constructs (predictable constructs), while a Q^2 value of less than 0 (zero) indicates that the model lacks predictive relevance (Sarstedt, 2017). (d) Path coefficient, The value of path coefficients ranges from -1 to +1, where the closer the value to +1, the stronger the relationship between the two constructs, on the contrary, the closer to -1.

3.3 Hypothesis test

After the data is processed with PLS-SEM it will produce a P value (P-value). This P value will be used to decide whether the hypothesis is accepted or not by comparing it with the alpha value (α) = 5% with the following conditions (a) If the p-value \leq value α then the decision taken is the hypothesis is accepted. (b) If p-value $>$ value α then the decision taken is the hypothesis is rejected.

4. RESULTS

Data collection in this study was carried out by distributing online and offline questionnaires, offline questionnaires were given by coming directly to the Stakeholders in each field in Temanggung Regency. From the distributed questionnaire data, it was found that the total number of respondents who filled out 160 respondents with details of 110 employee respondents who had certificates of procurement of goods and services and 50 service providers respondents who had carried out goods and services procurement activities in Temanggung Regency, most of the 160 respondents who participated in filling out the questionnaire consisted of male respondents with a total of 113 respondents or 70.63% and the rest were female respondents with a total of 47 respondents or 29.37%.

4.1 Inner Model

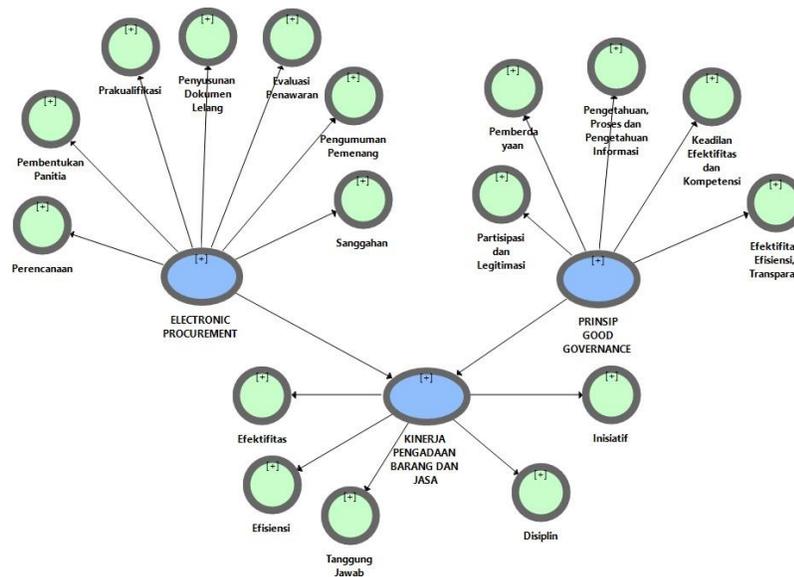


Figure 1 Inner Measurement Model on SmartplsSource: Research Results 2021 (data processed)

From Figure 1, it can be seen that the performance of the procurement of goods and services is an endogenous latent variable whose existence is influenced by exogenous variables, namely electronic procurement and the principle of good governance.

4.2 Outer Model

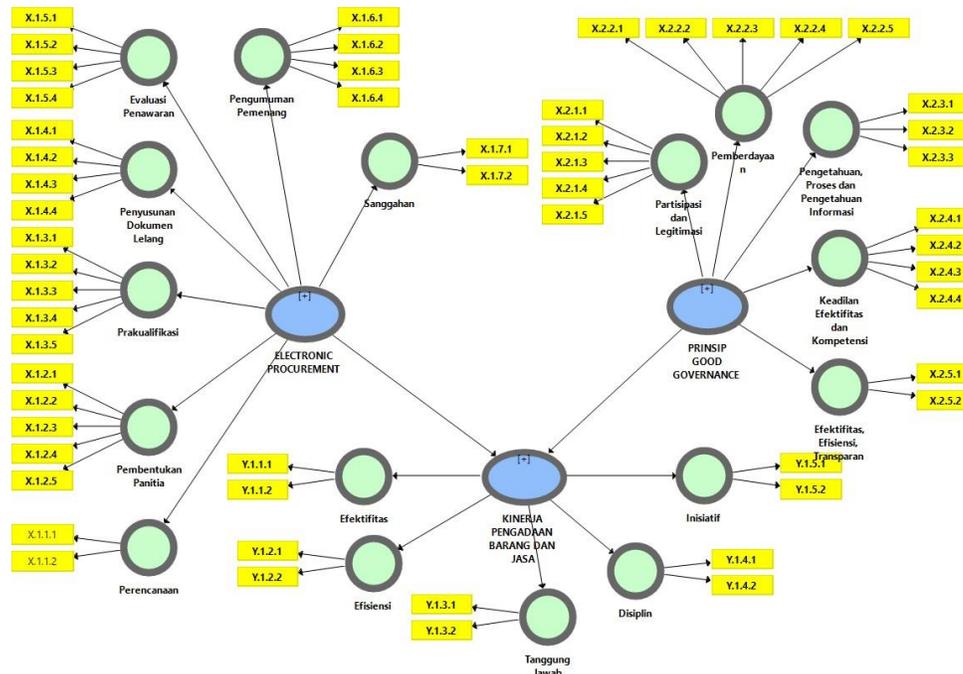


Figure 2 Outer Measurement Model on SmartplsSource: Research Results 2021 (data processed)

In Figure 2 it can be seen that the latent variable in this study is reflective wherein the measurement model the manifest variable block (indicator) associated with the latent variable (construct) is a reflection of the variation of the latent variable so that the causal relationship that occurs comes from the latent variable towards to indicators. When running with the questionnaire data that has been transferred in excel form, we get a measurement model with the path coefficient value in Figure 3 as follows:

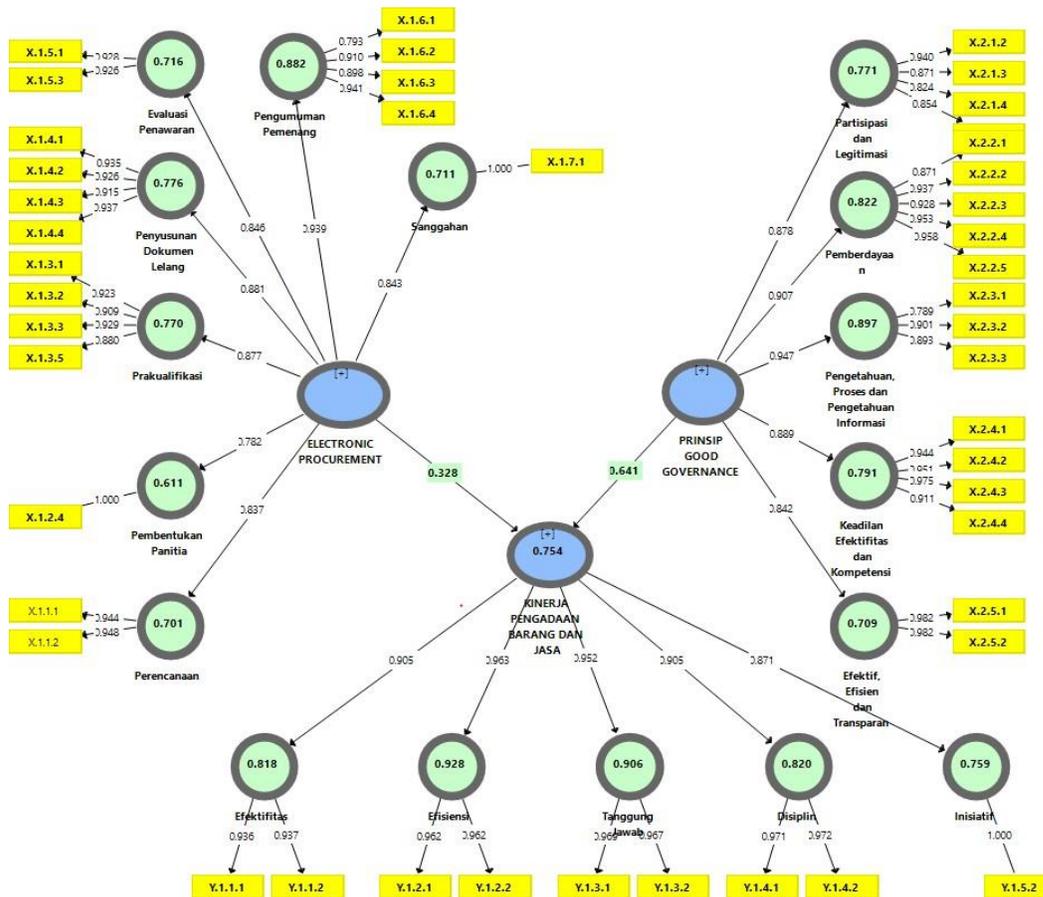


Figure 3 PLS Model Estimation Results Source: Research Results 2021 (data processed)

Based on the results of the analysis in Figure 3 above, it can be seen that after the invalid indicators are removed from the model, all indicators in the model are valid and the AVE value of all constructs has exceeded 0.5, this means that all indicators in the PLS model have met the criteria for convergent validity required. The path coefficient values can be modeled into a formula. For more details from the results of running bootstrapping, validity and reliability tests are needed to determine the validity of the questionnaire itself as a measuring tool.

4.3 Coefficient Determination (R^2)

The value of the determination coefficient (R^2) is used to assess how much the endogenous variable is influenced by other endogenous variables. The magnitude of the effect is seen from the R^2 value of 0.67; 0.33; and 0.19 which indicates that each model is good, moderate, and weak (Nevit, 2001). The large value of R^2 for all constructs except for the X12 dimension (committee formation) is in the strong criteria, while the R^2 dimension X1.2 has R^2 on the medium criteria, this indicates a strong influence of exogenous variables on endogenous, especially the R^2 value of

construct Y (performance of procurement of goods and services) of 0.757 indicates that

75.7% of the performance variable for the procurement of goods and services is influenced by electronic procurement and the application of good governance principles.

4.4 f Square effect (f^2)

Table 2 F^2 Value

Variabel Eksogen	f^2	Criteria
• <i>Electronic procurement</i>	0.319	Medium
• <i>Prinsip Good Governance</i>	0.908	Big

Source: Research Results 2021 (data processed)

In Table 2, the f^2 value for electronic procurement on the performance of the procurement of goods and services is 0.319, indicating that the effect size of electronic procurement on the performance of the procurement of goods and services is in the medium category, while the effect size of the principle of good governance on the performance of the procurement of goods and services is 0.908, indicating the effect size in the high category, this means that between electronic procurement and the principle of good governance, between the two exogenous variables, seen from the effect size value, the most influential factor on the performance of the procurement of goods and services is the principle of good governance.

4.5 Prediction Relevance Test (Q^2)

The endogenous variable for the performance of the procurement of goods and services (Y) has a Q^2 of 0.587, this indicates that the full PLS model which shows the relationship between electronic procurement and the principle of good governance on the performance of the procurement of goods and services has strong predictive relevance because its value is greater than zero.

4.6 Path Coefficient and Hypothesis Testing

This study conducted a two-tailed test because this study did not know whether the direction of the hypothesis was positive or negative. By conducting a two-tailed test, the expected t-statistic value is 1.96 with alpha (α) = 5% and p-values <0.05. If these criteria are met, it can be stated that the variable has a significant and positive effect.

Table 3 Significance Test Results using bootstrapping

	<i>Original Sample (O)</i>	<i>Sample Mean (M)</i>	<i>Standard Deviation (STDEV)</i>	<i>T Statistics (O/STDEV)</i>	<i>P Values</i>
X1 -> Y	0.331	0.331	0.159	2.087	0.019
X2 -> Y	0.645	0.647	0.168	3.845	0.000

Source: Research Results 2021 (data processed)

From the results of the variable significance test using bootstrapping as presented in Table 3, the results show that:

1. Electronic procurement has a positive and significant effect on the performance of the procurement of goods and services, indicated by a p value of 0.019, a T statistic of 2.087 and a path coefficient of 0.331.

2. The principle of Good Governance has a positive and significant effect on the performance of the procurement of goods and services, indicated by the p value of 0.000, the T statistic of 3.845 and the path coefficient of 0.645

4.7 Hypothesis Testing Results

Hypothesis testing in this study was obtained from the results of the PLS analysis. The following is a summary of the results of hypothesis testing based on the results of the PLS analysis:

Table 4 Hypothesis Testing Results

Hypothesis	Result	Conclusions
<ul style="list-style-type: none"> H1 : <i>Electronic procurement affects the performance of the procurement of goods and services</i> 	<ul style="list-style-type: none"> Path Coef = 0.331; T Stat = 2,087; P value = 0,019 	Accept
<ul style="list-style-type: none"> H2 : Good Governance principles affect the performance of the procurement of goods and services 	<ul style="list-style-type: none"> Path Coef = 0.645; T Stat = 3,845; P value = 0,000 	Accept
<ul style="list-style-type: none"> H3 : <i>Electronic procurement and the principles of Good Governance affect the performance of the procurement of goods and services</i> 	<ul style="list-style-type: none"> R Square Y = 0,757 	Accept

Source: Research Results 2021 (data processed)

6. CONCLUSIONS

Based on the results of the analysis that has been carried out, there are several important things that can be concluded, including:

1. The results of testing the significance of the path coefficient between the constructs of electronic procurement produce t-statistics values of 2.087 and p-values of 0.019. The criteria used in the test is the alpha value (α) = 5%, then the path coefficient is declared significant if the t-statistic value 1.96 and p-value 0.05. Thus the results of the analysis obtained from this study indicate that electronic procurement has a significant effect on the performance of the procurement of goods and services.

2. The results of the path coefficient significance test between the constructs of good governance principles produce t-statistics values of 3.845 and p-values of 0.000. The criteria used in the test is the alpha value (α) = 5%, then the path coefficient is declared significant if the t-statistic value 1.96 and p-value 0.05. Thus the results of the analysis obtained from this study indicate that the principle of good governance has a significant effect on the performance of the procurement of goods and services.

3. The test results between the electronic procurement variable and the principle of

good governance on the performance of the procurement of goods and services resulted in an R² value of construct Y (performance of goods and services procurement) of 0.757 indicating that 75.7% of the variable performance of procurement of goods and services was influenced by electronic procurement and the application of the good governance.

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Parallel Session 1

Room E (09:50 - 11:20)

Moderator:

Category: Project Management

ANALYSIS OF BUILDING INFORMATION MODELING (BIM) IMPLEMENTATION IN CONSTRUCTION COMPANIES

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ABSTRACT

BIM (Building Information Modeling) is one of the innovative technologies in the AEC (Architecture, Engineering, and Construction) industry. This research aims to analyze the implementation of BIM in construction companies. BIM Maturity and Technology Acceptance Model (TAM) were used as variables to measure BIM implementation. The questionnaire is used as a tool for data collection with respondent practitioners and managers in construction companies who have used and implemented BIM. The questionnaire data were then analyzed using Quadrant Analysis to map the strengths, weaknesses and obstacles in implementing BIM in construction companies. For model validation, one of the state-owned construction companies - PT WXY (persero) Tbk., which used BIM as one of their business strategies - was used as a case study. The results showed that PT.WXY (Persero) Tbk., in general has accepted BIM technology, both individually and organizationally; covering aspects of technology, processes and policies. Based on the results of the Quadrant Analysis, the problems faced in the application of BIM are caused by the behavioral intention of individuals to use BIM. In addition, BIM technology requires a large investment and interoperability of BIM softwares. The availability of competent human resources to use BIM also needs to be a concern for the company.

Keywords: BIM (Building Information Modeling); BIM Maturity; TAM (Technology Acceptance Model); Construction Project

1. INTRODUCTION

Infrastructure development projects are increasingly widespread in various fields, including the construction of toll roads, dams, ports, airports, etc. Infrastructure development has an important role in meeting the needs of facilities and infrastructure for human life. Infrastructure development is included as part of increasing the rate of economic growth that supports people's welfare.

Recent challenges in the world of construction include the industrial revolution 4.0 and VUCA (Volatile / volatile, Uncertain / uncertain, Complex / complex, Ambiguous / unclear). The industrial revolution 4.0 includes changes in the digital revolution of the Internet of Things (IoT), Big Data, 3D Printing, Augmented Reality (AR), Artificial Intelligence (AI), cloud computing, etc. The use and implementation of technology requires adjustments or adaptations from both users and beneficiaries. Facing VUCA requires readiness for all parts of the construction company through communication, collaboration and integration with the support of technology and innovation.

Building Information Modeling (BIM) is one of the innovative technologies and continues to grow in the AEC (Architecture, Engineering, and Construction) industry. BIM is able to simulate all the information in a development project in 3D to 7D models. BIM can be applied in all cycles or stages of a construction project from the decision-making stage, design stage, construction stage, operation and maintenance stages to demolition.

Several studies on the implementation of BIM in various countries have been carried out. Generally, research leads to trends, benefits, and risk in the use of BIM (Azhar, 2011). However, not much research has been explored regarding the implementation of BIM in construction companies, especially in Indonesia. Several models used in research to measure BIM implementation in construction companies are BIM Maturity and TAM (Technology Acceptance Model) (Succar, 2010; Miaoli, 2020). Unfortunately, the two models are mostly used by themselves partially, even though they are complementary in measuring BIM implementation.

This research aims to analyze the implementation of BIM in construction company in Indonesia. In addition to identifying the benefits, problems and obstacles in the implementation of BIM. This research will also propose strategic steps in the implementation and development of BIM in construction companies. This research adopts a survey-based approach through questionnaires and interviews within the construction company (PT. WXY (Persero) Tbk.), to identify BIM implementation and problems that hinder BIM implementation and development. Through the proposed strategic steps in implementing, developing and utilizing BIM, so that in the future it will be better and can also help achieve the company's strategic goals.

2. LITERATURE REVIEW

2.1 BIM (Building Information Modeling)

BIM (Building Information Modeling) is a methodology in which all project information (including specifications, quantity, price, stages of work, work methods, implementation schedule, etc.) is integrated in the form of a building model. BIM offers benefits to increase effectiveness, reduce risk, optimize resources and achieve project objectives. Through model visualization, coordination, simulation and collaboration, BIM can analyze all the information and optimize and increase efficiency in each phase of the construction project cycle.

BIM represents digitally with complete data so that information is easy to understand and easy to evaluate. A variety of structured information provided in the BIM can facilitate stakeholders in the decision-making process, including final approval.

The advantages of BIM include: reducing material waste, reducing the number of design changes, improving design and construction quality, increasing communication

efficiency, and promoting efficient cost, quality and time management (Li et al., 2014b; Morin, 2015; Doumbouya et al., 2016; Haraguchi, 2016).

2.2.1 BIM Maturity

BIM Maturity is a concept that defines the various evolutionary variations of existing and planned stages based on the collaborative approach in the BIM system. BIM competency represents the ability of BIM users to meet the objectives and benefits of BIM by being identified from the implementation objectives and assessment of BIM. The relationship between aspects of BIM Maturity is depicted in the diagram of Figure 1. The classification in the implementation of BIM in general consists of 3 aspects, namely (Bilal Succar, 2010):

- a. Technology: software, hardware and networks.
- b. Process: leadership, infrastructure, human resources, and products / services.
- c. Policy: contracts, regulation, and research / education.

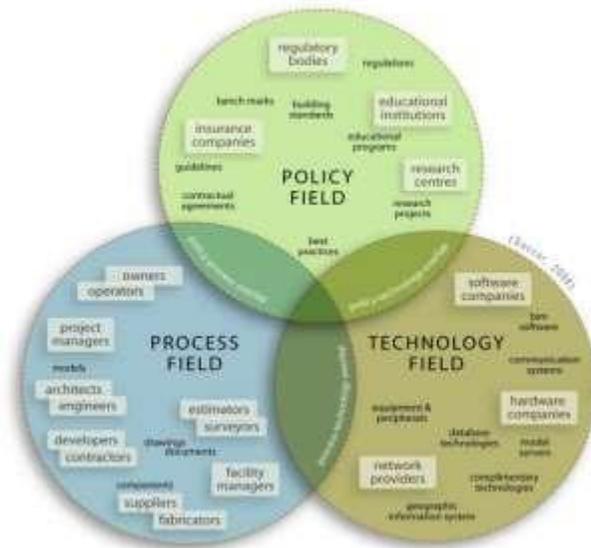


Figure 1. Three areas in BIM activity (Bilal Succar, 2010)

2.2 TAM (Technology Acceptance Model)

Technology Acceptance Model (TAM) is a theoretical model that is formed to analyze and understand several factors that affect the acceptability of the use of a technology or technology system within an organization. TAM aims to explain and predict / estimate the acceptance of use of a technology system. The main purpose of TAM is to provide an explanation of the determination of computer acceptance in general, providing an explanation of the behavior or attitudes of users in a population (Davis et.al., 1989). TAM explains the causal relationship between the tendency of intention and attitude to use / accept technology (behavioral intention to use) of two beliefs, namely, perceived usefulness and perceived ease of use.

The studies on TAM, the study of the application of the TAM model in examining the acceptance of BIM in organizations combined with the information success model and

the motivation model using the Structural Equation Model (SEM) to explore the important motivational factors in the adoption of BIM in organizational construction (Lee et al, 2015). The TAM defines external variables that can affect user behavior and it can be have a definition of the requirements of user's view for making system (Hong et al, 2018).

3. METHODS

This research variable is a combination of TAM and BIM Maturity to identify the implementation of BIM in construction companies. One of the state-owned construction companies, PT WXY (persero) Tbk., was used as a case study. PT WXY (Persero) is used as a case study because they are a company that uses BIM as one of their business strategies. With the consideration that the implementation of BIM in a company is influenced by external variables and internal variables which are selected based on relevant previous studies. The variables to be used in the research instrument are described in Figure 2.

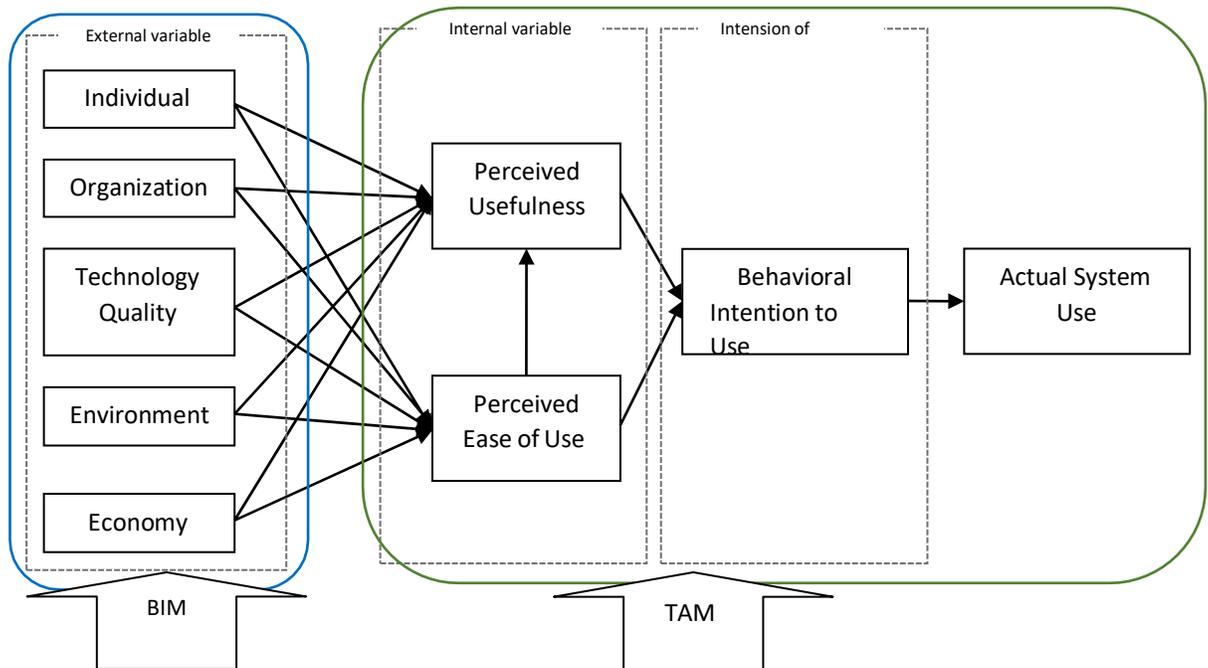


Figure 2. Relationship Between Variables in Research

This research adopts an online questionnaire survey and interview-based approach in the corporate environment to identify, obtain information that is in line with project needs and overcome problems that hinder implementation and BIM development. The variables related to the implementation and development of BIM (totaling 23 variables) which include TAM (Technology Acceptance Model) and BIM Maturity, are derived based on literature studies and structured interviews with practitioners and validated by experts. The research variables used in this study are described in Table 1.

Table 1. Research Variabels

Code	Labels	Var	Category	Assessment Items
E-1	External Variable	E	Individual	Familiar with BIM tools/technology.
E-2	External Variable	Ext Var	Individual	Individual acceptance in the implementation and utilization of BIM.
E-3	External Variable	E	Organizational	Availability of personnel in the needs of BIM implementation.
E-4	External Variable	Ext Var	Organizational	Top management support.
E-5	External Variable	E	Organizational	BIM training program as the provision of human resources for BIM implementation.
E-6	External Variable	Ext Var	Organizational	Award for successful BIM implementation from management.
E-7	External Variable	E	Technology quality	Ease and completeness of data from BIM tools/technology.
E-8	External Variable	Ext	Technology	BIM software capabilities/ capability/ functionality.
	External Variable	Var	quality	
E-9	External Variable	E	Environment	Use of BIM as a requirement/contract of work.
E-10	External Variable	Ext Var	Environment	The application of BIM is due to its popularity, as an industrial competition.
E-11	External Variable	E	Economy	Costs in the provision of resources (hardware and software) BIM.
E-12	External Variable	Ext Var	Organizational	Organizational/team support.
I-1	Internal Variabel	I	Perceived Usefulness	BIM provides the required information.

I-2	Internal Variabel	Inte Var	Perceived Usefulness	BIM helps achieve company goals (time, risk, cost)
I-3	Internal Variabel	I	Perceived Usefulness	Ease of collaboration and reciprocity BIM.
I-4	Internal Variabel	Inte Var	Perceived Usefulness	BIM assists in decision making with relevant stakeholders.
I-5	Internal Variabel	I	Perceived Usefulness	Comparison of benefits received with costs for BIM implementation.
I-6	Internal Variabel	Inte Var	Ease of Perceived Use	BIM makes work easier in general.
I-7	Internal Variabel	I	Perceived Ease of Use	Ease of BIM data integration.
I-8	Internal Variabel	Inte Var	Behavioral Intention to Use	Individual intention and desire to apply BIM in work.
I-9	Internal Variabel	I	Behavi oral Intention to Use	Curiosity/innovation to know more about BIM.
I-10	Internal Variabel	Inte Var	Behavioral Intention to Use	Recommend the use of BIM.
I-11	Internal Variabel	I	Behavi oral Intention to Use	Organizations create rules for using BIM.

The sampling technique in this study uses Non-Probability Sampling, with method purposive sampling. This approach is taken because not everyone (only certain people in the company) who master and use BIM in their duties.

The samples / respondents in this study include direct (users, experts) and beneficiaries / decision makers (managers, top management) who are related to the implementation and development of BIM in the construction company. The data obtained from respondents is used to obtain information performance. Meanwhile, the data obtained from respondent beneficiaries / decision makers is used to obtain information importance. Quadrant Analysis is finally used to describe the conditions of BIM implementation in PT. WXY (Persero) Tbk.

4. RESULTS AND DISCUSSION

4.1 Survey Results

The research survey was conducted from March to April 2021 by collecting opinions from survey respondents including direct users (users, experts) and decision makers (manager, top

management). In the implementation of data collection, data was taken that represented the types of respondents who could reflect the actors in the implementation of BIM in the company.

The questionnaires were distributed using an online platform. The number of questionnaires collected was 74 questionnaires (87% of the total questionnaires distributed). Figure 3 shows the profile of research respondents from the aspect of experience using BIM.

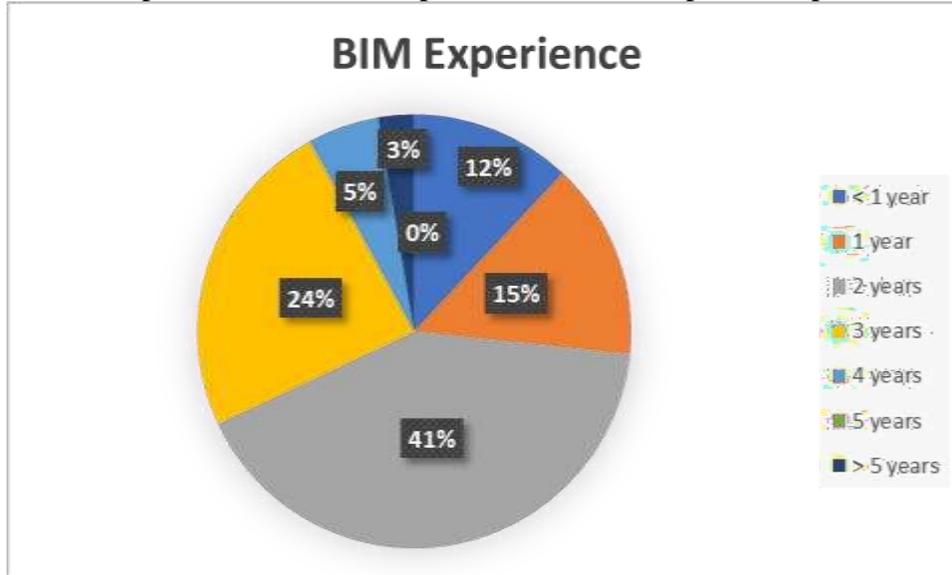


Figure 3. Profile of respondents in duration of BIM Experience

4.2 Research Results and Analysis

In the research, there are two main parts of the respondent, namely: decision makers (manager, top management) to provide an assessment of importance (importance) and direct users (users, experts) as respondents for performance assessment (performance). The assessment is measured using a Likert scale of 1 to 5. In the importance rating, a higher score indicates the more important the attributes that are being asked in the questionnaire. Meanwhile, in the performance appraisal, a higher score indicates the better the attributes asked in the questionnaire.

The results of the recapitulation of the calculation of the level of importance and the level of performance can be seen in Table 2. Henceforth mapped in the science diagram in Figure 5.

Table 2. Weight of Importance and Performance

Assessment Items	Weight of Performance (X)	Weight of Importance (Y)	Average Performance (\bar{X})	Average Importance (\bar{Y})	Gap Score
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	VE-1	157	133	3.83	4.03	- 0.20
	VE-2	173	152	4.22	4.61	- 0.39
	VE-3	128	132	3.12	4.00	- 0.88
	VE-4	158	152	3.85	4.61	- 0.75
	VE-5	139	134	3.39	4.06	- 0.67
	VE-6	158	148	3.85	4.48	- 0.63
	VE-7	159	140	3.88	4.24	- 0.36
	VE-8	142	143	3.46	4.33	- 0.87
	VE-9	159	125	3.88	3.79	0.09
10	VE-	162	132	3.95	4.00	- 0.05
11	VE-	169	128	4.12	3.88	0.24
12	VE-	157	144	3.83	4.36	- 0.53
	VI-1	159	150	3.88	4.55	- 0.67
	VI-2	147	147	3.59	4.45	- 0.87
	VI-3	150	139	3.66	4.21	- 0.55
	VI-4	159	152	3.88	4.61	- 0.73
	VI-5	146	147	3.56	4.45	- 0.89
	VI-6	163	149	3.98	4.52	- 0.54
	VI-7	147	142	3.59	4.30	- 0.72
	VI-8	146	145	3.56	4.39	- 0.83
	VI-9	177	151	4.32	4.58	- 0.26
10	VI-	179	151	4.37	4.58	- 0.21
11	VI-	158	135	3.85	4.09	- 0.24
	\bar{X} and \bar{Y}			3.81	4.31	

In Table 2, there is the most significant gap score between performance and importance, namely the attribute comparison of benefits received with costs for

implementing BIM (VI-5) with a gap score of -0.89 and the attribute number of BIM personnel (VE-3) with a gap score - 0.88. This means that respondents think that the use of BIM still does not provide profitable Benefit- Costs. BIM is still considered expensive and has not provided significant benefits in increasing project cost efficiency and work productivity.

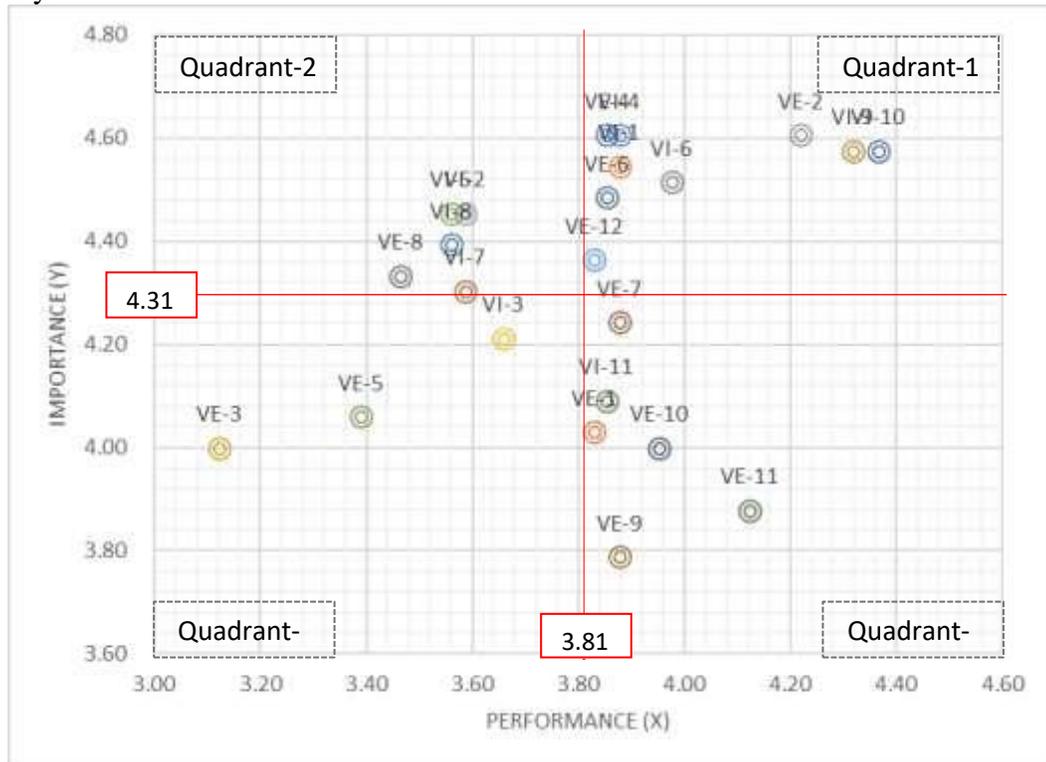


Figure 4. The results of the Quadrant Analysis diagram mapping

From the results of data processing using the Quadrant Analysis diagram in Figure 4 above, the mapping of the position of each attribute in the quadrant diagram can be described. In general, of the 23 research attributes, the company already has good performance and interests with 9 attributes in quadrant-1 (keep up the good work). In quadrant-2 (concentrate here) and quadrant-4 (possible overkill), both have 6 attributes, while in quadrant-3 (low priority) there are 3 attributes.

4.3 Discussion and Findings

Based on the results of Quadrant Analysis, in general the company PT. WXY (Persero) accepts the application of BIM, both individually and organizationally. The acceptance of BIM implementation in the company cannot be separated from the support from top management through reward mechanism which is carried out regularly every year, as a motivation for each individual or project team to innovate using BIM. BIM technology provides perceived ease of use in project or individual work. From the implementation of BIM, companies get many benefits, especially the integration of information needed by stakeholders in the project.

Application of BIM at PT. WXY (Persero) has covered most of the main aspects of

BIM Maturity, including aspects of technology, processes and policies. PT. WXY (Persero) has started implementing BIM since 2018, through BIM training programs in small groups and socialization to top management and project teams. BIM implementation begins with a pilot project from each division to obtain feedback information from BIM implementation.

Based on the results of the analysis, the main problem in implementing BIM is that the individual's desire to apply BIM in work is still not strong enough. In addition, there are technological constraints that require large investment costs and software interoperability. Obstacles to BIM implementation in terms of software interoperability make it difficult to integrate data between departments, and there is not enough data that shows the value of BIM efficiency on projects that have been carried out by the company. To overcome this, it is necessary to form a formal research and development team to standardize quality and procedures in the implementation of BIM. The formation of a special organization by management in the BIM structure must be clear about its role in the team and in accordance with the required competencies. On the other hand, the number of ongoing projects is inversely proportional to the number of personnel who have the competence to implement BIM. As a result, the implementation of BIM in companies is currently not optimal. Therefore, the company continues to prepare infrastructure and human resources in the implementation and monitoring of BIM.

Based on the results of discussions with experts, managers, and academics, several proposed solutions were obtained. Improvements need to be the organization, human resources (HR), and BIM technology.

To support and succeed the company's goals through technology or digital transformation, one of which is the implementation and development of BIM. The development of integrated systems and technology is one of the visions of PT. WXY (Persero) Tbk., namely, to become a trusted, sustainable and integrated Indonesian company in the construction and investment sector.

Some of the company's future strategic plans -the results of the Focus Group Discussion- are as follows:

- a. Digitization of construction as company culture and standards.
- b. Efficiency and improvement of engineering performance, quantity surveyor (QS), quality control (QC), Production Control Division (PCD), and Supply Chain Management (SCM).
- c. The increasing role of automation, computing, robotics and the Internet of Things (IoT) in construction work.
- d. Strategic and market studies.
- e. Increasing the competence of human resources (HR) to adapt the technology.
- f. Synergy and external cooperation with government, industry, educational institutions, and the construction service community.
- g. Creating innovation through the integration of BIM (Building Information Modeling) and GIS (Geographic Information System).
- h. Create quality standards and standard procedures for BIM implementation.

6. CONCLUSIONS

Based on the results of Quadrant Analysis, in general the company PT. WXY (Persero) accepts the application of BIM, both individually and organizationally.

Implementation of BIM PT. WXY (Persero) has covered most major aspects of BIM Maturity, including technology, processes and policies.

The main problem in implementing BIM is the willingness of individuals to use BIM, as well as technological constraints that require large investment costs and software interoperability.

Strategic proposals to increase the effectiveness of BIM implementation in construction companies include increasing HR competencies to adapt, synergize and integrate with BIM technology, as well as increasing the role of automation, computing, robotics and the Internet of Things (IoT).

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Xuan Qin, Y. S. (2020). Using a Tam-Toe Model To Explore Factors of Building Information Modelling(Bim) Adoption in the Construction Industry. *Journal of Civil Engineering and Management*.

IDENTIFICATION OF AGILE PROJECT MANAGEMENT (APM) RISK IN THE CONSTRUCTION DESIGN PROCESS

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ABSTRACT

Agile Project Management (APM) is one of the newest concepts in the selection of implementation methods in the construction sector which has its own advantages. Agile Project Management (APM) is a project management methodology that has high adaptability to changes that occur. In its application the construction field itself has many changes and the choice of method is very important so that this agile method can be applied to the construction field with the intention of producing a better effect. The application of this method is mostly in the design phase due to frequent changes in the planning phase and the importance of aligning the wishes of the project owner with the planning team. In the implementation process, it still poses risks so that risk is still an important thing that must be considered and controlled. The method used is a qualitative method by conducting literature studies and media surveys with data analysis using the Guttman Scale. The results of the study amounted to 76 variables derived from the literature, and became 69 variables after an analysis with the Guttman scale consisted of 9 variables of communication threat risk, 6 variables of collaboration threat risk, 12 organizational threat risk, 8 technical threat risk, the risk of communication opportunities is 11 variables, the risk of collaboration opportunities is 6 variables, the risk of organizational opportunities is 11 variables, and the risk of technical opportunities is 6 variables.

Keywords: Agile Project Management (APM), Construction Design Process, Threats Risk, Opportunities Risk, Guttman Scale.

1. INTRODUCTION

The way construction projects are managed has not changed significantly in the last few decades, but stakeholders, materials, user requirements and competition continue to change dynamically with the times, which ultimately creates a gap between the current managerial view of how construction projects are carried and how they can be managed to improve efficiency, the construction world can use new methods to act on projects and learn from the experiences of other industries, which requires construction companies to improve performance to increase competitiveness, increase added value for customers and for the construction companies themselves (Streule, Miserini, Bartlome, Klippel, and De Soto, 2016).

Proper supervision of project management in the implementation of construction projects can assist in the dynamic implementation of work that is required by the many changes that often

occur in the construction process, but what cannot be avoided is the risk that accompanies each project and is part of all stages of the construction project implementation cycle. (Obrova, 2013),

so that risk management and the selection of management approach methods are important for the implementation of a good construction project, but currently most project management used is a traditional approach, with this traditional approach system being the most frequent reason for project failure because it is not optimal in handling many external changes (Buganova, Simickova, 2019).

So far, the use of the Agile Project Management (APM) approach has been widely used in software projects, and it has proven that its success can indeed be felt in the short or long term, both in terms of product results and in terms of the organization in it (Turner, 2014). The results also show that the Agile method is successful and has great potential in the world of construction planning (Streule, Miserini, Bartlome, Klippel, and De Soto, 2016).

Although the use of an agile approach in construction project management helps to overcome the weaknesses associated with traditional methodologies of managing projects (Kähkönen & Abrahamsson, 2003), the use of Agile Project Management (APM) methodologies is still faced subject to a number of risks and there is a need to understand these risks with the aim of improving future use. Little knowledge of the risks associated with the use of Agile Project Management (APM) makes it an application in designing and building projects to be a risk for many planners, project risk can be described as an infinite phenomenon whose emergence can have a positive or negative (Shrivastava & Rathod, 2013). Therefore, this research is expected to assist in identifying risk problems which are divided into threat risks and opportunity risks to improve project management efficiency.

2. LITERATUR REVIEW

2.1. Agile Project Management (APM)

Agile Project Management (APM) is a modern and flexible approach to project management where it makes it possible to break down large projects into more manageable tasks, which are handled in short iterations or sprints. This allows the team to adapt to rapid changes and produce work quickly. Where the first principle of agile is to place customer satisfaction as the highest priority and is the key in producing products according to what customers want. Therefore, in order to remain competitive and relevant, organizations can no longer only focus internally but must focus more on the outside to see what customers want for their projects (Agile Practice Guide, 2017). In Agile Project Management (APM) linking values, principles and practice by articulating Agile as a mindset that is determined by values, guided by principles and activated by practice (Agile Practice Guide, 2017).

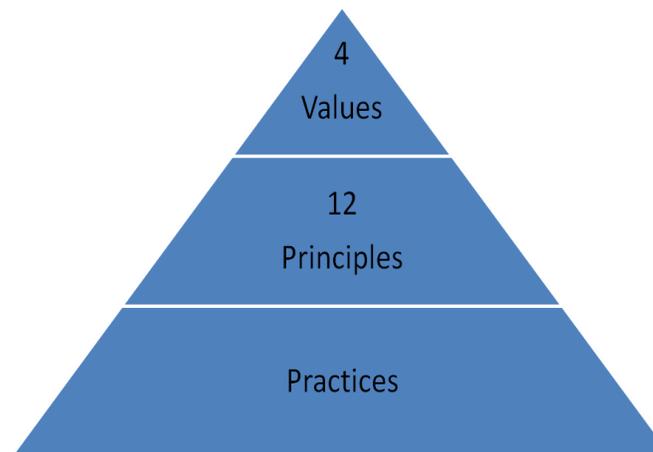


Figure 1. Mindset Agile (Agile Practice Guide, 2017)

Traditional and agile methods in the field of construction projects take two different views. Owner involvement in project planning is an important assumption of agile methods. Agile methods emphasize a level of individuality and qualification of project teams consisting of fewer people than in the case of traditional methods (Buganova, Simickova, 2019).

In the construction industry, one of the biggest challenges when creating a building is to account for the unexpected. To reduce the number of unexpected events, project managers typically use templates, checklists and often models with phases, sub-phases. This so-called sequential project management approach aims to plan the project in detail and try to do it without deviation. The development of these plans often requires significant resources before the actual construction begins. In many cases, this process is so long that by the time the execution phase has begun, the plan will need to be revised due to modified project requirements. The constant modification of project requirements coupled with problems that occur in defining requirements causes cost overruns and schedule delays and lowers product quality construction company design and planning (Streule, Miserini, Bartlome, Klippel, and De Soto, 2016).

2.2. Risk Management

The definition of risk management according to PMBOK, 2017 is as follows:

- a. It is a formal process, where risk factors are systematically identified, analyzed, and addressed.
- b. It is a formal, systematic management method that concentrates on identifying and controlling areas or events that have the potential to cause undesired change.
- c. In the context of a project, it is an art and science in identifying, analyzing and responding to risk factors that exist during the implementation of a project.

Risk management aims to coordinate risk-oriented organizational control and management activities (Řehák, 2018). Risk is defined as the impact of uncertainty from a goal, either negative (threat), or positive (opportunity), the threat risk itself is a risk that has been defined from the start and no effective preventive handling has been carried out so that the risk can occur and have a large impact on implementation the construction project, and the opportunity risk is a risk that has been defined and discovered from the start and if it can be overcome and preventive measures are taken, it can turn this risk into an opportunity for

success that can add value to the project (PMBOK, 2017).

In the implementation of risk management, the main thing that must be done is to identify risks, where each project is specific and carries a typical risk, the reason is not only because of the uniqueness of the project but also the financial demands and a longer period of time to realize the project (Streule, Miserini, Bartlome, Klippel, and De Soto, 2016). Risk identification itself is the process of determining and recording the types of risks that have the potential to affect the project and the character of each risk (PMBOK, 2017). During the risk identification process, it is best to classify risks into several groups, this will make it easier to prevent and handling, in addition, risk grouping can help create a comprehensive and non-overlapping risk list (no more than one risk has the same meaning).

3. METHODS

3.1. Research Concept

This study was made to explore the extent to which the Agile Project Management (APM) method is used in the construction world in the planning section as well as the risk variables that might occur by conducting a literature study to obtain risk variables, which was then conducted a survey of respondents to obtain validation of the relevance of risk and risk classification. The questionnaire was submitted for assessment to 5 respondents from 4 planning consultants with major qualifications with a minimum of 15 years of work experience.

3.2. Data Analysis

The results of the data obtained from the literature study will be grouped by category, which is divided into 4 categories namely communication, collaboration, organization, and technical, then analyzed using the Guttman scale where the Guttman Scale according to Sugiyono, 2014 is the scale used to obtain a firm answer from the respondent, that is, there are only two intervals such as "agree-disagree"; "Yes No"; "True False"; and others". This measurement scale can produce questions in the form of multiple choice and check lists, with the highest score (agree) two and the lowest (disagree) one. The Guttman scale was carried out to obtain validation results from respondents who agreed or disagreed that the risk variables that had been obtained from the literature study were risk variables in the implementation of Agile Project Management (APM) in the construction design process. After getting the validation results, it is continued with the respondents classifying the risk variables that have been approved as risk variables for construction design.

4. RESULTS

4.1. Risk Variables

There are 76 risk variables in the literature study with a description of the risk variables as follows:

Table 1. Literature Study Risk Variables

No	Identification of Risk Variables	Study of Literature
	Communication	

R1	Communication between teams in projects in the implementation of APM	Ujhelyi, 2012; Sakthivel, 2009
R2	The way employees think during the transition from traditional approaches to APM is inadequate	Ujhelyi, 2012
R3	Frequent face-to-face communication meetings in the implementation of APM	Thoughtworks, 2018
R4	Self-management in the implementation of APM	Thoughtworks, 2018
R5	Communication between individuals in the project team in the implementation of APM	Thoughtworks, 2018
R6	Communication between the project team and stakeholders/management in the implementation of APM	Thoughtworks, 2018
R7	Uniform use of language	Persson, 2009; Ujhelyi, 2012;
R8	Individual motivation in implementing APM	Persson, 2009
R9	Exchanging information between individuals in the implementation of APM	Persson, 2009
R10	Coordination in the division of project tasks on the implementation of APM	Persson, 2009
R11	There is a coordination problem in the suitability of the technology used in the implementation of APM	Sakthivel, 2009
R12	Inappropriate strategy between stakeholders/management and individuals in the APM team	Bell & Kozlowski, 2012
R13	Lack of understanding of Agile requirements by each individual in the team	Bell & Kozlowski, 2012
R14	Transparency of communication with clear flow in the implementation of APM	Bell & Kozlowski, 2012
R15	There is a conflict of interest between individuals in the implementation of APM	Bell & Kozlowski, 2012
R16	The indifferent attitude of each individual in the implementation of APM	Bell & Kozlowski, 2012
R17	Lack of interest in learning new implementation methods APM	Bell & Kozlowski, 2012
R18	Communication between teams and third parties in the implementation of APM	Highsmith, 2009
R19	Communication skills of each member in the implementation of APM	Highsmith, 2009
R20	Trust between teams and third parties in the implementation of APM	Highsmith, 2009
R21	Structured communication lines in implementing the APM	Highsmith, 2009; Sakthivel, 2009; Ujhelyi, 2012
R22	Integration of the whole design at the beginning of the application of the APM method	Buganova & Simickova, 2019

Collaboration		
R23	Collaboration between teams in the implementation of APM	Thoughtworks, 2018
R24	Different locations of individuals lead to hampered coordination in the implementation of APM	Mudumba & Lee, 2010
R25	Work culture and experience between different individuals in the implementation of APM	Mudumba & Lee, 2010
R26	Great geographic distance between individuals and projects in the implementation of APM	Persson, 2009
R27	Inadequate collaboration structure in the implementation of APM	Persson, 2009
R28	Relationships between stakeholders/management that are not aligned in the implementation of APM	Persson, 2009
R29	There is development in technology and standards in the implementation of APM	Sakthivel, 2009
R30	There are not many projects that use APM implementation	Bell & Kozlowski, 2012
R31	Acceleration needs of project owners to project implementers are quickly met in the implementation of APM	Bell & Kozlowski, 2012; Mudumba & Lee, 2010
R32	Collaboration between stakeholders/management in the implementation of APM	Buganova & Simickova, 2019
R33	Collaboration between members in a team in the implementation of APM	Buganova & Simickova, 2019
R34	Collaboration between teams and project owners in APM implementation	Buganova & Simickova, 2019
Organization		
R35	Organizational management in projects that are poorly trained in APM implementation	Buganova & Simickova, 2019
R36	Lack of support from senior organizational management in implementing APM	Buganova & Simickova, 2019
R37	Human resource management in the organization of implementation APM	Buganova & Simickova, 2019
R38	Submission of project status to members who are still lacking in APM implementation	Buganova & Simickova, 2019
R39	The number of team members is too large in the organization that is not in accordance with the implementation of APM	Ujhelyi, 2012; Mudumba & Lee, 2010; Highsmith, 2009; Sakthivel, 2009
R40	The use of traditional methods that have been inherent in the organization so far	Thoughtworks, 2018
R41	Team accountability in implementing the APM method which is easier because the division of tasks is detailed	Mudumba & Lee, 2010
R42	The number of teams in the organization facilitates the division of work in the implementation of APM	Mudumba & Lee, 2010

R43	There is strategic synergy within the organization for the application of the APM method	Mudumba & Lee, 2010
R44	There is a career advancement path in the application of the APM method	Mudumba & Lee, 2010
R45	The number of stakeholders/management in the organization so that it is easier to handle problems in the implementation of APM	Mudumba & Lee, 2010
R46	The difference in the number of teams formed in the implementation of APM	Mudumba & Lee, 2010
R47	Organizational regulations in the application of the APM method	Bavani, 2011
R48	Routines in the organization that change according to each project carried out	Bavani, 2011
R49	Perceptions in each individual are different in the application of the APM method in the organization	Persson, 2009
R50	Detailed management of projects and processes within the organization on implementation APM	Sakthivel, 2009
R51	Differences in views between business strategy and technology used in the application of the APM method	Sakthivel, 2009
R52	Individuals in organizations who have a fear of losing the power of office in implementing APM	Bell & Kozlowski, 2012
R53	The use of human resources in the organization that is right on target for the application of the APM method	Highsmith, 2009
R54	Selection of team leaders in the application of the APM method	Highsmith, 2009
R55	Selection of team members according to job categories in the application of the APM method	Highsmith, 2009
R56	Project owner support in the use of the APM method	Highsmith, 2009
R57	The selection of third parties in the application of the APM method	Highsmith, 2009
R58	Knowledge of scrum is still minimal in each individual who applies the APM method	Highsmith, 2009
R59	The project organization structure is better in the application of the APM method	Highsmith, 2009
R60	Lack of government support in implementing the APM method	Highsmith, 2009
Technical		
R61	Changes in project scope due to frequent external changes in APM implementation	Buganova & Simickova, 2019
R62	There is an opportunity to be able to reduce costs in project implementation if using APM	Buganova & Simickova, 2019
R63	Running too many projects that do not fit in the implementation of the APM approach	Buganova & Simickova, 2019
R64	Uncertain project funding in the implementation of the APM approach	Buganova & Simickova, 2019

R65	Inconsistency in choosing APM or traditional approach to project implementation	Buganova & Simickova, 2019; Highsmith, 2009
R66	Selection of programs in the implementation of APM	Persson, 2009
R67	Doing the wrong project in the application of the APM approach	Buganova & Simickova, 2019
R68	The program used is not in accordance with the APM approach	Buganova & Simickova, 2019
R69	Lack of planning skills for the implementation of the APM approach	Buganova & Simickova, 2019
R70	Design of work plans that are constantly changing in the implementation of APM	Bavani, 2011
R71	Project documentation in the use of the APM method	Persson, 2009
R72	A more detailed analysis of job requirements makes the implementation of APM faster to meet the needs of the projectowner	Bell & Kozlowski, 2012
R73	Detailed technical specifications in the implementation of APM	Bell & Kozlowski, 2012
R74	The division of detailed work planning in the implementation of APM can achieve progress quickly	Bell & Kozlowski, 2012
R75	Work project objectives can be achieved quickly in the implementation of APM	Bell & Kozlowski, 2012
R76	Can find out the priority of work in the project if using the APM approach	Bell & Kozlowski, 2012

From the table it can be interpreted that there are quite a number of risk variables that can occur in the implementation of the Agile Project Management (APM) method by foreign researchers and in this study brought back to assess whether it is relevant to the implementation of the design project and divide the risk variables into 2 risk classification, namely threat risk and opportunity risk.

4.2. Risk Relevance and Risk Classification

In the process of assessing the risk relevance of all variables, data analysis using the Guttman Scale is carried out which is known that if only one respondent states the risk variable is "Agree", then the risk variable may occur in construction design using Agile Project Management (APM) methods. The next survey carried out a classification of risk variables that had been previously assessed by the same respondent by selecting the risk variables included in the classification between "Threat Risk" or "Opportunity Risk".

Table 2. Final Number of Risk Variables

No.	Risk Variable Category	Number of Literature Study Variables	Risk Variable Classification	Number of Research Results Variables
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Threat of

1	Communication	22	Communication Opportunities of Communication	11
			Threat of Collaboration	6
2	Collaboration	12	Opportunities of Collaboration	6
			Threat of Organization	12
3	Organization	26	Opportunities of Organization	11
			Threat of Technical	8
4	Technical	16	Opportunities of Technical	6
Total Number of Variables Study Literature		76	Total Number of Research Results Variables	69

The results of the table can be seen that there is a reduction in the number of risk variables where there are 7 risk variables which are declared not to be risk variables in the design process, namely, the variable Use of uniform language (R7), Integration of the whole design at the beginning of the application of the APM method (R22), Differences in the number a team formed in the application of APM (R46), organizational regulations in the application of the APM method (R47), Routines in the organization that change following each project carried out (R48), Selection of programs in the implementation of APM (R66), and project documentation in the use of the APM method (R71), the risk variable by all respondents stated "Disagree" is a risk variable in the application of APM in the design process, so it is eliminated, and the total number for risk variables which was originally 76 to 69 with classification division in each category – each. The risk and opportunity variables themselves are related to the overall implementer a construction design process.

5. CONCLUSIONS

Refers to the results of the risk analysis that may occur in the construction design process using the Agile Project Management (APM) method that has been carried out previously. The author can draw the following conclusions: Identifying the risk of threats and opportunities that may occur in the application of the Agile Project Management (APM) method in the construction design stage, the number of variables that were originally 76 from the literature study became 69 variables as a result of respondent assessment and data analysis by researchers, with 7 variables not included. become the final result of the research, which is divided into 4 categories, namely communication, collaboration, organizational, and technical, as well as 2 classifications in each category, namely the threat risk variable and the opportunity risk variable.

6. MORE RESEARCH

The results of the risk variables that have been obtained by researchers can be carried

out the next step by analyzing the risk variables to obtain variables with a high level of risk to know what risk variables are dominant and need to be handled better.

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MAXIMUM PRODUCTIVITY ANALYSIS OF LAND USE WITH THE HIGHEST AND BEST USE (HBU) METHOD ON INSTITUTE TECNHNOLOGY SEPULUH NOVENBER COMERSIL LAND, SURABAYA

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ABSTRACT

Sepuluh Nopember Institute of Technology (ITS) is designated as a Legal Entity State University based on Government Regulation Number 83 of 2014. ITS has a commercial area of 55,000 m² that is ready to be developed. Based on the identification of ITS needs, the development of commercial areas that can support the function of the Tri Dharma of Higher Education include dormitories, student apartments, convention buildings for seminars and academic activities. The results of the initial survey show that within a five kilometer radius there is a commercial trend in the form of apartments, malls, convention buildings, hotels, and hospitals. For this reason, it is necessary to optimize land use so that the land can provide the highest income and land value. This study is to identify and analyze alternative properties that can provide maximum productivity on commercial land ITS Surabaya with the Highest and Best Use method by reviewing the physical, legal, financial and maximum productivity aspects. As well as analyzing the pattern of Cooperation with Business Entities that is most likely to obtain maximum results. From Highest and Best Use Analysis, an investment is said to be feasible as long as it fulfills four aspects, namely legal aspects, financial aspects, physical aspects and maximum productivity. In PPP analysis, an investment is said to be feasible as long as it fulfills financial aspects and risks that will be taken when collaborating with other business entities or private companies.

Keywords: Maximum Productivity, Land Value, Highest and Best Use, PPP

1. INTRODUCTION

Sepuluh Nopember Institute of Technology (ITS) which was founded in 1957 is one of the State Universities in the city of Surabaya that focuses on science and technology. Based on Government Regulation Number 83 of 2014 concerning the Determination of the Sepuluh Nopember Institute of Technology as a Legal Entity State University, ITS has officially changed its status, which was originally a Public Service Agency State University (PTN BLU) changed to a Legal Entity State University (PTN-BH).

In accordance with Government Regulation of the Republic of Indonesia Number 58 of 2013 concerning Forms and Mechanisms of Legal Entity State Universities, Article 10 paragraph 1 states that "PTN Legal Entities can obtain funds from business activities by establishing and/or owning a business entity, managing endowments, and the management of state property rights whose management rights are granted by the Government and/or regional governments are carried out in accordance with the provisions of laws and regulations." Therefore, ITS is expected to be able to manage finances and resources independently. One way to earn income independently is by utilizing and optimizing the assets owned by ITS.

Based on the review of the ITS Masterplan, ITS has a commercial area of 55,000 m² that is ready to be developed, the area is located on the north side of the ITS campus, precisely on Jalan Raya ITS Sukolilo Keputih Surabaya. Based on the identification of ITS needs, the development of commercial areas that can support the function of the Tri Dharma of Higher Education include dormitories, student apartments, convention buildings for seminars and academic activities. The results of the initial survey show that within a five kilometer radius there is a commercial trend in the form of apartments, malls, convention buildings, hotels, and hospitals. The results of field observations show that the apartment business is the most dominant land use to be developed.

There are two possible investment analyzes for ITS as PTNBH, including using the Highest and Best Use and PPP. PPP is defined as cooperation between the Government and Business Entities in the Provision of Infrastructure aimed at the public interest by referring to the specifications previously determined by the Minister/Head of Institution/Head of Region/BUMN/BUMD, which partially or wholly uses the resources of the Business Entity with due observance of risk sharing between the parties.

This study is to identify and analyze alternative properties that can provide maximum productivity on commercial land ITS Surabaya with the Highest and Best Use method and PPP by reviewing the physical, legal, financial and maximum productivity aspects. This study also tries to analyze the forms of cooperation and the most likely risks of cooperation in order to obtain maximum results.

2. LITERATURE REVIEW

Literature study is carried out by looking for theories that are relevant to the problem under study. After collecting related theories and research, the authors conducted a comparison of previous studies. This stage produces a theoretical framework on which the research is based. The method used in this research method is the same as the method that has been applied previously. Bogor Agricultural University and the University of North Sumatra are universities that have implemented this method with a system of collaboration with external parties. The difference with the development at the previous university is that ITS is located in Surabaya, has a fairly large commercial area, and has different potential and development areas from previous universities.

3. METHODS

This research is an applied research, namely to apply, test and evaluate the ability of a theory that is applied in solving practical problems. In this case, the identification of benefits and specific objectives or data needed for decision making in the use of ITS commercial land in Surabaya. This study uses a financial model with the application of the Highest and Best Use

(HBU)analysis for making the highest and best land use decisions on ITS commercial land and analyzes the most possible form of cooperation in order to obtain maximum results with the PPP investmentcooperation pattern method (Government Cooperation). and Business Entities).

The initial stage of this research is a survey to find and process data through a literature review and documents related to the object of research. To conduct research, it is necessary to havesome supporting data in the field by collecting data, including:

1. Primary Data Collection.

Primary data collection is data collection from the first source which is carried out in several ways,namely:

a. Live Observation

Field observations were carried out to collect information about land use functions, building layout, the physical condition of the land on Jalan Raya ITS Sukolilo Keputih Surabaya, environmental conditions such as land area, land form, existing facilities around the land and typesof property around the land (with 5km radius).

b. Interviews and Questionnaires

This method of collecting data with structured interviews is to find out what alternatives can beused on land use at the ITS Sukolilo Campus. This data collection is done by distributing questionnaires to stakeholders who have influence and interest in land commercial plans, namely the ITS Investment Team, ITS Directorate of Business Cooperation and Management. , ITS lecturers, ITS students, property businesses, and the community who will have an impact on the useof development land.

2. Secondary Data Collection.

Secondary data is data that indirectly provides data to researchers. This data is obtained from applicable regulations such as the Department of Human Settlements and Spatial Planning of the City of Surabaya, literature studies, comparisons of similar properties, and applicable regulations.

Here are some secondary data need[[ed in this research penelitian

- a. ITS Sukolilo Surabaya Campus Spatial Plan (ITS Masterplan),
- b. Detailed Spatial Plan for ITS Sukolilo Surabaya Campus (ITS Strategic Plan),
- c. Comparative data of similar properties,
- d. Books and literature studies,
- e. Journals and past research

4. RESULTS

Based on the direction of the spatial pattern specified in the Detailed Layout Plan City Space (RDTRK) Development Unit (UP), use plan the land around the study site will be developedas a trade function and services, settlements, public facilities and green open spaces. The boundariesof the development site include the northern boundary: Jl. Mulyosari, south boundary : ITS building,west boundary : Surabaya Polytechnic, and east boundary : residential area.

4.1. Highest and Best Use Analysis

4.1.1. Legal Aspect

Based on the Surabaya City Regional Regulation number 8 of 2018 concerning the DetailedSpatial Planning and Zoning Regulations of the City of Surabaya for 2018-2038, the land is locatedin the Mulyosari Development Unit which is included in the

national/international scale trade and service development area.

Tabel 4.1 Directions for Limiting Development Intensity

Component	Allocation	
	Hotels and Apartments	Apartments and Offices
Building Floor Coefficient - KLB	12	12
Maximum Building Base Coefficient (Block System)	50%	50%
Green Basic Coefficient – KDH	10%	10%
Basement Tread Coefficient	70%	70%
Maximum direction of the basement floor	3 floor	3 floor
Altitude (TAP Directive)	≤ 200 m	≤ 200 m

Source : Surabaya Mayor Regulation Number 52 Year 2017

Maximum Building Base Coefficient (Block System)	= 50%*55.000 = 27.500
m2 Building Floor Coefficient – KLB	= 12*55.000 = 660.000
m2	
Basement Tread Coefficient	= 70%*55.000= 38.500 m2
Altitude (TAP Directive)	= 200m/5m = 40 lantai
Green Basic Coefficient – KDH	= 10%* 55.000= 5.500 m2

From the results of the legal aspect analysis, the area of the ground floor in each alternative land development that can be built should not exceed 16,500 m². The total floor area of the building that can be built is 660,000 m² and the building may not exceed 200 meters or 40 floors if the floor height is 5 meters. The permitted number of basement floors is 3 floors where the basement area per floor should not exceed 38,500m²/floor. These requirements will later serve as a basis for reference in determining the alternative design of the building to be erected

4.1.2. Physical Aspect

From the physical aspect, the shape and location of the land allows for the use of buildings both in a combination of apartment buildings - office buildings or a combination of hotel and apartment buildings. The accessibility of the research area is also very good because it has a wide road width and can be traversed by many public vehicles. In addition, the research area has the availability of complete and adequate utilities for the sustainability of the activities of building users.

4.1.3. Financial Aspect

From the results of the analysis of financial aspects by considering investment costs, income, operations, residual value of the building and the minimum rate of return on capital. NPV (Net Present Value), IRR, and Discounted Payback Period to determine investment feasibility. Investment is declared accepted if the NPV (Net Present Value) is positive, the IRR (Internal Rate of Return) is greater than the MARR (Minimum Attractive Rate of Return) (Syamsudin, 2011). The interest rate/MARR (Minimum Attractive Rate of Return) used to

discount the difference between incoming and outgoing cash flows is obtained from the calculation of the cost of capital used (WACC). For this investment, the MARR is set at 4.88%, obtained from the determination of the Commercial Bank Daily Report (LBHU) as of Monday 5 April 2021.

4.2. Government Cooperation with Business Entities Analysis or PPP Analysis

PPP project is declared financially feasible if the income and profits are greater than the operational costs and investment capital. This can be done by calculating the NPV (Net Present Value), IRR, and Discounted Payback Period to determine the feasibility of the investment. Investment is declared accepted if the NPV (Net Present Value) is positive, the IRR (Internal Rate of Return) is greater than the MARR (Minimum Attractive Rate of Return).

There are three stages of a PPP project, namely planning, construction, operation and maintenance. Risks that occur at the planning stage include difficulties in land acquisition, regulatory changes (cutting government budgets), immature designs, unclear contracts. At the construction stage, the three highest risks include risks at the testing & commissioning stage, security and work safety risks. Meanwhile, in the operation and maintenance stages, it is identified: the risk of a declining number of customers, high operational and maintenance costs.

The main strategies for handling these risks include choosing a reliable planning consultant, providing legal and procedural knowledge in project implementation, seeking government support (VGF) so that it will anticipate project failures due to changes in political conditions, choosing strong and competent business partners, improving an effective communication system, adding professional and quality human resources, as well as commitment to the agreed policies.

5. CONCLUSIONS

After the research data analysis is completed, the authors draw conclusions on the results of the research conducted. Through the data that has been collected and analyzed, it can be concluded that the Investment Analysis with the Highest and Best Use method and the PPP produces several alternative investments that will be used in research to achieve maximum productivity on commercial land at the Sepuluh November Institute of Technology (ITS). So based on the conclusions obtained, some suggestions can be given so that further research can be better.

From the conclusions obtained in this study, suggestions are given that can be used by further researchers to develop this research to the next level.

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ANP MODEL DEVELOPMENT FOR FLOWLINE CONSTRUCTION PROJECT OF NKT-01 TW GAS WELL IN PT XYZ GUNDIH FIELD

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ABSTRACT

The NKT-01TW flowline construction project is one of the largest project conducted by PT XYZ. The high maintenance cost of existing flowline and loss production opportunities due to existing flowline leakage make PT XYZ should be able to determine important criteria and alternatives for this project. The purpose of this research is to develop the Analytical Network Process (ANP) model that those analysis will show the relationship among elements comprehensively. Preliminary study was conducted through literature study and secondary data to obtain initial criteria, alternatives, relationships and then validated using questionnaire by experts. From the research results, it was found that the criteria were functional, operation & maintenance, environmental and economic with the sub-criteria were tensile strength, elastic modulus, linear expansion, corrosion resistance, scaling resistance, reliability, maintainability, energy consumption, health risk, recyclability, material cost, operation & maintenance cost, density, market availability and roughness. Stainless steel, carbon steel with internal cladding, cast iron, galvanize and fiber-reinforced plastics are alternatives in this research. All the elements have relationship as shown by the ANP model.

Keywords: Analytical Network Process, Flowline, Loss Production Opportunities

1. INTRODUCTION

Gundih Field is one of the largest gas fields operated by PT XYZ which contributes 97% of the total gas sales. Production decline from several wells and the presence of new customers who intend to buy gas from the Gundih field has caused PT XYZ try to find new gas sources by producing NKT-01 TW gas well to get additional gas production. Gas production result from the NKT-01 TW well will be transported to Gundih Central Processing Plant (CPP) to remove the H₂S gas contained to obtain clean gas and condensate for on sale to customers. Due to the absence of a gas pipeline facility from the well to Gundih CPP, PT XYZ want to build an underground flowline along this route.

There are several challenges in this project that need more attention from the company. The flowline route will through rice fields, residential areas, gardens, road crossings, rail crossings, and several other areas which are very difficult and different from other existing pipeline routes. The other problems are many existing flowlines with low reliability and high cost of operation and maintenance. Leakage of flowline are common in

recent years causing loss of production opportunity. From existing flowlines operated by PT XYZ, it was recorded that the maintenance costs from 2019 and 2020 were still quite high at Rp. 6.7 billion per year. This condition makes PT XYZ should evaluate the next flowline development project related to the material to be used.

From some of the problems above, research about determination of criteria, alternatives, and correlation between them is very important to overcome those gaps or problems.

In order to accommodate the possibility of a relationship between criteria, sub-criteria, and alternatives, this research will use the Analytical Network Process (ANP). The ANP method is able to improve the weaknesses of AHP because it has the ability to accommodate the relationships between criteria or alternatives (saaty, 1999a). By using the ANP method, this research aims to determine the criteria and sub-criteria that are important in the selection of pipe types, determine alternative types of pipes that can be used in the underground flowline development project for the NKT-01 TW gas well, and develop the ANP model to show the relationship between the elements.

Several research related to the ANP model development as part of pipe material selection using the Analytical Network Process (ANP) method and other MCDM methods have been carried out by many researchers. Haruna et al (2020) conducted a research entitled “Design, Material Selection and Manufacturing for Sustainable Construction : An Analytical Network Process Approach”. The results of the research concluded that ANP is an excellent tool to be applied in the construction sector. Milani et al (2013) conducted a research comparing AHP and ANP entitled “A application of the analytic network process in multiple criteria material selection”, stating that the case study conducted using ANP and AHP clearly illustrates that internal or external dependencies (relationship) between decisions criteria and alternatives can change the final material solution. It should also be noted that ANP offers a greater degree of freedom by allowing designers / decision makers to make selection problems model under multifunctional performance requirements using clusters. The advantage of this feature is the possibility of displaying easier weights and sensitivities especially for inexperienced designers, or on large-scale problems, where clusters can be graded against each other. Horenbeek (2013) conducted a research entitled “Development of a maintenance performance measurement framework—using the analytic network process (ANP) for maintenance performance indicator selection”, the result of the research conclude that The ANP approach enables the decision maker to better understand the complex relationships in the decision problem, which improves the reliability of the corresponding decisions.

From the previous research, it can be seen that the ANP method is widely used to solve problems that cannot be arranged in a hierarchical form because it involves the interaction and dependence of higher level elements on lower level elements.

ANP model development need the criteria and alternatives that suitable for the flowline construction project in PT XYZ. Some research related to the criteria and alternative for pipe material selection have been carried out by many researchers. Zhao (2016) used the AHP method in his research entitled “Selection of Commercially Available Materials in Sustainable Design : An Integrated Multi-Attribute Decision Making Approach”. The results of his research concluded that from the three alternative solutions analyzed, polyvinyl chloride (PVC), polypropylene (PP) and polyethylene (PE), it is concluded that PVC pipe is the best alternative material and PE is the last alternative.

Wei (2017) used the AHP method in his research entitled “Optimal selection of building water supply pipes based on an analytical hierarchy process”. The criteria are reliability, economical and reasonable cost, easy maintenance and environmental friendliness. Zhao (2019) uses the TOPSIS method in his research entitled “An IVTIFN–TOPSIS Based Computational Approach for Pipe Materials Selection”. The results of his research concluded that plastic

materials are better than metal materials because they are more resistant to corrosion from the nature of the material. HDPE is the best alternative material for the collection and transportation of wastewater. Camerling (2018) uses the AHP method in selecting pipe materials to prevent corrosion of the raw water filter for the SWD 6TM410RR PLTD Hative Kecil engine. The results of his research concluded that the best alternative raw water filter material is the AW type PVC alternative.

The position of this research is seeks to take part of the discussion that has not been discussed by previous research. The difference with previous research is about the case study and type of fluid from previous research. The case in this research is an onshore gas pipeline project with very high H₂S and CO₂ gas fluid content. This research is expected to be used as a means of information in the development and application of project management science, especially related to decision making in the oil and gas industry using the ANP model.

2. LITERATURE REVIEW

Flowline is an oil and gas pipeline that carries fluids from wells to production facilities. We can say that the boundary of the flowline pipe is the pipe that carries the fluid from the Wellhead to the Manifold at the gathering station (Oil or Gas). In general, the type of pipe material can be divided into two, namely metal and non-metal.

The use of pipe material must be in accordance with the fluid to be transported. For gas fluids with high H₂S and CO₂ content such as gas from Gundih field PT XYZ, there are some criteria to be considered for material selection. Jatmoko (2018) in his research states the materials that can be used for gas fluids with a high H₂S and CO₂ content are as follows:

1. Carbon steel

Carbon steel or carbon steel is an iron-carbon alloy material containing a maximum of 0.3% carbon (C) element. Carbon steel pipe is widely used in the oil and gas industry. This pipe is of high strength and strength, is weldable and durable. The drawback is that it is not resistant to corrosion attack by H₂SO₄, carbonate (K₂CO₃) and seawater. Therefore, for pipes that are installed under water and underground, a special coating or coating of some resistant material (internal cladding) is required.

2. Stainless steel

Stainless steel is carbon steel that contains a minimum of 12% Chrome (by weight) and other elements such as Nickel with the aim of increasing corrosion resistance (standard ASTM A790).

3. Cast Iron

Cast iron is corrosion resistant and has a high degree of hardness but is also very brittle and therefore unsuitable for facilities subject to high contraction and vibration.

4. Galvanize

Galvanized Pipes are made of carbon steel but with zinc coated outer and inner surfaces to

make them resistant to rust.

5. Fiber Reinforced Plastic (FRP)

FRP pipe is a composite material. The standard used is API 15 LR / API 15 HR. Composite is a material consisting of two main constituents, namely the matrix or resin and reinforcement. FRP consists of synthetic thermosetting plastic material whose main content consists of resin material (in the form of polyester resin or epoxy resin) and reinforcing material (in the form of fiber glass roving or fiber glass chopped strand or fiber glass woven fabric) and other additional materials (such as sand), dyes, additives for fire resistance and others). The advantages of using FRP over metal materials are good corrosion resistance, Anti-scale on internal pipe, has a relatively small pressure drop because the surface is relatively smooth or the roughness coefficient is small, and low density.

In a flowline construction project, the criteria, alternatives and the relationship are the main thing that determines the success or failure of the project. In order to find the best pipe material, it is necessary to understand the decisive factors in getting the best pipe material to be used in a flowline construction project. In terms of factors that influence the selection of pipe materials, there are several research conducted by researchers, namely Niaei (2018), Zhao et al (2019), and Jassim (2018).

Niaei (2018) in his research on the selection of pipe materials for the water distribution system stated that the criteria needed were aspects of cost, health, and the environment to obtain the optimum pipe material. Zhao et al (2019) stated that the indicators/attributes in the selection of pipe materials are classified into three categories, namely functional, economic and environmental attributes to reflect the most important criteria that must be considered in the selection of pipe materials for piping system design. Jassim (2019) in his research states that the factors that are very important in the selection of pipe materials for water supply pipes are cost, time required for construction, material quality, constructibility and maintainability.

From the field survey at PT XYZ, additional criteria that need to be considered in the selection of gas pipe materials apart from the literature above are market availability, maintainability, reliability and operation maintenance costs. Maintainability comes from the words maintain and ability. Maintainability can be defined as the ability to maintain a system that has the possibility of a damaged system to be returned to full working condition within a predetermined period of time. Reliability is the probability of an item to work normally during operation (not experiencing an unplanned shutdown).

Based on the literature data and the initial survey above, it can be summarized for the important initial criteria in selecting the type of pipe material and its attributes as follows :

Table 1. Initial Criteria and Subcriteria

CRITERIA	SUBCRITERIA	PERFORMANCE Benefit (+), Cost (-)	REFERENCE
Functiona	Tensile Strength	+	Zhao et al.
	Elastic Modulus	+	
	Linear Expansion	+	

1	Corrosion resistance	+	(2019) Anojkumar (2014)
	Scaling resistance	+	
Economic	Material Cost	-	Zhao et al. (2019)
	Density (berat material)	-	
	Operation & Maintenance Cost	-	
	Market Availability	+	
	Roughness	-	
Environmental	Energy Consumption	-	Zhao et al. (2019)
	Health Risk	-	
	Recyclability	+	
Operation & Maintenance	Reliability	+	Jassim (2019)
	Maintainability	+	

This research use the ANP method for data analysis. Analytic Network Process (ANP) is a mathematical theory that is able to analyze the effect with an approach of assumptions to solve the problem. ANP is a new alternative approach for qualitative studies that can combine intangible values and subjective judgments with statistical data and other tangible factors (saaty, 2008). This method is used in the form of a solution by considering the adjustment of the complexity of the problem along with the priority scale that produces the greatest priority effect.

ANP is a generalization of the Analytic Hierarchy Process, considering the dependencies between the elements of the hierarchy. Many decision problems cannot be structured hierarchically because they involve the interaction and dependence of higher-level elements in the hierarchy on lower-level elements (saaty, 2008). Many decision-making processes of a problem cannot be arranged in a hierarchical form because it involves the interaction and dependence of higher-level elements to lower-level elements.

The ANP method is able to improve the weakness of AHP in the form of the ability to accommodate the relationship between criteria or alternatives. The ANP component consists of a control hierarchy, clusters, elements, relationships between elements and relationships between clusters. There are 2 types of relationship in the ANP method, namely relationship within a set of elements (inner dependence) and relationship between different elements (outer dependence).

3. METHODS

The methodology adopted for this research is the semi quantitative approach. It's an

approach that seeks to get insight and to understand people or group. As a research instrument, a structured questionnaire was used to obtain primary information from experts in the field of sustainability in construction.

3.1. Literature Study

Preliminary study conducted by researchers through literature from previous research and engineering book to get the initial criteria and alternatives. Beside that, researcher also collect secondary data that already exists in the company related to the problems to be studied. Data is obtained by accessing it through PT XYZ's computer/database.

3.2. Expert opinion survey

Respondents for this research were 10 experts in the surface facilities construction project selected to evaluate the initial criteria, sub-criteria and alternatives based on literature and filled out the research questionnaire. All selected experts has more than five years of working experience in oil and gas and surface facilities construction projects.

3.3. Criteria and sub-criteria selection

The questionnaire used to determine the important criteria and sub-criteria in this research is an open questionnaire and it was designed based on a scale of 1, 2, 3 and 4 which represents, not importance, less importance, and very importance for pipe material selection. Respondents can add other criteria and sub-criteria that according to the respondent are recommended in this research in addition to the initial criteria and sub-criteria listed in the questionnaire (open questionnaire).

Because of respondents are multi-person, the conclusion is taken using the percentage of scores (likert scale) as follows :

Table 2. The Percentage of Score

SCORE	CONCLUSION
0% - 19.99%	Strongly disagree
20% - 39.99%	Disagree
40% - 59.99%	Neither agree nor disagree
60% - 79.99%	Agree
80% - 100%	Strongly agree

To get the score above, the calculation is done by comparing the value obtained from the questionnaire with the maximum possible value that can be obtained. A criterion, sub-criteria, alternatives and relationship between elements can be selected in the research if the scores at least 60% or more.

3.4. Alternatif selection

The questionnaire used to determine the recommended alternatives in this research is an open questionnaire and it was designed based on a scale of 1, 2, 3 and 4 representing, not recommended, less recommended, recommended and highly recommended for pipe material selection. Respondents can add other alternatives that according to respondents can be recommended in this research beside the initial alternatives listed in the questionnaire (open questionnaire). In the same way as the selection of criteria, the recommended alternatives in

the study will be obtained.

3.5. Relationship between criteria, sub-criteria and alternatives

To determine whether there is an inner or outer dependence relationship on criteria, sub-criteria and alternatives, then fill in a questionnaire with the format following the ANP supermatrix and filled out by the same respondent as the selection of criteria and alternatives. In the same way as the selection of criteria, it will be obtained relationship between these elements in this research.

3.6. ANP Model development

The ANP model was developed with clusters and nodes constructed and relationship assigned to each of the respective clusters and nodes. The cluster and their respective nodes consisting of network relationships were set.

4. RESULTS

Based on the questionnaires that have been distributed to the respondents, the results are as described below.

4.1. Result of criteria determination

From the questionnaire to 10 respondents, there were no additional criteria. The value of each criterion is as follows:

Table 3. Results of the Criteria Selection Questionnaire

Criteria	Respondents									
	1	2	3	4	5	6	7	8	9	10
Functional	4	4	4	4	4	4	4	4	4	4
Operation & Maintenance	4	4	4	4	4	4	4	4	4	4
Environmental	4	4	4	3	4	4	3	3	4	4
Economic	4	4	3	3	3	3	3	4	3	4

From the results above, then a calculation is carried out to determine the percentage of the value obtained for each criterion after being compared with the maximum value as shown below :

Table 4. Calculation results of the criteria value

CRITERIA	VALUE										TOTAL	MAXIMUM VALUE	SCORE
	1	2	3	4									
Functional	0	0	0	4	0	40	40	100%					
Operation & Maintenance	0	0	0	4	0	40	40	100%					
Environmental	0	0	9	2	8	37	40	93%					
Economic	0	0	1	1	6	34	40	85%					

From the table above, the following conclusions are obtained :

Table 5. Result of criteria determination

N O	Crite ria	Scor e	Conclusion
1	Functional	100 %	Strongly Agree
2	Operation & Maintenance	100 %	Strongly Agree
3	Environmental	93%	Strongly Agree
4	Economic	85%	Strongly Agree

Based on the table above, the important criteria in selecting the best type of material for the NKT-01 TW gas pipeline at PT XYZ Gundih Field are functional, operation & maintenance, environmental and economic.

4.2. Result of sub-criteria determination

With the same process and calculation as the selection of the criteria above, the data obtained for the sub-criteria are :

Table 6. Result of sub-criteria determination

Criteria	Subcriteria	Scor e	Conclusi on
Functional	Tensile Strength	88%	Strongly Agree
	Elastic Modulus	83%	Strongly Agree
	Linear Expansion	88%	Strongly Agree
	Corrosion Resistance	98%	Strongly Agree
	Scaling Resistance	80%	Strongly Agree
Operati on & Mainte nance	Reliability	100 %	Strongly Agree
	Maintainability	93%	Strongly Agree
Environme ntal	Energy Consumption	78%	Agree
	Health Risk	88%	Strongly Agree
	Recyclability	63%	Agree
Economic	Material Cost	90%	Strongly Agree
	Operation & Maintenance Cost	88%	Strongly Agree
	Density	75%	Agree
	Market Availability	80%	Strongly Agree
	Roughness	73%	Agree

Based on the table above, the important sub-criteria in selecting the best type of material for the NKT-01 TW gas pipeline at Gundih Field PT XYZ are tensile strength, elastic modulus, linear expansion, corrosion resistance, scaling resistance, reliability, maintainability, energy consumption, health risk, recyclability, material cost, operation & maintenance cost, density, market availability and roughness.

4.3. Result of alternatives determination

With the same process and calculation as the selection of the criteria above, the data obtained for alternatives are :

Table 7. Result of alternatives determination

N O	Alternatives	Score	Conclusion
1	Stainless Steel	98%	Strongly Agree
2	CS With Internal Cladding	95%	Strongly Agree
3	Cast iron	78%	Agree
4	Galvanize	75%	Agree
5	FRP	98%	Strongly Agree

Based on the conclusions above, it is determined that the alternative types of materials in this research are stainless steel, CS with internal cladding, cast iron, galvanize and FRP.

4.4. Result of criteria, sub-criteria and alternatives relationship analysis

To determine whether there is a relationship on the criteria, sub-criteria and alternatives, a questionnaire was filled out by 10 respondents who have been determined as the selection of criteria and alternatives. Conclusions are obtained based on the same calculation method as in determining the criteria above to show a relationship. From the calculation results, it is found that there is a relationship between each element, both inner and outer dependence. This relationship can be described in the ANP network model below.

4.5. Result of ANP model development

From the results of relationship analysis above, an ANP network model can be made for selecting the best type of pipe material for the NKT-01 TW underground flowline project as follows :

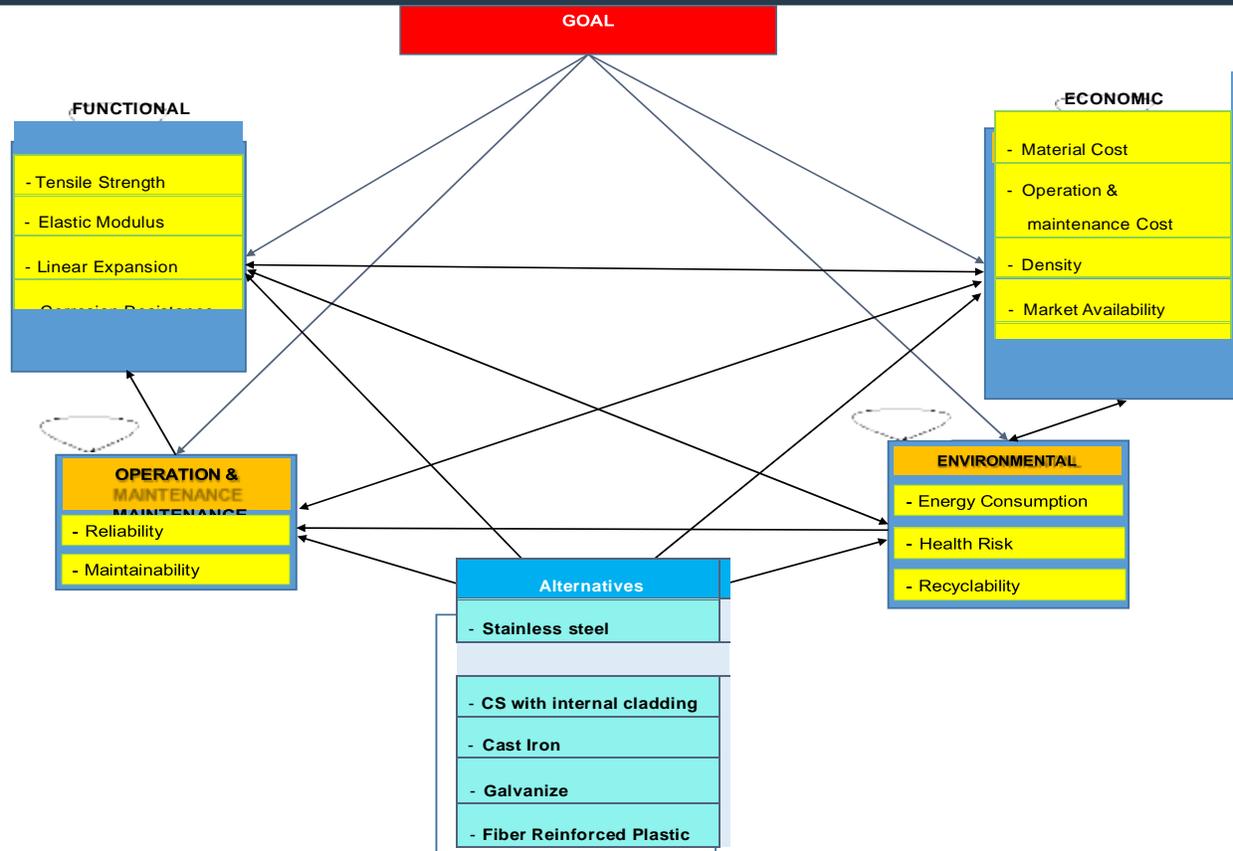


Figure 1. The ANP network model

From the network model above, it can be seen that there are relationship between criteria, sub-criteria and alternatives (inner and outer dependence). Functional criteria cluster has inner and outer dependencies for each element (sub-criteria), namely tensile strength has a relationship with modulus of elasticity, linear expansion and all alternatives. Materials that have a high modulus of elasticity (high elastic resistance/rigidity) and high linear expansion (elongation) tend to have high tensile strength. Elastic modulus has a relationship with tensile strength, linear expansion and all alternatives. Linear expansion has a relationship with tensile strength, elastic modulus, and all alternatives. Corrosion resistance has relationship with material cost, operation & maintenance cost and all alternatives. Scaling resistance also has relationship with recycling, operation & maintenance costs, ruggedness and all alternatives.

Operation & Maintenance criteria cluster has inner and outer dependence for each element (sub-criteria), namely reliability has a relationship with tensile strength, elastic modulus, linear expansion, corrosion resistance, maintainability and all alternatives. Materials that have high tensile strength, elastic modulus, linear expansion corrosion resistance and maintainability will also have high reliability. While maintainability has a relationship with reliability, material costs, operation & maintenance costs and all alternatives.

Environmental criteria cluster has inner and outer dependence for each element (sub-criteria), namely energy consumption has a relationship with scaling resistance, operation & maintenance cost, density, roughness and all alternatives. Materials that have excellent

scaling resistance, low density and good surface roughness will reduce energy consumption. Health risk has a relationship with corrosion resistance, scaling resistance, reliability, maintainability, energy consumption and all alternatives. While recyclability has a relationship with corrosion resistance, scaling resistance, health risk and all alternatives.

The economic criteria cluster also has inner and outer dependence for each of its elements (subcriteria), namely material cost has a relationship with tensile strength, elastic modulus, linear expansion, corrosion resistance, scaling resistance, reliability, maintainability, energy consumption, health risk, recyclability, density, market availability, roughness and all alternatives. Pipe material that have high properties tend to have a high price. Operation & Maintenance Cost has a relationship with tensile strength, elastic modulus, linear expansion, corrosion resistance, scaling resistance, reliability, maintainability, energy consumption, health risk, recyclability and all alternatives. Materials with poor properties will cause high operation and maintenance costs. Density has a relationship with energy consumption and all alternatives. The greater the density of the material, the greater the energy consumption during installation. Market availability has a relationship with tensile strength, elastic modulus, linear expansion, corrosion resistance, scaling resistance, reliability, maintainability, energy consumption, health risk, recyclability and all alternatives. Materials with high characteristics or properties tend to be very difficult to find in the market, so they require a long order in advance. Roughness has a relationship with energy consumption and all alternatives. Roughness causes the flowing fluid to have a large frictional force so that it requires a high energy consumption as well.

For the alternative clusters, the relationship also occurs when the alternative is a control cluster. The experts agreed according to filling out the questionnaire that there was feedback from all alternatives to all sub-criteria. This indicates that the alternative is strongly influenced by each sub-criteria.

5. CONCLUSIONS

Based on the research process that has been carried out, it can be concluded that the criteria selected in this research are functional, operation & maintenance, environmental and economic with the sub-criteria are tensile strength, elastic modulus, linear expansion, corrosion resistance, scaling resistance, reliability, maintainability, energy consumption, health risk, recyclability, material cost, operation & maintenance cost, density, market availability and roughness. While Stainless steel, carbon steel with internal cladding, cast iron, galvanize and fiber-reinforced plastics are alternatives in this research. All those elements have relationship (inner & outer dependence) as shown by the ANP model.

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IMPACTS OF THE COMPANY'S ACTION PLAN ON THE FINANCIAL PERFORMANCE OF COMBINE CYCLE POWER PLANT

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ABSTRACT

Currently, electricity is one of the essential needs for humans. Based on BPS data for 2019, national electricity consumption in the 2013-2018 period continues to increase. To balance the needs of the community, the capacity of electricity generation is also being increased, including from private companies. Based on the 2019 PLN report, the total installed capacity of the private sector (IPP) is 18,976.12 MW or 30.2%. This will cause a decrease in Capacity Factor (CF) from existing power plants, one of which is the existing power plant in Jakarta, especially at the moment 8,240 MW private power plants development project around DKI Jakarta is under way. With the continuous growth of new power plants, the CF from existing power plants will continue to decline, whereas the only source of revenue for power plants is electricity production, so with a decrease in CF, electricity production will also decrease and revenue will continue to decline. Currently, to overcome that problem, several budget optimizations are carried out annually. In 2020, the optimization of the budget for maintenance was Rp. 32 billion. The efforts that are planned to be carried out will of course have an impact on the company's financial performance. The impact of these efforts, of course, must be identified as early as possible so that the best decision making can be made so that the company can still benefit all stakeholders on an ongoing basis. The analysis is carried out based on the company's financial statements and projections using financial ratios including liquidity ratios, activity ratios and profitability ratios. The author will build a financial model that represents the entire company's operating activities for the needs of this analysis. So that this research will produce recommendations for the company in determining the right corporate action so that the company's goals can be achieved as well as possible.

Keywords: Financial Performance, Financial Modelling, Ratio Analysis

1. INTRODUCTION

Currently electricity is one of the essential needs for humans, electricity can be said as a basic need, because to carry out activities, humans need electricity as a source of energy and also as a source of lighting during activities. Along with the increasing population and the increasing number of technological advances, the need for electricity is increasing. Programs from the government to increase the electrification ratio also affect the increase in electricity demand. Based on 2019 BPS data, national electricity consumption in the 2013-2018 period continued to increase. This shows that the Indonesian people's need for electricity continues to increase every year. The largest increase in electricity consumption occurred in 2017 and 2018.

With the increase in national electricity consumption in the 2013-2018 period, the government seeks to balance the needs of the community by continuing to increase electricity generation capacity so that community needs can continue to be met.

Efforts from the government to be able to provide electricity are also ongoing. Increasing installed capacity by adding new power plants is a program that continues to be carried out by the government. Various types of power plants were added to accommodate the system needs to be able to provide electricity services to customers and prospective customers, one of the added power plants is the Gas and Steam Power Plant (PLTGU). PLTGU which has the advantage of being able to provide electricity in a short time is needed, especially in the capital city area. The following table shows data regarding the installed capacity of national power plants, national PLTGU, PLTGU in DKI Jakarta.

Nationally, the increase in power generation capacity is carried out by the government by increasing the number of power plants consisting of several companies, including private power plants, which are usually called independent power producers (IPP). Based on the 2019 PLN report, the total national installed capacity of the generating units owned by PLN and its subsidiaries is 43,856.58 MW and the total installed capacity is 62,832.70 MW. This means that privately owned installed capacity (IPP) is 18,976.12 MW or 30.2% of the installed capacity is privately owned. In the electricity supply system, there are systems that can be connected to each other, so there is a possibility that the electricity needed by the DKI Jakarta Province is not only supplied by power plants in the DKI Jakarta Province, because the systems are interconnected, systems outside DKI Jakarta. such as Banten, West Java, Central Java, and even East Java can supply electricity to DKI Jakarta Province. Thus, to provide electricity, PT. PLN will choose the most efficient generator to meet the needs of an area. This is where competition between power plants occurs, the most efficient generator will have more opportunities to supply electricity, and at this time, the IPP capacity of 30.2% will greatly affect the production of electricity generated by the power plants owned by PLN and its subsidiaries, one of which is the other is PLTGU from a subsidiary. This is because, with more modern technology, the relatively new IPP plants have newer technology so that the efficiency of these plants is better than their predecessors, which are dominated by plants owned by PLN and its subsidiaries. Based on the 2019-2028 Electricity Supply Business Plan, there are a total of 17,458 MW of phase 2 power plant acceleration projects, of which there are 11,459 MW of IPP generators. 8,240 MW of which are IPP power projects in the areas of Banten, West Java, Central Java, and East Java. This means that the areas of Banten, West Java, Central Java, East Java, and including DKI Jakarta will receive many additional generators in a short time.

With the decrease in CF from PLTGU, of course, electricity sales will also decrease. With so many new plants and the impact of CF from PLTGU, a financial evaluation of PLTGU is needed. Because to run its business, the PLTGU has to spend a lot of money to be able to continue to produce electricity. In this study, the author intends to analyze financial performance to measure the performance of PLTGU and identify company action plans to improve company performance. So that a comprehensive analysis is obtained regarding the impact of the company's action plan on the company's health performance. The purpose of writing this thesis is to analyze the historical financial performance of the company, to build a financial model that represents the company's overall operating activities, to identify the company's action plan to improve the company's performance, to analyze the impact of the company's action plan on the company's health performance

2. LITERATURE REVIEW

2.1 Ratio Analysis

Logistics systems Financial ratio analysis is part of a business analysis of the company's prospects and risks for decision-making purposes by structuring the analysis task through an evaluation of the company's business environment, strategy, and financial position and performance. (Subramanyam and Wild, 2012)

Financial ratio analysis is a ratio that describes a relationship or consideration (mathematical relationship) between a certain amount and another amount, using an analytical tool in the form of a ratio that provides an overview to the analyst about the good or bad financial condition of the company, especially when the ratio figure is compared with the figure. comparison ratio used as standard. (Munawir, 2007)

Ratio analysis is the second method for standardizing financial information on the income statement and balance sheet. The ratio itself has no meaning unless the ratio is compared with the previous period or year or compared to companies in the same industry. (Gunarta, 2020)

Based on the explanation above, financial ratios are analytical tools to explain certain relationships between one element and another in a financial report. Financial ratio analysis is one of the techniques in analyzing financial statements to assess the financial performance of a company by linking various estimates contained in the financial statements in the form of financial ratios that explain to the analyst the state or financial position of a company.

2.2 Balance

The balance sheet is one of the most important financial statements for a company. Every company is required to present financial statements in the form of a balance sheet. The balance sheet is usually prepared over a certain period, for example 1 year. However, balance sheets can also be made at certain times to find out the current condition of the company if needed. According to James C. van Horne (2005) balance sheet is a summary of the company's financial position on a certain date which shows total assets with total liabilities plus total owner's equity.

From the above understanding, the balance sheet is a summary of the financial statements in outline and not in detail. Then the balance sheet also shows the financial position in the form of assets, liabilities (debt), and company capital (equity) at a certain time. A balance sheet can be made to determine the condition (amount and type) of assets, debts, and company capital. The process of determining the criteria definition is becoming the most critical phase in the decision-making process since this process is related to relative weight determination in the supplier selection process. (Mukherjee, 2017). After carrying out the identification process, the criteria are tabulated into a list that consisted of the information historical records of suppliers (Company's name, average business volume, type of activity, certification, etc.).

2.3 Profitability Ratio

According to Sartono (2011), the profitability ratio is a ratio that can measure the company's ability to earn profits, both in relation to sales, assets and own capital.

Net Profit Margin

Shows the company's ability to generate profits at a certain level of sales. In general, a low ratio indicates management inefficiency. (Sartono, 2011)

Return on Investment

ROI or the rate of return on investment and the effectiveness of the company's overall operations is to measure the company's ability with the overall funds invested in assets used for operations in order to generate profits. (Kuswadi, 2004)

Return on Equity

This ratio is used to measure the company's ability to obtain profits available to the company's shareholders. This ratio is a measure of profitability from the point of view of shareholders. (Kuswadi, 2004)

2.4 Liquidity Ratio

The liquidity ratio shows the ability of a company to meet its financial obligations that must be met immediately, or the company's ability to meet financial obligations when billed. (Munawir, 2004) According to Fred Weston (1990), states that the liquidity ratio (liquidity ratio) is a ratio that describes the company's ability to meet short-term obligations (debt). This means that if the company is billed, it will be able to meet the debt (pay) especially the debt that is due.

Current Ratio

The current ratio or current ratio is a ratio to measure the company's ability to pay short-term obligations or debts that are due immediately when billed in their entirety. In other words, how much current assets are available to cover short-term liabilities that are due soon. The current ratio can also be said as a form to measure the level of security (margin of safety) of a company. (Sartono, 2011)

The higher the current ratio means the greater the company's ability to meet short-term financial obligations. Current assets include cash, marketable securities, receivables, and inventories.

Quick Ratio

The quick ratio (quick ratio) or very current ratio is a ratio that shows the company's ability to meet or pay current liabilities or debts (short-term debt) with current assets without taking into account the value of inventory (inventory). That is, we ignore the value of inventory, by deducting it from the total value of current assets. This is done because inventories are considered to take a relatively longer time to be cashed, if the company needs funds quickly to pay its obligations compared to other current assets.

2.5 Activity Ratio

The activity ratio is the ratio used to measure the effectiveness of the company in using its assets. Or it can also be said that this ratio is used to measure the level of efficiency in the use of company resources. Efficiency is carried out for example in the areas of sales,

inventory,

collection of receivables, and efficiency in other fields. The activity ratio is also used to assess the company's ability to carry out daily activities.

Inventory Turn Over

The inventory turnover ratio measures the number of times a company's inventory has been sold during a certain period, for example during a certain year. This figure measures the efficiency of inventory management within the company. (Sartono, 2011)

High inventory turnover indicates the smaller inventory in one year and this indicates the effectiveness of the company's management. Conversely, low inventory turnover indicates a lack of effective inventory control.

Total Asset Turn Over

Total asset turnover shows how the level of effectiveness of the company in using all assets to create sales in using all assets to create sales and profit income. This turnover rate is determined by the turnover of the asset element itself. (Sartono, 2011)

3. METHODS

3.1 Data collection

At the data collection stage, references were collected relating to this research. The source of data in this study is secondary data obtained from the relevant division responsible for the data. The data needed in this study is Financial Performance Data which includes the company's Financial Performance Report from 2016-2020. Then the next data is the Planned and Realized Capacity Factor Data for 2016-2020 and 2021-2023.

3.2 Data Modeling and Processing

At this stage, modeling is carried out and then data processing is carried out. The modeling is made so that it can represent the real situation on Microsoft Excel working papers and then make financial performance simulations. The data that has been obtained can be used as input data for modeling, so that modeling can represent the actual situation based on real data. The first step is to conduct an evaluation based on the 2016-2020 financial performance report. At this stage, calculations will be carried out so that the results of the ratio analysis of financial performance in that period will be obtained. Then using the working paper that has been made, a simulation for the financial performance of 2021-2023 is carried out using Microsoft Excel. After performing the simulation, the calculation of the return ratio analysis is carried out based on the data from the simulation results. The next step is to optimize the Capacity Factor (CF) using a goal seeker or solver so that the optimum CF is obtained to produce good financial performance seen from the ratio analysis study.

3.3 Data Analysis and Discussion

At this stage, the data from the modeling results have been obtained. From the data obtained then analyzed. From the modeling results, historical financial performance data of

PLTGU will also be obtained from 2016-2020, then analysis of PLTGU's financial performance projection data will be carried out based on existing CF projection data. And then an analysis of the PLTGU's financial performance is carried out based on the corporate action plan carried out. So that the impact of each corporate action on the financial performance of PLTGU is obtained. The financial performance analysis in question is ratio analysis which includes liquidity ratios, profitability ratios, and activity ratios.

After that, in the discussion stage, the results of the analysis that have been obtained will be discussed. The discussion will include the results of the ratio analysis in the 2016-2020 period, what factors influence it, the results of the ratio analysis based on the financial performance simulation for the 2021-2023 period, and what strategies must be taken so that the PLTGU financial performance will be good and continue to be sustainable in the midst of accelerated development. power plants, especially IPP, which causes the CF of PLTGU to continue to decline. This discussion will explain the strategy undertaken and how it affects the financial performance of the PLTGU. What was discussed related to the results of the ratio analysis based on the financial performance simulation for the 2021-2023 period was the CF optimization strategy with the variable number of machines being maintained or the number of machines being deactivated, so that the optimum CF was obtained which would result in good financial performance for the PLTGU.

3.4 Conclusion

Conclusions are obtained to answer the research objectives that have been set in Chapter

I. At this stage, the results of the ratio analysis will be concluded, both the liquidity, activity, and profitability ratios for the 2016-2020 period. At the conclusion stage, there will also be results of financial performance and ratio analysis for the period 2021-2023 from the simulation results. And in conclusion, there are strategies that companies can do to optimize CF, so that good financial performance is obtained for PLTGU. Then in the suggestions section, explaining the development of further research that can be done to complete the shortcomings in this research.

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CORRELATION STUDY BETWEEN STRESSOR AND WORKINGSTRESS OF CONSTRUCTION PROJECT MANAGER IN SURABAYA

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ABSTRACT

Every decision made by the Project Manager has a direct impact on time, cost, quality and ultimate success of a construction project. Occupying a crucial position in a construction project, the Project Manager must experience a lot of stress. They may act unsafely like taking shortcuts to complete their work as quickly as possible when they are suffering from physical stress. This increases the risk of an accident and can result in injury. Meanwhile, Occupational Health and Safety can be the key for sustainable development. Decision making that made by construction project managers, have risks to become more rigid, simple, and shallow. Therefore, stress is considered as a negative impact on humans. Not to mention the COVID-19 pandemic. However, stress is not always harmful, because the stimulus of stress is always accompanied by motivation and this is fundamental for every successful experience. The purpose of this study was to analyze the correlation between stressors and working stress of building construction project managers in Surabaya. Questionnaires were distributed to the managers of the ongoing building construction project in Surabaya and obtained a total of 27 respondents. By using the regression analysis method, we can conclude that Organizational Stressors give a high influence to Burnout and Physical Stressors give a high influence to Physiological Stress. Stress at work can be easier to control based on type and cause, and if we can control it, the project performance will be improve to be better.

Keywords: stressors, working stress, construction project managers, COVID-19, Surabaya.

1. INTRODUCTION

A construction project is a uniquely human endeavor that has mixed goals and objectives for multi-stakeholders, that must be complete a specific project or task within a limited time. The construction industry is known as a stressful industry due to their complexity of tasks, tight timeframes, complicated working group relationships among various parties, and poor working environment on construction projects (Leung et al., 2008). According to a study by the Chartered Institute of Building that cited in the research of Leung et al. (2010), stress has become a common phenomenon among construction professionals, with nearly 70% of construction professionals suffering from stress, anxiety, or depression as

a direct result of work.

Among the stakeholders in a construction project, Construction Project Managers are required to be proficient in various skills, such as scheduling, cost control, social skills, negotiation, and so on, to plan, organize and oversee project tasks involving design, construction, inspection and maintenance. Project Managers are the only construction professionals who take over construction projects from pre-construction to post-construction stages. Since every decision that made by the Project Manager has a direct impact on the time, cost, quality, and ultimate success of a construction project, the Project Manager has been considered as a key person in the success of construction project for a long time. Occupying a crucial position in a construction project, the Project Manager is bound to experience enormous stress due to the highly demanding time pressures, intrinsic uncertainty, and dynamic social structure of construction projects. According to Cherrington that cited in the study of Leung et al. (2005), the decision making of individuals who work in situations with excessive stress are generally more rigid, simple, and shallow. Therefore, stress is considered as a negative impact on humans.

Not to mention the COVID-19 pandemic. Quoted from money.kompas.com, based on the results of the PPM Management survey, it is known that 80% of workers experience symptoms of stress during the corona virus pandemic (Covid-19). Psychologist and Head of Center for Human Capital Development of PPM Management Maharsi Anindyajati said that the greatest stress experienced by respondents was related to the health and safety of family members, which reached 59%. Followed by fear of being infected with the corona virus which reached 56%. On the other hand, stress due to thinking about business sustainability during this pandemic, the construction sector responded by 30%. This condition, for a construction project manager, can certainly affect the performance in carry out their duties. To maintain and improve the performance of construction project managers, it is necessary to avoid stress for the construction project managers, because working stress will decreased their performance (Tuten and Neidermeyer, 2004). However, stress is not always dangerous. As in Selye's research that cited by Leung et al. (2008), "Without stress, there would be no life." Stress stimulus is fundamental for every successful experience, because it is always accompanied by motivation.

2. LITERATURE REVIEW

Handoko (2008) stated that: "Stress is a condition of tension that affects emotions, thought processes and one's condition, conditions that tend to cause stress are called stressors." According to this understanding, stress will affect a person's condition which will trigger tension in people who experience stress.

Categorization of stress (Leung et al 2008) is divided into three, namely:

- Objective Stress
Objective stress refers to the evaluation of threats that arise from cognitive factors. Objective stress is induced due to a mismatch between the individual's perceived ability and their actual ability to effectively handle the task. In real situations, there are many cognitive factors that affect the construction project manager's objective stress, such as the number of project deadlines, the number of tasks, and the difficulty of the tasks.
- Burnout

Burnout and frustration are result from the failure of work, life, or relationships to produce the expected rewards. Symptoms of burnout include changes in the individual's social life (e.g., construction project managers may avoid communication with people at work or in their personal lives) and attitudes at work (i.e., low motivation and low commitment at work due to prolonged frustration, and frequent complain about underachievement).

- Physiological Stress

Stress can affect humans physiologically. When the body is faced with a certain stressful situation, hormones are released from the brain to support other parts of the body during a stressful change or state. The body then tries to deal with the stress by physiological adjustments. After some time, this adjustment can return to normal if the body is no longer affected by the stressor. However, if stressful conditions continue to affect a person, physiological adjustments will be continue. Physiological stress gradually appears in the form of headaches, backaches, loss of appetite, and so on. Research has found that manager's physiological stress is generally caused by role of ambiguity, lack of feedback, career development difficulties, and problems that involve organizational structure.

Stressor is not only caused by one factor, but stress can occur due to a combination of several causes at once. According to Leung et al (2009), work-related stressors are divided into:

- Task Stressors

Task stressors usually refer to work overload, role conflict, and role of ambiguity in the day-to- day job of construction project managers. Excessive workload means the work demands are too much for one individual. Role of conflict occurs when construction project managers are torn between contrary of job demands or doing things that they really don't want to do or don't consider as part of their job specification. Role of ambiguity means a lack of clarity about job role expectations also the scope and responsibilities of the job.

- Organisational Stressors

Organizational stressors refer to sources of stress originating from and within the organization itself. Causes of this stress include organizational structure and career development environment. Poor organizational structure includes the existence of bureaucracy and hierarchies, omnipotence of rules, and unfair treatment by organizations in the construction companies. The career development environment indicates organizational culture, level of participation in the decision-making process, and job instability of construction project managers.

- Personal Stressors

Personal stressors include intrapersonal and interpersonal stressors. Intrapersonal stressors usually refer to an individual's personal behavior. On the other hand, good interpersonal relationships at work have been recognized as the key ability for construction project managers to achieve good performance.

- Physical Stressors

Physical stressors refer to sources of environmental stress present in either construction project manager's work environment or home. At construction sites, construction project managers are usually required to work in poor physical conditions, such as room temperature which extremely high or low, improper lighting, lack of privacy, and so on. In addition to the work environment, the construction project manager's home environment should also be considered, because a bad home environment can directly affect the

construction project manager's personal health and stress.

3. METHODS

This study uses a questionnaire survey as a tool to collect data. The questionnaire was addressed to construction project managers who are working on high-rise building projects in the city of Surabaya. The distribution of questionnaires was carried out by making direct observations in the field for companies that is doing high-rise building projects and directly visited the office of the owner, contractor, consultant, and sub-contractor company. Questionnaires were also distributed via google form to reach managers of building construction projects around Surabaya. Of the total 47 questionnaires and google forms that have been distributed, only 27 questionnaires

were returned to the researcher. The data that has been obtained was process using Minitab 16 software. The variables in this study are as follows.

- Response Variable 1 (SK1) = Burnout
- Response Variable 2 (SK2) = Physiological Stress
- Response Variable 3 (SK3) = Objective Stress
- Predictor Variable 1 (PS1) = Task Stressors
- Predictor Variable 2 (PS2) = Organisational Stressors
- Predictor Variable 3 (PS3) = Personal Stressors
- Predictor Variable 4 (PS4) = Physical Stressors

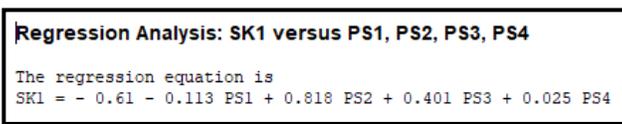
4. RESULTS

4.1 Regression Analysis

In this Multiple Linear Regression Analysis, the first step is to determine the multiple linear regression equation model. After that, the regression parameters will be tested simultaneously and partially and calculate the coefficient of determination.

a) Multiple Linear Regression Modeling

Multiple linear regression analysis was used to prove the hypothesis regarding the influence of the predictor variables partially or jointly on the response variable. The results of dataprocessing with the Minitab program are as follows:



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Regression Analysis: SK1 versus PS1, PS2, PS3, PS4
The regression equation is
SK1 = - 0.61 - 0.113 PS1 + 0.818 PS2 + 0.401 PS3 + 0.025 PS4
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Figure 1. Regression Analysis between Stressors and Burnout

From the regression equation in **Figure 1**, it can be concluded as

follows:

- If Task Stressors (PS1) increases by 1 unit, the effect of Burnout (SK1) will increase by -0.1133 units.
- If Organizational Stressors (PS2) increases by 1 unit, the effect of Burnout (SK1) will

increase by 0.8176 units.

- If Personal Stressors (PS3) increases by 1 unit, then the effect of Burnout (SK1) will increase by 0.4005 units.
- If Physical Stressors (PS4) increases by 1 unit, the effect of Burnout (SK1) will increase by 0.0247 units.

Regression Analysis: SK2 versus PS1, PS2, PS3, PS4
The regression equation is
 $SK2 = -0.502 + 0.124 PS1 + 0.205 PS2 - 0.008 PS3 + 0.762 PS4$

Figure 2. Regression Analysis between Stressors and Physiological Stress

From the regression equation in **Figure 2**, it can be concluded as follows:

- If Task Stressors (PS1) has increased by 1 unit, the effect of Physiological Stress (SK2) will increase by 0.1235 units.
- If Organizational Stressors (PS2) increases by 1 unit, the effect of Physiological Stress (SK2) will increase by 0.2049 units.
- If Personal Stressors (PS3) increase by 1 unit, then the effect of Physiological Stress (SK2) will increase by -0.0076 units.
- If Physical Stressors (PS4) increases by 1 unit, then the effect of Physiological Stress (SK2) will increase by 0.7618 units.

Regression Analysis: SK3 versus PS1, PS2, PS3, PS4
The regression equation is
 $SK3 = 1.10 - 0.004 PS1 - 0.155 PS2 + 0.520 PS3 - 0.132 PS4$

Figure 3. Analisis Regresi antara Penyebab Stres Kerja dan Objective Stress

From the regression equation in **Figure 3**, it can be concluded as follows:

- If Task Stressors (PS1) increases by 1 unit, the effect of Objective Stress (SK3) will increase by -0.0038 units.
- If Organizational Stressors (PS2) increases by 1 unit, the effect of Objective Stress (SK3) will increase by -0.1555 units.
- If Personal Stressors (PS3) increases by 1 unit, the effect of Objective Stress (SK3) will increase by 0.5204 units.
- If Physical Stressors (PS4) increase by 1 unit, then the effect of Objective Stress (SK3) will increase by -0.1324 units.

b) Simultaneous Test (F test)

Simultaneous test is used to determine whether the results of the regression analysis are significant or not, in other words the model is suspected to be appropriate or not.

H_0 is accepted if $F_{count} < F_{table}$ → Predictor variable has no significant effect on the response

variable

H_0 is rejected if $F_{count} > F_{table}$ → Predictor variable has a significant effect on the response

variable variabel

Based on the analysis of variance using Minitab software, whether or not there is a significant effect between predictor variables and response variables is explained in **Table 1**.

Table 1. The Influence of the Stressors on Working Stress Based on F test

Relationship between Predictor Variables and Response Variables	F table value	F count value	Hypothesis Decision	Definition
Stressors and Burnout (SK1)	2.82	5.29	H_0 rejected	There is a significant influence
Stressors and <i>Physiological Stress</i> (SK2)	2.82	12.64	H_0 rejected	There is a significant influence
Stressors and <i>Objective Stress</i> (SK3)	2.82	0.69	H_0 accepted	No significant effect

Based on **Table 1**, Task Stressors (PS1), Organizational Stressors (PS2), Personal Stressors (PS3) and Physical Stressors (PS4) together have a significant effect on Burnout and Physiological Stress. However, Task Stressors (PS1), Organizational Stressors (PS2), Personal Stressors (PS3) and Physical Stressors (PS4) together have no significant effect on Objective Stress.

c) Partial Test (T test)

Partial test was conducted to test the significance of the effect of predictor variables on individual response variables.

H_0 is accepted if $t_{count} < t_{table}$ → Predictor variable has no significant effect on the response

variable

H_0 is rejected if $t_{count} > t_{table}$ → Predictor variable has a significant effect on the response

variable variabel

Based on regression analysis using Minitab software, whether or not there is a significant effect between predictor variables and response variables is explained in **Table 2**.

Table 2. The Effect of Stressors on Working Stress Based on T Test

Predictor Variable	t table value	t count value	P-Value	Hypothesis Decision	Definition
Regression between Stressors and Burnout					
Task Stressors (PS1)	1.70814	-0.54	0.596	H0 accepted	There is no significant effect with Burnout (SK1)
Organisational Stressors (PS2)	1.70814	2.84	0.010	H0 rejected	There is a significant effect with Burnout (SK1)
Personal Stressors (PS3)	1.70814	0.76	0.453	H0 accepted	There is no significant effect with Burnout (SK1)
Physical Stressors (PS4)	1.70814	0.09	0.931	H0 accepted	There is no significant effect with Burnout (SK1)
Regression between Stressors and Physiological Stress					
Task Stressors (PS1)	1.70814	0.91	0.370	H0 accepted	There is no significant effect with Physiological Stress (SK2)
Organisational Stressors (PS2)	1.70814	1.11	0.280	H0 accepted	There is no significant effect with Physiological Stress (SK2)
Personal Stressors (PS3)	1.70814	-0.02	0.982	H0 accepted	There is no significant effect with Physiological Stress (SK2)
Physical Stressors (PS4)	1.70814	4.23	0.000	H0 rejected	There is a significant effect with Physiological Stress (SK2)
Regression between Stressors and Objective Stress					
Task Stressors (PS1)	1.70814	-0.03	0.979	H0 accepted	There is no significant effect with Objective Stress (SK3)
Organisational Stressors (PS2)	1.70814	-0.81	0.428	H0 accepted	There is no significant effect with Objective Stress (SK3)
Personal Stressors (PS3)	1.70814	1.48	0.152	H0 accepted	There is no significant effect with Objective Stress (SK3)
Physical Stressors (PS4)	1.70814	-0.70	0.488	H0 accepted	There is no significant effect with Objective Stress (SK3)

d) Coefficient of Determination

The coefficient of determination is used to see the contribution/support of the independent variable to the dependent variable.

Table 3. Goodness of Fit in Regression Analysis

S Value	R-Sq Value	R-Sq (adj) Value
Regression between Stressors and Burnout		
1.70814	-0.54	0.596

S Value	R-Sq Value	R-Sq (adj) Value
Regression between Stressors and Physiological Stress		
1.70814	0.91	0.370
Regression between Stressors and Objective Stress		
1.70814	-0.03	0.979

From the regression analysis between stressors and burnout, the coefficient of determination (R-Sq) is 0.490. This means that 49.0% of the Burnout variable will be explained by the predictor variable. While the remaining 51.0% of the Burnout variable will be explained by other variables not discussed in this study. The R-Sq value of 0.490 belongs to a fairly strong relationship level because it is between 0.400 – 0.599.

From the regression analysis between stressors and Physiological Stress, the coefficient of determination (R-Sq) is 0.697. This means that 69.7% of Physiological Stress variables will be explained by predictor variables. While the remaining 30.3% of Physiological Stress variables will be explained by other variables not discussed in this study. The R-Sq value of 0.697 belongs to the level of a strong relationship because it is between 0.600 – 0.799.

From the regression analysis between stressors and Objective Stress, the coefficient of determination (R-Sq) is 0.111. This means that 11.1% of Objective Stress variables will be explained by predictor variables. While the remaining 88.9% of Objective Stress variables will be explained by other variables not discussed in this study. The R-Sq value of 0.111 belongs to a very low level of relationship because it is between 0.000 – 0.199.

4.2 Classical Assumption Test

a) Multicollinearity Test

The multicollinearity test is used to determine whether or not there is a deviation from the classical assumption of multicollinearity, that is the existence of a linear relationship between independent variables in the regression model. From the Variance Inflation Factor (VIF), we can detect the presence or absence of multicollinearity. If the VIF value > 10 , it indicates the presence of multicollinearity. And if on the contrary, $VIF < 10$, then there is no multicollinearity. Based on regression analysis using Minitab software, whether or not there are indications of cases of multicollinearity between predictor variables is explained in **Table 4**.

Table 4. Multicollinearity Case Analysis on Predictor Variables Based on VIF Value

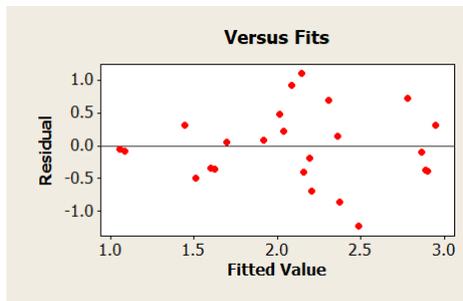
Predictor Variable	VIF Value	Definition
Task Stressors (PS1)	1.086	There is no indication of multicollinearity cases

Organisational Stressors (PS2)	1.979	There is no indication of multicollinearity cases
Personal Stressors (PS3)	1.654	There is no indication of multicollinearity cases
Physical Stressors (PS4)	1.867	There is no indication of multicollinearity cases

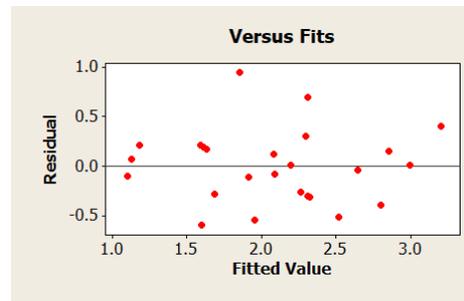
b) Heteroscedasticity Test

This test aims to test whether the regression model has the same residual variance or not. A good regression model is a model that has the same residual variance (homoscedasticity).

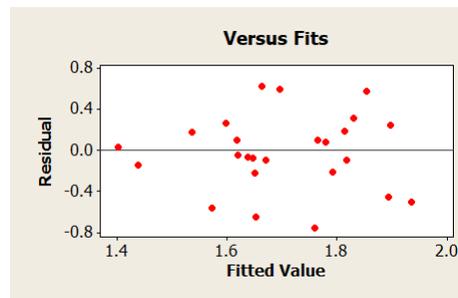
The way to test homoscedasticity is to look at the graph plot between the predicted value of the dependent variable (dependent) and its residual. If there is a certain pattern, such as the existing dots forming a certain regular pattern (wavy, widening and then narrowing), it indicates that heteroscedasticity has occurred (the assumption of homoscedasticity is not met). Meanwhile, if there is no clear pattern, and the points spread above and below the number 0 on the Y axis, then there is no heteroscedasticity or H_0 is accepted.



(a) Versus Fits of Stressors and Burnout



(b) Versus Fits of Stressors and Physiological Stress



(c) Versus Fits of Stressors and Objective Stress

Figure 4. Residual Plot vs Fitted Value

From the results of the scatterplot in **Figure 4(a)**, it can be concluded that there is no certain pattern, it can be seen that the points are scattered randomly (not patterned) both above and below the number 0 on the Y axis, so it can be concluded that the model in the image above is free from heteroscedasticity problem or does not occur heteroscedasticity.

From the results of the scatterplot in **Figure 4(b)**, it can be concluded that there is no

particular pattern, it can be seen that the points are scattered randomly (not patterned) both above and below the number 0 on the Y axis, so it can be concluded that the model in the image above is free from heteroscedasticity problem or there is no heteroscedasticity.

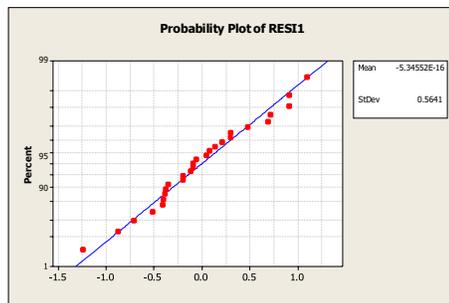
From the results of the scatterplot in **Figure 4(c)**, it can be concluded that there is no certain pattern, it can be seen that the points are scattered randomly (not patterned) both above and below the number 0 on the Y axis, so it can be concluded that in the image model above, it is free from heteroscedasticity problem or does not occur heteroscedasticity.

c) Normality test

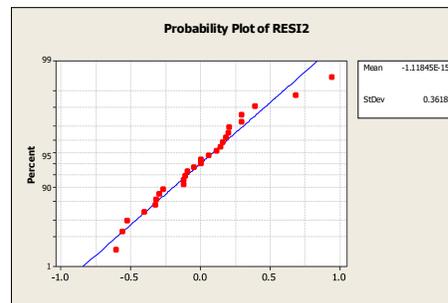
Normality is the residual that should be normally distributed around the scores of the dependent variable. Residue is the remainder or difference in the results between the value of the observation data of the dependent variable and the value of the predicted dependent variable. The regression model can be said to meet the assumption of normality if the residuals obtained from the regression model are normally distributed.

H_0 is accepted if $p\text{-value} > \alpha$ ($\alpha=5\%$) → Residual data follows normal distribution

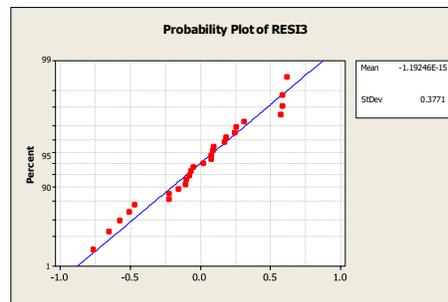
H_0 is rejected if $p\text{-value} < \alpha$ ($\alpha=5\%$) → Residual data does not follow the normal distribution



(a) Probability Plot of Stressors and Burnout



(b) Probability Plot of Stressors and Physiological Stress



(c) Probability Plot of Stressors and Objective Stress

Gambar 5. Normality Test

Based on **Figure 5(a)** shows that the normality test plot shows the probability value of each residual spreading along a straight line, and the p-value (0.645) > 0.05, then the data is normally distributed.

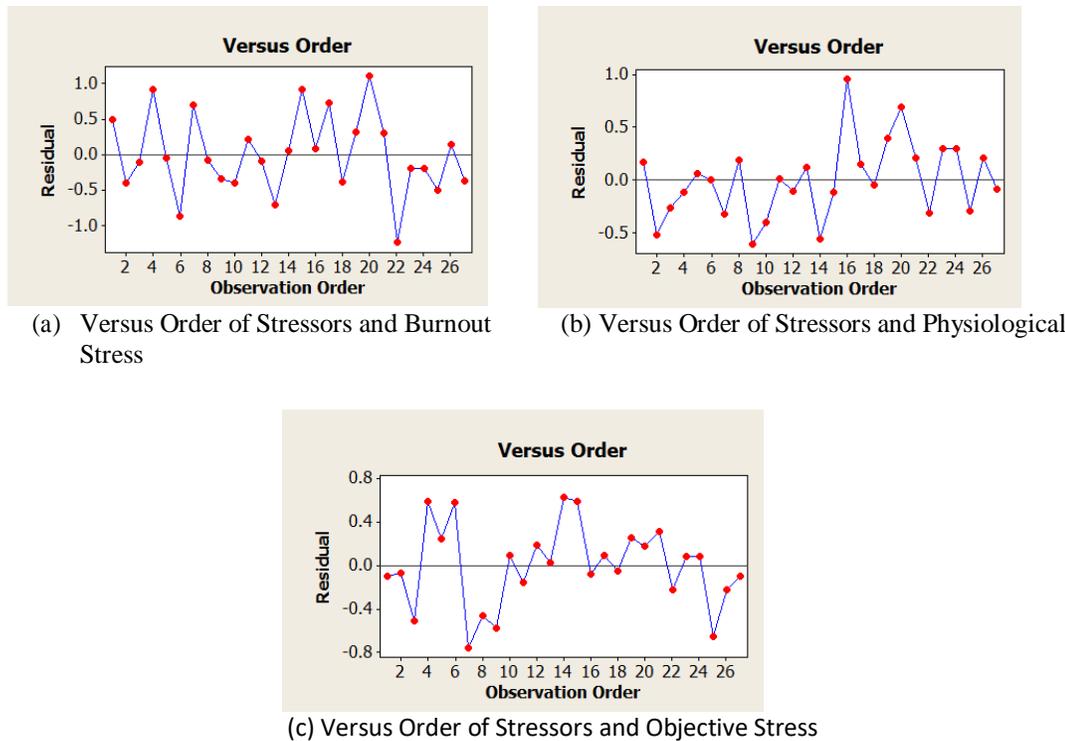
Based on **Figure 5(b)** shows that the normality test plot shows the probability value of

each residual spreading along a straight line, and the p-value (0.668) > 0.05, then the data is normally distributed.

Based on **Figure 5(c)** shows that the normality test plot shows the probability value of each residual spreading along a straight line, and the p-value (0.461) > 0.05, then the data is normally distributed.

d) Autocorrelation Assumption Test

The autocorrelation test is used to determine whether or not there is a deviation from the classical assumption of autocorrelation, that is the correlation that occurs between the residuals in one observation with other observations in the regression model. This test was carried out by looking at the residual vs order plot (order of observations) and using the Durbin Watson test.



Gambar 6. Plot Residual vs Observation Order

Based on **Figure 6(a)** shows that from the data we can know that the graph is not patterned or does not have a certain pattern. It can be seen from the residual range that is not symmetrical, the points on the graph tend to be up and down. So that visually the graph can be said to be independent.

Based on **Figure 6(b)** shows that from the data we can know that the graph is not patterned or does not have a certain pattern. It can be seen from the residual range that is not symmetrical, the points on the graph tend to be up and down. So that visually the graph can be said to be independent.

Based on **Figure 6(c)** shows that from the data we can know that the graph is not patterned or does not have a certain pattern. It can be seen from the residual range that is not symmetrical, the points on the graph tend to be up and down. So that visually the graph can be said to be independent.

However, graphical testing is not enough because it is only based on the subjectivity of the researcher. Then the Durbin-Watson dependency test was carried out as follows.

H_0 is accepted if $dU \leq d \leq 4-dU$ → There is no autocorrelation
 H_0 is rejected if $d < dL$ → There is autocorrelation
 If $4-dU \leq d \leq 4-dL$ or $dL \leq d \leq dU$ → Does not come to a definite conclusion

Table 5. Autocorrelation Test Interpretation

Relationship Model	d value	dL value	dU value	Definition
Stressors and <i>Burnout</i> (SK1)	2.07401	1.0836	1.7527	There is no autocorrelation
Stressors and <i>Physiological Stress</i> (SK2)	1.80456	1.0836	1.7527	There is no autocorrelation
Stressors and <i>Objective Stress</i> (SK3)	1.68658	1.0836	1.7527	Does not come to a definite conclusion

6. CONCLUSIONS

From the results of the simultaneous test, it can be concluded that at least one of the Task Stressors, Organizational Stressors, Personal Stressors, or Physical Stressors has a significant effect on Burnout and Physiological Stress. However, none of the four stressors have a significant effect on Objective Stress. And after the partial test, the variables that have a significant effect on the Burnout variable are Organizational Stressors, while the variables that have a significant effect on the Physiological Stress variable are Physical Stressors. Some examples of organizational stressors experienced by building project managers in Surabaya are the condition of the organizational structure and the potential for career development in the work environment. While some examples of Physical Stressors experienced by building project managers in Surabaya are the conditions of the work environment and the conditions of the home environment. By knowing that it is Organizational Stressors that can cause Burnout and Physical Stressors that can cause Physiological Stress, the company can determine actions to control working stress that occurs in construction project managers more easily, so that project performance can increase.

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Parallel Session 1

Room F (09:50 - 11:20)

Moderator:

Category: Data Analytics and Business Intelligent

ANALYSIS OF THE INFLUENCE OF PRODUCT QUALITY, SERVICE, PRICE, AND PRODUCT AVAILABILITY ON PURCHASE DECISION MAKING

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ABSTRACT

Internet of Things (IoT) products are widely applied in industry to assist companies in control and monitoring processes. The application of IoT products has a positive impact on a company's growth in terms of productivity and efficiency. As an authorized partner company for IoT products of the Advantech brand, company XYZ experienced a decline in sales in 2020, especially related to the UNO-2484 product. Many factors are considered by customers when purchasing products, such as reliability, price, ease of use, and product availability. An authorized partner company must be able to provide maximum service to customers, both presales and after-sales, in order to provide positive feedback to the company. This study aimed to find the factors that have a dominant influence on purchasing decisions related to the UNO-2484 product in order to determine an appropriate targeted marketing strategy. The factors tested were: product quality, service, price, and product availability. The data used consisted of primary data for 2017 to 2020 from a total of 40 potential customers. The research method used was quantitative analysis of data obtained by distributing a questionnaire. The responses were analyzed by structural equation modeling (SEM), revealing that only product quality had a significant and positive effect on purchasing decisions, with an R-square value of 74.8%. The vertical market consisted of system integrators (75%), end users (17.9%), and resellers (7.1%).

Keywords: Internet of Things, presales, after sales, structural equation modeling

1. INTRODUCTION

The implementation of Internet of Things (IoT) products is widely done in the industrial world, especially by companies that focus on Industry 4.0. This has a positive impact on a company's growth in terms of productivity and efficiency. The Internet of Things (IoT) is extensively integrated into industrial enterprise networks in order to increase computing and storage capabilities and to monitor and exercise physical control over remotely located equipment so as to increase productivity and maximize economic benefits (Xu, He & Li, 2014). Indonesian enterprises are expected to gradually develop an agenda for purchasing IoT

products in the future.

Due to the advancement of information technology, customers are better informed and have more options when making purchasing decisions. This poses a challenge to company XYZ because customers could decide to purchase products offered by competitors. Company XYZ is an authorized partner of one of the largest IoT brands in the world (Advantech), selling industrial computer and automation & control system products, such as industrial-grade PCs bundled with Supervisory Control and Data Acquisition (SCADA) software. As a distributor company, they must be able to provide maximum service to prospective buyers, both presales and after-sales, to provide customer comfort, satisfaction and trust. In general, quality of service is often conceptualized as a comparison between expected and actual service performance (Berry, Parasuraman & Zeithaml, 1988).

The sales of IoT products by company XYZ increased significantly from 2017 to the following years, but in 2020 there was a decrease, which had an impact on the company's revenue; the difference in company profits is shown in Figure 1. The present study was conducted at company XYZ and focused specifically on the UNO-2484 product because it supports all industrial company processes in terms of automation equipment. Determination of factors that influence purchasing decisions was conducted using structural equation modeling (SEM). The SEM method can explain the complex relationship between one variable and other variables that influence each other directly or indirectly (mediating variables) (Ferdinand, 2006). SEM can measure latent variables and perform three activities simultaneously, namely checking the validity and reliability of the instrument (equivalent to path analysis) and exploration.



Figure 1. Revenue line graph from 2017 to 2020.

Many previous studies have been carried out to determine the dominant factors in making purchasing decisions using the SEM method, for example Wahid (2016) and Apriando, Soesanto & Indriani (2019). Winoto (2020) specifically investigated the product quality factor. The service quality factor was investigated by Nariswati & Iriawan (2012) and Nasution, Maksum & Derriawan (2018). The price factor was investigated by Winoto (2020) and Hati et al., (2021) and the product availability factor was investigated by Apriando, Soesanto & Indriani (2019). The product quality, price and product availability factors influence purchasing decisions in a significantly different way compared to the way the service quality factor, which affects customer loyalty.

These previous researches did not provide sufficient information to determine an appropriate direction for company XYZ's product marketing strategy. This study was done to know the effect of the factors product quality, service, price, and product availability on product purchasing decisions in order to determine appropriate targeted marketing strategies.

2. LITERATURE REVIEW

2.1 Research Gap

Many previous studies have been carried out to determine dominant factors in purchasing decisions, considering product quality (Wahid, 2016; Kafabih, 2018; Apriando, Soesanto & Indriani, 2019; Winoto, 2020), service quality (Nariswati & Iriawan, 2012; Nasution, Maksum & Derriawan, 2018), price (Nasution, Maksum & Derriawan, 2018; Winoto, 2020; Hati, et al., 2021), or product availability (Apriando, Soesanto & Indriani, 2019). The dominant factors resulting from the present study were used to determine an appropriate marketing strategy using the marketing mix system (product, price, promotion and place).

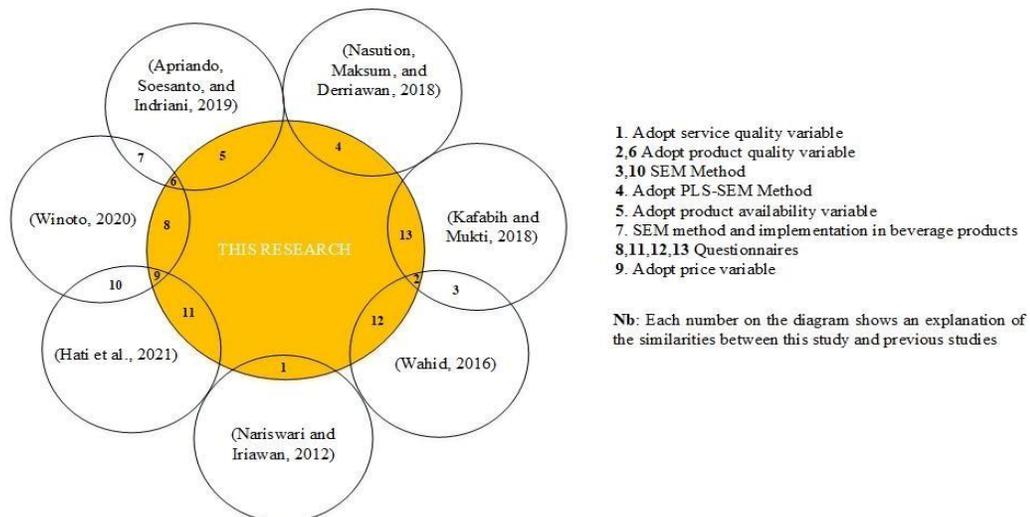


Figure 2. The position of the present study compared to previous studies.

2.2 Marketing

Marketing is an important activity for companies to successfully sell their products. Marketing can be defined as a social and managerial process by which individuals and groups can obtain what they need and want through creating and exchanging products and value with others (Kotler & Armstrong, 2010). Another way to define marketing is as a process of planning and executing the concept, pricing, promotion and distribution of ideas, goods or products and services that are able to provide positive value to individuals and organizations (Lamb, Hair & McDaniel, 2001).

Marketing strategy is the marketing logic by which a company hopes to achieve its business goals (Kotler, 2000). Designing a competitive marketing strategy begins with conducting an analysis of the competition. The company compares the customer value and satisfaction provided by its products, prices, promotions and distribution (marketing mix) against its competitors.

Marketing, or what is usually referred to as the marketing mix, is a collection of controlled tactical tools that a company uses to produce the desired response in the target

market (Kotler & Armstrong, 2008). The marketing mix consists of all things a company can do to influence the demand for its products, i.e. all marketing activities that determine the success of selling a product or a service. In the so-called 4P strategy these marketing activities are related to the variables product, price, promotion and place (distribution) (Kismono, 2008).

2.3 Buying Decision

Consumer decision making is an integration process that combines knowledge to evaluate two or more alternative behaviors in order to choose one of them. The result of this integration is a choice that is described cognitively as a behavioral desire (Setiadi, 2003). Purchasing decisions can also be explained as individual actions that are directly or indirectly involved in the effort to obtain and use a product or service that is needed (Tjiptono, 2008).

There are factors that influence consumers in making purchasing decisions, such as cultural factors, social factors, personal factors and psychological factors (Amir, 2005). One of the goals of companies is to make a profit by selling products to consumers. Many different methods can be used by companies to influence consumer in making purchasing decisions, for example by using attractive marketing. Five stages can be distinguished in the process of making purchasing decisions by consumers, namely the introduction of needs, information search, evaluation of alternatives, purchase decision, and behavior after purchase (Kotler and Keller, 2009).

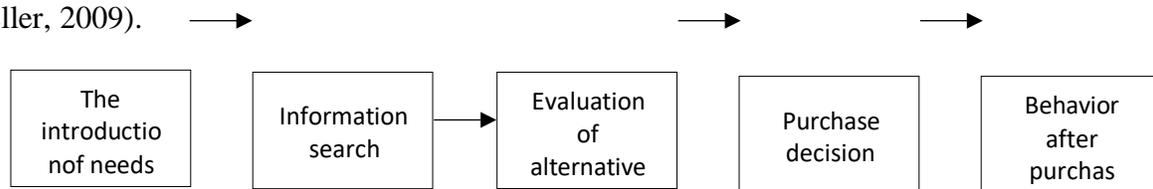


Figure 3. The five stages of the decision-making process.

2.4 Product Quality

A product is anything that can be offered to a market to satisfy a want or a need, including physical goods, services, places, properties, organizations, and ideas (Kotler and Keller, 2009). In running a retail business, product quality is one of the benefits that can be offered to consumers. It can also be referred to as a selling point, i.e. an added value that creates a competitive advantage.

Consumers have a preference for products that have good quality and that bring benefits to the consumers concerned. Some characteristics or dimensions of the product that are considered by consumers in making purchasing decisions are product form, product characteristics, product performance, product conformity with specifications, product durability, ease of repair, and product design (Kotler and Keller, 2016). Adapted to the object of research and the conditions in the field, this research used several indicator variables to determine product quality, namely: performance, features, reliability, conformation, durability, ease of repair, and brand or product form.

2.5 Service Quality

Service quality is often conceptualized as a comparison between expectations and actual service performance (Berry, Parasuraman & Zeithaml, 1988). Service quality in service and retail companies is very important from the consumer's point of view, making it the basis of service marketers because in their case the main product offered is performance (Iskandar & Bernardo, 2007).

There are five attributes and dimensions of service quality related to customers, namely physical appearance (tangibles), reliability, responsiveness, assurance, empathy, which form the basis for developing service quality (Berry, Parasuraman & Zeithaml, 1988). Service quality is influenced by two variables, namely expected service and perceived service. If the received or perceived service is smaller than the expected service, the customer will no longer be interested in the service provider concerned. On the other hand, if the perceived service is better than the expected service there is a possibility that the customer will make a repeat order (Rangkuti, 2002).

2.6 Price

Price is everything that consumers are willing to exchange in return for the benefits offered through a company's product or service (Cannon, Perreault & McCarthy, 2008). The price of the product or service being marketed is a crucial factor because it can determine or influence market demand. With the development of increasingly fierce business competition, companies must be able to determine an appropriate price for their products or services.

For an authorized partner company, the price set by the company depends on the price list provided by the manufacturer or the principle. Thus the price offered to consumers is a price that includes a margin for the company. Based on the object of the present research, the indicator variables used to determine price suitability were: price affordability, price competitiveness, price conformity with quality, price suitability with benefits and terms of payment.

2.7 Product Availability

Companies arrange distribution channels to distribute goods or products to consumers. Distribution channel strategy has the goal of attaining optimal customer satisfaction. Distribution channels are determined by consumer buying patterns. The nature of the market is one of the determining factors that influence the company's distribution channel selection. Things that need to be considered include market, product, intermediary and company considerations (Tjiptono, 2008). One of the factors that influence consumer buying interest is product availability (Kotler & Armstrong, 2014). Product availability is a factor related to the ease of obtaining products and everything the consumer needs to consume these products (Conlon & Mortimer, 2010). Good availability of a product makes it easier for consumers to obtain the desired product. The indicator variables in product availability used in this study were: product inventory and product completeness (Utama, Irda & Kamela, 2014) as well as lead time or delivery time.

2.8 SEM-PLS

Structural equation modeling (SEM) is a method that combines regression analysis, path analysis, and factor analysis (Lee, 2007). SEM can be used to obtain a comprehensive model by testing the relationship between variables, both recursively and non-recursively (Ghozali, 2008). SEM uses a variance matrix or correlation matrix as input data for the overall estimate (Ferdinand, 2006).

The SEM approach can be divided into covariance-based SEM and variance-based SEM. Covariance-based SEM can be modified with a variance approach known as Partial Least Square (PLS) to overcome problems when the parametric assumptions are not met. SEM information based on variance is called Partial Least Square-SEM (PLS-SEM) (Ghozali, 2011). PLS-SEM can be used for the purpose of developing a prediction model, hypothesis testing or

for exploratory purposes. PLS can explain the relationship between latent variables and at the same time analyze a construct both on formative and reflective indicators (Dajani & Hegleh, 2019).

3. METHODS

This section describes the methodology used to carry out the research in a structured, systematic, and directed manner.

3.1 Source and data collection

The data used in this study was primary data collected from the customer database of company XYZ. The collection method used in this study was an online questionnaire. The questionnaire used a multiple-choice model with a 5-point Likert scale and was distributed to companies that had asked for offers or quotations related to IoT products from 2017 to 2020.

3.2 Variable identification

The variables used in this study are described as path diagrams in Figure 4.

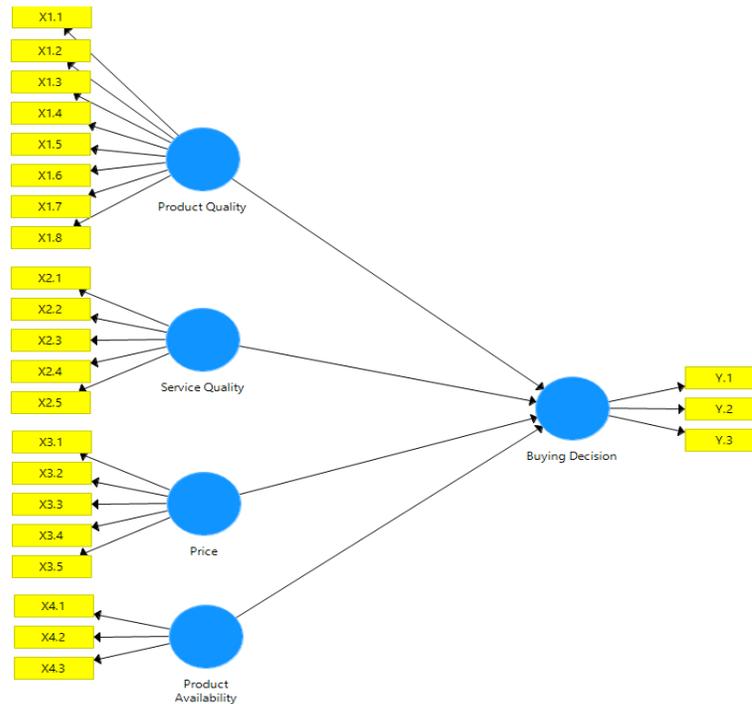


Figure 4. Path Diagram

3.3 Hypothesis determination

This study tested the proposed five hypotheses based on previous research, as shown in Table 1.

Table 1. Five hypotheses

H ₀	:	Product quality, service quality, price and product availability has not significant and positive effect on purchasing decisions.
H ₁	:	Product quality has a significant and positive effect on purchasing decisions.
H ₂	:	Service quality has an indirect influence on purchasing decisions.
H ₃	:	Price has a significant and positive effect on purchasing decisions.
H ₄	:	Product availability has a significant and positive effect on purchasing decisions.

3.4 Data analysis and processing

Quantitative analysis of the data was done mathematically in several stages, namely initial analysis, frequency distribution, and PLS-SEM.

4. RESULTS

4.1 Analysis

1. Respondent demographic analysis

This analysis was conducted to determine the general characteristics of the respondent profiles based on the following variables: gender, age, education, occupation (position in a company or institution), vertical market (end users, system integrators, and resellers), and the company's focus domain (business sector).

Table 2. Respondent demographic analysis (consumers of the UNO-2484 product).

Gender	Respondent	Deal	Lost	Percentage	Purchase Percentage
Male	31	22	9	77.5%	78.6%
Female	9	6	3	22.5%	21.4%
Total	40	28	12	100%	100%
Age (Year)	Respondent	Deal	Lost	Percentage	Purchase Percentage
21-25	3	1	2	7.5%	3.6%
26-30	11	2	9	27.5%	7.1%
31-35	9	9	0	22.5%	32.1%
36-40	12	11	1	30.0%	39.3%
41-45	5	5	0	12.5%	17.9%
Total	40	28	12	100%	100%
Education	Respondent	Deal	Lost	Percentage	Purchase Percentage
SMA	1	1	0	2.5%	3.6%
D3	8	7	1	20.0%	25.0%
S1	26	20	6	65.0%	71.4%
S2	4	0	4	10.0%	0.0%
S3	1	0	1	2.5%	0.0%
Total	40	28	12	100%	100%
Profession	Respondent	Deal	Lost	Percentage	Purchase Percentage
Student	5	1	4	12.5%	3.6%
Marketing	4	3	1	10.0%	10.7%
Purchasing	5	5	0	12.5%	17.9%
Engineer	11	6	5	27.5%	21.4%
Manager	11	10	1	27.5%	35.7%
Director	3	3	0	7.5%	10.7%
Operator	1	0	1	2.5%	0.0%
Total	40	28	12	100%	100%
Vertical Market	Respondent	Deal	Lost	Percentage	Purchase Percentage
End User	5	5	0	12.5%	17.9%
System Integrator	21	21	0	52.5%	75.0%
Reseller	2	2	0	5.0%	7.1%
Other	12	0	12	30.0%	0.0%
Total	40	28	12	100%	100%
Business Sector	Respondent	Deal	Lost	Percentage	Purchase Percentage
Power Energy	4	2	2	10.0%	7.1%
Transportation	8	8	0	20.0%	28.6%

Factory Automation	6	5	1	15.0%	17.9%
University	5	1	4	12.5%	3.6%
IT Consultant	12	12	0	30.0%	42.9%
Pharmaceutical	1	0	1	2.5%	0.0%
Other	2	0	2	5.0%	0.0%
Oil and Gas	2	0	2	5.0%	0.0%
Total	40	28	12	100%	100%

The result of the vertical market demographics was divided into four groups based on the intended use of the product, namely: end users, system integrators (implementation in projects), resellers, and others (not yet used). Out of a total of 40 potential customers of company XYZ, the majority of customers who requested a quotation for the UNO-2484 product were system integrators(52.5%). In total 28 respondents had previously bought products from company XYZ, while the rest (12 respondents) had not yet bought or used products from company XYZ. Based on the respondents who had bought products from company XYZ, the vertical market consisted of system integrators(75%), end users (17.9%), and resellers (7.1%).

2. PLS-SEM Analysis

The test was done on two models, namely a measurement model (outer model) and a structural model (inner model).

a. Outer Model

The steps taken in this test are used to determine the values of convergent validity and discriminant validity of the indicators that are latent variables. The convergent validity is determined based on the value of factor loading and average variance extracted(AVE), while the discriminant validity is determined using cross loading. Determination of the reliability value is based on the value of composite reliability and Cronbach's alpha for each indicator block. The convergent validity result can be seen in Table 3.

Table 3. Convergent Validity Test

Variable	Indicator Variable	Loading Factor	AVE	Result
Product Quality (X1)	X1.1	0.819	0.769	Valid
	X1.2	0.929		Valid
	X1.3	0.898		Valid
	X1.4	0.922		Valid
	X1.5	0.864		Valid
	X1.6	0.807		Valid
	X1.7	0.844		Valid
	X1.8	0.923		Valid
Service Quality (X2)	X2.1	0.802	0.772	Valid
	X2.2	0.950		Valid
	X2.3	0.747		Valid
	X2.4	0.922		Valid
	X2.5	0.953		Valid
Price (X3)	X3.1	0.906	0.842	Valid
	X3.2	0.954		Valid
	X3.3	0.898		Valid
	X3.4	0.912		Valid
	X3.5	0.916		Valid
Product Availability	X4.1	0.912	0.817	Valid
	X4.2	0.905		Valid

(X4)	X4.3	0.894		Valid
Buying Decision (Y)	Y.1	0.852	0.739	Valid
	Y.2	0.853		Valid
	Y.3	0.874		Valid

The test results of convergent validity on the outer model test show that all indicators had an AVE value > 0.50 and an outer loading > 0.70 . The results of the discriminant cross loading validity test can be seen in Table 4. Based on Table 4, the loading value of each indicator item on the construct was greater than the loading of the other constructs (cross loading). The results of the reliability test on the measurement model can be seen in Table 4. Based on the table, the value of Cronbach's alpha and composite reliability for each variable was above > 0.70 .

Table 4. Discriminant Validity Test (left) and Reliability Test (right)

Indicator	X3	Y	X4	X2	X1
X1.1	0.232	0.795	0.746	0.301	0.819
X1.2	0.510	0.757	0.738	0.522	0.929
X1.3	0.527	0.764	0.681	0.625	0.898
X1.4	0.456	0.780	0.785	0.602	0.922
X1.5	0.666	0.602	0.732	0.647	0.864
X1.6	0.399	0.722	0.577	0.468	0.807
X1.7	0.648	0.714	0.699	0.627	0.844
X1.8	0.649	0.659	0.721	0.619	0.923
X2.1	0.755	0.355	0.532	0.802	0.552
X2.2	0.800	0.412	0.393	0.950	0.618
X2.3	0.645	0.233	0.263	0.747	0.371
X2.4	0.742	0.428	0.392	0.922	0.546
X2.5	0.847	0.427	0.498	0.953	0.606
X3.1	0.906	0.325	0.488	0.872	0.550
X3.2	0.954	0.285	0.431	0.785	0.538
X3.3	0.898	0.330	0.291	0.786	0.536
X3.4	0.912	0.293	0.334	0.786	0.533
X3.5	0.916	0.315	0.338	0.728	0.469
X4.1	0.345	0.749	0.912	0.421	0.779
X4.2	0.275	0.738	0.905	0.386	0.700
X4.3	0.519	0.611	0.894	0.508	0.719
Y.1	0.195	0.852	0.532	0.320	0.714
Y.2	0.209	0.853	0.664	0.276	0.643
Y.3	0.450	0.874	0.800	0.504	0.783

Variable	Cronbach's Alpha	Composite Reliability	Result
X3	0.953	0.964	Reliable
Y	0.824	0.805	Reliable

b. Inner Model

The model was valid and reliable. The next stage of the test was used to evaluate the structural model. This test is done by predicting the relationship between the independent variable and the dependent variables. The first step in testing the inner model is to determine the R-square value.

The R-square test value of the dependent variable Y (Purchase Decision) was 0.748. This means that Y can be explained by 74.8% of the research model while the remaining 25.2% is explained by variables outside the research model. The f-square effect is used to assess the magnitude of the effect of the independent variable on the dependent variables of the model. The f-square effect is used to assess the magnitude of the effect of the independent variable on the dependent variables of the model.

Table 5. F-square test results

Variable Relationship	Original Sample (O)	Result
Price □ Buying Decision	0.052	Small effect
Product Availability □ Buying Decision	0.098	Small effect
Service Quality □ Buying Decision	0.003	No effect
Product Quality □ Buying Decision	0.526	Large effect

The values of f^2 , 0.02, 0.15, and 0.35 respectively, indicated that the latent predictor variable had a small, medium and large effect on the structural model of the study (Ghozali, 2011).

The value of cross-validated redundancy (Q^2) was used to determine the accuracy of the research model. A value of $Q^2 > 0$ indicates that the model has predictive relevance, while $Q^2 < 0$ indicates that the model lacks predictive relevance (Ghozali, 2011). The Q^2 values of 0.02, 0.15 and 0.35 respectively indicated a weak, moderate and high level of predictive relevance (Cohen, 1988).

Table 6. Q^2 Result.

Variable Dependent	SSO	SSE	$Q^2 (=1-SSE/SSO)$
Buying Decision	120.000	60.650	0.495

The next step in the inner model test is to evaluate the significance of the influence between the latent variables used in the study. The process for measuring the path coefficient consists of bootstrapping PLS-SEM and the two-tailed test method.

Table 7. Path Coefficient Test Results

Variable Relationship	Path Coefficient	T Statistics (O/STDEV)	P Values
Price □ Buying Decision	-0.231	0.969	0.333
Product Availability □ Buying Decision	0.271	1.352	0.177
Service Quality □ Buying Decision	0.062	0.261	0.794
Product Quality □ Buying Decision	0.707	2.594	0.010

The significance relationship between the latent variables used was based on the t- statistic value and the p-value. The standard error value used was 1.96 with an alpha value of 5%. H_0 was accepted when P value > 0.05 or H_0 was accepted when P value $<$

0.05. The next step was to test the hypothesis based on the t-statistic and p-value.

The results of hypothesis testing can be seen in Table 8.

Table 8. The research hypotheses

Variable Relationship	Path Coefficient	T Statistics	P Values	Result
Product Quality \square Buying Decision	0.707	2.594	0.010	H ₀ Rejected
Service Quality \square Buying Decision	0.062	0.261	0.794	H ₀ Accepted
Price \square Buying Decision	-0.231	0.969	0.333	H ₀ Accepted
Product Availability \square Buying Decision	0.271	1.352	0.177	H ₀ Accepted

4.2 Discussion

Based on the results of the tests that were carried out, the proposed research model showed that the dependent variable Y (Purchase Decision) could be explained by 74.8% of the model, while the remaining 25.2% was explained by variables outside of the model. The structural model generated in this study is shown in Figure 4. This shows that not all of the proposed variables had a significant and positive effect on the purchasing decisions.

Product quality had a significant and positive effect on the purchasing decisions from the proposed model show that the variables service quality, price and product availability did not affect purchasing decisions. In previous researches, service quality had a significant effect on customer satisfaction (Nariswati & Iriawan, 2012; Nasution, Maksum & Derriawan, 2018), while price had a significant and positive influence on the purchasing decision (Winoto, 2020; Hati et al., 2021). In this study, price had a negative influence. This means that price is not the main factor considered in purchasing industrial-grade IoT products. The result for product availability also contrasted with previous research, where product availability had a significant influence on the purchasing decision (Apriando, Soesanto & Indriani, 2019). In other words, in the present study a ready-stock program did not necessarily make customers want to make a purchase.

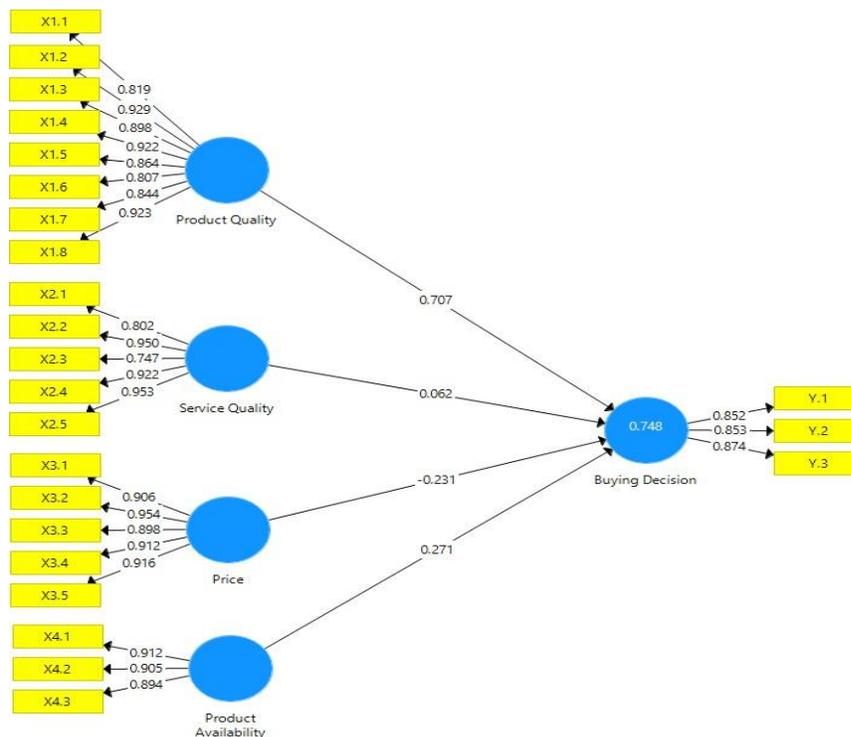


Figure 5. Structural model this research.

5. CONCLUSIONS

Based on the results of the analysis that was carried out in this study there are two conclusions that can be drawn in accordance with the initial objectives of the study, namely:

1. The PLS-SEM analysis showed that the R-square value was 74.8%. Product quality had a significant and positive effect on the purchasing decisions. The other factors used in the research (service quality, price, and product availability) did not have a significant and positive influence on the purchasing decisions.
2. Determination of an appropriate marketing strategy must be based on segmentation, targeting and positioning. Marketing aimed at end users is different from marketing aimed at system integrators or resellers. The ultimate goal of end users is to acquire product solutions according to their company's sector or customer base. The goal of system integrators is to create collaborations with other system integrators to fill each other's gaps and in so doing create added value. A reseller can provide discounts or product promotions to incentivize customers to frequently place repeat orders.

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TRAFFIC MODELING OF VEHICLES ON THE JOMBANG-MOJOKERTO TOLL ROAD USING THE MACHINE LEARNING METHOD AS A PREDICT AND ANALYSIS OF VEHICLE SPEED FACTORS

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ABSTRACT

The Jombang-Mojokerto toll road is a part of the Trans Java (Banyuwangi-Merak) toll road which is integrated with four other toll roads in Cluster 3 (Surabaya-Semarang). The existence of this toll road allows road users to drive safely, comfortably and smoothly. However, road users often still drive at speeds that exceed the limits according to government regulations regarding toll roads, which are a minimum of 60 km/hour and a maximum of 100 km/hour (outside the city), this has the potential to cause traffic accidents. This study aims to model vehicle traffic data that passes through toll roads using the Machine Learning Random Forest method which is able to model vehicle traffic data that exceeds the speed limit with good prediction accuracy results. This study takes vehicle traffic data that passes through the Jombang-Mojokerto toll road which is taken from vehicle transaction data that comes out at the Bandar Toll Gate. The research process starts from data retrieval & processing, development of a random forest classifier model, data testing and analysis of test results. The results of this study obtained a fairly good classification accuracy with an accuracy of 78% and an AUC value of 0.75, and it is known that the important/significant variables in the order of the top four values of the highest Gini importance are toll entry hours, toll exit hours, origin gates, and vehicle class. Thus the results of this study can be a decision aid for toll road operators and other interested parties in carrying out preventive and curative action strategies for road users who drive beyond the limits of the Jombang-Mojokerto toll road rules on the basis of known important variables.

Keywords: Machine Learning, Random Forest, Toll Road, Vehicle Speed

1. INTRODUCTION

The Jombang-Mojokerto toll road is a part of the Trans Java (Banyuwangi-Merak) toll road with a length of 40.5 KM. The toll road that connects Jombang Regency to Mojokerto Regency stretches from Kayen Village, Bandar Kedungmulyo District, Jombang Regency to Cangg Village, Jetis District, Mojokerto Regency.

The Jombang-Mojokerto Toll Road is integrated with four toll roads, namely Surabaya - Mojokerto Toll Road, Ngawi - Kertosono Toll Road, Solo - Ngawi Toll Road, and Solo-Semarang Toll Road which are all incorporated in the Trans Java Cluster 3 (Surabaya-Semarang) Toll Road. The Jombang-Mojokerto Toll Road has three toll gates, namely the West Mojokerto Toll Gate, the Jombang Toll Gate, and the Bandar Toll Gate.



Figure 1. Trans Java Toll Map

(image source: <http://gis.bpjt.pu.go.id/> accessed 03 Nov 2020 13:20 WIB)

On December 21, 2018, the Trans Java Toll Road (including Cluster 3) began operating and was fully integrated. This has an impact on the growth in the number of vehicular traffic which is also directly proportional to the increase in the number of traffic accidents. In 2019 there was an increase in the number of accidents by 95% from the previous year (before the integration of cluster 3) on the Jombang-Mojokerto Toll Road (viva.co.id, 2019). Speeds that exceed the limit are the most common cause of accidents (Raharjo, 2018, p. 99). From these conditions, what has been done by the Jombang-Mojokerto Toll Road include alerting patrol personnel, preparing tow trucks, ambulances, rescue cars, and adding signs (viva.co.id, 2019). The Jombang-Mojokerto Toll Road also carries out preventive activities by holding safety campaigns for both internal employees (Jombang-Mojokerto, You Tube ASTRA ASTRA Jombang-Mojokerto Toll Road, 2020) and externally (road users) on banners, and social media activities or knowledge sharing in collaboration with external parties (Jombang-Mojokerto, Instagram ASTRA Jombang-Mojokerto Toll Road, 2020). As well as for the curative activities of the Jombang-Mojokerto Toll Road, his party has collaborated with the Directorate of Traffic (Ditlantas) of the East Java Police with the Traffic Unit (Satlantas) of the Jombang Police to install a Speed Gun and enforce a ticket at the toll gate exiting the Bandar Toll Gate (beritajatim.com, 2018), although the schedule is tentative according to the direction of the police. The Jombang-Mojokerto Toll Road also provides driving safety notifications on vehicle transaction receipts that pass the normal transaction time limit (kompas.tv, 2020).

Activities that have been carried out by the Jombang-Mojokerto Toll Road in a preventive context to reduce road users crossing the line can still be improved with more accurate analysis through existing data. This needs to be done because road users can still drive at speeds that exceed the limit according to government regulations regarding toll roads, namely a minimum of 60 km/hour and a maximum of 100 km/hour (outside the city) which has the potential for traffic accidents. It is necessary to model the traffic data of vehicles passing through the toll road at speeds exceeding the normal limit to find out the variables that are important/significant so that they can be analyzed into further decisions.

There are thirty related studies (See Appendix A) that have been carried out regarding vehicle traffic data modeling, five of which are using the Deep Learning Model which develops a traffic prediction model to identify traffic conditions so that cars can decide routes (Miglani & Kumar, 2019), using Regression (ML), K-Nearest Neighbor (KNN), Artificial

Neural Networks (ANN), Support Vector Machines (SVM), Decision Trees (DT), Random Forest (RF) to predict the accident rate at the Toll Gate (Xing, et al., 2020), using Long-Short-Time Memory (LSTM) for traffic prediction and Naive Bayes for vehicle number plate & color detection (Yao & Ye, 2020), using Singular Spectrum Analysis (SSA) with Artificial Neural Networks (ANN) to predict traffic volumes that have been attempted at Greek stations (Kolidakis, Botzoris, Profillidis, & Lemonakis, 2019), using Artificial Neural Networks (ANN) to simulate traffic density to divide routes to reduce congestion and pollution (Zhang & Kamel, 2018).

This study tries a new approach to modeling vehicle traffic data on toll roads using the Machine Learning Random Forest method which is able to model vehicle traffic data that exceeds the speed limit with good prediction accuracy results. This study takes vehicle traffic data that passes through the Jombang-Mojokerto toll road which is taken from vehicle transaction data that comes out at the Bandar Toll Gate. The research process starts from data retrieval & processing, development of a random forest classifier model, data testing and analysis of test results. The result of this study is the existence of important/significant variables that are known from the vehicle traffic model that goes beyond the normal limit so that it can be analyzed into further decisions. Thus, the results of this study can be used as a decision aid in carrying out preventive and curative action strategies for road users who drive beyond the limits of the Jombang- Mojokerto toll road.

2. LITERATURE REVIEW

2.1 Toll Road

The Trans-Java Toll Road is a toll road network that connects cities on the island of Java, Indonesia. The Trans-Java Toll Road stretches between Merak Port, Cilegon, in Banten Province to Ketapang Port, Banyuwangi, in East Java Province. This toll road network connects the two largest cities in Indonesia, Jakarta and Surabaya via toll roads. The toll network that stretches for

±1,000 km is included in the Asian Highway 2 (AH2) or the Asian Road Network that connects the Asian continent from Denpasar, Bali, Indonesia to Khosravi, Iran (Wikipedia, n.d.)

Toll roads are also regulated by binding regulations such as the rules regarding speedlimits as set out in Government Regulation No. 70 of 2013 concerning road traffic and transportation networks article 23 paragraph 4, as well as the Regulation of the Minister of Transportation concerning procedures for setting vehicle limits in article 3 paragraph 4 , among others, the speed of the toll road is a minimum of 60 (sixty) kilometers per hour and a maximum of 100 (one hundred) kilometers per hour.

2.2 Machine Learning Random Forest

The random forest algorithm According to Breiman (2001) is one of the supervised learning methods from Machine Learning. This method is a development of the classification and regression tree method and applies the Bagging (Bootstrap Aggregating) and random feature selection methods (Irhamna, 2019). Basically the random forest algorithm is a set of decision trees whose results will be averaged into a prediction result. In terms of doing classification, the final result of a classification that is formed from several trees is then selected based on Majority- Voting. This method is also useful in knowing important/significant variables (Liaw & Wiener, 2020). Some comparisons of the performance of the Random Forest method can be shown in the following table:

Table 1. Machine Learning Method Performance Comparison

Article Identity	Method	Results
<i>Comparison of different models for evaluating vehicle collision risks at upstream diverging area of toll plaza</i> (Xing, et al., 2020, p. 8).	Regression (ML), K-Nearest Neighbor (KNN), Artificial Neural Networks (ANN), Support Vector Machines (SVM), Decision Trees (DT), Random Forest (RF)	The performance of random forest accuracysis better.
<i>Application of Machine Learning to characterize uneconomical managed lane choice behaviour</i> (Sharifi & Burris,2019, pp. 787-788).	Random Forest and Logistic Regression	The performance of random forest accuracysis better.
<i>Annual average daily traffic estimation in England and Wales: An application of clustering and regression modelling.</i> (Sfyridis & Agnolucci, 2020, p. 1)	Linear Regression, Support Vector Regression (SVR) and Random Forest(RF)	The performance of random forest accuracysis better.

3. METHOD

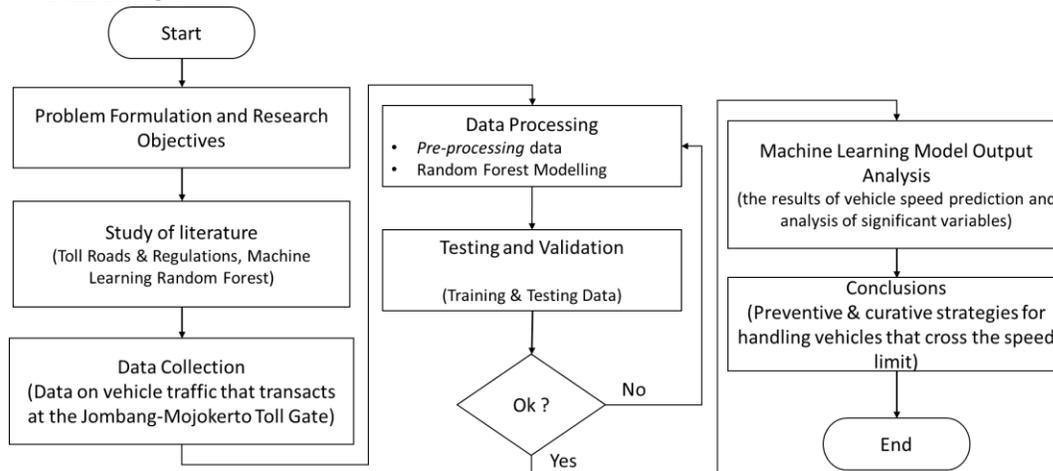


Figure 2. Research Method

The data taken from this study is secondary data from vehicle toll transaction data that exits/transactions at the Bandar Toll Gate, Jombang-Mojokerto Toll Road. The data used is transaction data in November and December 2020 with a total of 254.741. At the pre-processing stage, the data is carried out to handle missing values in the data, so that the raw data becomes data that is ready to be processed for further processing.

The next step is to determine the feature (X) and label (Y). Feature is an independent variable that acts as an input predictor in the system. The label variable is the final result. The features used in the model for prediction needs are selected by means of feature selection. Feature selection is carried out with the aim of knowing whether there is multicollinearity between the independent variables. The method used in selecting predictor variables (Feature Selection) is using Backward Selection. The variables used to form the vehicle speed classification model areas follows:

Table 2. Research Variable

No	Var.	V	Description	Data Scale
1		Y	Vehicle Speed	1=Non overspeed (≤ 100 km/hour), 2=Overspeed (>100 km/hour)
2	1	X	Vehicle Class	1=Class 1, 2=Class 2, 3=Class 3, 4=Class 4, 5=Class 5.
3	2	X	Origin Section	1= Surabaya-Mojokerto Toll Road, 2=Jombang-Mojokerto Toll Road, 3=Ngawi-kertosono Toll Road, 4=Solo-Ngawi Toll Road, 5=Semarang-Solo Toll Road
4	3	X	Origin Gate	1=Warugunung, 2=Driyorejo 4, 3=Krian, 4=Penompo, 5=Mojokerto Barat, 6=Jombang, 7=Bandar, 8=Nganjuk, 9=Caruban, 10=Madiun, 11=Ngawi, 12=Sragen, 13=Karanganyar, 14=Gondang Rejo, 15=Ngemplak, 16=Colomadu, 17=Boyolali, 18=Salatiga, 19=Bawen, 20=Ungaran, 21=Banyumanik
5	4	X	Type of payment	1=Epayment Mandiri, 2=Epayment BCA, 3=Epayment BRI, 4=Epayment BNI
6	5	X	Balance	1=Balance < 50 rb, 2=Balance $> =50$ rb
7	6	X	Day	1=Weekday, 2=Weekend/National Holiday
8	7	X	Toll EntryHours	1=Morning (00.01 - 10.00), 2=Noon (10.01 - 14.00), 3=Afternoon (14.01 - 18.00), 4=Night (18.01 - 00.00)
9	8	X	Toll ExitHours	

After the pre-processing stage and the determination of feature (X) and label (Y) is done. Then the traffic data modeling is carried out using the Random Forest algorithm with the following steps:

a. Apply the random forest algorithm to the research data. The classification used in this study has two classes, namely 1=Non overspeed (≤ 100 km/hour) and 2=Overspeed (>100 km/hour) with the number of proportions used is 75% for training data, 25% for testing data. The proportion of splitting dataset training and dataset testing is based on Reitermanova (2010) and Esfandyari (2016).

b. Establish a confusion matrix and calculate the performance of the classification method based on the accuracy and AUC (Area Under Curve) values.

c. Determine significant variables based on Gini importance.

d. Evaluation of modeling results and variables obtained from the random forest classification.

4. RESULTS

In this study, random forest modeling was carried out using the Python programming language with the class `sklearn.ensemble.RandomForestClassifier()`. Furthermore, from the model, the confusion matrix performance measurement is carried out with the `sklearn.metrics.confusion_matrix()` class, the results of which can be seen in Figure 3.

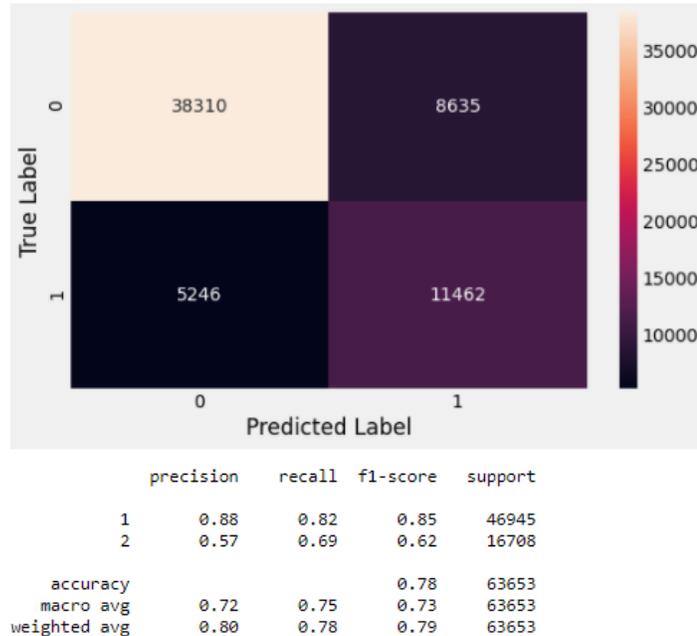


Figure 3. Confusion Matrix Results

Based on Figure 3, it can be seen that there are 11,462 True Positives (TP) data, 8,635 False Positives (FP) data, 38,310 True Negatives (TN) data, 5,246 False Negatives (FN) data. The accuracy data for this model is 0,78 or 78% which is a fairly good classification model accuracy. From Figure 3 can also be obtained the value of True Positive Rate (TPR), False Negative Rate (FPR), and Area Under Curve (AUC) which are formulated as follows:

$$TPR = \frac{TP}{TP+FN} = \frac{11462}{11462+5246} = 0,686019$$

$$FPR = 1 - \frac{TN}{TN+FP} = 1 - \frac{38310}{38310+8635} = 0,183939$$

$$AUC = \frac{1+TPR-FPR}{2} = \frac{1+0,686019-0,183939}{2} = 0,75104$$

Based on the calculation formula above, it can be seen that the trend of the true positive value increases closer to the value of one with an AUC value of 0.75, which means that this classification model is a Fair Classification (Jain, 2019).

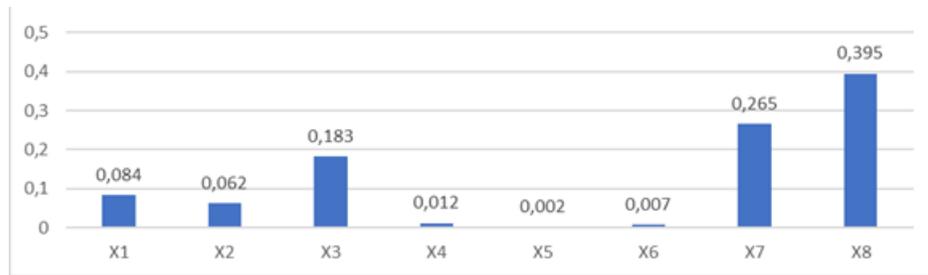


Figure 4. Variable Importances Graph

From Figure 4 it can be seen that the variable that has the highest significance is the variable X8 (Toll Exit Hours) of 0.395, followed by the X7 variable (Toll Entry Hours) of 0.265, the X3 variable (Original Gate) of 0.183, the X1 variable (Vehicle Class) of 0.084, variable X2 (Original Section) of 0.062, variable X4 (Type of Payment) of 0.012, variable X6 (Days) of 0.007, variable X5 (Balance) of 0.002.

The number of Non-Overspeed vehicles is 187.899 (74%) while the overspeed vehicles are 66.710 (26%). Of the eight variables above that have the same characteristics when the conditions are Overspeed and Non-Overspeed are Vehicle Class, Payment Type, Day, and Transaction Balance. This indicates that whatever driving conditions road users still follow the traffic pattern of the Jombang-Mojokerto toll road in general. Meanwhile, the variables that have different characteristics during Overspeed and Non-Overspeed conditions are Toll Exit Hours, Toll Entry Hours, Origin Gates, and Origin Sections.

At Toll Exit Hours, the majority of vehicles are in overspeed conditions during the day (42%) and in the morning (36%), while the majority of non-overspeed vehicles are at night (31%) and afternoon (27%). In the Toll Entry Hours variable when the vehicle is in overspeed condition, the majority are in the morning (43%) and afternoon (37%), while when the vehicle is in non-overspeed condition, the majority are in the morning (28%), afternoon (27.3%) and night. (26, 87%) and Afternoon (27%). This indicates that the majority of overspeed vehicles are carried out when the surrounding conditions look bright or bright.

The Origin Gate Variable will always follow the Origin Segment Variable, because in one patented segment consists of several gates. The majority of origin roads are dominated by the Surabaya-Mojokerto toll road with an overspeed percentage of 75.9% and non-overspeed 67% with the highest origin gate being the Warugunung Gate.

In the Vehicle Class Variables, the majority are dominated by class 1 vehicles with a percentage of 98% overspeed and 89% non-overspeed. This indicates that vehicles that frequently perform Overspeed speeds follow the percentage of Non-Overspeed vehicles, which are mostly carried out by people transporting vehicles (group 1) compared to goods transporting vehicles (groups 2-5).

5. CONCLUSIONS

The conclusions obtained from the results of the analysis and discussion that have been carried out are as follows:

1. All variables ranging from Vehicle Class, Origin, Gate of Origin, Payment Type, Balance, Day, Toll Entry Hours and Toll Exit Hours are proven to have an influence in determining the vehicle speed process on the Jombang-Mojokerto toll road. There are five important variables that have a high influence with the largest Gini Importance value, namely Toll Exit Hours (0.4), Toll Entry Hours (0.3), Origin Gate (0.2), Vehicle Class (0.08), and

Section Origin (0.06).

2. The Random Forest classification model generated in predicting vehicle speed on the Jombang-Mojokerto toll road is quite good (fair classification) with an accuracy of 78% and an AUC value of 75%.

3. Operators of the Jombang-Mojokerto Toll Road or other interested parties can take preventive and curative actions in reducing vehicles that exceed the limit by focusing on five important variables that have been selected based on the Gini Importance value, such as the Variable Hours of Entry and Exit Toll focused on morning and afternoon conditions, on the Origin Gate Variable focused on the Warugunung, Penompo, Krian, Jombang, and Madiun gates, on the Vehicle Class Variable focused on people transporting vehicles (class 1), on the Origin segment variable focused on the Surabaya-Mojokerto Toll Road and Jombang-Mojokerto Toll Road.

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Appendix A: Related Research

o	Researcher	Research Topic
	Boukerche & Wang (2020)	<i>Machine Learning</i> -based traffic prediction models for Intelligent.
	Miglani & Kumar (2019)	Deep learning models for traffic flow prediction in autonomous vehicles <u>Areview, solutions, and challenges.</u>
	Xing, et al. (2020)	Comparison of different models for evaluating vehicle collision risks at upstream diverging area of toll plaza.
	Yao & Ye (2020)	The effect of image recognition traffic prediction method under deeplearning and naive Bayes algorithm on freeway trafficsafety.
	Bagloee, Johansson, & Asadi(2019)	A hybrid machine-learning and optimization method for contraflow designin post-disaster cases and traffic management scenarios.
	Kolidakis, Botzoris, Profillidis, &Lemonakis (2019)	Road traffic forecasting—A hybrid approach combining Artificial NeuralNetwork with Singular Spectrum Analysis.
	Sharifi & Burris (2019)	Application of <i>Machine Learning</i> to characterize uneconomical managedlane choice behaviour.
	Ding, Zhang, & Zhao (2017)	A collaborative calculation on real-time stream in smart cities.
	Zhang & Kamel (2018)	Virtual traffic simulation with neural network learned mobility model.
0	Abdollahi, Khaleghi, & Yang(2020)	An integrated feature learning approach using deep learning for travel timeprediction.
1	Sfyridis & Agnolucci (2020)	Annual average daily traffic estimation in England and Wales: Anapplication of clustering and regression modelling.

2	Zhan, Li, & Ukkusuri (2020)	Link-based traffic state estimation and prediction for arterial networks using license-plate recognition data.
3	Venkadavarahan, Raj, & Marisamynathan (2020)	Development of freight travel demand model with characteristics of vehicle tour activities.
4	Yang, et al. (2020)	Optimization of real-time traffic network assignment based on IoT data using DBN and clustering model in smart city.
5	Javed, Zeadally, & Hamida (2019)	Data analytics for Cooperative Intelligent Transport Systems.
6	Nagy & Simon (2018)	Survey on traffic prediction in smart cities.
7	Saharan, Bawa, & Kumar (2020)	Dynamic pricing techniques for Intelligent Transportation System in smart cities: A systematic review.
8	Lin, et al (2018)	Quantifying uncertainty in short-term traffic prediction and its application to optimal staffing plan development.
9	Filho, et al (2020)	Enhancing intelligence in traffic management systems to aid in vehicle traffic congestion problems in smart cities.
0	Zou, et al (2016)	An agent-based choice model for travel mode and departure time and its case study in Beijing.
1	Raharjo (2018)	Analysis of Traffic Accidents on Frontage Road East Side of Jalan Ahmad Yani, Surabaya City
2	Damayanti (2018)	Factors Affecting Types of Traffic Violations in Tulungagung Regency in 2017
3	Esesiawati (2017)	Forecasting Short-Term Traffic Flow Using the K-Nearest Neighbor Method (Case Study: Jalan Basuki Rahmat Surabaya)
4	Dewi P. L. (2016)	Modeling of Factors Causing Traffic Accidents Based on Geographically Weighted Regression Method in East Java.
5	Ramadhan (2018)	Vehicle Speed Violation Monitoring Using Two Camera Sensors.
6	Dewi N. C. (2018)	Factors Affecting Traffic Accident Rates in East Java Province Using Spline Truncated Nonparametric Regression.
7	Zulvan (2016)	Analysis of Traffic Accidents on the Lawang – Singosari Highway
8	Metekohy (2017)	Analysis of Traffic Accident Characteristics (Case Study: Ambon City).
9	Andiasti (2018)	Impact of Heavy Traffic with Overload on the Planned Life of the Madura Side Suramadu Toll Road Access.
0	Arini (2017)	Route Selection Model Between Toll Road And Ngawi-Kertosono National Road Using Diversion Curve Method.

ANALYSIS OF BRAND AWARENESS AND SENTIMENT ANALYSIS ON LAPTOP PRODUCTS IN INDONESIA USING TWITTER

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ABSTRACT

Social media is currently a very popular communication medium among the people of Indonesia. One of the most popular social media today is Twitter. Twitter social media displays very diverse information from the public. Data from this information can be processed into sentiment analysis. This study aims to make a sentiment analysis of the community in the form of positive, neutral, and negative sentiments. The input data is tweet data from consumers of ASUS, ACER, and Apple laptop products and the results will show a visualization of positive, neutral, and negative sentiment data. Sentiment analysis used in this research is fine-grained sentiment analysis with lexicon-based method. The lexicon used is InSet (Indonesia Sentiment Lexicon) which was built by Fajri Koto and Gemala Y. Rahmaningtyas. The results of this study can be used by brands to monitor their brand awareness in the eyes of the public and help determine policies to be taken in the future.

Keywords: social media, brand awareness, sentiment analysis, etc.

1. INTRODUCTION

Currently, social media has become more popular among young and senior citizens. Social media users often show their expression by writing their complaints to many objects. In 2014, Indonesia had 20 million active users of Twitter. This number highlights the importance of social media channel for sales campaign of many products and services. Nowadays, social media marketing becoming one of the key strategic brand activities in the world. Good responses from people could awake the desire for a product, create brand awareness, encourage a positive attitude toward the product (brand reputation) and affect intentions for buying the products. Driven by this phenomenon, many companies tried to acquire more customers with social media marketing.

Although it has been widely used, the analysis of promotions through Twitter is only limited to calculating the number of retweets, comments, and followers. The analysis has not seen whether the meaning of comments is positive or negative for brand products. Things like this will affect people's buying decisions if the comments given are negative, and on the contrary positive comments will improve the company's image in the eyes of stakeholders. This is also supported by the need to know the positive and negative responses from customer comments. Determining the opinion of this twitter must be explored with various in-depth research methods. The method offered to clarify public opinion on social media is sentiment

analysis. This paper researches sentiment-based brand awareness analysis of three well-known laptop brands in Indonesia. The companies chosen for this particular study are ACER, Apple, and ASUS.

In this study, the author uses InSet (Indonesian Sentiment), an Indonesian sentiment lexicon built by Fajri Koto and Gemal Y. Rahmaningtyas to identify written opinions and categorize them into positive or negative opinions, which can be used to analyze public sentiment on topics, events, or certain products. Compiled using a collection of words from Indonesian tweets, InSet is built by manually weighting each word and enhanced by adding stemming and synonym sets. The result, obtained 3,609 positive words and 6,609 negative words with a score range of -5 and +5. Koto & Rahmaningtyas (2018) explained that this method outperformed other Indonesian lexicon used as the basis for lexicon-based sentiment analysis research.

2. LITERATURE REVIEW

2.1 Brand Awareness

David Aaker (1991) wrote that brand awareness is the ability of potential buyers to recognize that a brand is part of a certain product category. Terence Shimp (2003) explained that brand awareness is a basic dimension in brand equity. Brand equity is the value that the brand brings to the company. Brand equity refers to the emotions and experiences that arise in consumers' minds when viewing a brand. A strong relationship between brands and consumers will create high brand equity as well. There are 4 dimensions of brand equity, namely brand awareness, perceived quality, brand association, and brand loyalty. There are 4 categories of brand awareness, namely unaware of brand, brand recognition, brand recall, and top of mind. The main purpose of increasing brand awareness can be divided into 4, namely increasing brand presence, attracting new customers, increasing selling value, and as a form of trust.

2.2 Data Crawling

Bing Liu (2011) explained that data crawling is the process of quickly taking large numbers of web pages into a local repository and indexing them based on a number of keywords. Web crawling is a data collection technique used to index information on a page using a URL (Uniform Resource Locator) by including an API (Application Programming Interface) for mining larger datasets. The data that you can collect can be in the form of text, audio, video, and images. You can start by mining data on an open-source API like the one provided by Twitter. To crawl data on Twitter you can use the scrapy or tweepy libraries in python.

2.3 Data Mining

According to Hand, Mannila, & Smyth (2001) data mining is the analysis of a large dataset to find unexpected relationships and to infer data in various ways. Data mining also can be defined as the process of finding patterns in data. The pattern found must be meaningful and the pattern provides benefits, usually economic benefits.

2.4 Sentiment Analysis

Sentiment analysis is a depiction of polarity in a text or word according to Esuli & Sebastiani (2006). Meanwhile, Kumar & Sebastian (2012) explain the definition of sentiment analysis as a computational study related to opinion and oriented to natural language processing. Sentiment analysis has 2 approaches, namely learning-based and lexicon-based. The

learning- based approach (using machine learning) uses a dataset that has been previously classified manually as training data to generate an opinion text classification automatically. While the lexicon-based approach relies on the lexicon for classification determination. The lexicon contains a number of words that are used to identify the type of opinion in a sentence.

3. METHODS

This research was conducted in several stages. At the data collection stage, the data are in the form of sentences obtained from Indonesian-language tweets regarding the results of public perceptions. After the data is collected then preprocessing is carried out so that the data can be processed using sentiment analysis. Data retrieval from Twitter will use the API (Application programming interface) provided by Twitter to get the desired tweet data. The data is taken from the accounts of Indonesian twitter users who use predefined keywords. The author will also take the last 10 tweets from official ASUS, ACER, and Apple accounts including the number of replies, retweets, and likes of those tweets. The data pre-processing stage can be divided into 4 stages, namely as follows.

- a. Case Folding, which is the stage to uniform the writing format by removing capitals and entering only Latin letters.
- b. Cleaning, which is the process of removing noise from each tweet. The things that are cleaned up in this process are duplication, URLs, twitter usernames, and unnecessary punctuation like %, /, +, ".
- c. Tokenization, is the process of cutting or separating strings from sentences formed in tweets into word tokens.
- d. Stopword removal, is the process of removing stopwords using a stoplist.

After all the steps are carried out, a tweet collection file is generated and ready to be analyzed using several methods that have been determined.

After the data is processed, the next step is text weighting with InSet (Indonesia Sentiment Lexicon) by Fajri Koto and Gemala Y. Rahmanningtyas. The total weighting of the sentence will determine the value of the sentence sentiment which then classifies it into negative or positive sentiment.

The analysis and conclusions will be presented in 3 points. The first conclusion will discuss the results of sentiment analysis using InSet which will provide the percentage of positive, neutral, and negative sentiments for the three products. The second conclusion will discuss the level of brand awareness of the three products. The number of customer interactions with the official accounts of the three products will be the basis for seeing the brand awareness of the three products. The customer interactions in question include the number of replies, retweets, and likes from the last 10 tweets of official accounts regarding laptop products from their respective brands. The third conclusion will discuss the strengths and weaknesses of the brand in the eyes of the public. The advantage will be obtained from the most keywords in positive sentiment, while the weakness will be obtained from the most keywords in negative sentiment.

4. RESULTS

4.1 Sentiment Analysis

After 100 data from each brand were acquired, processed, and given a sentiment value, the author was able to see the general opinion of the Indonesian people towards the following

brands.

ACER received a good response from the Indonesian people with 41 positive sentiments, 41 neutral responses, and 17 negative responses. Positive opinions about ACER are usually related to 3 main factors, namely the attractive design of ACER laptops, service support that supports customers and is easy to find, and prices that can be considered affordable for various groups of people. Negative opinions directed at ACER laptop products usually allude to the quality of the hardware/casing which is vulnerable and easily broken. Public opinion about the durability of Acer laptops seems predictable, namely that they are fragile and prone to damage. This assumption is not without reason. Compared to other brands, Acer laptops are known to be more easily damaged. However, this kind of problem is actually getting rare. Acer's good support services are also considered to be able to compensate for this weakness.

The results of the sentiment analysis of Apple products are quite different from ACER with 34 positive sentiments, 27 negative sentiments, and 38 neutral sentiments. Although still fairly good with more positive sentiment than negative, neutral sentiment is the most prominent sentiment on Apple products. Indonesian people take a more neutral side on this one product. Positive opinion on Apple is generally related to the prestige value and luxurious design it offers. High durability is also the focus of society when discussing Apple laptops. Meanwhile, the negative sentiment towards Apple mostly discussed the price of the product, both the purchase price and spare parts/service.

The general public's response to ASUS products is also dominated by positive sentiments, namely 44, followed by 37 neutral sentiments, and 19 negative sentiments. Positive opinions on ASUS laptop products discuss several factors, namely good durability when playing games, relatively affordable prices, and a long-lasting warranty. Meanwhile, negative opinions about ASUS laptop products regarding the service facilities offered are inadequate.

With the data above, we will add some social media metrics to the data. Social media metrics are important because they prove that a company can measure how successful a campaign is, how well your social strategy is performing, and ultimately whether you will have an impact on your business as a whole. Having these metrics not only gives you the opportunity to show executives the impact of a company's work, but providing consistent reports on social media metrics can lead to major changes for a company's social team, including increased budgets and increased access to resources. And last but not least, metrics keep companies informed of general social profiles and brand health. This study will discuss 2 social media metrics, namely Net Brand Reputation and Brand Favorable Talkability.

The first metric to be displayed is Net Brand Reputation. Net Brand Reputation (NBR) is the net value of brand reputation on a number of social media. This value is approximately equal to the Net Promoter Score (NPS). Calculation of Net Brand Reputation (NBR) is as follows: NBR

$$= \% \text{ total positive mentions} - \% \text{ Total negative mentions}$$

The calculation of Net Brand Reputation (NBR) aims to simplify the method of measuring consumer loyalty to a brand. With this index, we can focus on increasing positive mentions (called "promoters") and reducing negative mentions (called "detractors").

Brand	Negatif	Netral	Positif	Net Brand Reputation
ACER	17%	41%	41%	24%
Apple	27%	38%	34%	7%
Asus	19%	37%	44%	25%

Table 1 NBR Metric

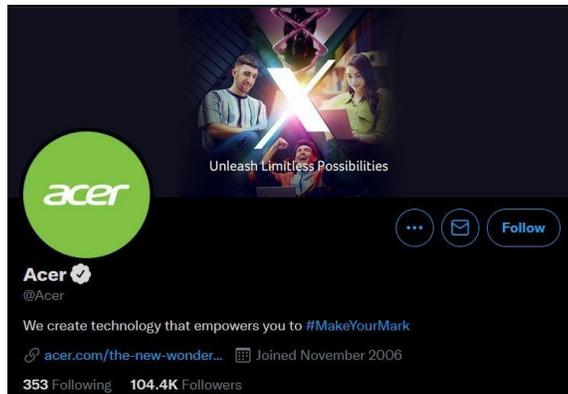
The second metric that will be displayed is Brand Favorable Talkability (BFT). Brand Favorable Talkability is a measurement of a brand's conversations that are considered positive, neutral and negative. The difference between Brand Talkable Favorability (BTF) and Net Brand Reputation (NBR) is that neutral sentiment is considered a good mention, as it involves talking about the brand. The Brand Talkable Favorability (BTF) formula is as follows: $BTF = (\% \text{ total positive mentions} + \% \text{ total neutral mentions}) - \% \text{ total negative mentions}$.

Brand	Negatif	Netral	Positif	Brand Talkability Favourability
ACER	17%	41%	41%	65%
Apple	27%	38%	34%	45%
Asus	19%	37%	44%	62%

Table 2 BFT Metric

4.2 Brand Awareness Analysis

Brand awareness analysis is also conducted by observing the official twitter accounts of the 3 brands. These are the results of that observation.

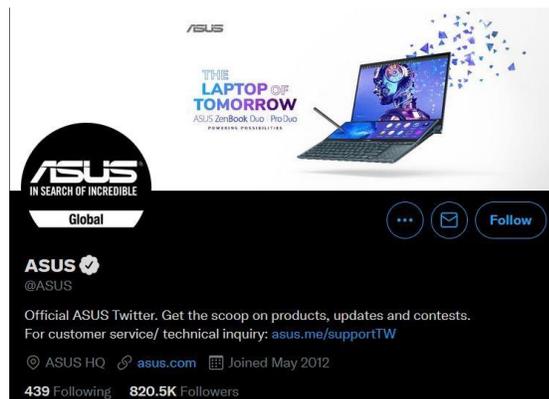


Picture 1 ACER official twitter account

ACER's official account has 104,000 followers. This number can be considered small considering that ACER is one of the largest technology companies in the world. With 14.1 averagelikes and only 12 retweets in the last 10 tweets, it can be concluded that ACER's brand awareness on Twitter social media, especially Indonesia, is not too big.



Picture 2 ASUS ROG official twitter account



Picture 3 ASUS official twitter account

ASUS official twitter account has 820 thousand followers. This number is quite large considering that ASUS has a ROG account (@ASUS_ROG), a branch of ASUS that focuses on gaming laptops. The ROG account has even more followers than the main ASUS account with 911K followers. The main ASUS account had an average of 49.8 likes and 54 retweets in their last 10 tweets while the ROG account had an average of 354.7 likes and 244 retweets in their last 10 tweets. This number is much higher than the amount found in ACER. This data confirms the level of ASUS brand awareness which is quite good in Indonesia.



Picture 4 Apple official twitter account

Apple's official Twitter account has 6.4 million followers and 0 tweet. However, Apple also has the largest growth between the 3 brands with +3,933 average followers per day. This is because Apple goes for the paid promotional strategy (during the launch event) on Twitter instead of tweeting perpetually on the platform. To stay on to the minds of people who are your potential customers, grabbing their attention is the key for sure but doing that on/for a particular time-slot is more important but due to the volatile nature of the Twitter platform where attention spans are very short — It becomes more difficult to achieve the goal. This marketing strategy makes Apple the one of if not the most recognized laptop brand in the world right now. The data above also confirms the fact that Apple's brand awareness outperforms all other global technology companies. Their ability to keep their branding simple, aesthetically pleasing as well as marketing in an engaging and informative manner greatly contributes to their branding success. Brand awareness is a very important component of brand strength. Effective branding leads to recognition and prominence. This means that your product logo and marketing efforts must provide the knowledge and level of enthusiasm that makes people excited to try the products on offer. Unfortunately, until now Apple still hides all the tweets they have issued so that data collection on likes and retweets cannot be obtained.

5. CONCLUSIONS

The results of the sentiment analysis of the three brands conclude that the three products are seen well on Indonesian Twitter social media where the positive sentiment of the three brands is greater than the negative sentiment with ACER brand specifications with 41 to 17, Apple brands at 34 to 27, and ASUS brands at 44 to 19.

Apple has the highest level of brand awareness according to twitter data with 6.4 million followers, followed by the ASUS brand with 820 thousand followers having an average of 49.8 likes and 54 retweets in their last 10 tweets, and finally the ACER brand with 104 thousand followers, 14, 1 average number of likes and only 12 retweets in their last 10 tweets.

Positive opinions about ACER are usually related to 3 main factors, namely the attractive design of ACER laptops, service support that supports customers and is easy to find, and prices that can be considered affordable for various groups of people. Negative opinions directed at ACER laptop products usually allude to the quality of the hardware/casing which is vulnerable and easily broken. Positive opinion on Apple generally discusses Apple's advantages, namely the prestige value and luxurious design it offers. High durability is also the focus of society when discussing Apple laptops. Meanwhile, negative sentiment towards Apple alludes to Apple's weakness, namely product prices, both purchase prices and spare parts/services. Positive opinions on ASUS laptop products discuss the advantages of ASUS, namely good durability when playing games, relatively affordable prices, and a long-lasting warranty. While the negative opinion of ASUS laptop products concerns the weakness of ASUS, namely the service facilities offered are inadequate. The Net Brand Reputation metric shows that ASUS products have the best reputation sentiment with a score of 25%, followed by ACER with 24%, and Apple with 7%. The Brand Talkable Favorability (BTF) metric concludes that ACER has the best reputation with 65% BTF rating, followed by Asus with 62%, and Apple with 45%.

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BRAND REPUTATION ANALYSIS BASED ON TWITTER SENTIMENT ANALYSIS CASE STUDY INDIHOME

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ABSTRACT

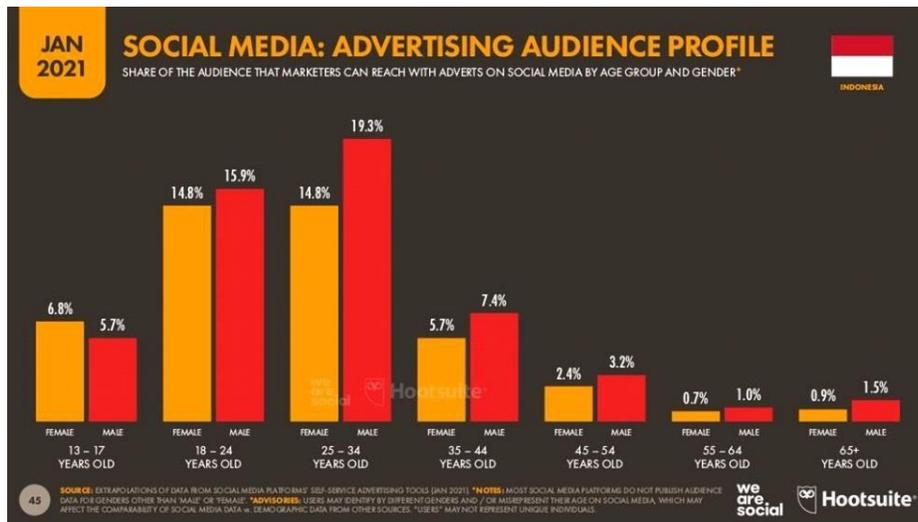
Currently, most people use social media as a medium to express opinions and most of them use Twitter. on twitter we can get a lot of information on public sentiment regarding an item or service. This study aims to make an analysis of public sentiment in the form of positive, neutral, and negative sentiments. The input data is in the form of consumer tweet data for some internet service provider (ISP) and the results will display a visualization of positive, neutral, and negative sentiment data. Sentiment analysis used in this study is a fine-grained sentiment analysis with a lexicon-based method. The lexicon used is InSet (Indonesia Sentiment Lexicon) which was built by Fajri Koto and Gemala Y. Rahmaningtyas. The results of this study can be used by brands to monitor their brand reputation in the public eye and help determine policies that will be taken in the future.

Keywords: social media, brand reputation, sentiment analysis, lexicon.

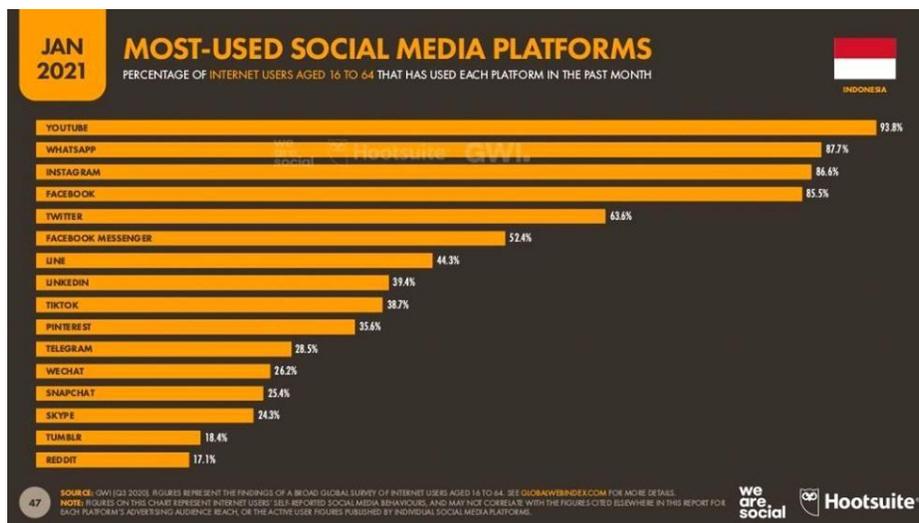
1. INTRODUCTION

Along with the growth of internet users in Indonesia, the number of active users of social media (social media) was also increased, which has now reached 170 million users. The latest report We Are social, a British company working with Hootsuite as of January 2021, active users of social media increase of 6.3% or the equivalent of 10 million users compared in January 2020. When viewed from the number of the population of INDONESIA is around 274,9 million, then the 61.8% of them are active on social media. In the meantime, be aware of internet users of Indonesia reached 202,6 million. Interestingly, of the 170 million active user of social media in Indonesia, 168,5 million access it through mobile devices, such as smartphones. Another fact is, We Are Social and Hootsuite mention the average social media users in Indonesia can spend the time until 3 hours 14 minutes per day. In terms of the age of social media users, this report shows that residents with an age range of 25-34 years dominate. After that age group of 18-24 years.

Referring to the rampant use of social media, Social media marketing is becoming one of the key strategic branding activities in the world. This is evidenced by the majority 94% of the companies in the world use social media for marketing purposes. In addition, there is research that shows that since 2011, social media has provided a change for their business, one of them in improving the return on investment for their company.



Picture 1 Advertising Audience Profile



Picture 2 Most-Used Social Media Platforms

Sentiment analysis is defined as the task of researching opinions about a particular entity. The decision-making process from the person influenced by the opinions formed by the user. When someone wants to buy a product online, they will usually start by looking for reviews and opinions written by other people on a wide variety of bids. The system automatically determines the angle of view will allow the user to understand most of the opinions expressed on the internet, ranging from product reviews to the position on the political case.

In this digital era, people tend to express an opinion or impression of them against an entity in the social media that they have. For marketers, of course, it can give a deep insight related to the tendency of the behavior of the customers also give you the opportunity to learn about the feelings and perceptions of customers in real-time. But it appears a new challenge in analyzing the sentiment of social media, namely the number of data samples is very large, which

will certainly complicate the marketers. With sentiment analysis, the problem of a large volume of data can be overcome so that it will facilitate marketers or perpetrators of marketing research. Through the process of sentiment analysis will show how the tendency of an opinion or the opinion of someone on a topic or issue to determine the classification of sentiment into two or more classes.

Generally, there are 2 approaches in conducting sentiment analysis, i.e. for learning-based (approach using machine learning) and lexicon-based (approach-based lexical). Approach learning-based using a dataset that has been classified manually before as training data to generate text classification opinions automatically. While the approach to the lexicon-based and depends on the dictionary's opinion (lexicon) for the determination of the classification. Dictionary of opinion contains a number of words that are used to identify the type of opinion in a sentence.

Lexicon-based approach is the scientific method that is often used in a study sentiment analysis. The workings of this method is to use a dictionary word or a corpus which is equipped with a weight on every word as the source language or lexical. The results of the analysis by the method of this form of classification of sentiment is positive, negative, and neutral. This method is a part of machine learning is unsupervised. The quality of the results depends on the word dictionary or corpus used.

Lexicon used in this study is InSet Lexicon because it has been tested well enough for the analysis of sentiment data in Indonesian language. InSet Lexicon (Indonesia Sentiment lexicon) consists of 3.609 positive words and 6.609 negative words in Indonesian language has a weight value or polarity score on every word with a weight range between -5 to +5. Polarity score is used to classify the type of sentiment.

InSet lexicon compiled by Fajri Koto and Gemal Y. Rahmanningtyas on previous research by using the words collected from twitter as a social media that is commonly used in Indonesia. InSet lexicon is built to identify opinion writing and categorizes them into the opinion is positive or negative that can be used to analyze public sentiment against the topic, event, or a particular product. The results of the test and evaluation of the research showed that the InSet lexicon is able to provide performance and the performance is quite satisfactory as a dictionary of the sentiment of Indonesia with a degree of accuracy by 65.78%.

2. LITERATURE REVIEW

2.1 Brand Reputation

The brand is a key element of corporate strategy. The brand is the company's promise to consistently deliver the features, benefits and services to its customers. Promise this is what makes people know the brand over other brands. (Futrell and Stanton, 1989; Keagan et al, 1992; Aaker, 1991). Kotler and Keller (2006) stated a brand is essentially a promise marketers to submit the performance of the products or services that can be predicted. Brands that are well known and have a positive image of the often times become a mainstay in determining the final value or success of a product (Kertajaya, 2004).

Reputation is an award obtained by the company because of the advantages that exist in the company, such as the ability owned by the company, so the company will continue to be able to develop himself to continue to be able to create things that are new again for the fulfillment of the needs of the consumer. To be successful and profitable, the brand must have a positive reputation (Herbig and Milewicz, 1995). Reputation is the perception aggregate from outside parties on the characteristics of companies that stand out (fombrun and Rindova, 2000).

2.2 Twitter Crawling

Twitter provides Application Programming Interface Streaming (APIs) to facilitate data crawling. The API allows users to retrieve data tweets in real time. The purpose of the early establishment of the Twitter API is to know the relation and interaction between the users, but on the contrary the Twitter API lot used to dig up information specific community over his views on trending topics (Nguyen & Zheng, 2014).

Crawling is the process of taking a large number of web pages quickly to a place of local storage and index it based on a number of keywords (Liu, Web Crawling, 2011). Web search engines work by storing information about many web pages, which are taken directly from the site and for this study will take the opinions from the twitter account of t. These pages were taken with the twitter crawler automatically follows every link/link he saw. The contents of each page are then analysed to determine how to index (for example, the words taken from the title, the subtitle, or special field called meta tags).

Data about web pages are stored in a database index to be used in the next search. Most of the search engines, such as Google, store all or part of the source page (a so-called cache) as well as information about the web page itself. This study also do the same way by utilizing the twitter API, then create an application based on Python to capture the keywords on the desired product.

2.3 Sentiment Analysis

The sentiment is textual information within the website and contains about fact and opinion. Sentiment is a statement of subjective, which reflects one's perception of an event (Dave, Lawrence, & Pennock, 2003). Other studies have expressed the sentiment analysis is the study of computing that relates to the opinions and oriented with natural language processing (Kumar & Sebastian, 2012).

In general, Sentiment analysis is divided into 2 general categories (Schneider, 2005):

- a. Coarse-grained sentiment analysis
- b. Fined-grained sentiment analysis

Coarse-grained sentiment analysis - this category perform the process of analysis at the level of the document. In a nutshell is we try to classify the orientation of a document as a whole. This orientation there are 3 categories: Positive, Neutral, Negative. However, there are also what makes the value of this orientation is continuous or not discrete.

Fined-grained sentiment analysis - the second category of this are popular right now. The intention is researchers mostly focus on this type. The object to be classified is not at the level of the document but rather a phrase in a document.

Generally, there are 2 approaches in conducting sentiment analysis, i.e. for learning-based (approach using machine learning) and lexicon-based (approach-based lexical). Approach learning-based using a dataset that has been classified manually before as training data to generate text classification opinions automatically. While the approach to the lexicon-based and depends on the dictionary's opinion (lexicon) for the determination of the classification. Dictionary of opinion contains a number of words that are used to identify the type of opinion in a sentence. In this study, researchers used a method approach lexicon-based where the dictionary lexicon that we used is InSet (Indonesia Sentiment Lexicon) made by Fajri Koto and Gemala Y.

3. METHODS

Steps of research in analyzing the data are as follows.

1. Do scrapping on twitter with the keyword "indihome" and "first media". Remove data that is not needed such as the "screen name", "display url" and lainyya. Here the authors

use only the data in the “text” and “location”. Data retrieval is done by using the API (Application programming interface) that has been provided by twitter

2. Clearing the data for the “text” of the object that are not required as mention and emoticons. Do tokenization and POS Tagging, To get the subject, predicate, verb, and adverb-other description here the authors use one of the library available in python that nltk (Natural Language Toolkit).
3. The weighting of the text using the InSet (Indonesia Sentiment Lexicon) made by Fajri Koto and Gemala Y will produce the value of the sentiment of sentences which are then classified whether he's positive sentiment or sentiment negative.
4. Calculation of the value of the sentiment of every word will be summed. If the value of the sentiment of the sentence is negative then the sentence is classified as negative sentiment, and vice versa if the value of the sentiment of the sentence is positive then the sentence was classified as positive sentiment.
5. The analysis and conclusions.

4. RESULTS

After performing the stages of data processing, then the next step is to perform the calculation of the total value of the sentiment of every brand. The amount of the final data used is 400 data from any brand. The following is a table of the value of the acquisition of the sentiment of both products.

Table 1 Sentiment Result

	Indihome	Firstmedia
Positive Sentiment	212 (53%)	196 (49%)
Negative Sentiment	104 (26%)	135 (33,75%)
Neutral Sentiment	84 (21%)	69 (17,25%)
Total	400	400

The above table shows that the majority of the community is still a positive outlook on the product indihome with a percentage of 53% positive sentiment, 26% negative sentiment, and the rest or 21% worth the sentiment is neutral. As for the product firstmedia get 49% positive sentiment, 33,75% negative sentiment, and the rest or sentiment neutral is by 17,25%.

From the sentiment is positive or negative, the author tries to find the words that appear most often and obtained a few words to indihome product that is worth the positive sentiment that “area and asik” and to the sentiment of negative is “mahal, gangguan, and lemot”. For products firstmedia words that often appear to positive sentiment is “jaringan” and for the sentiment negate is “gangguan and kendala”.

6. CONCLUSIONS

Conclusion from the data we get is indihome still have a positive sentiment more than firstmedia and have fewer of the negative sentiment. the advantages of indihome of the sentiment that emerges from the society is indihome has area coverage compared firstmedia and the drawback is indihome tend to have prices that are more expensive and have instability in

some areas.

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NOWCASTING APPROACH TO ANALYZE FACTORS AFFECTING ONLINE SALES DURING COVID 19 PANDEMIC IN SEVERAL CITIES/REGENCY IN EAST JAVA

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ABSTRACT

In March 2020, WHO declared Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2) or COVID-19 as a pandemic. The COVID-19 pandemic has caused the government to implement physical distancing and social distancing even lockdown policies. The COVID-19 pandemic gave rise to a new normal era which was marked by the development of digital services. New normal era influenced people's new habits in shopping, thereby increasing online shopping transactions. At the beginning of the pandemic, several health commodities which were not originally basic necessities, experienced an increase in demand, resulting in a shortage of certain commodities and delays in the delivery of goods. Therefore, it is necessary to analyze the factors that influence shopping habits during the COVID-19 pandemic in several cities/regency in East Java. One approach that can be used predict "present" conditions is the nowcasting approach by involving the Google Trends Index. There are allegations that real time internet search data can improve predictions. The modeling method that can be used is panel data regression. This research is expected to be able to make a scientific contribution to the nowcasting approach and development in the field of panel data modeling.

Keywords: COVID-19, Google Trends, Nowcasting, Online Selling, Panel Data Regression

1. INTRODUCTION

Coronavirus disease (COVID-19) is a disease caused by the Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2). The World Health Organization (WHO) announced COVID-19 as a pandemic on March 12, 2020. A pandemic is a spread of a new disease throughout the world (WHO, 2020). The first COVID-19 case in Indonesia was reported on March 2, 2020. Since then until June 21, 2021, the number of cases in Indonesia reached 2,004,445 cases, and 54,956 of them died (Satuan Tugas Penanganan COVID-19, 2021). As of June 21, 2021, East Java Province has the highest national COVID-19 death rate, reaching 7.8 percent of the total cases in Indonesia.

The government implements various policies, such as physical distancing and social distancing. Research results from Google, Tamasek, Bain & Company (2020) stated that during the COVID-19 pandemic, the number of digital service users in Indonesia increased by 37 percent. In addition, during the COVID-19 pandemic, Indonesians spend an average of 4.7 hours per day

accessing the internet. As a result, more people are connected through the internet network, which affects people's online shopping habits.

During the COVID-19 pandemic, the needs for several health products shifted, classified initially as a tertiary necessity, become secondary needs and even primary needs. The surge in demand that cannot be fulfilled causes scarcity and increases the price of goods. In addition, the failure to predict the increase in online sales has led to an increase in estimates of the arrival of goods to buyers. Therefore, it is necessary to analyze the factors that influence online sales that require accurate and timely data.

Currently, Google Trends is widely used as market intelligence to see the popularity of a particular topic at a certain time, so it can be used as a basis for determining sales targets. Internet searches provide additional information about consumers' actions, preferences, and intentions so that they can be used to assess the situation better (Barreira, Godinho, & Melo, 2013). The nowcasting approach involving real-time internet search data is considered capable of predicting the present. The modeling method that can be used is panel data regression involving cross-section data and time-series data. This study aims to determine the characteristics of online sales in several cities/districts in East Java and the factors that influence them during the COVID-19 pandemic.

2. LITERATURE REVIEW

2.1 NOWCASTING

The nowcasting method is a method that is generally used in the field of meteorology. The term nowcasting method is then widely used in economics to refer to the words "now" and "forecasting" or predict the present. In contrast to forecasting, which aims to predict the future in the long term, medium term, and short term, nowcasting is mainly used to predict current conditions which are short-range. The nowcasting method can be used to solve the time lag of the release date. The nowcasting method involves the economic variance of the Google search engine.

2.2 PANEL DATA AND PANEL REGRESSION

Panel data is a combination of data between cross-section data and time-series data. Panel data can be interpreted as cross-section data repeatedly observed on the same individual (Murray, 2006). The general model of panel data regression for y_{it} , which i -th individual for the t -time period on the response variable with $i = 1, 2, \dots, n; t = 1, 2, \dots, T$ can be written as follow.

$$\mathbf{y}_{it} = \alpha + \mathbf{X}'_{it}\boldsymbol{\beta} + \boldsymbol{\varepsilon}_{it} \quad (1)$$

α is the intercept the i -th individual \mathbf{X}'_{it} for the t -time period on the predictor variable, $\boldsymbol{\beta}$ is the regression parameter (slope coefficient) measuring $k \times 1$, and $\boldsymbol{\varepsilon}_{it}$ is regression error of the i -th individual for the time period t .

2.3 PANEL DATA REGRESSION ESTIMATION METHOD

There are three kinds of panel data regression model estimates, Common Effect Model (CEM), Fixed Effect Model (FEM), and Random Effect Model (REM). Parameter estimation in CEM and FEM uses the Ordinary Least Square (OLS) approach, but the intercept coefficient in the FEM approach is expressed by a dummy variable or Least Square Dummy Variable (LSDV). In REM, parameter estimation is done using Generalized Least Square (GLS) (Greene, 2003).

CEM assumes that the intercept and slope coefficients are the same for all cross-section and time-series units. According to Widarjono (2007), CEM is the simplest estimated panel data regression model. The CEM equation can be written as follows.

$$Y_{it} = \alpha + X_1\beta_1 + X_2\beta_2 + \dots + X_k\beta_k + \varepsilon_{it} \quad (2)$$

In FEM, it is assumed that the coefficient of the intercept value is different, but the slope coefficient is constant. The following is the FEM regression equation.

$$y_i = D_i\alpha_i + X_i\beta + \varepsilon_i \quad (3)$$

REM is a model estimate obtained by adding a random error term. In REM, it is assumed that there are different intercepts for each individual.

$$y_{it} = \alpha_i + X'_{it}\beta + \varepsilon_{it} \quad (4)$$

2.4 SELECTION OF PANEL DATA REGRESSION MODEL

If the model estimate has been obtained, then the next thing is to choose the best model. There are three types of tests that can be performed to select the best panel data regression model, namely the Chow test, the Lagrange Multiplier (LM) test, and the Hausman test.

The Chow test aims to determine the best panel data regression model between CEM and FEM. The test statistic used is the F test statistic with the formula.

$$F_{hitung} = \frac{(R^2_{LSDV} - R^2_{Pooled}) / (n-1)}{(1 - R^2_{LSDV}) / (nT - n - k)} \quad (5)$$

where R^2_{LSDV} is the coefficient of determination of the FEM model, R^2_{Pooled} is the coefficient of

determination of the CEM model. The test results are significant if the calculated F value is greater than the F table at the significance level α with degrees of freedom $n-1$ and $nT-n-k$. If the test is significant, then the appropriate model is the FEM model. On the other hand, if the test is not significant, then the appropriate model is the CEM model.

The LM test is used to compare the best regression model between CEM and REM (Widarjono, 2007).

$$LM = \frac{nT}{2(T-1)} \frac{\left[\sum_{i=1}^n (\sum_{t=1}^T e_{it})^2 \right]}{\sum_{i=1}^n \sum_{t=1}^T e_{it}^2} \quad (6)$$

The test result is statistically significant if the LM statistical value is greater than the *chi-square* at the significance level α with a degree of freedom of 1, and the appropriate model is the REM model. On the other hand, if the test is not significant, then the appropriate model is the CEM model.

Hausman test is used to select the REM and FEM models with test statistics.

$$W = [\mathbf{b} - \hat{\boldsymbol{\beta}}]' \boldsymbol{\Psi}^{-1} [\mathbf{b} - \hat{\boldsymbol{\beta}}] \quad (7)$$

with

$$\boldsymbol{\Psi} = \text{var}[\mathbf{b}] - \text{var}[\hat{\boldsymbol{\beta}}] \quad (8)$$

The test result is significant if the statistical value of the W is greater than the *chi-square* at the significance level α with k degrees of freedom and the appropriate model is the FEM model. Conversely, if the test is not significant, then the appropriate model is the REM model.

2.5 ASSUMPTION OF REGRESSION ANALYSIS

There are four principal assumptions which justify the use of regression analysis. There is no case of multicollinearity, meaning that there is no correlation between predictor variables.

Multicollinearity can be detected using the value of Variance Inflation Factors (VIF). Identical Residuals show that between residuals have a constant variance or also known as homoscedasticity. Independent Residuals indicate that there is no covariance between residuals or no autocorrelation between residuals. Normally distributed residuals can be identified using the Kolmogorov-Smirnov test statistic.

2.6 PARAMETER TEST

Simultaneous testing to determine the effect of the predictor variables together on the response variable with test statistics.

$$F_{hitung} = \frac{R^2 / (n + K - 1)}{(1 - R^2) / (nT - n - K)} \quad (9)$$

the rejection area is $F_{hitung} > F_{(\alpha, n+K-1, nT-n-K)}$. Partial Testing to determine the effect of individual predictor variables on response variables with test statistics.

$$t_{hitung} = \frac{\hat{\beta}_k}{se(\hat{\beta}_k)} \quad (10)$$

the rejection area is $|t| \geq t_{(\alpha/2; NT-k-1)}$.

3. METHODS

3.1 DATA

The data collection technique used in this study is a secondary data collection technique. Secondary data is data obtained or collected indirectly from other parties. The data taken is data with a daily time range for the observation period from March 20, 2020, to November 30, 2020. The secondary data source for the predictor variable for the GT index web search for each keyword was obtained from the official Google Trends website (<https://trends.google.co.id/>). GT index data retrieval on a macro basis is done with data collection intervals every 90 days. Taking a long data collection period was done by taking data at 90-day intervals. So for 256 days of observation, data collection was carried out three times; 20 March 2020 to 17 June 2020 (period 1), June 17, 2020, to September 14, 2020 (period 2), and September 14, 2020, to November 30, 2020 (period 3).

Because the GT index calculation uses frequency relative to the overall frequency of the search period, each search time interval will result in the highest search peak being worth 100. Retrieval in a long period by breaking the data collection period causes some peak searches to be worth 100 in a long period. There should only be one peak. Therefore, the search interval is 90 days, so there will be an overlap of one day in each data collection period. The overlap value is then used as a multiplier or divisor for the next search period so that in a long time, only one search peak is worth 100.

As for the predictor variable, the positivity rate was obtained by processing data from East Java Province's website (<https://infocovid19.jatimprov.go.id/>), while the calculation of the positivity rate data is carried out using a comparison of positive confirmed cases with the number of specimens or for data that is not available, the calculation of the number of cases per 1000 population is used (according to the target of the inspection rate indicator, which is one person per 1000 population per week).

3.2 RESEARCH VARIABLES

The predictor variable in this study was the GT index for five search keywords, namely "online sales" and "masks," as well as the positivity rate of COVID-19. The response variable used is the level of online sales.

Table 1. The Research Variables

Variable Type	Symbol	Variable Name	Operational Definition
Response	Y	Online sales	Level of online sales which is sent via PT X's expedition which is observed daily in each Regency/City in East Java. Kabupaten/Kota di Jawa Timur.
Predictor	X_1	GT index keyword "jualan online"	A number that shows the relative frequency of trends to the overall frequency of web searches for certain keywords on Google with a scale of 0-100 in each Regency/City in East Java.
	X_2	GT index keyword "masker"	
	X_3	Positivity rate	A number that shows a comparison of the positive COVID cases compared to the number of tests performed.

3.2 RESEARCH METHOD

The characteristics of each variable are identified using descriptive statistics. Moreover, the steps of modeling online sales in East Java using panel data regression are as follows.

1. Identifying multicollinearity using VIF.
2. Doing modeling using CEM based on OLS estimation.
3. Perform FEM modeling assuming fixed individual effects and LSDV parameter estimation.
4. Performing REM modeling with GLS parameter estimation.
5. Perform the Chow test to select the best model between FEM and REM. If the decision to reject H_0 is obtained, the analysis step continues to step 6. However, if the decision is obtained to fail to reject H_0 then proceed to the analysis step 7.
6. Perform the Hausman test to select the best model between FEM and REM. If the decision to reject H_0 is obtained, then the best model is FEM. However, if the decision is made to fail to reject H_0 then the best model is REM.
7. Perform the Lagrange Multiplier (LM) test to select the best model between CEM and REM. If the decision to reject H_0 is obtained, then the best model is REM. However, if the decision is obtained to fail to reject H_0 then the best model is CEM.
8. Test the assumption that the residuals are identical, independent, and normally distributed.
9. Perform parameter significance test. If there is an insignificant predictor variable, then modeling is carried out again by not including the insignificant predictor variable. So that it repeats from step ii until a model with significant variables is obtained.
10. Interpret the obtained model.

4. RESULTS

The pattern of data formed between the level of online sales and each predictor variable that tends to form a positive relationship and does not form a certain pattern (Figure 1). The greater the value of the GT index and the positivity rate, the greater the level of online sales. That

is, the relationship between the three predictor variables and the response variable tends to be positive.

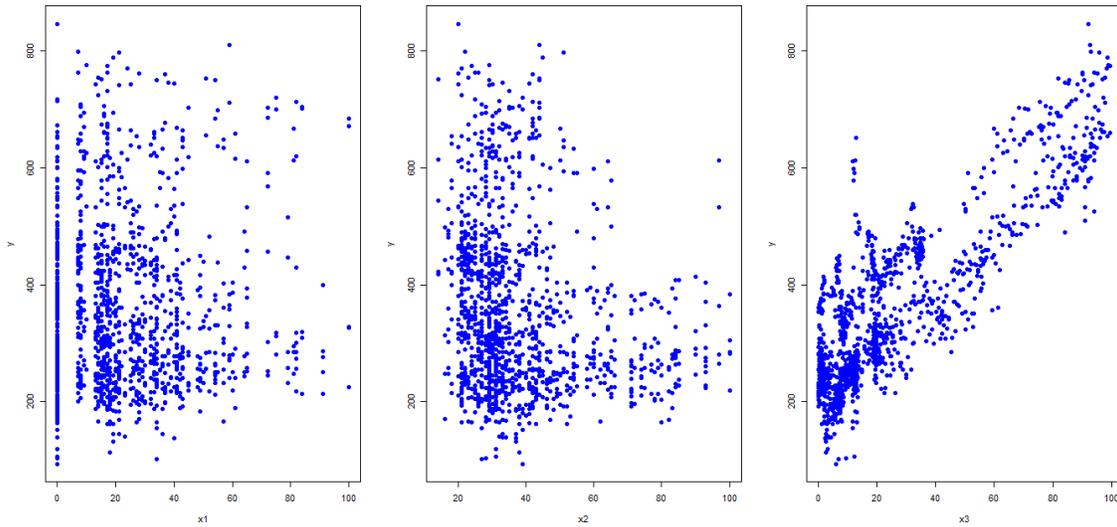


Figure 1. Scatterplot

Figure 1 shows that the GT index variable "jualan online" and the positivity rate variable tend to positively correlate with the level of online sales in the study area because the points are spread out with an upper right-sloping pattern. Meanwhile, the "masker" GT index variable tends to have a random pattern but tends to be lower right. Thus, the GT index variable is thought to have the opposite correlation with the online sales level variable. This can happen because, in the early days of the pandemic in Indonesia, masks were rare and expensive items, so they were not related to the level of online sales.

In panel data regression, one of the classical regression assumptions that must be met is multicollinearity. Based on the results in Table 2, it can be seen that the correlation value between the predictor variables is less than 0.85, so it can be concluded that there is no relationship between the predictor variables or the case of free multicollinearity.

Table 2. The Result of Multicollinierity Test

	X_1	X_2	X_3
X_1	1	0,1765	-0,0576
X_2	0,1765	1	-0,3507
X_3	-0,0576	-0,3507	1

The regression model obtained is as follows.

$$Y_{it} = \alpha_{0i} + X_1\beta_{1it} + X_2\beta_{2it} + X_3\beta_{3it} + \varepsilon$$

The expected sign for parameter $\alpha_{0i} > 0$ because α_{0i} indicates the level of online sales in the i -th

Cities/Regencies when the predictor variable is zero, so the magnitude of α_{0i} cannot be negative.

While the expected sign for $\beta_1, \beta_2, \beta_3$ are positive.

Furthermore, the modeling of each response variable is carried out with all predictor variables included in the model. Based on Table 2 and Table 3, the best estimation model is REM.

Table 3. F Statistical Test with All Predictor Variables

Model	Statistics Test	P-value	R-sq
Common Effect Model	1254.062	0.000000	0.7467
Fixed Effect Model	1467.197	0.000000	0.8898
Random Effect Model	1777.357	0.000000	0.8069

Table 4. The Result of Selection Model Test

Selection Mode Test	Statistics Test	P-value	Decision	Conclusion
<i>Chow</i>	412.8224	0.0000	Reject H ₀	Select FEM
<i>Hausman</i>	6.8286	0.0776	Fail Reject H ₀	Select REM

The *F*-statistics test from the simultaneous test is 1777.357, and the *p*-value is 0, which means all the variables are statistically significant. Moreover, the parameter significance test in Table 5 shows that all the variables are significant at the 5 percent significance level.

Table 5. The Result of Partial Test

Variable	Coefficient	Std Error	t-Statistics	P-Value
Coefficient	224,8948	19,0187	11,8250	0,0000
<i>X</i> ₁	0,5356	0,0678	7,9051	0,0000
<i>X</i> ₂	0,4367	0,8683	5,0299	0,0000
<i>X</i> ₃	4,0325	0,05803	69,4902	0,0000

With a random error for each city/regency as follows.

Table 6. Random Error Effects

No	Cities/Regencies	ϵ_i
1	Kabupaten Gresik	-61,5915
2	Kabupaten Malang	-25,2385
3	Kabupaten Sidoarjo	91,9782
4	Kota Malang	-46,2865
5	Kota Surabaya	41,1382

The REM can be written as follows.

$$\hat{y}_i = 224.8948 + 0.5356x_1 + 0.4367x_2 + 4.0325x_3 + \epsilon_i$$

with R² of 80.69 percent. The interpretation of the model that has been obtained is that each addition of one GT index for the search for the keyword "jualan online," it will increase online sales by 0.5356, assuming other variables remain. Each addition of one GT index for the search for the keyword "masker", it will increase the level of online sales by 0.4367, assuming other variables remain. Each addition of one percent of the positivity rate will increase the level of online sales by 4.0325, assuming other variables remain.

The classical regression assumption test consists of identical, independent, and normally distributed assumption tests. The assumption of identical residuals was tested using the Breusch-Pagan test and obtained a BP statistic of 5.464 and a *p*-value of 0.1408, so it was concluded that it failed to reject H₀ because the *p*-value was greater than the significance level (0.05). Moreover, the graphical method using scatterplot can be used to determine identical assumptions shown in Figure 2.

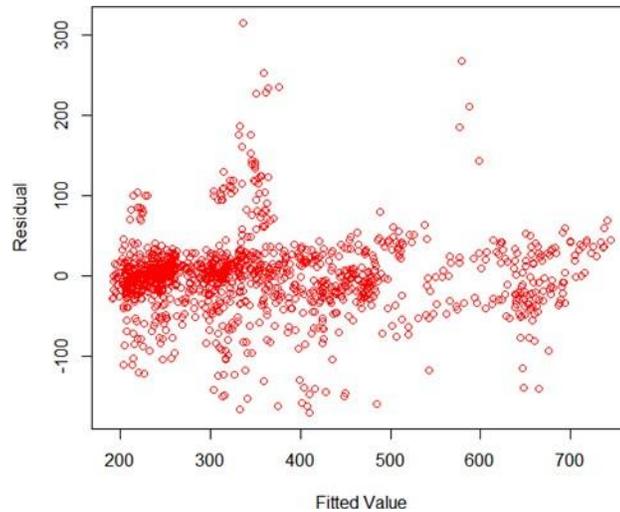


Figure 2. Scatterplot Fits vs. Residual

The independent residual test is by using the Breusch-Godfrey test, the chi-square statistic is 725.81, and the p-value is $2.2e-16$, so it can be concluded that H_0 is rejected, which means that the residuals do not meet the independent assumptions or there is an indication that there is an autocorrelation case in the model formed. However, dependencies or autocorrelation generally occur in time series data, so that in panel data, the assumption of residuals, independence or autocorrelation tests on data that are not time series (cross-sections or panels) will be useless or meaningless. In this study, the residuals are assumed to meet the independent assumptions.

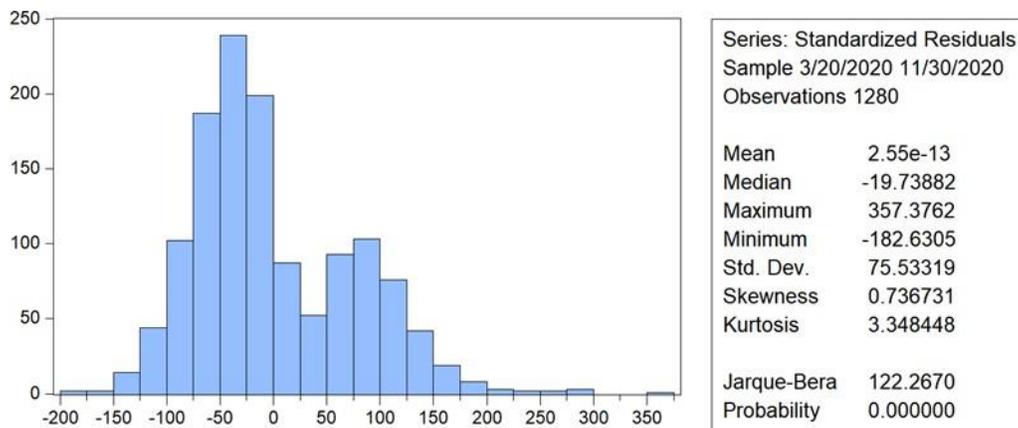


Figure 3. Normality Test

The results of the normal assumption test are known that the p-value of 0.000 is less than $= 0.05$, so reject H_0 . This result means that the residual does not meet the assumption of a normal distribution.

The results of forecasting the level of online sales for the period 20 March 2020 to 30 November 2021 in five cities/districts in East Java are shown in Figure 4 using REM with RMSE 48,16756. A relatively low RMSE value means that the predicted value is close to the observed or observed value. In addition, the MAPE value or the percentage of error is 9.8561 percent. A MAPE value of less than 10 percent means that the ability of the forecasting model is good. The smaller the percentage error in MAPE, the more accurate the forecasting result will be.

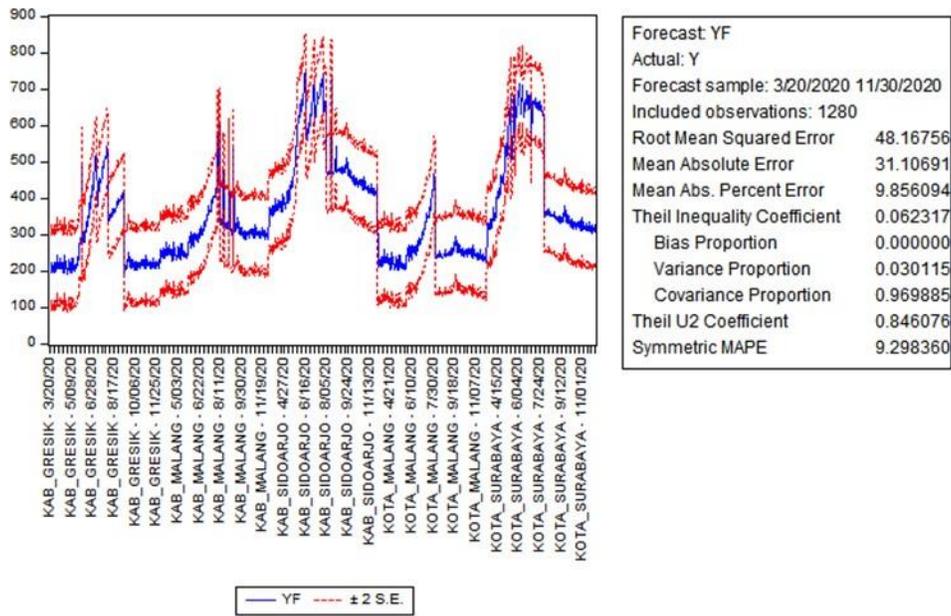


Figure 3. Nowcasting

6. CONCLUSIONS

Based on the results and discussions that have been carried out, we obtained three conclusions. First, the best panel data regression modeling for online sales modeling during the COVID-19 pandemic is the Random Effect Model estimation method with cross-section effects. Second, the overall predictor variables used are "jualan online," "masker," and the positivity rate have a significant effect with an R^2 of 70.647 percent. Third, The resulting model is good to use for forecasting because of the value of RMSE=48,16756 and MAPE=9,8561.

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BUSINESS INTELLIGENCE BASED ON ASPECT BASED SENTIMENT ANALYSIS (ABSA) USING CONVOLUTIONAL NEURAL NETWORK ON ONLINE MARKETPLACE PRODUCT REVIEWS

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ABSTRACT

Most online marketplace provide review facilities that contain responses to a product. There are 75% percent of companies that do not respond to customer reviews or reviews, even though businesses that respond to their customers show an increase in revenue with an average of 4% for each customer review. Sentiment analysis is needed to extract information in large amounts of text data to get sentiments about aspects, services or companies to improve and evaluate company. This research aims to classify aspect-based sentiment using the Convolutional Neural Network (CNN) and provide managerial recommendations by comparing best practices from other online marketplaces for each aspect. The use of CNN for aspect-based sentiment analysis produces good scores at 87.84% accuracy, 96.35% precision, 90.04% recall and 93.02% f measure. Strategies used include minimizing negative sentiment in aspects of accuracy, quality, service, price, packaging and delivery are opening live streaming access for all stores, adding performance appraisals from buyer feedback, providing incentives for each store to upload product videos, adding a dashboard for the percentage of responded chats, facilitating the purchase of packaging (bubble wrap, cardboard), creating challenges related to performance measurement parameters, adding an assessment feature for delivery service and using recommendation features regarding delivery accuracy which will be adjusted to the buyer's based on their area.

Keywords: Aspects, Convolutional Neural Network (CNN), Marketplace, Review, Sentiment, business intelligence.

1. INTRODUCTION

The online marketplace platform provides various features needed by its users, one of which is an online review that can be displayed on the product page. According to research, Clewley (2009) states that online reviews can influence consumers' decisions to make purchases. Online review feature is also can be a form of electronic word of mouth (e-WOM). According to a survey conducted by *womply.com*, there is 75% percent of companies that do not respond to customer reviews, even though businesses respond to their customers, show an increase in revenue

with an average of 4% for each customer review. The form of response, in this case, can be improving services, providing appropriate solutions, and handling customer complaints. Another survey conducted by *bazarvoice.de* shows that 41% of customers say that a brand, business, or company that responds to online reviews creates the perception that the company cares about its customers and will impact purchase intention and sentiment on a product or service. Sentiment analysis, in general, has three advantages. First, it helps build a model to collect opinions to get valuable insights for individuals or companies. Second, it converts large and unstructured texts into a form that allows predicting the outcome of certain events. Third, a method that is useful for gathering information on public reactions or specific targets to design marketing strategies or advertising campaigns. There are many research of sentiment analysis such as sentiment analysis used to find out sentiment on aspects of accuracy, quality, service, price, packaging, and delivery in online marketplaces (Bangsa, Priyanta, and Suyanto, 2020), aspects of food, service, price, atmosphere, location, and facilities at hotels (Mubarok, Adiwijaya, and Aldhi, 2017), aspects of User Interface, User Experience, performance and functionality, security and support for updates on mobile apps (Siyam, 2018). Researchers use many methods to get sentiment analysis, one of which is the Convolutional Neural Network (CNN). The use of the CNN algorithm was chosen because it is considered better in overcoming big data and machine learning problems so that it can be developed to build a model to classify a word, sentence, or paragraph and is expected to be able to describe the public's view of online marketplace services or products through online reviews combined with business intelligence so the company will be able to provide the best recommendations for business decision making.

2. LITERATURE REVIEW

2.1 Convolutional Neural Network (CNN)

According to Yih, He and Meek (2014), CNN was initially used for computer vision which is currently the core of most systems today, from automatic photo tagging on social media platforms such as Facebook to autonomous cars. The CNN was firstly used by LeChun. et al. (2015), and today is one of the significant breakthroughs in the development of image classification. However, the CNN model has proven to be effective for Natural Language Processing (NLP) and has achieved excellent results for text classification in several studies.

2.2 Business Intelligence

According to Vercellis (2009), in his book *Business Intelligence: Data Mining and Optimization for Decision Making*, he explains that Business Intelligence (BI) is defined as a set of mathematical models and analytical methodologies that exploit available data to produce useful information and knowledge for the decision-making process: complex decisions. The main purpose of a BI system is to provide knowledge to users with the right tools and methodologies so that BI users can make effective and timely decisions. The main benefit of a company or organization adopting a BI system is when the company is faced with the two problems described above, then a series of questions arise from what kind of decision-makers and how to develop an analysis that fits the decision. Therefore, decision-makers must make decisions by examining and comparing several of the best options. If the decision-maker can apply the BI system, then the quality of the decisions can be accounted for.

2.3 Aspect based sentiment analysis

Aspect-based sentiment analysis (ABSA) extracts polarity of opinion based on specific aspects of a particular problem or object. These aspects vary depending on the context of object research. Each opinion consists of sentiment (positive or negative) and has its own target opinion

on the ABSA. Sentiment analysis is applied to each aspect where aspects are often in the form of words or a series of words that represent each aspect.

ABSA is needed because sentiment analysis at the document and sentence levels is insufficient to represent specific opinions because sentiment polarity is measured based on the whole sentence or document so that accurate analysis is needed to find aspects and determine positive or negative sentiments towards these aspects.

3. METHODS

3.1 Aspect based sentiment analysis using CNN

The process starts from the input. Dataset comes from a scraping process in previous research. Then data are labeled with aspects and sentiments manually. After that, data is cleaned using preprocessing techniques such as case-folding, symbol removal, and normalization of non-standard words into standard words. Furthermore, the preprocessed data is converted into word vectors using Word2Vec so that the CNN algorithm can process it for aspect and sentiment classification, and the best model is taken from the parameters to be tested. Details can be seen in Figure 1. below.

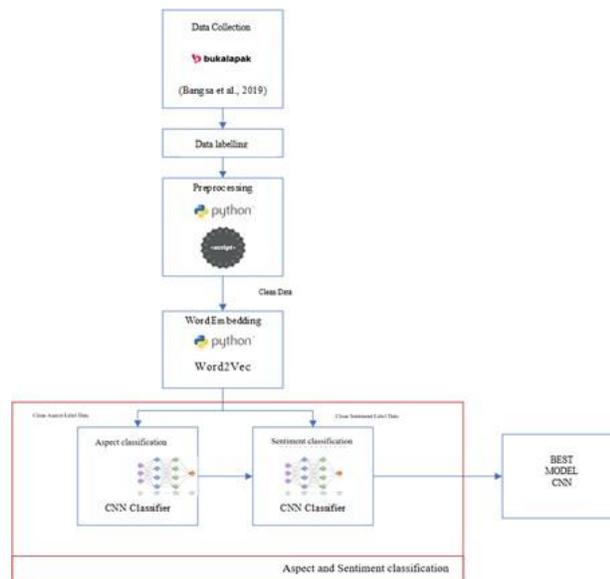


Figure 1. Methodology

3.1.1 Data collection

The data used in this thesis is data from previous research (Bangsa, Priyanta, and Suyanto, 2020) collected using the scraping method on an online marketplace website using the selenium library in python programming. There are 7500 labelled datasets and 228,612 datasets for word embedding. The file is stored in CSV form. The data used is product review data in the electronic category.

3.1.2 Data labeling

The collected data is duplicated into two datasets. It has been designated for the aspect category and sentiment classification. There are six categories of aspects such as quality, service, accuracy, price, packaging, and delivery. The details of the aspects that will be used along with the parameters according to Bangsa, Priyanta, and Suyanto (2019), can be seen in Table 1. below.

Review	Aspect Category					
	Accuracy	Quality	Service	Price	Packaging	Delivery
<i>Barang sesuai gambar pengiriman cepat</i>	1	0	0	0	0	1
<i>Harganya cukup mahal kualitasnya jelek</i>	0	1	0	1	0	0
<i>Admin tidak responsif saat dihubungi, pengiriman 6 hari baru sampai rumah</i>	0	0	1	0	0	1
<i>Barang bagus banget dengan harga murah</i>	0	1	0	1	0	0

Table 1. Aspect category (review in Bahasa Indonesia)

After being labeled on the related aspects, the polarity of the sentiment in each category of these aspects is determined with positive and negative classes. The following can be seen in Table 2. below, an example of a dataset for sentiment classification.

Review	Sentiment Category					
	Accuracy	Quality	Service	Price	Packaging	Delivery
<i>Barang sesuai gambar pengiriman cepat</i>	Pos	0	0	0	0	Pos
<i>Harganya cukup mahal kualitasnya jelek</i>	0	Neg	0	Neg	0	0
<i>Admin tidak responsif saat dihubungi, pengiriman 6 hari baru sampai rumah</i>	0	0	Neg	0	0	Neg
<i>Barang bagus banget dengan harga murah</i>	0	Pos	0	Pos	0	0

Table 2. Sentiment category

Table 3. Parameter

Parameter	Value
Architecture	<i>Skip-gram</i>
Window size	10
Vector size	300
Iteration	5
Corpus	228,612 review

3.1.3 Data Preprocessing

The data that has been obtained from previous research needs to be preprocessed, which aims to improve data quality and facilitate interpretation in the data processing process using case folding, symbol removal, and word normalization

3.1.4 Word embedding

Dataset has been preprocessed and then made a model where the main goal is to convert every word in the training data into a vector value to be processed in the CNN algorithm. The word distribution used in this study is a corpus of reviews taken from the online marketplace as many as 228,612 reviews from 98 stores. In making the Word2Vec model using the gensim 4.0.0 library using python programming. Here can be seen in Table 3, the parameter of the Word2Vec model.

3.1.5 Classification of aspect and sentiment

In this step, the authors choose the best hyperparameter from each training and testing of aspect classification and sentiment classification, as shown in Figure 2. After obtaining the best hyperparameter, the author train and testing hyperparameter from both sequentially. Each incoming text data is converted into a vector value using the Word2Vec model. The results of this vector value act as input for the classification of aspect categories with the model used from the training results of certain aspect categories that have previously been processed. The output of this classification is in the form of label 1 (detected to have certain aspects) and label 0 (not detected to have certain aspects). Aspect labels that have a value 1 or are detected as having certain aspects forwarded to the next steps, namely the sentiment classification steps using a certain aspect sentiment model that has been carried out in the training process. The output of this sentiment classification is in the form of label 1 for positive sentiment or label 0 for negative sentiment. Especially for aspect labels with a label 0 or are not detected, certain aspects of a sentence are changed to label -1 or false, which will later be combined with the sentiment classification output. In the end, the classification process after merging has three classes which are represented by the labels -1 (false), 0 (negative), and 1 (positive), which will be tested with a confusion matrix so that accuracy is obtained for the two-stage model simultaneously.

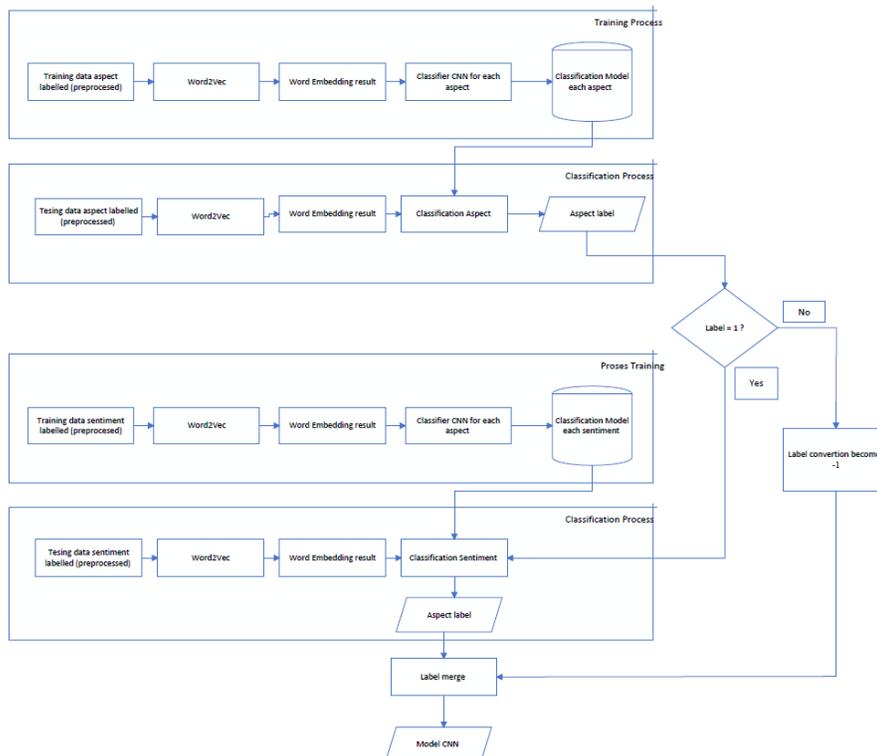


Figure 2. Aspect-based sentiment analysis

3.2 Business Intelligence

In this process, the authors gain insight from the dataset that has been analyzed regarding the sentiment and what aspects need to be improved in the online marketplace. The process to obtain a recommendation can be seen in Figure 3.

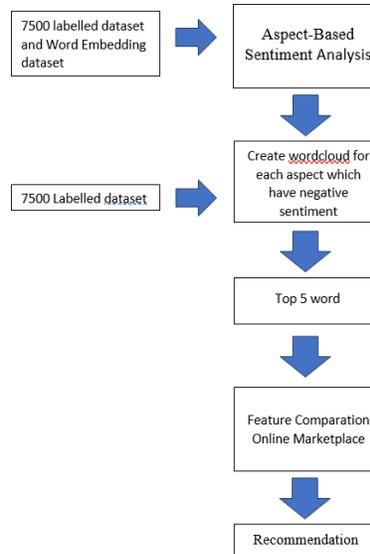


Figure 3. Business Intelligence process

The recommendation formulation process basically starts with making an aspect-based sentiment analysis where from this process the aspect classification and sentiment polarity, then a wordcloud is made from negative sentiment to find out the symptoms of the problem in each aspect where the output is a negative word that often appears in the data for each aspect—after that, comparing the features of competitor marketplaces to overcome these problems. Recommendations issued by the author are best practices from each competitor's marketplace or from research-related.

4. RESULTS

4.1 Data

This research is 7500 product reviews where the data are grouped into six classes, namely accuracy, quality, service, packaging, price, and delivery, and in each class, there is a positive and negative sentiment. The following table shows the distribution of labelled data.

Table 4. Labelled data

Aspect Category	Sentiment Polarity	Total
accuracy	Positive	2226
	Negative	992
quality	Positive	3007
	Negative	1337
service	Positive	880
	Negative	479
packaging	Positive	806
	Negative	386
price	Positive	831
	Negative	234
delivery	Positive	1142
	Negative	458

From the appearance of the word, it can be concluded that the incidence of negative sentiment in the online marketplace platform in the aspect of accuracy is affected by the mismatch between the images, colors, and descriptions that appear on the page, and this is giving a sense of disappointment from the buyer. After comparing several online marketplaces, the average has made corrective action to overcome problems in the aspect of accuracy, but several things can be implemented, such as a marketplace “X” can applies a reputation based on the assessment of buyers and opens a live streaming feature for all stores without exception so that buyers can better compare the goods to be purchased through the live streaming feature.

4.3.2 Quality aspect

The quality aspect, in this case, can be translated as the product arrives well without defects or damage when it reaches the buyer. It can be seen in Figure 5, the wordcloud of 1337 reviews with negative sentiment, from this wordcloud taken top 5 words that often appear related to quality aspects that can be seen on the table below.

Table 9. Top 5 word quality

Word	Word Frequency
<i>rusak</i>	365
<i>jelek</i>	106
<i>kecewa</i>	79
<i>berfungsi</i>	78
<i>asli</i>	72



Figure 5. Wordcloud quality

From the appearance of the word, the incidence of negative sentiment in the platform online marketplace on the quality aspect is affected by the goods received in damaged condition, which creates a feeling of disappointment from the buyer. Several online marketplaces have made corrective efforts so that these incidents can be minimized. However, there are several things that can be implemented, such as a marketplace “X” provide incentives to sellers who upload videos related to products that can target quality aspects and can add warranty features by paying a certain nominal value to the buyer if the goods used within a certain period are damaged.

4.3.3 Services aspect

The service aspect can be translated as the seller's responsiveness in answering questions and product complaints. Here can be seen in Figure 6. wordcloud of 479 reviews with negative sentiment. From this wordcloud, the top 5 words that often appear related to the service aspect are taken, and it is concluded that the emergence of negative sentiment in the online marketplace platform on the service aspect is influenced by the seller's slow response messages from buyers. Some online marketplaces have made corrective efforts to minimize these incidents, but several things can be implemented, such as the marketplace “X” can add information that includes seller responsiveness to incoming chats as a separate consideration for buyers.

Table 10. Top 5 word quality

Word	Word Frequency
<i>lambat respon</i>	110
<i>pelapak</i>	81
<i>respon</i>	81
<i>penjual</i>	76
<i>respon lambat</i>	75



4.3.4 Packaging aspect

The packaging aspect, in this case, can be translated as packaging the purchased product neatly and without defects. Here can be seen in Figure 7. wordcloud from 386 reviews with negative sentiment. From this wordcloud, the top 5 words that often appear related to the packaging aspect are taken, it is concluded that the emergence of negative sentiment in the online marketplace platform on the packaging aspect is influenced by the security of packing goods, packaging damage, in this case, is dented, neatness of packaging and the speed of seller to package the goods before it is sent to delivery service. Meanwhile, several online marketplaces have made corrective efforts so that these incidents can be minimized. However, there are several things that can be implemented, such as the marketplace “X” can facilitate the purchase of packaging (bubble wrap, cardboard) with specific promos as an effort to make sellers more aware of the importance of packaging to ensure package security.

Table 11. Top 5 word packaging

Word	Word Frequency
<i>aman</i>	71
<i>rusak</i>	51
<i>rapi</i>	49
<i>penyok</i>	45
<i>cepat</i>	39



Figure 7. Wordcloud packaging

4.3.5 Price aspect

The price aspect can be translated as goods purchased cheaply. Here can be seen in Figure

8. wordcloud of 234 reviews with negative sentiment. From this wordcloud, the top 5 words that often appear related to the price aspect are taken, and it is concluded that the emergence of negative sentiment in the online marketplace platform on the price aspect is influenced by high prices compared to other stores. Meanwhile, several online marketplaces have made corrective efforts so that these incidents can be minimized. However, several things can be implemented, such as marketplace “X” makes a challenge that sellers can do to improve store performance. In Marketplace “B”, one of the challenges is to make one store promo where this can be done to encourage the seller to provide promos. After carrying out the challenge, sellers can get benefits inbalances for store advertising purposes.

Table 12. Top 5 word price

Word	Word Frequency
<i>mahal</i>	178
<i>harganya</i>	38
<i>kemahalan</i>	38
<i>ongkos</i>	38
<i>penjual</i>	18



Figure 8. Wordcloud price

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Parallel Session 1

Room G (09:50 - 11:20)

Moderator:

Category: Data Analytics and Business Intelligent

DEVELOPMENT OF MODEL FOR PREDICTING HOUSE SELLING PRICE USING MACHINE LEARNING

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ABSTRACT

In the Big data Era, the Internet had been swarmed with a lot of information. Virtual Marketplaces on the internet have become a new way for trading. In the pandemic, online is preferred instead of offline trading. One of the marketplaces is a property marketplace. People get the price of house selling, location, facilities on the property marketplace. The property marketplaces provide sharing information and data and are free to use. The property marketplaces are become a source of data for analytics. By utilizing web scrapping, data is easily extracted for further analysis. In this paper, data of house selling price for Jakarta and the supporting area such as Bogor, Depok, Tangerang, and Bekasi are extracted. Cleaning the extracted data is an important phase to evaluate the data. Based on the cleaned data, Exploratory Data Analysis had been performed to see correlation of data. Additional variables are added such as relative location with school, shopping mall. Data Visualization based on map are provided using Google data Studio. Model has been developed for prediction of house selling price. Generalized Additive models (GAM) and Artificial Neural Network (ANN) had been used to develop the model. The predicted values of selling house and real price are compared for each area.

Keywords: Big Data Analytic, Data Visualization, Machine Learning, Prediction, Web scrapping.

THE EVALUATION OF MAPPING ATMs BANK IN SURABAYA AREA BY USING CLUSTER ANALYSIS METHOD

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ABSTRACT

ATM (Automated Teller Machine) is a transaction machine that has used a computerized system to serve and assist bank customers in conducting several types of transactions. Services provide many advantages for both bank and customer, such as minimizing the transaction also distribution costs, and allowing customers to make transactions anywhere and anytime. There are research opportunities regarding ATM productivity, which influence by several factors, such as the number of transactions that occur at ATMs and ATMs placement. This study aims to evaluate the procurement of ATMs in the Surabaya area and its surroundings by clustering and describe the characteristics of the procurement of ATMs based on its most influencing factors. By using clustering analysis, a form of cluster analysis as a tool to classify ATMs in the shaded area of the Bank X Surabaya office will be made based on productivity indicators consisting of TID, branches, type of machine used, day operational, hours of operation, number of fillings within 4 hours, month and the number of transactions in the last four months (TRX). Four clusters have made: first, ATMs with mediocre productivity operating for 24 hours every day; second, more productive ATMs operating for 24 hours every day; third, ATMs with mediocre productivity not running for 24 hours; last, ATMs with modest productivity not running every day. The interpretation will be constructed based on evaluating the pattern formed in the clustering results and sorting the branches from the highest non-productive ATMs percentage.

Keywords: ATM, Clustering, Evaluation, Productivity.

1. INTRODUCTION

Both central and commercial banks are at the core of each country's financial system. Banks are financial institutions that become places for companies, government, and private agencies and individuals to store their funds. Through credit activities and various services provided, the Bank serves the financing needs and payment system mechanisms for all sectors of the economy. The Bank acts, among others, as an intermediary for parties that have a surplus of funds with parties that lack and *lack funds* and help the financing needs and launch payment system mechanisms for all sectors of the community economy. In such conditions, the Bank is an institution that relies on public trust in the Bank. The government should try to protect the public as customers from the actions of institutions or employees of the Bank that are irresponsible and damage the joint trust of the people. ATM (*Automated Teller Machine*) is

one of the means provided by banks in *self-service*. ATM is a transaction machine that has used a computerized system to serve and help customers make several types of transactions. With ATMs and ATM cards, customers can access their savings accounts to make transactions such as balance checks, cash withdrawals, money transfers, bill payments, and so on quickly and practically without going to the teller at the branch office [1].

Society faced the global economy in 2020 with several different challenges from previous crises. The crisis that began from the health crisis caused by the Covid-19 pandemic quickly developed into an economic crisis due to restricting the mobility of people in various countries to reduce the spread of Covid-19. Restrictions on people's mobility have resulted in a sharp decline in global economic activity, consumption, production, trade in goods and services, and investment. [2]. The economic slowdown due to Covid-19 decreased payment activity but encouraged the acceleration of the adoption of digital financial technology. Cash growth contracted in line with the implementation of PSBB, which reduced the community's mobility and cash transaction needs. Cashless payment transactions through ATM, Debit Card, Credit Card, and Electronic Money (EU) contracted, digital banking transactions and payment transaction volume slowed. Positive developments had seen the increasing preference and acceptance of the public by using digital platforms and financial instruments, such as e-commerce, to fulfill daily needs. With the background of the above problems, it felt that there needs to be a study to examine the productivity of ATMs in Surabaya and surrounding areas to produce the correct grouping for ATMs based on the characteristics of the machine.

This study examines the characteristics of data on ATM productivity that describes the current condition and analyzes the results of mapping the productivity of ATMs in the area of Bank X Surabaya office. This research is only limited to the shaded area of Surabaya. The data used is an internal factor consisting of the number of transactions, type of machine, supervision area, External factors such as the placement of ATMs in specific locations such as supermarkets with parking capacity, etc., research. The method used is Clustering Analysis with a machine learning approach to measure the effectiveness of ATM placement.

2. LITERATURE REVIEW

2.1 Pre-Processing Data

Pre-Processing Data is the manipulation of data to a more informative form or in the form of information. [3]. Some factors that require pre-processing are incomplete data, noise, and inconsistencies. The main objectives in data processing are for data cleanup, integration, transformation, reduction, and discretization [4], besides missing value and outliers.

2.2 Exploratory Data Analysis

The application of explorative data analysis in interpreting and processing information is necessary to support current knowledge. Explorative data analysis is a method of data exploration using arithmetic techniques and graphic techniques in summarizing observation data. The first way to analyze the data is to study the characteristics of the data. The first reason for checking the information is to check for errors – errors that are may review at various stages. Starting from data recording in the field to data entry on the computer to explore data to determine the suitable analysis model [5].

2.3 Cluster Analysis

Cluster analysis is a multivariate technique that aims to classify an object that differs from group to group. Objects classified in one cluster are objects with relative proximity to other objects [7]. According to Johnson, grouping is based on the size of similarities or distance dissimilarities. One of these measures of inscription obtained proximity matrix through is

Euclidean distance [6]. Euclidian distance, i.e., if $x'=[x_1, x_2, L, x_p]$; Euclidian distance: $y'=[y_1, y_2, L, y_p]$

then the

$$d(x, y) = \sqrt{(x-y)'(x-y)}$$

A hierarchical method is a method that starts grouping with two or more objects that have the closest similarity. Then the process is continued to another thing that has second proximity. So, the cluster will form a kind of "tree" where there is a clear hierarchy (level) between objects, from the most similar to the most minor alike. Usually, this grouping present in a dendrogram, which is identical to a "tree diagram structure." A dendrogram is a visual representation of cluster analysis steps that shows how clusters formed and the value of the distance coefficient at each step[8].

2.4 Elbow Method

The Elbow method is used to generate information in determining the best number of clusters by looking at the percentage of the final result of the comparison between the number of cluster that will form elbows. This method provides ideas by selecting the cluster value and then adding the cluster value as a data model to determine the best cluster. In addition, the percentage of calculations generated is a comparison between the number of cluster that is added. Different percentage results of each cluster value can demonstrate using a graph as the source of information. If the value of the first cluster with the weight of the second cluster provides an angle in the graph or its value decreases the most, then the cluster value is best. To get the comparison is to calculate the SSE (Sum of Square Error) of each cluster value. Because the larger the number of clusters K , the smaller the SSE value.

2.5 Silhouette Coefficient

In testing, a model is done to get information as close as possible. What is the relationship between one object and another cluster, also how far between a cluster to another cluster. The testing method used in this case is to look for silhouette coefficient where this method is a merger rather than the other two methods, namely the Cohesion method, which helps measure how closely the relationship between one object and another object on a cluster and separation method that is useful to calculate how far a cluster split from another cluster or how far a cluster with another cluster [9]. The Silhouette coefficient is found in the number between the values -1 to 1 where the importance of silhouette coefficient is closer to the value of 1, the better the grouping of objects into a cluster and vice versa if the Silhouette coefficient is close to the number -1, the worse the method of grouping data on the cluster where this measurement method combines the Cohesion method with Separation.

2.6 Unsupervised Learning and Machine Learning Method

Unsupervised learning is a machine learning algorithm used to conclude datasets consisting of input labeled response data. The most common unsupervised learning method is

clustering, which is used in data to search for hidden patterns or groupings in data [10]. Machine learning (ML) is a technique to infer data with a mathematical approach. The essence of machine learning is to create (mathematical) models that reflect data patterns. As the name implies, ML tries to mimic how human processes or smart-machine learning and generalize [11]. Machine Learning's algorithmic (learning process) method consists of Supervised Learning, Unsupervised Learning, and Reinforcement Learning. Supervised Machine Learning applies existing information to the data by providing specific labels such as previously classified (directed) data. This algorithm can give targets to the output carried out by comparing past learning experiences [12] [13].

2.7 Research Position

The COVID-19 pandemic has put pressure on many businesses and caused unprecedented trade disruptions in most industrial sectors. Retailers and MSMEs face many short-term challenges, such as those related to health and safety, supply chain and labor, cash flow, consumer demand, sales, and marketing. It also has a considerable influence on the circulation of physical money in Indonesia. The payment model, until the trade transaction, has a significant difference in the community. New payment methods supported by many start-ups engaged in financial technology make people have a new habit of transacting. Large-scale Social Restriction Regulation has a considerable impact on economic actors from both sellers and buyers. It also has a significant influence on ATM transactions in Surabaya and surrounding areas.

From the results of the literature study above can be concluded that, in general, there are research opportunities on atm productivity that influenced by several factors, among others, the number of transactions that occur at ATMs, the location of ATM placement, characteristics, etc. This study aims to evaluate the procurement of ATMs in Surabaya and surrounding areas by clustering and describing the aspects of ATM procurement based on the factors that most influence the grouping results. This research focuses on atm procurement by characteristics of the region or demand of the community in the area. Thus, it can be determined the position of research that is on the evaluation of ATM performance that has not studied concerning the factors that affect.

3. RESEARCH METHODS

3.1 Types of Research

This research is applied research leads to a quantitative approach to producing the correct grouping for ATMs based on the characteristics of the machine. Variables used in this study are productivity indicators, namely TID, KC Supervision, Longitude, Latitude, software used (Operation System), operating days, operating hours, the number of filling within four months, and average number of transactions per month in the last four months (TRX).

3.2 Population and Research Variables

The population in this study is KC Supervision which is studied includes Surabaya and its surroundings. The data source used in this applied study is secondary data obtained from Bank X. The data used is the productivity of ATMs located in the Surabaya area. The data period used from January 2019 to September 2020. There are 25 critical locations analyzed in the study. For variable measurement, used is a numerical scale based on the calculation of

ATM productivity with the following details:

Tabel 3.1 Research Variables and measurement scales

Label s	Variable	Type of Data
X ₁	KC Supervision	Category
X ₂	Latitude	Numerical
X ₃	Longitude	Numerical
X ₄	Types of ATMs (OS)	Nominal/ Category
X ₅	ATM Operating Day	Ordinal/ Category
X ₆	ATM Operating Hours	Ordinal/ Category
X ₇	ATM operating time / day	Ratio/ Numerical
X ₈	Number of ATM charging in 4 months	Ratio/ Numerical
X ₉	Average monthly transactions (last 4 months)	Ratio/ Numerical

3.3 Research Model

This research uses descriptive analysis and cluster analysis. The descriptive analysis in this study aims to provide a deeper picture of how the data characteristics in the 25 central locations and consideration in selecting clustering methods. Furthermore, multivariate analysis conducted in the form of cluster analysis as a tool to group ATMs in the area of Bank X Surabaya office based on productivity indicators consisting of TID, KC Supervision, Longitude, Latitude, software used (OS), working days, operating hours, filling within four months and the number of transactions in the last four months (TRX).

3.4 Data Analysis Technique

The cluster analysis method used in this study is the Hierarchy Method using agglomerative grouping procedure with average linkage technique and Euclidean distance size. First, the characteristics of ATM productivity data in Surabaya and surrounding areas were identified by conducting descriptive statistical analysis and a time series plot. Data Standardization will also use for the use of further study. Standardization of data is analysis by converting data into z-score form, with formulas [14]:

Two assumption tests will be conducted:

- a. Testing sample adequacy

$$z = \frac{x - \bar{x}}{s}$$

(3.1)

This step means that the sample used must represent the population. To find out it is used the value of Kaiser Meyer Olkin (KMO). Where the KMO value is less than 0.5 indicates that the sample used is not representative. [15].

b. Testing multicollinearity

To detect whether or not multicollinearity seen simple correlation coefficient (Pearson correlation) between free variables, if there is a value that reaches or exceeds 0.8 then multicollinearity occurs [16].

By using Rstudio programs, algorithms in cluster analysis will be done. This study used agglomerative hierarchy cluster analysis with the Ward method to determine the size of similarity with Euclidean distance. Next, choose the number of clusters and their members by looking at the WSS values that make up an elbow on the most prominent Elbow and Silhouette Score methods. Last but not least, interpret and analyze clusters in 25 regions for the evaluation purpose.

4. RESULT OF ANALYSIS

4.1 Descriptive Statistics

As an early stage in the evaluation of ATM mapping, it is crucial to recognize the characteristics of the data before entering the analysis stage. In Figure 1, it appears that the distribution of data on both some transactions and ATM replenishment in the last four months tends to skewness to the right, which means that more than 50% of the number of transactions and replenishment has a value below average. It would be interesting to study ATMs with above-average values as an example in the evaluation results later.

Figure 2 explains the relationship between ATM hours and working days to the number of transactions and atm replenishment. It appears that while weekdays do not cause a significant difference in the number of fills, it does affect the number of transactions. While it seems that working hours in specific categories drive a substantial difference in the number of transactions and atm replenishment.

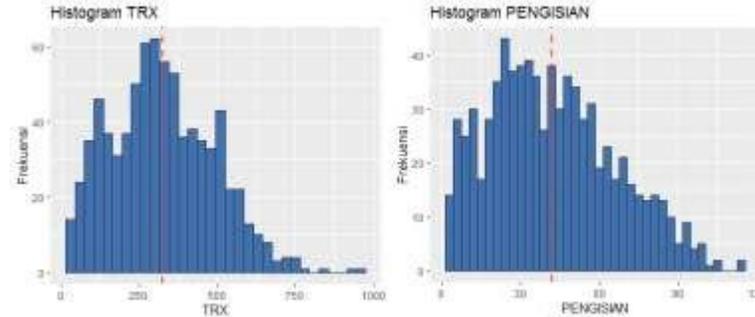


Figure 1. Histogram of Transactions Number and ATM Replenishment in the Last 4 Months

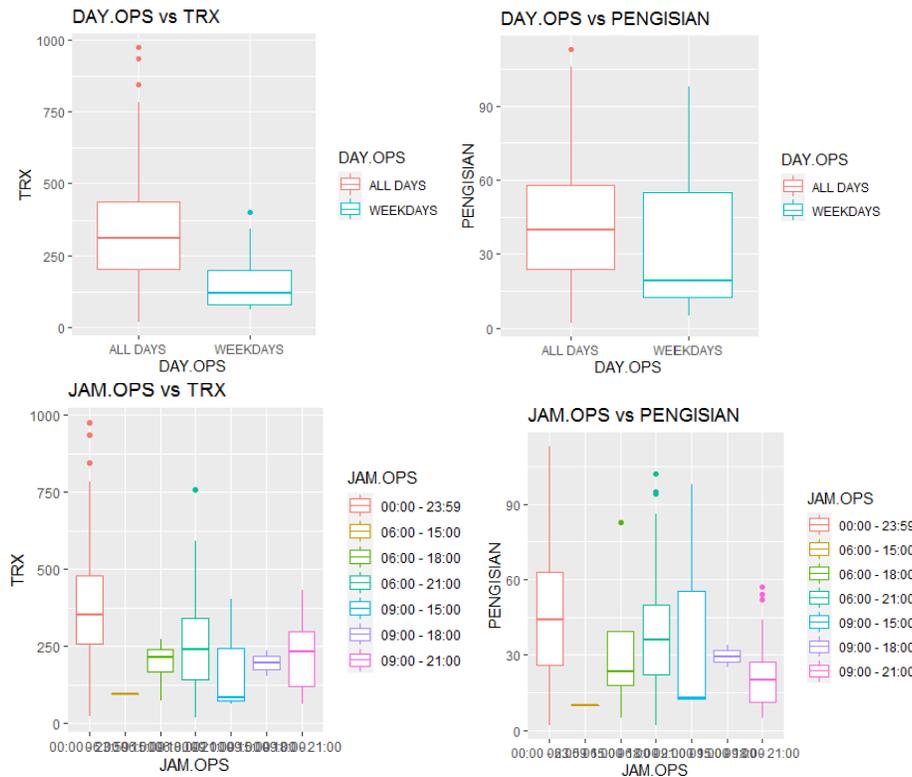


Figure 2. Boxplot Hours and Weekdays vs. Number of Fills and Transactions

It is determined that the recorded ATM has an average number of transactions in the last four months of less than 181, considered an unproductive ATM. Out of 781 ATMs, there were 169 unproductive ATMs (21.64% of the total ATMs). Figure 3 shows the percentage of non-productive ATMs in each branch of supervision in the Surabaya area. In the visualization of cluster results per branch, the branch name will be sorted from having the most significant percentage of non-productive ATMs.

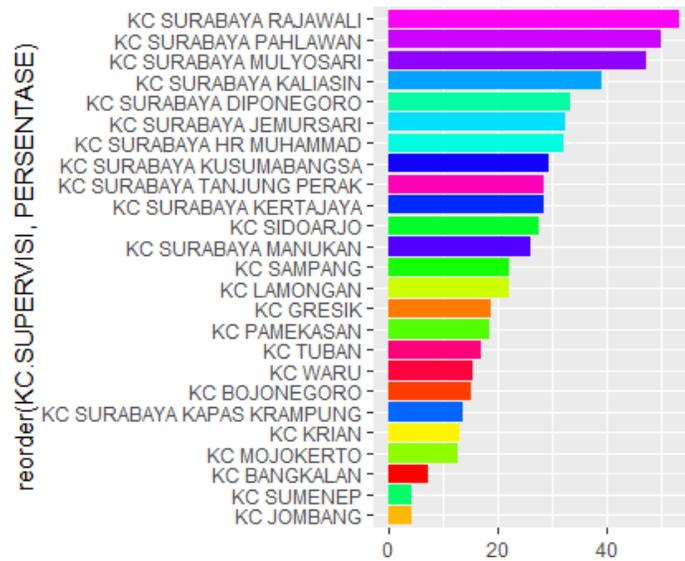


Figure 3. Percentage of Non-Productive ATMs Per Supervising Branch

Next will be presented correlation plot in Figure 4 to show the relationship between variables to be used in cluster analysis.



Figure 4. Correlation Plot between variables

It appears that there is no significant relationship between variables, which is characterized by the absence of correlation coefficients that are worth more than 0.8. This result indicates that there are no symptoms of multicollinearity, so it can continue to cluster analysis.

4.2 Clustering Analysis

At this stage, several stages will perform to get good cluster results. With the analysis of agglomerative hierarchy clusters with the Ward method, in this case, it was found that the optimum number of cluster is as many as four, indicated by the WSS value that makes up the elbow, and the highest silhouette score is at $k=4$ as shown in Figure 5. Furthermore, the results of clustering at 781 ATMs visualize in Figure 6.

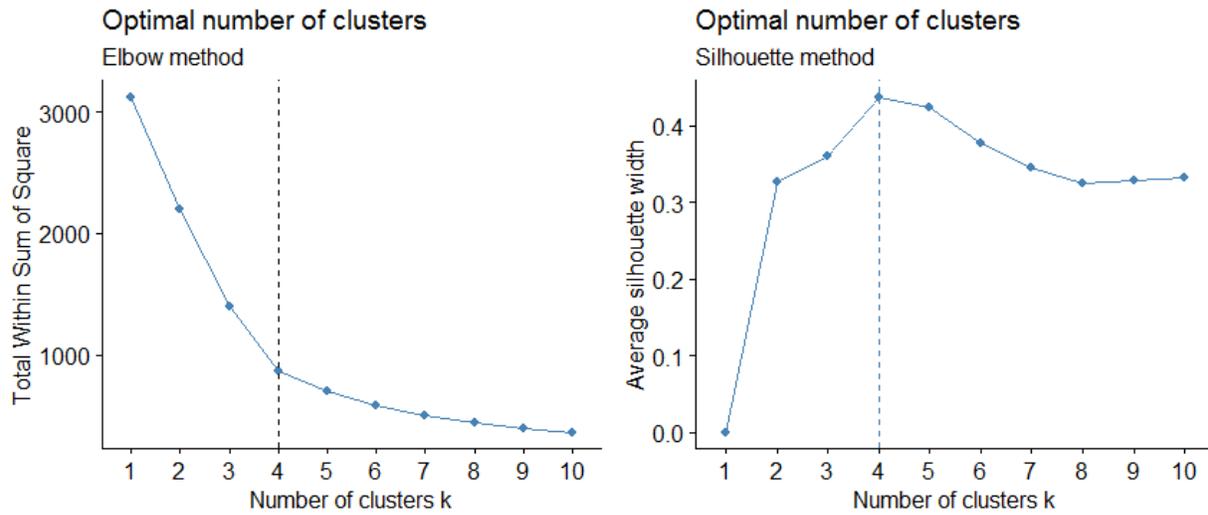
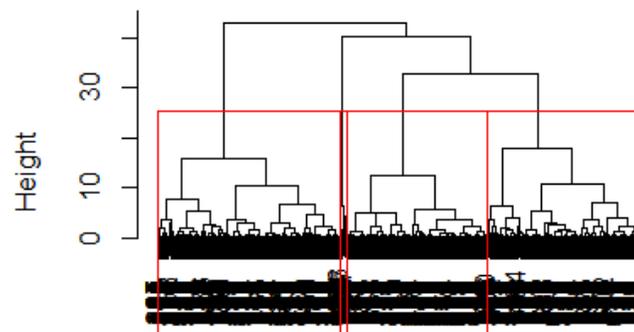


Figure 5. Plot of Elbow Method and Silhouette

Cluster Dendrogram



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x
stats::hclust (*, "ward.D2")
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Figure 6. Clustering Result Visualization

Furthermore, some visualizations of grouping results will be shown to consider concerning the proposed implementation of ATM mapping.

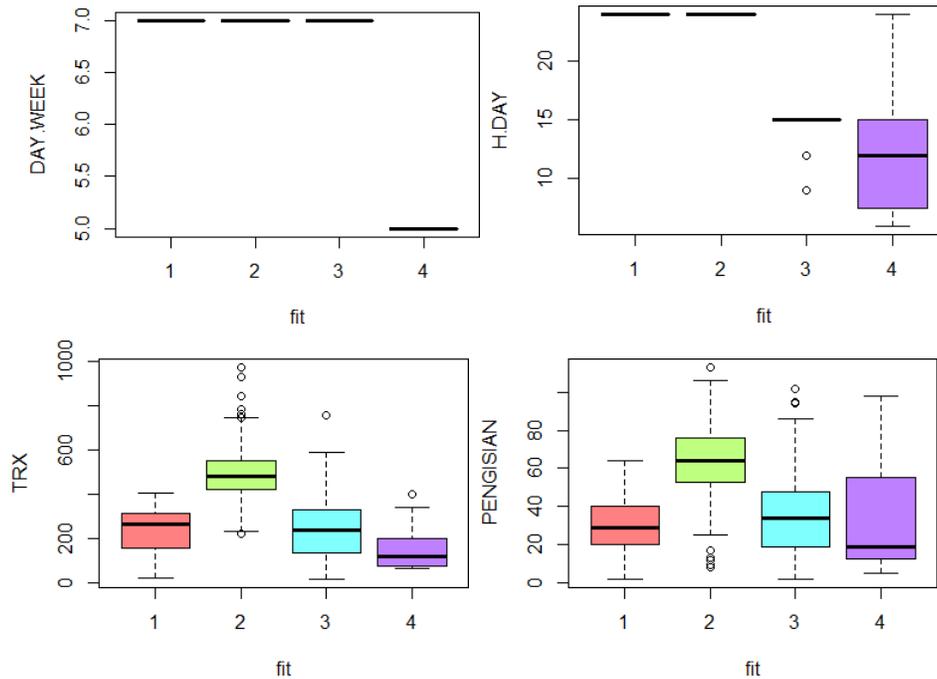


Figure 7. Boxplot Each Cluster Result on Each Variable

An overview of the cluster results can be seen from the visualization in Figure 7. Clusters 1 and 2 have the same operating hours, operating for 24 hours every day; however, only cluster 2 has significantly higher transaction and charging numbers than other clusters. While cluster 1 does not differ in the number of transactions, replenishment with clusters 3 and 4 does not operate for 24 hours. Cluster 3 is an ATM that never operates 24 hours, while cluster 4 is an ATM that only works on weekdays.

Furthermore, in Figure 8, a diagram of the frequency bar of the number of ATMs located in a particular cluster in each supervision branch, where the percentage of non-productive ATMs has sorted the supervision branch from the largest to facilitate interpretation.

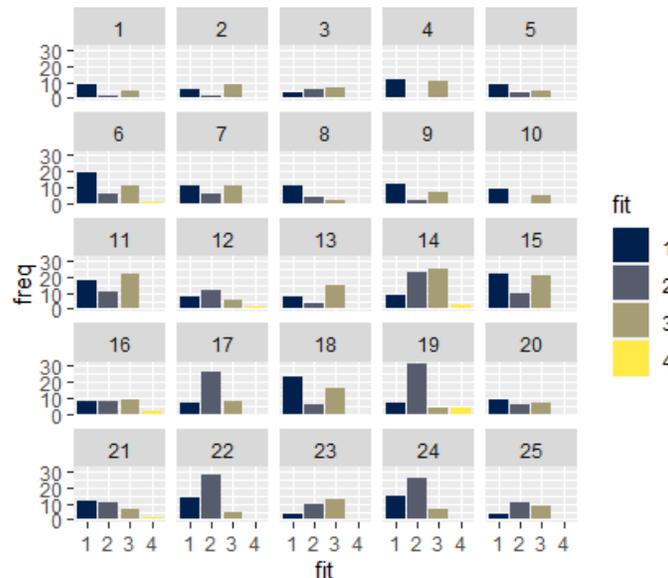


Figure 8. Cluster Result plot bar on Each Branch

It appears that, in general, branches with a more significant percentage of non-productive ATMs tend to be dominant ATM cluster 1 and minimal cluster 2. While units with a smaller percentage of non-productive ATMs tend to show the opposite. Clusters 3 and 4 do not offer such a linear pattern, although cluster 3 tends to have a number in the middle of clusters 1 and 2. This result of analysis means that the number of transactions at ATMs operating for a total of 24 hours does play an essential role in productivity, but it will still be interesting if the potential at an ATM that does not work for a total 24 hours can explore further.

5. CONCLUSION AND SUGGESTION

Based on analysis results, it is shown how pattern caused by the number of transactions also type of operational time to productivity of ATMs both in a region and overall. Related to patterns formed in the area partially, can be formulated evaluation for management based on the analysis results.

- 1) In areas where ATM cluster 1 is dominant, it is indicated that productivity is not good enough. The number of ATMs that operate for 24 hours but have a low transaction rate indicates a problem in the mapping of ATMs in the region. It may be considered to revoke some ATMs, especially cluster 1 ATMs in the area.
- 2) In areas where ATM cluster 2 is dominant, it is indicated that productivity is good. It can be maintained so that productivity does not decrease as long as there is no excessive overload that harms the customer.
- 3) In areas where ATM cluster 3 or 4 is dominant, it is indicated that there is potential to increase overall productivity in the region. It can be considered to do a combination of the revocation of ATM cluster 1 and make the ATM on cluster 3 or 4 as an ATM that operates for a total of 24 hours, proportionally.

Furthermore, in the future, this research can be developed to be more varied. Things like reviewing operating hours variables in more detail, adding variables such as the number of customers in each region, even if combined with geographical circumstances such as area, can be considered for further research.

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CREDIT CARD DEFAULT PREDICTION USING MACHINE LEARNING

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ABSTRACT

The credit card industry had been around for decades and is a product of changing consumer habits also increasing the national income. There has been a significant increase in the number of card issuers, issuing banks to transaction volumes. However, with the increase in credit card transactions, the amount due and the arrears rate of credit card loans are also issue that cannot ignore. This issue is crucial for the successful development of the banking industry in the future. The study focused on modeling and predicting an individual's willingness to repay credit card loans. The methods used in this study are machine learning with random forest approach, artificial neural network, support vector machine, logistic regression, and naïve Bayes. There are 11 variables to be analyzed in this study, and the performance of the five methods will be compared to the evaluation of ROC, and AUC. The result of this research as follows. The random forest method is considered the most appropriate for processing the credit card default dataset with AUC 89%. This model can contribute to the settlement of default probabilities and is of great help to the credit card industry. Based on the PDP, managerially it can be determined that for income and credit card limits the range of 7-50 million is more prone to default.

Keywords: Credit Card, Classification, Default Prediction, and Imbalance Data.

1. INTRODUCTION

Payment failure (default) on credit cards has become a major problem in various financial institutions in the world. The number of defaults on credit cards is motivated by external factors from customers of financial institutions. The improvement of the system in predicting payment failure is expected to reduce the risk of financial loss for banks. There are two mechanisms, among others, to avoid losses due to default: default prevention and default scoring system. Default prevention is a proactive method, which prevents defaults from occurring. On the other hand, a scoring system is needed to predict credit card defaults.

Default credit card deals with the illegal use of credit card information for purchases. Credit card transactions can be done both physically and digitally. In physical transactions, credit cards are involved during the transaction. In digital transactions, this can happen over the phone or the internet. The cardholder usually provides the card number, expiration date, and card verification number by telephone or website.

The emergence of e-commerce in the last decade has also triggered an increase in the

volume of credit card transactions in Indonesia. The volume of credit card transactions in 2013 in Indonesia was around 239 million transactions and increased in 2019 to 349 million transactions [1]. Along with the increase in the number of credit card usage, the number of default cases continues to

increase. Although many authorization techniques have been applied, the case of credit card defaults has not been effectively deterred. The rise of credit card default cases has had a significant impact on the financial industry. The disadvantages of credit card defaults affect the merchandisers, where they cover all costs, including card issuer fees, fees, and administration fees. Because the merchant has to bear the loss, some items are priced higher, or discounts and incentives are lowered. Therefore, it is crucial to reduce losses, and an effective default prediction system to reduce or eliminate default cases is important. In various studies on the prediction of credit card defaults, several machine learning methods are used, such as artificial neural networks (ANN), naïve Bayes, Logistic Regression, support vector machines (SVM) dan Random Forest.

2. LITERATURE REVIEW

2.1 Default credit card

Default Credit card occurs when the debtor is in arrears on credit card payments. This is a severe credit card status that affects not only the debtor's position with the credit card issuer, but also the debtor's credit status in general and the client's ability to get approved for credit cards, loans, and other credit-based services. Data regarding credit card transactions has information about the type of card, account number, location and time of the transaction, number of transactions, balance, credit limit, etc. This information is used as the basis of research to determine or differentiate the default from the user or detect data noise or outliers.

2.2 Credit Risk Scoring

Credit Risk Scoring Method is a standard tool in measuring individual risk levels, which is made based on statistical methods through an assessment of historical data that includes parameters or criteria that are estimated to have a significant influence on customer failure to repay loans (default). The key factors that influence the failure of credit payments consist of two categories, namely the financial category and the non-financial category. Each of these categories consists of several criteria and sub-criteria used to determine credit risk ratings. The purpose of the feasibility assessment with this method is to measure credit risk individually, which is expected to be fulfilled[2].

2.3 Support Vector Machine (SVM)

Support Vector Machine (SVM) was developed by Boser, Guyon, Vapnik and was first presented in 1992 at the "Annual Workshop on Computational Learning Theory." The basic concept of SVM is a harmonious combination of computational theories that have existed decades before, such as the hyperplane margin. The kernel was introduced by Aronszajn in 1950, and so were the other supporting concepts. However, until 1992, there had never been an attempt to assemble these components. The application of SVM for default prediction can be seen in [3].

2.4 Naïve Bayes

Naïve Bayes algorithm is a form of data classification using probability and statistical methods. This method was first introduced by British scientist Thomas Bayes, which is used to predict future opportunities based on past experience, so it is known as Bayes' theorem. The Bayes theorem method is then combined with naivety, assumed to be with conditions between independent attributes. The Naive Bayes algorithm can be interpreted as a method that has no rules. The Naive Bayes uses a branch of mathematics known as probability theory to find the largest opportunity from possible classifications by looking at the frequency of each classification in the training data. Naive Bayes is also a very popular classification method and is included in the ten best algorithms in data mining. This algorithm is also known as Idiot's Bayes, Simple Bayes, and Independence Bayes. Bayesian classification has similar classification capabilities to decision trees and neural networks. Naive Bayes classification is a statistical classification that can be used to predict the probability of membership of a class. Bayes rule is used to calculate the probability of a class. The Naive Bayes algorithm provides a way of combining previous probabilities with possible conditions into a formula that can be used to calculate the probability of each possibility that occurs.

2.5 Logistic Regression

Logistics Regression (sometimes called a logistic model or logit model) is one part of regression analysis that is used to predict the probability of an event occurring by matching the data to the logit function of the logistic curve. This method is a general linear model used for binomial regression. Like regression analysis in general, this method uses several independent variables, both numerical and categorical. Logistics Regression does not require assumptions of normality, heteroscedasticity, and autocorrelation, because the dependent variable contained in Logistics Regression is a dummy variable (0 and 1), so the residuals do not require the three tests. For the assumption of multicollinearity, because it only involves independent variables, it still needs to be tested. For this multicollinearity test, the goodness of fit test can be used, which is then followed by hypothesis testing to see which independent variables are significant so that they can still be used in research. Furthermore, among the significant independent variables, a correlation matrix can be formed. If there are no independent variables that have a high correlation with each other, it can be concluded that there is no multicollinearity disorder in the research model [4]. The application of the logit model for default prediction can be seen in [5].

2.6 Random Forest

Random forest is a bagging method, which is a method that generates a number of trees from sample data where the creation of one tree during training does not depend on the previous tree, then the decision is taken based on the most votes [6]. Two concepts that form the basis of random forest are building an ensemble of trees via bagging with replacement and random selection of features for each tree that is built. The first thing means that each sample taken from the dataset for the training tree can be used again for another training tree, while the second means that the features used during training for each are a subset of the features owned by the dataset [7].

2.7 Artificial Neural Network (ANN)

Neural Networks, better known as Artificial Neural Networks, is an information

processing using performance characteristics similar to delivering human nerve impulses. [8]. The ANN was developed with a mathematical equation model using the following assumptions:

- i. Information processing occurs in the simplest elements called neurons (nodes).
- ii. Between neurons with each other are interconnected and have connections.
- iii. Each connection connects one node with another node and has a certain weighting value.
- iv. Each node has an activation function (usually non-linear) as an input and also to determine the output result.

Another characteristic of a neural network is the existence of an architecture which is a connection between nodes. It takes an activation function that determines the weighting between connections and is commonly referred to as training or learning.

3. METHODS

3.1 Flowchart Diagram

This research will go through six stages, Pre-Processing data (data cleansing), Descriptive analysis (for all data variables), correlation testing (Perform a correlation test between predictor variables with a correlation plot to detect pairs of closely related predictor variables, indicated by a correlation value of more than 0.70. Suppose there is a pair of variables that have a value of more than 0.70. In that case, a feature extraction will be carried out, with PCA), divide the data into training data and testing data (It is known that the proportion of data between default and non-default is 1.7% and 98.3%. Then the proportion of data will be divided into 70:30 with stratified random sampling method), classifying data using predetermined machine learning methods (support vector machine, naïve Bayes, logistic regression, random forest, ANN), Evaluation result (AUC, PDP), comparing result and implement the result into the managerial analysis.

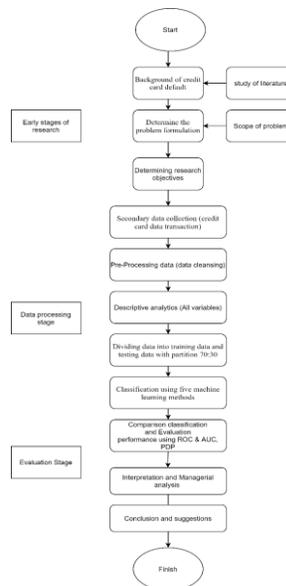


Figure 1. Research methodology

3.2 Data source

Original collection of credit card data from financial institutions at PT. XYZ is used in this research experiment. This data is based on cardholders from the territory of Indonesia in April 2020. It does not collect complete transaction data and is limited to 1000 transactions recorded, with 17 transactions classified as Default. The features used in the experiment are given in Table 2.

Table 2. Research data features

Variabl e	Information	Measurement Scale
X1	<i>Amount</i>	Numerical
X2	<i>Limit</i>	Numerical
X3	<i>Age</i>	Ordinal/Category
X4	<i>Income</i>	Numerical
X5	<i>Collectability</i>	Ordinal/Category
X6	<i>Profession</i>	Nominal/Category
X7	<i>Credit Card Type</i>	Nominal/Category
X8	<i>Marital status</i>	Nominal/Category
X9	<i>Gender</i>	Binary
Y	<i>Default</i>	Binary

4. RESULTS

4.1 Empirical analysis

Exploratory Data Analysis (EDA) played an integral part in understanding the credit card dataset. It was vital to get familiar with different relationships within the data through different plots before moving towards classification. Analyzing these relationships helped us with interpreting the outcomes of the models. Asking questions about these relationships provides us with additional knowledge about relationships that we may not have known existed. This section will further investigate data distribution and ask specific questions about the data lying within the dataset. The credit card has nine features of the transaction. Then, there will be some correspondence between variables to determine the level of correlation formed between variables that are indicated to correlate.

Based on the graph of the correspondence between variables, it can be concluded that there is no relationship between variables for each comparison of variables, so there is an insignificant effect between variables. After that, a correlation check will be carried out based on the correlation matrix for each variable likely, payment status, income, credit card limit, and employment. The relationship between income and limit is not formed due to many outliers (can be seen in the plot of many points that are spread evenly, but there is one gathering point). The outlier cannot be removed because it is a characteristic of the data itself (because there are many outliers).

If there is one pair of predictor variables that has a correlation value greater than 0.7. Then the feature extraction will be carried out using the PCA (Principal Component Analysis) method. Based on figure 3, none of the pairs of variables have a correlation value > 0.7 . So, there is no need for feature extraction. With no single highly correlated variable, classification can be continued. This paper used five machine learning algorithms, the random forest, support vector machine, artificial neural network, logistic regression, and naïve Bayes, to work

out a credit card default prediction model. The model results are shown below with their classification report to get a better understanding of the accuracy and other scores of the five models.

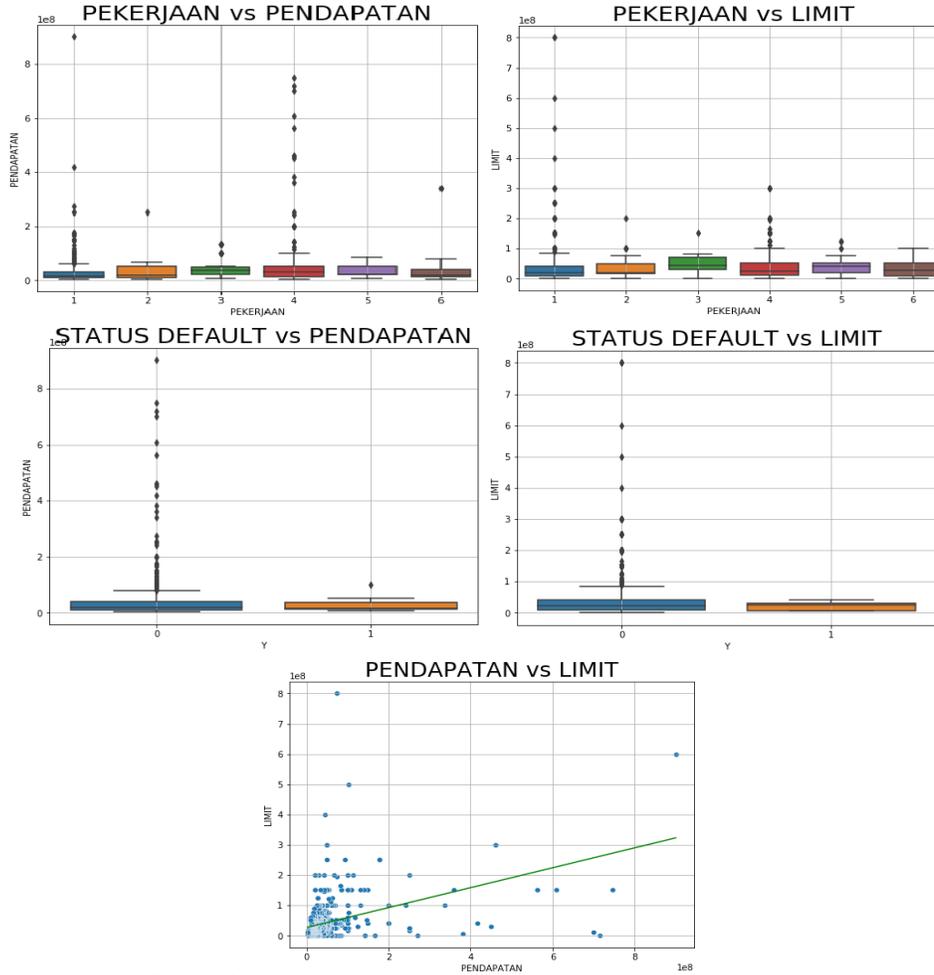


Figure 2. Graph of the relationship between several variables

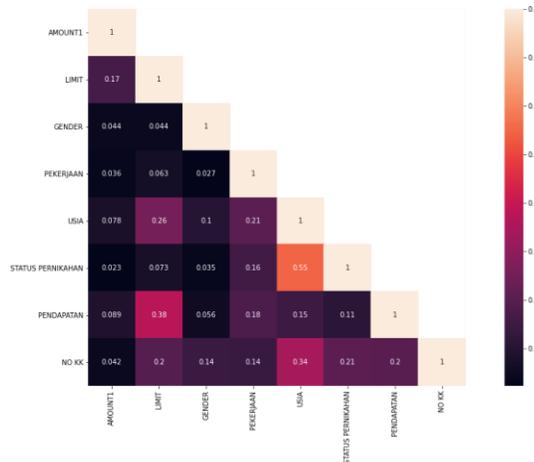


Figure 3. Correlation matrix of several variables

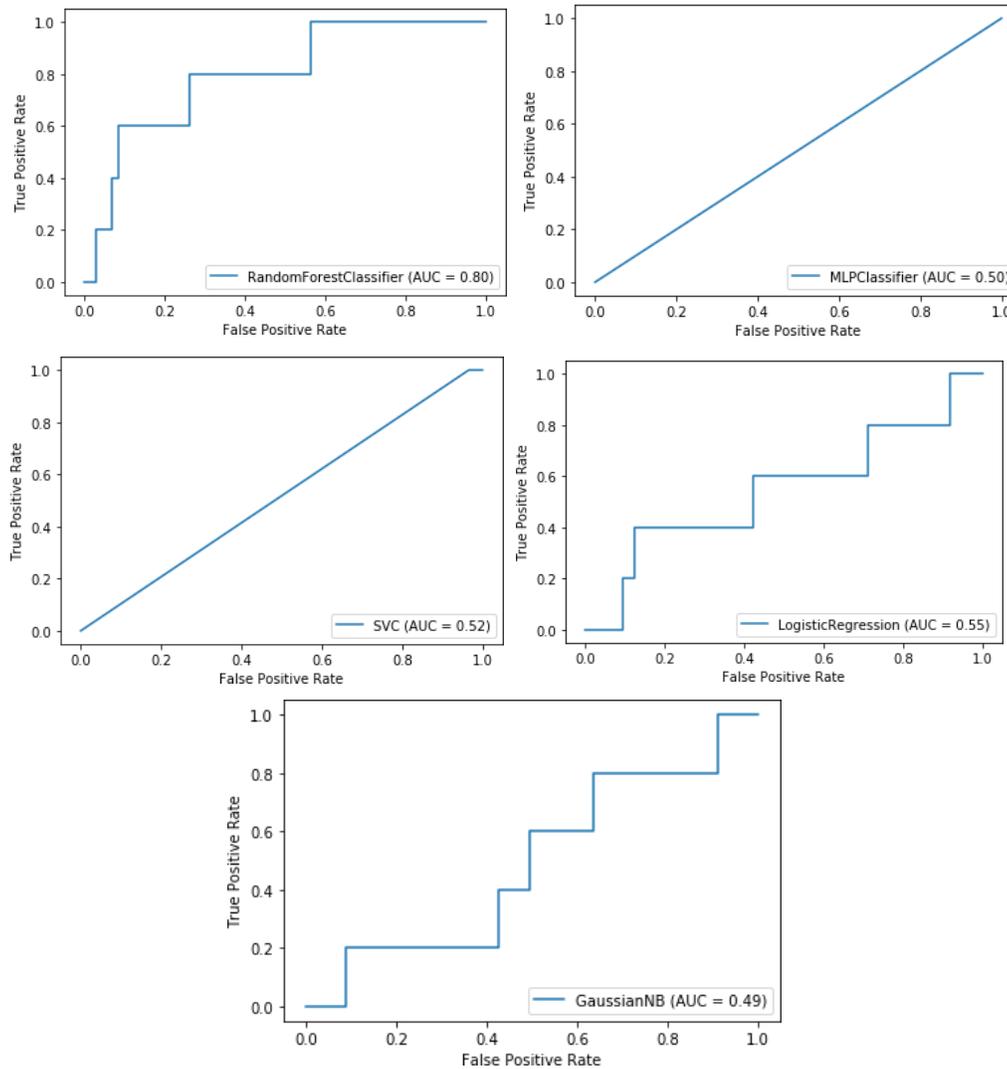


Figure 4. ROC Plot

Based on the ROC plot for each variable, it is known that the steeper the resulting graph, the better the classification method is. Based on Figure 4, it is known that the random forest method produces a fairly steep graph, which means that the random forest method can classify better than the other three methods. The Naïve Bayes method produces the worst classification. The AUC score can be seen in Table 3.

Table 3. Summary of AUC score from several classification methods

Classification Methods	AUC
Random Forest	0,80
Logistic Regression	0,55
Support Vector Machine (SVM)	0,52
Artificial Neural Network (ANN)	0,50
Naïve Bayes	0,49

The results obtained in Table 3 are the best results from each classification method (based on several comparison coefficients). It is known that the Random Forest classification

produces the highest AUC score, which is 0.80. The Naïve Bayes method produces the lowest AUC score. Once the best classification method is known, a partial dependency plot will be shown for several variables that most influence the default, namely limits, age, and income. The following is a Partial Dependence Plot (PDP) of the three variables.

4.2 Partial Dependence Plot (PDP)

The PDP can show whether the relationship between targets and features is linear, monotonous, or more complex. For example, when applied to a linear regression model, the partial dependency plot always shows a linear relationship. For classifications where the Machine Learning model outputs probabilities, the partial dependency plot displays the probabilities for a given class assigned different values for the features. An easy way to handle multiple classes is to draw one line or plot per class. In this study, PDP uses income, age, and limit variables. The following is the PDP of the three variables.

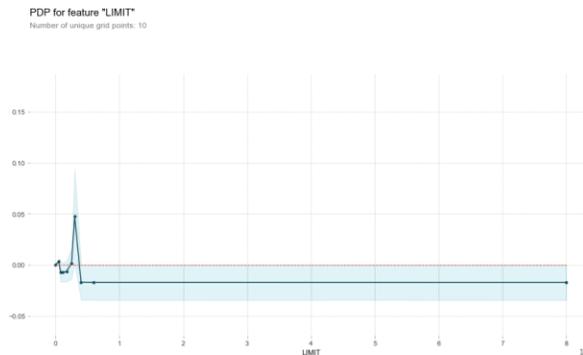


Figure 5. PDP of the limit variable

Based on Figure 5, it is known that there was an increase in plots of around 7 to 30 million, and after that, there was no plot movement. It can be concluded that around the credit limit of 7 to 30 million, there is an increase in the probability of default. So, to apply for credit with a limit of 7 to 30 million, credit card issuers have to tighten the requirements because defaults are the most common in that range. The following is the PDP of the age variable.

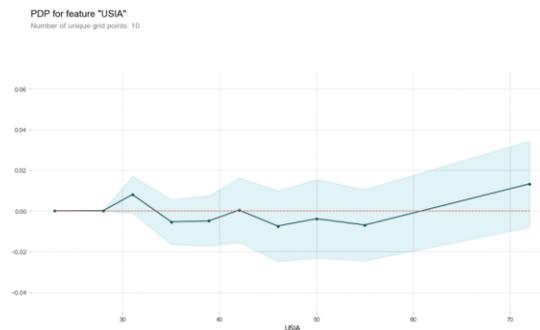


Figure 6. PDP of the Age variable

Based on Figure 6, it is known that there is an increase in the probability around the age of 27 to 32 and after the age of 60 years. It was concluded that in the age range of 27 to 32 years, and after the age of 60 years, there were many defaults. So for credit card service providers around the age of 27 - 32 and above 60 years are given a more stringent selection in credit card considerations. After that, the PDP will be obtained from the income variable.

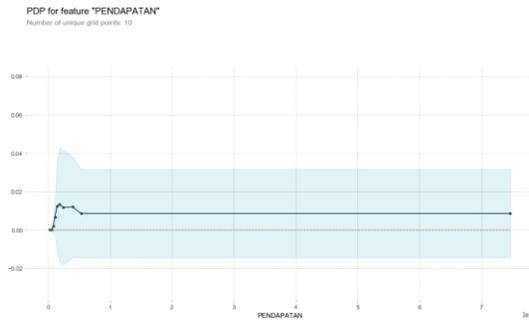


Figure 7. PDP of the income variable

Based on Figure 7, it is known that there is an increase in the probability in the range of 7 – 50 million, and after 50 million Rupiah, it has a positive but stable probability. It is concluded that in the income range of 7 – 50 million Rupiah, there is an increase in the probability of default, and above 50 million Rupiah has the same default probability. So, all income levels have a probability of default, but the lowest is in the income range of 7 – 50 million Rupiah. So, there is no need for a selection distinction for credit card service providers based on income except in the income range of 7-50 million Rupiah because the probability generated is higher. However, all income levels have a probability of default.

The movement is relatively the same in PDP based on income and credit card limits, around 7-50 million. Based on several theories regarding the structure of company workers with the salary they receive for each structure, it is known that for the range 7-50 million are workers with the structure as managers (managers). Meanwhile, below 7 million are operators (production), and above 50 million are policymakers (strategic). Based on the PDP, it can be explained that for the level of manager-class workers who have the highest probability of default.

5. CONCLUSIONS AND SUGGESTIONS

This paper aimed to explore, analyze, and build a machine learning algorithm to correctly identify whether a person, given certain attributes, has a high probability of defaulting on a credit card. Credit card transactions could use this type of model to identify certain traits of future borrowers that could have the potential to default and not pay back their loan by the designated time.

- 1) Based on five classification methods used in this study (Logistics Regression, Naïve Bayes, SVM, Random Forest, and ANN). The resulting accuracy rate is based on the highest AUC score obtained by the random forest method, with an AUC score of 0.80. So, for the classification of default credit can use the Random Forest.
- 2) Based on the PDP of several variables, it is concluded that
 - a. For the Limit variable, there is an increase in the default probability at the limit of around 7 – 30 million Rupiah. So that requests for credit cards with a limit of 7 – 30 million Rupiah require a more stringent selection because the probability of default is quite large.
 - b. For the Age variable, there is an increase in the probability of default at the limit around the age of 27 – 32 years and more than 60 years. So that requests for credit cards with the applicant's age around 27-32 years and above 60 years

require a more stringent selection because the probability of default has increased.

- c. For the Income variable, there is an increase in the default probability at a limit of around 7 – 50 million Rupiah. However, for the entire income range, it yields a positive probability of default.
- 3) Based on the PDP of several variables, it is concluded that based on the results of the PDP on income and credit card limits, it is known that managers class workers have a higher probability of default than other working classes. So that based on PDP on income and credit card limits, it can be used as a reference for selection for credit card applicants.

So, for any income, there is a default probability. So, there is no difference in a selection based on income because each income level has a default probability that tends to be the same. Since the algorithm puts some non-defaulters in the default class, we might want to look further into this issue to help the model accurately predict capable credit card users. For the management, it can consider the conversion of positions that can be universally allocated, which means equalizing a job into a level of position. With the universal job conversion, data quality, especially job data, becomes more valid and accurate for selecting credit card applicants whether to be accepted or rejected.

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CIRCULAR ECONOMY FRAMEWORK IN CIGARETTE FILTER COMPANY (CFC) USING MATERIAL CIRCULARITY INDICATOR (MCI)

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ABSTRACT

Living in a finite planet and operating in linear take-make-dispose system strains our resources and stresses businesses with increased material costs and scarcity. As a result, there is a growing desire among businesses to adopt Circular Economy (CE). In order to track the transition to a more CE, it is important to obtain adequate tools to monitor and quantify this CE journey. The Material Circularity Indicator (MCI) is computed using the feedstock's virgin, reused, and recycled inputs. However, the present MCI tool does not encompass material flows within B2B company that produces intermediate goods. In this study, a modified MCI is presented and tested to accommodate the circularity journey of Cigarette Filter Company (CFC). As a result, switching to cellulose as a filtration media is preferred in order to achieve the maximum MCI calculation within CFC.

Keywords: Circular Economy, Material Circularity Indicator, Recycle, Reuse.

1. INTRODUCTION

Living in a finite planet and operating in a linear take-make-dispose system strains our resources and stresses businesses with increased material costs and scarcity (Evans and Bocken, 2014). A circular economy (CE) is an alternative global economic model that aims to decouple economic growth and development from the use of finite resources (Ellen MacArthur Foundation, 2015a). Businesses are exposed to supply disruptions and price volatility as a result of rising demand and scarcity of natural resources, risking their long-term profitability and survival. As a result, there is a growing desire among businesses to adopt sustainable practices such as CE (Ellen MacArthur Foundation and McKinsey & Company, 2014). Sustainable value creation is fostered by a more balanced, systemic, and comprehensive approach in a CE strategy, which improves a company's total economic, environmental, and social performance (Fonseca et al., 2018). Circularity has also opened up new markets, led to the formation of new business models, and created new business prospects (European Commission, 2018).

The CE's concept contains two long threads, the first of which is concerned with the

flow of materials through an economy, and the second with considering the economic conditions that can lead to such a flow (Ekins et al., 2019). It is becoming vital for actors and industrial practitioners to obtain appropriate methodologies and tools, including indicators, to monitor and quantify this CE journey in order to track and successfully achieve the transition to a more CE

(Geng et al., 2012). Furthermore, introduction of the CE principles requires continuous monitoring of how effective a company is in making the transition from the linear to the circular models (Ellen MacArthur Foundation, 2015a). Circularity indicators are being developed primarily for use in product design, but they could also be used for internal reporting, procurement, and investment decisions (Ellen MacArthur Foundation, 2015a). Ellen MacArthur Foundation (EMF) is one of the organizations that recognized the lack of circularity indicators and launched projects to measure product circularity and the transition to circularity (Saidani et al., 2017). In 2015, EMF together with Granta Design developed the Material Circularity Indicator (MCI). MCI is built on four ideas that focus on the restoration of material flows at the product and company levels: i) using feedstock that has been reused or recycled ii) once the product has been used, reusing components or recycling materials iii) extending the life of products iv) making more intense use of products (Ellen MacArthur Foundation, 2015a).

Cigarette Filters Company (CFC) is a B2B company in Indonesia who manufactures cigarette filters. CFC's value proposition is an independent provider of innovative special filters that provides solutions to meet the consumer driven demands in tobacco industry. CFC has a four-pillared sustainability strategy: responsible response consumption, energy and climate change, people and community, and a responsible supplier chain. CFC has also conducted their first sustainability materiality evaluation, which was overseen by an external consultant and followed a standardized approach. CE has been highlighted as a sustainable component in CFC, albeit its relevance remains limited to the specific pillar of responsible resource usage.

Indonesia has also committed to incorporating CE concepts into its vision and development plans by 2045, with subsequent steps including the establishment of a National Action Plan and the inclusion of CE in the next National Medium-Term Development Plan (RPJMN) 2025-2029 (Ministry of National Planning and Development Indonesia, 2021). According to British American Tobacco (BAT), one of the largest participants in the tobacco business, embracing CE principles will result in better products for consumers, more operational efficiency, chances for staff to innovate, and a reduction in BAT's total environmental impact (BAT, 2019). Since many policymakers, such as those in Indonesia, and a rising number of organizations, such as BAT, as one of CFC's top customers, are implementing CE strategies, demonstrating how important and urgent CE implementation is. As a result, the research problems investigated in this work are:

1. to apply MCI tool that applicable for B2B company to measure current CE level in CFC
2. to propose a product design that adheres to the CE framework in order to improve MCI in CFC

2. LITERATURE REVIEW

2.1. Circular Economy

CE has attracted international attention in recent years as a viable alternative to the

conventional take-make-waste model of manufacturing and consumption (Tonelli and Cristoni, 2018). CE was first founded in the 1970s with the goal of promoting a world in which nothing goes to waste (World Economic Forum, 2018). The Ellen MacArthur Foundation (EMF) is currently seen as the world leader in CE thinking. According to EMF (2015b), CE is characterized as “an economy that is restorative and regenerative by design and aims to keep products, components, and materials at their highest utility and value at all times, distinguishing between technical and biological cycles”. Scaling up the CE from early adopters to the majority of economic players will help to achieve carbon neutrality by 2050 and decouple economic growth from resource use (European Commission, 2020). The CE is becoming more widely recognized as a promising way to alleviating global environmental constraints (Bocken et al., 2016), while also providing positive economic profit (Brinkman, 2015). It has been projected that transition to the CE could unlock USD \$4.5 trillion of GDP growth worldwide by 2030 (Lacy and Rutqvist, 2015).

2.2 Material Circularity Indicator

To overcome the lack of instruments for a CE transition, EMF (2015b) proposes the MCI, designed for internal usage by businesses in the development of new goods, internal reporting, and procurement. It combines a measure of restorative flows with complementary impacts and risk indicators to create a holistic picture. In comparison with Life Cycle Assessment (LCA), the MCI methodology considers flows instead of impacts. The MCI (value between 0 and 1) is computed using the feedstock's virgin, reused, and recycled inputs, as well as the reused input. It takes into account the duration and intensity of use, as well as the end-of-life scenario. The Bill of Materials for the product is the MCI's input (Dwek, 2018).

2.3 Cigarette Filters

Cigarettes used to be unfiltered, but the tobacco industry began marketing filtered cigarettes as a "healthier" alternative to unfiltered cigarettes in the 1950s. This transformation irrevocably changed the industry, making filtered cigarettes the most popular tobacco product (Harris, 2011). The main ingredient in cigarette filters is Cellulose Acetate (CA), which is a compressed plastic product, which not biodegradable and have an extremely slow decomposition rate (Bonanomi, et al, 2015). The first-ever European strategy for plastics in a CE, which was agreed in January 2018, will change the way plastic items are designed, used, produced, and recycled in the EU, promoting more sustainable and safer plastic consumption and manufacturing patterns (European Commission, 2018).

3. METHODS

In comparison to a similar industry-average product, the MCI for a product assesses the extent to which linear flow has been minimized and restorative flow has been maximized for its component materials, as well as how long and intensively it is utilized.

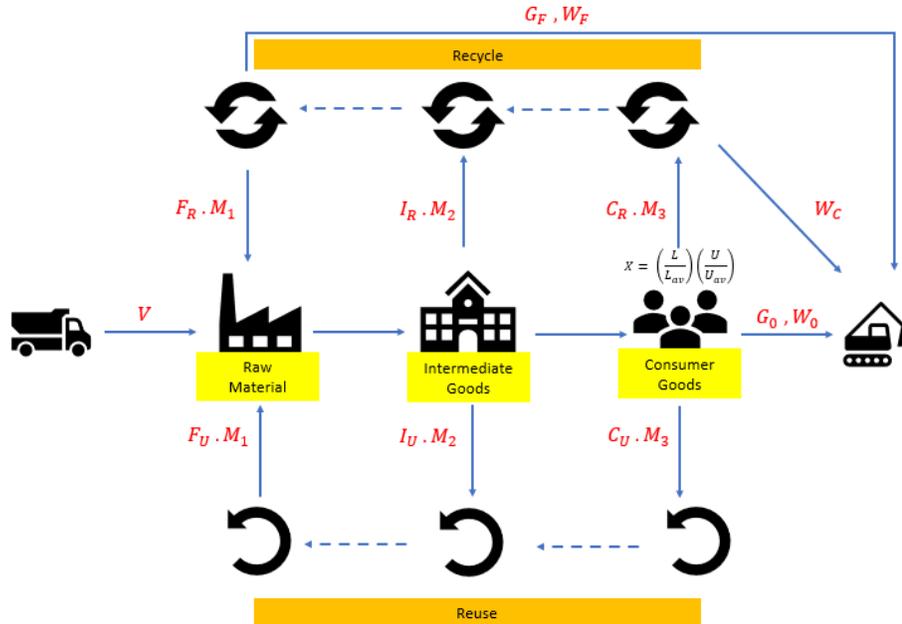


Figure 1 Diagrammatic of modified MCI to represent MCI formula (*source: own*)

Regrettably, the present MCI tool developed by EMF to evaluate the extent of circularity does not encompass material flow within B2B company that produce intermediate goods. In this study, a modified MCI is presented and tested to accommodate B2B company, with the study taking place in CFC, a cigarette filter manufacturer. The associated material flows are summarized in Figure 1.

The MCI is calculated by adding together the following variables (Ellen MacArthur Foundation, 2015a; Janik A.; Ryszko A., 2017):

- the Linear Flow Index (LFI), which measures the proportion of materials flowing in a linear fashion, sourced from virgin materials (V) and ending up as unrecoverable waste (W); the index takes a value between 1 and 0, where 1 is a completely linear flow and 0 a completely restorative flow

$$LFI = \text{Linear Flow Index} = \frac{V + G + W}{3M + \frac{G_F}{2} + \frac{W_F - W_C}{2}} \dots\dots\dots(1)$$

- the utility factor (X), which takes account of the length of the phase of the product use (lifetime) and the intensity of the product use (functional unit)

$$X = \left(\frac{L}{L_{av}}\right) \left(\frac{U}{U_{av}}\right) \dots\dots\dots(2)$$

- The MCI, single score, gives a value between 0 and 1 where higher values indicate a

higher circularity. In order to compute the MCI, the following formulae defining relevant variables need to be applied:

$$MCI = 1 - LFI \cdot F(X)$$

.....(3)

Several design approaches were developed and evaluated utilizing the modified MCI formula and material flows as stated above in order to improve the MCI of product in CFC. In addition, certain significant aspects were added, such as legislation and economic benefit.

4. RESULTS

CFC produces a wide range of cigarette filters with a variety of filter configurations, starting with the most basic, known as a mono filter, and progressing to dual, triple, and quad format filters, which are made up of several mono segments. Because CFC is a B2B company that manufactures cigarette filters for cigarette businesses, its forecast is highly reliant on demand from its customers, not directly from end consumer. To test the current MCI of product in CFC, this research was started primarily with the basic filters format, which is mono filter, by identifying the highest production volume and long run production. This with consideration, improvement to the more circularity model will bring bigger benefits to CFC. The research was continued by assessing the Bill of Materials (BOM) to get the specified quantity of CA was set by theoretical product design. This MCI calculation, will be focused on the CA material only, as it is the main material in cigarette filters which builds up to 90% weight from finish filters.

With the input from CFC's consumption material data, a general customized table or an MCI dashboard can be created to calculate the circularity of CA material, The MCI dashboard has been divided into two tables: Table 1 for input data and Table 2 for output data from excel calculations, both tables show the existing MCI level of the Mono06 item. Several schemes can be built using the following generic table from excel calculation to acquire the best suggestion in order to improve MCI, notably in CFC. Table 3 summarizes all design plans; the parameters for raw material supplier and cigarette company stay the same. The reuse scheme does not apply to CA waste since the shape of CA changes after the creation of cigarette filters because it bonds with plasticizer. This MCI improvement is solely focused on CFC, with the goal of improving MCI through activities that can be implemented internally, such as reprocessing CA waste into plastic pellets and selling them to a third party, or investing in extrusion technology, which might be used to start a diversification business. Another option is to redesign the material to be entirely made of cellulose, a free plastics material, which is safer for the environment, and to adhere to EU regulations such as the Single Use Plastics Directive (SUPD). Table 4 shows the MCI results and regulatory considerations for the various designs discussed above.

Table 1. MCI input parameters of Mono06 existing design

Raw Material Supplier

% Recycled to feedstock (F_R)	0
% Reused to feedstock (F_U)	0
B2B Company (Intermediate Goods)	
Product code	Mono06
Mass based on BOM	0.544
% Recycled after manufacture (I_R)	0
% Reused after manufacture (I_U)	0
% Efficiency of recycling to feedstock (F_F)	0
B2C Company (Consumer Goods)	
% Recycled after use (C_R)	0
% Reused after use (C_U)	0
% Efficiency of recycling at the end phase (E_C)	0
% Efficiency of recycling to feedstock (E_F)	0
B2C Company (Consumer Goods)	
Lifetime of product/material	2
Average lifetime of similar type industries	2

Table 2. MCI input parameters of Mono06 existing design

Output	Result
Virgin Feedstock (V)	0.506
Waste from cigarette filters going to landfill/energy recovery (G_0)	0.506
Waste generated in the recycling process for feedstock (G_F)	0.506
Waste total during/after cigarette filters manufacturing (G)	0
Waste from cigarette going to landfill/energy recovery (W_0)	0.506
Waste generated in the recycling process at the end phase (W_C)	0.506
Waste generated in the recycling process for feedstock (W_F)	0
Waste total during/after cigarette manufacturing (W)	0.506
Linear Flow Index (LFI)	1
Utility (X)	1
Material Circularity Indicator (MCI)	0

Table 3. Various designs proposal to improve MCI in CFC

	Baseline	Redesign: Recycle material	Redesign: Recycle material	Redesign: Material change
Filtration material	Cellulose Acetate	Cellulose Acetate	Cellulose Acetate	Cellulose
Feedstock source	Virgin material + Chemical treatment	Virgin material + Chemical treatment	Virgin material + Chemical treatment	Virgin material
Material mass	0.5440	0.5440	0.5440	0.7340
Destination after cigarette filters manufacturing	No recycling and no reuse	Recycling 50% to plastic pellets	Recycling 75% to plastic pellets	Recycling 100% to cellulose

Table 4. MCI results and regulation consideration of various designs proposal

	Baseline	Redesign: Recycle material (A)	Redesign: Recycle material (B)	Redesign: Material change
Material Circularity Indicator (MCI)	0	0.167	0.250	0.333
Average material cost	Existing material cost	No change from baseline	No change from baseline	+/- 25% reduction from baseline
Regulation	Considered as plastics; cigarette company may face Extended Producer Responsibility (EPR) policy in some countries	Considered as plastics; cigarette company may face Extended Producer Responsibility (EPR) policy in some countries	Considered as plastics; cigarette company may face Extended Producer Responsibility (EPR) policy in some countries	Free plastics material, 100% nature source, faster (bio)degradable

The use of cellulose in the cigarette filter industry is not yet widespread, as it necessitates equipment that differs from that used to process CA. However, given the advantages of circularity and comply with nowadays regulation, this material is worth further development.

5. CONCLUSIONS

Despite the numerous CE frameworks recently offered by some organizations, CE is increasingly being transformed into defined action plans with particular indicators. However, it is obvious that the majority of the indicators are concerned with material preservation measures. This study focused on the quantitative micro scale indicator implementation, i.e., measuring the material flows within the supply chain system to determine circularity at the organizational level. This study provides a modified MCI to improve the existing was designed by EMF to suit B2B company or intermediate goods manufacturer which not covered yet. The circularity level of current CFC's product was measured using this modified tool. As well as decision-making tool for product redesign to improve CFC circularity. As a result, switching to cellulose as a filtration media is preferred in order to achieve the maximum MCI calculation while also complying with SUPD regulations. CE is a comprehensive economy system, which necessitates its application by all company practitioners. Later, in order to maximize the MCI, the circularity improvement journey would require collaboration from all business roles.

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SENTIMENT ANALYSIS OF DISPLACEMENT INDONESIAN CAPITAL TO EAST BORNEO PROVINCE IN TWITTER USING NAÏVE BAYES BASED TWO OR THREE CLASSIFICATION

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ABSTRACT

The policy of displacement Indonesian capital was recently announced by the Indonesian government. This policy was taken because Jakarta as an Indonesian capital has increasingly complex problems. After the President announced regarding the plan to displace the Indonesian capital, it become a hot issue of discussion on the social media platform Twitter. This issue is considerable interesting for there are two opinions that develop within the general on public jakarta as a capital, the opinion in favor of the policy and the one that opposes it, with each side having their own arguments. It is necessary to have accurate information on how many citizens support the policy and how many are against it. Therefore, this study is essential in showing the pattern of public sentiment towards a decision-making policy. study on public opinion concerning the moving of the capital city plays a vital role in curbing the possible emergence of vehement protests (anti-policy). This study managed to build a classifier model of public sentiment patterns on the social media platform Twitter based on keywords in Indonesian. The naïve Bayes classifier model is based on two-class and three-class sentiment. The best results is shown by the two-class classifier, with a score of 78%. The two-class naïve Bayes method has an excellent level of accuracy as a polarity classification of public opinion. The naïve Bayes three-class classification requires additional methods to increase the score in each evaluation. For future study, it would be better to use feature selection to increase the accuracy of the classifier.

Keywords: Sentiment Analysis, Government Policy, Naïve Bayes.

1. INTRODUCTION

The Indonesian government has recently announced its Indonesian Capital Displacement Plan policy. The increasingly complex problems of Jakarta as an Indonesian capital make it necessary to carry out this policy. Geographical conditions, demographic dividend, political, economic centralize, and social activities are the causes of many problems in Jakarta. Some exhibits of problems that constantly occur in Jakarta are traffic congestion, the increasing rate of urbanization in Jakarta, and annual flooding. Traffic congestion in Jakarta makes Indonesia suffer economic losses of up to 28.1 trillions rupiahs every year (Mirlanda, 2011). In addition, the concentration of economic activity and development in Jakarta causes

the rate of urbanization to Jakarta to continue increasing every year (Agassi, 2013). In addition, the annual flooding disrupts

economic and government activities (Wijaya in The Jakarta Post, 2018; Agassi, 2013). Jakarta as an Indonesian Capital give huge contribution of growth economy in Indonesia based on Quarter II in 2019 by 5.71 percent of growth year on year and above the average economic growth of 34 provinces (Badan Pusat Statistik Jakarta, 2019) so that there is economic inequality in Indonesia. Due to the many problems that occur and accumulated in the Capital of Indonesia, the government took a crucial step by moving the Capital of the Republic of Indonesia to Penajam Panser, East Kalimantan.

The making of a crucial policy such as the one regarding the moving of the Indonesian capital will naturally raise supportive opinions and anti-policy opinions. These opinions need to be sorted out and chosen by the government to carry on with the policy. Nowadays, we can use the social media platform Twitter to examine opinions from people who support the government policies and the ones who oppose them as there are 140 million active Indonesian users who regularly tweet, resulting in more than 400 million tweets every day. According to Kumar, Morstatter, and Liu, Twitter plays a vital role in socio-political events for its speed and ease of publication have made Twitter an indispensable medium of communication for people from all walks of life (Kumar, Morstatter, & Liu, 2014). The substantial amount of information and public opinions makes it necessary to use a model to classify the trend of public opinions. It becomes so interesting for there are two opinions that develop within the general public, the opinion in favor of the policy and the one that opposes it, with each side having their own arguments. It is necessary to have accurate information on how many citizens support the policy and how many are against it. On that premise, this study is essential in showing the pattern of public sentiment towards a decision-making policy.

This study applies sentiment analysis to examine the trend of public opinions. According to Ahmad, sentiment analysis is a computer-based systematic analysis of written texts or excerpts of a speech to determine the attitude of the writer or speaker toward a particular topic (Ahmad, 2011). The problem of sentiment analysis is in the classification of sentiment polarization. This classification of sentiment aims to see how much polarization of public opinion is anti-policy so that the government can use it to curb anti-policy polarization so that it does not grow massive. One way to help solve classification problems is to use the naïve Bayes algorithm. Naïve Bayes classification has good performance and has an error rate that is minimal compared to the other methods of classification, even though it uses the “naïve” and quite a simple assumption.

This study aims to determine the polarization of public opinion, which is able to show a pattern of sentiment toward a decision-making policy. Study regarding the public opinion on the relocation of the Indonesian capital plays a vital role in curbing the possible emergence of vehement protests (anti-policy). It can also show the amount of anti-policy opinions so that the government can control them. For instance, the government could give socialization through online media in a language style that the wider audience finds appealing.

2. LITERATURE REVIEW

Companies frequently use the study of sentiment analysis to increase revenue by looking at product reviews from customers. However, it can also be used to see public opinion on a particular topic. Researchers such as Fang, et al. (2018), and Martin-Domingo, et al. (2019)

reviewed customers using sentiment analysis, whereas Lei and Liu (Lei & Liu, 2018), Öztürk and Ayvaz (Öztürk & Ayvaz, 2018), Teran and Mancera (Terán & Mancera, 2019), Asif, et al. (2020), Hand and Ching (Hand & Ching, 2019) used sentiment analysis for specific topics. Fang, et al. (2018), conducted a sentiment analysis on customer opinions in Chinese phrases. The researchers used several strategic methods in sentiment analysis because of the puzzling characters of Chinese phrases. The results obtained were quite effective in seeing the strength of customer polarity by using the Support Vector Machine and Naïve Bayes classification in classifying textual documents (Fang, Tan, & Zhang, 2018). Furthermore, Martin-Domingo, et al. (2019) used sentiment analysis to improve the quality of service on the airport, based on comments on social media. By using sentiment analysis, Martin-Domingo, et al. (2019) discovered that there were good and bad areas in airport service performance. Therefore the decision-makers would have a strong basis of reasons to improve their services. On the other hand, a study conducted by Lei and Liu (Lei & Liu, 2018) identified sentiment patterns in strategic speeches made by American presidential candidates. The study discovers that presidential candidate Trump repeated negative sentiment as his best campaign strategy. Öztürk and Ayvaz (Öztürk & Ayvaz, 2018) conducted sentiment analysis related to Syrian refugees on two types of tweets: English tweets and Turkish tweets. Analysis of the two types of tweets has quite different results. Turkey's tweet sentiment towards Syrian refugees tends to be positive. They focus on caring for the refugee community. On the other hand, English-language tweets have both a neutral inclination and negative sentiment, focusing on the legal aspects of immigration and the political situation. In another study by Teran and Mancera (Terán & Mancera, 2019), they used direct answers and questionnaires method to develop sentiment analysis for Voting Advice Application users as an element to create candidate profiles that match the users' needs. Asif, et al. (2020) conducted a sentiment analysis study on extremists on social media in a particular area, with the classification of high, medium, low extremists, and neutral. They used naïve Bayes and linear support vector as method of classification. In addition, Hand and Ching's study (Hand & Ching, 2019) discusses the relationship between social media users' reactions to police agents and the issue of police shooting civilians using the Google Clouds natural language API. However, these studies used the conventional classification process without taking the speed of data processing into account.

There have been many discussions concerning the classification process development. However, discussions on the use of textual data processing are still seldom conducted. As an instance, the study conducted by Rahab, et al. (2019) used a classification method based on Support Vector Machine, Naïve Bayes, K-Nearest Neighbors to analyze newspapers comments written in Arabic. The results obtained depend on stemming, which gives differing classifications. In that study, Rahab, et al. (2019) still used the conventional classification process. Hasonah, et al. (2020) developed the use of algorithms derived from natural occurrences in the use of textual data classification processes. They combined the *Multi-verse optimizer algorithm* with a support-vector machine classification process for the best feature selection. The results show that the use of metaheuristic algorithms is able to support the classification process and increase the percentage.

3. METHODS

This study has five main stages: identification of problems and formulation of initial hypotheses, retrieval and initial processing of raw data, data processing with naïve Bayes

classifier, analysis of the results, and the last step is drawing conclusions and offer suggestions.

Identification of the problem begins with examining the issue of Indonesian Capital Displacement Plan, which causes division of opinion in the community, as seen from public opinion on social media platforms, especially on Twitter. It is necessary to polarize public comments to identify the trends of the general public opinions. The extensive amount of people's comments or opinions on the social media platform Twitter make the identification process more difficult and time-consuming, so this process requires tools to make the identification process more efficient. One of the tools to identify the public opinions is the analysis of sentiment. Based on that premise, the initial hypothesis is that we can use sentiment analysis to identify public opinion.

After determining the initial hypothesis, the next step is to collect data on public opinion on Twitter to capture the phenomena that occur in the socialization process regarding the moving plan of the capital city. This study uses the data scraping method to collect data. The process took place from August 26, 2019 to February 2, 2020. The Twitter data scraping step is done by building the *source code* in Python. After retrieving the raw data, the next step is preprocessing the data. Data preprocessing is the initial step to convert raw data into data that is ready for further processing. The steps of this stage are *filtering labeling data*, *data cleaning*, *case folding*, *spelling normalization*, *stopwords removal*, *tokenizing*, and *stemming*. The result is ready-to-process data for the classification process.

The following process is to determine the weight value using TF-IDF. The TF-IDF weighting converts words into vector data which is then assigned a value or weight for each word which can then be processed using a classification algorithm. Naïve Bayes classification is a classification with a simple statistical probability approach to calculate a set of probabilities using the number of frequencies and combinations of the given datasets. There are two major approaches to analyze the polarisations of public opinions. They are (1) public opinion with two polarizations (positive and negative) and (2) public opinion with three polarisations (positive, negative, and neutral). The results of the two approaches were then analyzed using a comparative model evaluation which included accuracy, precision, sensitivity, and F1 score.

The next process is drawing conclusions and suggestions. The researcher concludes the results of the analysis and formulates several suggestions for the development of further research. The following flowchart in Figure 1 provides an overview of the steps and stages of the research process.

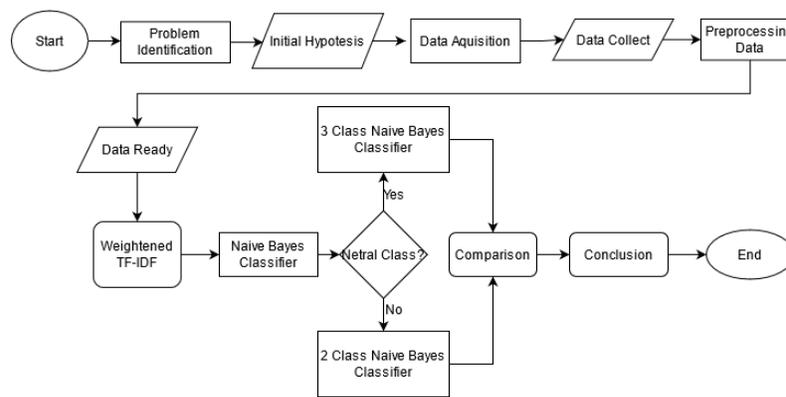


Figure 1. Research Methods

4. RESULTS

The researcher conducted data scraping between August 26, 2019 to February 2, 2020 and retrieved 19985 tweets related to the plan to move the capital city: with 6640 positive tweets supporting the plan, 8911 neutral tweets or nonpartisan opinions about the plan, and 4434 negative tweets or opinions opposing the plan. To keep the proportion of each class in balance, the researcher took 4000 data per class from the tweets.

4.1 Naïve Two-class Classification

Based on the results of the naïve Bayes two-class classification (positive and negative), the results of the confusion matrix evaluation are as follows:

Table 4. 1. The results of the Naïve Bayes two-class classification

	-1	1
-1	936	241
1	296	927

Table 4.1 Explains that the results of the confusion matrix of the naïve Bayes two-class classification represent the results of the classification process. *True Positive* (TP), *True Negative* (TN), *False Positive* (FP) and *False Negative* (FN). The *True Negative* (TN) value is the number of negative data that were correctly detected as negative with 936 data, whereas *False Positive* (FP) value is negative data that were detected as positive with 241 data. *True Positive* (TP) value is positive data that were correctly detected as positive with 927 data, whereas *False Negative* (FN) value is positive data that were detected as negative with 296 data.

Performance Evaluation is a useful parameter for measuring the model performance, how accurate the established system model is. From the representation of the multi-class confusion matrix, the researcher derived the parameter measurement. The multi-class confusion matrix is a method to measure the performance of an established classification system.

Table 4. 2. The Evaluation Results of the Naïve Bayes Three-class

Class	Classification			
	precision	recall	f1-score	support
-1	0.76	0.80	0.78	1177
1	0.79	0.76	0.78	1223
accuracy			0.78	2400
Macro avg	0.78	0.78	0.78	2400
Weighted avg	0.78	0.78	0.78	2400

Table 4.2 Explains the results of the evaluation of naïve Bayes two-class classification in regards to precision, accuracy, and recall. "Accuracy" is a performance standard that indicates the level of accuracy of the overall model. In other words, it calculates all the correct predictions from the total amount of the data. "Accuracy" is derived from each class which in actual class conditions can be accurately predicted. Based on the evaluation results, the

accuracy score is 78%, which means according to the model the naïve Bayes two-class classification gives satisfactory performance.

"Precision" is a performance standard that provides information from the prediction as a positive class that is actually positive. "Precision" is measured by calculating the precision score of each class, then adding them up and figuring the average value. The average precision score of naïve Bayes two-class classification is 78%.

"Recall" is a performance standard that provides information on the positive prediction of the class that was predicted as negative. "Recall" is measured by calculating the recall score of each class, then adding them up and figuring the average value. The average recall score of naïve Bayes two-class classification is 78%.

In conclusion, based on the evaluation results, the naïve Bayes two-class classification provides satisfactory performance in classifying public opinion regarding the plan to move the capital city.

4.2 Naïve Bayes Three-class Classification

Based on the results of the naïve Bayes three-class classification (positive, negative, and neutral), the results of the confusion matrix evaluation are as follows:

Table 4. 3 The Results of the Naïve Bayes Two-class Classification

Class	-1	0	1
-1	885	230	142
0	275	584	292
1	233	318	641

Table 4.1 Explains that the results of the confusion matrix of the naïve Bayes three-class classification represent the results of the classification process. *True Positive* (TP), *True Negative* (TN), *False Positive* (FP) and *False Negative* (FN). The *True Negative* (TN) value is the number of negative data that were correctly detected as negative with 1974 data, whereas *False Positive* (FP) value is negative data that were detected as positive with 511 data. *True Positive* (TP) value is positive data that were correctly detected as positive with 641 data, whereas *False Negative* (FN) value is positive data that were detected as negative with 434 data.

Table 4. 4 The Evaluation Results of the Naïve Bayes Three-class Classification

Class	precision	recall	f1-score	Support
-1	0.64	0.70	0.67	1257
0	0.52	0.51	0.51	1151
1	0.60	0.54	0.57	1192
accuracy			0.59	3600
macro avg	0.58	0.58	0.58	3600

weighted avg	0.58	0.59	0.58	3600
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Table 4.4 Shows that based on the evaluation results, the accuracy score is 59%, which means according to the model the naïve Bayes three-class classification gives an adequate performance. The average precision score of naïve Bayes two-class classification is 58%. The average recall score of naïve Bayes two-class classification is 58%.

In conclusion, based on the evaluation results, the naïve Bayes three-class classification provides adequate performance in classifying public opinion regarding the plan to displace the Indonesian Capital.

6. CONCLUSIONS

The following are the conclusions based on the analysis and discussion presented in the previous chapters:

1. the naïve Bayes two-class classification method presents satisfactory results with a score of 78% in concerning the accuracy, precision, and of meaurment. It can be said that 78% of accuracy provides a satisfactory degree of accuracy as a polarity classification two class naïve Bayes method for public opinion.
2. However, the naïve Bayes three-class classification method gives a score of 58% on the measurement of accuracy, precision, and recall. Within value of 58% it can be inferred that this classifier presents a biased of sentiment polarization.
3. In other words, the naïve Bayes classifier still shows a small accuracy (below 80%) so that need to make improvement by adding metaheuristics to feature selection. This addition suggests to eliminating bias words that can affect the class of sentiment.

The conclusion is a preliminary study as a basis for conducting further research in an effort to overcome the weakness of the naïve Bayes classifier on the sentiment pattern of public opinion regarding the plan to displacement Indonesian Capital. Further studies with a more comprehensive approach need to be conducted by adding feature selection using metaheuristic methods.

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IDENTIFICATION IMPACT OF COVID – 19 ON REAL ESTATE STOCK RETURNS USING ARMAX – ARCH/GARCHX METHOD

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ABSTRACT

Covid-19 isn't only threatening to human health, but also impact the world economic growth, including Indonesia. COVID – 19 impact in real estate sector such as revenues and shares by 5.37% -52.44% and 25.37% - 61.34%. Therefore, research was conducted to model stock returns with the Armax – Archx/Garchx approach to calculate value at risk (VaR) and provide solutions to the company. The data which were used in this study are data closing stock prices from Alam Sutera Realty (ASRI), PT. PP Property Tbk (PPRO) and Jaya Real Property (JRPT) on 237 trading days (12 September 2019 - August 31, 2020). The steps are calculating the stock return value and JCI, identifying the model and estimating Armax parameter with exogenous variables (JCI return), performing diagnostic checking of white noise assumption, selecting the Armax model using the AIC criteria, performing heteroscedasticity test, creating model Armax – Archx/Garchx and calculating VaR. The outcome of the stock return model as follow: ARMAX([38,47],0)-ARCHX([1,4,10,37],0), ARMAX ([32],0)-ARCHX(1), ARMAX ([32],0)-GARCHX(3). Estimated risk comes with minimum, maximum and average are -0.10% - -13.97%, maximum 0.08% - 0.4%, and average -0.005 - 0.06%. The VaR results obtained by companies with the minimum and maximum risk are ASRI with a potential loss of 13.97% and JRPT with a potential profit of 0.40% and confidence level of 95%. The solution provided is to change the sales strategy to digital, provide promos to service tenants and manage finances efficiently.

Keywords : ARMAX – ARCHX/GARCHX, COVID – 19, Return, Trading Volume Activity, Value at risk

1. INTRODUCTION

The World Health Organization (WHO) decided COVID-19 as a pandemic on March 11th, 2020. The origin of its emergence began in the city of Wuhan, China in December 2019. While the first transmission in Indonesia was on March 2, 2020 by 2 Indonesian citizens who identified infected by the virus (Ihsanuddin, 2020). COVID-19 spreads rapidly from one country to another, until several regions in Indonesia. . To restrict the virus transmission, some efforts has been taken by government, such as canceling face-to-face learning activities (schools), social distancing, wearing mask in all places and enforcing a work from home (wfh) system.

Real-estate industry is one of the sectors that can provide information on the country's economy (Solihin, 2018). Development on this sector can provide social welfare for the community, such as create jobs especially during construction process. Currently, Commercial

property decreased as much as 0.26% YoY at third quarter – 2020. Depression happen almost in all these sectors, according to the Executive Director of Research at Colliers International Asia, Andrew Haskin, this is impact of lockdown policy. This policy has to be responsible on performance obstruction of office space rental activities and shopping centers construction property sector eminent in office space rental activities and the construction of shopping centers (malls) in several locations, as well as the cancellation of several events and concerts (Rahman, 2020). And Based on Figure 1, property sector depressed on residential property price index (IHPR) at third quarter – 2020 of 1.51 (0.42%). This caused by the wages of workers and the price of building materials increased.

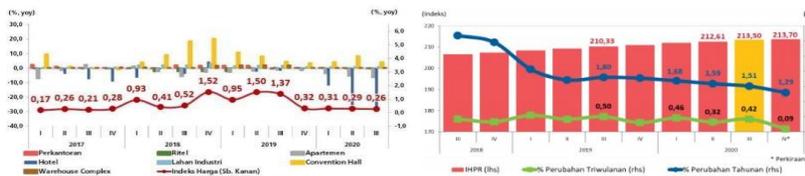


Figure 1. Development state of Commercial Property and Residential Property Price Index

Analysis of COVID-19 impact on the stock price index has been investigated on several research, including the following:

- Haryanto (2020), Study of actual COVID-19 impact on movement of the Rupiah exchange rate and JCI movement using Multiple Linear Regression.
- Septiana Na'afi (2020), stated that COVID-19 has impact on weakening of the composite stock price index which results in OJK issued stock buyback policy and a reduction of shares outstanding in IDX. This study used a qualitative method by using the JCI depression result history from January 2020 - March 2020.

Based on the history, the researchers are interested to study COVID-19 impact on the movement of property stocks with time series method to determine the risks for investors. The result will be stated in a study titled "Identification of the Effect of COVID-19 on Stock Returns in the Real Estate Sector using ARMAX – ARCHX / GARCHX Method."

2. LITERATURE REVIEW

2.1. Shares

Shares are proof of company ownership. Meanwhile, the term share refers to the buying and selling transactions of issuers in the market model. Hartono (2015) said, shares are divided into 3 types, i.e., a) Preferred stock, is stock which has combination between common stock and bonds. The difference between ordinary shares and preferred shares is company's payment rights is by putting investors as priority in the event of liquidation, but the shareholders (investors) does not have rights in the RUPS meeting. b) Ordinary Shares are shares which has no special position in a company. Stockholders have lower priority than preferred stock, especially if there is a dividend distribution and liquidation of the company. c) Treasury shares, are shares that have been sold by the company and re-circulated, then the company bought back and stored it as a treasury. According to Biswas (2015), stock returns is outcome that obtained from investments and are separated into two types, i.e., a) positive returns which causing investors believe to invest in the company, and b) negative returns that are not expected by investors. Since it is causing losses to the stock.

According to Hartono (2015), stock returns are differed into 2 types, i.e.:

- Realized Return (Actual Return)

Any steps that should be taken in order to calculate historical data to measure the capability of one company as a basis on making long-term decision (Maknuun, 2019). In order to calculate the Actual Return, it expressed by Equation (1) : $R_{it} = \frac{P_{it} - P_{it-1}}{P_{it-1}}$ (1)

b. Expected Return

Expected Return are the return of investment which obtained from some parts of interest rates so that the result can be difference with actual return (Suryanto, 2015).

According to Hartono (2015), it is divided into 3 models, i.e.:

- Mean Adjusted Model, is an Expected Return which has a fixed value before estimate period and after the event period.

- Market Model, is a calculation that is adjusted to the expected return and using Ordinary Least Square (OLS) regression analysis

$$\beta = \frac{(\sum XY) - (\sum X)(\sum Y)}{(\sum x^2) - (\sum x)^2} \dots \dots \dots (2) \text{ and } \alpha = \frac{\sum Y - \beta (\sum X)}{n} \dots \dots \dots (3)$$

- Market Adjusted Model, to find the value of the market adjusted model by calculating the market index to estimate the return of each company. To see the market index using the JCI can use

$$\text{equation (4) : } R_{mt} = \frac{IHSgt - IHSgt-1}{IHSgt-1} \dots \dots \dots (4)$$

2.2. Time Series Analysis

According to Wei (2006), time series analysis is used to detect events such as Autoregressive (AR), Autoregressive Moving Average (ARMA), Autoregressive Integrated Moving Average (ARIMA), Generalized Autoregressive Conditional Heteroscedasticity (GARCH), Moving Average (MA), Autoregressive Moving Average with Exogenous Variables (ARMAX), Generalized Autoregressive Conditional Heteroscedasticity with Exogenous Variables (GARCHX).

2.2.1. Autoregressive Moving Average with Exogenous Variables

According to Wei (2006), ARMA is a combination between MA with AR which described Z_t caused by the previous period ($Z_{t-1}, Z_{t-2}, \dots, Z_{t-p}$) and α_t has white noise properties, where MA(q) and AR (p) by adding additional variables which called ARMAX, with the equation (5):

$$Z_t = \sum_{u=1}^q W_u X_{u,t} + \sum_{j=1}^p \theta_j Z_{t-j} - \sum_{j=1}^p \theta_j a_{t-j} + \alpha_t \dots \dots \dots (5)$$

The steps of the ARMAX model are as follows:

Model Identification

Equation (5) can describe the identification of the ARMAX model (p, q) and then find for a predictive model by create a time series model and determine the type of transformation and check the non-stationary model as shown in Table 1.

Table 1. Box-Cox Transformation (Wei, 2006).

Value	-1.0	-0.5	0	0.5	1
transformationType	$\frac{1}{Z_t}$	$\frac{1}{\sqrt{Z_t}}$	$\ln Z_t$	$\sqrt{Z_t}$	Z_t

The characteristics of the PACF and ACF forms to describe the ARMAX model represented in Table 2. (Wei, 2006)

Table 2. Identification of the ARMA model according to the PACF and ACF form (Wei, 2006).

Model	AR (p)	MA (q)	ARMA (p,q)
ACF	Diesdown	Cut off at lag to - q	Diesdown
PACF	Cut off at lag to - p	Diesdown	Diesdown

Parameter Estimation

This step use the Maximum Likelihood Estimation Method, which has a small variance value. If

the model is ARMAX, then use Equation (6) with the function $\alpha = (\alpha_1, \alpha_2, \dots, \alpha_n)$, it can be written as follow (Firdauz, 2017):

$$P(\alpha|\phi, \mu, \theta, \sigma_a^2) = (2\pi\sigma_a^2)^{-n/2} \exp\left[-\frac{1}{2\sigma_a^2} \sum_{t=1}^n \alpha_t^2\right] \dots \dots \dots (6)$$

- Diagnostic Check

Diagnostic check is step to check ARMAX model whether formed white noise and normally distributed (Wei, 2006), including: Examination of residual white noise that used to detect the model whether has met the assumptions by using the Ljung-Box test.

Hypothesis:

H0 : $\rho_1 = \rho_2 = \dots = \rho_k = 0$ (residual white noise)

H1 : One $\rho_k \neq 0, k = 1, 2, \dots$, (there is a correlation in the residual)

The equation for the white noise test can be seen in the formula (7) (Firdauz, 2017):

$$Q = n(n+2) \sum_{k=1}^k (n-k)^{-1} \rho_k^2 \dots \dots \dots (7)$$

- Model Selection

Model selection is determination of the ARMAX model using AIC with the parameter of the model in conjunction with equation (8) (Wei, 2006): $AIC(\Psi) = n \ln \sigma_a^2 + 2\Psi \dots \dots \dots (8)$

2.2.2. Generalized Autoregressive Conditional Heteroscedasticity with Exogenous Variables

The GARCHX model is a form of econometrics (Manganelli & Engle, 2001). The heteroscedasticity problem can use a regression model with the Equation (9) (Wei, 2006):

$$Z_t = \mu_t + \epsilon_t \dots \dots \dots (9)$$

The value of t used by ARCH to see the heteroscedasticity problem. The ARCH(r) model use the Equation (10) (Firdauz, 2017): $\sigma_t^2 = \omega + \sum_{j=1}^r \phi_j \epsilon_{t-j}^2 \dots \dots \dots (10)$

Development of a GARCH contains volatility and exogenous variables use the Equation (11) (Apergis & Reztitis, 2011): $\sigma_t^2 = \omega + \sum_{j=1}^r \phi_j \alpha_{t-j}^2 + \sum_{j=1}^s \beta_j \sigma_{t-j}^2 + \sum_{l=1}^m \pi_l X_{lt}^2 \dots \dots \dots (11)$

The stages of the GARCHX model:

- Lagrange Multiplier (LM) Test

According to Firdauz (2017), the LM test used to determine the effect of heteroscedasticity (ARCH-GARCH) with the Equation (12) (Firdauz, 2017): $LM = (n - r) R^2 \dots \dots \dots (12)$

- Parameter Estimation

This step use Maximum Likelihood Estimation (MLE) method which is maximize the conditional equation of the remainder with the Equation (13) (Firdauz, 2017):

$$L(\beta, \varphi|Y) = \prod_{t=1}^n \left(\frac{1}{2\pi\sigma_t^2}\right)^{1/2} \exp\left(-\frac{\epsilon_t^2}{2\sigma_t^2}\right) \dots \dots \dots (13)$$

2.3. Value at Risk

Value at Risk used to describe losses and opportunities that dispersed around 0, when taking a confidence level of L with the equation (14): $Var_{\alpha} = \inf\{\epsilon \in \mathbb{R} : P(L > \epsilon) \leq 1 - \alpha\} \dots \dots \dots (14)$

3. METHODS

3.1. Research variable

The variables to be used in this study are response variables and predictor variables. Predictor variable is JCI return data, and response variable is daily stock return of the property and real estate sub-sector. These variables are shown clearly in Table 3. Data to be used on this study is closing stock price of Alam Sutera Realty (ASRI), Jaya Real Property (JRPT) and PT. PP Property Tbk (ppro) with duration 237 trading days (12 September 2019 – 31 August 2020). To see the structure of the data research can be seen in Table 4

Table 3. Research variables

Variable	Z1,t	Z2,t	Z3,t	X1,t
Description (Share Return)	Alam Sutera Realty Tbk	Jaya Real Property Tbk	PP Properti Tbk	Jakarta Composite Index Ratio
Scale	Ratio	Ratio	Ratio	Ratio

Table 4. Research Data Structure

Date	t	Z1,t	Z2,t	Z3,t	X1,t
12/09/2019	1	Z1,1	Z2,1	Z3,1	X1,1
13/09/2019	2	Z1,2	Z2,2	Z3,2	X1,2
...
30/08/2020	n-1	Z1,n-1	Z2,n-1	Z3,n-1	X1,n-1

3.2. Data analysis technique

Steps to be used to analyze the Value at Risk are using the ARMAX – GARCHX method, which can be explained by the following steps: calculate the return value using equation (1), calculate the JCI return value using equation (4), Identify the ARMAX model of stock returns, estimate the parameters of the ARMAX form with exogenous variables, namely the Composite Stock Price Index return, test the ARMAX model parameters, perform diagnostic checking for whitenoise assumptions, choose the best ARMAX model using minimum AIC, identify the error value of the ARMAX model formed from ARCHX / GARCHX effect, determine the ARCHX / GARCHX model, parameters and perform significant tests, obtain the ARMAX – ARCHX / GARCHX model, and calculate the VaR value.

3.3. Hypothesis testing

3.3.1. Stationarity Test

Stationarity test carried out in two ways, namely the degree of integration test and the unit root test (Augmented Dickey – Fuller) using Rstudio software. Decision-making use the augmented dickey - fuller test to be done If Probability > significance level (0.05), H0 is accepted and H1 is rejected, then the data is not stationary and the degree of integration test carried out and vice versa.

3.3.2. Diagnostic Check

The test used to detect the residual model meets with assumption of white noise using the Ljung Box test. If the P value > 0.05, then the assumption of white noise has been fulfilled and vice versa.

3.3. Heteroscedasticity Test

Heteroscedasticity test used to detect whether there is an effect of ARCH and GARCH with the help of Rstudio. Decision-making use ArchTest is if P value > 0.05 then the residual is not normally distributed and there is an ARCH effect and vice versa.

4. RESULTS AND Discussion

4.1. Description of Research Data

4.1.1. Data Jakarta Composite Index (JCI)

In Figure 3. is showing that the JCI depressed from January 2020. This was due to the COVID-19, which appeared in Wuhan and reached the peak of depression on March 2020. According to Fakhiri Hilmi, the depression was due to 2 events, specifically: 1) COVID-19 pandemic - 19, 2) oil price conflict between Russia and Saudi Arabia which causes economic uncertainty. In 2021, JCI began to improve because the government carried out a vaccine program for the Indonesian people and implemented a new normal policy.

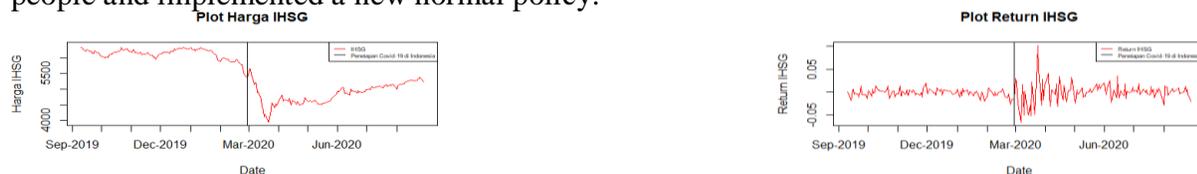
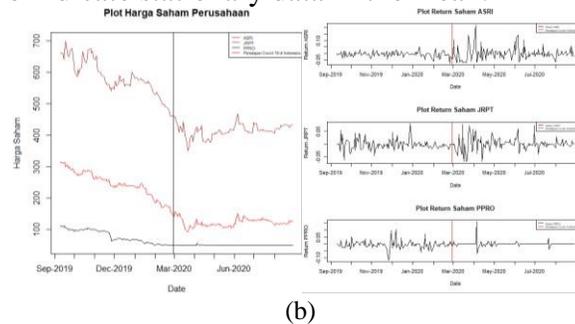


Figure 3. Plot of JCI Price and Return

4.1.2. Share Data of Real Estate Companies

The data to be used is the closing price of shares from finance.yahoo.com, which has return and risk analysis feature. In order to confirm this statement, Figure 3. and Figure 4(a). Are showing a highly significant relationship when stock prices rise, then the JCI also rises and vice versa. Investors are investing to get maximum profits by minimizing the losses that can be obtained, or

in investment science known as high return then high risk. Figure 4(b). shows the fluctuating movement of stock returns from September 2019 to August 2020 between -0.10 to 0.10. Return values that are around zero indicate stationary data in the mean.



(a)

(b)

Figure 4. Plot of Stock (a) Closing Price Data and (b) Return

4.2. Stock Return Modeling with ARMAX – ARCHX/GARCHX

The modeling used consists of 2 types, namely stock returns using ARMAX and variance using ARCHX/GARCHX. ARMAX modeling use the transferred type ARIMA model by forcing the X (JCI Return) model for Y data (stock return), then the results are obtained from the error value and the stock return model. Defining the ARMAX model afterward. The ARMAX model used for initial identification of data patterns by looking at ACF/PACF, which add exogenous variables and testing the white noise assumption afterward, then the ARMAX model will produce the best output. Then, heteroscedasticity test was carried out to determine the ARCHX/GARCHX effect so that 3 pairs model were obtained (predictor variable – response).

4.2.1. Stock Return Modeling with ARMAX

4.2.1.1. Stationarity Test

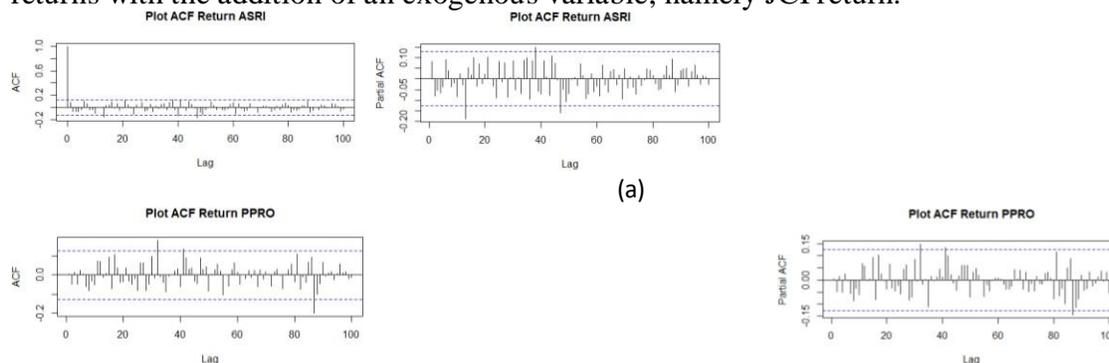
In Table 5, it explained that the probability value $(0.01) < 0.05$, then H_1 is accepted and H_0 is rejected. Thus, the stationary data in the mean shown in Figure 4(b). ASRI, PPRO and JRPT returns are not stationary in variance because the volatility measure is not constant.

Table 5. Return Stock Stationarity Test Results

Stock	ASRI	PPRO	JRPT
T - Stat	-5.5493	-6.3772	-6.0041
Probability	0.01	0.01	0.01

4.2.1.2. Identify and Significant ARMAX Parameters

Identification of the initial model using the PACF and ACF plots of ASRI, PPRO and JRPT returns with the addition of an exogenous variable, namely JCI return.



(a)

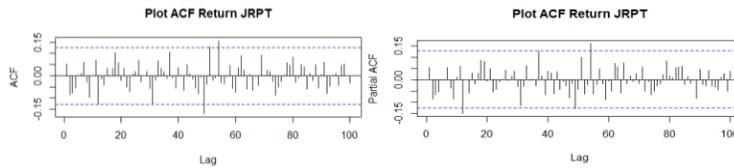


Figure 5. Plots of PACF and ACF Return (a) ASRI, (b) PPRO and (c) JRPT

The results of Figure 5(a). shows the PACF and ACF plots of ASRI returns, it can be seen that the PACF and ACF dies-down plots, then used for subset modeling, namely $ARMAX(0,[13,40,47])$, $ARMAX((0,[13, 40])$, $ARMAX(0,[13,47])$, $ARMAX(0,[40,47])$, $ARMAX([13,47],0)$ and $ARMAX([13,38,47],0)$ which shows that the model results are not significant due to the P value > 0.05 . Then define a significant model, namely $ARMAX([38,47],0)$. Significant PACF and ACF lags shown in Figure 5(b). using a subset model of 32 $ARMAX([32],0)$ and $ARMAX(0,[32])$ lags due to P value < 0.05 . and in Figure 5(c). it can be seen that the ACF and PACF plots use a subset model at lag 54, namely $ARMAX(0,[54])$ and $ARMAX([54],0)$ because Pvalue < 0.05 .

Table 6. Estimation and Significant Testing of the ARMAX Model

Stock	ASRI			PPRO				JRPT			
Model	$ARMAX([38,47],0)$			$ARMAX([32],0)$		$ARMAX(0,[32])$		$ARMAX([54],0)$		$ARMAX(0,[54])$	
Parameter	ϕ_{38}	ϕ_{47}	X_1	ϕ_{32}	X_1	θ_{31}	X_1	ϕ_{54}	X_1	θ_{54}	X_1
Estimation	0.1169	-0.1089	1.5257	0.1865	0.2320	0.1893	0.2285	0.2770	0.6012	0.2652	0.6073
zvalue	1.844	-1.7392	13.4015	2.9745	2.3818	2.8897	2.3403	4.2189	7.3544	3.8507	7.3404
Pr(> z)	0.0452	0.0420	$< 2.2e-16$	0.0029	0.0172	0.0039	0.0193	$2.46E-05$	$1.92E-13$	0.0001	$2.13E-13$

Based on Table 6., the estimated parameter values for the ARMAX model are obtained in 3 companies, namely P value < 0.05 , which means that all parameters of the ARMAX model are significant.

4.2.1.3. Diagnostic Check

After step 4.2.1.2, diagnostic checking carried out to detect the residual model that meets the white noise assumption using the Ljung Box test. From the results on Table 7. The model obtained by 3 companies has a P value > 0.05 so that the white noise assumption has been fulfilled.

Table 7. Diagnostic Checking Residual ARMAX Model

Stock	ASRI	PPRO	PPRO	JRPT	JRPT
Model	$ARMAX([38,47],0)$	$ARMAX([32],0)$	$ARMAX(0,[32])$	$ARMAX([54],0)$	$ARMAX(0,[54])$
X-Squared	68.209	44.954	45.172	52.297	53.54
Pvalue	0.05399	0.7114	0.7033	0.4234	0.3771

4.2.1.4. Selection of the Best ARMAX Models

The selection of the ARMAX model use the minimum AIC, so that the results of Table 8., we get the PPRO and JRPT models with AIC values, namely $ARMAX([32],0)$ of -7.456668 and $ARMAX([54],0)$ of -7.788699, where the model meets assumption of white noise due to heteroscedasticity in the residual variance.

Table 8. Selection of the Best ARMAX Model

Stock	PPRO		JRPT	
Model	$ARMAX([32],0)$	$ARMAX(0,[32])$	$ARMAX([54],0)$	$ARMAX(0,[54])$
AIC	-7.456668	-7.45631	-7.788699	-7.781182

4.2.2. Return Modeling with ARMAX - ARCHX/GARCHX

4.2.2.1. Heteroscedasticity Test

Based on results in Table 9. ASRI, PPRO and JRPT models contain heteroscedasticity and residuals are not normally distributed. The ASRI and PPRO models have a P value < 0.05 , which

means that there is an ARCH effect, while the JRPT model has a P value > 0.05. After that, the variance model of ARCHX/GARCHX searched by identifying and estimating the significant parameters of the 3 models.

Table 9. Heteroscedasticity Test

Stock	Model	Chi-squared	lag	Pvalue
ASRI	ARMAX([38,47],0)	4.6945	1	0.03026
		4.7429	2	0.03334
		4.7679	3	0.03496
		9.7699	4	0.04449
		11.416	5	0.04373
PPRO	ARMAX([32],0)	25.006	1	5.716e-07
		26.678	2	1.611e-06
		26.688	3	6.845e-06
		26.65	4	2.34e-05
		27.167	5	27.167
JRPT	ARMAX(54],0)	0.075204	1	0.7839
		3.0744	2	0.215
		2.818	3	0.1275
		2.193	4	0.1597
		2.38	5	0.15839

4.2.2.2. Identification and Estimation of Significant Parameters of ARMAX – ARCHX/GARCHX

Identification of ARMAX – ARCHX/GARCHX Model using PACF and ACF plots from Squared Residual in determining the initial model with the addition of exogenous variables (JCI return).

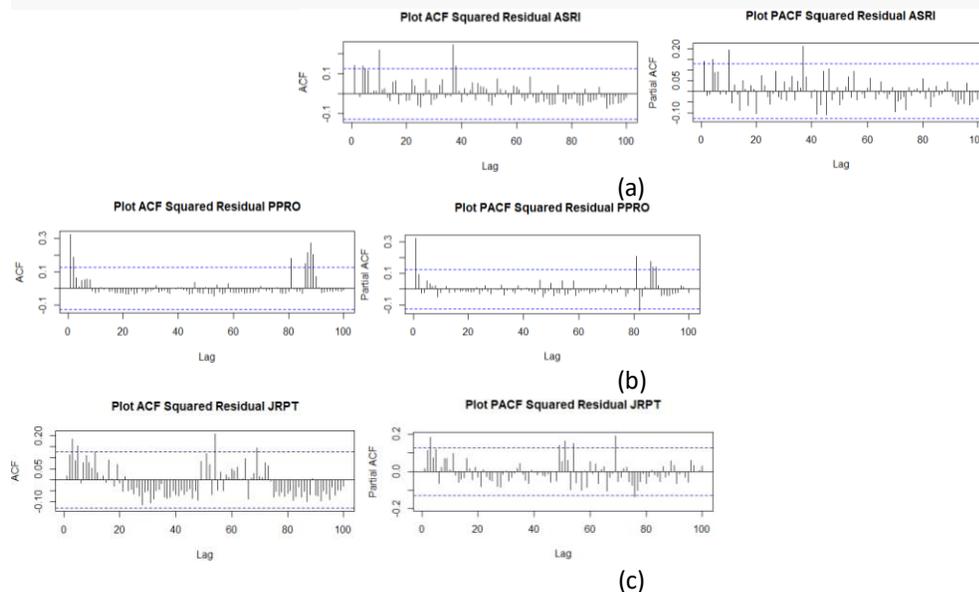


Figure 6. Plots of PACF and ACF Squared Residual (a) ASRI, (b) PPRO and (c) JRPT

The results of Figure 6(a), shows the ACF cut-off plot after lag 1, then the model obtained ARMAX([38,47],0) – ARCHX(1) is not significant because the Pvalue of one of the parameters >

0.05. Then define a significant model, namely ARMAX ([38,47],0)-ARCHX([1,4,10,37],0). Lag –lag plot ACF cut off after lag 1 in Figure 6(b), then the model obtained is ARMAX ([32],0) –

ARCHX(1) significant because Pvalue < 0.05. while Figure 6(c)., shows the PACF plot using the subset model in lag 3, then the model obtained is ARMAX([54,0],0) – GARCHX(3)

Table 10. Identification and Estimation of ARMAX Model Parameters – ARCHX/GARCHX

Stock	Model	Parameter	Estimation	tvalue	Pr(> t)
ASRI	ARMAX([38,47],0)- ARCHX([1,4,10,37],0)	μ	-0.035429	-4.5724e+03	0.0000
		ϕ_{38}	0.411252	3.9772e+03	0.0000
		ϕ_{47}	-0.352867	-4.3238e+03	0.0000
		X_1	-64.103704	-4.5677e+03	0.0000
		ω	0.000001	5.5660e+00	0.0000
		β_1	0.026335	4.5828e+03	0.0000
		β_4	0.027094	4.5812e+03	0.0000
		β_{10}	0.028866	4.5819e+03	0.0000
PPRO	MAX ([32],0) – ARCHX(1)	μ	-0.001989	-1.2288e+00	0.0000
		ϕ_{32}	0.143112	2.3853e+00	0.017066
		X_1	0.174419	2.0286e+00	0.042503
		β_1	0.995529	4.0373e+04	0.000000
JRPT	MAX ([54],0) – GARCHX(3)	μ	-0.000197	-4.5628e+03	0.0000
		ϕ_{54}	0.122915	4.4868e+03	0.000000
		X_1	0.630374	5.6300e+03	0.000000
		ω	0.000002	9.5863e+00	0.000000
		α_3	0.072443	4.5052e+03	0.000000

4.3. Value at Risk

4.3.1. Determining the Standard Error Distribution

In determining the standard error distribution of the ARMAX – GARCHX & ARMAX – ARCHX model, it is done by determining the suitable distribution of the 3 models using the formula

$$\hat{Z}_t = \hat{K} (15)_t$$

After obtaining Z_t , the distribution according to the Anderson – Darling test is determined, with the results shown in Table 11.

Table 11. Test Anderson – Darling ARMAX – ARCHX & ARMAX - GARCHX

Stock	ASRI			PPRO			JRPT		
Distribution	Normal	t-student	Laplace	Normal	t-student	Laplace	Normal	t-student	Laplace
PValue	2.53E-06	0.007053	0.05	2.53E-06	0.02574	0.05267	2.53E-06	2.53E-06	0.09368

To select the appropriate standard error distribution using Pvalue > 0.05, so that the distribution chosen from the company is ASRI, PPRO and JRPT uses the Laplace distribution. The estimated values for the parameters of the Laplace distribution are:

Table 12. Distribution of the estimated standard error of the Model ARMAX – ARCHX/GARCHX.

Stock	ASRI		PPRO		JRPT	
Distribution	Laplace		Laplace		Laplace	
Parameter	θ	s	θ	s	θ	s
Estimated Value	-0.091338	108.1795	0.066615	0.615739	-0.000339	80.37379

4.3.2. Predicting Value at Risk

To get the expected return that will predict future returns, the standard error distribution generated by using the Laplace distribution of the ARMA – ARCHX & ARMAX – GARCHX models. The estimated return results sorted from the smallest to the largest with a significance level(0.05) which is the ordering of the k values, formula : $k = [\alpha \times n] + 1$, with $\alpha = 0.05$ & $n = 236$.

Table 13. VaR Calculation Results from Stock Return

Stock	Minimum	Maximum	Mean
ASRI	-13.97 (%)	0.11 (%)	0.06 (%)
PPRO	-0.10 (%)	0.08 (%)	0.002 (%)
JRPT	-0.55 (%)	0.40 (%)	-0.005 (%)

Time series modeling used to determine the spread of the standard error from a time span of 236 stock exchange days, with the risk value seen from the movement of stock returns and stock prices in the capital market with 270 simulation calculations. Results Table 13. More quantitatively because investors can see the maximum, minimum and average risk values every day. If an investor invests in ASRI as much as 1,000,000 with a loss of 13.97% so, what he gets is $1,000,000 - (1,000,000 * (13.97/100)) = 1,000,000 - 139,700 = 860,300$. While investing in JRPT gets a profit of 0.40% so that what the investor will get is $1,000,000 + (1,000,000 * (0.4/100)) = 1,000,000 + 4,000 = 1,004,000$ and confidence level of 95%. So it is concluded that the highest risk has a high loss and vice versa so that there is a risk relationship with return that is directly proportional, which means that if the risk is small, the return obtained is also small and vice versa

4.4. Management Implications

Level 4.2 used to model the time series, while the value at risk calculation uses step 4.3, which used to see the maximum, minimum and average risk values obtained. This is a quantitative calculation that causes COVID-19 to have impact on price movements. Giving recommendations is done by distributing questionnaires, reading company news, looking at financial reports, so it is concluded that rent discount (promo) with the aim of easing the burden on tenants who use property services, property sales have shifted from the traditional model (in the form of stands or distributing brochures) into digital form (websites, advertisements on social media) or doing digital marketing. And manage company finances efficiently by recording the goods needed by the company appropriately.

5. CONCLUSIONS

From the analysis of the results, it can be concluded that the results of the ASRI, PPRO and JRPT stock return models with the ARMAX model $([38,47],0) - ARCHX([1,4,10,37],0)$, $ARMAX([32],0) - ARCHX(1)$, $ARMAX([32],0) - GARCHX(3)$, provides a minimum estimated risk of -0.10% to -13.97%, maximum 0.08% to 0.4%, average -0.005 to 0.06%. The VaR results obtained by companies with the minimum and maximum risk are ASRI with a potential loss of 13.97% and JRPT with a potential profit of 0.40% and also a confidence level of 95%. The solution provided is to change the sales strategy to digital, provide promos to service tenants and manage finances efficiently.

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Parallel Session 2

Room H (12.10 – 13.55)

Moderator:

Category: Consumer Behavior

FACTORS AFFECTING ENTREPRENEURIAL INTENTION IN INSTITUTION OF TECHNOLOGY STUDENTS XYZ

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ABSTRACT

One of the most significant discussions today in economic development is entrepreneurship, it is considered as one of the main economic development strategies to advance a country's economic growth and to maintain competitiveness in the face of increasing globalization trends. Entrepreneurial intention is very important to understand entrepreneurship, this is the first step in the process of finding, creating, and taking advantage of business opportunities. Technological and scientific universities are potential sources of spin-offs and start-ups, but it was found that the entrepreneurial self-efficacy of engineering students was lower than that of non-science and non-engineering students. The low level of entrepreneurial intention and self-efficacy in engineering students needs further attention. The role of engineering students both as professionals and innovators in the creation of new ideas or businesses is very important to be raised as an urgency, because the foundation of entrepreneurial intention needs to emerge from practitioners. This study analyzes the factors that influence entrepreneurial intention in XYZ Institution students. The theory used in this research uses the Theory of Planned Behavior with the variables studied, namely subjective norms, attitude, perceived behavioral control, personality traits, and self-efficacy. This study involved 215 respondents from students of various faculties and departments in undergraduate and master's programs. Based on the results of the analysis, it shows that the variables of attitude, perceived behavioral control, personality traits, and self-efficacy have a significant positive effect on the entrepreneurial intention of XYZ Institute of Technology students. The benefits of research results can be input for universities and institutions to provide education, instill interest and awareness about entrepreneurship, especially for engineering students who have high potential to participate in entrepreneurial activities.

Keywords: Entrepreneurship, entrepreneurial intention, theory of planned behavior, personality traits, self-efficacy.

1. INTRODUCTION

Economics prospect in Indonesia promising economic and business growth. Indonesia's economics status are relatively stable, this condition shown in the consistent value of gross Domestic Product Growth (GDP). The GDP growth on 2016 marked 5,03%, this percentage presented enhancement compare to 2015. In 2018, Indonesia's GDP increased 5,17%, this is the best growth for the past 5 years, meantime, in 2019 the GDP decreased by 0,15%.

According to World Economic Forum, Human Capital Index, in 2018 Indonesia remain on rank 6 out of 9 countries. It is a challenge for Indonesia to escalate human skill, considering Indonesia has a high potential for labor force but low number for people with high skill. The significant discussion for Indonesia's economic development is entrepreneurship. Shamsudin et al, (2017), mentioned that entrepreneurship is considered as one of the main economic development strategic to bring forward the growth of economics in a country and also to maintain competitiveness in this globalization era.

2. LITERATURE REVIEW

Entrepreneurship is defined as the process of perceive opportunities to build new products or services, and integrating the necessary resources to take advantage of those opportunities. Sarmin and Ashrafuzzaman (2017) mentioned entrepreneurs as is a versatile scheme and the factors that influence entrepreneurial intention have been extended to areas such as psychology (McClelland, 1961), sociology (Weber, 1930) and economics (Schumpeter, 1934). The essence of entrepreneurship is positive energy that challenges or changes existing conventions by responding sharply to a changing environment with innovative and creative minds.

Entrepreneurship is seen as an effective way to develop the economic benefits of the commercialization of science and has attracted academic interest. As well as the policies of this decade that provide a place for entrepreneurship to accelerate economic development by generating new ideas and turning them into profitable businesses. Education about entrepreneurship has become an important part of the curriculum in universities around the world (Sarmin and Ashrafuzzaman, 2017). Students who are undergoing the educational process at the university can become prospective entrepreneurs.

Entrepreneurial Intention

Experts and psychologists state that the intention assessment is the clearest tool for predicting behavior (Sun et al., 2020). According to Liu et al., (2019), entrepreneurial intention is the most important predictor of individual entrepreneurial behavior. Through various perspectives, various studies have examined the factors that influence entrepreneurial intention. Cooper and Dunkelberg (1986) mention that entrepreneurs who set up companies have different behaviors from those who are promoted or hired. According to Indarti and Rostiani (2008) in Kusmintarti et al., (2017) suggest that personality factors include achievement needs and self-efficacy which act as determinants of entrepreneurial intention.

Theory of Planned Behavior (TPB)

The Theory of Planned behavior (TPB) is an established theory and has been widely used to explain and predict human behavior in various domains of life. Ajzen (2005) specify that according to TPB, intention and behavior are the functions of three basic determinants; personal, reflects social influence, and the third deals with control issues. The TPB model developed by Ajzen is as follows: The theory assumes that perceived behavioral control has motivational implications for intention. The Theory of Planned Behavior proposes three stages of behavior formation, those are behavior determined by the behavioral intention of an individual, commend to behavioral attitudes, subjective norms, and perceived

behavioral control (Wu et al., 2020). According to Wu et al., (2020), since Ajzen proposed TPB, perceived behavioral control has become the spiritual core of TPB.

Self-Efficacy

Self-efficacy concept was first proposed by psychologist Bandura. Based on the category of psychological theory, self-efficacy represents individuals about predictions, beliefs, and beliefs about the abilities needed in the process of achieving certain goals. Murugesan and Jayavelu (2017) explain that several studies report the important role of self-efficacy as an important antecedent in the formation of entrepreneurial intention, besides self-efficacy as a major determinant of entrepreneurial intention and activity.

Personality Traits

According to Ajzen (2005), there are five main personality dimensions that describe an individual's position on various trait terms found in common language. Personality traits or personality factors are measured by Saucier's Mini Markers Inventory which includes 5 personality traits factors :

1. Extraversion
2. Openness
3. Neuroticism
4. Conscientiousness
5. Agreeableness

3. METHODS

The research method used in this study uses quantitative research methods. This method is a scientific or scientific method because it has fulfilled scientific principles, namely concrete or empirical, objective, measurable, rational, and systematic.

Samples taken from the population must represent the problem being studied (Sugiyono, 2017). The population in this study were students of the undergraduate and postgraduate study programs at the XYZ Institute of Technology who were still active. The sampling technique used in this study uses convenience sampling, which is a data source sampling technique based on the availability of elements and the ease of obtaining samples (Sugiyono, 2017).

Data collecting technique in this study using primary data. Primary data is obtained from the results of questionnaires that have been answered by respondents with closed statements. The questionnaire is an efficient data collection technique if the researcher knows with certainty the variables to be measured and understands what can be expected from the respondents (Sugiyono, 2017).

4. RESULTS

The demographics of respondents based on gender are 215 XYZ Institute of Technology student, respondents were 54% male, while 46% female respondents. Meanwhile, demographics based on age group showed that respondents were dominated by the age group of 18 to 22 years, which was 60.5%, the age group of 23 to 27 years was 22.8%, while the lowest demographic of respondents was in the age group >37 years, which was 2.3%. The results of the demographics of the age group showed that the majority of the research respondents were undergraduate students of the XYZ Institute of Technology, with an age range of 18-22 years. This age group is part of Generation Z (GenZ) who were born in 1997-2010. Generation Z is a transitional generation of the Millennial Generation with technology and knowledge, and an increasingly developing industry. Generation Z has a preference for starting a new business,

entrepreneurship as a career choice, being the successor of the millennial generation in the spirit of entrepreneurship. Generation Z emphasizes social relationships over work-life balance and good daily experiences for greater benefits (Purnomo et al., 2019).

Based on the data that has been obtained, the demographic results of study programs and departments from a total of 215 respondents from the XYZ Institute of Technology are dominated by undergraduate students (S1), which is 70.7% while 29.3% are graduate students (S2). This shows that respondents are dominated by undergraduate students from various faculties and departments, while 63 respondents are students of the technology management master's program. Engineering students have a high potential to become entrepreneurs and it has been widely proven that engineering students create various start-up businesses, they also have entrepreneurial intentions like students in general at the business faculty (Sababha et al., 2020).

Based on data from respondents, it shows that the majority of XYZ Institute of Technology students, namely 63% have a family business background, while as many as 37% do not have that background. Students with family business backgrounds have more potential to participate in entrepreneurial activities and have high potential to start a new business.

Based on data from respondents, 55% of respondents have a GPA of 03.00 – 03.50, then 37% of students have a GPA > 03.50. This shows that respondents from XYZ Institute of Technology students have relatively good GPA scores. Students who have moderate academic achievement do not have a definite advantage in getting a job, and students will actively think about how to increase their employment possibilities through various means. Entrepreneurial intention was found to be stronger in students who had satisfactory grades. Students with moderate academic achievement choose stable, high-paying, or prestigious careers. Meanwhile, students with poor academic achievement do not have a definite plan about their career choices. Although the GPA value can predict entrepreneurial intention in students, Saleem et al., (2020) stated that student achievement scores cannot be used as the only reference and are not a vital role for measuring entrepreneurial intention.

Based on data from respondents, 67% of respondents stated that they had never received formal education on entrepreneurship, while 33% received entrepreneurship education. This matter needs to be considered further by the XYZ Institute of Technology when it will transform into an entrepreneurial university.

Based on data obtained from respondents, XYZ Institute of Technology students have various entrepreneurial interests. As many as 30% of respondents have an interest in *foodpreneurship*, 27% have an interest in *technopreneurship*, and 17% of respondents have an interest in *sociopreneurship*. Concurrently, *womenpreneurship* and *ecopreneurship* showed the interest of each respondent as much as 13%.

Based on data obtained from respondents, XYZ Institute of Technology students have the highest level of business interest, namely the Creative Industry at 42%, the second highest level is the Manufacturing Industry at 20%, the Service Industry at 12%, the Primary Industry at 8%, the Construction Industry at 7 %, 4% of Secondary Industry, and 7% of other industries. The high interest of XYZ Institute of Technology students in the creative industry shows an interest in creating innovation through creation and uniqueness. Creative industry is the process of creation, creativity, and ideas from a person or group of people who are able to produce works without exploiting natural resources and can make works as economic products. The creative industry is expected to be another alternative for the current industrial development. Belas et al., (2017) state that entrepreneurship is an important aspect of the creative industry (Černevičiūtė, Strazdas, 2014) and cannot be separated from trends in creative society (Pečiulis, 2015; Reimeris, 2016).

Through the efforts and support of entrepreneurship, the creation of creative businesses, many government support programs are needed to be drawn on the education system at universities so that entrepreneurial tendencies can be created among young graduates (Greene, Saridakis, 2008; Ahmed et al., 2017).

6. CONCLUSIONS

Based on the results and analysis in this study, the following are conclusions from the overall results of the data that have been processed and analyzed and carried out based on the research objectives, specifically : This study has 215 respondent data from students of the XYZ Institute of Technology, both from undergraduate and master's programs. The results of the analysis of the quantitative test, showed that the factors, namely attitude, perceived behavioral control, personality traits, and self-efficacy had a significant positive effect on Entrepreneurial Intention of XYZ Technology Institution students. These factors explain 72.6% of the research model on the effect on entrepreneurial intention, while 27.4% is explained by other variables outside this study. Factors that do not have a significant positive effect on entrepreneurial intention of XYZ Institute of Technology students are subjective norms. This determine that the subjective norms and social environment of XYZ Institute of Technology students have no effect on students' decisions to accomplish entrepreneurial activities or create new businesses.

The attitude and perceived behavioral control used based on the Theory of Planned Behavior show that they have a significant positive effect on entrepreneurial intention. The results of this study also found that the personality traits factor with the characteristics of openness gave a significant positive influence on the entrepreneurial intention of students. This shows that XYZ Institution students have the openness and creativity needed in carrying out entrepreneurship and business processes. In addition, this study also found that the entrepreneurial self-efficacy factor had a significant positive effect on the entrepreneurial intention of students. Based on the findings through the analysis in this study, there are several important things and strategies that must be considered by the government, policy makers, XYZ Institute of Technology, and other educational institutions. The results determine that subjective norms do not have a significant positive effect, meaning that the XYZ Institute of Technology needs to take major steps to increase student entrepreneurial intention through social support, instilling interest, and creating an ecosystem for business start-ups and prospective entrepreneurs. Business training can be a new business development strategy for students, where the research results show that students have entrepreneurial intentions, so the task of educational institutions is to encourage that interest into real action.

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ANALYSIS OF INTEREST IN USING THE PLN MOBILE APPLICATION USING A MODIFIED TAM MODEL

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ABSTRACT

The development of information technology in Indonesia is very rapid from year to year. One of them is the increasing penetration of smartphone use in Indonesia which has experienced a rapid increase. One of the main steps to achieve the success of Mobile Application technology is the acceptance of this technology by its users. Therefore, identifying the factors that influence the successful acceptance of technology is very important. This study aims to identify the usefulness of technology in this application. This study uses the Extended TAM Model because the TAM model is a parsimony model, which is a simple but valid model built on a strong theoretical basis. (Jogiyanto 2007). To test the research hypothesis, the Partial Least Square Structural Equation Modeling (PLS-SEM) method was used. This research is a quantitative study with a survey approach to respondents, where the respondent must have used the PLN Mobile application technology. The expected results from this study are that the factors that have the most significant influence on the acceptance of PLN Mobile application technology are obtained, and recommendations for strategic decisions towards PT PLN (Persero) regarding the application of the PLN Mobile application technology.

Keywords: PLN Mobile Application, Partial Least Square Structural Equation Modeling (PLS-SEM), Technology Acceptance Model (TAM).

THE DEVELOPMENT OF UTAUT 2 MODEL FOR MOBILE CUSTOMER APPLICATIONS ON FIXED BROADBAND SERVICE

TO IMPROVE CUSTOMER EXPERIENCE (CASE STUDY : MY INDIHOME CUSTOMER)

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ABSTRACT

Data connection requirement in the era of the Industrial Revolution 4.0 is currently extremely needed by people throughout Indonesia. Currently, people in Indonesia really need internet services which are very fast and can help their activities. The Internet services based on Fix Broadband Services usage is one of the alternatives needed by Indonesian people. Wherein, by using Fix Broadband Services which in fact uses an integrated fiber optic connection, it will greatly assist very fast data connectivity. Good service, installation speed, smooth connectivity, and fast response are some of the things that Fix Broadband Services Consumers really need today. The Best Service from Sales to After-sales must use the right key performance indicators so that it has a good impact on sales growth, can minimize disruption and will certainly improve customer experience. The use of a questionnaire method was required, where customers could directly assess the satisfaction of installation services, starting from new post-installation installations to post-disruption installations reported by customers to Fixed Broadband Service providers so that they could improve Service Level Agreement and Service Level Guaranty to Fixed broadband Service Providers as well, it also can improve customer experience on Fix Broadband Service operators, especially the MY Indihome Application based on Analysis Results that was used UTAUT-2. The process of grouping data was conducted by Direct Interviews mechanism, questionnaires to all Stakeholders in the company. Furthermore, Goodness Of Fit was a method used to test how well the measured variable could represent the previously formed construct was Goodness Of Fit. Goodness Of Fit was also used to determine the significance of the estimated coefficients and to test whether the questions in the questionnaire were representative (valid) and accurate or consistent (reliable). The next was, Structural Equation Modeling (SEM) was a multivariate analysis technique that was used to test existing theories about the relationship between a number of variables simultaneously. The set of relations in question were the relationship between one or more independent variables and one or more dependent variables. Some of the processes above would make recommendations for development for management that can be used by Fixed Internet Service providers to improve key Performance Indicators in the Customer Experience field so that customers are more loyal and make the company grow according to the calculations that have been done. In the UTAUT2 model (Unified theory of acceptance and use of technology2), the factors that influenced interest in using a technology service (Behavioral Intention) were Performance Expectancy, Effort Expectancy, Social Influence, Habit, Facilitating Condition, Price Value, and Hedonic Motivation. This study offered an UTAUT2 development model by adding service quality and trust variables, where these two variables in previous studies were proven to increase Behavioral Intention. The method used to analyze the model was the Structural Equation Model (SEM). Research data collection was done through online

questionnaires. The results of this study tested 12 hypotheses that affected Behavioral Intention and Use Behavior in using fixed broadband services in Indonesia. In the end, this research would get a development model from UTAUT 2, that was FBAM (FIX Broadband Adoption Model).

Keywords: SEM, Trust, Service Quality, Customer Experience, UTAUT 2, Fix Broadband Services

1. INTRODUCTION

Today, internet has become a basic need by people, starting from children to adults. In the current COVID-19 pandemic moment, people are forced to always has an interaction via internet. The trend of internet users using fixed broadband services has a penetration of 56% or the equivalent of 150 million people, for mobile internet users it reaches 53% or equivalent to 142.8 million people. According on the contribution of internet users per province, the largest are come from North Sumatra, West Kalimantan, West Java, and South Sulawesi. The largest penetration was in Bengkulu province at 85% and then DKI Jakarta, West Kalimantan, Southeast Sulawesi, Papua, and West Nusa Tenggara (APJII, 2019). The main factor that causes od increases fixed broadband service users is the need for large bandwidth which currently can only be covered by fiber optic networks. The number of competitors for Fix Broadband Service and Mobile Broadband which is very fast makes marketshare competition become more stringent. There are several providers in Indonesia, both local and international providers which provide services to each other very competitively. Seeing the digital transformation development, equitable distribution of telecommunications infrastructure and services throughout Indonesia is stated to be a challenge that must be faced nowadays. There is a need for analysis and suggestion to increase product growth and increase product customer experience. This analysis was conducted by us on MY Indihome Customer application in which this application is an application that was used by Indihome customers in their daily life, from new installations registration, service interruptions, until bill payments. By using UTAUT 2 Analysis Model, we added some new constructs, those were trust and service quality as Novelty from this research. With the existence of those new constructs, it is expected to increase consumer trust and satisfaction with Indihome products so that IndiHome will become a product from Telkom that is capable to compete and be the best compared to other fixed broadband service operators.

2. LITERATURE REVIEW

2.1 Unified Theory of Acceptance and Use of Technology 2 UTAUT 2

Unified Theory of Acceptance and Use of Technology 2 or abbreviated as UTAUT 2 is the latest model to identify technology acceptance where the model is formulated based on eight theories of technology acceptance (Venkatesh, 2012) Unified Theory of Acceptance and Use of Technology 2 or abbreviated as UTAUT 2 is a development of UTAUT. However, UTAUT2 is more legitimate and precise than UTAUT because it is able to explain 70% of behavioral motive (behavioral intention) in using technology and about 50% is able to explain about the use behavior or behavior in using technology (Venkatesh, 2012). In UTAUT2 model, there are additional variables that does not exist before in UTAUT, those are Price Value, Hedonic Motivation, and Habit.

2.2 Trust

In every social environment that involves the role of people and technology, trust becomes a critical issue. Trust can help to set social relationships and reduce the uncertainty of human behavior. Therefore, trust is a very vital thing in the financial services adoption which is used mobile internet and is even more critical from an online business perspective. Trust is a subjective tendency to believe that the occurrence of an consistent action with the positive assumption (Guan, 2010). Hence, trust can be achieved when the level of ability, kindness and integrity are found adequate in a specific system, trust has an important influence

on the behavior of intention to adopt technology and choose a relationship inversely proportional with risk. Thus, high trust in a technology can reduce perceived risk and affect to behavioral intention positively (BW, 1994).

2.3 Service quality

Service quality can be defined as the difference between reality and customers' expectation for the service they receive or accept. The customers' expectation is basically the same as what kind of service a company should provide to their customers. This customers' expectation are based on word of mouth, personal needs, past experiences, and external communications (advertisement and other forms of company promotion). Some of Service Quality Model developments identify ten service quality dimensions which are reduced to five service quality dimensions which includes tangibles, reliability, responsiveness, assurance, and empathy (A. V. Parasuraman, 2006)

2.4 Partial Least Square Structural Equation Modeling (PLS SEM)

Structural Equation Modeling that based on covariance is generally tests a theory, while PLS (Partial Least Square) is tend to be more predictive model. In PLS, it can be conducted the measurement of model with structural testing. The measurement model (outer model) is used to test the validity and reliability test, while the structural model (inner model) is used to test causality (test hypotheses with predictive models). With the result that, PLS is a causality prediction tool that is used for theory development (Hair, 2016) Some stages of PLS Sem using WarpPLS are as follows:

2.4.1 Evaluation of Outer Model (Construct Model)

The evaluation of the outer model is used to see whether the indicators or question items in the study are able to measure the research variables well valid and reliable (Kock, 2013) The evaluation of the outer model in PLS are divided into three parts, those are:

1. Evaluation of convergent validity
2. Evaluation of discriminant validity
3. Evaluation of construct reliability

2.4.2 Inner Model Evaluation (Structural Model)

The second stage is the evaluation of the inner model (structural model), at this stage the relationship between variables will be tested according to the research hypothesis also evaluating the goodness of fit model will be conducted (Kock, 2013) .the inner model evaluation consists of four parts, those are :

1. Multicollinearity test
2. Evaluation Of Goodness Of Fitt
3. Corrected coefficient determination evaluation (adjusted R2)
4. Hypothesis test

3 METHODS

3.1 Flowchart diagrams

In this stage contemplating and preparing this research report will be done. The development of UTAUT 2 model in using mobile customer applications on fixed broadband service to improve customer experience (case study : My Indihome customer) as described in **Figure 1**.

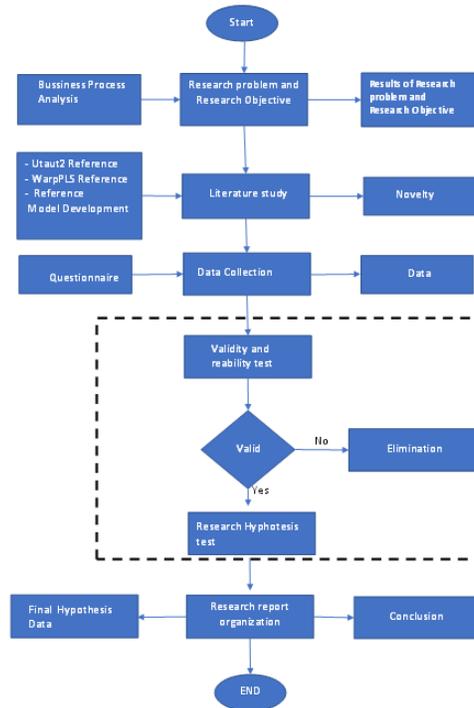


Figure 1 Flowchart diagram of research methodology

Before interpreting the model, an analysis is arranged first towards the model assumption which will be made (Bethan Alexandera, 2019), as described in **Figure 2**.

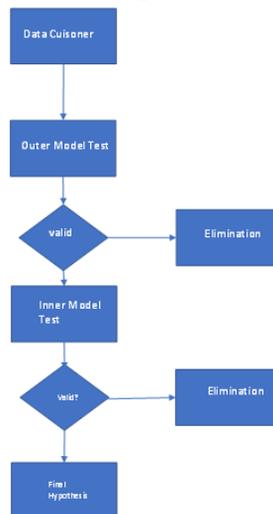


Figure 2 SEM Analyst

3.2 Data collection

Data collection in this study was done by using an online survey method. Online surveys were carried out by using Google Document Forms documents or generally abbreviated as Google Forms. Then, this online questionnaire was distributed through social media such as Whatsapp, Telegram, Instagram, Facebook, and Email. The research attributes that was used refer to previous studies. Questionnaires were distributed by online to all Indihome service users in Indonesia. Each indicator from each variable used a likert scale interval data measurement with a measurement scale as follows (Bagranoff, 2010): Strongly Agree (SS) score = 5, Agree (SS) score = 4 Disagree (KS) score = 3 Disagree (KS) score = 2 Strongly Disagree (KS) score = 1. The following were references related to questions that have been used in previous studies and became the material for questionnaire questions in this study which were described in **Table 1**.

Table 1 Research Questionnaire

Variable	Item Variable
Performance Expectancy (PE)	Perceived benefit (PE1)
	Time efficiency (PE2)
	Increase productivity (PE3)
Effort Expectancy (EE)	Easy to use (EE1)
	User friendly interface display (EE2)
	Good and fast application (EE3)
Social Influence (SI)	Persuasion (SI1)
	Service provider influence (SI2)
	Advertisement influence (SI3)
Facilitating Conditions (FC)	Resouces (FC1)
	Technologist (FC2)
	Help from others (FC3)
Hedonic Motivation (HM)	Fun (HM1)
Hedonic Motivation (HM)	Enjoyable (HM2)
Price Value (PV)	Rational Price (PV1)
	Value (PV2)
	Conversion value (PV3)
Habit (HT)	Habit (HT1)
	Service addiction (HT2)
	Requirement(HT3)
Trust (T)	Trust (T1)
	Transaction security (T2)
	Trust of protection (T3)
Service Quality (SQ)	Tangibles (SQ1)
	Assurance (SQ2)
	Reliability (SQ3)
	Responsiveness (SQ4)
	Emphaty (SQ5)
Behavioral Intention (BI)	Daily usage intention(BI1)
	Future usage intention (BI2)
	Future usage intensity (BI3)
Use Behavior (U)	Usage frequency (U1)
	Usage rate (U2)

3.3 Research Variable Model

Figure 3 below was the model used in this study. This research model explained the behavioral intention and usage behavior of consumers in Indonesia in using Fix Broadband Service. In this model there were the basic variables development of the UTAUT2 model, such as trust and service quality. The model proposed in this study was called FBAM (FIX Broadband Adoption Model).

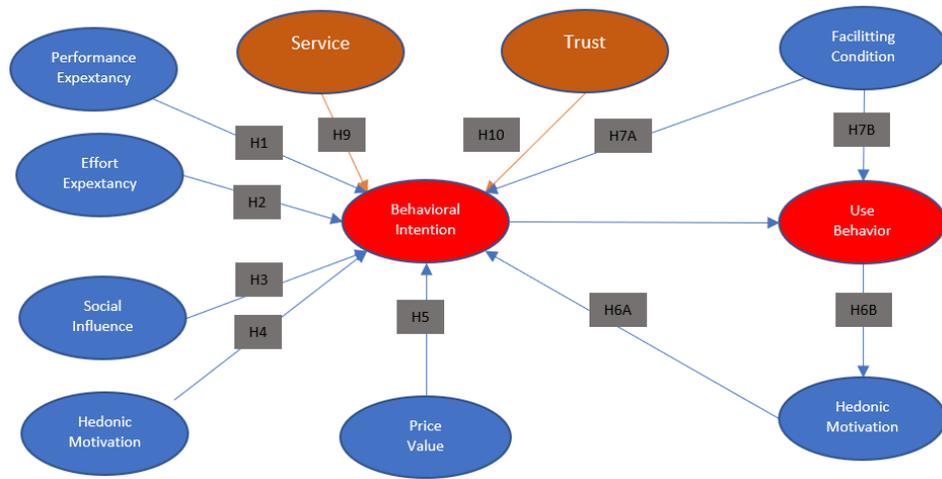


Figure 3 Research Variable Model

4. RESULTS

4.1 Data Collection

The number of questionnaire respondents obtained in this study were 273 respondents. The questionnaire was collected for approximately 4 weeks from end of May to mid-June 2021. Through online distribution and was spread to several social medias. The survey method used a web google form, where users could directly filled out the questionnaire form instantly and was recorded directly by the system. From the 273 respondent datas, then filtered again with the parameters of respondents who had subscribed to indihome and had installed my indihome and there was obtained customer data as follows: 16 respondents who had not subscribed to Indihome, 31 respondents who had subscribed to indihome but had not installed my indihome. 228 respondents who had already subscribed to indihome and installed my indihome application.

4.2 Partial Least Square Analysis (PLS -SEM)

There were two stages of PLS analysis, such as the outer model evaluation (constructive model) and the inner model evaluation (structural model). PLS-SEM analysis in this study was conducted using the WarpPLS 7.0 software.

4.2.1 Outer Model Evaluation (Construct Model)

Outer model evaluation was used to see whether the indicators or question items in the study were able to properly measure the research variables (valid and reliable). The evaluation of the outer model in PLS was divided into three parts, those were:

4.2.1.1 Convergent Validity Evaluation

The results of the convergent validity test showed that each indicator/question item in this study had an outer loading value greater than 0.7. The test results showed that each indicator/question item had good convergent validity. as described in

Table 2 Convergent Validity Evaluation

VARIABLE	Loading Factor
PE1	0,899
PE2	0,848
PE3	0,889
EE1	0,868
EE2	0,849
EE3	0,873
SI1	0,871
SI2	0,734
SI3	0,839
PV1	0,854
PV2	0,863

VARIABLE	Loading Factor
PV3	0,846
HT1	0,867
HT2	0,873
HT3	0,904
T1	0,896
T2	0,872
T3	0,912
HM1	0,897
HM2	0,897
BI1	0,909
BI2	0,909

VARIABLE	Loading Factor
U1	0,838
U2	0,838
SQ1	0,767
SQ2	0,861
SQ3	0,868
SQ4	0,847
SQ5	0,856
FC1	0,873
FC2	0,825
FC3	0,842

4.2.1.2 Discriminant Validity Evaluation

Discriminant validity evaluation was performed to test whether the indicator/question item in a variable can only be used to measure the variable and cannot be used to measure other variables (Hair, 2016).

$$VE = \frac{\sum \lambda_i^2}{\sum \lambda_i^2 \sum_i \text{var}(\epsilon_i)} \quad (1)$$

In which :

λ_i = loading factor, $\text{var}(\epsilon_i) = 1 - \lambda_i^2$

Table 3 Discriminant Validity Evaluation

	PE	EE	SI	FC	HM	PV	HT	T	SQ	BI	UB
PE	0.879	0.781	0.513	0.624	0.665	0.657	0.656	0.680	0.653	0.599	0.581
EE	0.781	0.863	0.578	0.704	0.694	0.674	0.707	0.718	0.637	0.582	0.567
SI	0.513	0.578	0.817	0.595	0.586	0.662	0.556	0.514	0.593	0.553	0.529
FC	0.624	0.704	0.595	0.847	0.761	0.706	0.676	0.716	0.664	0.564	0.553
HM	0.665	0.694	0.586	0.761	0.897	0.778	0.773	0.765	0.757	0.648	0.595
PV	0.657	0.674	0.662	0.706	0.778	0.854	0.740	0.772	0.772	0.635	0.565
HT	0.656	0.707	0.556	0.676	0.773	0.740	0.882	0.740	0.745	0.694	0.616
T	0.680	0.718	0.514	0.716	0.765	0.772	0.740	0.893	0.789	0.646	0.559
SQ	0.653	0.637	0.593	0.664	0.757	0.772	0.745	0.789	0.840	0.731	0.615
BI	0.599	0.582	0.553	0.564	0.648	0.635	0.694	0.646	0.731	0.909	0.715
UB	0.581	0.567	0.529	0.553	0.595	0.565	0.616	0.559	0.615	0.715	0.838

The results of the discriminant validity evaluation showed the AVE root value which was shown through the bold diagonal value in **Table 3**. The AVE root value on performance expectancy was 0.879, which was greater than the performance correlation value with other variables. It was also the same as the other variables which was known to have the AVE root value greater than the variable correlation value with other variables in the model. Thus, it can be stated that the question items in this study had good

discriminant validity, so that the question item of a variable could only described the variable and could be distinguished from other variable question items in the research model.

4.2.1.3 Construct Reliability Evaluation

Construct reliability evaluation was conducted to see whether the research question items were reliable/reliable in measuring the research variables. Reliability according to Sugiyono (Kock, 2013) was the extent to which an indicator/question item tested on the same object would produce the same data analysis results.

$$CR = \frac{(\sum_{i=1}^n \lambda)^2}{(\sum_{i=1}^n \lambda)^2 + \sum_{i=1}^n 1 - \lambda^2} \quad (2)$$

In which, was the loading factor from the indicator/question item, while n was the number of indicators/items in the latent variable.

Table 4 Composite Reability

Variabel	Composite Reliability	Variabel	Composite Reliability
Performance Expectancy	0.911	Habit	0.913
Effort Expectancy	0.898	Trust	0.922
Social Influence	0.857	Service Quality	0.923
Facilitating Condition	0.884	Behavioral Intention	0.904
Hedonic Motivation	0.891	Use Behaviour	0.825
Price Value	0.890		

Table 4 showed that each variable in this study had a composite reliability value ranging from 0.825 to 0.923. The composite reliability value for each variable was greater than 0.7, which meant that each variable in this study had reliable/credible indicators/question items.

4.2.2 Inner Model Evaluation (Structural Model)

The second stage was inner model evaluation (structural model), at this stage it tested the relationship between variables according to the research hypothesis and evaluated the goodness of fit model was done. Inner model evaluation consists of four parts, such as:

4.2.1.1 Multicollinearity Test

The existence of multicollinearity is indicated if there is one variable that has a Variance Inflation Factor (VIF) value of more than 5, so if there is a variable that had a VIF value > 5, it is necessary to consider including that variable in the model (Hair, 2016).

$$VIF = \frac{1}{1 - R_x^2} \quad (3)$$

VIF is obtained from the R² of exogenous variabels value in the research model. (Hair, et al., 2016) and the results obtained from the warpls application were as follows:

Table 5 VIF

Variabel	VIF
Performance Expectancy	3.015
Effort Expectancy	3.666
Social Influence	2.112
Facilitating Condition	3.033
Hedonic Motivation	4.095
Price Value	4.011

Variabel	VIF
Habit	3.547
Trust	4.087
Service Quality	4.101
Behavioral Intention	3.024
Use Behaviour	2.329

The results of multicollinearity test used VIF in **Table 5** showed that all variables in this study had VIF value were less than 5. Thus, it can be concluded that there was no multicollinearity between variables in this study so that testing bias can be avoided.

4.2.2.2 Goodness of Fit Model Assessment

Goodness of fit assessment in Partial Least Square (PLS) which is used WarpPLS can be done by looking at some of the references that have been given by (Kock, 2013) Goodness of fit criteria value as a result of the PLS analysis in this study was described in **Table 6** was acquired by doing calculations through the WarpPLS application, where the model that has been obtained was described in the tools then it was achieved the Goodness of fit value according to the WarpPLS criteria from each - each variable.

Table 6 The Result of Goodness of Fit Model Assessment

No	Criteria	Value	Explanation
1	ARS	< 0,001	Good
2	AARS	< 0,001	Good
3	AVIF	3,373	Ideal
4	AFVIF	3,365	Ideal
5	TGoF	0,712	Good
6	SPR	1,000	Ideal
7	SSR	1,000	Ideal

The results of the goodness of fit assessment showed that of the seven criterias that is set by (Kock, 2013) it was found in **Table 6** that all the criteria were fulfilled so that it can be stated that the model was decent and good to be used for the research hypothesis testing process.

4.2.2.3 Coefficient of Determination Assessment (Adjusted R₂)

The corrected determination coefficient was used to assess the role of exogenous variables towards endogenous variables in this study. The corrected determination coefficient usage was suggested by (cohen, 2017) to avoid bias in the number of predictors that is included in the model. were described in **Table 7**.

Table 7 Adjusted R2

Endogenous Variable	Adjusted R ²
Behavioral Intention	0.794
Use Behaviour	0.560
Average Adjusted R²	0.670

The average adjusted R-square in the structural model was 0.670 which indicated that overall the research model can be explained by research variables of 67.0% while the remaining 33.0% was explained by other variables outside the study. According to (Ghozali, 2014) the adjusted R squared value > 0.25 (25%) indicates that the model is good or the relationship between variables is appointed to be quite close in the study.

4.2.2.4 Research Hypothesis Test

Research hypothesis test was carried out by looking at the path coefficient and path coefficient's p-value in the structural model. The path coefficient pointed the size and direction of the relationship between two variables, while the p-value pointed whether the research hypothesis was accepted or not. If the p-value was smaller than the degree of error (α) of the study, which was 5%, it was stated that the research hypothesis was accepted and it was stated that there was an effect of exogenous variables on endogenous, were described in **Table 8**.

Table 8 Research Hypothesis Test

Hypothesis	Path Coefficient	P-Value	Explanation
H1: Performance Expectancy has positive influence towards Behavioral Intention	0.120	0.030	accepted
H2: Effort Expectancy has positive influence towards Behavioral Intention	0.070	0.139	rejected
H3: Social Influence has positive influence towards Behavioral Intention	0.154	0.008	accepted
H4: Hedonic Motivation has positive influence towards Behavioral Intention	0.073	0.128	rejected
H5: Price Value has positive influence towards Behavioral Intention	0.031	0.314	rejected
H6a: Habit memiliki has positive influence towards Behavioral Intention	0.229	<0.001	accepted
H6b: Habit has positive influence towards Use Behavior	0.187	0.002	accepted
H7a: Facilitating Conditions has positive influence towards Behavioral Intention	0.050	0.220	rejected
H7b: Facilitating Conditions has positive influence towards Use Behavior	0.134	0.018	accepted
H8: Behavioral Intention has positive influence towards Use Behavior	0.504	<0.001	accepted
H9: Trust has positive influence towards Behavioral Intention	-0.007	0.456	rejected
H10: Service Quality has positive influence towards Behavioral Intention	0.447	<0.001	accepted

6. CONCLUSIONS

Factors that could affect against customer experience analysis on My Indihome customer services were: Performance Expectancy, Social Influence, Habit, Facilitating Condition and service quality while the factors that had no effect were: Effort Expectancy, Hedonic motivation, price value, and trust. In other words, the trust variable could not affect the UTAUT2 model that was applied to mobile customers because the trust path coefficient on Behavioral Intention was found to be negative, that is -0.007 with the p-value in this hypothesis was 0.456 which was greater than (5%). While the Service Quality Variable can be accepted because it was based on the path coefficient value which was positive, that is 0.447 with a p-value smaller than (5%)

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ANALYSIS OF TELKOMSEL CUSTOMER LOYALTY IN GRAPARI TELKOMSEL CIPUTRA SURABAYA USING MIX METHOD

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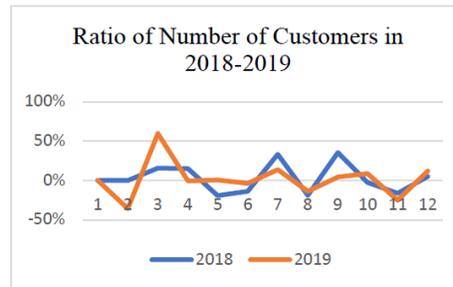
ABSTRACT

Modernization is one of the impacts of the growth and development of various existing forms of business. Data, information, goods and services are part of the basis for the birth of modernization that occurs in life, especially in the service sector. GraPARI Telkomsel is a service office for cellular provider companies in Indonesia. Based on a previous survey, it shows indications of problems at GraPARI Ciputra Surabaya, the most influential factor is customer loyalty. This study will analyze the effect of service quality on loyal customers from the value of customer satisfaction based on the perception of customers who come to GraPARI Ciputra Surabaya. This study used a mixed method. This method is a combination of quantitative methods derived from Partial Least Square (PLS), then the results are analyzed again by qualitative methods from interviews, theories and previous research. This study used a sample of 124 respondents who were selected according to the required criteria. The results of this study are the influence of customer quality on loyal customers, customer satisfaction is not a variable that affects customer quality towards loyal customers, then gender, age and customer perspectives affect customer perceptions to become loyal customers.

Keywords: Mix Method, PLS, Service Quality, Customer Satisfaction, Customers Loyalty.

1. INTRODUCTION

Modern society at this time has the desire to continue to update and meet their needs, both in terms of the speed of getting information and technology, which include the need for services in the field of telecommunications and data (Aris, 2016). The increasing demands and needs of customers have resulted in high competition for telecommunication service providers to be at the forefront. PT. Telkomsel is one of the largest cellular telecommunications operators in Indonesia. GraPARI Ciputra Surabaya is a Telkomsel service office located in the western part of Surabaya. Based on a pre survey conducted at GraPARI Ciputra Surabaya, it was found that there were indications of problems that: 1. The number of customers for each product could not be recorded because the customers who came every month were not the same and the coverage area was quite wide from the GraPARI Ciputra area, 2. The number of customer arrivals at GraPARI Ciputra Surabaya has the smallest value compared to other GraPARI, which raises the issue that GraPARI is not functioning properly. This is reinforced by the following data support.



The picture above shows the ratio of the number of Telkomsel customers who came to GraPARI Ciputra Surabaya in 2018- 2019 experiencing an unfavorable trend. Companies will find it difficult to achieve sales targets and customer loyalty from customers with increasing competition between companies. This study will analyze the effect of service quality on customer loyalty from the value of customer satisfaction who comes to GraPARI Ciputra Surabaya using a mix method. It is hoped that by using Partial Least Square analysis, researchers can find out customer perceptions regarding services at GraPARI Ciputra Surabaya, improve service quality and be able to establish better relationships with customers, in the future. While the qualitative data obtained from the interviews are expected to provide a real picture of the existing conditions, so that they can easily find better development solutions in the future.

2. LITERATURE REVIEW

2.1 Service

The definition of service according to Kotler & Keller (2012) is a performance or activity that is intangible but can be seen, felt and related to the value or benefit of the service provider. Goetsch & Davis (1994) in Tjiptono (2012:152) reveals that quality can be interpreted as the relationship between the company's products and services or services provided by the company to customers that can meet customer expectations and satisfaction.

2.2 Service Quality

Service quality is an assessment of the results of comparing the expectations of service quality perceived by customers with the performance of a company (Saghier & Nathan, 2013). If the service received is in accordance with the perception (desire) of the customer, the service is in accordance with expectations so that the quality of the service is perceived positively and the customer is satisfied. Quality service in a company can meet the compatibility between customer expectations and service provider companies in accordance with the level of service provided in order to meet and even exceed the expectations of customers who consume services (Lupiyoadi, 2013).

2.3 Customer Satisfaction

Customer satisfaction is the result of the level of feelings of customers who have received services after comparing the service performance obtained with their expectations. Customers can experience one of three levels of satisfaction, namely service below expectations which will make customers disappointed, service as expected (according to customer expectations) and service that can exceed expectations (service beyond customer expectations with positive connotations) which will make customers happy (Kotler & Keller, 2013: 35).

2.4 Customer Loyalty

Loyalty is a process, where at the end of the process satisfaction is the perceived customer's perception of the product/service that has an impact on the use of the product/service repeatedly or switching to a competing company (Ishaq et al., 2014). According to Oliver (1999) customer loyalty is a closely held

commitment to buy/use a product/service of a company consistently which causes the purchase of good offers from competing companies.

3. METHODS

3.1 Mix Method

According to Cresswell and Clark (2007) this mixed research focuses on collecting, analyzing and mixing qualitative and quantitative data in a study. The use of a combination of qualitative and quantitative approaches can provide a better understanding of research problems than using a single approach (Samsu, 2017). There are four types in the mix method according to Cresswell and Clark (2007), namely triangulation design, the embedded design, explanatory design and exploratory design. The approach used in this research is triangulation design.

3.2. Partial Least Square (PLS)

In this study, the data analysis used the Partial Least Square (PLS) approach. PLS was first introduced in general by Herman Wold in 1974. PLS is an alternative approach that shifts from a covariance-based SEM approach to a variance-based approach. Covariance-based SEM is used to test the causality model, while PLS is ore predictive model (Ghozali, 2008). Here are the PLS steps.

1. Designing Structural Models, Measurement Models and Constructing Path Diagrams.
2. Outer model. Measurement of indicators related to latent variables. The evaluation stage of the outer model is the stage in measuring the variables to be tested for validity and reliability (Abdillah & Jogiyanto, 2015).

- a. Convergent Validity, the measurement of convergent validity is based on the value of the loading factor with a measurement scale of 0.50 to 0.60 and T Statistics > 1.96.
- b. Discriminant Validity, the measurement of discriminant validity uses the cross loading value. It is said to meet discriminant validity by comparing the square root of average variance extracted (AVE) for each variable with a correlation value between variables.

$$AVE = \frac{\sum \lambda_i^2}{\sum \lambda_i^2 + \sum i_{var}(\epsilon_i)}$$

- c. The reliability test can be seen based on cronbach's alpha must be more than 0.6 and the composite reliability value is more than 0.7.

$$\rho_c = \frac{(\sum \lambda_i)^2}{(\sum \lambda_i)^2 + \sum i_{var}(\epsilon_i)}$$

3. Inner Model. This model describes the relationship between latent variables based on substantive theory. The criteria for evaluating the inner model are as follows:

- a. Assessment of Goodness of Fit with an R-Square. In assessing the structural model, it begins by looking at the Rsquare value for each endogenous variable value as the predictive power of the structural model. The higher the Rsquare value, the better the prediction model and the proposed research model (Ghozali, 2008).

$$\eta_1 = \gamma \xi_1 + \gamma_2 \xi_2 + \zeta_1$$

$$\eta_1 = \beta_1 \eta_1 + \gamma_3 \xi_1 + \gamma_4 \xi_2 + \zeta_2$$

- b. Q2 Predictive Relevance. In addition to looking at the magnitude of R-square, the evaluation of the PLS model can also be done by looking at Q2 to present the synthesis of cross-validation and fitting functions with predictions from observed variables and estimates of construct parameters.

$$Q^2 = 1 - (1 - R_1^2) (1 - R_2^2) \dots (1 - R_p^2)$$

- c. Inner Weight. This measurement is used to determine the magnitude of the effect and the level of significance by using the Resampling Bootstrapping process that is hypothesized.

3.3 Analysis Model

The formulation of the research hypothesis is as follows:

H1 : Service Quality has a positive effect on Customer Loyalty

H2 : Service Quality has a positive effect on Customer Satisfaction

H3: Customer Satisfaction has a positive effect on Customer Loyalty

H4: Customer Satisfaction moderates the effect of a positive Service Quality relationship on Customer Loyalty.

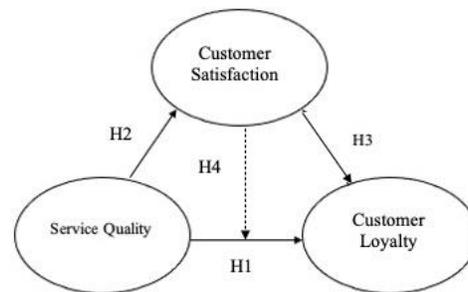


Figure 1. Analysis Model

3.4 Sample

The sampling technique in this study uses purposive sampling, using a sample of 124 customers. Customers based on gender are grouped into two types, namely male and female. as many as 82 customers are male or about 66.1% of the total sample, while 42 customers are female or about 33.9% of the total sample. The sample in this study is dominated by customers aged 20 years and over with customers aged 31-40 years as many as 61 customers, then customers aged 20-30 years as many as 34 customers, the rest at the age of 40-50 years as many as 26 customers and age >51 years as many as 3 customers.

Table 1. Descriptive Result

	n	Percentage (%)
Gender		
Male	82	66,1%
Female	42	33,9%
Age		
20-30	34	27,4%
31-40	61	49,2%
41-50	26	21%
>51	3	2,4%

interviews to describe the existing conditions. Interviews were conducted to obtain more detailed information related to the relationship between elements or variables. The sources of the interviews were divided based on the categories of sources, namely: gender, age and perspective. Conducted to determine whether gender, age and perspective can affect the results of the interview.

1. Informant W1: Visitor 1 female aged 20-30 years old
2. Informant W2: Visitor 2 female aged 31-40 years old
3. Informant W3: Visitor 3 female aged 41- >50 years old

4. Informant P1: Visitor 1 male aged 20- 30 years old
5. Informant P2: Visitor 2 male aged 31- 40 years old
6. Informant P3: Visitor 3 male aged 41- >50 years old
7. Informant X: Team Leader (service provider perspective)

4. RESULTS

4.1 PLS Result

Testing the research hypothesis used Partial Least Square (PLS) analysis using the SmartPLS 2.0 program with the following research results.

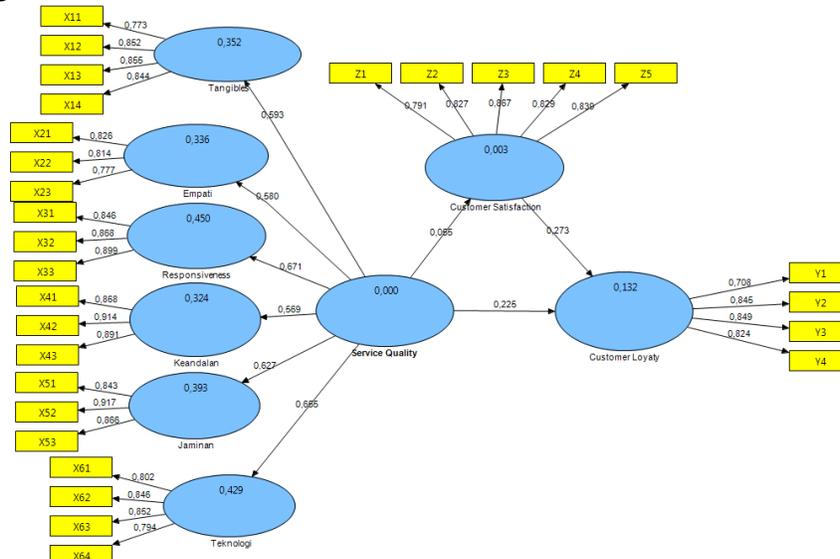


Figure 2. Algorithm Outer Model SmartPLS

Table 2. Outer loading *Second Order Variabel Service Quality*

	Emphaty	Assurance	Reliability	Responsive	Tangibles	Technology
EM1	0,825598					
EM2	0,814227					
EM3	0,777068					
J1		0,843362				
J2		0,917288				
J3		0,865772				
K1			0,867962			
K2			0,867962			
K3			0,867962			
Res1				0,845513		
Res2				0,867511		
Res3				0,898843		
Tang1					0,773376	
Tang2					0,852071	
Tang3					0,854764	
Tang4					0,843596	
Tek1						0,801794
Tek2						0,845867
Tek3						0,852240
Tek4						0,794187

Based on the table of variables (first order) and service quality indicators (second order) has a loading factor value of 0.5-0.6 so that it can meet convergent validity. Then in the measurement of discriminant validity in this study, the convergent AVE value > from 0.5 indicates a good adequacy of validity for the latent variable.

Table 3. Indicator Validity Test Results Through AVE (Average Variance Extracted)

	AVE
Customer Loyaty	0,653
Customer Satisfaction	0,690
Emphaty	0,649
Assurance	0,767
Reliability	0,793
Responsiveness	0,758
Tangibles	0,691
Technology	0,678

The results of the reliability test on each latent variable meet the standard value of more than 0.70. This indicates that all variables are reliable and can be used in research.

Table 4. Composite Reliability

	Composite Reliability
Customer Loyaty	0,882
Customer Satisfaction	0,917
Emphaty	0,847
Assurance	0,908
Reliability	0,920
Responsiveness	0,903
Tangibles	0,899
Technology	0,894

Based on the Table 4, it can be seen that the results of the reliability test on each latent variable meet the standard value, which is more than 0.70. This indicates that all variables are reliable and can be used in research. The next step, testing the structural model is done by looking at the R-Square value which is the goodness-fit test of the model. so to find the R-square is as follows $R^2 = 0,134$.

4.2 Hypothesis

The following is the research hypothesis testing based on the bootstrap estimation results on SmartPLS.

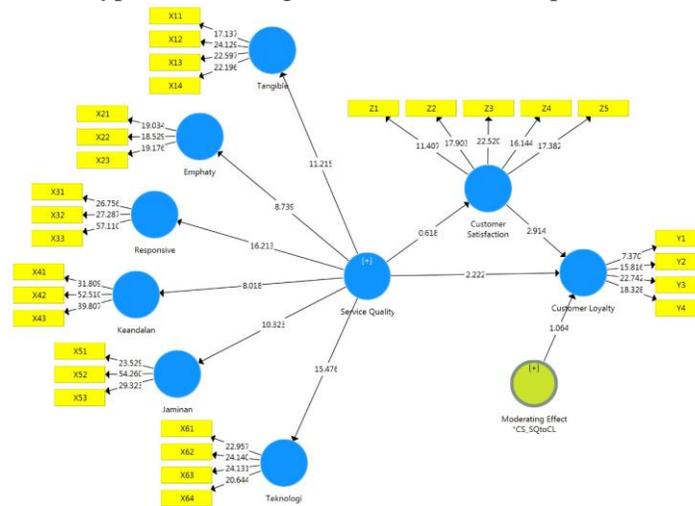


Figure 3. Bootstrapping SmartPLS

Table 5. Path Coefficients Test Results (MEAN, STDEV T-Values)

	Path Coefficients (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics ((O/STDEV))	P Values
Customer Satisfaction->Customer Loyalty	0,253	0,282	0,087	2,914	0,004
Moderating Effect *CS_SQtoCL -> Customer L Loyalty	-0,130	-0,116	0,122	1,064	0,288
Service Quality -> Customer Loyalty	0,232	0,240	0,104	2,222	0,027
Service Quality -> Customer Satisfaction	0,055	0,048	0,090	0,618	0,537

Table 6, shows the output that describes the results of testing the research hypothesis as follows:

1. Hypothesis 1 states that service quality has a positive effect on customer loyalty and is acceptable. It has a positive effect on customer loyalty GraPARI Telkomsel Ciputra Surabaya, with a positive path coefficient of 0.232, where the p-values = 0.02 is smaller than the value of = 0.05.
2. Hypothesis 2 states that service quality has a positive effect on customer satisfaction. H1 is rejected or H0 is accepted. It has a positive path coefficient of 0.053, where the p-values = 0.537 is greater than the value of = 0.05
3. Hypothesis 3 states that customer satisfaction has a positive effect on customer loyalty and can be accepted. It has positive path coefficient of 0.253, where the p-values = 0.004 is smaller than the value of = 0.05
4. Hypothesis 4 states that service quality has a positive effect on customer loyalty with customer satisfaction as a moderating variable H1 is rejected or H0 is accepted. It has negative path coefficient of -0.130, where pvalues = 0.288 greater than the value of = 0.05.

4.2.1 The Effect of Service Quality on Customer Loyalty

Based on the results of hypothesis testing, it is known that service quality has a positive effect on customer loyalty. GraPARI Telkomsel Ciputra Surabaya customers are accepted. The results of this study are in line with research conducted by Lee.S.H (2013) which states that service quality and customer satisfaction have a significant effect on customer loyalty. This is as revealed from the results of interviews with the following informants: "Because it's comfortable and have a good relationship with the cs at GraPARI Ciputra, so if there are complaints or want to ask for buy a promo package, usually customers will come or can use cs's personal whatsapp if they can't come on the same day" (Informant W3) "I'm satisfied at GraPARI Ciputra because the place is quieter than the central GraPARI so the handling is faster, cs also explained patiently. So, I also recommend to friends who have problems, let them go to GraPARI Ciputra only" (Informant W2)

Based on the existing conditions at GraPARI Telkomsel Ciputra Surabaya, the level of customer loyalty is evidenced by the good relationship between customer service employees and loyal customers.

4.2.2 The Effect of Service Quality on Customer Satisfaction

Based on the results of hypothesis testing, it is known that service quality has a positive effect on customer satisfaction of GraPARI Telkomsel Ciputra Surabaya customers rejected. The results of this study are in line with research conducted by Kummer (2018) which states that although service quality consists of five dimensions. However, in the case of Indian Telecommunications Industry, not all dimensions affect customer satisfaction and Service Loyalty. Only empathy and reliability have a significant effect on Customer Satisfaction. This is as revealed from the results of interviews with the following informants: "There should be a notification via SMS or an application when the grace period is over, don't suddenly burn it and cannot be activated. If the number is important, it's also difficult to take care of the bank and other accounts" (Informant P3) "If it's burned, the solution is just a subscription card, while not all customers

are comfortable with such a system. In my opinion, the subscription package price is also expensive, even though prepaid calls can be free up to 6000 minutes" (Informant W1) In addition, the company's rules that cannot leak customer data unless the customer himself asks for too much data is a case of fraud and often disappoints the customer. This is in accordance with the value of the empathy dimension which is smaller than the other dimensions. This is as revealed from the results of interviews with the following informants: "Many cases, such as customers coming to tell about cases of fraud and even infidelity and asking cs to help provide information about the owner of the number, if it is only based on empathy and humanity, the desire to help is definitely there but this violates the SOP and requires great responsibility. So it definitely can't be given" (Informant X) Referring to the research conducted, this is in line with the existing conditions.

4.2.3 The Effect of Customer Satisfaction on Customer Loyalty

Based on the results of the hypothesis that customer satisfaction has a positive effect on customer loyalty, GraPARI Telkomsel Ciputra Surabaya customers are accepted. The results of this study are in line with research conducted by Rachmat and Ningtyas (2011) which states that customer satisfaction has a significant effect on customer loyalty at their research. This is as revealed from the results of interviews with the following informants: "Usually there to update the latest packages, because I don't understand about cheap packages and how to buy them. Usually later, the customer service will help choose so I just believe them" (Informant P3) "The cs are patient when explaining or providing information, if it's a parent, it's really difficult, sis, if it's complicated like that. So, if I have time, I will try to come by to ask about the active period of the number" (W3 Informant) In addition, the situation at GraPARI Telkomsel Ciputra Surabaya that supports the creation of customer loyalty in perceived satisfaction is one of them by providing merchandise to customers on a regular basis, especially to customers who often make transactions at GraPARI Telkomsel Ciputra Surabaya.

4.2.4 The Effect of Service Quality on Customer Loyalty with Customer Satisfaction as Moderating Variable

Based on the hypothesis put forward by the researcher which states that service quality has a positive effect on customer loyalty with customer satisfaction as a moderating variable at GraPARI Telkomsel Ciputra Surabaya, the results are not acceptable or H0 is accepted. Because customer satisfaction does not act as a moderating variable. The results of this study are in accordance with research conducted by Lee (2013) which states that the results of the moderating effect indicate that the interaction of service quality and perceived value has a significant effect on customer satisfaction. Interaction of customer satisfaction and perceived switching costs have a significant effect on customer loyalty. Based on the existing conditions at GraPARI Telkomsel Ciputra Surabaya, the influence of service quality through customer satisfaction on loyal customers cannot be accepted as evidenced by several customers who seem satisfied and feel they have been able to accept an explanation from customer service for complaints or obstacles they propose does not guarantee these customers provide good rating in customer satisfaction web survey. On the other hand, customers who do not give the impression of being dissatisfied when the service is performed can come back again and become loyal customers at GraPARI Telkomsel Ciputra Surabaya Surabaya. This is as revealed from the results of interviews with the following informants: "Often when receiving customer satisfaction web sms results, there are customers who give bad grades. Usually, every cs who is affected by a bad rating must contact the customer and ask about the lack of service" (Informant X) "At that time, at

GraPARI, I complained about the problem with the credit being cut off, cs informed me that a report would be made to IT and waited 3x24 hours. finally informed after the fifth day" (Informant P1)

4.3 Analysis of Interview Results

Based on the results of the analysis above, gender, age and customer perspective affect customer perceptions when answering questions. Informants with female gender in the three age groups dominate positive answers and have the potential to become loyal customers, this is in accordance with previous research which states that women are more loyal than men. While the male gender in the three age groups dominated negative answers and dissatisfaction with the service, this is in accordance with previous research which stated that female customers showed a higher level of satisfaction than men. Male and female informants in the age group 41->51 years who have a positive perception and previous research stated that customers aged 31-50 years tend to easily submit complaints. This is where the role of customer service is needed in providing special treatment to customers in the elderly category.

4.4 Managerial Aspect

Referring to the results of research conducted, to add new customers and produce loyal customers, it is necessary to have a system that can improve service quality so that customer satisfaction increases. Knowledge Management System or commonly called KMS is a system that helps companies identify, select, organize, disseminate and transfer important information and expertise that is part of the company's memory (Turban, 2008) which is usually used by companies as a reference and learning for customer service. in improving services. PT Telkomsel itself already has a KMS which is used by employees every day as a reference in service and resolution of cases reported by customers. In this study, the description of the existing conditions can be used as material to formulate, identify and evaluate the KMS that has been used at GraPARI Telkomsel Ciputra Surabaya for the better. The results of this study can be used as inputs and descriptions that may occur in other GraPARI in the city of Surabaya.

6. CONCLUSIONS

Based on the analysis and discussion of the research results, the following conclusions are obtained:

1. Service quality has a positive effect on customer loyalty GraPARI Telkomsel Ciputra Surabaya, the result is H1 is accepted.
2. Service quality has a positive effect on customer satisfaction GraPARI Telkomsel Ciputra Surabaya, the result is H0 is accepted or H1 is rejected.
3. Customer satisfaction has a positive effect on customer loyalty GraPARI Telkomsel Ciputra Surabaya, the result is H1 is accepted.
4. Service quality has a positive effect on customer loyalty and customer satisfaction as a moderating variable at GraPARI Telkomsel Ciputra Surabaya, the result is H0 is accepted or H1 is rejected. This is because

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INFLUENCE FACTORS OF USER EXPERIENCES AND SERVICE QUALITY ON CONTINUANCE INTENTION TO USE FOR MOBILE PAYMENT IN MILLENNIAL GENERATION

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ABSTRACT

At the beginning of 2020 the whole world had Covid-19 pandemic or commonly known as the Corona Virus, including Indonesia. Since that day, the government has implemented the PSBB policy. This policy has created a new phenomenon in the community, namely the habit of digital cash transactions, because it can help stop the Covid-19 chain of transmission. One of the digital payments in Indonesia is e-wallet. OVO has recorded a new user growth of 267%. OVO also noted that 43% of the largest users are in the age range of 25 - 35 years, that is millennials. The growth of e-wallets has occurred of big cities such as in East Java. Therefore, this study aims to determine what factors affect the continuous intention. The method used in this research is to use Partial Least Square - Structural Equation Modeling (PLS-SEM). This research show that e-wallets has influenced by user experiences such as perceived credibility, perceived usefulness, perceived integration, and service quality. Trust is also considered as an important factor in using e-wallets.

Keywords: Mobile payment, OVO, Millennial, Perceived credibility, Perceived usefulness, Perceived integration, Service quality, Trust, Continuous intention.

1. INTRODUCTION

In early March 2020 Covid-19 pandemic or Corona Virus had on Indonesia, since then the spread of the Corona virus has continued to occur in almost all of Indonesia. The government has set a policy that called PSBB, to reduce the spread of the corona virus. The policy made a new phenomenon in the community to shop online with digital transactions, which one e-wallet. People feel safe when payments using digital (cashless), this is because it can help stop the chain of transmission of the corona virus (JAKPAT, 2020). The sources inform that during pandemic e-wallet was increasing 4% in Indonesia. Moreover, Indonesia has positive growth of e-wallet, which is always increasing every year, especially in 2020 during the pandemic. One of the big e-wallet at Indonesia is OVO, they stated that there was a big spike in transactions during pandemic, the increasing of more than 100% (Catriana, 2020).

Cashless has identic with millennial generation, that fact at Indonesia. Most of the use of e-wallet in Indonesia is the younger generation who already have the ability to pay (Ramadhan, 2020). The source states that the highest percentage of e-wallet users is in the middle of 25-40 years old, that called millennial generation. It is very important for OVO to know a trend that

occurs in the millennial generation so that next OVO can know the characteristics of consumers and of course can make a strategy in marketing its products. Indonesia has many big cities especially at Java. The positive growth of E-wallet has significant on several cities in East Java which had a penetration of 7.45% in the fourth quarter of 2019 and became the third largest province in mobile payment penetration on the island of Java after DKI Jakarta and Banten (Panca, 2020).

Harianto Gunawan as Director of OVO confirm that the spread of e-wallet usage has not been maximized throughout Indonesia, and one of the problems that occurs is that many Indonesian people still don't believe using e-wallet, so it is a challenge for OVO to be able to prove that e-wallet assisting the public in transacting safely and comfortably, as well as creating trust in e-wallet (Nadia, 2020). OVO must be able to manage its business strategy so that consumers continue to using OVO so that OVO can maintain its existence.

This research has objective to know what factors influence of continuous intention for e-wallet especially for the millennial generation in big cities in East Java. Currently the millennial generation is the largest contributor to e-wallet and East Java is the third largest province in mobile payment market penetration.

2. LITERATURE REVIEW

User experiences using digital payments is internal source of information, which can help evaluate their intention to continue using digital payments or not (Hong Zhu & Ying L. Y. P. Chang, 2017). User experiences have three factor, (1) Perceived credibility, is a factor that has a positive influence on continuous intention, because digital payments involve consumer personal financial information. (2) Perceived usefulness, is a factor that is quite important to the formation of attitude and behavior that is one of the keys of continuous intention. (3) Perceived integration, the integration factor with other platforms, this factor important because digital payment need consistency transaction with other platforms.

Beside user experiences, digital technology need an Information System Success Model. The Information System Success Model used to measure the success of e-commerce was growing (DeLone & McLean, 2004). DeLone and McLean was developed their theory by focusing on Information System function services by including service quality. Service quality in general is a representation of expectations and performance. In general, consumers will compare the services they experience with the services they expect (Choi & Sun, 2016). Choi and Sun said continuance intention is a probability that can be seen from the last use of an application and is a direct economic benefit of a company. Besides that, continuance intention have significant factors, that is trust (Wang, Shen, & Sun, 2013). This research has five hypothesis (H1) Perceived credibility has positive effect on trust, (H2) Perceived usefulness has positive effect on trust, (H3) Perceived integration has positive effect on trust, (H4) Service quality has positive effect on trust, (H5) Trust has positive effect on continuous intention. This research has direct and indirect factor for continuous intention, detail on diagram below.

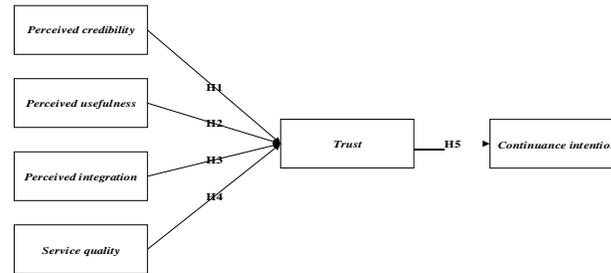


Figure 1. Research framework

3. METHODS

For the empirical research, a questionnaire survey was used to collect the data. The technique sampling used is Non Probability Sampling, which is a technique that doesn't provide equal opportunities or opportunities for each member of the population to be selected as a sample. Non Probability Sampling taken is purposive sampling. Purposive sampling is used because the researcher has determined certain characteristics of the respondents, namely based on the age of the respondent and the respondents domicile (Sugiyono, 2007).

First, a pilot questioner with ten respondents to give the feedback from questioner, that called face validity. A total of 200 questionnaires, the technique used in this study is Structural Equation Model (SEM). In SEM there are two testing techniques, one of technique is Partial Least Square – Structural Equation Modeling (PLS-SEM). PLS-SEM is used to estimate complex models with many construct variables (latent), indicators, and structural paths without imposing distributional assumptions on the data (Hair, Risher, Sarstedt, & Ringle, 2019).

4. RESULTS

The survey sample represents various sectors. Table 1 presents the demographic characteristics of the respondents. All of the survey respondents reported to have used an OVO more than once per week, domicile at East Java, and millennial generation.

Table 1. Demographic respondent

Characteristic	Percentage (%)
Gender	
Male	56
Female	44
Age Range	
25 – 30	79
31 – 35	15
36 – 40	6
Education	
High School	4
Diploma	5
S1	71,5
S2	19
S3	0,5

Motivation using OVO

Entertainment	14
Food & Beverage	32
Payment Electrical	8
E-commerce	20
Transportation	25

The initial stage that needs to be done in the PLS-SEM method is to check the **measurement model** that consist of outer loading, discriminant validity, convergent validity and reliability. The indicators SQU1, SQU5, and CIN4 was removed from this research because outer loading value (indicator) < 0,708, so the three indicator not valid. Discriminant validity for this research already fulfilled because there's no greater indicator value than going to the construct variable. So it can be said that each construct variable (latent) is different from other latent variables. The convergent validity will be passed if the value AVE ≥ 0.50 . The indicator will be reliable if the value of Cronbanch's Alpha ≥ 0.70 and ≤ 0.95 .

Table 2. Convergent Validity and Reliability

Variable	AVE	Cronbach's Alpha
Perceived Credibility	0,756	0,839
Perceived Usefulness	0,633	0,709
Perceived Integration	0,769	0,848
Service Quality	0,611	0,788
Trust	0,692	0,888
Continuance Intention	0,796	0,872

The next stage is **structural model** that used to see the relationship between the construct variables. This stage consists of collinearity, coefficient determination, and path coefficient. The table 3 proves that there is no collinearity problem in the structural model of this research, because all construct variables have value of VIF ≤ 3 . The table 3 show that R² on the Trust 0.582 means that the Trust variable can be explained by Perceived Credibility, Perceived Usefulness, Perceived Integration, and Service Quality of 58.2%, while the remaining 41.8% is explained by other variables outside this research model, and also the Continuance Intention variable.

Table 3. Collinearity and Coefficient Determination

Variable	VIF	R Square
Perceived Credibility	1.572	
Perceived Usefulness	1.576	
Perceived Integration	1.499	
Service Quality	1.650	
Trust		0.582
Continuance Intention		0.513

Path Coefficients is assisted by the SmartPLS 3.0 program with a confidence level of

95%, and a significance of 5%. The figure 1 show the relationship between variable and answers the hypothesis.

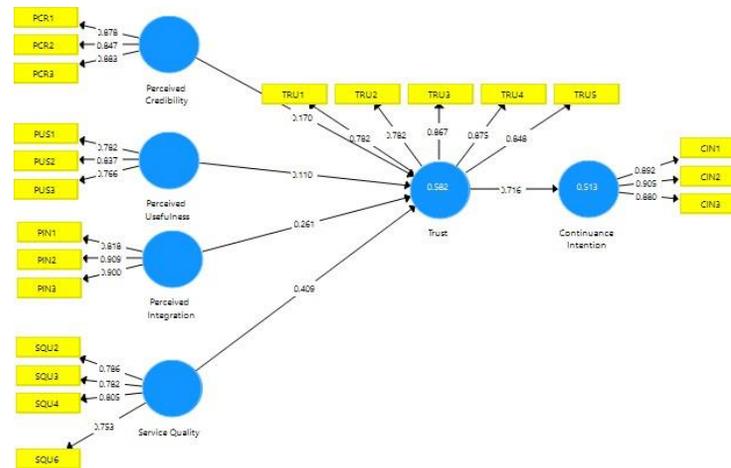


Figure 2. Path Coefficient

Table 4. Hypothesis Test Result

	Original Sample	t value	p values	Status
H1 Perceived Credibility -> Trust	0.170	2.943	0.003	Supported
H2 Perceived Usefulness -> Trust	0.110	2.017	0.044	Supported
H3 Perceived Integration -> Trust	0.261	5.086	0.000	Supported
H4 Service Quality -> Trust	0.409	7.417	0.000	Supported
H5 Trust -> Continuance Intention	0.716	16.079	0.000	Supported

Perceived credibility affects trust significantly and positively. Perceived credibility is a consumer's rating of OVO regarding privacy and security issues in using its payment services, so it concludes OVO already has a positive privacy, which causes customer to feel confident in using OVO. This result suitable with previous research, that Perceived credibility is persuasive in digital payment services which affects the trust that consumers have in these services (Hong Zhu & Ying

L. Y. P. Chang, 2017). The positive value of trust can certainly influence a customer to determine in reusing OVO in a transaction. The research before prove that positive credibility or trust that will be felt by consumers which will ultimately determine decision making (Cosenza, Solomon, & Kwon, 2014).

The usefulness of a technology is believed to improve performance, which helps the effectiveness and efficiency of a job. After a customer feels OVO can increase effectiveness and efficiency in a job, it can be said that the customer forms a trust in OVO. This statement is as explained in previous research that the usefulness factor is a deep consideration for consumers about digital payment services and can form trust in digital payments (Hong Zhu & Ying L. Y.

P. Chang, 2017). For indirect effect, perceived usefulness doesn't affect continuous intention. OVO customers currently feel that the function of the application can make digital transactions easier, but there are other factors that allow customers to switch to other applications such as discounts, promos, and bonuses that customers get from OVO competitors.

The value of Perceived integration is an aggregation of data, information, and coordination from one platform with the OVO application. Currently, there are many other platforms that have been developed and what consumers expect to be well integrated by OVO, make it easier to use. Low perceived integration between various digital payment platforms can lead to a bad experience for consumers, which will certainly affect trust. The results of this research is perceived integration positively affects trust. In addition, perceived integration positively affects continuous intention mediated by trust. So, it can be concluding that the integration of OVO can made customer using OVO continuously. The results of this research is in accordance with previous studies which stated that Trust is a mediation which is considered quite important in the relationship between perceived integration and continuous intention (Hong Zhu & Ying L. Y. P. Chang, 2017)

Service quality has several factors such as ease of use, visual appeal of customers in digital financing. OVO has a positive service quality value so that it can be relied on and trusted by its customers, this is in accordance with previous research that if digital payment service providers are unreliable and have a slow response to consumers, then consumers can't build trust (Zhou, 2013). In accordance with this study, OVO's service quality positively affects continuous intention mediated by trust, positive value in service quality can increase the continuous use of OVO.

Trust affects continuous intention significantly and positively. In this research, it is known that OVO has a fairly large trust value from customers and greatly affects its continuous use in a positive manner. The hacker continuously trying to hack the system, therefore OVO needs to build good enough security so that it gets the trust of its customers. The results of this study can be supported by previous research which states that trust is an important factor in electronic transactions and cyber decisions (Kim, 2007). Trust is an important strategy to deal with uncertainty and an uncontrollable future.

5. CONCLUSIONS

The purpose of this research is to find out various factors that can affect continuous intention in OVO mobile payments mediated by trust. From the results perceived credibility, perceived usefulness, perceived integration, service quality, have a direct and positive effect on trust. The results of this study also prove that trust has a direct and positive effect on the continuance intention. There is an indirect relationship in this study, where the results show a very strong relationship between perceived credibility, perceived integration, and service quality with continuous intention mediated by trust. This research give suggestion for OVO to be able to increase the value by having good service quality, when customers need an easy and clear form of visualization in support very dynamic activities, especially in the regions urban areas, so that if an error occurs in the transaction, then customers can easily cancel payments make it easier for users.

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ANALYSIS OF FACTORS AFFECTING INTEREST IN TRANSACTIONS USING EDC MACHINES IN CUSTOMERS PT. XYZ

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ABSTRACT

One of the tools needed to conduct business transactions in the current era of globalization and technological progress is innovation in the economic sector, namely the emergence of digital financial products called electronic money (e-money). To support these activities, banking companies make transaction tools called EDC (Electronic Data Capture) machines. In the midst of the increasing use of EDC machine transactions, Covid-19 is present and affects transaction interest. The purpose of this study is to analyze what factors influence transactional interest and which factors dominantly influence transactional interest in the use of PT. XYZ. In achieving these goals, several factors were analyzed, such as: Pandemic fear, Social Media Marketing Activities, Trust, Corporate Image. This type of research is quantitative research. This study uses a sample of 100 respondents which aims to collect data and based on the method convenience sampling. The data analysis technique used a statistical tool Structural Equation Modeling (SEM). The findings show Pandemic fear and Trust does not have a significant positive effect on Transactional Interest. Meanwhile, SMMA and Corporate Image have a significant positive effect on Transactional Interest. The managerial implication of this research is aimed at PT. XYZ as a service provider in order to find out the right strategy to increase transactional interest in EDC machines.

Keywords: Transactional Interests, Pandemic Fear, Social Media Marketing Activities, Trust, Corporate Image, Structural Equation Modeling (SEM)

1. INTRODUCTION

The current digital era makes people have to be smart in using technology to make it easier to interact with each other. The development of the times has also influenced the character of the community as people are getting used to the existence of technology which then encourages more responsive business needs. One of the tools needed to conduct business transactions in the era of globalization and current technological advances is innovation in the economic sector known as electronic money (e-money). The tool used to transact with

electronic money is called an EDC machine.

In the midst of the increasing use of EDC machines, pandemic fear is present in the community and affects global economic growth. The reality of very high infection and death rates causes severe mental stress such as fear, anxiety, and depression and makes most individuals worry about being infected with Covid-19 (Lin, 2020). Government steps to deal with pandemic fear through restrictions on people's mobility, this resulted in a decline in complex business activities, including banking transaction activities. One of the impacting banking transaction activities is the use of EDC machines. Social restrictions have made physical transactions including EDC machine transactions hit very hard. In line with the research of Brewer & Sebby (2021), the results of his research reveal the variable *pandemic fear* positive effect on buying interest. In line with previous research, researchers Saputra and Budiarti (2020), also found that the corona virus pandemic variable had a positive and significant effect on buying interest. Bank Indonesia recorded during the period of *pandemic fear*, a decrease in transactions with EDC machines that are *face to face* at 7.1% or around Rp. 291 billion in 2020.

Buying interest in this case is an interest in making transactions using one of XYZ's banking products, namely the EDC machine. In line with the theory of Ferdinand, (2006) in Faradiba and Astuti (2013) which states that transactional interest is the tendency of consumers to make purchases of a product. Furthermore, in this study, interest will be referred to as transactional interest. Buying interest is something related to consumer plans to buy a product offered and about the number of product units that become consumer needs in a certain time (Howard & Sheth, 1969 in Priansa, 2017).

Considering that currently, the Covid-19 pandemic is affecting the character of people's behavior, the banking industry is required to be adaptive to the pressures of the pandemic to survive in a competitive environment. The increasing use of the internet in the community during the Covid-19 pandemic must be used as an opportunity for banking. By utilizing existing technological advances, banks must be able to attract a lot of consumer interest in using EDC machines on their social media platforms. The social media marketing approach provides new opportunities and challenges for companies to increase their customers' buying interest (Ismail, 2017). The company's strategy to continue its business activities is referred to as Social Media Marketing Activities (SMMA) (Shareef, et al., 2017).

In the SMMA campaign, companies must be able to build consumer trust (Li, et al., 2007). The spread of the Covid-19 pandemic has had a negative impact on the growth of the banking economy, so banks must be able to maintain the level of public trust to grow the volume of transactions for the products/services provided. Steps built by PT. XYZ to build consumer trust is to provide quality and comprehensive financial solutions through *platform* reliable EDC machine service.

Corporate image can help consumers to gain a better understanding of the products provided or offered by a particular company and further reduce their uncertainty when making purchasing decisions. (Robertson & Gatignon, 1986). PT. XYZ has implemented several strategies to maintain a good corporate image. PT. XYZ formed a special team that handles issues related to the company's overall image.

Research on transactional interest is important and is considered necessary because customer transaction interest is important to determine how the strategy will be used by the company in making decisions and of course very influential on the company's income.

Therefore, it is important to study how the influence of pandemic fear, social media marketing, trust, and corporate image on the interest in transacting using the EDC machine of PT. XYZ. This research is limited only to customers of PT. XYZ in the city of Surabaya. The aim of this study is to provide a review towards practitioners, academics, government and put forward reflection on the development of the banking industry.

2. LITERATURE

1.1 Transactional Interest

A person's tendency to show interest in a product or service can be seen based on the following characteristics: Willingness to seek information on a product or service (Ekinci, 2009:45; Hariani, 2013:25). In this study, transactional interest will be measured with the customer's EDC machine of PT. XYZ. There are several indicators that influence consumer buying interest. Buying interest indicators are divided into (1) transactional interest, (2) referential interest, (3) preferential interest, (4) exploratory interest (Ferdinand, 2006 in Faradiba and Astuti, 2013).

1.2 Pandemic Fear

The pandemic managed to create a very deep and severe impact on the global economy. Several shopping centers, entertainment venues, hotels, restaurants, and many transportation are closed. This pandemic has spread and brought fear to many people in the world. The reality of very high infection and death rates has caused mental stress such as fear, anxiety, and depression (Brewer & Sebby, 2021). This certainly greatly affects several business sectors, including the banking sector. One of the Indonesian banks that was hit hard by the existence of *pandemic fear* is PT. XYZ. The decrease in transactions on the EDC machine was due to the fact that many consumers were unable to come to several crowded places such as shopping centers, entertainment venues, hotels, restaurants and transportation so they could not swipe their debit or credit cards into the EDC machine as a transaction aid. In Brewer & Sebby's research, 2021 has analyzed *pandemic fear* has reduced buying interest in food in some restaurants. As cities around the world put restrictions on Covid-19, consumers' lifestyles are changing drastically, leading to an increased desire for convenience services, especially for food ordering and delivery (Brewer & Sebby, 2021). Pandemic fear is influenced by several factors that represent fear and anxiety. Research from Collins, Francesca (2021) states that in his research, pandemic fear influenced by 3 significant factors. These three factors are 1) fear of infection (fear of being infected, worried that my family will catch it, and I'm afraid of infecting others), 2) feeling of insecurity (ie, feeling that I have lost control of life, feeling that life is threatening, and feeling insecure about myself), and a sense of work-related instability (worried that my friends or family will distance themselves from me because of my job duties, fear of being pressured by being in a place where COVID-19 might be affected). These factors were then adopted by researchers and drawn into 7 items that were adapted to this research.

1.3 Social Media Marketing Activities

It is unavoidable that during a pandemic internet usage increases sharply. In line with the development of digital technology and the application of Banking From Home, then strategy marketing PT. XYZ will be focused on activities digital marketing. Some of the main work plans that support the development of marketing strategies for its products and services, one

of which is to strengthen initiatives *digital marketing at social media (twitter, facebook and instagram)*, including continuing refinement *digital command center* to monitor and manage activities on social media and improve performance digital marketing PT. XYZ. *Social Media Marketing Activities* also used by PT. XYZ in implementing the online channels program in which a lot of product information is conveyed, including the promos provided. One of them is the information and attractiveness of using PT. XYZ.

Ssocial media defined as a group application based Internet that built on basic ideology and technology Web 2.0. Web 2.0 is basic *platform* media social (Kaplan & haenlein, 2010). According to, Yadav & Rahman (2017), the dimensions of social media marketing are divided into 5, namely, interactivity, informativinies, personalization, trendy and word-of-mouth. Which was then adopted by the researcher and drawn into a questionnaire item.

1.4 Trust

Trust is aspect central in Lots transaction economy (Mayer, et al., 1995). Trust consumer to company in research this PT. XYZ need in Wake up with some step *management*. in line with theories related trust consumer, PT. XYZ have long build trust the customer with give quality service machine EDC with transaction that more secure and supported network bank correspondence that broad. Trust conceptualized as one set confidence that Specific including among them is integrity, virtue and ability (Hess, et al, 2009). According to research Lu, et al., (2015), on model structural modeled indicator that shape trust that is integrity, virtue and ability. According to Mayer, et al., (1995) find model Where trust built from 3 points that is (1) ability, defined person that trusted have knowledge, ability, and Skills that take effect (2) virtue, covers person that trusted motivated for To do something that by sincere helpful to person other of the herself alone (3) integrity, covers person that trusted adhere to some principles that are acceptable to believers.

1.5 Corporate Image

Image company could defined as attitude consumer and feeling subjective that obtained from company and behavior they. Image company in research this is image that feel customer to PT. XYZ. For maintain image company, PT. XYZ hurry up and responsive in management complaint customer, Sub Division Hello XYZ *Contact Center* and *Customers Care* coordinate with units work related other, including Among other Group Business *Consumer Card*, Division Credit Consumer and Center Service Banking Electronic especially handling about transaction machine EDC. With convenience and some plate that support that too influence image company to appraisern customers. Image company could help consumer got understanding that more good about product that offered something company certain and next could reduce uncertainty they moment make decision purchase (Robertson & gatignon, 1986). On research Ozkaya & Ene (2014) have group factors that influence image company that is (1) location store (2) save prestige (3) quality service (4) product store (5) promotion in store (6) service endorsement and equipment.

3. METHOD

This type of research is quantitative. Quantitative methods use population research and specific samples with statistical data analysis. This data analysis is intended to answer

the problem formulation and test the truth of the hypothesis (Ferdinand, 2014). This study shows a consequential relationship between exogenous variables and endogenous variables. Research that shows cause and effect is intended to explain the effect of exogenous and endogenous variables. Data was collected through a survey method, namely by distributing research questionnaires. Likert scale used 1-5 (strongly disagree-strongly agree). The number of samples was taken based analyzed using Smart PLS.

4. ANALYSIS

Validity and Reliability Test

After To do test validity, could is known that all items have significance < 0.05 . On test validity in research this show all items in questionnaire already able measure every variable and could understood with good by respondents. Following this Table 1 is result test validity dan reliability. Table 1 Validity Test Results

Variable Latent	Variable Observed	Factor Loading	AVE	Information
Pandemic Fear	PF1.1	0.788	0.758	Valid
	PF1.2	0.851		Valid
	PF2.1	0.905		Valid
	PF2.2	0.911		Valid
	PF2.3	0.884		Valid
	PF3.1	0.906		Valid
	PF3.2	0.840		Valid
Social Media Marketing Activities	INT.1	0.649	0.640	Valid
	INT.2	0.740		Valid
	INT.3	0.775		Valid
	INF.1	0.769		Valid
	INF.2	0.800		Valid
	INF.3	0.813		Valid
	PRESS.1	0.856		Valid
	PRESS.2	0.847		Valid
	PRESS.3	0.816		Valid
	TREND.1	0.880		Valid
	TREND.2	0.853		Valid
	TREND.3	0.817		Valid
	WOM.1	0.774		Valid
	WOM.2	0.803		Valid
	WOM.3	0.786		Valid
INTEG	INTEG.1	0.823		Valid
	INTEG.2	0.784		Valid
	INTEG.3	0.801		Valid

MR.1	0.823	Valid
MT.1	0.792	Valid

Table 2 Results Test Reliability

Variable Latent	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
X1 (Pandemic fear)	0.947	0.984	0.956	0.758
X2 (SMMA)	0.960	0.962	0.964	0.640
X3 (trust)	0.939	0.945	0.947	0.622
X4 (Corporate images)	0.957	0.958	0.961	0.592
Y1 (Interest transactional)	0.810	0.822	0.868	0.570

Based on Table 2 in on, result test reliability show that each variable latent and whole data from indicator have Fulfill requirements test reliability with good. Score composite reliability from each variable latent on research this have Fulfill requirements score composite reliability that is has a value > 0.7

Linearity Test

Test linearity done with destination for knowing form relationship Among variable free with variable bound. Basic taking decision on testing this is score significance on *linearity*. If score significance linearity in under 0.05, could said there are relationship linear Among variable X and variable Y. Indicator other is score Sig. *deviation from linearity* that used for knowing existence pattern linear from error (in Thing this called deviation). If score significance deviation from linearity in under 0.05 could said there are relationship linear on error in model linear Among X and

Y. Results from test linearity in group variables in this study are described in Table 3 Table 3 Table Anova

ANOVA Table

			Sum of Squares	df	Mean Square	F	Sig.
Unstandardized Residual * Unstandardized Predicted Value	Between Groups	(Combined)	1848.511	106	17.439	4.373	.007
		Linearity	.000	1	.000	.000	1.000
		Deviation from Linearity	1848.511	105	17.605	4.415	.007
	Within Groups		39.875	10	3.988		
	Total		1888.386	116			

Based on output from Table 3, score sig. *deviation from linearity* < 0.05 , so that could concluded not there are relationship that linear by significant Among variable dependent with variable independent. With thus, each variable on research this not Fulfill requirements test

assumption classic and has poor regression.

Model-Fit Test Uji

Parameter that right for used is with rate *Standardized Root mean Square Residual* (SRMR) and *normed Fit Index* (NFI). Hooper et al (2007) in *Structural Equation Modeling: Guidelines for Determining Model Fit* have introduce SRMR as size goodness of fit moment use PLS-SEM that where could used for avoid error specification model. SRMR is root square from difference Among residue sample matrix covariance and model covariance that hypothesized. Quantity SRMR calculated based on scale on each indicator, by because that, if questionnaire contain items with level that varied (some items maybe range 1 - 5 while that other range 1 - 7), score for range SRMR from zero to 1.0 with model installation that good must get score less from 0.05) Byrne, 1998; Diamantopoulus and siguaw, 2000), while score most high 0.08 considered could be accepted (Hu and Bentler, 1999). SRMR 0 show compatibility perfect however permanent must noted that SRMR will more low if there are amount big parameter in model and model based on size sample that big. Size fit next that used is NFI. NFI is size compatibility additional that calculate score Chi-square from model that proposed and compared with benchmark measuring that mean. Below is Table 4 Explanation of Test Results Model Fit in this study.

Table 4 Test Results of Fit Model

	Model Saturated	Model Estimate
SRMR	0.074	0.074
d_ ULS	8,486	8,486
d_ G	7.186	7.186
Chi-Square	3191,627	3191,627
NFI	0.594	0.594

Hypothesis testing

Based on testing hypothesis with path coefficient that already done, then next is To do test hypothesis with based on score statistics and p-value. Test Hypothesis done for determine is hypothesis that already submitted previous be accepted or rejected. Results test hypothesis showed on table below this.

Table 5 Results Test Hypothesis

Hypothesi s	Relationship Variable	Path Coefficient	T Statistics	P Values	Results Hypothesis
H1	Pandemic Fear -> Interest Transactional	0.017	0.259	0.796	Rejected
H2	high school -> Interest Transactional	0.352	3.168	0.002	Be accepted
H3	Trust -> Interest Transactional	-0.181	1,236	0.217	Rejected.

H4	Corporate Image -> Interest Transactional	0.528	3,674	0.000	Be accepted
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Based on result from bootstrapping on Table 5, variable high school and Corporate Image have score t statistics > 1.96 then second hypothesis be accepted so that second variable dependent take effect to variable independent. high school and Corporate Image too have score *p-value* by whole positive and could be accepted because score *p-value* < 0.05 . However for variable Pandemic Fear and Trust have score t statistics < 1.96 then second hypothesis rejected so second variable dependent that not take effect to variable independent. Besides that variable Pandemic Fear and Trust too have score *p-value* > 0.05 so that second variable shown below is an image of Bootstrapping using Smart Pls.

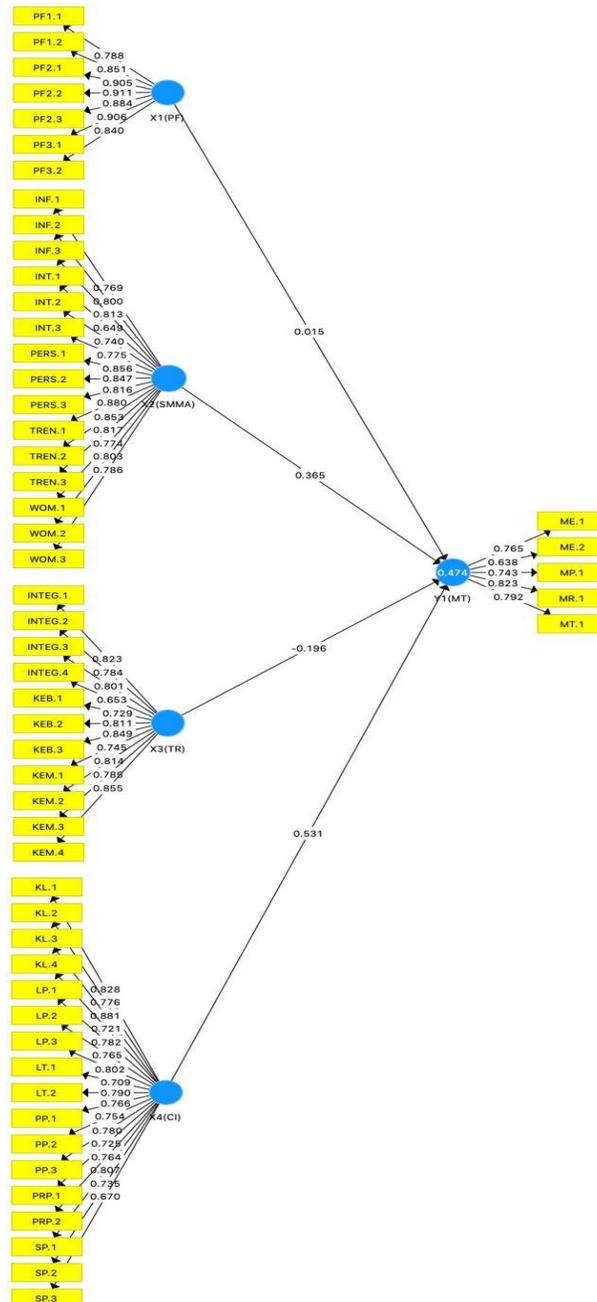


Figure 1 Bootstrapping

2. CONCLUSION

Based on the results of the study, it can be concluded that Pandemic Fear and Trust have no positive and significant effect on Transactional Interest. Meanwhile, Social Media Marketing Activities and Corporate Image have a positive and significant impact on Transactional Interest.

1. Pandemic Fear not take effect by positive significant on Transactional Interest

There is research this found that Pandemic Fear not take effect to Interest Transactional. Meaning that level Fright customer to pandemic Covid-19 not influence drop transaction with use machine EDC. Thing this not in line with research Brewer & Sebby (2021), result the research reveal variable *pandemic fear* take effect positive to interest buy. With existence phenomenon that then for permanent keep and Upgrade interest transactional need marketing that focus in field media social.

2. High School take effect by positive significant on Transactional Interest

high school take effect by positive significant on Interest Transactional with coefficient as big as 0.352. With score coefficient path as big as show that variable that have influence to interest transaction customer PT. XYZ. Tbk with machine EDC. Results test this in line with research Balakrishnan, et al., (2014), find that high school (marketing media social) could create interest transactional.

3. Trust not take effect by positive significant on Transactional Interest

Hypothesis 3 explain about influence trust to interest transactional. Results test with PLS- SEM show that variable Trust have p-value 0.217 to Interest Transactional with score path coefficient as big as -0.181. until variable Trust not take effect by positive and significant to interest transactional. Research this in line with research previous by Watanabe, et al., (2019), that reveal result the research that trust consumer not take effect significant to intention beli.

4. Corporate Image take effect by positive significant on Transactional Interest

Hypothesis 4 explain influence Corporate Image to Interest Transactional. From result testing show that variable Corporate Image take effect by positive and significant to Interest Transactional with score *path coefficient* as big as 0.528. Research this in line with research before by Kijpanjasub & Jitkukul (2019), on his research, reveal that image companies are statistically significant in a positive relationship to purchase intention.

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Parallel Session 2

Room I (12.10 – 13.55)

Moderator:

Category: Decision System Analysis

IMPLEMENTATION OF AHP AND TOPSIS METHODS FOR NONSIMULATION ENHANCED OIL RECOVERY TECHNIQUES SCREENING IN “X” AND “Y” FIELDS

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ABSTRACT

The "X" and "Y" fields are among the oil fields in the Java basin. As oil production decreases due to exploitation activities, it is necessary to carry out activities to increase production. To increase the yield of its oil production, Enhanced Oil Recovery (EOR) technology is needed. Enhanced oil recovery (EOR) technique screening analysis is needed to be carried out at the initial stage of the feasibility study in the EOR project. At present, there is no fully established method for identifying potential candidates for the EOR technique. The most common approach used for selecting EOR techniques is conventional filtering, which is generally based on the "go-no go" trial and error, with a reduced chance of success. Besides, determining potential candidates for EOR techniques often uses a reservoir simulation approach, but this is time-consuming and requires high costs in using the software license. EOR technique screening with a method that explains how to form a multi-criteria decision-making model with a combination of AHP and TOPSIS methods together as a systematic and measurable method to get the best EOR techniques in both X and Y fields that have been scientifically tested and recognized. From the research results, it was found that the CO₂ Immiscible Technique was the most appropriate to be applied in EOR in fields X and Y, because it has the highest preference value (0.676), is then followed by the Micellar technique (preference value 0.645) and HC Immiscible (preference value 0.517). With the multi-criteria decision-making technique, the best EOR technique results are obtained by considering the multi-criteria aspect, then the proposal can be used to provide useful recommendations for company management so as to be able to increase oil production in both fields X and Y with a method that is faster, accurate and inexpensive compared to reservoir simulation method which has a longer processing time and more expensive costs so that it has the potential to reduce operational costs.

Keywords: Screening, reservoir, Enhanced Oil Recovery, MCDM, AHP, TOPSIS.

1. INTRODUCTION

Currently, most of the oil produced in the world comes from mature oil fields. Meanwhile, due to the expensive and time-consuming exploration operation, it is not easy to replace this resource with new exploration. On the other hand, world oil demand continues to increase. It is expected to continue to be the dominant energy source in the next few decades. In order to increase oil & gas production in Indonesia, two main steps can be taken, namely extensification and intensification. The extensification step is an effort to increase reserves by exploring or finding new oil & gas wells. Besides the intensification step, increasing oil & gas production by increasing the recovery factor (increase in recovery) of the remaining oil in rock reservoirs with advanced technology called Enhanced Oil Recovery (EOR).

The most commonly used approach to selecting an EOR process is the conventional way, referred to as go-no-go. This strategy is based on a lookup table in which validity intervals are established based on technical considerations by gathering "expert opinion" or analyzing data from successful field cases. Combining all of these approaches is the most likely situation to be encountered. The process of selecting potentials for EOR operations is a complex task involving a set of relief parameters and the technical and economic setup. It can be concluded that the evaluation of the EOR technique is critical to the success of the project. Currently, there is no fully established technique for the identification of potential candidates for EOR surgery. The operation is basically based on trial and error; by reducing the chances of success. In addition, the potential for EOR operations often uses a reservoir simulation approach, but this requires a long time and requires high costs in terms of using the software.

Fields X and Y are located in Block C, an oil and gas Mining Working Area covering Bojonegoro Regency, Blora Regency, East Java Province, and Central Java Province area of 919.19 km² (91,920 HA). Fields X and Y have total extracted reserves of 960 Million Barrels of oil. Production is currently at an average of 220 thousand barrels of oil per day. Over time and continuous field exploitation, there has been a decrease in production due to a natural decrease in reservoir pressure. EOR technology is needed to increase the declining oil production so that research will be conducted to select the best EOR technique in both fields X and Y.

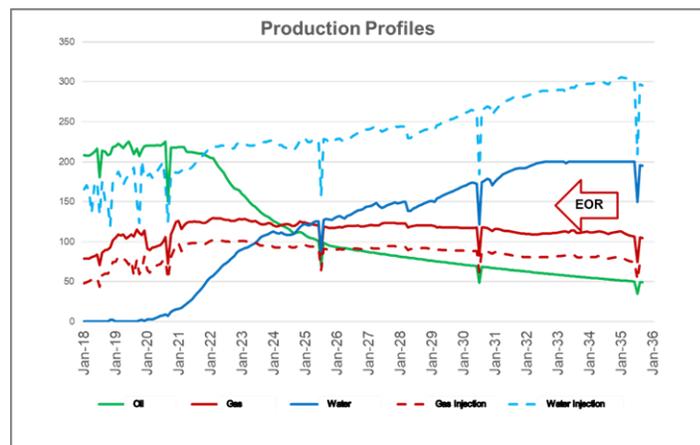


Figure 1. Production Profiles Field X & Y

Based on the description above, in this study, the author will screen the EOR technique with a method that explains how to form a multi-criteria decision-making model with a combination of the AHP and TOPSIS methods for screening the best EOR techniques in both fields X and Y. The modeling of the decision-making system that is considered to be proposed as the target chosen in this research is motivated by research constraints, problem structure, and/objectives to be achieved. The proposed model is based on the preference factors of decision-makers with related subjectivity in the selection of criteria used in the decision process (Ciptomulyono, 2010). The procedure for screening the EOR technique mentioned above for the two fields to be studied will be described in detail.

2. METHODOLOGY

2.1 Data Collection Procedure

The data collected are primary data and secondary data. Secondary data already exists in the company related to the problem to be investigated by accessing it through its database. Primary data will be obtained by using observation techniques, surveys using questionnaires, and in-depth interviews (Delphi method), involving experts in the field of EOR.

2.1.1 Selection of Experts and Decision Makers

Respondents for this study were experts in EOR and Reservoir, totaling three experts selected to evaluate reservoir parameter criteria and fill out the questionnaire for this study. All appointed experts have more than five years of working experience in oil and gas and Enhanced Oil Recovery (EOR). The experts consist of :

- i. One lecturer of Petroleum Engineering Department Program
- ii. One Senior EOR Engineer
- iii. One Reservoir Manager

2.1.2 Selection of Criteria and alternatives

As a result of the consensus of experts in the field of oil and gas & EOR, namely, the reservoir parameter criteria that will be used in this study. The developed reservoir parameter criteria will then be used for pairwise comparison questionnaires, AHP calculations, and TOPSIS applications. The criteria and alternatives for the EOR technique used in this study based on the initial literature study are shown in the following figure :

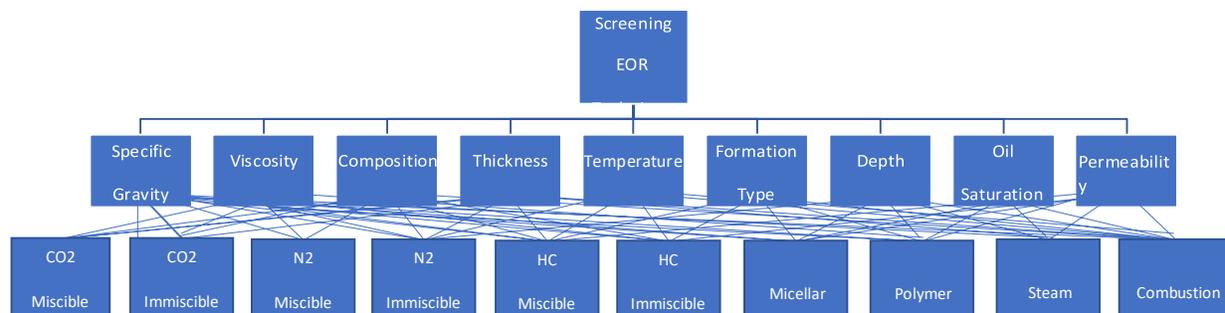


Figure 2. EOR technique selection criteria and alternatives

Nine reservoir parameters include gravity, viscosity, fluid composition, oil saturation, formation

lithology, formation thickness, permeability, formation depth and temperature as well as ten alternative EOR techniques including N₂ miscible injection, hydrocarbon gas miscible injection, CO₂ miscible injection, N₂ miscible injection, injection of immiscible hydrocarbon gas, injection of immiscible CO₂, micellar injection, polymer injection, in-situ combustion, and steam injection were considered to develop alternative proposed techniques.

2.1.3 Questionnaire / Survey

Primary data is a paired comparison questionnaire to compare each criterion used to select the best alternative EOR technique and identify the extent to which one criterion is more or less critical or preferable to another. As suggested by Saaty (1990), a nine-point scale was used to establish pairwise comparisons of all elements at each hierarchical level.

Table 1. Saaty fundamental scale

Rating Scale	Definition	Explanation
1	Equal importance	Two elements contribute equally to the objective
2	Weak	Between equal and moderate
3	Moderate importance	Experience and judgment slightly favor one element over another
4	Moderate plus	Between moderate and strong
5	Strong importance	Experience and judgment strongly favor one element over another
6	Strong plus	Between strong and very strong
7	Very strong or demonstrated importance	An element is favored very strongly over another; its dominance demonstrated in practice
8	Very, very strong	Between very strong and extreme
9	Extreme importance	The evidence favoring one element over another is one of the highest possible order or affirmation

A rating scale is required for direct assessment by highly involved people with the EOR implementation project to obtain the total value of each reservoir parameter criterion.

2.2 Data Processing Procedure

Data processing will be divided into two steps. The first step is to analyze the weight of each reservoir parameter criteria using the Analytic Hierarchy Process (AHP) method. The AHP method uses a technical approach to the decision maker's preference level based on relative importance by giving a score of 1-9 (saaty scale). After the selection criteria are entirely structured and the comparison matrix has been developed, then checking for consistency is the step that must be done. Consistency ratio (CR) measurements should be performed to check whether the assessments used are sufficiently consistent. The decision to produce the best reservoir parameter choice is not based on low consistency. The CR should be 10% or less. If it is more than 10%, then the assessment should be revised as needed.

The second step is to make a preference for each criterion indicator on the nine alternative EOR techniques. The weight of the results from the AHP for the reservoir parameter criteria is used to determine the best alternative from the EOR technique in the X and Y fields using the TOPSIS method.

3. RESULT & DISCUSSION

3.1 Delphi Method Data Analysis

The results of this survey can formulate nine criteria of reservoir parameters and objectives in determining the best EOR technique from the perspective of the respondents' preferences. The subjective/preference weighing scale in the Delphi survey for each criterion ranges from 0-100.

Composition	0.0923	0.0536	0.0741	0.2903	0.1791	0.0800	0.0952	0.0800	0.0548	0.1110
Permeability	0.1846	0.1071	0.1481	0.0968	0.0597	0.1600	0.1429	0.1600	0.0822	0.1268
Depth	0.0923	0.0536	0.0741	0.0323	0.0896	0.0800	0.0476	0.1600	0.0822	0.0791
Specific Gravity	0.0308	0.1071	0.2222	0.0968	0.1791	0.1600	0.0952	0.0800	0.0822	0.1170
Viscosity	0.0923	0.3214	0.1481	0.0968	0.1791	0.1600	0.1905	0.1600	0.3288	0.1863
Temperature	0.0923	0.0536	0.0741	0.0484	0.0896	0.0800	0.0952	0.0800	0.0822	0.0773
Oil Saturation	0.0462	0.0357	0.0741	0.0484	0.0448	0.0400	0.0476	0.0400	0.0411	0.0464
Thickness	0.0923	0.0536	0.0370	0.0968	0.0896	0.0800	0.0952	0.0800	0.0822	0.0785

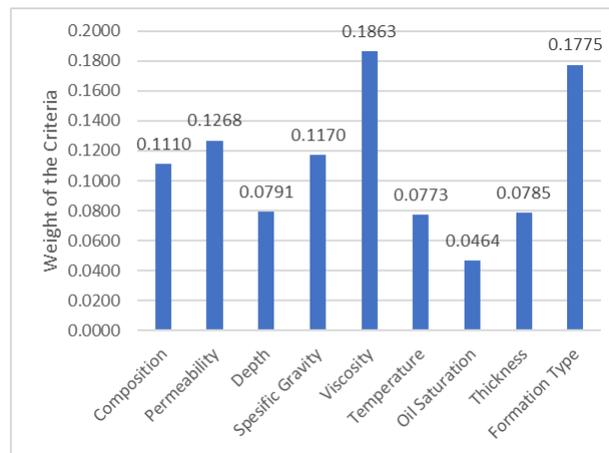


Figure 3. Reservoir parameter weight of criteria

The data obtained from the questionnaire were tested for consistency. In theory, the consistency value is obtained and compared with the value of the Random Consistency Index (RCI) as listed in literature or the value of 1.45. After processing the pairwise comparison data, the processed data from Ms. Excel generates important weights and consistency values for each group of pairwise comparisons. For this study, the result of the consistency value is still below the value of 0.10, so it means that the data is considered consistent.

3.3 TOPSIS Method Data Processing

The TOPSIS method is used to rank the existing EOR technique alternatives by making a decision matrix and assessing the suitability of the criteria. This assessment is the result of the Delphi and AHP methods through a survey of three respondents. The data from the survey results were then processed using the TOPSIS method, with the weight of each criterion obtained from the calculation of the survey results. The following is data processing using the TOPSIS method :

3.3.1 Creating a Decision Matrix

The decision matrix was prepared using the criteria from the Delphi method and the alternatives included in the scope of this research. The values in the table for each of the following fields are obtained from the conversion of ideal values to the reservoir conditions of each field and respondents for the weight of criteria for each alternative.

Table 4. Decision Matrix X Field

Alternative	Criteria								
	Composition	Permeability	Depth	Specific Gravity	Viscosity	Temperature	Dil Saturation	Thickness	Formation Type
CO ₂ Immiscible	5.0000	0.0936	4.9278	8.2286	6.7500	5.0000	7.8488	5.0000	1.0000
CO ₂ Miscible	8.4989	0.0208	3.1340	6.4000	3.3750	5.0000	7.5843	5.0000	9.0000
N ₂ Immiscible	5.0000	0.0334	2.2641	5.3333	0.7875	5.0000	6.8528	5.0000	1.0000
N ₂ Miscible	4.9133	0.0334	2.2641	5.3333	0.7875	5.0000	8.4375	5.0000	9.0000
HC Immiscible	5.0000	0.0936	5.9837	6.0000	2.8125	5.0000	8.1325	5.0000	1.0000
HC Miscible	6.7948	0.0187	2.6343	5.0526	0.4500	5.0000	6.8878	5.0000	9.0000
Micellar	5.0000	0.0616	5.2658	7.3846	4.5000	2.9630	8.9400	5.0000	7.0000
Polymer	5.0000	0.0170	1.3537	6.7765	4.5000	2.7407	8.2317	5.0000	7.0000
Combustion	5.0000	0.0062	0.7735	7.5789	5.6250	8.5185	7.1809	0.4500	7.0000
Steam	5.0000	0.0062	0.3868	8.7273	2.4000	5.0000	7.5000	0.9000	7.0000

1.1.1 Calculating a Normalized Decision Matrix

The decision matrix needs to be normalized according to the procedure in the TOPSIS method. Normalization aims to simplify the calculation process. The following table shows the results of the normalization of the decision matrix that has been compiled.

Table 5. Normalized Decision Matrix X Field

Alternative	Criteria								
	Composition	Permeability	Depth	Specific Gravity	Viscosity	Temperature	Dil Saturation	Thickness	Formation Type
CO ₂ Immiscible	0.2806	0.5956	0.4548	0.3832	0.5621	0.3078	0.3187	0.3527	0.0476
CO ₂ Miscible	0.4769	0.1323	0.2892	0.2980	0.2810	0.3078	0.3080	0.3527	0.4281
N ₂ Immiscible	0.2806	0.2127	0.2090	0.2484	0.0656	0.3078	0.2783	0.3527	0.0476
N ₂ Miscible	0.2757	0.2127	0.2090	0.2484	0.0656	0.3078	0.3426	0.3527	0.4281
HC Immiscible	0.2806	0.5956	0.5522	0.2794	0.2342	0.3078	0.3303	0.3527	0.0476
HC Miscible	0.3813	0.1191	0.2431	0.2353	0.0375	0.3078	0.2797	0.3527	0.4281
Micellar	0.2806	0.3918	0.4860	0.3439	0.3747	0.1824	0.3631	0.3527	0.3330
Polymer	0.2806	0.1083	0.1249	0.3156	0.3747	0.1687	0.3343	0.3527	0.3330
Combustion	0.2806	0.0397	0.0714	0.3529	0.4684	0.5244	0.2916	0.0317	0.3330
Steam	0.2806	0.0397	0.0357	0.4064	0.1999	0.3078	0.3046	0.0635	0.3330

1.1.2 Calculating the Weighted Normalized Decision Matrix

In the normalized decision matrix, the weights of each sub-criteria obtained from the Delphi method are then entered and calculated to bring a weighted normalized decision matrix. Table 6 show the weighted normalized decision matrix.

Table 6. Weighted Normalized Decision Matrix X Field

Alternative	Criteria								
	Composition	Permeability	Depth	Specific Gravity	Viscosity	Temperature	Dil Saturation	Thickness	Formation Type
Weight	0.09	0.21	0.04	0.11	0.25	0.05	0.02	0.02	0.21
CO ₂ Immiscible	0.0246	0.1231	0.0178	0.0433	0.1409	0.0156	0.0054	0.0073	0.0102
CO ₂ Miscible	0.0418	0.0274	0.0113	0.0337	0.0704	0.0156	0.0052	0.0073	0.0919
N ₂ Immiscible	0.0246	0.0440	0.0082	0.0280	0.0164	0.0156	0.0047	0.0073	0.0102
N ₂ Miscible	0.0242	0.0440	0.0082	0.0280	0.0164	0.0156	0.0058	0.0073	0.0919
HC Immiscible	0.0246	0.1231	0.0216	0.0316	0.0587	0.0156	0.0056	0.0073	0.0102
HC Miscible	0.0335	0.0246	0.0095	0.0266	0.0094	0.0156	0.0048	0.0073	0.0919

Micellar	0.0246	0.0810	0.0190	0.0388	0.0939	0.0092	0.0062	0.0073	0.0715
Polymer	0.0246	0.0224	0.0049	0.0356	0.0939	0.0085	0.0057	0.0073	0.0715
Combustion	0.0246	0.0082	0.0028	0.0399	0.1174	0.0265	0.0050	0.0007	0.0715
Steam	0.0246	0.0082	0.0014	0.0459	0.0501	0.0156	0.0052	0.0013	0.0715
Sum	0.2718	0.5059	0.1045	0.3513	0.6675	0.1533	0.0536	0.0601	0.5926
Max	0.0418	0.1231	0.0216	0.0459	0.1409	0.0265	0.0062	0.0073	0.0919
Min	0.0242	0.0082	0.0014	0.0266	0.0094	0.0085	0.0047	0.0007	0.0102

1.1.3 Determining the Positive Ideal Solution and the Negative Ideal Solution

After obtaining a weighted normalized decision matrix, then the value of the positive ideal solution and the negative ideal solution is calculated. The following table is the value of the positive ideal solution and the negative ideal solution from the calculation results.

Table 7. Positive Ideal Solution and the Negative Ideal Solution X Field

Ideal Solution	Criteria								
	Composition	Permeability	Depth	Specific Gravity	Viscosity	Temperature	Oil Saturation	Thickness	Formation Type
Positive	0.0418	0.1231	0.0216	0.0459	0.1409	0.0265	0.0062	0.0073	0.0919
Negative	0.0242	0.0082	0.0014	0.0266	0.0094	0.0085	0.0047	0.0007	0.0102

1.1.1 Determining the Relative Closeness to the Positive Ideal Solution and the Negative Ideal Solution

Furthermore, the relative closeness of each alternative to the positive ideal solution and the negative ideal solution is determined. The calculation results are shown in the following table. The relative closeness to the positive and negative ideal solutions for the X field will be obtained, which will then be determined by the preference value to get the rank of the EOR technique that will be used.

Table 8. Relative Closeness to the Positive Ideal Solution and the Negative Ideal Solution X Field

Alternative	Relative Closeness to the Positive Ideal Solution	Relative Closeness to the Negative Ideal Solution
CO ₂ Immiscible	0.0886	0.1666
CO ₂ Miscible	0.1188	0.1052
N ₂ Immiscible	0.1627	0.0400
N ₂ Miscible	0.1383	0.0947
HC Immiscible	0.1137	0.1300
HC Miscible	0.1548	0.0891
Micellar	0.0688	0.1253
Polymer	0.1198	0.0984
Combustion	0.1274	0.1146
Steam	0.1481	0.0762

1.1.2 Determining Preference Values for each Alternative

The preference value indicates whether an alternative is preferable to another alternative, considering the preference value according to equation (13). In this study, the alternative order (EOR technique) obtained from the calculation results. A more excellent preference value indicates that the alternative is better to choose.

Table 9. Preference Values X Field

Alternative	Preference Value	Ranking
CO ₂ Immiscible	0.676	1
CO ₂ Miscible	0.469	6
N ₂ Immiscible	0.183	10
N ₂ Miscible	0.375	7
HC Immiscible	0.517	3
HC Miscible	0.338	8
Micellar	0.645	2
Polymer	0.475	5
Combustion	0.508	4
Steam	0.336	9

The TOPSIS calculation found that the alternative EOR CO₂ Immiscible technique was the best alternative to be chosen in the X and Y fields, followed by micellar, then HC Immiscible. These results indicate that respondents consider the need for the EOR technique to be applied in the X and Y fields as an improvement in increasing oil production to increase the company's revenue.

4. SENSITIVITY ANALYSIS

In this study, the simulation of sensitivity analysis was carried out by changing the weight of the criteria included in the reservoir parameters. Changes were made with a deviation of +- 20% and +- 15% on the viscosity criteria. The viscosity criterion was chosen because it has the highest/dominant weight, so changes to this criterion will have the greatest impact on the decision results. A TOPSIS calculation follows this weight change to determine the preference value of each alternative.

Table 10. Preferred Value with +- 15% Weight Change X Field

Alternative	Preference Value X Field			Ranking		
	Initial	+15%	-15%	Initial	+15%	-15%
CO ₂ Immiscible	0.6765	0.7011	0.6528	1	1	1
CO ₂ Miscible	0.4691	0.4685	0.4697	6	6	5
N ₂ Immiscible	0.1829	0.1681	0.1974	10	10	10
N ₂ Miscible	0.3748	0.3434	0.4065	7	7	7
HC Immiscible	0.5174	0.5007	0.5334	3	4	3
HC Miscible	0.3376	0.3097	0.3652	8	9	8
Micellar	0.6453	0.6449	0.6457	2	2	2
Polymer	0.4746	0.4980	0.4509	5	5	6
Combustion	0.5083	0.5427	0.4735	4	3	4
Steam	0.3364	0.3328	0.3398	9	8	9

Based on the sensitivity analysis results for changes in viscosity weight of +-15% using the AHP method approach, data obtained that the first to second priority rankings in the X field does not change in order.

Table 11. Preferred Value with +- 20% Weight Change X Field

Alternative	Preference Value X Field			Ranking		
	Initial	+20%	-20%	Initial	+20%	-20%
CO ₂ Immiscible	0.6765	0.7094	0.6453	1	1	2

CO ₂ Miscible	0.4691	0.4682	0.4699	6	6	4
N ₂ Immiscible	0.1829	0.1633	0.2021	10	10	10
N ₂ Miscible	0.3748	0.3331	0.4169	7	7	7
HC Immiscible	0.5174	0.4950	0.5384	3	5	3
HC Miscible	0.3376	0.3005	0.3742	8	9	8
Micellar	0.6453	0.6447	0.6458	2	2	1
Polymer	0.4746	0.5056	0.4432	5	4	6
Combustion	0.5083	0.5540	0.4621	4	3	5
Steam	0.3364	0.3316	0.3409	9	8	9

Based on the results of sensitivity analysis for changes in viscosity weight of + - 20% using the AHP method approach, it was found that the first priority ranking in the X field changed the order.

The entire table above shows that changes in the weight of the viscosity criteria up to +- 15% does not affect the order of 1-2 in the EOR technique alternative for the X field, where the EOR CO₂ Immiscible Technique is still ranked first, and the EOR Micellar Technique is still ranked second. For the Y field, the change in the weight of the viscosity criteria up to +-20% does not affect the order of 1-2 in the EOR technique alternative, where the EOR CO₂ Immiscible technique ranks first, and EOR Micellar technique still ranks second. Therefore, it can be concluded that this decision is robust and consistent.

5. CONCLUSIONS

Based on the entire research process that has been carried out, the following conclusions can be drawn:

1. From this research, the criteria (reservoir parameters) were obtained where the experts agreed to be used to select alternatives to Extend the Analysis Process and the point of view of selecting alternative EOR techniques in the X and Y fields. The criteria (reservoir parameters) were permeability, depth, specific gravity, viscosity, temperature, oil saturation, thickness, formation type, and composition.
2. Based on the TOPSIS calculation, the best alternative in field X is the CO₂ Immiscible technique. It has the highest preference level of 0.638, followed by the micellar technique with a preference level of 0.637 combustion technique with a preference level of 0.525.
3. Based on the TOPSIS calculation, the best alternative in field Y is the CO₂ Immiscible technique. It has the highest preference level of 0.645, followed by the micellar technique with a preference level of 0.616 CO₂ Miscible technique with a preference level of 0.524.
4. Sensitivity analysis shows that changes in the weight of the viscosity criteria up to +-15% do not affect the order of 1-2 in the alternative EOR technique for the X and Y fields, where the CO₂ Immiscible EOR technique still ranks first, and the Micellar EOR technique still ranks second. Therefore, it can be said that this decision is solid and consistent.
5. By integrating the AHP and TOPSIS methods, the best EOR technique is obtained by considering the results of multi-criteria aspects. The proposal can provide valuable recommendations for company management to increase oil production in both fields X and Y with a faster, accurate, and inexpensive method than the reservoir simulation method, which has a longer processing time and more expensive costs so that there may be a decrease in operational costs.

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ANALYSIS OF PITOT PROBE RELIABILITY PART NUMBER 0851HL ON AIRCRAFT AIRBUS A320-200 PT. XYZ USING LIFE DATA ANALYSIS METHODE

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ABSTRACT

Currently, national and global aviation industry at it's lowest point since financial crisis in 2008 due to Covid-19 virus pandemic. Even in times of crisis, aircraft maintenance process must be carried out by perform maintenance effectively and efficiently. During the period from 2016 to 2021, the A320-200 aircraft of PT. XYZ has 8 flight delays with an average length of 1 hour and 1 flight cancellation caused by the failure of the pitot probe part number 0851HL, there are also 107 unscheduled replacements due to damage to the pitot probe with the main cause of damage due to insulation resistance of heating system exceeds the limit when carried out a routine heating resistance check every 24 months. This research calculate the time interval for effective maintenance of pitot probe and number of spare parts availability based on the age of the unscheduled replacement of the pitot probe components. With the calculation using Weibull++ this research resulted optimum interval of 4000FH with reliability 95,24%. Spare calculation of Pitot Probe for this research resulted number of safety stock 6 with reorder point of 7 and Economic Order Quantity 2 item. This new policy increase service level of component fulfillment by 29,6%

Keywords: Maintenance time interval, reliability, pitot, spare parts

1. INTRODUCTION

Currently, the national and global aviation industry is at its lowest point since the financial crisis in 2008 due to the Covid-19 virus pandemic. Despite being in a time of crisis, the aircraft maintenance process must still be carried out by carrying out maintenance effectively and efficiently. The reliability of a component is one that must be maintained in every aircraft maintenance process so that the airworthiness of an aircraft can be achieved. In the A320-200 aircraft fleet of PT. XYZ during the period 2016 to 2021, there were 8 flight delays from 6 different aircraft with an average length of 1 hour and 1 flight cancellation due to the failure of the pitot probe component in carrying out its functions. The Pitot probe is a component for calculating aircraft speed based on air pressure entering through the air duct in the form of a small pipe attached to the outside of the fuselage. In addition to flight delays and cancellations, during the same period on Airbus A320-200 aircraft there were also 107 unscheduled replacements due to damage from pitot probe part number 0851HL with the main cause of damage due to insulation resistance in the heating system exceeding the limit. Based on the data above, the Airbus A320-200 aircraft was chosen as the object

in this study because as of April 31, 2021, the price of 1 Pitot Probe referring to the price from Airbus is USD 7,560.

One of the maintenance programs carried out is checking the resistance value of the pitot probe heater with a time span of once every 24 months. Checking the heating resistance on these components is done so that when the aircraft is at an altitude with very low temperatures, the pitot probe does not experience interference caused by the air ducts being covered by ice. The purpose of this research will determine the effective maintenance interval for pitot probe components and the availability of the optimum number of pitot probe component spare parts.

2. LITERATURE REVIEW

2.1. Aircraft Maintenance

Aircraft maintenance is an activity carried out by airlines to ensure that the components and systems contained in the aircraft remain in airworthy condition. Aircraft maintenance can be carried out in line maintenance or base maintenance. Line maintenance is aircraft maintenance carried out in the line station area with light routine maintenance types such as oil changes, hydraulic fluid changes, refueling, aircraft cleaning and light inspections that can be seen easily. Base maintenance is maintenance carried out at the base area of the airline. Where in this base area has complete facilities such as hangars.

2.2. Reliability Centered Maintenance

Reliability Centered Maintenance (RCM) is a standard methodology in developing maintenance programs for newly designed systems or improvements to each aircraft. The aim of the RCM methodology is to develop an aircraft maintenance program that can return to its original state after a period of use at minimal cost. The use of RCM in the aviation world is different from the industry in general because it must obtain approval from regulators such as DGCA / DKPPU for the airspace of the Unitary Republic of Indonesia

2.3. Pitot Probe

The Pitot Probe is a sensor with a pipe-like shape that is attached to the front of the aircraft and facing forward. This sensor will measure the amount of air pressure that enters the pipe. The results of these measurements are used to display the airspeed of the aircraft on the aircraft speed indicator. The sensor consists of a probe containing a pitot hole and a drain hole then a mount that keeps the probe a few inches out of the fuselage and a base plate containing the electrical and pressure fittings. Pressure on the pitot is felt at an opening at the front end of the probe. On the Airbus A320-200 aircraft, 3 pitot probes are installed, namely 2 on the left for Pitot Captain (No. 1) and Standby (No. 3) and 1 on the right for Pitot Copilot or First Officer (FO) (No. 2).



Figure 1. Pitot Probe part number 0851HL (Source: personal documentation)

2.4. FMEA

FMEA is a method used to analyze the reliability of a system and the causes of failure that occur in the system. The FMEA method is also used as part of the RCM analysis to prevent damage, eliminate or reduce the cause of the damage. When the cause of the damage is known for each failure mode, then the next action is to determine the time of preventive maintenance to reduce the failure rate

2.5. Reliability

Reliability (Kapur, 1977) is the probability that when the operation of a system is in certain environmental conditions, the system will show its ability in accordance with the expected function within a certain time interval. In analyzing the reliability of a system, the parameter used is the unit of time. If at time $t = 0$, the component or system is in normal operating condition according to its function so that the probability of the component or system to fail at $t = 0$ is 0. If $R(t)$ is a function of the reliability of a component or a system as a function of time, the relationship between the reliability function of $R(t)$ with respect to time is as follows (Ebeling, 1997):

$$R'(t) = 1 - R(t)$$

2.5.1. Model Distribution Between Failure

In analyzing the reliability of a component or system, there are several distribution models that can be used such as Exponential, Normal, Weibull and Lognormal distributions. From the distribution model, several parameters will be determined such as probability density function (pdf), cumulative distribution function (CDF), reliability ($R(t)$), failure rate ($f(t)$), time Mean Time To Failure (MTTF).

2.5.2. Distribution Test

By using Weibull++6 software, it is possible to estimate reliability parameters from failure data. Then which distribution model is best selected by using the following three parameters of the test method.

a. Average Goodness of Fit (AVGOF)

The Goodness of Fit test is based on the Kolmogorov-Smirnov test which assumes that the distribution of the variable being tested is continuous and the sample is taken from a simple population (Ebeling, 1997).

b. Average of Plot (AVPLOT)

AvPlot is based on the normalized index of the plot fit test. The test results are shown in the AvPlot index which is a normalization of the correlation coefficient (ρ').

c. Likelihood Function Ratio (LKV)

This test is based on the likelihood ratio, which describes how many times there is a match between a data group and the characteristics of a model. The stipulation of the LKV value is that the larger the value, the better for the distribution under test.

2.6. Economic Order Quantity (EOQ)

EOQ is one of the calculation methods to get the optimal amount of demand for a company by using the value of demand (demand), purchase cost per unit (cost). To get the optimal amount of inventory, the company must determine the Economic Order Quantity (EOQ), Safety Stock (Ss) and Reorder Point (ROP). The formula for obtaining the Economic Order Quantity (EOQ) is as follows:

$$EOO = \sqrt{\frac{2xDxC}{P}}$$

Where:

- EOQ = Total economic ordering cost
- D = Order quantity
- C = Cost of each order
- P = price of goods per unit

then to calculate the safety stock and reorder point is as follows:

$$Ss = Zx\sqrt{(AVG LT x STDEV D)^2 + (AVG D x STDEV LT)^2}$$

and

$$ROP = Ss + (AVG D x AVG LT)$$

Where :

- Ss = Safety Stock
- Zx = Coefficient Service based on company KPI
- ROP = Reorder point
- AVG D = Average demand for goods
- AVG LT = Average lead time of goods

3. METHODS

In carrying out this research, a structured and systematic method is needed to achieve the expected goals. The method contains certain stages in carrying out this research where these stages are adjusted to the formulation of the problem and research objectives.

3.1. Failure Mode and Effect Analysis

In this subsection, the causes of failure of the pitot probe using Failure Mode and Effect Analysis (FMEA) are explained with the main variables, namely Function, Functional failure, Failure Mode and Failure Effect & Symptoms plus 3 variables used to describe the impact of failure from the lightest to the most severe which is severity, occurrence and detection.

The FMEA method also recognizes what is called the Risk Priority Number (RPN), which is a number that describes which areas need to be prioritized. RPN is measured based on rating considerations of the three factors above, namely severity, occurrence, and detection.

$$RPN = Severity \times Occurrence \times Detection$$

3.2. Determine Inspection Interval

- a. Data cleansing uses Microsoft Excel to clean the data to be used from data that is still empty from data for the replacement of the pitot probe component, then classify the replacement of the pitot probe component based on the type of replacement (scheduled or unscheduled).
- b. With Weibull++ Calculate and determine the distribution test from the filtered data to get the most suitable distribution model by comparing the AVGO, AVPLOT and LKV values for each distribution
- c. Determine the reliability function against time and the probability-solid function based on the age when the component is damaged to calculate the reliability of the pitot probe component in a certain period of time
- d. Calculating the failure rate to determine the failure rate of the pitot probe component against time.
- e. Calculating effective maintenance and inspection time intervals based on inspection costs,

aircraft delay costs, replacement costs for each pitot probe component and the average flight time of each aircraft each month.

3.3. Determine Amount of Spare Parts

After getting an effective maintenance time interval, the next step is to determine the number of spare parts for the pitot probe component with the following steps:

- Calculate the number of spare parts needed based on the Data Demand and Data Lead Time of each order
- Calculate safety stock, reorder points and Economic Order Quantity.
- Determine the amount of spare parts availability.
- Compare existing condition with new spare parts policy

4. RESULTS

4.1. Failure Mode and Effect Analysis

The larger the RPN value, it can indicate which failure areas get priority for handling attention. Based on the FMEA ranking table, the failure of the pitot probe component caused by the heating insulation value exceeding the limit gets first priority.

Table 1. Failure Mode and Effect Analysis Result

<i>Failure Mode</i>	<i>Failure Symptoms</i>	<i>Failure Effects</i>	<i>Rank</i>
Heating insulation value exceeds the limit	Cockpit Warning <i>ANTI ICE ALL PITOT</i> <i>ANTI ICE CAPT+F/O PITOT</i> <i>ANTI ICE CAPT+STBY PITOT</i>	2 or more component failure on ground will be caused delay or flight cancellation	3
	<i>ANTI ICE F/O+STBY PITOT</i>	2 or more component failure in flight caused air turn back	2
	Cockpit Warning <i>ANTI ICE CAPT PITOT</i> , or <i>ANTI ICE F/O PITOT</i> , or <i>ANTI ICE STBY PITOT</i>	1 component failure on ground will be caused delay or flight cancellation	1
Pitot probe tip deformation (dented)	Air speed indication different appeared on Cockpit	2 or more component failure on ground caused delay	8
		2 or more component failure in flight caused air turn back	7
		1 component failure on ground caused delay	9
Pitot Probe channel closed due to foreign object (Insect)	Air speed indication different appeared on Cockpit	2 or more component failure on ground caused delay	5
		2 or more component failure in flight caused air turn back	4
		1 component failure on ground caused delay	6

4.2. Determine Inspection Interval

In analyzing component reliability, Microsoft Excel and Weibull++6 software were used to process the data. In the period from January 1, 2016 to April 30, 2021, there were 107 data on unscheduled removals for Pitot probes.

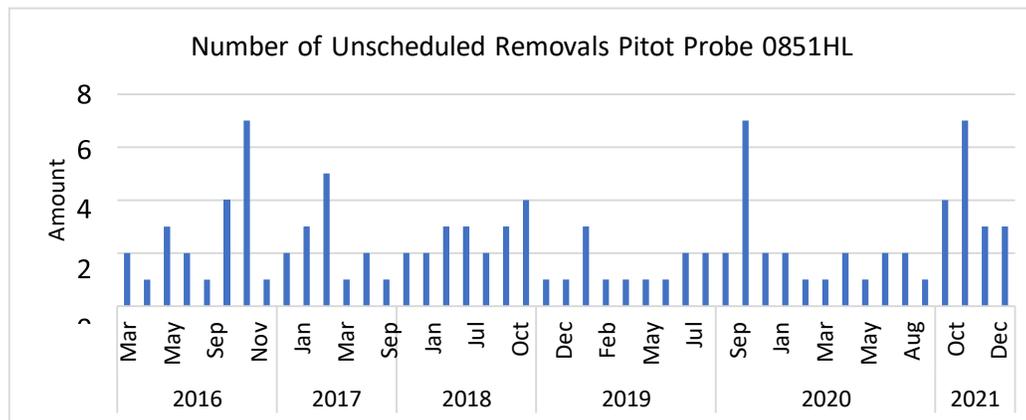


Figure 2. Number of Unscheduled Removals Pitot Probe 0851HL

Referring to the replacement data for the 0851HL pitot probe component, the age distribution pattern is obtained when a component failure occurs. Age here is the accumulated age in flight hours since the component was first installed on the aircraft until the component was damaged or called Time Since New (TSN).

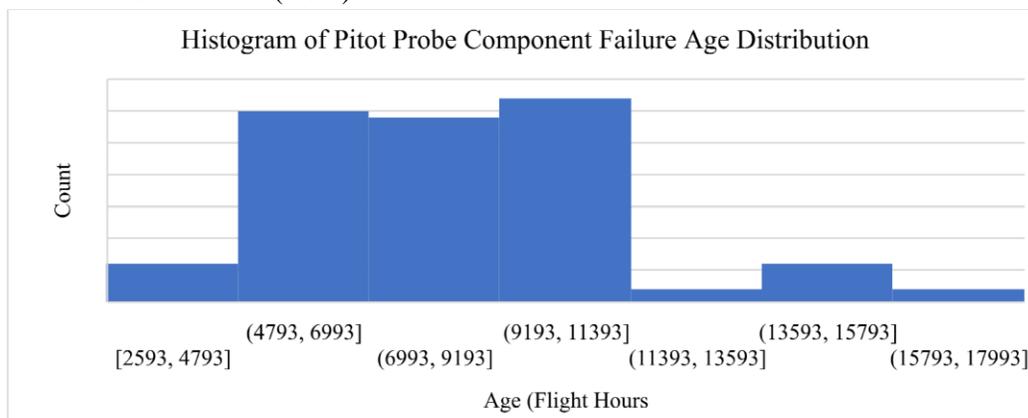


Figure 3. Histogram of Pitot Probe Component Failure Age Distribution

4.2.1. Distribution Test

The best distribution was obtained from the first rank of the test results on 3 test parameters, namely, Average Good of Fitness (AvGOF), Average of Plot (AvPlot), and Likelihood Function Ratio (LKV).

Table 2. Selection of Data Distribution on Pitot Probe components

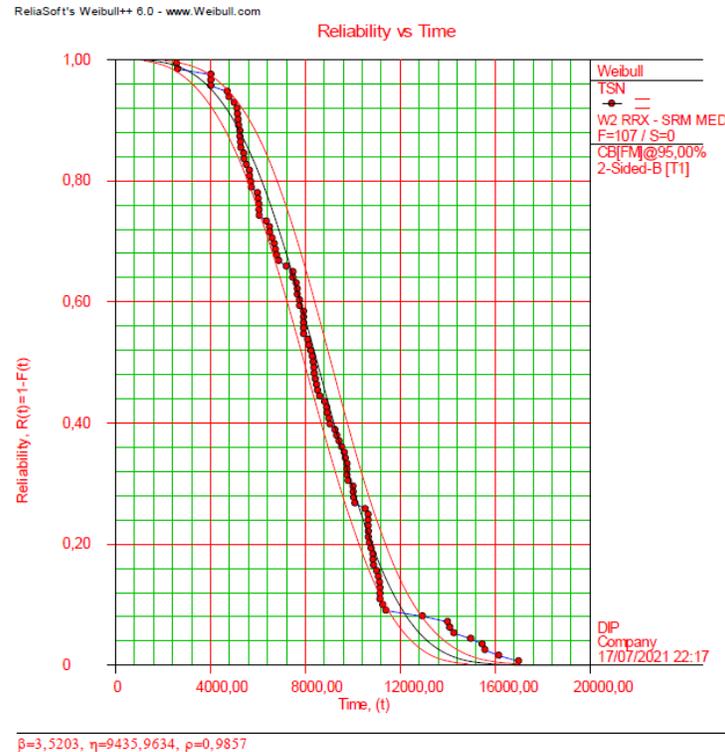
DISTRIBUTION	AvGOF	AvPlot	LKV	Ranking
Exponential 1	100	24,9452978	-1084,1761	4
Weibull 2P	27,1955935	2,36386951	-1006,588	1
Weibull 3P	51,1332539	2,08098114	-1002,6235	3
Normal	40,6647317	2,55444213	-1005,1164	2

Source: The results of data processing with Weibull++6 and Microsoft Excel

Based on Table 2, the distribution between failure times in the pitot probe component system is Weibull 2 parameters with reliability parameters Shape parameter (β): 3.52026981 Scale parameter (η): 9435,96339

1.1.1. Reliability Function

Based on Figure 4, we could see that most of the failures are predicted to be happened on lifetime between 4700 to 11000 FH.



$\beta=3,5203, \eta=9435,9634, \rho=0,9857$

Figure 4. Reliability vs Time plot

Source: The results of data processing with Weibull++6

1.1.2. Failure Rate

Seeing figure 4, at this interval, failure probability is clearly below 80%. With confidence bound setting is 95%, obtained MTTF is at 7946 (lower bound) to 9076 FH (upper bound). This could explain why our components mostly failed somewhere between 6000 to 11,000 FH.

Table 3. Calculated MTTF

	MTTF	Reliability
Upper Bound (0.95)	9076	41,39%
Normal Bound MTTF	8492	48,35%
Lower Bound (0.05)	7946	55,13%

That way, scheduled maintenance can restore the component / system condition to a better reliability level. Figure 4 below illustrated Pitot Probe has a constant failure rate relatively over the time. The failure rate is increases with time also shown by having β (beta) parameter > 1 ($\beta = 3,5203$)

1.1.3. Calculation of Inspection Interval Time

In this section, three cost will be elaborated: scheduled inspection cost, scheduled restoration cost, and unscheduled replacement cost. Scheduled inspection cost consist of man-

hour consumed to insulation check of the pitot probe, while replacement cost consists man-hour consumed to perform pitot probe replacement if any finding during capacity check and material cost. Therefore, inspection and restoration cost can be presented in following table:

Table 4. Inspection and Replacement Cost for each Pitot Probe P/N 0851HL

Item	Duration (Hrs)	No. of Unit	Cost / Unit	Total Cost
Inspection	0,5	1,5	\$ 38	\$ 57
Replacement	4,75	1	\$ 38	\$ 180,50
Pitot Probe Cost	-	1	\$ 8089	\$ 8089
Total Replacement Cost				\$ 8326,50

Two delay and cancel cost scenario were taken into account in this analysis:

Table 6. Delay Cost Scenarios

Component	Description	Total Duration	No. of Rem.	Cost / Unit	Total Cost
Average delay cost	Average cost from 1 delay span from 2016 - 2020 divided by total removal	8,73	107	\$ 6.299,60	\$ 514,17
Worst case delay cost case #1	Assumed that there will be a delay for every unscheduled removal, with total duration equal to the maximum duration of occurred delay (evaluated from 2016 - 2020)	1,73	1	\$ 6.299,60	\$ 10.898,31
Worst case cancel cost case #1	Assumed that there will be a cancel for every unscheduled removal, with total duration equal to the maximum duration of occurred cancel (evaluated from 2016 - 2020)	16,00	1	\$ 57.192,91	\$ 57.192,91

Combining this with the scheduled inspection/replacement cost, the following summary can be summarized:

Table 7. Planned and Unplanned Cost Scenario

Case	Cost Component	Unscheduled Cost	Scheduled Cost
1	Avg. Delay Cost (each duration is equal to average duration)	\$ 8.840,67	\$ 8.326,50
2	Max Delay Cost (each duration is equal to max. duration)	\$ 19.224,81	\$ 8.326,50
3	Max Cancel Cost (each duration is equal to max. duration)	\$ 65.519,41	\$ 8.326,50

With three cost (scheduled inspection, scheduled restoration, and unscheduled replacement) are now elaborated, we can calculate plot the optimal scheduled inspection and restoration.

Table 8. Optimal Analysis Result (in elapsed FH)

Case 1	Scheduled cost	\$8.326,50
	Unscheduled cost	\$8.840,67
	Optimum Cost	5,354196767
	Optimum Interval	14000,00
	Reliability	1,81%
Case 2	Scheduled cost	\$8.326,50
	Unscheduled cost	\$19.224,81
	Optimum Cost	7,905300590
	Optimum Interval	6000,00
	Reliability	81,62%
Case 3	Scheduled cost	\$8.326,50
	Unscheduled cost	\$65.519,41
	Optimum Cost	11,015138859
	Optimum Interval	4000,00
	Reliability	95,24%

Source: The results of data processing with Weibull++6 and Microsoft Excel Providing

highest reliability among 3 cases, Case 3 optimum interval results on 4000FH with reliability of 95,24%. In accordance with Aircraft monthly utilization from January 2016 to April 2021 the average daily FH for one single aircraft can be calculated as:

$$AVG \text{ Daily Utilization} = \frac{\text{Total Flying Hours}}{\text{A/C Days inservice}} = \frac{609543}{82605} = 7,38 \text{ Flying Hours}$$

Then the optimum interval for insulation check of Pitot Probe will be

$$\text{Optimum Interval} = \frac{4000 \text{ Flying Hours}}{7,38 \text{ Flying Hours} \times 30,5 \text{ days}} = 17,7 \text{ months}$$

1.2. Determine Amount of Spare Parts

Based on the data on spare parts that have been collected, such as the number of requests and the lead time, then data processing is carried out as the input basis for calculating the number of spare parts.

1.2.1. Calculation of Safety Stock, Reorder Point and Economic Order Quantity

With the average demand per month is 2 pieces with a standard deviation of 1.6 pieces and the average lead time is 22.6 days or 0.74 months with a standard deviation of 32.4 days or 1.06 months. the next step is to calculate the number of safety stock and reorder points that refer to the company's Service Level. For the fulfillment of spare parts for the Pitot Probe Service component, the target level used is 98% (Management, 2020)

$$Z_x = \text{Normsinv} (98\%) = 2,05$$

$$S_s = Z_x \sqrt{(\text{AVG LT (month)} \times \text{STDEV D})^2 + (\text{AVG D} \times \text{STDEV LT (month)})^2}$$

$$Ss = 2,05\sqrt{(0,74 \times 1,6)^2 + (2 \times 1,06)^2}$$

$$Ss = 5,90$$

$$Ss = 6 \text{ (Rounding)}$$

and

$$ROP = Ss + (AVG D \text{ per day} \times AVG LT(\text{days}))$$

$$ROP = 6 + ((107/1946) \times 22,6)$$

$$ROP = 7 \text{ (Rounding)}$$

1.2.2. Analysis Existing Condition

With a total purchase of 28 pitot probe components for the period from May 2020 to April 2021, it was used to meet demand for components during the same period with a total of 27 pieces. In July to September 2020 there was no increase in the number of inventories because the spare parts supplying country experienced a Covid-19 pandemic lockdown so that there was a demand for 8 spare parts which were fulfilled using components from aircraft that were not flying (Robbing).

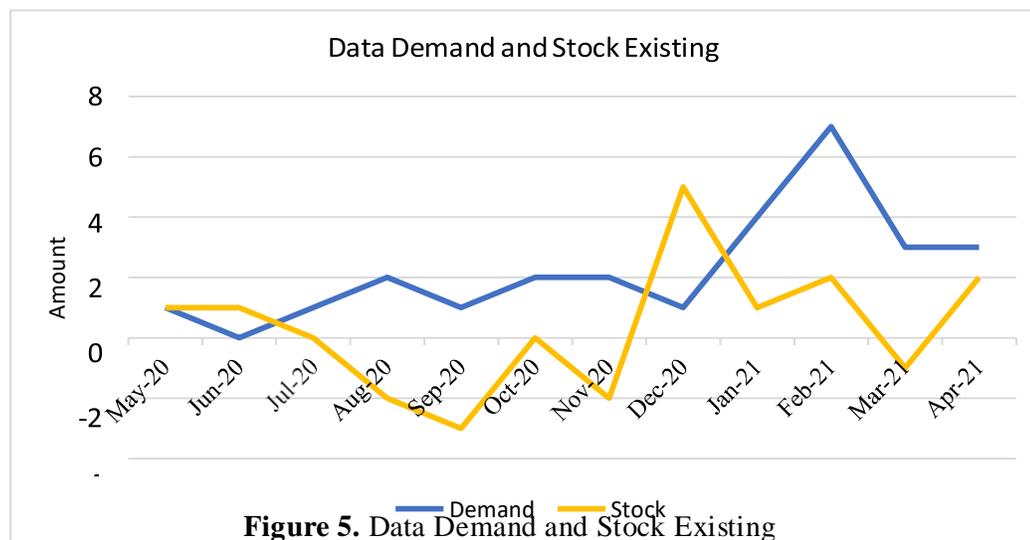


Figure 5. Data Demand and Stock Existing

1.2.3. Analysis of Changes in Spare Inventory Policy

The initial step of this analysis is to determine the initial stock amount on the Pitot Probe component. In this analysis, the initial stock of buffer inventory is set at 100% of the calculated Reorder Point value, which is 7 spare parts using the same number of requests for the period May 2020 to April 2021.

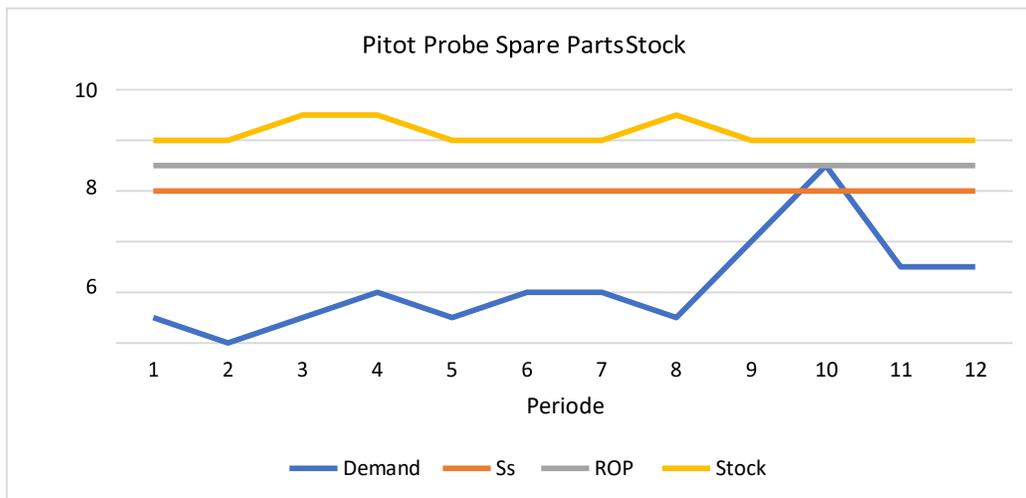


Figure. Pitot Probe Spare Parts Stock

Table 4. Service Level Comparison

Condition	Demand	Robbing	Service Level
Existing	28	8	71,4%
New Policy	28	0	100%

By implementing Safety Stock and Reorder Point for a 12 month period, spare parts inventory never runs out and the number of orders is always below the ROP value. This affects the amount of service level that must be met by the company. Service level on changes in spare parts inventory policy was able to increase service level up to 29.6%

2. CONCLUSIONS

The optimum interval of pitot probe insulation check using Life Data Analysis method by calculating the mean time to failure and flight interruption cost is obtained at 17,7 months with reliability achieved 95,24% compared with previous interval of inspection insulation at 24 months.

For spares stock inventory, new policy of Safety Stock, Reorder Point and Economic Order Quantity can increase service level up to 29,6% from previously 71,4%.

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MULTI-CRITERIA SUPPLIERS SELECTION IN STRATEGIC PARTNERSHIP TO SUPPORT OVERHAUL MAINTENANCE OF THE INDONESIAN NATIONAL ARMED FORCES (AURI) AIRCRAFT GTC

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ABSTRACT

Supplier selection is one of the important aspects of maintaining relations with strategic customer. In addition, this process also effects for operational costs and reliability, especially in the aviation industry for the military sector. The purpose of this study is to find the appropriate supplier criteria attributes to support repair and maintenance projects on gas turbine compressors for aviation in the military industries, this useful in strategic partnerships that are built to obtain results by comparing qualitative and quantitative elements that can be validated the factors intuitive can be minimized. The criteria for selecting suppliers is depends on the company needs. This study uses a combined of the Delphi method and the fuzzy analytic hierarchy process (fuzzy-AHP). The Delphi method is used for communication system structure consisting of several experts to express their opinions on a problem to reach an agreement, while fuzzy-AHP is used to solve problem in multi-criteria decision making for qualitative and quantitative data types. This study provides point for a method of selecting suppliers in aviation projects on military business.

Keywords : aviation, strategic partnership , military industry, fuzzy-AHP

1. INTRODUCTION

Modernization and renewal of the defense system equipment in the air force are a very strategic matter and will determine the military strength of a country, including Indonesia. The percentage of the number of Indonesian aircraft in airworthy condition is less than 50% of the total Indonesian defense equipment system. With the government's program to improve the airworthiness of the aircraft, this will increase aircraft maintenance activities and require equipment from Ground Support Equipment. Good capabilities at all times and locations are the main factors needed by the Alutsista used by the Indonesian Air Force. In the maintenance of the Indonesian Air Force, one of the costs that will appear with the highest percentage when a maintenance project is carried out is the cost of purchasing materials, this will reach 60% of the total project value. Fulfillment of materials will be closely related to material suppliers. Material suppliers are expected to assist the process of material fulfillment with good prices and good quality. The supplier selection process requires certain evaluation criteria involving various factors including qualitative and quantitative factors. The supplier selection process in military projects has a higher quality and warranty value than the general industry, this is because operational demands of the military must be ready at any time.

In the maintenance business for Ground Support Equipment (GSE) maintenance services at PT GMF AeroAsia has a different purchasing approach from the aircraft division, maintenance services on GSE

equipment at PT GMF AeroAsia have a project-based purchasing approach, while airplanes are more of a long-term project whose maintenance system has been determined by aircraft manufacturing. This will affect the material procurement process in requesting quotations to each approved vendor, then procurement will focus on the value of the vendor for the lowest price, appropriate payment time, and fast delivery. Therefore, after the payment process is approved, the material will be sent to PT GMF AeroAsia. Meanwhile, the aircraft division has more mature procedures, the aircraft division has forecast the materials needed and will be provided by the aircraft manufacturer directly. In Ground Support Equipment (GSE) maintenance services, it is almost impossible for every project to be sourced directly from the manufacturer because using a tender system requires the lowest prices, appropriate payment times, and fast delivery. Therefore, in GSE maintenance, it is necessary to be more objective in procuring materials from vendors.

In the aviation industry, aircraft APU is known with the main purpose of providing power when starting the aircraft main engine. The turbine engine on the aircraft must be accelerated to obtain a high rotational speed in order to provide sufficient compressed air to make the aircraft engine operate independently. Small jet engines can be assisted by electric motors, while larger airplane engines can be assisted by turbine motors for greater thrust. The APU is also used to run aircraft accessories when the aircraft engine is off. This allows for increased passenger comfort in the aircraft cabin, before the engine is started. Electrical power is supplied to run the system for preflights checks, some APUs are also connected to hydraulic pumps to assist in flap operation before starting the aircraft engines. GTC is ground support equipment that helps supply power to meet the air used to help rotate aircraft engines during the initial preflights. Both GTC and APU have the same working system because they use the same turbine engine and work the same way. The most prominent difference is that GTC is an assembled product of Ground Support Equipment manufacturers which has its own standards and reliability standards that are different from the standards of aircraft manufacturers. This will greatly affect the implementation of the maintenance program owned by GTC, from predictive maintenance, preventive maintenance, and also corrective maintenance. This research focuses on corrective maintenance.

To help decision makers who have tangible and intangible values in their criteria, the Fuzzy AHP method is used in the solution to help reduce the ambiguity value of an expert opinion. The results of the analysis will be used as a basis for recommending priority attributes in the selection of suppliers for GSE maintenance services. The results of the analysis will be used as a basis for recommending priority attributes in the selection of suppliers for GSE maintenance services. Then based on the supplier's performance, which supplier is suitable for PT GMF AeroAsia in GTC maintenance for the Air Force project. And also what system is in accordance with the procurement of the GTC AURI maintenance project so that it can help improve the accuracy of project completion according to the timeframe.

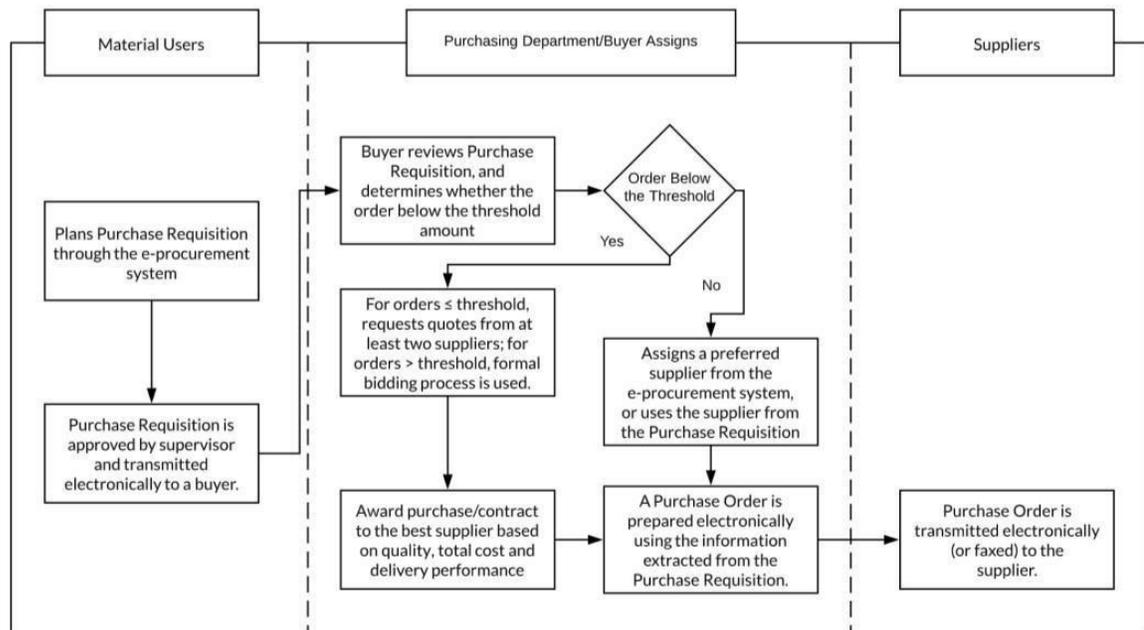


Figure 1 Electronic Procurement System

2. LITERATURE REVIEW

A process is a series of activities that have a beginning and an end, appear in a certain order, and have inputs and outputs. In his book, (Spencer, 2008) states that the purchasing management process begins with knowing all the needs and ends with an evaluation of the relationship with each supplier. Therefore, it is necessary to develop a constant process in purchasing management because it involves a large volume of goods, involves a large amount of money, requires a good and transparent inspection of the money in and out process as well as regular processes, the worst consequence of poor performance the potential contribution to operational activities will result in unexpected results. Therefore, organizational effectiveness will be an important factor in supporting the system for procurement in a procurement or purchasing activity. The buying process is basically a communication process, so it can determine what needs to be communicated, to whom, in what form and when to determine the key to success in the buying process. The important steps in the buying process are (Held & Koch, 2019). To complete material needs, suppliers are needed who are able to help meet production needs. In choosing a good supplier, it is necessary to choose a supplier that has good quality. In selecting suppliers, the 3-stage Delphi method is used to determine the criteria according to production needs

Delphi methods know as a structure communication system that consists of several experts and each member need to share their opinion regarding the problem that shared to reach agreement. (Yu et al., 2013). This method will help to get insight about the criteria and importance factor that identified by collecting experience of a group of experts that have a specific requirement and knowledge of the issue. The F-AHP method is the development of the AHP method which is associated with fuzzy logic. The AHP method was first introduced by Saaty in 1971 and is widely used in various fields such as economic planning, portfolio selection, supplier selection, analysis of method is appropriate if it is done on the multi criteria decision making (MCDM) problem for qualitative and quantitative data types. However, conventional AHP methods cannot reflect human thinking because of uncertainty or fuzziness that makes data collection subjective so that decision making process are more complex (Li, Chen, & Wang, 2007).

The F-AHP method is the development of the AHP method which is associated with fuzzy logic.

The AHP method was first introduced by Saaty in 1971 and is widely used in various fields such as economic planning, portfolio selection, supplier selection, analysis of performance criteria, profit loss analysis and several applications applied to other industries. AHP method is appropriate if it is done on the multi criteria decision making (MCDM) problem for qualitative and quantitative data types. However, conventional AHP methods cannot reflect human thinking because of uncertainty or fuzziness that makes data collection subjective so that decision making process are more complex (Li et al., 2007). Fuzzy logic was introduced by Lotfi A. Zadeh in 1965 and has a mathematical method definition that deals with data and problems that are not right to produce many solutions. This logic resembles human logic and is simply able to explain ambiguous, vague problems, and data. To overcome this, a fuzzy set approach is used with a membership function that shows the purpose of membership levels that are between 0 and 1. This set is developed to resolve uncertainties and ambiguities in problems caused by lack of information. Fuzzy set suitable for use in solving problems that involve information in the form of opinions or estimates. In fuzzy logic there are two sets, namely the crisp and the fuzzy set. In the crisp set, suppose if the membership value of a number in set A denoted by $\mu_A [x]$ will have two possibilities, there are:

- 1 (one), i.e. the number is a member in a set, or
- 0 (zero), i.e. the numbers do not belong to the set

While in the fuzzy set, a number can be a member of two different sets where the membership value of each set shows the level of its existence. There are two approaches in fuzzy logic, there are :

- Fuzzification: change input that is crisp (non fuzzy) into fuzzy set.
- Defuzzification: converts fuzzy sets to crisp actual shapes

3. METHODS

Within the supplier selection methods, numerous multi-criteria choice making strategies have been connected such as fuzzy TOPSIS, analytic network process (ANP), data envelopment analysis (DEA), analytic hierarchy process (AHP), and mathematical programming (Tahriri, Mousavi, Hozhabri Haghighi, & Zawiah Md Dawal, 2014). Another approach that can be evaluated and applied to the supplier-selection decision making process is a technique that integrates integer programming, goal programming, stochastic method, fuzzy set theory, and fuzzy multiple attribute decision making (FMADM) into a one inclusive approach. There are some development on supplier selection and evaluation model, The fuzzy Delphi method (FDM), an integration of the fuzzy concept and the Delphi method, requires only a small survey sample to obtain an objective and reasonable result. With this method, time and costs of collecting questionnaires can be reduced, and expert opinion can be kept as they are without being twisted (Li et al., 2007).

AHP is one of the foremost commonly utilized strategies of estimation for numerous criteria through pairwise comparisons and depending on subject judgment in scaling the priority for many fields such as selection, evaluation, planning and development, decision making, forecasting, and etc (Durak, Yilmaz, & Yilmaz, 2020). AHP will be simple methods and captures both qualitative and quantitative criteria also use in both criteria comparison and individual aspects within each criterion can be tackled. But, the disadvantages will be inconsistent and need additional involvement to clarify the variables, to deal with the problem of fuzziness, the fuzzy set theory is adopted. This method is known as Fuzzy Analytic Hierarchy Process (FAHP) which combines fuzzy theory, and AHP is introduced by Chang (1996) that combines the fuzzy concept with the AHP method using triangular fuzzy number (TFN). Fuzzy AHP is considered better in describing vague decisions than AHP (Hsu

& Huang, 2014). The fuzzy AHP method provides more flexibility, comprehensive and realistic results, especially for the criteria that have qualitative nature. It is crucial to ensure that the opinions given come from experts who are full of skills, harmony, and prudence when using the Fuzzy AHP method. Fuzzy AHP with Delphi can be an effective problem-solving methodology that uses almost clear application decisions by taking into account the uncertainty of one's judgment and will increase questionnaire recovery rate and will clarify the invertible fuzziness in interview with the help of the expert to obtain more reasonable and proper responses (Tahriri et al., 2014).

Hypothesis

Determination of supplier criteria is an important part in determining suppliers that are in accordance with ongoing projects. This will be a support in the assessment by the expert in providing an assessment in each of the criteria and sub-criteria for suppliers. The supplier criteria in the study are linked between the study literature and the criteria owned by the company. Some of these criteria are grouped into 5 criteria and 21 attributes for the selection of related vendors. These criteria include price, service, quality, organization, and delivery, as for the sub-criteria used in table 2.

Table 1. Grouping of Attributes

Supplier Attributes					
Criteria	Cost	Services	Quality	Organization	Delivery
Sub Criteria	Material Price	Warranties	Product Reliability	Long Term Relationship	Delivery Reliability
	Payment Term	Responsiveness	Product Consistency	Company Reputation	Incidental Delivery
	Price Stability	Tech Support	Conformation to Specification	Knowledge Management	Distance
	Discount	Product Development		Vendor Financial Position	Expediting
	Price Transparency			Integrity	

Of the 21 attributes will be grouped into 5 criteria for supplier selection. This will assist in the weighting of each criterion for supplier selection. According to Pujawan and Mahendrawati (2010), this AHP method helps solve complex problems with the structure of a hierarchy of criteria, stakeholders, results and by drawing various considerations to develop weights or priorities. This method also combines the power of feelings and logic involved in various problems, then synthesizes various considerations into results that match our estimates intuitively presented in the considerations that have been made. The steps taken in using the AHP method are as follows:

Define selection criteria, determination of the weight of each criterion, identification of alternatives (suppliers) to be evaluated, evaluation of each alternative with the above criteria, calculating the weighted value of each supplier, sorting suppliers based on these weighted values. The research hypothesis chart can be presented as follows:

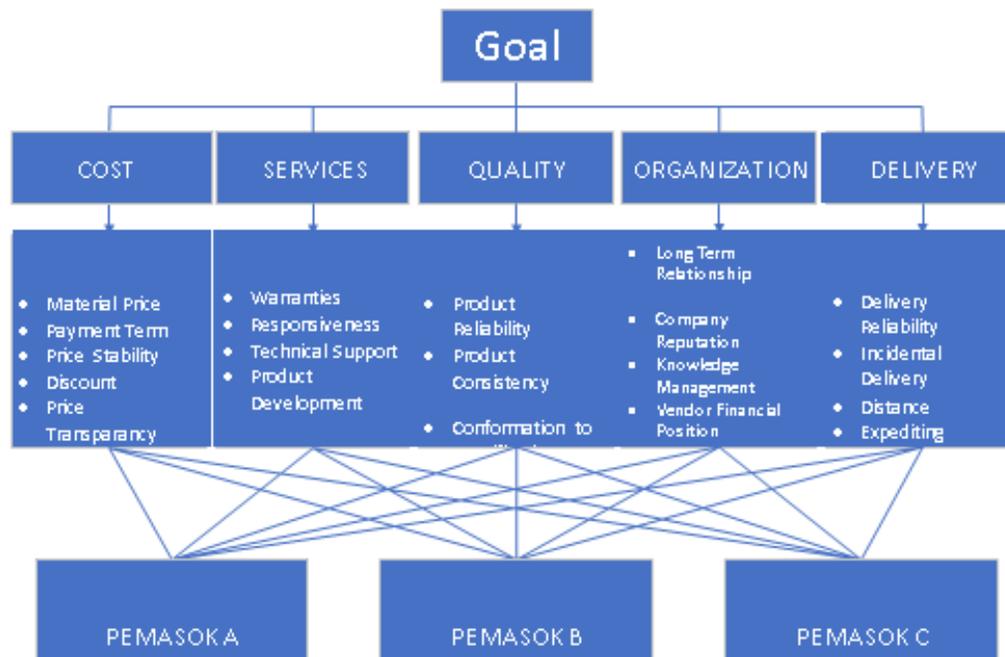


Figure 2 Research Hypothesis AHP Process

4. RESULTS

As explained in the process of attribute selection will be performed using Delphi methods, Delphi process that using in this research have three stages, brainstorming stage, grouping stage, and consensus stage. Explanation of the process each stage will be informed to the subject expert to ensure the process of supplier selection are effective. This research activity starts from literature studies and field studies so as to obtain reliable data. The method used is adapted to the problems studied, namely using descriptive analysis method using primary and secondary data analysis. The approach used is qualitative in nature, which is carried out through interviews and discussions/Forum Group Discussions (FGD). This research will be based on a case study at PT GMF AeroAsia is the case for the GTC Project for the Air Force. The combination of quantitative and qualitative methods will be used in the research, such as discussions using the Delphi method, and fuzzy analytical process hierarchy (F-AHP), to help answer the research objectives.

Table 2. Supplier Attributes Description

No	Supplier Selection Attributes	Description
1	Material Price	cost of materials used to manufacture a product or provide a service
2	Discount	reduced prices or something being sold at a price lower than that item is normally sold for
3	Product Reliability	probability that a device will perform its required function, subjected to stated conditions, for a specific period of time.
4	Terms of Payment	sale state how and when an invoice is to be paid.
5	Product Consistency	how closely products are linked to each other. Less the variation among products more is the consistency

6	Delivery Reliability	Ratio of the number of deliveries made without any error (regarding time, place, price, quantity, and/or quality) to the total number of deliveries in a period.
7	Warranties	type of guarantee that a manufacturer or similar party makes regarding the condition of its product
8	Supplier Responsiveness	ability of a supplier or organisation to adapt to changes and requests in the marketplace
9	Technical Support	a service provided by a suppliers which provides registered users with help and advice about their products.
10	Conformation to Specifiation	products will match with technical specification requested (match part number, alternative part number)
11	Price Stability	ensuring that the price level increases gradually, by an average followed inflation rate
12	Expediting	make a delivery happen sooner or be accomplished more quickly.
13	Handling of Complaints	suppliers evaluated the complaints and could deliver the solution
14	Knowledge Management	conscious process of defining, structuring, retaining and sharing the knowledge and experience of suppliers to organization
15	Longterm Relationship	suppliers already manage the project before and have satisfaction letter from GMF

No	Supplier Selection Attributes	Description
16	Company Reputation	suppliers already well-known and have a good review about the organization itself and the products
17	Inventory Cost	material supplied need special handling or specific specs of warehouse
18	Integrity	the quality of being honest and having strong moral principles
19	Product Durability	products that last longer
20	Attitude	supplier's representative have well manner and obey all rules in organization
21	Impression	suppliers company is well-known and they advertised the company in industrial fair or website
22	Product Development	The creation of products with new or different characteristics that offer new or additional benefits to the customer.
23	Labor Relation	the relationship between the management of a company or organization and its workforce
24	Vendor Financial Position	The account status of a firm's or individual's assets, liabilities, and equity positions as reflected on its financial statement.

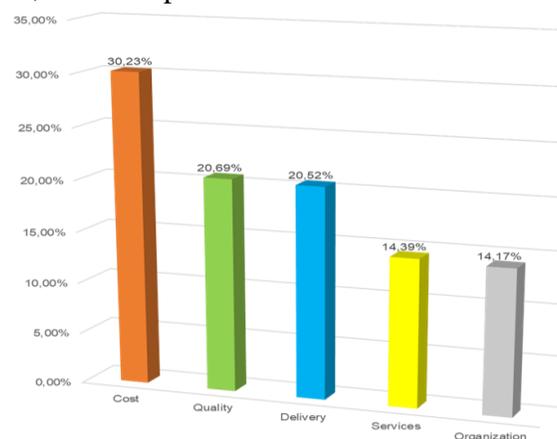
Although there are some differences in preferences during the categorization process, however, each attribute has been categorized by more than 60% of the total experts in a particular dimension. Highest difference (25%) is on warranties that placed on quality or services, since the 75% of expert chosen services

since warranties could escalate or de-escalated and negotiable, so they agree to put in services. The result of categorization process that reflects the hierarchical structure of supplier attributes can be seen in Figure below. The respondent's assessment was converted into a traditional AHP matrix so that a matrix for each criterion and sub-criteria was obtained. The first step in processing pairwise comparisons between criteria is to convert the matrix into TFN numbers. As explained in the TFN number formulation and the hierarchical model, the following is a fuzzy matrix model between criteria that occurs. The second stage is to take the average value of the three respondents in each column of elements in each matrix, so that the following results are obtained.

The hierarchical structure of the supplier criteria attributes is then used to measure the priority of each attribute. The empirical study was conducted by involving the operation of personnel management services from Garuda maintenance facilities and other parties who use the services of GMF Ground Support Equipment in carrying out asset maintenance. There were fifteen respondents involved with this process in detail. A total of ten respondents represent the management of PT GMF AeroAsia, and five respondents represent the Indonesian Air Force. At this stage, data from fifteen respondents was processed using the fuzzy analytical hierarchy method. Data was obtained from a questionnaire form which was distributed to each respondent with a response rate of 100%. Data collection and processing is carried out separately for domestic and international cargo operations. Data processing is carried out by Microsoft Excel using the equations described in the previous chapter. From the respondent feedback, the cost factor explained as the most important of the other that will be impacted on the maintenance cost of the MRO to provide the lowest price for the project. It reaches 30,23 % followed by the quality factor which including the material reliability and product certification that affected the quality of the product deliver and longevity of the component after maintenance. The services took 14,9% and the last is an organization with 14,17%.

	Cost	Services	Quality	Organization	Delivery
Cost	1	2.9333	2.5333	3.2000	1.8667
Services	0.3409	1	0.7689	1.4889	0.7167
Quality	0.3947	1.3006	1	1.4889	1.7911
Organization	0.3125	0.6716	0.6716	1	0.6222
Delivery	0.5357	1.3953	0.5583	1.5101	1
Total in Column	2.5839	7.3009	5.5322	8.6878	5.9966

With the previous equation, then compare the criteria of each FSE. The minimum value of each



criterion will be used as a result of normalizing the weight of each criterion. Normalized weight will be weighted.

Figure 3 F-AHP Process : 1st Level Comparison

In addition to choosing the most important attributes, experts were also allowed to add attributes that they think were not on the list. There is one additional attribute added by the expert, namely, Sudden delivery as we know in another department of AoG support and product certification. These additional attributes are then followed up by discussing the descriptions with experts. As a result, both are included in the list. Then for each attribute will be compared on each sub-criteria to get the percentage of each hierarchy process.

In this study, there are three suppliers who are considered to supply the most consumables for gas turbine engines, namely supplier A, supplier B, and supplier C. Supplier A from Thailand in Southeast Asia and the Pacific, Supplier B from the Netherlands, and Supplier C from the USA. Supplier A is well-known as the biggest market player in southeast Asia and supplies spare parts for OEMs as well, while supplier B is an independent supplier who has the longest journey and experience in the gas turbine field, also known as a reliable supplier and durable product, and supplier C is an US-based military and aeroderivative center.

After calculating the results of the round weighting carried out on each criterion, sub- criteria and supplier, it can be seen the final weight of the supplier per each sub-criteria. The final supplier weights of these sub-criteria can then be multiplied by the main criteria weights to get the final supplier results. The following table lists the weights and priority values for each alternative criteria, sub-criteria and suppliers. The process is the same as the sub-criteria level cost, quality, delivery, organization and services, by taking the average value of all respondents in each column of elements in each matrix, so that the following results are obtained:

Sub Criteria : Price Stability	Supplier A	Supplier B	Supplier C
Supplier A	1	1.8282	2.0504
Supplier B	0.5469	1	3.5555
Supplier C	0.4876	0.2812	1
Jumlah	2.0346	3.1094	6.6060

The next step is to calculate the consistency ratio with the following step. Calculate the average of the matrix in the grid from the table and add up the total rows and columns in each criterion, normalize the matrix by dividing each column by the total column, calculate the vector eigenvalues by averaging the normalized values obtained in the second step, calculating priority weights by adding up the product of the initial matrix before being normalized by vector, a dividing priority weights by vector eigenvalues. For the overall weighting which is the final value of the supplier value evaluation that is influenced by the criteria and sub-criteria can be seen in the following table:

Dimension	Cost	Service	Quality	Organization	Delivery	Final Weight
Criteria Weight	0,3023	0,1439	0,2069	0,1417	0,2052	

Supplier A	31,47%	36,22%	21,69%	37,07%	34,02%	31,44%
Supplier B	38,18%	51,84%	53,39%	40,63%	48,38%	45,73%
Supplier C	30,35%	29,70%	24,92%	22,27%	17,60%	25,37%

5. CONCLUSIONS

Of all dimensions, supplier B leads in all segments with a total final weight of 45.73%, followed by supplier A with 31.44%, and the third position is supplier C with 25.37%. This shows that supplier B is recommended as a supplier of consumables for gas turbine engines for projects in Indonesia because of its high cost, good service performance, good product quality, fast and reliable delivery with a desire to receive complaints. Based on the results of the study, the conclusions that can be drawn are as follows, The Delphi method performs the process of determining and grouping attributes. The experts involved in this process are 12 people from several department representatives. The Delphi method is carried out in 3 stages using the optimal software workshop. The first stage is the process of brainstorming a description of each attribute, and selecting the 10-20 most important supplier attributes of strategic materials in the Indonesian National Armed Forces (AURI) GTC project. The second stage is carried out to categorize supplier attributes. The third stage is carried out by consensus on the results of supplier attribute categorization. From Fuzzy AHP which was carried out on supplier attribute criteria, the most important criteria results were cost of 30.23%, followed by quality with 20.69%, slightly different from delivery with 20.52%, and service with 14.39% closer to an organization with 14.17%. Obtained consecutive supplier ratings, namely Supplier B, Supplier A, and Supplier C focuses on cost, delivery, quality, organization and service.

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ANALITICAL THE EFFECT OF FLEXIBLE MANPOWER SUPPLY STRATEGY ON PROJECT PERFORMANCE NARROW BODY AIRCRAFT MAINTENANCE IN BASE MAINTENANCE DEPARTMENT OF PT. GMF AERO ASIA

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ABSTRACT

The market opportunity for the aircraft maintenance industry is predicted to increase rapidly in line with the development of the global market for the number of flights and the number of aircraft. Based on IATA statistical data, the growth of the aircraft maintenance industry is predicted to increase by 4.6% every year. It is predicted that the demand for an increase in the maintenance of narrow body aircraft is predicted to increase until 2025. Due to the COVID-19 pandemic, the effectiveness and efficiency of business strategies must be carried out to reduce the effects of the pandemic, including effectiveness in managing human resources.

One of the supply manpower methods in human resource management is flexible strategy, there are 4 types of flexible strategy which are widely discussed including temporal, numerical, functional & wage. The data needed in this study will be obtained from direct observation at the base maintenance service at PT. GMF Aero Asia with the help of a Likert Type questionnaire. The subjects to be studied are 14 project owners 10 managers & 6 senior managers.

From the results of the canonical content of the X variant, it is known that the functional strategy has the highest load value while the temporal strategy has the lowest load value . This shows that the functional and numerical strategies are the manpower supply strategy variables that have the closest relationship. From the results of canonical cross-loading of the X variant, it is known that the functional strategy has the highest load value while the temporal strategy has the lowest load value . This is in line with the results of canonical load analysis. The two variables with the highest canonical cross-load are functional and numerical strategies which have a close relationship with project performance variables.

Keywords: Flexible strategy, Likert Type questionnaire, manpower, MRO, Canonical Coorelation.

1. INTRODUCTION

The development of the aircraft maintenance industry in Indonesia is facing a rapid spike in line with the surge in the number of flights in Indonesia and the number of flights worldwide, based on statistical data from IATA, the global market for the aircraft maintenance industry is predicted to experience market growth in 2027 of USD 118 billion. or growing 4.6 percent annually, the number

of registered civil aircraft fleets worldwide in 2017 amounted to 29,100 aircraft and will experience a 3.1% increase every year. This large market opportunity for the aircraft maintenance industry can be absorbed by domestic MRO if the capability and capacity of domestic MRO can match the needs of the MRO market. The challenge of market growth can be well absorbed by domestic MRO if domestic MRO can maintain quality standards of maintenance and on time aircraft maintenance.

Factors that influence the performance of an aircraft maintenance process project, including the availability of labor, the distribution of labor in the aircraft maintenance industry, must be prepared properly to meet optimal service levels and costs. In an effort to improve the competitiveness of the aircraft maintenance industry, in addition to the safety aspect, good performance to complete projects is also very necessary, competition from airline operators around the world creates an atmosphere of fast and precise service, especially flight operators from the LCC class, the limited fleet of aircraft carrier's class. LCC causes the aircraft maintenance process to be carried out very efficiently and effectively. LCC class operators do not have much time to be able to carry out aircraft maintenance. This market opportunity must be captured by the aircraft maintenance industry. The most significant factor in aircraft maintenance is the availability of maintenance personnel who already have an aircraft maintenance license. It is impossible for maintenance services to run on time if availability is not met properly.

In its development PT. GMF Aero Asia in obtaining margins, revenue Base Maintenance showed a positive trend from 2016 to 2019, while Operating Margin experienced a significant decline in 2018 and was stable in 2019. Base Maintenance Unit at PT. GMF Aero Asia is a unit that performs maintenance with light to heavy maintenance loads or types of C-Check and D-Check treatments, the duration required for maintenance varies greatly, depending on the type of treatment. The need for technicians in each ongoing project varies greatly. Manpower Supply Planning in the Base Maintenance service is currently carried out every 3 months based on the number of aircraft that will carry out maintenance, the Man Hours Plan will be reported every 3 months to the Vice President and will be forwarded to the Director of Human Resources for a review of man power needs.

Increased productivity can be done by planning effective workforce requirements and optimizing capacity (Berseneva et al., 2014). One of the models used in responding to changes in labor demand in a project is the flexible strategy management model, where this management strategy model is very popular in today's modern business and industry developments. In flexible strategy management there are 4 very interesting and widely discussed categories, namely Functional Flexibility, Numerical Flexibility, Temporal Flexibility and Wage Flexibility (Blyton and Morris, 1992) in (Yan, Yang, and Chen, 2004). Functional flexibility is a model in which the workforce is equipped with various abilities and competencies, so that one workforce can perform various types of different jobs with different abilities. Numerical flexibility is a model where the number of workers or the number of working hours adjusts to changes and organizational needs, this model is used for workers who are contracted for a certain time according to project needs. Temporal flexibility is a strategy model related to flexibility and variations in the number of working hours, where everyone has different working hours, rest periods and number of working hours. Wage Flexibility is a strategic model related to the wages of each worker, each worker receives a different wage according to his level of work Based on the background, the formulation of the problem in this study is how the flexible manpower supply strategy influences the performance of the narrow body aircraft maintenance project at the base maintenance service of PT. GMF Aero Asia.

This study aims to analyze the effect of the flexible manpower supply strategy on the performance of the narrow body aircraft maintenance project at the base maintenance service of PT. GMF Aero Asia.

The expected benefits of this research include: The results of this study can be used as input whether the long-term plan that will be implemented can increase the effectiveness, efficiency and

productivity of manpower in the narrow body aircraft maintenance project at the base maintenance service of PT. GMF Aero Asia. Can be input to the management of PT. GMF Aero Asia in making decisions regarding Manpower Planning issues at the Base Maintenance unit of PT GMF Aero Asia. This research is expected to contribute to further research for the development of science in the Indonesian aviation industry in general, and human resource management in the aviation industry in particular

2. LITERATURE REVIEW

2.1 HR Planning Objectives

According to Alwi (2001), HR planning is a plan prepared at the operational level that is proposed to meet the demand for HR with the required qualifications. Graham and Benet in Alwi state that HR planning is an effort to project how many employees and what the organization needs in the future. According to Grundy in Holbenche defines HR strategy as plans, programs and intentions to develop human capabilities within an organization to meet the future needs of its external and internal environment.

According to Grinold and Marshall in Gass and Assad (2005:172) workforce planning is a temporal model to ensure that the right number of people are available with the right skills at the right time, and according to Holbenche (2009:100) states that whatever we do in the setting people in an organization must have some good impact outcomes.

2.2 Human Resource Management Flexibility

Wright and Snell (1998) define that the flexibility of human resources is the degree to which existing resources can enjoy any changes that occur within the company, so that it can be the basis for making the best decisions in the face of a competitive environment, so that they can utilize existing resources efficiently. optimal. One of the models used in responding to changes in labor demand in a project is the Flexible Strategy management model, where this management strategy model is very popular in today's modern business and industry developments. In Flexible Strategy management there are 4 categories that are very interesting and widely discussed, namely Functional Flexibility, Numerical Flexibility, Temporal Flexibility and Wage Flexibility (Blyton and Morris, 1992). Functional flexibility is a model in which the workforce is equipped with various abilities and competencies, so that one workforce can perform various types of different jobs with different abilities. Numerical flexibility is a model where the number of workers in a project can be different in each type of project, this can be applied in the form of a combination of contract employees and permanent employees in completing projects, or also the need for experts and the number of supporting staff adjusted to the needs of the project. Temporal flexibility is a strategy model related to the flexibility of variations in the number of working hours, where each person has different working hours, rest periods and number of working hours. Wage flexibility is a strategy model related to the wages of each worker, each worker receives a different wage according to the level of his work.

1.1 Project Performance

Aircraft maintenance costs are a major challenge in the aviation industry, because they will ensure the airworthiness of the aircraft and the availability of aircraft operations (Mofokeng, Mativenga, and Marnewick 2020), Projects are defined as a series of activities and tasks that have time, cost, and resource constraints when meeting specifications. desired or standard of performance (Kulkarni, Yadav, and Nikraz 2017). Heavy maintenance in aircraft maintenance projects involves a technical process within a certain period of time, a reasonable amount of time, a reasonable cost, and meets airworthiness standards (Kulkarni, Yadav, and Nikraz 2017)

1.2 Canonical Correlation

Canonical correlation is a multivariate statistical method that aims to examine the relationship (correlation) between more than one dependent variable and more than one independent variable, in contrast to multiple linear regression only predicting one dependent variable with more than one independent variable, while canonical correlation can predict relationship of more than one independent variable and dependent variable simultaneously (Ghozali, 2011). The optimal linear combination between the two variables and the strong relationship between the two variables will be described in the canonical correlation (Ghozali, 2011). The general form of the canonical function is described by Siregar (2003), which is as follows:

$$Y_1 + Y_2 + Y_3 \dots Y_q = X_1 + X_2 + X_3 \dots X_q$$

(Metric, nonmetric)

(Metric, nonmetric)

If there are p number of independent variables $X_1, X_2, X_3 \dots X_p$ and q variable dependent variables $Y_1, Y_2, Y_3 \dots Y_q$ then the number of pairs of variables is a minimum of p and q. So the possible linear relationship is as follows

$$U_1 = a_{11} X_1 + a_{12} X_2 + \dots a_{1p} X_p ; U_2 = a_{21} X_1 + a_{22} X_2 + \dots a_{2p} X_p ; \dots$$

$$U_r = a_{r1} X_1 + a_{r2} X_2 + \dots a_{rp} X_p \text{ And}$$

$$V_1 = b_{11} Y_1 + b_{12} Y_2 + \dots b_{1q} Y_q ; V_2 = b_{21} Y_1 + b_{22} Y_2 + \dots b_{2q} Y_q ; \dots ;$$

$$V_r = b_{r1} Y_1 + b_{r2} Y_2 + \dots b_{rq} Y_q$$

Where r is the minimum value of p and q. This relationship is chosen such that correlation of U_1 and V_1 being the maximum correlation; the correlation of U_2 and V_2 is also maximum among the variables that are not related to U_1 and V_1 ; Correlation and so on

2. METHODS

Analysis of the influence of the flexible manpower supply strategy on project performance using canonical correlation analysis, this technique is used to determine the effect of the independent variable (X) on the dependent variable (Y), the concept of research and measurement of variables in this discussion can be seen in the figure 1

The instrument used as a measurement in this study is an indicator of each variable. This indicator will be used as a question posed to respondents through a questionnaire. The scale used in this study is the Likert scale. This scale is used to measure the respondent's level of agreement between 1 to 5, where a scale of 1 indicates the respondent's perception is strongly disagree with the indicator up to 5 indicates the respondent is strongly agree with the indicator

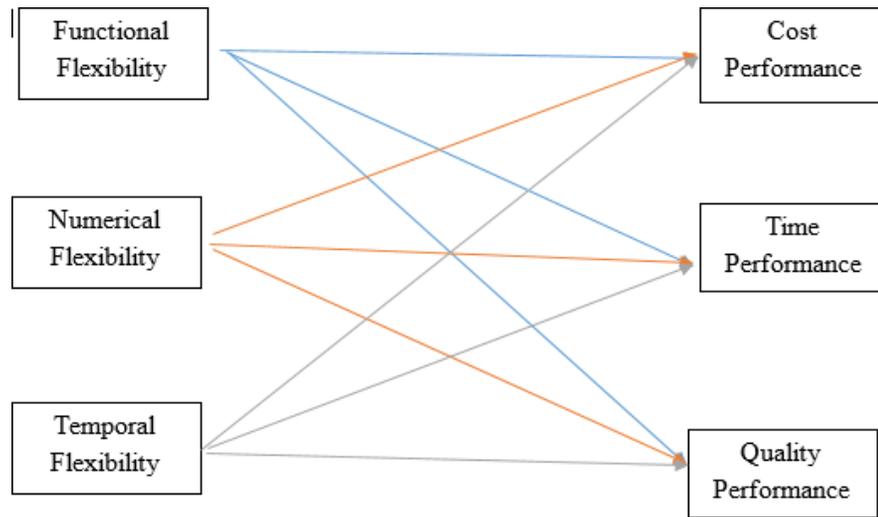


Figure 1. Research Model

2.1 Data Analysis Stage

The analytical method used in this study is Canonical Correlation Analysis (Canonical Correlation).

a. Data Assumption Test

According to (Mattjik & Sumertajaya, 2011) the assumptions that must be met before processing the data in the canonical analysis test are:

1. Linearity where this condition describes the relationship between two variables has a linear nature, linearity test uses linear regression correlation analysis between the two variables
2. Multivariate normality was performed to test the significance of each canonical function. At this stage a normality test is carried out for each variable, if individually a variable meets the normality test, then the assumption of normality as a whole will have an effect. This normality test was carried out with Kolmogorov Smirnov and plots the normal distribution
3. Between independent and dependent variables there is no multicollinearity (Nonmulticollinearity)

Homoscedasticity to test the error value in the statistical model, the aim is to see whether the variance or variance is affected by other factors or not.

- b. Determination of canonical variables and estimation of canonical coefficients
- c. Canonical Correlation Significance Test
- d. Redundancy test
- e. Canonical Variation Interpretation

3. RESULTS

3.1 Data Analysis of Questionnaire Results

Data test and classical assumption test need to be done before processing the data with canonical correlation. Incomplete data tests (missing values) were not carried out because the data were complete. Classical assumption tests performed were linearity test, normality test, multicollinearity test, and homoscedasticity test.

a. Linearity Test

The linearity test was carried out by linear-regression correlation analysis on the flexible manpower supply strategy variable as the independent variable and the project performance variable as the dependent variable. A summary of the results of the linearity test is shown in Table 4.8 below. It is known that there is a linear relationship between the independent and dependent variables, but the functional variable on time performance is not linear because the value of sig. deviation from linearity < 0.05 .

Table 1 Linearity Test Results

Independent	Dependent	Sig. Deviation from Linierity
Functional	Cost Performance	0.270
	Time Performance	0.002
	Quality Performance	0.543
Numerical	Cost Performance	0.303
	Time Performance	0.154
	Quality Performance	0.055
Temporal	Cost Performance	0.110
	Time Performance	0.357
	Quality Performance	0.287

b. Normality test

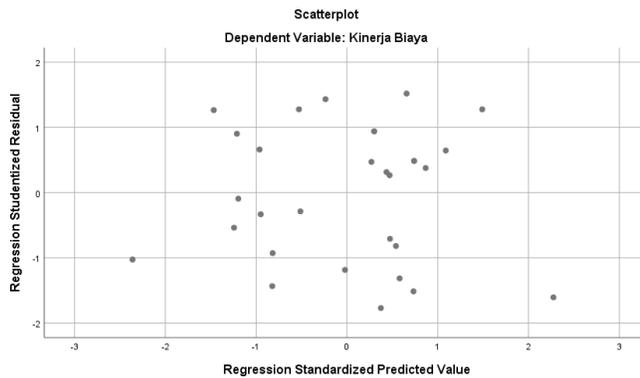
The normality test of independent and dependent variables was carried out using the Kolmogorov-Smirnov test. The data is normally distributed if sig. > 0.05 and the data is not normally distributed if sig. < 0.05 . Based on the results of the normality test obtained the value of sig. for all independent and dependent variables > 0.05 , then the data is normally distributed.

c. Multicollinearity Test

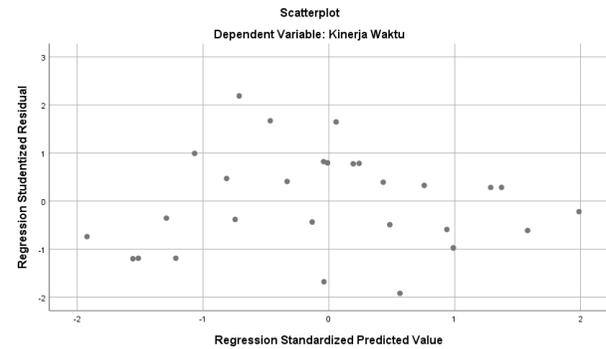
The multicollinearity test uses the VIF test by looking at the VIF value or by looking at the tolerance value for each variable of the flexible manpower supply strategy for each project performance variable. If the VIF value is < 10 or the tolerance value is > 0.10 , then there is no multicollinearity. From the test results, it can be concluded that there are no symptoms of multicollinearity because the VIF value is less than 10 and the tolerance value is greater than 0.10 for each variable.

d. Homoscedasticity Test

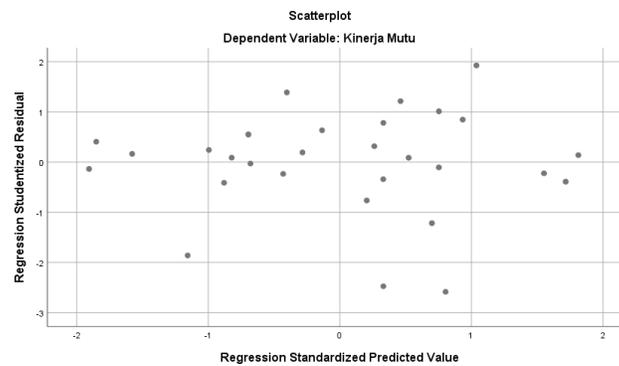
Homoscedasticity test was performed using a graph. The following graphic shows that the data points spread well above and below or around the number 0 on the Y axis, other than that the points do not form a certain pattern. Based on this, it can be concluded that there is no heteroscedasticity



(1)



(2)



(3)

Figure 2 . Homoscedasticity Test Cost Performance (1), Time Performance(2), Quality Performance (3).

3.2 Canonical Correlation Analysis

In this study, we will analyze the effect of flexible manpower supply strategy variables on project performance variables

- a. Results of Determining Canonical Variates and Estimating Canonical Coefficients In the first stage of canonical correlation analysis, a matrix as shown in Figure 3 is obtained. The first matrix describes the correlation between independent variables, the second matrix describes the correlation between independent variables, and the third matrix describes the correlation between independent and dependent variables.

```
Correlations for Set-1
      function numerica temporal
function  1.0000   .7089   .5275
numerica  .7089   1.0000   .5504
temporal  .5275   .5504   1.0000
```

```
Correlations for Set-2
      biaya waktu mutu
biaya  1.0000  .2769  .5176
waktu  .2769  1.0000  .3909
mutu   .5176  .3909  1.0000
```

```
Correlations Between Set-1 and Set-2
      biaya waktu mutu
function  .5780  -.0058  .5732
numerica  .6449  .0394  .3970
temporal  .6017  .1540  .2847
```

Figure 3 Canonical Correlation Matrix

The number of canonical functions formed follows the variable with the smallest number. In this case, there are 3 independent variables and 3 dependent variables. Therefore, the functions formed are 3 canonical functions. From the results of the analysis shown in the following table, it is known that the canonical correlation value (R) of the 1st function is 0.752, which is greater than the 2nd and 3rd functions and is the maximum correlation value obtained from the correlation between X and Y variables. it can be concluded that the 1st function is more meaningful than the other functions because it has the highest correlation value. Likewise, the canonical correlation square value has a value of 0.565 which determines the canonical function which is considered sufficient to explain the structure of the X and Y relationships.

Table 2 Canonical Correlation Value

Function	canonical Coorelation (R)	cor. canonical square (R ²)
1	0,752	0,565
2	0,482	0,232
3	0,087	0,007

b. Canonical Correlation Significance Test Results

The most common method used in the significance test is Wilk's Lambda because it tends to have the most general application to determine whether or not the canonical model is feasible. In this case, the test error tolerance (real level) that can be tolerated is 0.01. Based on the results of the analysis in the following table, only function 1 meets the significance test with a value less than = 0.01. While functions 2 and 3 values do not meet the significance test because they have a significant value greater than = 0.01. So that will be used for further analysis is function 1.

Table 3 Canonical Correlation Significance Test

Fungsi	Wilk's	Chi-Sq	DF	Sig of F
1	0,331	28,197	9,00	0,001
2	0,762	6,924	4,00	0,140
3	0,992	0,194	1,00	0,659

C. Redundancy Index

Based on table 4, it can be explained that the overall redundancy index of the Y variable is greater than that of the X variable. This means that the Y variable can explain as much as 45.3% of the variance in the X variant, while the X variable can explain 29.3% of the variance in the Y variant. In the first canonical function, the Y variable can explain 40.9% of the variance in the X variant and the X variable can explain 25.3% of the variance in the Y variant. In this study, the 1st function is better able to explain the variance in both X and Y variants. Therefore, the 1st function will be used as a reference for further analysis.

Table 4. Redundancy Indexs

Canonical function	Cor. Canonical square (R ²)	Total Varian Group	Redudancy Index
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The proportion of the variance of the independent variable (X) explained by the opposite canonical variable			
1	0,565	0,447	0,253
2	0,232	0,159	0,037
3	0,007	0,395	0,003
			0,293
Proportion of the variance of the dependent variable (Y) explained by the opposite canonical variable			
1	0,565	0,723	0,409
2	0,232	0,144	0,034
3	0,007	0,132	0,010
			0,453

a. Canonical Variation Interpretation Results

Based on the results of the table 5 above, it is known that canonical charge and canonical cross-charge have a unidirectional relationship indicated by the same sign (negative sign). This shows that if the value of variable X increases, the value of variable Y also increases. Conversely, if the value of variable X decreases, the value of variable Y also decreases.

Table 5. Canonical Load and Canonical Cross Load (1st Function)

Variabel	Muatan Kanonikal	Muatan Silang Kanonikal
Strategi Manpower Supply (X)		
Functional	-0,926	-0,696
Numerical	-0,884	-0,665
Temporal	-0,730	-0,549
Kinerja Proyek (Y)		
Kinerja Biaya	-0,923	-0,695
Kinerja Waktu	-0,065	-0,049
Kinerja Mutu	-0,695	-0,523

4. CONCLUSIONS

From the results of the canonical content of the X variant, it is known that the functional strategy has the highest load value (0.926) while the temporal strategy has the lowest load value (0.730). This shows that the functional and numerical strategies are the manpower supply strategy variables that have the closest relationship. While the results of the Y-variate canonical load show that cost performance has the highest load value (0.923) and time performance has the lowest load value (0.065). This shows that cost performance and quality performance are project performance variables that have the closest relationship.

From the results of canonical cross-loading of the X variant, it is known that the functional strategy has the highest load value (0.696) while the temporal strategy has the lowest load value (0.549). This is in line with the results of canonical load analysis. While the results of canonical cross-loading of

the Y variant, it is known that cost performance has the highest load value (0.695) and time performance has the lowest load value (0.049). This is in line with the results of canonical load analysis. The two variables with the highest canonical cross-load are functional and numerical strategies which have a close relationship with project performance variables. Meanwhile, for project performance variables that have the highest cross-loading value are cost performance and quality performance. This shows that these two project performance variables have the closest relationship with functional and numerical variables.

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AHP MODELS IN SELECTING GOODS/SERVICES PROVIDERS BASED ON E-CATALOGUE AT INSTITUT TEKNOLOGI SEPULUH NOPEMBER (ITS) SURABAYA

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ABSTRACT

This study focuses on the problem of provider selection that occurs in Institut Teknologi Sepuluh Nopember (ITS) Surabaya. Unlike the manufacturing industry or private institutions in general, the selected providers of goods and services an e-catalogue for ITS has been regulating in Perpres RI No.16 of 2018 concerning the procurement of government goods/services and their implementation developed by the Government Goods/Services Procurement Policy Institute (LKPP), so ITS's must conduct provider selection according to these regulations. Up to this point, there have been several problems in the process of procuring goods/services based on e-catalogue, including the delays of goods/services delivery, an incomplete administration that lead to the obstructed transaction process, outdated stock, lack of goods/services availability, which means that the complaints to providers unaccommodated. In addition, there is no formal systematic procedure and approach for selecting providers, ITS does not have good guidelines in practising good provider selection. This study uses the Analytical Hierarchy Process (AHP) models to accommodate the needs of ITS in selecting the providers, by minimizing the emergence of problems caused by less reliable and less committed providers. In determining the criteria and subcriteria, a focus group discussion was conducted by involving stakeholders and key decisionmakers in the process of procuring goods and services. To provide recommendations on selecting a good provider for ITS, this research is expected to enrich the case study literature and develop methods related to the process of procuring goods and services in the educational environment.

Keywords: Analytical Hierarchy Process, Procurement, and Provider Selection.

1. INTRODUCTION

In the government environment, the procurement of goods/services is the procuring activity of goods/services by Ministries/Institutions/Regional Apparatuses (K/L/PD) financed by the APBN/APBD whose process starts from the identification of needs until the handover of the work. An efficient and effective procurement process for goods/services is an important part of improving the management of state finances. One of the manifestations is in the implementation of the government's procurement of goods/services electronically (e-procurement), namely the procurement of goods/services carried out using information technology and electronic transactions in accordance with the provisions of laws and regulations. This e-procurement process will further improve and ensure efficiency, effectiveness, transparency, and accountability in the spending of state money, as

e-procurement eliminates the opportunity for direct interaction between prospective goods/service providers and the Working Group (Pokja) so that the process can be more transparent. The efficiency in terms of time, cost and easy implementation for financial accountability can reduce the opportunities for KKN (Tefa, 2009), the implementation of e-procurement in Indonesia supports the resilience of local governance (Hidayat, 2015), implications of e-procurement for efficiency use of state finances and improvement of service functions at the University of Lampung (Mukhlis & Pranoto, 2020). However, there is no research on e-procurement with a focus on universities, both public and private. In these two aspects, this research has a high scientific contribution and novelty value.

The procurement of government goods/services electronically is regulated in the Presidential Regulation of the Republic of Indonesia no. 16 at 2018 by concerning the procurement of government goods/services as stipulated in article 50 paragraph 5 of the regulation above, K/L/PD required to carry out procurement of goods/services electronically through the e- tendering or e-purchasing method. As a method of good/services electronic procurement, e- purchasing is a procedure for purchasing goods/services through an electronic catalog system (e- catalogue) developed by the Government Goods/Services Procurement Policy Institute (LKPP) using an information system consisting of: Electronic Procurement System (SPSE) and SPSE support system. Where as e-catalogue is an electronic information system that contains lists, types, technical specifications and prices of certain goods from various providers of government goods/services to meet national strategic needs determined by the minister, head of the institution, or head of the region.

The government agency that is the object of research is Institute Technology Sepuluh Nopember (ITS) Surabaya, which is one of the most respected government institutions engaged in education in East Java and even in Indonesia, ITS has an area of 180 hectares with a total of 2005 employees (consisting of lecturers and staff). education) and 20,799 students. Under these conditions, ITS has great potential as a consumer in the procuring process of goods/services, both the number of tenders and amount of the budget. Based on this and the Government Regulation of the Republic of Indonesia number 54 of 2015 concerning the statute of the Institut Teknologi Sepuluh Nopember states that the procurement of goods and services is carried out based on the principles of efficiency and economy in accordance with sound business practices and refers to the provisions for the procurement of goods and services for government agencies, ITS represented by the Goods and Services Procurement Unit (UKPBJ) continues to strive for development in improving organizational governance and service quality regarding the procurement of goods/services, especially e-catalogue to all stakeholders.

The problems that are often faced by stakeholders at ITS when using e-catalogue are the object of the provider which is considered to be one of the sources of problems such as (1) delays in the delivery of goods/services; (2) incomplete administration so that the transaction process becomes hampered; (3) outdated stocks; (4) lack of availability of goods/services; (5) incompatibility of goods specifications with prices and (6) facilities for complaints to providers are unaccommodated which causes delays in performance ITS work programs and the realization of financial management. The selection of providers has a very important role in affecting the performance of ITS and the image of ITS as a professional educational institution. So far, there is no formal systematic procedure and approach for selecting providers, which means that ITS does not have good guidelines in the appropriate provider's selection and functions as ITS partners.

By referring to these conditions, the research find out more about the problems faced by ITS in selecting providers, especially e-catalogues based on real problems that occurred at ITS. To support the decision-making, different assessment standards from each criterion and sub-criteria can be analyzed using the available methods in the Multi Criteria Decision Making (MCDM). MCDM. MCDM is engaging technique to note from MCDM is AHP. Up to recently, this method has been widely used in solving decision-making problems (Nydick, Robert L. and Hill, 1992; Fong & Choi, 2000; Bayazit & Karpak, 2005; Jharkharia & Shankar, 2007; Sultan et al., 2012; Ozkan et al., 2011;

Dweiri et al., 2016). The AHP method allows for analysis using multiple criteria, whether the criteria are quantitative, qualitative, or a combination of both. In addition, AHP is relatively easy to understand, widely used in several government agencies and ideal for calculating the weight of each criterion and sub-criteria

2. LITERATURE REVIEW

2.1. Supplier Selection Criteria

Selection criteria is one of the essential things in supplier selection. The used criteria must reflect the supply chain strategy and the characteristics of the items to be supplied (Pujawan, 2017). Identification of decision-making criteria alongside the appropriate supplier selection method is a driving factor that determines the growth and competitiveness of a company, so criteria are crucial in supplier selection. For many years, the traditional approach to supplier selection was to select suppliers based solely on price. However, as companies have learned that the sole emphasis on price as a single criterion for supplier selection is not well organized, they have shifted to a more comprehensive multi-criteria approach (O Pal & AK Gupta, 2013).

The criteria used in the selection of suppliers from some literatures are:

1. The criteria for supplier selection according to Dickson based on the ranking / order of importance are as follows (Weber, Charles A., Current, John R. & Benton, 1991): quality, delivery, performance history, warranties & claims policies, production facilities and capacity, price, technical capability), financial position, procedural compliance, communication system, reputation and tract in industry, desire for business, management and organization, operating controls, repair service, attitude, impression, packaging ability, labor relations record, geographical location, amount of business, training Aids, and reciprocal arrangements.
2. The criteria on supplier selection criteria according to (Nydick, Robert L. & Hill, 1992): quality, price, service, and delivery.

2.2. Multi Criteria Decision Making (MCDM)

Multi Criteria Decision Making (MCDM) is an alternative method in a selection process to obtain the optimum solution from several alternative decisions by considering more than one criteria or objectives in conflicting situations (Ciptomulyono, 2010).

MCDM divided into 2 (two) different approaches:

- Multiple Objective Decision Making (MODM), the optimization models completion with multiple objectives and conflicting objectives. The decision activity defined as the searched decision variable (continuous variable) is not determined beforehand. There were more than 2 objective functions that should be optimized simultaneously and the constraints of the decision system are formed by these variables (Ciptomulyono, 2010). Examples of methods using the approach Multi Objective Decision Making (MODM) are Global Criteria Method, Compromise Programming, Utility Function Method, Compromise Constraints Method, Goal Programming (Interactive, non Linier, Integer), De Novo Programming, SEMOPS Method, GPSTEM, Zions and Wallenius Method, STEP (STEM), Geoffrion and Dyer Method, PROTRADE.
- Multiple Attribute Decision Making (MADM), is a multi criteria solving technique for selection or selection problems with no classical mathematical program approach is needed. The decision variable is considered a finite discrete variable. The methods example using the Multiple Attribute

Decision Making (MADM) approach consists of Analytical Hierarchy Process (AHP), Analytical Network Process (ANP), Parametric Approach, SWT (Surrogate Worth Method Trade Off), ELECTRE I, II, III, IV, IS, Exclusionary Screening, Lexicographic Method, Multi-Attribute Utility Theorem (MAUT), PROMETHEE I, II, III, TOPSIS, dan SMART.

2.3. Analytical Hierarchy Process (AHP) Method

One of the methods used in ranking alternatives based on several existing criteria is the Analytical Hierarchy Process (AHP) method. The Analytical Hierarchy Process (AHP) method was developed by Saaty (saaty, 1994) in the period 1971 – 1975 at the Wharton School, University of Pennsylvania. The AHP method is a framework for effective decision-making on complex issues by simplifying and accelerating the decision-making process. This method divides the problem into its parts by arranging these parts or variables in a hierarchical arrangement, assign numerical values to subjective considerations about the importance of each variable and synthesize these various considerations to determine the highest variable priority and influence results in that situation. In addition, there are several reasons why AHP is very easy to use, including:

1. A hierarchical structure, as a consequence of the selected criteria, to the deepest sub-criteria..
 2. Consider the tolerance limit of validity up to the inconsistency of various criteria and alternatives selected by the decision maker.
 3. Consider the output resistance of the sensitivity analysis of decision-making.
- In addition to several reasons why AHP used because AHP has advantages includes:
1. Unity, AHP makes broad and unstructured problems into a flexible model and easy to understand.
 2. Complexity, AHP solves complex problems through a systems approach and deductive integration. Interdependence (Inter Dependence) AHP is used on system elements independent of each other and does not require a linear relationship.
 3. Hierarchy Structure (Hierarchy Structuring), AHP represents natural thinking that tends to group system elements into different levels from each level containing similar components.
 4. Measurement (Measurement), AHP provides a scale of measurement and methods to get priority.
 5. Consistency, AHP considers logical consistency in the assessment used to determine priorities.
 6. Synthesizes, AHP refers to an overall estimate of how desirable each alternative is.
 7. Trade Off AHP considers the relative priority of the factors in the system so that people are able to select the best alternative based on their goals.
 8. Judgment and Consensus, AHP does not require a consensus, but combines the results of different assessments.
 9. Process Repetition, AHP is able to make people filter the definition of a problem by developing their assessment and understanding through a repetition process.

Stages Decision Making in AHP Method, the stages of decision making in the AHP method include:

1. Define the problem and determine the desired solution;
2. Create a hierarchical structure that begins with a general goal, followed by sub-goals, criteria, and possible alternatives to the options you want to rank;
3. Create a pairwise matrix comparison that describes the relative contribution or effect of each element based on each goal or criterion at the level above. Comparisons are made based on the choice (judgment) of the decision maker by assessing the level of importance of an element compared to other components;
4. Normalize the data by dividing the value of each element in the paired matrix by the total value of each column;

5. Calculate the eigenvector value or relative weight and test its consistency, if it is not consistent then the data collection needs to be repeated;
6. Repeat steps 3, 4, and 5 for all levels of the hierarchy;
7. Calculate the eigenvectors of each pairwise comparison matrix to find the matrix value (λ_{maks}). The eigenvector value is the weight of each element, while the value of matrix (λ_{maks}) is the average value of (λ_{maks}). This step is to synthesize the choices (judgments) in determining the priority of elements at the lowest hierarchical level until the achievement of goals;

$$\lambda_{maks} = \Sigma \lambda / n \quad (2.1)$$
8. Calculate the consistency index (CI) and consistency ratio (CR) values, then test the consistency of the hierarchy

$$CI = (\lambda_{maks} - n) / (n-1) \quad (2.2)$$

$$CR = CI / RI \quad (2.3)$$

Matrix order	1	2	3	4	5	6	7	8	9	10
(RI)	0,00	0,00	0,58	0,90	1,12	1,24	1,32	1,41	1,45	1,49

Figure 1. Random Index Score (RI)

If $CR > 0.1$ than the pair wise comparison matrix, then it should repeated until $CR \leq 0.1$

3. METHODS

This research begins with a field study to get a detailed picture of the happening background and problems. It continues with the screening process for the respondent's selection as well as the criteria and sub-criteria, the chosen respondent's understand the issues of goods/services providers selection based on e-catalogue at ITS and own a certificate issued by LKPP. Meanwhile, the screening process for criteria and sub-criteria are based on literature and field studies. Furthermore, the experts (respondents) discussed the results in an online Forum Group Discussion (FGD). FGD is used to obtain relevant criteria and sub-criteria in selecting providers of goods/services based on e-catalogue at ITS. The next stage is the preparation of a decision hierarchy, the preparation and distribution of questionnaires to respondents and then

processing the data by analyzing the weights of each criterion and sub-criteria as well as the ranking of alternatives/providers using the Analytic Hierarchy Process (AHP) method with the help of expert choice software.

4. RESULTS

To meet the needs of stakeholders, ITS has 5 (five) providers of procurement of goods/services based on e-catalogue. The 9 (nine) proposed criteria based on literature and field studies, using the FGD method, 8 (eight) criteria were obtained by eliminating 1 (one) technology and capability criteria. Those 8 (eight) criteria are:

Criteria	Sub-criteria	Description
Quality	Product quality	Literature study and input from experts
	Frequency of product rejection shipment	
	Variations on current product	

	Providing warranty	
Service performance	flexibility	Literature study and input from experts
	Accuracy on order fulfillment	
	Suppliers attitude (honesty, caring, politeness)	
	Product availability in e-catalogue	
	Product return (refund) facility	
Supplier profile	Owned facilities	Literature study and input from experts
	Financial Status	
	Capital	
Delivery	Sustainability of delivery time (speed)	Literature study and input from experts
	Sustainability of delivery (location)	
Organizational Management	Experience sector	Literature study and input from experts
	Communication capability	
	References	
Cost	Unit price	Literature study and input from experts
	Promo	
Repair Service	Continuous improvement	Literature study and input from experts
	Call center for repair and maintenance services	
Long Term Relationship (Cooperation)	Commitment (integrity)	Literature study and input from experts
	Trust in suppliers	
	Consumer (stakeholder) assessment	

Figure 1. Results of Screening Process and FGD Method

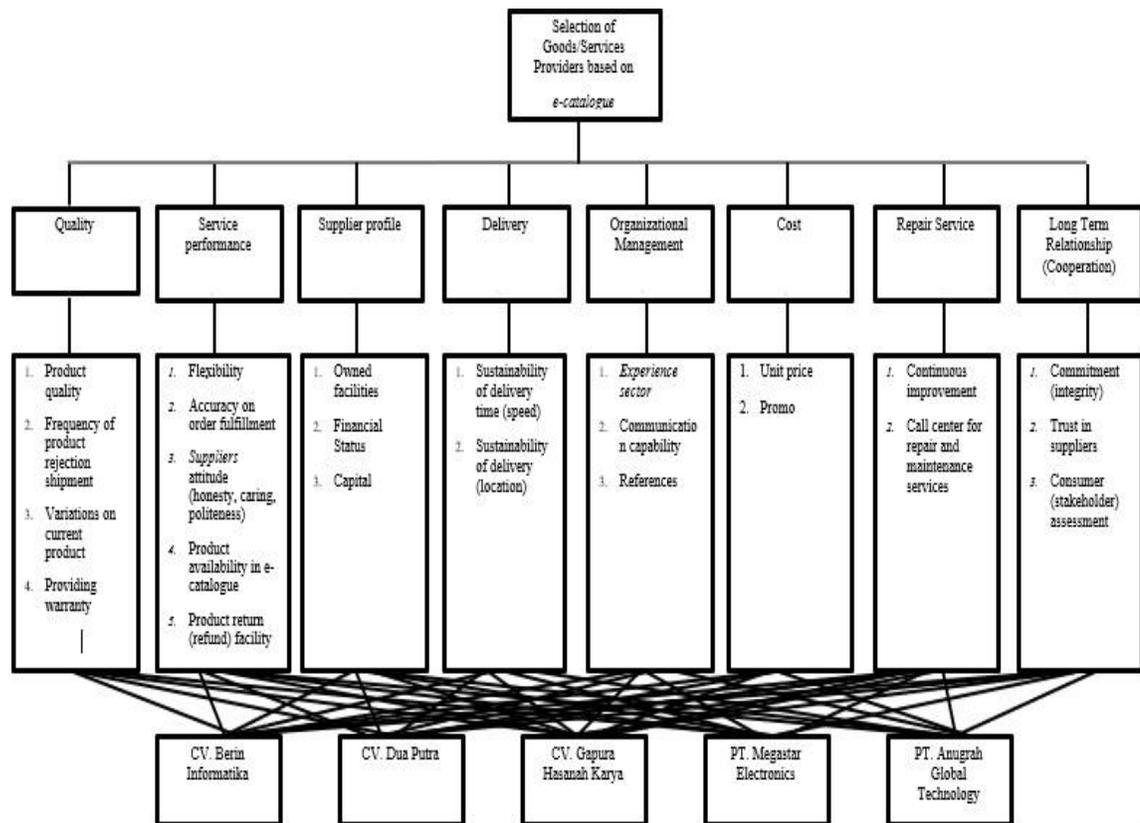


Figure 2. Hierarchy Decision Model with Main Criteria and Sub-criteria

Criteria	Weight	Inconsistency	Sub-criteria	Weight	Inconsistency
Quality	0,240	0,09	Product quality	0,613	0,08
			Frequency of product rejection shipment	0,048	
			Variations on current product	0,084	
			Providing warranty	0,254	
Service performance	0,112		flexibility	0,097	0,07
			Accuracy on order fulfillment	0,307	
			Suppliers attitude caring, (honesty, politeness)	0,092	

		Product availability in e-catalogue	0,438	
		Product return (refund) facility	0,066	
Supplier profile	0,025	Owned facilities	0,587	0,04
		Financial Status	0,249	
		Capital	0,164	
Delivery	0,080	Sustainability of delivery time (speed)	0,732	0,00
		Sustainability of delivery (location)	0,268	
Organizational Management	0,035	Experience sector	0,235	0,00574
		Communication capability	0,423	
		References	0,342	
Cost	0,223	Unit price	0,865	0,00
		Promo	0,135	
Repair Service	0,204	Continuous improvement	0,765	0,00
		Call center for repair and maintenance services	0,235	
Long Term Relationship (Cooperation)	0,080	Commitment (integrity)	0,577	0,04
		Trust in suppliers	0,145	
		Consumer (stakeholder) assessment	0,278	

Figure 3. Criteria and Sub-criteria Weight Priority for Goal Selection of E-catalogue based on Goods/Service Providers

The weights of the main criteria and sub-criteria were obtained from nine respondents questionnaire with a paired matrix assessment using the AHP method and calculated using expert choice software described in Figure 3. The highest criterion weight was quality (0.240) followed by cost (0.223),

repair services (0.204), service performance (0.112), delivery (0.080), and long-term relationship (cooperation) (0.080), while the criteria with the lowest weight are organizational management criteria (0.035) and supplier profile (0.025).

No.	Provider	Weight
1	CV. Berin Informatika	0,243
2	CV. Dua Putra	0,384
3	CV. Gapura Hasanah Karya	0,128
4	PT. Megastar Elektronik	0,127
5	PT. Anugrah Global Teknologi	0,117
Inconsistency Ratio		0,06

Figure 4. Alternative/Provider Weight Priority for Goal Selection of goods/services providers based on *E-catalogue*

The priority of the best alternative/provider from the alternative shown that CV. Dua Putra has the highest weight.

6. CONCLUSIONS

This research integrates supplier selection problem solving using the AHP method. The AHP method is applied to determine the weight of each main and sub-criteria criteria and the ranking of alternatives/providers of procurement of goods/services based on e-catalogue. The order of main criteria and sub-criteria in this study obtained from the pre-existing addition of criteria confirmed by ITS expert's input and previous research with 8 (eight) criteria and 24 (twenty-four) sub-criteria concluded based on the agreement of the experts by using the AHP method and data processing with expert choice. The weight of the criteria are quality criteria (0.240), cost (0.223), repair service (0.204), service performance (0.112), delivery (0.80), long-term relationship (cooperation) (0.080), organizational management (0.035) and supplier profile (0.025) with an inconsistency value of 0.09, which is below 0.1.

Based on the criteria and sub-criteria in the provider's selection using the distribution model on the overall expert choice. CV. Duta Putra is ranked as the best provider with a weight of 0.384, as the next priority is CV. Berin Informatics with a weight value of 0.243, and the last three priorities are CV. Gapura Hasanah Karya with a weight value of 0.128, PT. Megastar Electronics with a weight value of 0.127 and PT. Anugrah Global Teknologi with a weight value of 0.117. It has shown that the best provider of goods/services for ITS to serve as a long-term partner is CV. Dua Putra that has the highest weight value compared to the other 4 (four) providers that have advantages in the criteria of repair services, costs, quality, long-term relationships (cooperation), service performance, and supported by good organizational management.

So far, the decision-makings for the providers selection of goods/services at ITS based on e-catalogue that initially used for the company legality factor only (Deed, SIUP, NKP, NPWP, etc.), active tax (PKP), minimum turnover and domicile of the company in Greater Surabaya. However, with this study, the researcher provides other considerations, namely in the form of quality criteria, costs, repair services, service performance, delivery, long-term relationships (cooperation), organizational

management and supplier profiles. In addition to helping the decision-making process for goods/services providers selection based on e-catalogue with ease and efficiency, ITS can consider the level of satisfaction of ITS stakeholders who are consumers of the procurement of these goods/services. Provide recommendations on AHP methods that applicable in decision making in selecting an efficient and structured provider in a higher education environment.

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SELECTION OF ALTERNATIVE IMPLEMENTATION METHODS FOR THE FOUNDATION OF FUEL STORAGE TANKS IN AN EFFORT TO ENHANCE QUALITY AND COST PERFORMANCE

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ABSTRACT

The fuel tank cap 3000 KL construction at fuel terminal A experienced delays due to the use of conventional methods in the concreting method for the fuel storage tank foundation. This delay happened especially during the waiting period of the concrete foundation to be ready for loading. This study aimed to formulate the criteria that are considered by PT. X in selecting the implementation method for concreting the fuel storage tank foundation and determining the appropriate method based on the criteria of the selection. To achieve the research objectives, a Focus Group Discussion (FGD) method was employed among PT. X field workers to investigate the research variables, namely quality and cost performance. The variable data obtained from Focus Group Discussion (FGD) will be used as a reference for building a research design. Based on the research design, a survey will be carried out using a questionnaire for the respondents of field worker, middle level and top management level in PT X organization. Then the criteria for weighting or decision indicators and alternative are carried out using the Fuzzy Analytical Hierarchy Process (F-AHP) method. The alternative type of implementation method in this study made a positive contribution in the form of quality and cost performance for PT X.

Keywords: Concrete, Performance, Fuzzy Analytical Hierarchy Process.

1. INTRODUCTION

The fuel tank cap 3000 KL construction at fuel terminal X experienced delays due to the use of conventional methods in the concreting method for the fuel storage tank foundation. This condition does not only come from technical constraints for procurement of fuel tank material foundation, but also the waiting period for the concrete foundation ready to be loaded. Within 7 (seven) day curing for ordinary concrete, concrete (other than high initial strength concrete) shall be treated at a temperature above 10°C and in moist conditions for at least 7 (seven) days after placing, unless treated with another treatment (SNI, 2013) or achieving a strength equivalent with 0.65 factor within the 7 (seven) day for ordinary concrete. If it is not determined by experiments, then for calculating the strength and/or checking the concrete quality, the compressive strength ratio at various ages of 28 days concrete can be taken according to Table 1. (PBI 1971 N.I. - 2, 1971) :

Table 1. The Compressive Strength Comparison of Concrete at Various Ages

Concrete Ages (days)	3	7	21	28	90	365
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Ordinary Portland Cement (%)	0,40	0,65	0,88	1,00	1,20	1,35
Portland cement with high initial strength (%)	0,55	0,75	0,90	1,00	1,15	1,20

Concrete is a mixture of portland cement or other hydraulic cement, fine aggregate, coarse aggregate, and water, with or without admixture. Concrete is the main element of almost all types of construction projects. Speeding up the concrete work will speed up project execution significantly. However, concrete takes a long time to get a certain compressive strength, so that a special strategy is needed to overcome it (Al-Bayati et al., 2018). To guarantee that concrete could fulfill the research goal, criteria of concrete should be defined. Quality performance is defined as the first criterion, consisting of compressive strength and curing time of concrete. Compressive strength criterion is defined as an increase in the compressive strength of concrete from the benchmark concrete with unit measurement %. Basic performance of concrete can be notated as compressive strength increased. (Tan et al., 2019). Curing time is defined as a process of curing concrete until it is ready to be loaded in calendar days. The longer curing time, the more the porosity of concrete is decreased and the compressive strength is increased (Manica et al., 2020). The second criterion is cost efficiency, defined as reduction in the cost of making concrete per m³ compared with benchmark concrete. In conventional concrete, lower compressive strength, longer curing time means low cost of concrete (Ahmed & Avetisyan, 2016). The last criterion is environment impact, defined as the content of organic matter in the concrete mix to substitute cement. Higher organic content would be better if it did not reduce quality, increase curing time duration and increase cost of concrete (Kurda et al., 2019).

To solve delays of concreting method without ignoring criteria requirements, there are several ways to accelerate the concreting fuel tank foundation method until it is ready to be loaded. First, using chemical admixture that can both increase the concrete quality from the compressive strength, slump flow, and initial & final setting time, and accelerate the curing time. The use of MasterSure® 1007 admixture provides an increase in the compressive strength and curing time of concrete (Sipil et al., n.d.). Second, using organic admixture that can get the concrete with good quality on the third day. Carrot powder can be used as a substitute for cement in certain compositions to improve the concrete quality by reducing the percentage of cement volume. This can reduce the mixed concrete cost per m³ and obtain more friendly environment (Al-Zubaidi, 2015). Third, using precast concrete so the work that should be done in sequence can be done in parallel which will have implications for project acceleration. (Frederika¹ et al., 2014). Another method, Warm water and hot water can be used as accelerators to get concrete quality faster (Ozkul, 2001).

There are some conflicts in alternative for execution method acceleration of the fuel tank concrete foundation for example, in making curing time faster. Unfortunately, the faster curing time is, the lower concrete quality will be. Indeed, cheap concrete with high quality is very demanded and this high-quality concrete means higher cost we may need. Therefore, in making decision with multi-criteria, it should be possible to use MCDM (Rashid et al., 2020).

2. METHOD

From literature study, a research design was built as shown in figure 1. FGD will be carried out among respondents consisting of field workers (staff) at PT. X, Consultant civil under PT. X, and independent consultants from 2 (two) different institutions. Focus Group Discussion is an appropriate technique to explore data with special characteristics, research and specific purpose. Through FGD

techniques, perceptions, opinions, beliefs and attitudes s a product, service, concept or idea, can be identified as well as a need for study or program evaluation can be allowed to be carried out since it cannot be applied by using other data collection techniques. (Paramita & Kristiana, 2013) The FGD purpose is to get a final research design that will be offered for 3 (three)-level worker of PT. X using a questionnaire for getting Saaty perception scale for criteria and alternative final. A probability sampling, and disproportionate stratified random sampling was employed as the sampling technique because PT X organizations have employees from stratified and disproportionate educational background and experience (Trisnani, 2019).

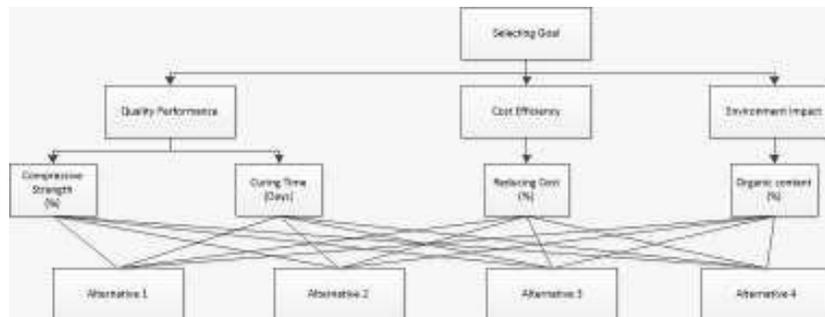


Figure 1. Research design

Estimating the importance of assessment criteria depends heavily on the experience and expertise of experts, particularly in a subjective assessment domain. State assessment is a kind of decision making problem, and, in particular, a multi criteria decision making problem, wherein the criteria should satisfy multiple conditions(Hamdia et al., 2018). Fuzzy- AHP method was used to get best alternative in analyzing the data in order to get selected goal from research. Fuzzy-AHP is one of the ranking methods and is a combination of the AHP method with the fuzzy concept approach. Fuzzy-AHP covers the weaknesses found in AHP, named problems with criteria that have more subjective characteristics. Fuzzy set theory helps in measurements related to human subjective judgments using language or linguistics. (Wang & Chin, 2011).

3. RESULT AND DISCUSSION

3.1. Research design final after FGD

The purpose of Focus Group Discussions (FGD) is to verify criteria and alternative methods of concreting fuel storage tanks through literature study to obtain a valid research design. The data collected used a likert scale survey from 12 FGD respondents to add or reduce criteria and alternatives from respondents' perceptions referring to the expertise and experience of respondents in the research field. The second data is a survey form to determine the pairwise comparison matrix using the Saaty scale which is converted into a triangular fuzzy number from 12 FGD respondents with criteria, alternatives and tested for consistency in determining whether or not the FGD results are valid. From the FGD, the final research design is shown in figure 2 :

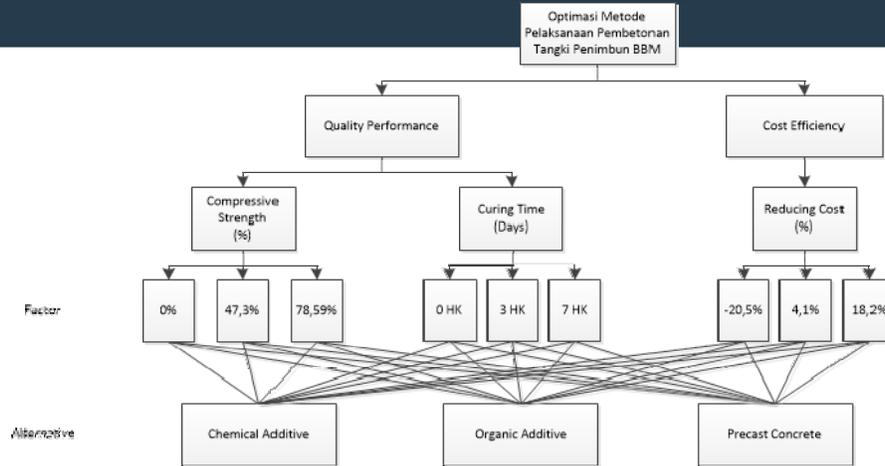


Figure 2 Research design after FGD

Criteria for organic content according to the respondents are not required for the selection criteria for the method for implementing the concrete foundation of the fuel tank with an average value of scale likert 1.3 out of 12 respondents participating in FGD. In addition, organic content should be removed because in the field implementation, referring to SNI and PBI standards, it is not regulated for the organic content. From the examination of physical characteristics and chemical properties of organic cement concentrate, it has been obtained an indication that the organic cement chemical compound resembles the chemical compound of portland cement while the physical characteristics are still under the physical characteristics of portland cement, especially on the ability of the compressive and tensile support. In an effort to improve the quality of organic cement, it is deemed necessary to conduct further experimental research. (Syarif et al., 2018)

3.2. Criteria and Alternative Selection

The survey was conducted through questionnaires with 14 field worker respondents with 85.71% response rate, 10 middle level respondents with 90% response rate and 9 top management respondents with 77.78% response rate. Response rate of survey is relatively high because some procedures for organisational researchers can use to improve response rates (Krishnan & Poulouse, 2016). The data obtained in a perception scale form of the current criteria and alternatives is relative to the research criteria. Then, the data is converted to a triangular fuzzy number, tested for consistency and then weighted using the Fuzzy-AHP method to obtain the relative weight of criteria and alternatives in making basic decision from field worker, middle level and top management point of views. Many scholars do not report a routine control of survey consistency. Its important to test the consistency of survey questionnaire to get validity of survey result. (Bulut et al., 2012).

1. Criteria and alternative selection of the field worker perception

Table 2. Alternative weights calculation to the research criteria of field worker responden

Criteria	Weights	AC	BP	AO	AC	BP	AO
CS	0,1612	0,7661	0,1042	0,1298	0,1235	0,0168	0,0209
CT	0,6749	0,0747	0,7458	0,1795	0,0504	0,5034	0,1212
RC	0,1639	0,7462	0,0719	0,1820	0,1223	0,0118	0,0298
Total					0,2962	0,5319	0,1719

Information :

CS : Criteria compressive strength CT :

Criteria curing time

RC : Criteria reducing cost

AC : Alternative additive chemical BP :

Alternative precast concrete AO : Alternatif
additive organic

Table 3. Alternative ranking to the research criteria of field worker respondents

No	Relative Weight	Alternative Method
1	0,5319	Precast Concrete
2	0,2962	Additive Chemical
3	0,1719	Additive Organic

Based on field worker perception, the alternative of precast concrete is an alternative chosen for implementing the concrete foundation of the fuel tank method with 0.5319 weight. Additive chemical becomes the second option alternative chosen with 0,2962 weight. And last, additive organic becomes the third option alternative chosen with 0,1719 weight.

2. Criteria and alternative selection of middle level perception

Table 4. Alternative weights calculation to the research criteria of middle level responden

	Weights	AC	BP	AO	AC	BP	AO
CS	0,0872	0,6512	0,1038	0,2451	0,0568	0,0090	0,0214
CT	0,7387	0,0805	0,7094	0,2101	0,0595	0,5240	0,1552
RC	0,1742	0,6137	0,0783	0,3080	0,1069	0,0136	0,0536
Total					0,2231	0,5467	0,2302

Table 5. Alternative ranking to the research criteria of middle level respondents

No	Relative Weight	Alternative Method
1	0,5467	Beton Precast
2	0,2302	Additive Organic
3	0,2231	Additive Chemical

Based on middle level perception, the alternative of precast concrete is an alternative chosen for implementing the concrete foundation of the fuel tank method with 0.5467 weight. Additive organic becomes the second option alternative chosen with 0,2302 weight. And last, additive chemical becomes the third option alternative chosen with 0,2231 weight.

3. Criteria and alternative selection of top management perception

Table 6. Alternative weights calculation to the research criteria of top management responden

	Weights	AC	BP	AO	AC	BP	AO
CS	0,0697	0,5306	0,1149	0,3545	0,0370	0,0080	0,0247
CT	0,2344	0,1740	0,5835	0,2426	0,0408	0,1367	0,0568
RC	0,6959	0,5363	0,0916	0,3721	0,3732	0,0638	0,2589
Total					0,4510	0,2085	0,3405

Table 7. Alternative ranking to the research criteria of top management respondents

No	Relatif Weight	Alternative method
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1	0,4510	Additive Chemical
2	0,3405	Additive Organic
3	0,2085	Precast Concrete

Based on top management perception, the chemical additive alternative is the chosen alternative for carrying out concreting in storage tank foundation method with 0.4510 weights. Additive organic becomes the second option alternative chosen with 0,3405 weight. And precast concrete becomes the third option alternative chosen with 0,2085 weight. There are differences in alternatives for selecting based on the field worker & middle level to top management perception. However, it should be continued to analyze alternative of perceptions of each criteria level. Consumer perception can be used for the positioning of the product. With the same approach, the perceptions of the respondents can also be used for positioning the criteria (Adina et al., 2015).

3.3. Perception of the management groups

The following is the respondents' perceptions position of the literature data and field implementation for research alternatives which are shown in table 8 :

Table 8. Perception of the management groups to the additive chemical for improving concrete performance

literature	CS	CT	RC	CS	CT	RC
AC	0,5683	0,1579	0,5220	Data benchmark to field implementation		
AO	0,3676	0,3158	0,3708			
BP	0,0641	0,5263	0,1072			
Field implementation						
AC	0,4903	0,2105	0,5616	-0,0779	0,0526	0,0397
AO	-	-	-			
BP	-	-	-			
Field worker respondent's perception						
AC	0,7661	0,0747	0,7462	0,1978	-0,0832	0,2242
AO	0,1298	0,1795	0,1820	-	-	-
BP	0,1042	0,7458	0,0719	-	-	-

Table 9. (continued)

Middle level respondent's perception	CS	CT	RC	CS	CT	RC
AC	0,6512	0,0805	0,6137	0,0829	-0,0774	0,0917
AO	0,2451	0,2101	0,3080	-	-	-
BP	0,1038	0,7094	0,0783	-	-	-
Top management respondent's perception						
AC	0,5306	0,1740	0,5363	-0,0377	0,0161	0,0143

AO	0,3545	0,2426	0,3721	-	-	-
BP	0,1149	0,5835	0,0916	-	-	-

Table 8 shows that in the alternative chemical additives, there is one criterion in which the field worker, middle level and top management have the same perception. The chemical additive alternative is considered for reducing costs by implementing an appropriate method for the fuel tank foundation concrete. This perception number is in line with the criteria increase in cost reduction after chemical additive alternatives are implemented in this field.

Table 10. Perception of the management groups to the additive organic and precast concrete

literature	CS	CT	RC	CS	CT	RC
AC	0,5683	0,1579	0,5220			
AO	0,3676	0,3158	0,3708			
BP	0,0641	0,5263	0,1072			
Field worker respondent's perception						
AC	0,7661	0,0747	0,7462			
AO	0,1298	0,1795	0,1820	-0,2378	-0,1363	-0,1889
BP	0,1042	0,7458	0,0719	0,0400	0,2195	-0,0353
Middle level respondents' perception						
AC	0,6512	0,0805	0,6137			
AO	0,2451	0,2101	0,3080	-0,1225	-0,1057	-0,0629
BP	0,1038	0,7094	0,0783	0,0396	0,1831	-0,0289
Top management respondents' perception						
AC	0,5306	0,1740	0,5363			
AO	0,3545	0,2426	0,3721	-0,0131	-0,0732	0,0012
BP	0,1149	0,5835	0,0916	0,0507	0,0571	-0,0155

From table 9, it can be seen that respondents' perceptions for alternative precast concrete have perception number higher than benchmark data from literature. This indicates that by using alternative precast concrete, it is expected to increase the performance in concrete implementation method for the fuel storage tank foundation. This alternative surely needs to be proven by field implementation so that it can obtain more comprehensive and valid data for the expected performance improvement quantification.

4. CONCLUSION & RECOMMENDATION

4.1. Conclusion

1. Based on the field worker perception, precast concrete is a chosen alternative for implementation method for the fuel tank concrete foundation with 0.5319 weight. Likewise, on the middle level perception, precast concrete is a chosen alternative with 0.5467 weight.

Middle level has a more optimistic perception of precast concrete alternatives than that of field worker. In addition, field worker and middle level perception focus more on curing time criterion than other criteria.

2. Based on the top management perception, chemical additive is a chosen alternative for execution method for the fuel tank concrete foundation with 0.4510 weight. Top management perception focuses more on cost reduction criterion than other criteria.
3. In chemical additives methods, reducing cost is one criterion in which the field worker, middle level and top management have the same perception. Chemical additives are considered to be able to reduce costs for implementation method for the fuel tank concrete foundation. Using validation with field implementation result, the chemical additive is able to make cost reduction of 52,4%.
4. In precast concrete methods, curing time is one criterion in which the field worker, middle level and top management have the same perception. Alternative precast concrete is expected to accelerate curing time of concreting methods.

4.2. Recommendation

1. For further research, it is suggested expanding wider model boundaries for concrete- based structural and non-structural buildings with a modified resource person population.
2. Regarding financial aspect, further research should consider the economic criterion such as Internal Rate Ratio (IRR), Net Present Value (NPV) and payback period in order to obtain alternatives with more comprehensive feasibility parameters.
3. It is recommended collecting data using FGD method instead of using a questionnaire to minimize the different perception of respondents' positions in the field worker, middle level and top management.
4. Field implementation data available in this research is chemical additive. For further research, field implementation data of organic additive and precast concrete are needed to compare three alternatives methods with the intention of increase the performances of concretes.

5. ACKNOWLEDGEMENT

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SELECTION OF PRIORITY ROAD INFRASTRUCTURE IN SPECIAL ECONOMIC ZONE (SEZ) THE MANDALIKA USING ANALYTIC NETWORK PROCESS (ANP)

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ABSTRACT

PT. XYZ is a state-owned company in the field of tourism area development. The tourism area being developed at this time is The Mandalika Special Economic Zone (KEK). The Mandalika is located in the West Nusa Tenggara Province, Central Lombok of which area development covers approximately 1250 Ha. Development of a tourism area starts from a construction of a basic infrastructure. One of the main basic infrastructures is the construction of road infrastructure. The road infrastructure in the tourism area built by PT. XYZ consists of various kinds of roads with total length of approximately 55 kilometers (km). This study aims to identify alternatives that will be selected in a decision-making process and to formulate criteria for PT. XYZ considerations in the selection of priority road infrastructure. To achieve the research objectives, the authors distributed questionnaires to several division heads related to tourism development. Data obtained from the questionnaire is used to weight the criteria or decision indicators by means of Analytic Network Process (ANP) method. Calculations with ANP method are assisted by employing a superdecision student version software. There are 4 criteria and 7 sub- criteria for selecting the priority for construction of The Mandalika road section. The criteria used are cost, land status, average daily traffic, land use. Based on the results of data processing with the ANP method, the priority of The Mandalika road construction is determined in sequence as follows: west roads (0.301574), event roads (0.254609), public facilities roads (0.8180829), east roads (0.115735) and the villa road section (0.088565). From the results of these calculations, it can be concluded that determining the priority of road development in tourism areas is different from that of other developments. Other areas generally start from the road construction in the back area and only emphasize on the lowest cost aspect. However, the most important thing for tourism is that such development must be carried out in areas that already have crowds and continue with following developments in order to attract new tourists.

Key Words: Basic Infrastructure, Road Infrastructure, Analytic Network Process, Super Decision Student Version

1. INTRODUCTION

Lombok has begun to develop as one of the important tourist destinations in the West Nusa Tenggara region. One of the tourist destinations in Lombok island is The Mandalika Special Economic Zone (SEZ). The Mandalika Special Economic Zone (SEZ) is currently being developed by PT XYZ. The government recently wants to maximize the potential of the tourism sector because it not only contributes to the country's foreign exchange, but also improves the standard of living and welfare of the surrounding community. The support provided by the government in the development of Indonesian tourism includes infrastructure improvement. Road infrastructure is the most basic infrastructure that must be built first in

regional development. Without road infrastructure, investors will not be able to see the location of the lots they are interested in. At this time, the road infrastructure development especially in a region is carried out randomly based on predictions from lot sales instead of priority. In addition, stakeholder desires it to be implemented with the absence of methods or techniques used for the selection of priority infrastructure development.

MCDA (Multi Criteria Decision Analysis) method is a technique used in making decisions that have many criteria/variables. The commonly used MCDM methods are the Analytic Hierarchy Process (AHP) and the Analytic Network Process (ANP) initiated by Thomas L. Saaty (1996). AHP is a measurement theory with pairwise comparisons and is based on the decisions of experts to develop a priority scale (saaty, 2008). Linda et al (2016) in their research on AHP application for selecting offshore outsourcing locations for personnel, found that the AHP method is able to include qualitative and quantitative criteria in the evaluation which will shorten the decision-making process. The development method of AHP is ANP (Analytical Network Process) which is a method for decision making that overcomes problems whose criteria are interrelated and cannot be structured hierarchically (saaty, 1996). The ANP method is an extension of the AHP method by considering the dependencies between its elements. The ANP method has a non-linear structure/network instead of a hierarchy and requires the AHP technique as the first step for the ANP process.

A problem that will be raised by the researcher is that there was originally only one company engaged in regional operations at this time, just restarting the activities of developing new regional tourism areas. This causes limited knowledge and resources for selecting development priorities. In consequence, the selection is carried out randomly and only based on the wishes of stakeholders so that the construction of road infrastructure in The Mandalika SEZ is implemented also by random and not effective. Based on this problem, the researcher wants to apply the ANP method for the selection of priority road infrastructure in The Mandalika Special Economic Zone (SEZ) in order to achieve an effective and efficient road infrastructure development.

2. LITERATURE REVIEW

Analytical Network Process (ANP) is one method that can be used to solve MCDM problems. The ANP is a development method from the former Analytic Hierarchy Process (AHP), in which the ANP method is able to make decisions by involving interactions and linkages between criteria and reciprocity of criteria within and between clusters (saaty & Vargas, 2006). The reciprocal structure does not have a hierarchical form (from top to bottom) but is in the form of a network without any level connecting its components and there are loops that connect the components to themselves (saaty & Sodenkamp, 2008). Beltran et al. (2014) used the AHP/ANP approach for the selection of project investments in solar power plants. There are 3 levels of criteria used, namely the identify and analyze criteria stage, the feasibility study stage and the project portfolio stage. The fundamental scale is the value used to compare each homogeneous element. This assessment consists of a verbal indicated on a scale and then there is a number associated with the assessment. The decision maker will perform pairwise comparisons of all elements in the ANP structure. The results of pairwise comparisons can then determine the priority of each criterion. Then the results will be converted into a pairwise comparison matrix. ANP fundamental scale can be seen in table 1 below.

Table 1. Fundamental Scale ANP

Intensity of interest	Definition
1	<i>Equal importance</i>
2	<i>Weak or slight</i>

3	<i>Moderate Importance</i>
4	<i>Moderate plus</i>
5	<i>Strong importance</i>
6	<i>Strong plus</i>
7	<i>Very strong or demonstrated Importance</i>
8	<i>Very, very strong</i>
9	<i>Extreme Importance</i>

3. METHOD

From literature study, research design was built shown in figure 1 :

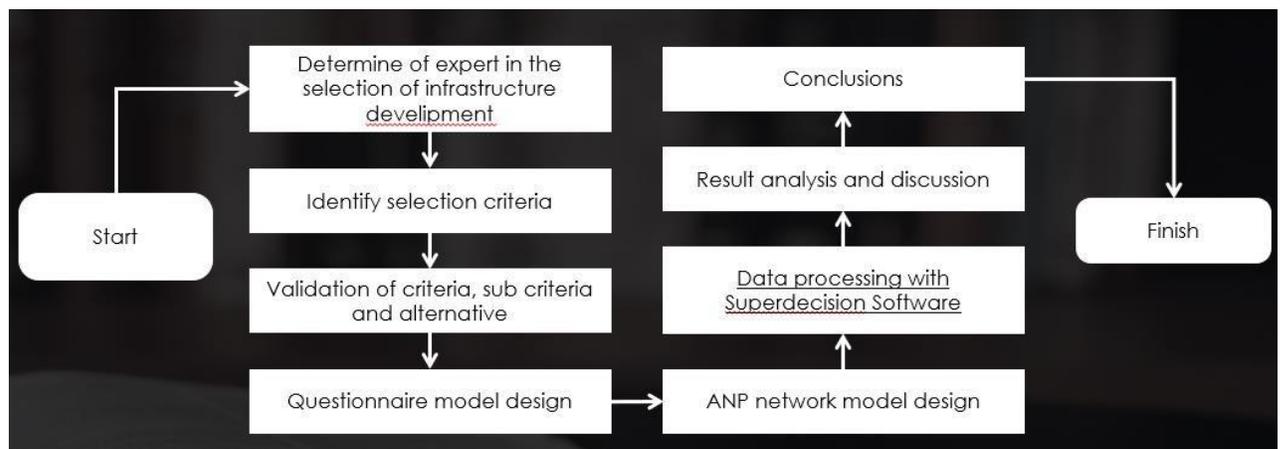


Figure 1. Research Scheme

The data needed in this study are primary data and secondary data. Secondary data is data obtained indirectly by collecting data in the form of historical records or reports. These data include:

- Company profile
- ANP Process
- Priority road infrastructure selection criteria

As for primary data, data collection is done directly, namely through observation, interviews and questionnaires. The primary data collection process consists of several stages, namely:

- Determine the expert in the field of infrastructure selection. The Experts who will fill out the questionnaire are the Head of the Project Management Office division, Head of the Construction Enhancement Division, Head of the Development Division, Head of the Procurement Division, Head of Destination Management Organization and Head of Operations Division.
- Perform alternative validation (division of roads), the criteria which are adopted from several previous studies and adapted to the circumstances and company strategy. The results of this stage are in the form of final criteria that have been approved by the company and can be used in the next stage.

- c. Designing a pairwise comparison questionnaire that is used to obtain the weight of the sub-criteria in the selection criteria for the ANP method. The questionnaire will be given to the same expert. The results of the questionnaire will be processed using the ANP method.
- d. Do a consistency test that aims to see the accuracy of the judgment values given by the expert. The consistency test calculation consists of consistency ratio (CR) and consistency index (CI). If the results of the consistency test show that the weighting is inconsistent, the numbers that are considered outliers will be removed and re-weighted. Consistency ratio results should not exceed 10% and the closer to 0 indicates that the matrix is consistent
- e. Creating a supermatrix consisting of 3 stages, namely the unweighted supermatrix obtained from the results of weighting between criteria, the weighted supermatrix obtained from the product of all elements of the unweighted supermatrix, and the limit matrix.
- f. The steps for calculating the ANP method will be carried out in the Super Decision student version. The hierarchical structure of the modeling can be seen in Figure 2 below.

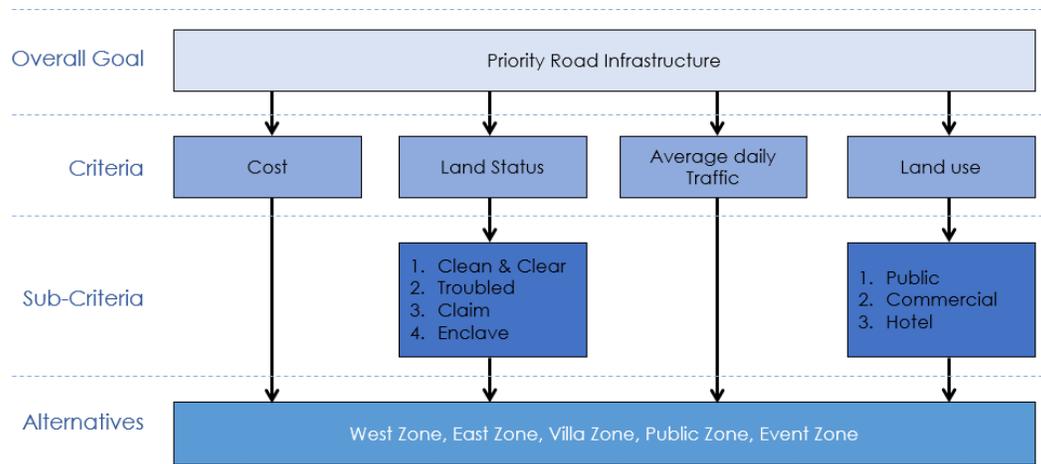


Figure 2. Decision Hierarchy Structure

4. RESULT AND DISCUSSION

4.1 RESULT

From the results of data processing, a decision has been obtained for the selection of road construction priorities in the Special Economic Zones (SEZ) for Tourism. Development priorities in the selection of roads can be seen in the table below.

Tabel 2 Weight Alternative

Description	Name	Normalized	Ideals
Criteria	Cost	0,31730991	1
	Avarage Daily Traffic	0,21574568	0,67992101
	Land Status	0,21877376	0,68946401
	Land Use	0,20807656	0,65575183
Subcriteria Land Status	Troubled	0,13114355	0,21136831
	Clean & Clear	0,62045036	1
	Enclave	0,08079491	0,13021978
	Claim	0,12456384	0,20076359

Subcriteria Land Use	Public Facilities	0,25952502	0,59518024
	Hotel	0,43604442	1
	Commercial	0,24481046	0,56143468
Alternative	West Zone	0,301574	1,000000
	Event Zone	0,254609	0,844265
	Public Zone	0,180829	0,599618
	East Zone	0,115735	0,383768
	Villa Zone	0,088565	0,293676

If seen from the table above, the first construction is carried out on the west road with a weight of 0.301574. When viewed from the cost side as shown in table 2, the west road segment has the second smallest construction cost with a total of 193 billion. The western road segment is mostly occupied by enclave land but does not intersect with the road. All roads in the western area are clean and clear. There are also many existing hotel facilities, public and commercial facilities on this western road. Local and foreign tourists have started to visit this western area a lot. Utilizing existing tourists in the area, without making too big effort to bring in crowds, prioritizing development on the west road section will certainly be able to increase the convenience of access to the area, which is already very qualified and comfortable to pass, marked by the landscape. The convenience and ease of access to the western area is expected to increase the number of local and foreign tourists visiting The Mandalika SEZ area.

The selection of the second priority is carried out on the event area roads. The weight of the road segment in the event area is 0.254609. The cost required for the construction of the road segment occupies the first position, which is 1 trillion Rupiahs. The land status on this road section is very much in contact with the enclave land. However, when viewed from the daily traffic criteria, the average event road takes second place. Hotel facilities, commercial and public facilities in this area are areas that have very large added value. According to the expert opinion, even though it costs a lot to increase the massive number of tourists, the manager of the area must make an event on an international scale. One of these international events is MotoGP. This increasing number of tourists will automatically increase the amount of income from an area marked by the occupancy rate of a hotel and commercial facilities.

The third priority development is carried out on the road area for public facilities. The cost needed to build a road segment is 229 billion (third position). The land status in this area is clean and clear. Daily traffic also takes third place. After the tourists who appear with the event and the arrangement of the existing area, the construction of roads to the public facilities zone is carried out in order to prevent the concentration of tourists in one area. PT. XYZ has 11 points of public facilities. In addition, to prevent skepticism from the public due to overcrowded tourists, public facilities are also equipped by micro, small and medium enterprises.

The next development is carried out in the eastern area, the weight obtained is 0.115735. The cost for this road segment is 517 billion (fourth position). The land status on this east road section consists of enclave and problematic land. The average daily area occupies the first position and public facilities in this area are relatively few. The east road area is located at the very end of the area and very far from the crowds. This eastern area is called the luxurious area. This area is dominated by 5-star hotels. The last development is carried out on the road section of the villa area. This road section criterion indeed costs the cheapest, but this road cannot be built if the western area and the event area have not been built because access to the villa segment road must pass through these 2 areas.

3.2. Work Packages

After analyzing and interpreting the data, the next step is making a work package. The work package is divided into 5 stages of work. The stages of work can be seen from the following figure 3.

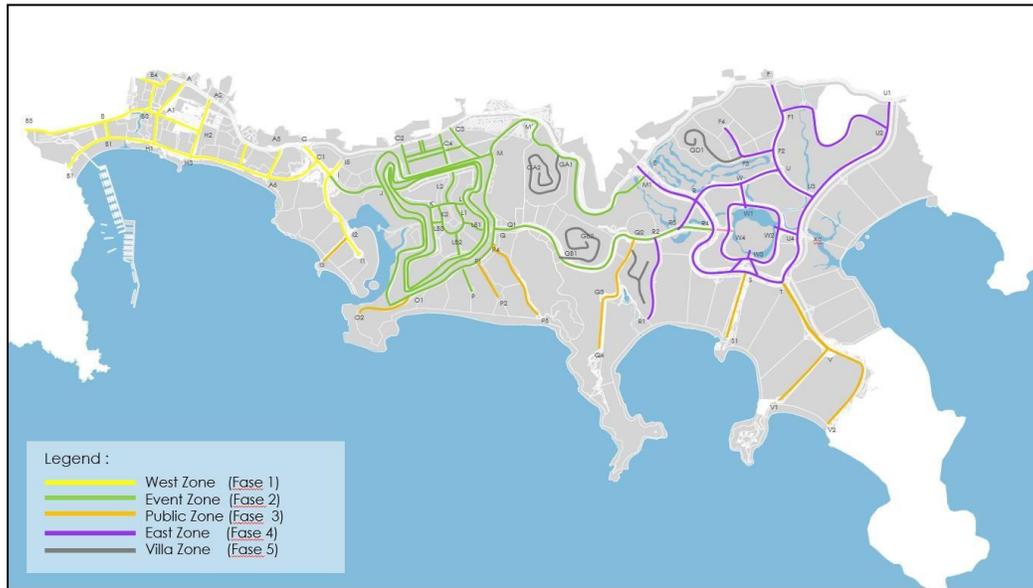


Figure 3. Staging of Development

If the results of the research above are compared with the current reality, the results of this study are expected to be used for further development. In 2015 PT.XYZ started work from the east road section. However, after 2 years running, PT.XYZ changed its development strategy by prioritizing development starting from the western area where a tourism ecosystem has been formed. Then proceed with the construction of the MotoGP track which is predicted to bring in millions of spectators so that it can create a multiplier effect.

5. CONCLUSION & SUGGESTION

5.1 CONCLUSION

1. Criteria and sub-criteria for selecting road development priorities in tourism areas have been validated by experts. The criteria are divided into 4, namely cost, land status, average daily traffic and land use. The sub-criteria only exist on land status criteria (clean and clear, problem land, enclave land, land claims) and sub-criteria on land use criteria (hotels, commercial and public facilities). The weights on the criteria obtained are cost (0.317310), land status (0.218774), average daily traffic (0.215746), land use (0.208077). The weights for the sub-criteria are clean and clear land (0.620450), problem land (0.131144), claim land (0.124564), enclave land (0.080795), hotel facilities (0.436044), public facilities (0.259525) and commercial facilities (0.244810)
2. Based on the criteria and sub-criteria, the development priorities start from the west road (0.301574), the event road (0.254609), the public facilities road (0.180829), the east road (0.115735), and road section villa (0.088565)
3. The strategy in determining road development priorities in tourism areas is different from that of other developments. Other areas generally start from the construction of the road in the back area and only emphasize on the lowest cost aspect. However, for tourism areas, the most important thing is that the development must be carried out in areas that already have crowds and continue with development to attract new tourists.

5.2 SUGGESTION

1. This research is only limited to the development of road infrastructure in tourism areas, does not include the development of other basic infrastructure. There should be further research on the development of other basic infrastructure for tourism areas.
2. This ANP method can be applied by companies to determine work packages and infrastructure development priorities.

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Parallel Session 2

Room J (12.10 – 13.55)

Moderator:

Category : Product Development and Innovation Strategy

STRATEGY FORMULATION OF SMART LOGISTICS DEVELOPMENT IN A NATIONAL LOGISTICS COMPANY

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ABSTRACT

Logistics companies need innovation to improve competitiveness in improving Indonesia's logistics performance. Indonesia is the largest archipelagic country in the world, so it becomes a big challenge for logistics companies because the movement of large goods between islands takes a long time and costs a lot of money. Therefore, logistics companies plan to create an integrated logistics system starting from raw material preparation, processing raw materials into finished goods, and shipping processes until finished goods are received by consumers. The things described above encourage this research, to utilize smart logistics technology to increase the efficiency of the overall logistics process. The approach used in this research is qualitative. This research aims to create strategy formulation of smart logistics development using Strengths, Opportunities, Aspirations, Results (SOAR) analysis, applying the Business Model Canvas (BMC) to describe the rationale for the ongoing logistics process improvement strategy and Balanced Scorecard (BSC) as a strategic framework for developing integrated smart logistics. The results of this study are to formulate recommendations for innovation strategies and the transformation of the logistics industry towards a more advanced direction.

Keywords: Balanced Scorecard, Business Model Canvas, Smart Logistics, SOAR Analysis, Strategy Formulation.

1. INTRODUCTION

Disruptive innovation is currently changing the landscape of many industries and their business models. Due to increasingly digital processes and the exponential growth of sensible data, the logistics industry sector is also affected by the fourth industrial revolution. The e-commerce ecosystem in Indonesia is the most dependent on logistics services, but the development of logistics industry innovation tends to be slow. The success of logistics solutions providers and their clients depends on the ability to vastly adapt to changing customer needs, innovate, develop and supply worldwide complex, high-quality, and greener products and services at a competitive rate (Cherneva & Voigt, 2015). Logistics companies

need innovation to improve competitiveness in providing their best services to consumers (Pane, Awangga, & Azhari, 2018).

Logistics performance is very important for the economic growth and competitiveness of a country, logistics performance has a global measurement called the Logistics Performance Index (LPI). LPI data are gathered through a worldwide survey of logistics professionals on how easy or difficult they experience trade logistics along six generic dimensions when dealing with eight preselected countries (Arvis, et al., 2018). Based on the LPI 2018, Germany was the best- performing country with an LPI score of 4.20, and Afghanistan was the lowest with a score of

1.95. Indonesia's ranking has increased from rank 63 with a score of 2.98 (2016) to rank 46 with a score of 3.15 (2018). There are six critical assessments from the World Bank, Indonesia has two parameters that need attention, the efficiency of customs clearance, and quality infrastructure. Therefore, logistics companies need innovation to increase competitiveness and improve the quality of logistics infrastructure.

Indonesia is the largest archipelagic country in the world consisting of 17,000 islands with a long coastline of 81,000 km (Bahagia, Sandee, & Meeuws, 2013). It is a big challenge for Indonesian logistics because the movement of large goods between islands takes a long time and costs a lot of money. Another challenge is the limited range of service networks, non-cellular, and still accustomed to using manual systems in logistics transactions. PT XYZ currently has several supporting technologies to run its business but does not yet have good integration in planning and operations between systems. PT XYZ sees more open logistics business opportunities and tighter competition due to disruptive phenomena. PT XYZ needs to seriously improve its business through innovative breakthroughs based on digital transformation so that the value proposition can continue to increase.

The things described above encourage this research to utilize smart logistics technology which aims to improve the efficiency of the logistics industry. The concept of smart logistics is an effort to modernize the way logistics works with technology. The goal is to keep operating costs and service costs down for consumers. The strategic planning process to realize smart logistics by implementing the Business Model Canvas (BMC), Balanced Scorecard (BSC), and the Strengths, Opportunities, Aspirations, Results (SOAR) analysis has the potential to produce integrated smart logistics. The purpose of this research is to apply BMC to identify the logistics business processes running in the company in various aspects, BSC as a strategic framework for developing smart logistics, and SOAR analysis as a method/approach to creating strategy formulation of integrated smart logistics development.

2. LITERATURE REVIEW

Smart logistics is an intelligent combination of technology, administration, and human activities to allow one to predict problems and to minimize their impact on a given area, to coordinate resources for an effective achievement of the goals accepted, to eliminate communication barriers between the involved elements of supply chains (Korczak & Kijewska, 2019). Smart logistics is a feasible and effective development mode of modern logistics, which can greatly reduce the cost of manufacturing industry, logistics industry and other industries and promote industry upgrading (Yan, 2019). BMC is a strategic tool used to describe a business model and describe the rationale for how organizations create, deliver, and capture value (Osterwalder & Pigneur, 2010). BSC helps organizations to translate their mission and strategy into tangible objectives and measures (Chimteno, Mkandawire, & Hanif, 2017). The most innovative aspect of the BSC is its capacity to generate strategic learning, providing a global vision of organizational performance and favoring the understanding of organizational objectives, minimizing the overload of information by limiting the number of measures used through four perspectives (Quesado, Guzmán, & Rodrigues, 2018). SOAR focuses on the formulation and implementation of a positive strategy by identifying strengths, building creativity in the form of opportunities, encouraging individuals and teams to share aspirations, and determining measurable and meaningful results. (Stavros & Cole, 2014).

3. METHODS

The approach used in this research is qualitative through Focus Group Discussion (FGD) and interviews with related parties. The data sources used in this study are divided into two parts based on the type of data. Primary data was obtained by direct observation and interviews/discussions with the corporate strategy team, system developers, and employees who were used as research objects to obtain information about the vision, mission, goals, and objectives of the strategy. Secondary data comes from several literatures such as books and research journals related to smart logistics, BMC, BSC, and SOAR analysis. The scientific research process consists of steps that also apply the principles of the scientific method. The steps in this study are shown in Figure 1.

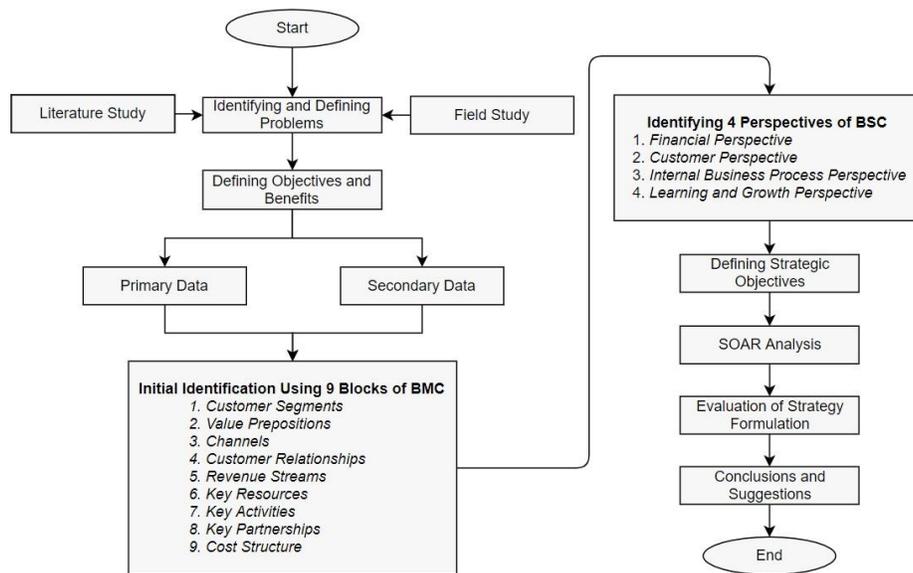


Figure 1. Research Flowchart

4. RESULTS

4.1 Analysis of Current Situation



Figure 2. Indonesia Logistics Market Revenues Forecast 2020-2024

According to a Ken Research report accessed at the Indonesia Economic Forum (IEF), Indonesia's logistics market is expected to earn a CAGR of 7.9 percent to reach USD 300.3 billion or equivalent to IDR 4,204.2 trillion (assuming an exchange rate of IDR 14,000 per USD) in 2024. The revenue includes freight transport, freight forwarding, warehousing, CEP (courier, express & parcel), value-added services, and cold chain logistics segments. Based on Figure 2, the projected revenue for the Indonesian logistics market in 2020 will reach USD 220.9 billion or equivalent to IDR 3,092.6 trillion, PT XYZ's market share is around 0.02%. PT XYZ is a State-Owned Enterprise (SOE) subsidiary engaged in courier and logistics which was established in 2012.

Table 1. Overview of Logistics Companies in Indonesia

	PT A	PT B	PT C
Revenue	USD 438,86 million	IDR 883,05 billion	IDR 1,05 trillion
Net Profit Margin	-13,72%	7,88%	8,49%
Total Assets	USD 574,14 million	IDR 966,36 billion	IDR 696,45 billion
Main Service	- Land, sea & air transportation - Contract & project logistics	- End-to-End service - Warehousing	- Freight railroads - Courier
Segment Focus	- Mining - Container	- FMCG - Agriculture	- Mining - Cement - Waste Industry
Key Capabilities	- International reach	- SOE - Extensive partnerships for customized industrial solutions	- SOE subsidiary - Rail transportation
Established Since	1964	1977	2009

Source: Annual report 2019 of each company

4.2 Business Model Canvas (BMC)

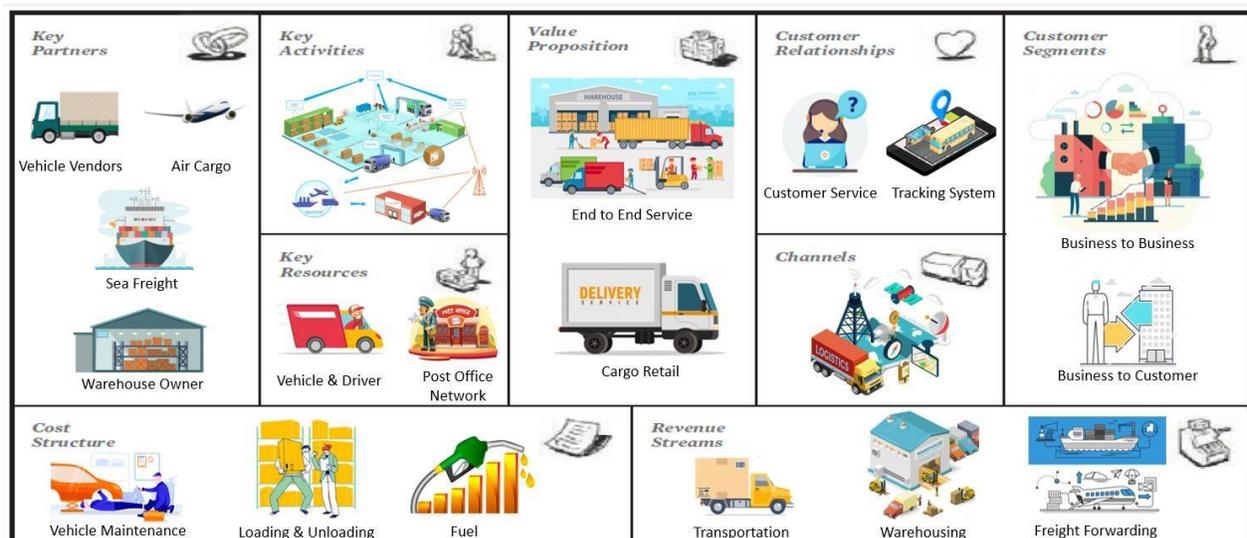


Figure 3. Business Model Canvas

The application of BMC to identify business model at PT XYZ in various aspects and divide them into 9 blocks, such as:

1. PT XYZ focuses on the B2B and B2C customer segments.
2. Value proposition offered is End-to-End Service and Cargo Retail.
3. The channels used by PT XYZ are websites, social media, logistics and supply chain magazines, and strategic cooperation.
4. To build good relationships with customers, PT XYZ employs customer service and provides a tracking system.
5. PT XYZ's revenue stream is obtained from transportation services, warehousing, and freight forwarding.
6. Key resources owned by PT XYZ are warehouses, truck-type vehicles, and utilize the holding company's network throughout Indonesia.
7. PT XYZ carries out distribution activities with flexible, reliable, and efficient land transportation modes to all corners of Indonesia with several transportation operating methods.
8. PT XYZ's key partners consist of truck-type vehicle vendors, air cargo, sea freight, and warehouse owners.
9. The cost structure at PT XYZ consists of vehicle maintenance, loading and unloading processes, and vehicle fuel.

4.3 Balanced Scorecard (BSC)

Identify the BSC perspective by mapping the company's strategy into several strategic themes that are viewed based on four perspectives, namely financial perspective, customer perspective, internal business process perspective, and learning & growth perspective. Strategic themes apply to every part of the organization and determine what major strategic drives the organization will pursue to achieve its vision, themes affect the four perspectives of the BSC. Strategic themes are areas where the organization must excel to achieve its vision (Perry, 2011). PT XYZ divides strategic themes into operational excellence, business development, and customer intimacy.

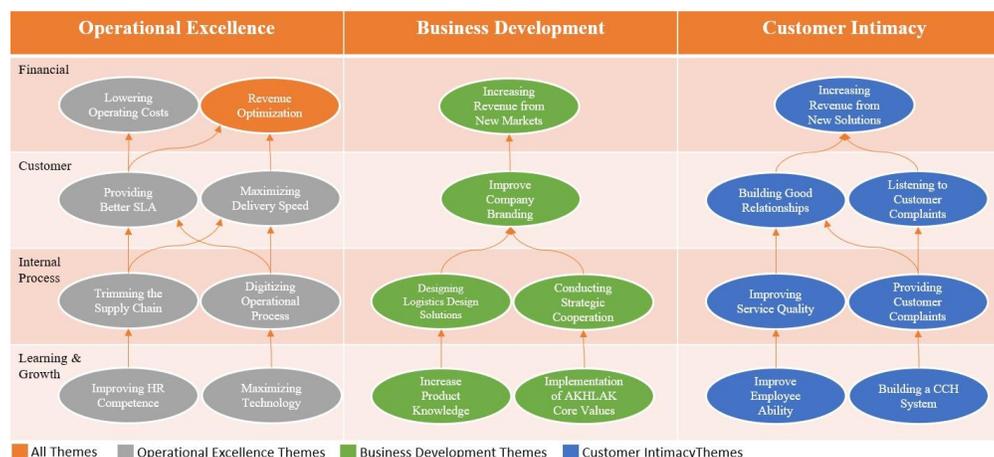


Figure 4. Theme Maps

The BSC strategy map provides a framework for viewing strategy from four different perspectives. The purpose of making a strategy map is to determine the causal relationship between strategic objectives, both vertically (relationships between strategic objectives in different perspectives) and horizontal relationships (relationships between strategic objectives in the same perspective). The type of causal relationship between strategic objectives means a positive relationship, where the achievement of a good

strategic objective will affect the other strategic objectives and vice versa.

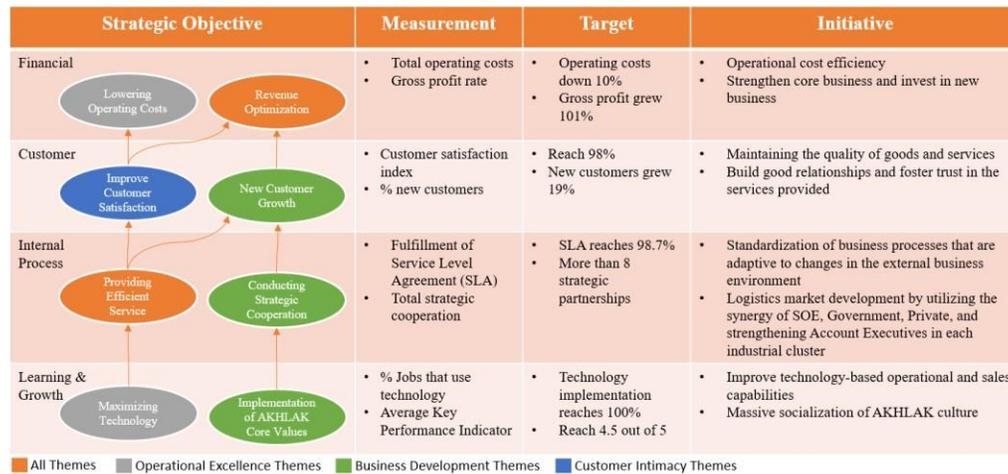


Figure 5. Strategy Maps

The application of BSC to map the company's strategy into several strategic themes which are viewed based on the following four perspectives:

1. The financial perspective strategy targets to be achieved are reducing operating costs and optimizing profits. The target of this strategy has a target, operating costs to decrease by 10% and gross profit to grow by 101%.
2. The target of the customer perspective strategy to be achieved is to increase customer satisfaction and the growth of new customers. The target of this strategy has a target, the customer satisfaction index reaches a value of 98% and the number of new customers grows by 19%.
3. The strategic target of the internal business process perspective to be achieved is to provide efficient services and the implementation of strategic cooperation. The target of this strategy has a target, the fulfillment of SLA reaching 98.7% and having more than 8 strategic partnerships.
4. The target of the learning and growth perspective strategy to be achieved is to maximize the use of technology and the implementation of AKHLAK core values. The target of this strategy has a target, work that uses technology to reach 100% and the average key performance indicator reaches a value of 4.5 out of 5.

4.4 Strategy Selection

PT XYZ's strategy is a growth strategy through aggressive and sustainable growth by maximizing SOE synergy and supported by competent, capable, and professional human resources and the use of appropriate technology. The business strategy is directed at producing services that can provide added value for customers and build competitive advantages in every line of business that the company enters. To achieve this goal, PT XYZ will implement the following business strategies:

1. SOE synergy, the SOE's logistics spending in 2021 is projected to reach IDR 280 trillion. PT XYZ will aggressively work on the SOE logistics market by prioritizing technology-based logistics services that can add value to the company.
2. Integrated logistics service management, marketing of company services is carried out in an integrated manner, namely providing services or solutions to customers in an end-to-end solution and supported by the application of an appropriate information technology system. In achieving the desired level of operating efficiency to achieve integrated logistics service management, the fulfillment of facilities and infrastructure can be done through investment, lease, or outsourcing.

In preparing a digital transformation strategy, PT XYZ does this by developing comprehensive smart logistics that is integrated internally (between divisions) and externally (holding, vendor, and customer). The basic components that drive a smart logistics system are the identification, placement, and sensing of goods. The main focus of smart logistics development only covers Transportation Management System (TMS) and Warehouse Management System (WMS).

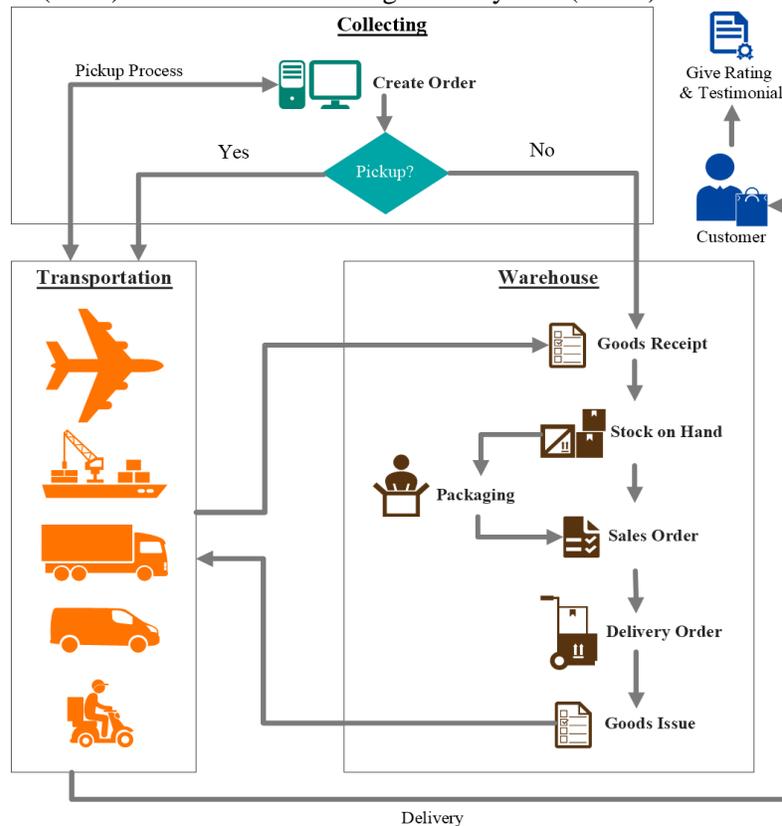


Figure 6. Smart Logistics Concept

4.5 SOAR Analysis

SOAR analysis is a powerful tool to bring stakeholders together to recognize the potential of the organization and create a shared vision of the future. Building on strengths requires less effort and resources than trying to fix weaknesses because people usually find it more interesting and exciting to focus their attention on the positives rather than the negatives. SOAR analysis is suitable to assist PT XYZ in developing smart logistics to integrate logistics processes. In implementing SOAR analysis, it started with FGD to discuss strategic formulation related to smart logistics development. There are four stages of FGD in developing smart logistics, namely exploring the strengths from all aspects, balancing opportunities and capacities, innovating to achieve the desired future, and producing tactical plans to implement the strategy.

4.5.1 Inquiry into Strength

Strength is one of the important factors to compete with other companies. The things that are the strengths and greatest assets owned by PT XYZ, both tangible assets and intangible assets. The strengths of PT XYZ in developing smart logistics are as follows:

1. PT XYZ is a subsidiary of SOE, where SOEs are currently encouraged to collaborate and synergize.
2. Flexible and agile in responding to markets and partnerships.

3. Technology-based operating processes such as WMS and TMS which are part of smart logistics that result in the comprehensive management of the goods flow and information flow throughout the logistics chain.
4. Having human resources for information technology developers who are capable and understand and are interested in the logistics sector.

4.5.2 Imagine the Opportunities

One of the conditions for the success of a company is its ability to maximize the opportunities it has. This requires a positive perspective in looking at the rapidly changing external environment. Here are some opportunities that can be used by PT XYZ to develop smart logistics are as follows:

1. Build as many collaborations as possible with logistics players to form a supply force that is ready to transform digitally, while providing a guarantee that the companies that join will not be run over by other companies in it.
2. Government policies to improve the performance of national logistics, to encourage the expansion and development of the Indonesian economy.
3. Industrial revolution 4.0 is a phenomenon that collaborates cyber and automation technology.
4. The growth of the e-commerce industry in Indonesia is projected to continue to increase, and this growth will also affect the growth of the logistics industry.

4.5.3 Innovate to Reach Aspirations

The members of the organization share aspirations and design the conditions for the future they dream of, which can lead to self-confidence and pride in themselves, their work, departments, and the organization. The following are some of the important aspirations conveyed by FGD participants in developing smart logistics as follows:

1. For customers, the sooner the goods arrive at their destination, the better the experience, including making customers loyal to the service.
2. Smart logistics can reduce labor costs in the warehousing segment, and full monitoring of the entire process of moving and storing goods, efficiency and accuracy will increase.
3. Building a marketplace-based platform that brings together goods transportation service providers and customers who need logistics transportation can be a new business model.
4. Implementation of green logistics, namely strategies and programs for reducing carbon dioxide (CO₂) emissions in the logistics sector, to make it happen, can be done through efficient and environmentally friendly operational practices.

4.5.4 Inspire to Achieve Results

Results mean determining the size of the results to be achieved in strategic planning, to find out the extent to which the goals have been mutually agreed upon. To make members of the organization feel motivated in their efforts to achieve the goals that have been set, it is necessary to design an attractive recognition and reward system. The following results are expected in the development of smart logistics are as follows:

1. Produce a blueprint for smart logistics development as a basis for policymaking which includes setting goals and objectives, formulating strategies, implementing programs, and focusing activities as well as steps or implementations that must be carried out by each unit in the PT XYZ work environment in developing smart logistics.
2. PT XYZ plans to conduct an Initial Public Offering (IPO), and can distribute a portion of the company's ownership in the form of shares to employees who have successfully developed and implemented smart logistics as a form of appreciation to employees.
3. Producing new business models such as 4PL, which requires PT XYZ to open a Strategic Business Unit (SBU) to accommodate this business model.

4.6 Evaluation of Strategy Formulation

In evaluating the success of the strategy formulation, it is done by determining the effectiveness of the resulting strategy formulation in achieving organizational goals. If the effectiveness of the strategy formulation is deemed insufficient to achieve PT XYZ's goals in developing smart logistics, it is necessary to prepare alternative strategies. Several things must be done by PT XYZ in ensuring the strategy is effective or not, namely a strategy must be consistent with the policy and the objectives of the strategy itself, problems in the organization can sometimes cause inconsistencies. Furthermore, PT XYZ must pay attention to the company's internal and external factors, a strategy must be able to represent an adaptive response to the external environment and the changes that occur. A strategy should not create new problems that are difficult to solve. In evaluating the strategy formulation, it is important to know whether the organization has the necessary capacity to carry out the company's strategy.

5. CONCLUSIONS

From the results of the strategy formulation of a smart logistics development at PT XYZ, it can be concluded:

1. The application of SOAR analysis to create a strategy formulation of integrated smart logistics development starts from the stages:
 - a. Inquiry into strengths, the things that become strengths of PT XYZ are (1) a subsidiary of a SOE, (2) flexible and agile in responding to markets and partnerships, (3) technology-based operating processes, and (4) having human resources for information technology developers.
 - b. Imagine the opportunities, several opportunities that can be utilized by PT XYZ (1) building collaboration with logistics companies, (2) government policies to improve national logistics performance, (3) industrial revolution 4.0, and (4) growth of the e-commerce industry in Indonesia.
 - c. Innovate to reach aspirations, several important aspirations in developing smart logistics are (1) meeting customer expectations, (2) reducing labor costs in the warehousing segment, (3) implementing a fourth-party logistics provider business model, and (4) implementing green logistics.
 - d. Inspire to achieve results, the expected results in the development of smart logistics are (1) generating a blueprint, (2) dividing the portion of company ownership in the form of shares, and (3) generating a new business model.
2. The managerial implication obtained from this research is to modernize the way logistics work with technology, thereby helping logistics companies to meet customer expectations, reduce supply chain costs, provide efficient services, and combine all logistics strengths in one platform. Smart logistics results in the comprehensive management of the flow of goods and information flow throughout the logistics chain to ensure that delivery service data can be organized in the right place, at the right time, and can be ensured in real-time.

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INNOVATION PRODUCT DEVELOPMENT FROM CORPORATE INNOVATION LAB IN TELECOMMUNICATION INDUSTRY USING IRL AND QFD

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ABSTRACT

The Telecommunications Industry is currently in a very strong competitive situation. This is caused by digitalization that makes market needs and technology change more quickly. This is due to the very fast product life cycle, resulting from the evolution of technology and the emergence of advances in digital communication technology and OTT services, which disrupt many legacy businesses. To deal with this, the telco industry has developed innovative products in various business models. However, many of these innovation products are stuck in the chasm phase, where many innovation products cannot be optimally adopted by the market. Therefore, this study aims to propose a strategy for developing potential digital innovation products in order to be able to pass the Chasm phase. This research raises a case study from the Corporate Innovation Lab (CI-Lab) owned by a telecommunications company in Indonesia. Potential innovation products are selected using the Analytical Hierarchy Process (AHP) method against several alternative innovation products by considering 4 criteria, namely the achievement of KPI, funding (cost), income, and risk. Next, value proposition canvas is carried out as input for customers and functional requirements in Quality Function Deployment (QFD). QFD approach is used to determine technical priorities in accordance with consumer expectations. It is also necessary to measure Innovation Readiness Levels (IRL) to find out which level of innovation is and provide recommendations to continue to develop to the next level. The results of this study are 78 recommendation points for improvement of Innovation H in the big data platform business with the achievement of Innovation readiness level is IRL level 3 which is the completion phase with 89.52% achievement rate.

Keywords: Corporate Innovation Lab, Innovation Readiness Levels, Analytical Hierarchy Process, Quality Function Deployment

1. INTRODUCTION

Telecommunications industry is very quickly affected by technological changes. Technological changes that occur from telegraph technology, fixed-line technology, GSM, until now have begun to be replaced with over the top (OTT) services such as whatsapp and others can cause the risk of failure to the legacy business. This is a challenge for companies to continue to develop innovative products to get new business opportunities that are in line with market needs. Only innovations that match the company's business and market needs have the potential to be successful (Wu et al, 2013). Innovation screening process is needed in order to find which innovations have the most potential and effectiveness to be prioritized (Ciriello et al, 2016).

In the development of innovation, there are several phases of market adoption, including Innovators (2.5% of the total market), Early Adopters (13.5% of the total market), Early Majority (34% of the total market), Late Majority (34% of the total market), to the last Laggards phase (16% of the total

market) (Tao et al, 2010). In the Early Adopters stage leading to the Early Majority there is a phase that must be passed which is called Chasm. Chasm is a condition where product innovation meets customer needs or demands, where there is a difference in the way of adoption between Early Adopters and Early Majority (Viki et al, 2017).

In this study, the author raised a case study from PT. XYZ, one of telecommunication company in Indonesia. Corporate innovation lab (CI-Lab) was built to accommodate innovations issued by internal employees. CI-Lab is a place to incubate and accelerate ideas from employees of PT. XYZ. In accordance with the direction of the board of directors, this program aims to create digital innovation and digital talent to support the company's digital business. However, most of the innovations produced by CI-Lab are still stalled in the chasm phase. Chasm phase makes many innovation products fail because they cannot be adopted by the market optimally. Therefore, this study was conducted with the aim of compiling recommendations for developing digital innovation products from CI-Lab that have the most potential to become new businesses for telecommunication companies, then determining development priorities using the QFD method and measuring the IRL.

2. LITERATURE REVIEW

A method that is very suitable to be used for screening innovations or products from the point of view of decision makers, management, and facilitators is using AHP (Calantone et al., 1999). AHP is used to select several alternatives by using or paying attention to many criteria. In 2013 research on new product development with AHP was conducted to determine the weight of consumer needs connected to new product development (Battistoni et al, 2013). AHP consists of 3 main structures, namely goals, criteria, and alternatives as depicted in Figure 1.

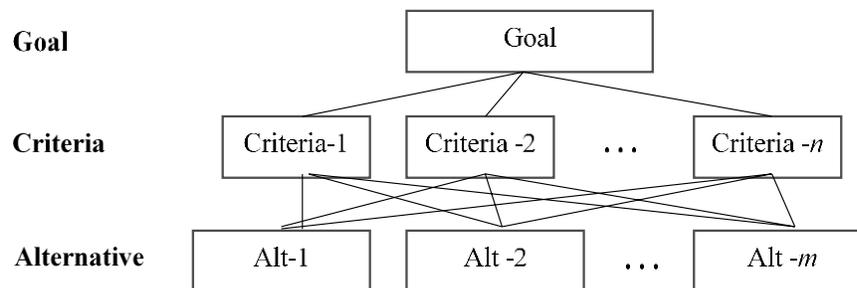


Figure 1. AHP Structure (Calantone et al, 1999)

QFD can be used for new product development, where in 2015 research was conducted on the use of QFD for the development of a new product Biometric Identification System, the results of which proved that QFD could be implemented in this case (Ionica et al, 2015). The relationship between the Business Model Canvas (BMC) and QFD was also proven in research in 2017, where customer requirements and functional requirements can be adopted from the customer segment and the value proposition from the Value Proposition Canvas (Pitayachaval et al, 2017). Customer segment in VPC becomes demand quality (customer requirement) on HoQ, while value proposition on VPC becomes quality characteristic (functional requirement) on HoQ (Paphakorn Pitayachaval, et al., 2017).

To measure the level of readiness of an innovation, the method that can be used is the Innovation Readiness Level (IRL). This method was first proposed by Lan Tao in 2010. In this study, it was found that IRL can help implement life-cycle innovations more effectively (Tao et al, 2010). In 2011, research was undertaken aimed at examining how technology, markets, and other aspects of innovation readiness can be described over the life cycle and to provide an IRL framework. The study recommends that IRL can be applied as a tool for innovation managers to measure their innovation readiness (Lee et al, 2011).

In 2018, IRL was used in research to evaluate innovations at the Husqvarna Group. The research resulted in the identification of important steps when developing a viable product. The findings show that the Technology Readiness Level (TRL) framework still has relevance, but the achievement criteria have been adjusted to make it more appropriate (Lunner et al, 2018). In 2020, the IRL framework is used to assess the level of innovation readiness of XYZ universities to face the industrial revolution 4.0 where the results of the IRL calculations are at level 2 (Utomo et al, 2020).

IRL is based on the 6C model which represents the phases of the innovation life cycle, namely Concept (IRL 1), Component (IRL 2), Completion (IRL 3), Chasm (IRL 4), Competition (IRL 5), and Changeover (IRL 6) (Setiawan et al, 2018). The IRL framework can be used as a tool for innovation managers to position and consider key elements related to innovation (Lee et al, 2011). Figure 2 illustrates how the relationship of technological development (IRL 1 to IRL 3) is related to TRL 1 to TRL 9. While market evolution (IRL 4 to IRL 6) is related to the market adoption cycle.

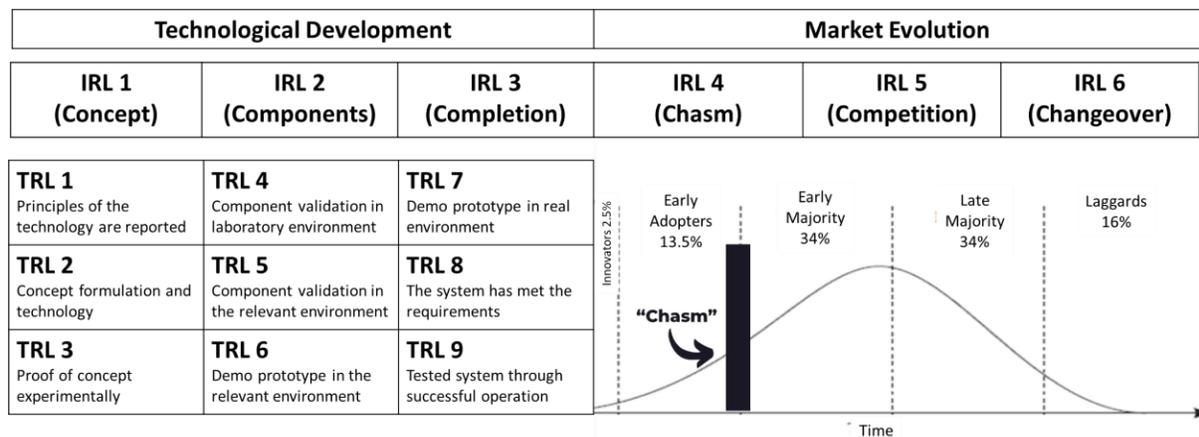


Figure 2. Concept of technological development and market evolution on IRL

3. METHOD

This research is focused on analyzing potential innovation business models, determining product development strategies by integrating VPC and QFD. Furthermore, the measurement of innovation readiness level is carried out using the innovation readiness level (IRL) measurement method. The research stages are depicted in Figure 3. The initial process in this research is to determine which innovation will be the object of research. This is of course by considering the innovations that have the most potential to generate new business for the company. Innovations that are focused on as research objects are innovations that have passed all stages of incubation. This is because innovations that have successfully passed all incubation stages have the greatest potential to be developed.

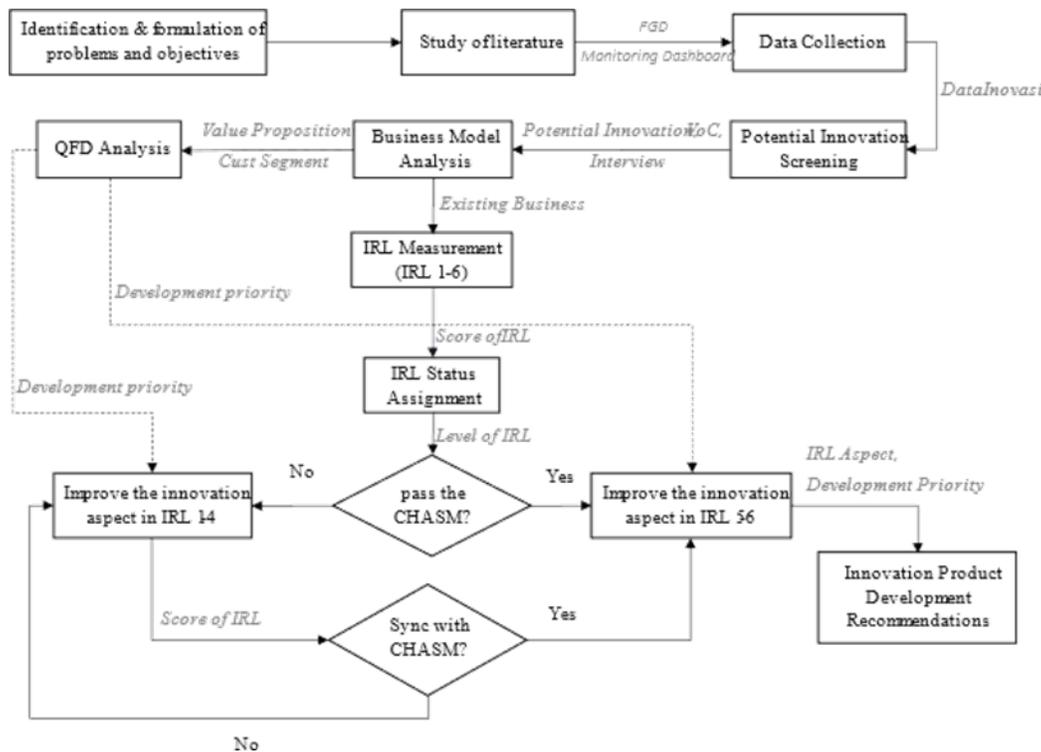


Figure 3. Research Flowchart

4. ANALYSIS AND DISCUSSION

4.1 Data Collection

Primary data is obtained from FGD/interviews with Innovators (Founder) of the selected innovations and the results of FGDs/interviews with customers who are the market segment of the innovation. The FGD with Innovators was aimed at obtaining data in designing business models, functional requirements, and in measuring IRL (generated in Figure 4 and Table 7). Meanwhile, FGD with customers is aimed at obtaining customer needs in designing voice of customer (VOC) (generated in Table 4). The secondary data used in this study is data from the company's Innovation Manager monitoring dashboard as shown in Table 1.

Table 1. Innovation at the graduate stage

No	Innovation Code	Business Focus	KPI Ach.	Cost Weight	Revenue Weight	Risk
1	A	VR / AR Platform	75%	0,13	0,08	High
2	B	Network Monitoring	50%	0,21	0,00	Medium
3	C	People Analytic	50%	0,22	0,02	High
4	D	Omni Communication	40%	0,14	0,00	Medium
5	E	AI Network	50%	0,50	0,00	Medium
6	F	Conversational AI	50%	0,15	0,00	High
7	G	Project Management	100%	0,32	0,00	Medium
8	H	Big Data Platform	100%	0,07	1,00	High
9	I	Corporate Innovation Lab	60%	0,14	0,12	Low
10	J	Digital Ads	100%	1,00	0,04	Medium

4.2 Potential Innovation Screening

To get the most potential innovations as development priorities, an innovation screening process is needed from 10 innovations that have currently completed the incubation stage and have graduated (already joined and are active in the tribe) as shown in Table 1. The criteria matrix is formed based on the importance of each criterion. At this stage, each criterion is compared with other criteria to determine the value or scale of importance of each criterion.

Table 2. Normalized Criteria Matrix

Kriteria	KPI Ach.	Cost	Revenue	Risk	Avg
KPI Ach.	0,08	0,05	0,06	0,14	0,08
Cost	0,25	0,16	0,09	0,21	0,18
Revenue	0,42	0,47	0,28	0,21	0,35
Risk	0,25	0,32	0,57	0,43	0,39

From Table 2 it can be concluded that the Risk and Revenue criteria are the 2 most important criteria. The alternative matrix for the 4 criteria is formed from the average value (Avg) of each alternative from each criterion as shown in Table 3.

Table 3. Innovation ranking

Innovation	KPI Ach.	Cost	Revenue	Risk	Overall Score	Ranking
A	0,10	0,05	0,10	0,04	0,06	8
B	0,02	0,09	0,04	0,11	0,07	6
C	0,03	0,09	0,04	0,04	0,05	10
D	0,02	0,05	0,04	0,11	0,07	7
E	0,03	0,21	0,04	0,10	0,09	5
F	0,03	0,05	0,04	0,06	0,05	9
G	0,25	0,16	0,04	0,11	0,11	4
H	0,25	0,01	0,45	0,04	0,20	1
I	0,04	0,05	0,17	0,28	0,18	2
J	0,25	0,24	0,06	0,11	0,13	3

It can be seen in Table 3 that Innovation H which is engaged in big data platform services has the highest score. It can be concluded from the results of these calculations that the innovation that has the highest potential is Innovation H.

4.3 Business Model And Value Proposition

The service developed by Founder Innovation H is an end-to-end data analytics platform to help companies manage big data. In the early adopters market, Innovation H targets BUMN, BUMD, and government companies as early customers. In compiling the VPC, there are 2 main steps taken, there are mapping the customer segment (CS) and mapping the value proposition (VP). CS was obtained from the results of FGDs with consumers from Innovation H. The consumer who became the object was one of the largest BUMDs in East Java that had the potential to subscribe to the services of Innovation H. From the mapping of VoC and the solutions, it can then be mapped CS and VP on the VPC as illustrated in Figure 4. Every pain and gain on the CS side, has a solution on the pain relievers and gain creator on the VP side. Therefore, the VPC can be said to be appropriate and can be continued as a reference for QFD.

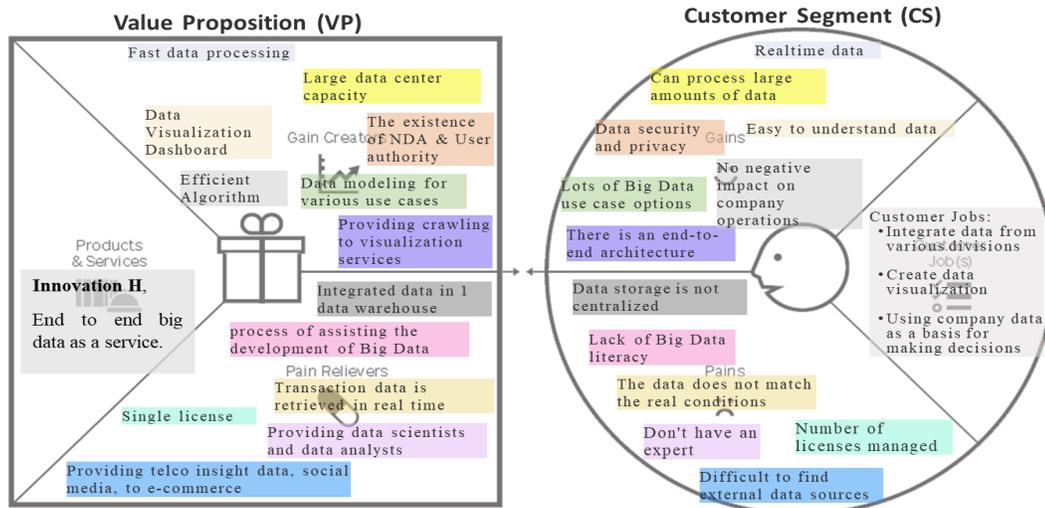


Figure 4. Value Proposition Canvas of Innovation H

4.4 QFD Analysis

To build the HoQ, the data used are data from VoC and FGD with Innovator. Based on the VoC, customer requirements can be mapped and grouped into 5 attributes as shown in Table 4. The technical response is mapped based on the functional requirements of the VPC. The requirements are grouped into 5 technical responses as illustrated in Table 5.

Table 4. Attribute mapping

No	Customer requirements (CS VPC)	Attribute
1	Centralized data storage	data collection
2	There is an end-to-end architecture	Infrastructure
3	Big Data literacy assistance	Product support
4	Lots of Big Data use case options	use case
5	Data according to real conditions	data collection
6	No negative impact on company operations	Safety
7	Data according to real conditions	data collection
8	There are experts	Product support
9	Manage 1 license	Infrastructure
10	Can process large amounts of data	data collection
11	Easy to understand data	use case
12	Availability of external data sources	data collection
13	Data security and privacy	Safety

Table 5. Technical response

No	Functional Requirements (VP VPC)	Technical Response
1	Integrated data in 1 data warehouse	Data integration design
2	Providing crawling to visualization services	Infrastructure design
3	There is a process of assisting the development of Big Data	Number of experts
4	Data modeling for various use cases	Number of experts
5	Transaction data can be retrieved in real time	Data integration design
6	Efficient Algorithm	Security

7	Fast and precise data processing	Data integration design
8	Providing certified data scientists and data analysts	Number of experts
9	Single license from data collection, data collection, modeling, to visualization.	Infrastructure design
10	Large data center capacity, as well as the best infrastructure	Data integration design
11	Availability of Data Visualization Dashboard	Web dashboard
12	Availability of telco insight data, social media, to e-commerce	Data integration design
13	The existence of NDA & User authority	Security

From Table 4 and Table 5, attribute mapping and technical response can be done to build HoQ. The HoQ formed is as shown in Figure 5. Customer requirements consist of the attributes in Table 4, while functional requirements consist of 5 technical responses according to Table 5. For customer requirements, a customer importance rating is performed with the lowest value being 1 and the highest being 4. Relationship between each attribute on customer requirements and each technical response on functional requirements is compiled to obtain a technical importance score. From the HoQ in Figure 5, we can arrange development priorities as in Table 6.

1: low, 4: high Customer importance rating	Customer Requirements - (What) ↓	Functional Requirements (How) →				
		Desain data integration	Desain infrastruktur	Jumlah expert	Security	Web dashboard
4	Data collection	9	9	1	1	9
4	Infrastruktur	3	9	3	3	3
3	Usecase	3		9	3	3
4	Safety	9	3	1	9	3
5	Penunjang produk			9		1
	Technical importance score	93	84	65	61	71
	Importance %	25%	22%	17%	16%	19%
	Priorities rank	1	2	4	5	3

Figure 5. Customer Requirement and Functional Requirement of HoQ

Table 6. Development Priority

Priority	Technical Response	Aspect	Functional Requirement
1	Data integration design	Technology	Data integration, processing, capacity, sources and security.
2	Infrastructure design	Technology	Complete infrastructure and single license.
3	Web dashboard	Technology	Data visualization dashboard.
4	Number of experts	Organization	Implementation assistance, data scientists and analysts.
5	Security	Risk	Non Disclosure Agreement (NDA) and User authority

1.1 IRL Measurement

The results obtained from the IRL measurement are listed in Table 7. IRL 1, IRL 2, and IRL 3, have a percentage of achievement greater than 80% (fulfilled), while IRL 4, IRL 5, and IRL 6 are below 80% (not fulfilled). Based on this, it can be concluded that the results of the IRL Innovation H Measurement are at IRL 3 or have matured in technology development.

Table 7. IRL Measurement of Innovation H

IRL	IRL 1	IRL 2	IRL 3	IRL 4	IRL 5	IRL 6
Value	108	99	94	82	82	29
Achievement	98,18%	94,29%	89,52%	74,55%	68,33%	41,43%
Status	fulfilled	fulfilled	fulfilled	Not fulfilled	Not fulfilled	Not fulfilled

1.1.1 Improvement For IRL 1-4

Innovation H is strong in the concept phase where the basic scientific principles of the innovation have been well observed and reported. Innovation H has not been supported by library facilities for learning facilities. In IRL 2, the components in Innovation H have been well developed and validated. The technological aspects have been well developed and documented. For the partnership, Innovation H cooperates with a subsidiary of the PT XYZ group to work together to utilize the existing infrastructure. Every time they submit a budget for development, Innovation H submits a JIB (Justification of Business Initials).

Chasm (IRL-4) is a phase that needs special attention from Innovation H. In general, the technology is ready to use, and planning documentation and procedures are prepared. However, one of the challenges that need to be resolved is to build market awareness and interest in technology products, so that technology products are widely adopted by the market. Innovation H already has a target consumer, to prepare the market positioning. Innovation H has not yet formed a formal company or organization, only as an R&D. Good Manufacturing Practice (GMP) has been carried out, but has not yet obtained a SNI certificate. Based on IRL measurements 1 to 4, several points for improvement were found in aspect technology (T), market (M), partnership (P), organization (O), manufacture (Mf), investment (I), and risk (R) as in Table 8.

Table 8. Improvement For IRL 1-4

No	Aspect	Improvement Effort
1	I	Complete business plan documents and market research.
2	I	Validate financial feasibility analysis on business operations.
3	I	Re-ensure that the products developed are in accordance with the preferences of all customer.
4	I	Making the results of the analysis of product acceptance identification in the market.
5	I	Conduct market research to estimate consumer absorption of the products offered.
6	Mf	Carry out Low Rate Initial Production (LRIP) to prepare for full-scale production.
7	Mf	Obtain a system design that is mostly stable through testing and evaluation.
8	Mf	Receive and optimally meet demands from consumers for the quality, and safety of the products.
9	Mf	Carry out quality assurance according to certain standards required to obtain a certificate.
10	Mf	Fulfill safety, quality, and legal requirements applied nationally and internationally.
11	M	Detailing the intellectual model, human capital, structural capital, and relationship capital.
12	M	Detailing the potential customer profile to ensure the product is focused on the customer needs.
13	M	Details the estimated price by product type in full.
14	M	Identify and analyze customer needs and expectations in more detail, and validate them.
15	M	Finalizing the marketing strategy so that it runs more effectively and gains added value.
16	M	Perform identification, analysis, and determination of competitors in a clear and detailed manner.
17	M	Implement factual market positioning analysis results for new products.
18	O	Improved library facilities for learning facilities and knowledge transfer.
19	O	Acquire sufficient numbers of key individuals and assigned in strategic positions.
20	O	Detailing the need for additional staff through the process of identification and evaluation.
21	O	Build partnerships with independent organizations that are formal and binding.

22	O	Forming a formal and legal business organization (not only at the R&D level).
23	P	Building a more appropriate partnership pattern in business development to achieve common goals.
24	P	Implement all agreed cooperation plans, and manage existing collaborations.
25	P	Conduct and utilize collaboration in dynamic networks (business group network).
26	R	Taking risk studies into consideration in every stage of technology development.
27	R	Validate the technology risk control plan at the technology application stage.
28	R	Validate the technology risk control plan at the engineering and operation stages.
29	R	Prepare and validate the social impact risk assessment at the product introduction stage.
30	R	Prepare and validate organizational risk studies at the stage of product introduction to the market.
31	R	Validate non-technological risk control plans at the stage of product introduction to the market.
32	T	Demonstrating success in terms of the acceptance of new products by the market.
33	T	Build market awareness and interest in technology products.
34	T	Conduct testing to obtain the key benefits of the new product.
35	T	Determine the general use of technology products by the broad market through the technical spec.

4.4.1 Improvement For IRL 5-6

In the changeover phase there are 2 choices for management, whether to reinnovate, or completely stop the innovation. For Innovation H, there are currently no signs of a saturated market as the characteristics of the emergence of competition and changeover phases. Innovation H in conducting technical, market, and other reviews was assisted by IDC. In general, Innovation H has not focused on the changeover phase. This is because big data products still have a chance in Indonesia, and their competitors are also still very minimal. With IDC data, there is an opportunity to forecast the market in the future. The Innovator uses the scrum method, including to align it with the market. Where currently the big data business is still relevant and it is not the time to pivot the business. Based on the measurements of IRL 5 and 6, several points for improvement were found in each aspect as in Table 9.

Table 9. Improvement For IRL 5 and IRL 6

No	Aspect	Improvement Effort
1	I	Increase production capacity based on market demand.
2	I	Identify and validate market expansion needs.
3	I	Identify advanced innovations as consideration for top management in decisions for re-invest.
4	Mf	Conduct product certification and institutional accreditation as a form of guarantee for the quality.
5	Mf	Implementing quality assurance according to standards (SNI) intensively as a tool for management.
6	Mf	Captures 360-degree internal and external input to management for performance improvement.
7	Mf	Implementing Lean Manufacturing, and has obtained benefits for companies and consumers.
8	Mf	Evaluating production performance to determine the need for development of new production tech.
9	M	Establish partnerships in various aspects from upstream to downstream with mutual benefits.
10	M	Verification and validation of business model improvements in almost saturated market.
11	M	Implement product differentiation strategy optimally.
12	M	Prepare after-sales service documents covering service locations, access, facilities, accountability.
13	M	Identify opportunities for market growth or new market expansion.

14	M	Taking the results of the market demand review for top management in decisions for re-innovation.
15	M	Making the results of market research analysis for top management to determine re-innovation.
16	M	Evaluate whether the market decline has occurred or not.
17	O	Reviewing technical and commercial processes to improve effectiveness and efficiency.
18	O	Identifying increased opportunities to meet technology products with market needs.
19	O	Carry out the necessary restructuring, starting with performance evaluation and improvements.
20	O	Continuously improve the effectiveness and cooperation of the organization.
21	O	Identify networks and there is a huge role to play in supporting Re-Innovation or Technology Dev.
22	O	The existence of the role of the organization in the form of real support form management.
23	P	Increase product distribution and marketing cooperation with partners.
24	P	Improving the quality of cooperation management that has been running with the principles.
25	P	Making efforts to increase cooperation in dynamic networks.
26	P	Identify potential partners to support Re-Innovation or New Technology Development.
27	P	Reviewing existing partnerships, and knowing the quality, advantages and disadvantages.
28	R	Prepare a social impact risk assessment at the market maturity stage.
29	R	Prepare an organizational risk assessment (especially financial) at the stage of market maturity.
30	R	Develop a non-technological risk control plan at the stage of market maturity.
31	R	Conduct risk assessments to support Re-Innovation or New Technology Development decisions
32	T	Carry out continuous development activities in an effort to answer customer complaints.
33	T	Providing spare parts supply for technology products, through after-sales service centers.
34	T	Provide after-sales service centers, both during warranty and post-warranty, in all major cities.
35	T	Provide a full official warranty as a consumer protection effort.
36	T	Reviewing options for re-innovating existing technology products, or developing new technology.
37	T	Conduct a review of the technological capabilities possessed to support re-innovation.
38	T	Conduct a review of the competitor's technology products.

5. CONCLUSION

From this research it can be concluded:

1. Selection of potential innovations with AHP based on the criteria KPI Achievement, cost, revenue, and risk resulting in Innovation H which is engaged in Big Data analytics business which has the highest score so that it is selected as the most potential innovation.
2. Customer segments in the value proposition canvas (VPC) can be used as a reference in determining the attributes in the QFD, where 5 attributes are obtained.
3. The value proposition on the value proposition canvas (VPC) can be used as a reference in determining the technical response in QFD, where 5 technical responses are obtained.
4. Based on the HoQ compiled, the first priority of technical development is data integration design, the second priority is infrastructure design, the third priority is the web dashboard, the fourth priority is the number of experts, and the fifth priority is security.
5. Based on the IRL measurement, it was found that Innovation H was at IRL 3 with an achievement rate in IRL 3 is 89.52% and achievement at IRL 4 is 74.55%.

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MARKET ORIENTED INDUSTRIAL SERVICES INNOVATION USING HYBRID QFD AND KANSEI ENGINEERING

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ABSTRACT

Industrial Gas Turbine Repair and Motor & Generator Overhaul is one of the business units in PT GMF Aeroasia, Tbk. This business unit is a derivative of aviation. With the large market potential and the decline in the aviation market due to the COVID-19 pandemic, this business is one of the company's hopes. With this, sales of these services need to be increased in order to help the company's business sustainability. Companies currently need to improve the quality of these services to increase sales and customer satisfaction.

This research was conducted at a business unit, namely Industrial Gas Turbine at the largest aircraft MRO company in Southeast Asia, PT GMF Aeroasia. The subject of this research is service design using the Kansei Engineering and Hybrid QFD methods. This approach is applied in order to improve customer service and satisfaction.

The research method begins with determining the performance of service attributes based on service quality elements, then followed by evaluating service gaps between perceived service and expected service, determining the kansei score and evaluating Kano on one dimensional and attractive attributes. After obtaining the importance weight, the design process is continued with HoQ. This study recommends new service innovation the company can apply to increase sales.

Keywords: Kansei Engineering, Hybrid QFD, Service Innovation

1. INTRODUCTION

With large market potential on industrial gas turbine and power generation area, it is tight competitive too. Beside of that, aviation service already disturbed due to COVID-19 pandemic since 2020, so PT GMF AeroAsia Tbk. as aviation service was very depressed. In line with the pandemic, corporation depend on non aviation businesses, one of them is Industrial Gas Turbine Repair dan Motor & Generator Overhaul. Because of that, the sales need to be escalated for supporting corporation existence. Corporation need service quality enhancement in order to escalate sales and customer's satisfaction. On other side, if COVID-19 pandemic is over, this business still needs enhancement in order to maintain service diversification and decrease dependence on PT Garuda Indonesia Tbk.

In this research focus on identify customer priority needs, services quality compared to competitors, priority improvement and appropriate innovation which help service quality improvement. Services scope is power services on motor generator and industrial gas turbine repair.

Hopefully, this research output could help corporation to determine appropriate policy so as improve service quality and get sales escalated well. Moreover, help employees find their service standard based on customer's satisfaction.

Service quality affect customer satisfaction, Ravichandran (2010). The assessment of service quality can be performed by investigating the gap between perceived quality and customer expectation . through a research tool known as SERVQUAL SERVQUAL as model with some items that determine service quality as degree and direction between perception and customer expectation (Berry,1985). SERVQUAL divide service to 10 items with 5 classification that are tangibles reliability responsiveness, assurance and empathy. SERQUAL model identify the reasons of discrepancy between perception and customer's expectation called GAP. This gap will lead us to measure service quality level.

Nowadays, customer needs more customer-oriented service quality improvement that fit with their behaviour, Nagamachi (2007). We need method that capable to solve this matter, that is Kansei Engineering (KE). KE is technology which translate customer need to specific design, Nagamachi (2011). KE able to understand customer need, analyzed it by using statistical method and transfer it so specific design both service and product. KE can be strengthened and extended by incorporating potential quality tools, such as the Kano model and QFD, Chen (2015). Kano is created model by classifying attributes based on how well services could satisfy customer need. Attributes are categorized as one dimensional , attractive and must be dimension. While QFD will finalize the weighted, prioritized service attributes. Quality Function Deployment (QFD) known as service quality improvement method on design, service and process, Mazur (2014). This method use survey, focus group discussion, statistic pattern and others as tools. QFD provide structural methodology called House of Quality (HoQ).

Thus, the objective of this research is to improve service quality of GMF industrial gas turbine repair and motor & generator overhaul service by using KE, Kano and QFD concepts. All data gathered by using interview and forum group discussion with GMF customers which interacted on last 12 month.

2. LITERATURE REVIEW KE Service

Nagamachi invented KE method at Hiroshima (1970) as customer's-oriented service improvement method. Now, there 3 types of KE are type I, II, III, IV, V and VI. Each type is improved model from previous model. There are 3 main point of KE, how to understand customer accurately, how reflect and translate it to service design, and how to build system and organization for Kansei oriented design. Recent KE research, more efficient approach is an extended model of KE, intended to solve potential contradiction in solutions, Hartono (2016)

KANO

The attributes of Kano are must be requirement, one dimensional requirement and attractive requirement. On must be requirement (M), customer never satisfied on both performance low and high. Customer thought the service is standard and must be performed. On one dimensional requirement (O), customer satisfaction is linear with service performance. And on attractive requirement (A), customer satisfaction is not decrease even performance is lowering.

Beside of 3 main attributes, there are 2 attributes that can be identified. These attributes are indifferent requirement (I) and reversal requirement (R).

Advantage obtained by classifying customer need with Kano model are service improvement priority and significant service terms well identified, customer satisfaction kano model could be combined with deployment quality optimally, solve problem in trade off situation of service

improvement, and Kano attributes could penetrate on diverse customer, Hinterhuber (1996)

QFD

QFD found on 1960 at Japan for serving design process of big ships. Recently, QFD is applied on industry that interpreted as systematic process for understanding customer's need and translate it to process transformation that involve supply chain (sourcing, purchasing, operations, warehousing, distribution, logistic, support and after sales service, Mazur (2003). QFD finalize the weighted and priorities service which produce customer satisfaction ratio, goal and improvement ratio, sales point, raw weight, normalized raw weight, technical attribute and technical evaluation. These product help us to view improvement service quality highlight

3. METHODS

This research begins with literature review and field study to gather reliable data. Use descriptive analysis method with primary and secondary data analysis. Gather data by interview and forum group discussion with GMF customer. Focus on hybrid QFD analysis. Describe customer satisfaction by using kano model, finalized weight with QFD and translate it to service design using KE.

This research utilized a modified SERVQUAL as service domain with 14-service attributes which are deployed into five dimensions (tangible, responsiveness, reliability, empathy, and assurance). For example, "*Customer waiting room is comfortable*", "*Services finished on time*", "*Staff respond customer quickly*". Using Likert scale that range from "1=strongly disagree" to "5= strongly agree" for measure customer perception for each attribute.

There were 14 kansei words which are related to the attributes. Using Likert scale that range from "1=strongly unrelated" to "5= strongly related" for measuring relation kansei words with the attributes.

Service quality gap for obtaining perceived score and expected score deployed as questioner. And using Likert scale from "1= very low" to "5=very high". Service gap is formulated as perceived value minus expected value.

Kano model evaluated both functional and dis-functional questioner question. Using Likert scale that range from "1=unsatisfied" to "5= satisfied". The result combined on kano evaluation table and classified into six kano attributes.

Importance level of service measured importance level and implementation level. Using Likert scale that range from "1= very low to "5= very high".

Data validation is tested by using Minitab 19 for Windows which compare value of r calculation with r table. If r calculation is higher than r table and value is positive, so the gathered data are valid, Ghazali (2001). And data reliability is tested by using Cronbach's Alpha calculation. A variable or data is reliable when Cronbach's Alpha result is higher than 0.6.

Amount of response is 50 person which are interacted with GMF on last 12 month with 10% tolerance. So, total gathered response are 33 persons.

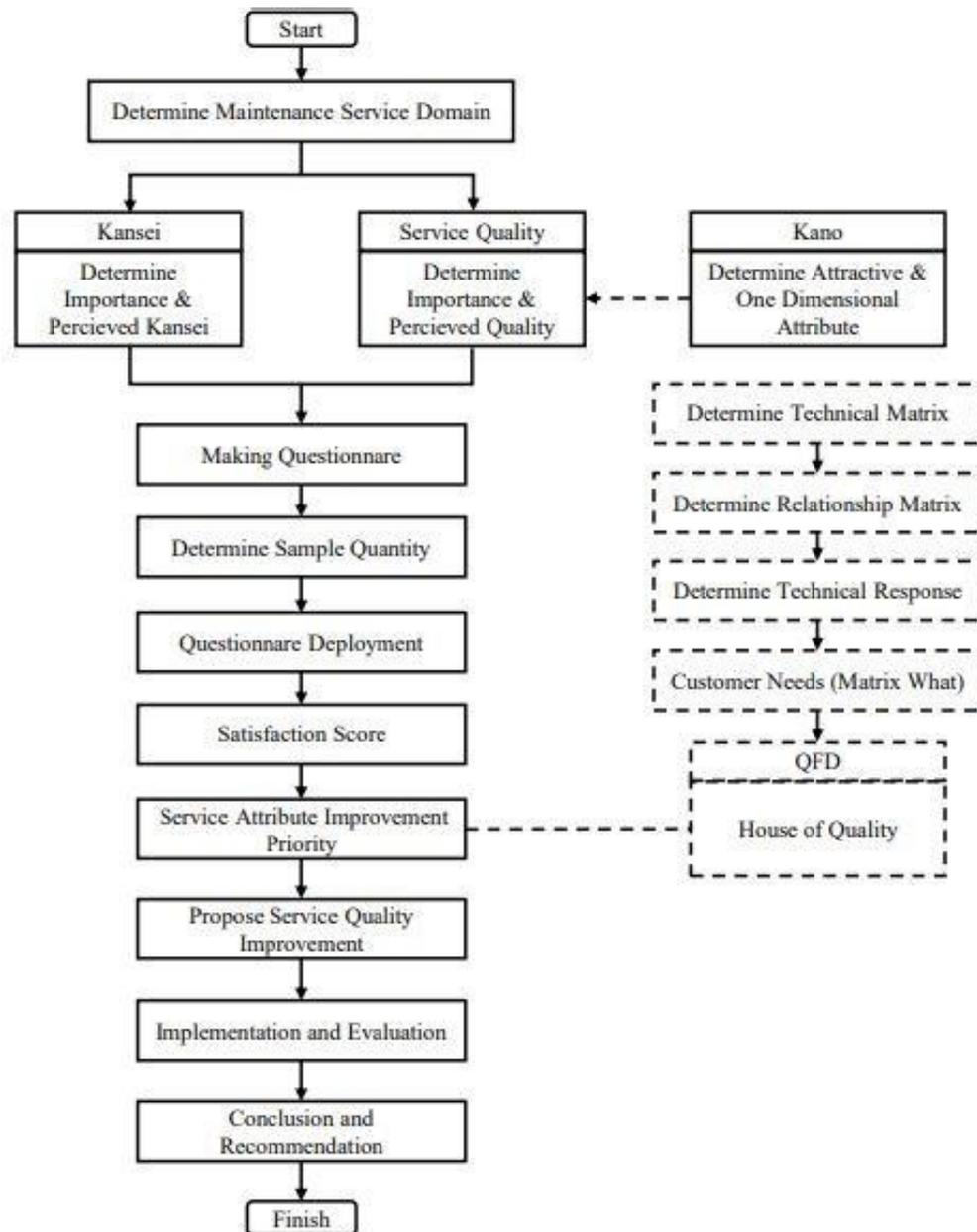


Figure 1. Flowchart Research

4. RESULTS

Most of kansei attributes have minus gap value see table1. It means that these attributes need improvement to reach the corporate goals as soon as possible. Top 3 kansei attributes that under customer expectation are workshop facility, on time performance and respond. Meanwhile, just 2 attributes are over customer expectation, they are comfortable of waiting room and how staff explain the service.

Table 1. Service Gap Evaluation

No	Kansei Attribute	Perceived (Mean)	Expected (Mean)	Gap (Perc-Exp)
1	Customer waiting room is comfortable	4.12	3.88	0.24
2	Workshop is clean and neat	4.03	4.30	(0.27)
3	Workshop facilities are modern, complete, and well maintained	2.85	4.24	(1.39)
4	Marketing or production staff appearance is convinced	4.09	4.21	(0.12)
5	Repair or service on time performed	3.15	4.52	(1.36)
6	Documentations or reports are accurate and complete	4.36	4.52	(0.15)
7	Administration documents are complete	4.21	4.39	(0.18)
8	Repair or service quality as corresponding as customer need	4.45	4.70	(0.24)
9	Cost is proportionate with service	4.30	4.42	(0.12)
10	Staff always support the customer problem	4.21	4.48	(0.27)
11	Staff give response quickly	3.21	4.39	(1.18)
12	Staff explain the detailed service completely	4.27	4.21	0.06
13	GMF staff has knowledge and ability to work and support the customer	4.45	4.48	(0.03)
14	GMF staff and management concern on customer need	4.12	4.39	(0.27)

Table 2 show level of importance of customer needs. Main concern of customer is repair or service quality (score 6.09). Second is staff response (score 5.9), there are 3 attributes with same score 5.78. They are staff support, workshop facility, cost, and on time performance.

Table 2. Attribute Importance Evaluation

No	Kansei Attribute	SP	P	TP	STP	Score
1	Customer waiting room is comfortable	9	19	5	0	5.24
2	Workshop is clean and neat	13	15	5	0	5.48
3	Workshop facilities are modern, complete and well maintained	14	18	1	0	5.78
4	Marketing or production staff appearance is convinced	9	19	5	0	5.24
5	Repair or service on time performed	14	18	1	0	5.78
6	Documentations or reports are accurate and complete	10	23	0	0	5.60
7	Administration documents are complete	12	16	5	0	5.42
8	Repair or service quality as corresponding as customer need	18	15	0	0	6.09
9	Cost is proportionate with service	15	16	2	0	5.78
10	Staff always support the customer problem	14	18	1	0	5.78
11	Staff give response quickly	15	18	0	0	5.90
12	Staff explain the detailed service completely	13	19	1	0	5.72
13	GMF staff has knowledge and ability to work and support the customer	12	19	2	0	5.60
14	GMF staff and management concern on customer need	10	21	2	0	5.48

Table 3 show priority of attribute based on its importance weight as result satisfaction, kano and kansei score. First priority is workshop facility with score 212.03. Second priority is on time performance with score 103.71. And third priority is staff appearance.

Table 3. Importance Weight each Attribute

No	Kansei Attribute	Attribute	Satisfaction Score	Kano Weight	Kanse i Score	Importanc e Weight
1	Customer waiting room is comfortable	A1	1.27	4	3.3	16.78

2	Workshop facilities are modern, complete, and well maintained	A3	8.07	2	13.14	212.03
3	Marketing or production staff appearance is convinced	A4	0.64	4	19.83	50.40
4	Repair or service on time performed	A5	7.89	2	6.57	103.71
5	Repair or service quality as corresponding as customer need	A8	1.48	2	11.46	33.84
6	Cost is proportionate with service	A9	0.70	4	6.54	18.35
7	GMF staff has knowledge and ability to work and support the customer	A13	0.17	4	7.09	4.82
8	GMF staff and management concern on customer need	A14	1.50	4	6.51	38.95

Based on QFD analysis, GMF has strength and weakness compared with the competitors. 3 main strengths are staff knowledge, staff support and how staff explain the service. Meanwhile, 3 main weakness are workshop facility, on time performing and staff response.

Beside of benchmarking, importance items as result of QFD analysis is technical response priority. Table 4 show priority of technical responses after QFD weight calculation. Main priority technical response is about workshop facilities both completing and new development. Second is work delivery correspondent with contract or purchase order and the third is on time performance proportionate with cost.

Table 4. Technical Responses Priority

No	Attribut e	Weight	%
1	Completing facility for surface treatment, welding, electrical and mechanical test	1908.23	18.66
2	New development facility for surface treatment, welding, electrical and mechanical test	1908.23	18.66
3	Develop maintenance system and calibration for controlled and documented facility	1908.23	18.66
4	Work delivery correspondent with contract or purchase order	933.37	9.13
5	On time performance proportionate with cost	476.30	4.66
6	Marketing appearance representatively	453.63	4.44
7	Production uniform representatively, complete safety device, clean and well maintained	453.63	4.44
8	Customer accommodation is fulfilled well during cooperate with GMF, such as hotel, entertainment, and transportation	350.57	3.43
9	Repair corresponding with work scope and comply testing repair parameters	304.59	2.98
10	Repairs comply minimum determined running hours	304.59	2.98
11	Maintenance quality proportionate with cost	266.71	2.61
12	Work warranties proportionate with cost	165.18	1.62
13	Standard cost of GMF services is stated well	165.18	1.62
14	Waiting or meeting rooms are facilitated well such as chair, table, TV, AC and foods.	150.98	1.48
15	Facilities are clean and maintained well	150.98	1.48
16	Waiting or meeting room appropriate COVID-19 protocols	150.98	1.48
17	GMF staff has knowledge appropriate with project or capability	43.36	0.42
18	GMF staff has experiences and skills appropriate with project and capability	43.36	0.42
19	GMF staff respond and support the customer need	43.36	0.42

Attribute		Importance Weight	HOWS											
A1	Ruang tunggu / meeting untuk customer nyaman	16.78												
A3	Fasilitas workshop modern, lengkap dan terpelihara	212.03												
A4	Penampilan karyawan produksi / marketing meyakinkan	50.40												
A5	Perbaikan / jasa selesai pada waktu yang disepakati	103.71			3									
A8	Hasil perbaikan / jasa berkualitas, sesuai pesanan	33.84	9	3										
A9	Biaya yang dikeluarkan sebanding dengan jasa yang didapatkan	18.35		9	9	9	9							
A13	Karyawan GMF memiliki pengetahuan dan kemampuan untuk bekerja dan membantu pelanggan	4.82						9	9	9	9			
A14	Karyawan dan perusahaan GMF memperhatikan kebutuhan customer secara individu	38.95												9
Total Weight			304.6	266.7	416.3	195.2	195.2	43.4	43.4	43.4	43.4			330.6
Percentage			29.8%	26.1%	40.6%	19.6%	19.6%	4.2%	4.2%	4.2%	4.2%			34.3%

All attributes priority were identified well. So, innovations and programs for improving service quality could be determined. There are some ideas about it. Do investment on welding, surface treatment, and bench test especially electrical and mechanical test. Create maintenance system and calibration apps for monitoring and documenting facilities correspond with ISO. Review internal processes for improving

delivery time such as supply chain, project management optimization, and production process. Designing staff development based on customer service excellent and service standard in order to serve the customer properly. Completing safety devices for production staff. Do review of work instruction and quality check based on manual parameters. And the last is reviewing service pricelist compares to the competitors.

CONCLUSIONS

Most of GMF services are below customer expectation, it is big challenge for improving service quality. Intermediate and long terms improvement program shall be planned based on importance priority carefully. Project management shall be controlled as tools to help GMF projects, in the end of service could be delivered correspond with the customer needs. Few research examines GMF service quality especially on power services. Customer survey and other research should be made periodically in order to view what exactly customer needs. Because of customer needs always change by time.

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APPLICATION OF BALANCED SCORECARD (BSC) AND STRESS TESTING METHOD FOR STRATEGY FORMULATION IN MAINTAINING BUSINESS SUSTAINABILITY OF PT XYZ (PERSERO)

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ABSTRACT

The industrial revolution encourages radical changes in all living systems, including the electricity system which is increasingly complex with various business model innovations, technology and regulatory shifts that have developed very rapidly. PT XYZ (Persero) as a State-Owned Enterprise (BUMN) that is fully responsible for the generation, transmission and distribution system of electric energy in Indonesia, is facing increasing challenges in lighting up the Nation. These challenges arise not only from internal but also external to the company, both in terms of business and company operations, as well as technological developments and changes in regulations or government policies. In an effort to face challenges and maintain the sustainability of the company's business, it is necessary to have synergy from the government and management in formulating and implementing business development strategies, relying on a comprehensive and structured analysis of company performance. This study consists of analyzing company performance using secondary data obtained from statistical reports, Annual Reports, Sustainability Reports, Electricity Supply Business Plans (RUPTL) using the Balanced Scorecard (BSC) framework and strengthened by stress testing methods to assess the company's performance from four perspectives (Financial Perspective, Customer Perspective, Internal Business Process Perspective and Learn & Growth Perspective). The results of this study are expected to provide an overview of key strategic issues and critical factors that affect company performance as well as proposed solutions / strategies for corporate business development.

Keywords: Performance Assessment Balanced Scorecard, Stress Testing Method, Financial Distress, Strategy Formulation, Sustainability Balanced Scorecard, Sustainability Business

1. INTRODUCTION

Nowadays, electrical energy has become a primary need in people's lives and industry, even the growth and distribution of electrical energy has become a symbol of the resilience and success of a country. Electric power that has reliable, smart, responsive to the flexibility of consumer demand, widely distributed, integrated with digital systems & platforms, safe and has a guarantee of environmental sustainability is the key success factor in developing future electricity business, amid the global trend of decarbonization, decentralization, digitalization, electrification, smart grid, smart technology, and producer-consumer (prosumer). In the midst of global challenges, PT XYZ (Persero) as one of the state-owned enterprises assigned to operate and manage the entire process of generating and distributing electrical energy in Indonesia faces various challenges in the development of operations and business.

These challenges consist of

- 1) Uncertain electricity system development policy, 2) Take or pay policy on power purchase agreement with IPP which burdens the company's financial performance, 3) The limitation of state budget to support the company's operations and business development, including the settlement of government receivables for electricity subsidies, 4) The efficiency and reliability of electricity system are not sufficient to meet customer expectations yet, 5) Excess power from the electricity production process itself and the purchase / lease of IPP electricity that has not been absorbed in the market, 6) Until 2019, the company relies heavily on electricity sales (97% of total revenue),
- 7) Company financial mismatch due to lower revenue operating expenses, interest & other financial expenses because of Dollar domination in expenses, 8) Determination of the basic electricity tariff determined by the government, 9) The potential for decreasing company's credit rating which will affect the ease of funding / investment, 10) Downward trend in electricity demand and purchase since 2014, due to the weakening nation's economy, 11) Development of disruptive technology in the electricity sector, and 12) Development trend of renewable energy.

As one of the most strategic state-owned enterprises, the company needs to improve in improving the company's operational, business and financial performance continuously and needs to create company's strategy that is more relevant to current and future condition.

2. LITERATURE REVIEW

This stage describes the theories of various related literatures as the basis of writing

2.1 Sustainability business, business analysis, business strategy, business model

Elkington (1997) sparked a triple line of business with 3 main aspects, namely profit, people and planet, so that in order to remain sustainable, companies have an obligation to pursue profits, be involved in fulfilling community welfare (people) and actively contribute in preserving the environment (planet). In addition to this, in order to maintain business continuity, it is necessary to carry out business analysis, preparation and adjustment of strategies and business models according to the results of the analysis. Business analysis is a strategic process that includes an analysis of the company's external and internal (M.E. Porter, 1985) with the order of external analysis, internal analysis, external opportunities and threats, internal strengths and weaknesses, identification of key strategic issues, evaluation of options and selection of strategy, implementation and management of the chosen strategy, monitoring and giving feedback continuously.

2.2 Financial statement analysis & Financial Distress

Financial statement analysis is a series of analytical processes to determine the financial position and performance as well as the business results of a business entity in a structured manner based on a certain time span, (Harahap, 2015). Financial Distress is a phenomenon that shows a downward trend in financial performance in a certain period and is one of the early indicators before bankruptcy occurs. According to Brahmana (2007), the Financial Distress indicator is indicated by the presence of negative numbers in the statements of operating profit, net income and book value of equity which is usually followed by corporate action by conducting a merger. In line with this, Hanifah (2013) revealed that an indicator of a company experiencing Financial Distress is the existence of a liquidity crisis trend, which can be viewed from the company's inability to meet obligations (debts) and existing costs.

2.3 Risk

Risk is a hazard or consequence that can occur as a result of an ongoing process or unpredictable future event and will cause a loss for the company (Chofaras, 2007), so it is necessary to make various efforts to minimize and eliminate potential losses that can interfere with business activities. , by creating an ecosystem capable of measuring, monitoring and mitigating the company's potential risks (Best, 1998). In general, risk is divided into business risk, strategic risk and financial risk (Jorion, 1997). Business risk is the risk that arises due to the quality and competitive advantage of several products owned by competing

companies. Strategic risk is a risk that arises due to failure to anticipate fundamental changes in the economic, political, social or business ecosystem as well as inaccuracies in the process of making or implementing strategic decisions. Financial risk is divided into several categories such as market risk, credit risk, liquidity risk, operational risk, legal & regulatory risk and human factor risk. All risk categories can cause financial losses for the company (Crouchy, 2001), but in relation to the business run by PT XYZ, this thesis focuses on discussing market risk (due to changes in macro & micro economy) and corporate liquidity risk due to operational risks and the dynamics of the role of the state.

2.4 Value at Risk

VaR is a method for calculating the estimated maximum loss that may occur on an asset by considering changes in risk factors in a certain period and level of confidence in normal market conditions. VaR value can be calculated using local valuation and full valuation methods. The local valuation method is carried out by valuing the portfolio only at the initial position, but risk measurement using the full valuation method is carried out by recalculating the portfolio on a scenario scale. Furthermore, the VaR value is determined using the percentile distribution (Jorion, 2007). The calculation of the VaR value is carried out using the variance-covariance method, the Monte Carlo simulation and the historical simulation. These methods begin with determining risk factors.

2.5 Stress Testing

Litterman (1996) states that stress testing is a method for generating a full revaluation estimate of a company's portfolio under a selected scenario based on a series of critical factor movements that have occurred in the past (historical stress test) or based on estimates of the movement of critical factors in the future. (prospective stress test).

2.6 Balanced Scorecard (BSC)

BSC is used to implement and manage the planned strategy. The BSC sets and measures the targets and achievements of the strategic initiative. The BSC was first introduced by Kaplan and Norton in 1992 through an article in the Harvard Business Review, based on the premise that believes performance improvement can be realized when the company plans, measures, monitors and evaluates the financial and non-financial aspects of the company continuously so that support the achievement of the company's vision. The measurement is divided into four perspectives, namely Financial, Customer/Stakeholder, Internal Business Process, Learn & Growth.

3. METHODS

This research has flow research as 1) Study Literature, 2) Problem Formulation & Methodology, 3a) Internal Analysis, 3b) External Analysis, 4) Key Strategic Issue's Identification, 5a) Risk Identification through Event Driven Approach, 5b) Risk Identification through Event Driven Approach, 6) Crucial & Critical Stress Factor Identification, 7) Stress Testing Analysis, 7) Result Analysis, 8). Formulation of Strategy Proposal and 9) Conclusion & Suggestion.

4. RESULTS

4.1 Macro and Micro External Analysis

4.1.1 Macro External Environment Analysis

a. Political Analysis

Strengthening the capital and financial structure of PT XYZ (Persero), is still very dependent on State Equity Participation (PMN) which is strongly influenced by the negotiation and political process to get the approval of the House of Representatives (DPR). This provides uncertainty regarding the amount and timing of PMN disbursement. In addition, the amount of electricity subsidies in the APBN is also very dependent on government policies in determining the amount of the Basic Electricity Tariff (TDL). This has always been an important issue in the dynamics of national politics.

b. Economical Analysis

The health crisis and the unpredictable timing of the Covid-19 pandemic recovery have the potential to cause economic activity to continue to decline and almost all economic sectors to a halt, especially in the manufacturing, construction and trade, wholesale & retail sectors.

c. Social Analysis

Constraints in the process of building and developing electricity infrastructure are closely related to the licensing process, land acquisition, environmental issues and the rejection from the community due to asymmetric information circulating in the community. The complexity and time of completion of the licensing process, which tends to be long, has hampered efforts to accelerate the development of electricity infrastructure.

d. Technological Analysis

The potential application of Big Data Analytics, Internet of Things (IoT) and smartgrid on energy management systems, distribution management systems and asset management systems in an integrated manner provides an opportunity for PT XYZ (Persero) to reduce Operational Expenditure (OPEX), improve performance and efficiency of plant operations, transmission and distribution to the end customer. These potentials need to be immediately presented in the daily operation & maintenance process and supported by the preparation of HR competencies that are in line with technological developments so that the sustainability of PT XYZ (Persero)'s business and operations is timeless.

e. Environmental Analysis The development, operation and management of electricity installations are closely related to issues and regulations related to environmental sustainability. As regulated in several regulations such as Law No. 32 of 2009, PP No. 61 of 2011, PP No. 27 of 2012, Minister of Environment Regulation No. 17 of 2012, Minister of Environment Regulation No. 8 of 2013, Minister of Environment Regulation No. 3 of 2013, poses a significant challenge. in the process and documents of licensing, reporting and environmental audits.

f. Legal The issuance of several government regulations that have the potential to hinder PT XYZ (Persero)'s business development efforts and threaten national electricity sovereignty.

4.1.2 Micro External Environment Analysis Competitive Rivalry Competition

There is no potential for a “price war” because retail tariffs are regulated directly by the government, (ii). There is still a lack of product and service differentiation (currently only the supply and maintenance of electricity for end consumers) and (iii). There are no big and integrated “players” other than PT XYZ. This makes PT XYZ still have strong competitive advantages and competitive rivalry. In accordance with the description, it can be said that the threat from new entrants is still in the low category.

Bargaining Power of Supplier

Based on data from the Annual Report & Sustainability Report of PT XYZ from 2008 to d. 2019, it was found that the purchase of primary energy and the purchase of electrical energy from IPP occupy the two highest positions in the operating expense structure of PT XYZ, with an average amount of 54% and 16%, respectively. This fact shows that primary energy suppliers and IPPs have bargaining power and a strong influence on PT XYZ's business and finances.

Bargaining Power of Customer

The customer/consumer is a key success factor in the electricity business. The growth in the number of customers and the shift in electricity consumption behavior have a vital role that can change the landscape and business model of the electricity industry. Moreover, the Indonesian economy is predicted to continue to grow and the national electrification ratio has not yet reached 100% so that the opportunity to increase the number of customers is still very open for PT XYZ. The development of business models, products and services based on the dynamic needs, desires and increasing added value for customers should be the focus of the company in developing its business. Although currently customers/consumers have no choice but to buy electricity from PT XYZ, the development of new technology and regulatory support from the government (through Minister of Energy and Mineral Resources Regulation No. 49 of 2018 concerning the Use of Rooftop Solar Power Generation System (PLTS) by PT XYZ Consumers) which

allows PT XYZ customers to provide electricity independently or from other sources and can sell excess power to PT XYZ and switch from PT XYZ services. In addition, until now, most of the customers/consumers are represented by the Government and the DPR or DPRD which have a vital role in the development of electricity and PT XYZ's business sustainability. These things increase the bargaining power of customers on the Porter's Five Force map. Based on this explanation, it can be said that the bargaining power of customers is in the high category.

Threat of New Entrants

The high entry barriers to the Indonesian electricity industry due to the highly regulated nature of the electricity business (especially related to tariffs), requiring large capital support, the absence of technical rules for implementing power wheeling or sharing electricity grids (PJBT), making the two threats considered insignificant. affect PT XYZ's business, it's just that these two things still have to be watched out because they have the potential to erode PT XYZ's market share and income in the future. In accordance with the description above, it can be concluded that the threat from newcomers is in the low category.

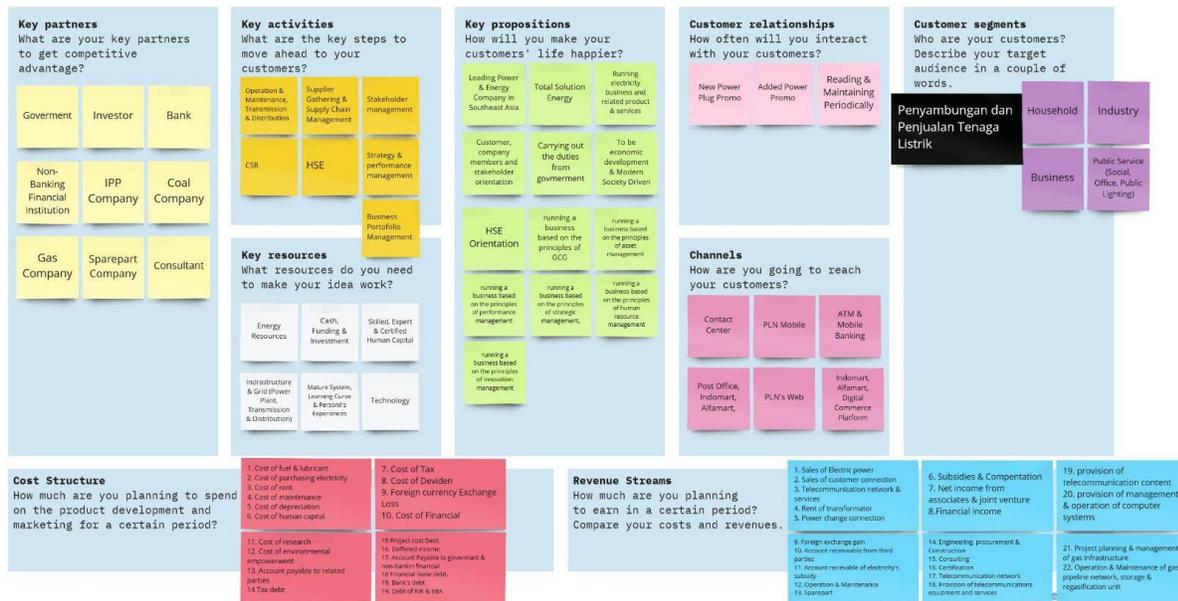
Threat of Substitutes

The development of substitute products is driven by the presence of power plants with the latest technology, the development of more economical NRE technology, the development of energy storage technology, the large opportunities for implementing distributed generation systems and smart grids, the development of urban gas pipelines that provide opportunities for the industrial and business sectors to develop captive power sourced from from gas and technology that enables customers to meet their needs and sell electricity to PT XYZ. Although the potential for the development of substitute products and services has become a necessity, its application in Indonesia is still very limited because several adjustments are needed in its implementation. This can pose a significant threat to the sustainability of PT XYZ's business in the future. Therefore, the threat of substitute products is in the middle / moderate category.

4.2 Internal Analysis



4.3 Business Model Analysis



Along with technological developments, increasingly complex customer needs & demands, global trends that can change the landscape of the electricity industry, as well as existing business models that burden the company's financial performance, PT PT XYZ (Peserto) should build and implement a new business model that is more relevant. , by considering: 1. Growing the electricity business by focusing on customer satisfaction and the fulfillment of products and customer services at a more efficient cost. 2. Cultivate and develop new initiatives in business development, products and services that can increase revenue, provided that: a. Targeting markets that have the potential to grow, but are not well served, as various global trends emerge. For example: Health, sustainability and environmental sustainability will be big trends that are very interesting to work on considering the lack of players involved. In this case, PT XYZ can play a role in (i). Development and implementation of electrical energy with more resources (other than fossil energy and EBT), reliable, cheap and easy to obtain and distribute, (ii). The trend of NRE growth, which urgently needs climate and weather certainty in Indonesia, encourages the need for the climate and weather engineering business industry, (iii). The widespread use of batteries for storage and electric vehicles provides great opportunities for the battery waste treatment industry and carbon dioxide capture technology. b. This market can be increased to significant growth and support the company's business growth. c. Improve the ability of PT XYZ in providing differentiation to various customers in the market. d. Targeting the international market to generate revenue in the form of dollars, so as to be able to help minimize miss match on the company's financial performance.

4.5 Company position and strategic alternatives

1. Strength

- Until now, PT XYZ is the only company engaged in the integrated electricity sector, starting from primary energy, generation, transmission, distribution and supporting services.
- PT XYZ has become a generic brand for electricity in Indonesia.
- PT XYZ has a centralized customer service system that can serve customers 24 hours a day.
- Until now, the Government is still the main shareholder of PT XYZ, so the company still gets protection and support from the government for investment and operational risks.
- PT XYZ has an electricity network that is distributed in almost all parts of Indonesia.
- PT XYZ has information on customer data and networks (location, capacity and type of network) spread throughout Indonesia.

- g. PT XYZ employees have expertise and experience in integrated electricity and customer service with more than 70 years of experience, so that PT XYZ has a more mature learning curve and competence compared to newcomers.
- h. PT XYZ's market share is spread in almost all parts of Indonesia, so it is not easy for new entrants to compete.
- i. PT XYZ gets priority in the management of electricity business areas throughout Indonesia.
- j. PT XYZ as a single off taker has a decisive strategic position in the Indonesian electricity industry.
- k. Proportion of the average age of employees who are starting to be dominated by young employees

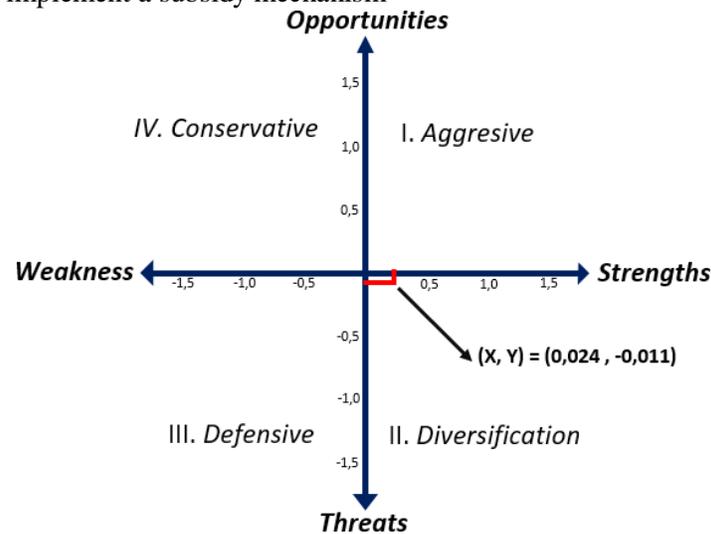
2. Weakness

- a. PT XYZ is a company with a wide and wide organizational distribution, so it affects the quality and speed of decision making due to the work system or coordination between units being not optimal.
- b. PT XYZ does not yet have an integrated business system and platform in anticipation of disruptive technologies & business.
- c. Customer service standards and the resulting products have not been able to accommodate various types of customer needs.
- d. There is still a competency gap between senior employees and junior employees, so that a system of competency development, career and regeneration as well as knowledge management is needed to be maximized.
- e. Most of the power plants owned are old with low efficiency levels, so they have the potential to be replaced by IPP plants with better efficiency levels and the latest technology.
- f. Stakeholder and regulatory management have not been implemented optimally.
- g. The structure of tariffs and models as well as the amount of subsidies imposed by the government to date are still burdensome for PT XYZ, thus making PT XYZ not have sufficient capacity to meet investment and business development needs.
- h. The management of business portfolios and subsidiaries as well as affiliated companies is not optimal, as indicated by the absence of standard guidelines on business portfolio governance and subsidiaries and affiliated companies.
- i. The construction management system and project funding at PT XYZ are still not optimal, as evidenced by the delay in project completion due to delays in disbursing funds.
- j. Bound by laws, regulations, policies and assignments imposed by the government, so it is not easy to run or develop PT XYZ's business
- k. Fluctuations in the Rupiah exchange rate and the increasing proportion of loans in foreign currency (foreign currency) make PT XYZ's financial structure more vulnerable to foreign exchange rates.
- l. The system for evaluating the performance and potential of the company in the future for potential customers, especially those from the business and industrial sectors, has not been carried out optimally. This is evidenced by the fact that there are still companies that are closed due to non-optimal business operations, when PT XYZ has built a system and electricity network for the company. This makes PT XYZ lose money.

3. Opportunity

- a. Indonesia's population growth, the level of electricity consumption per capita is still low, the electrification ratio has not yet reached 100% and the opportunity for Indonesia's economic growth is still very possible to provide market opportunities for PT XYZ.
- b. The availability of many renewable energy sources in Indonesia provides an opportunity for PT XYZ to develop future sources of electrical energy
- c. The development of big data technology, internet of things, smart grid, EBT, artificial intelligence, virtual power plant to increase efficiency, supply and service quality provides opportunities and potential for new business development for PT XYZ.

- d. Increased utilization of PT XYZ's assets to provide added value and revenue streams for PT XYZ.
- e. Development of a new business model in the provision of electricity based on a 2-party agreement (B2B or G2G) that can provide benefits for PT XYZ.
- f. The limited ability of the state budget to provide subsidies presents an opportunity for PT XYZ to restructure tariffs and implement a subsidy mechanism



Based on the figure, it is known that PT XYZ's position is currently in the second quadrant so that the company needs to develop and expand its business by diversifying through product development, services and business models that can be accepted by various types of customers.

4.6 Key Strategic Issues

- a. The development of the capacity and capability of the electricity system throughout Indonesia which is carried out efficiently and effectively by considering operational reliability.
- b. Security of primary energy supply (gas, coal) that can be fulfilled on time and of the best quality to maintain the economic life of the electricity system, especially power generation.
- c. Efficiency and reliability of operational processes to support the fulfillment of economical and sustainable electrical energy.
- d. Financial capability and independence so that the company is able to grow and develop sustainably.
- e. Readiness of the organization, technology and human resources to operate all current and future business processes.
- f. Strengthening regulatory, stakeholder and shareholder management functions to ensure the company's business sustainability.
- g. Trends in system development, governance and technology for electricity systems that are more environmentally friendly, decentralized with smart eco electric systems.
- h. The development of prosumer trends with the support of policies, technology and affordable economic values.
- i. Power purchase agreement contract with the TOP scheme which burdens the company's financial performance.
- j. Primary energy scarcity and rising primary energy prices.
- k. Optimizing structured, measurable and systematic business portfolio procedures, mechanisms and governance

4.7 Critical & Crucial Stress Factor

- a. Increased consumption of electricity kWh per capita (X10), the Fed's reference rate (X9), the exchange rate of Rupiah – US Dollar (X1), the number of new customers (X15), Gross Domestic Product/GDP (X5),

income per capita (X6), the number of national customers (X14), network losses (X13), energy sold (X12) energy production (X11) will simultaneously increase the company's revenue (Y1).

b. The number of new customers (X15) will affect interest and finance expenses (Y2).

c. Increasing electricity consumption Kwh per capita (X10), LNG price per metric ton (X3), oil price per barrel (X4), number of new customers (X15) and subsidies & compensation (X16) will increase the fuel load (Y3).

d. Increase in the Fed's reference interest rate (X9), electricity consumption Kwh per capita (X10), Rupiah – US Dollar exchange rate (X1), Gross Domestic Product/GDP (X5), income per capita (X6), number of national customers (X14), grid losses (X13), energy sold (X12) and energy production (X11) will increase the burden of purchasing electricity & rent (Y4).

e. An increase in the Fed's benchmark interest rate (X9), electricity consumption Kwh per capita (X10), the exchange rate of Rupiah – US Dollar (X1), the number of new customers (X15), Gross Domestic Product/GDP (X5), income per capita (X6), the number of national customers (X14), network losses (X13), energy sold (X12) and energy production (X11) will increase Total Load (Y5).

f. LNG price per metric ton (X3), oil price per barrel (X4) and subsidy & compensation (X16) will reduce profit/loss before subsidy and compensation (Y6).

g. Increased electricity consumption Kwh per capita (X10), LNG price per metric ton (X3), network losses (X13), number of new customers (X15), Gross Domestic Product/GDP (X5), energy sold (X12), energy production (X11), income per capita (X6), and the number of national customers (X14) will increase BPP (Y8).

h. The increasing value of Rupiah exchange rate – US Dollar (X1), network shrinkage (X13), number of new customers (X15), Gross Domestic Product/GDP (X5), energy sold (X12), energy production (X11), income per capita (X6), the number of national customers (X14), the Fed's benchmark interest rate (X9) and electricity consumption Kwh per capita (X10) will increase the Average Selling Price (Y9).

i. An increase in the Fed's benchmark interest rate will reduce total assets (Y10).

j. Increase in the exchange rate of Rupiah – US Dollar (X1), electricity consumption Kwh per capita (X10), Gross Domestic Product/GDP (X5), income per capita (X6), number of national customers (X14), network losses (X13), energy sold (X12) and energy production (X11) will increase total assets (Y10).

k. The increasing value of The Fed's reference interest rate (X9), electricity consumption Kwh per capita (X10), Rupiah – US Dollar exchange rate (X1), number of new customers (X15), Gross Domestic Product/GDP (X5), income per capita (X6), total national customers (X14), network losses (X13), energy sold (X12) and energy production (X11) will increase the company's short-term debt (Y11)

l. The increasing value of The Fed's reference interest rate (X9), electricity consumption Kwh per capita (X10), Rupiah – US Dollar exchange rate (X1), number of new customers (X15), Gross Domestic Product/GDP (X5), income per capita (X6), total national customers (X14), network losses (X13), energy sold (X12) and energy production (X11) will increase the company's long-term debt (Y12).

m. Decreasing value of in Indonesia's benchmark interest rate (X8) will increase the company's total debt (Y13)

n. Increased value of state investment (X17) will increase the company's total debt.

o. Increased consumption of electricity Kwh per capita (X10), number of new customers (X15), Gross Domestic Product/GDP (X5), income per capita (X6), number of national customers (X14), network losses (X13), energy sold (X12) and energy production (X11) will increase operating cash flow (Y14).

p. An increased value of the Fed's benchmark interest rate (X9), electricity consumption Kwh per capita (X10), the exchange rate of Rupiah – US Dollar (X1), coal price per metric ton (X2), Gross Domestic Product/GDP (X5), income per capita (X6), the number of national customers (X14), network losses (X13), energy sold (X12) and energy production (X11) will reduce the company's free cash flow (Y15).

q. An increased value of Indonesia's benchmark interest rate (X8) will reduce year-end cash flows (Y16).

r. An increased value of the Fed's benchmark interest rate (X9), electricity consumption Kwh per capita (X10), the exchange rate of Rupiah – US Dollar (X1), the number of new customers (X15), Gross Domestic Product/GDP (X5), income per capita (X6), the number of national customers (X14), network losses (X13), energy sold (X12) and energy production (X11) will increase year-end cash flow (Y16).

4.8 The results of scenarios analysis and sensitivity analysis

With the business model and governance that have been implemented so far as well as the projected movement of the risk factors that influence it, it can be said that the company has the potential to suffer losses in the long term, because it can be seen that in 2020 to 2030, both from pessimistic, moderate and optimistic scenarios, total revenue is always under total load. This is due to the projected weakening of the economy due to the prolonged Covid-19 pandemic, the weakening of the Rupiah against the Dollar, a decrease in GDP, a decrease in per capita income and a decrease in the number of customers, which leads to a potential decrease in electricity consumption per capita from the community. At the same time, as described above, the company's revenue is highly dependent on income from buying and selling electricity. In addition, when electricity consumption per capita decreases, interest & finance costs, fuel costs, as well as electricity purchases & rental costs actually increase due to the ToP IPP contract, increase in primary energy prices and renegotiation and restructuring of company debt due to limited company capital increase the number of expenses that will be borne by the company in the future. Moreover, there will be an addition of around 16 GW of new PLTU that will be connected to the PLN grid with the majority of the PLTU owned by IPP (attachment of figure 86). In accordance with these descriptions, in order to maintain the company's business sustainability, the following efforts need to be made:

1. Business expansion through the development of products, services, business models and markets, both in the electricity sector and its supporting sectors at home or abroad.
2. Conduct aggressive marketing by encouraging the mindset of everybody is marketer to all employees, both in the parent company, subsidiaries and affiliated companies.
3. Improve efficiency in all business processes and operations as well as reliability of generation, transmission and distribution.
4. Optimizing the adjustment of targets and prioritizing the fulfillment of power generation, transmission and distribution development.
5. Renegotiate the contract clause of the power purchase agreement with the IPP, at least which has not been in financial close status.
6. Ensure the addition of optimal IPP capacity and efficiency in accordance with the needs of the community with a mutually beneficial contract value between the company and the IPP. According to the calculation results based on scenario analysis and sensitivity analysis, it is known that the projected total income cannot cover the company's short-term debt. Moreover, according to the projection above (figure 29), it is known that the company has the potential to suffer losses over the next 11 years. This indicates that the business model and corporate governance that have been implemented have a negative impact on business performance, operations, and encourage the company not to have the ability to meet short-term obligations or debts.

5. CONCLUSIONS & SUGGESTION

5.1 Conclusions

The conclusions described in this chapter will answer the problem formulation and research objectives that have been described in Introduction. Here are the conclusions that can be given

1. According to the results of the assessment and study, the factors that become the main strategic issues and can affect the performance, resilience and sustainability of PT XYZ (Persero) are
 - l. The development of the capacity and capability of the electricity system throughout Indonesia which is carried out efficiently and effectively by considering operational reliability.
 - m. Security of primary energy supply (gas, coal) that can be fulfilled on time and of the best quality to

maintain the economic life of the electricity system, especially power generation.

n. Efficiency and reliability of operational processes to support the fulfillment of economical and sustainable electrical energy.

o. Financial capability and independence so that the company is able to grow and develop sustainably.

p. Readiness of the organization, technology and human resources to operate all current and future business processes.

q. Strengthening regulatory, stakeholder and shareholder management functions to ensure the company's business sustainability.

r. Trends in system development, governance and technology for electricity systems that are more environmentally friendly, decentralized with smart eco electric systems.

s. The development of prosumer trends with the support of policies, technology and affordable economic values.

t. Power purchase agreement contract with the TOP scheme which burdens the company's financial performance.

u. Primary energy scarcity and rising primary energy prices.

v. Optimizing structured, measurable and systematic business portfolio procedures, mechanisms and governance

2. Critical Factors that greatly affect the performance, resilience and business continuity of PT XYZ (Persero) are

s. Increased consumption of electricity kWh per capita (X10), the Fed's reference rate (X9), the exchange rate of Rupiah – US Dollar (X1), the number of new customers (X15), Gross Domestic Product/GDP (X5), income per capita (X6), the number of national customers (X14), network losses (X13), energy sold (X12) energy production (X11) will simultaneously increase the company's revenue (Y1).

t. The number of new customers (X15) will affect interest and finance expenses (Y2).

u. Increasing electricity consumption kWh per capita (X10), LNG price per metric ton (X3), oil price per barrel (X4), number of new customers (X15) and subsidies & compensation (X16) will increase the fuel load (Y3).

v. Increase in the Fed's reference interest rate (X9), electricity consumption kWh per capita (X10), Rupiah – US Dollar exchange rate (X1), Gross Domestic Product/GDP (X5), income per capita (X6), number of national customers (X14), grid losses (X13), energy sold (X12) and energy production (X11) will increase the burden of purchasing electricity & rent (Y4).

w. An increase in the Fed's benchmark interest rate (X9), electricity consumption kWh per capita (X10), the exchange rate of Rupiah – US Dollar (X1), the number of new customers (X15), Gross Domestic Product/GDP (X5), income per capita (X6), the number of national customers (X14), network losses (X13), energy sold (X12) and energy production (X11) will increase Total Load (Y5).

x. LNG price per metric ton (X3), oil price per barrel (X4) and subsidy & compensation (X16) will reduce profit/loss before subsidy and compensation (Y6).

y. Increased electricity consumption kWh per capita (X10), LNG price per metric ton (X3), network losses (X13), number of new customers (X15), Gross Domestic Product/GDP (X5), energy sold (X12), energy production (X11), income per capita (X6), and the number of national customers (X14) will increase BPP (Y8).

z. The increasing value of Rupiah exchange rate – US Dollar (X1), network shrinkage (X13), number of new customers (X15), Gross Domestic Product/GDP (X5), energy sold (X12), energy production (X11), income per capita (X6), the number of national customers (X14), the Fed's benchmark interest rate (X9) and electricity consumption kWh per capita (X10) will increase the Average Selling Price (Y9).

aa. An increase in the Fed's benchmark interest rate will reduce total assets (Y10).

bb. Increase in the exchange rate of Rupiah – US Dollar (X1), electricity consumption kWh per capita

(X10), Gross Domestic Product/GDP (X5), income per capita (X6), number of national customers (X14), network losses (X13), energy sold (X12) and energy production (X11) will increase total assets (Y10).

cc. The increasing value of The Fed's reference interest rate (X9), electricity consumption Kwh per capita (X10), Rupiah – US Dollar exchange rate (X1), number of new customers (X15), Gross Domestic Product/GDP (X5), income per capita (X6), total national customers (X14), network losses (X13), energy sold (X12) and energy production (X11) will increase the company's short-term debt (Y11)

dd. The increasing value of The Fed's reference interest rate (X9), electricity consumption Kwh per capita (X10), Rupiah – US Dollar exchange rate (X1), number of new customers (X15), Gross Domestic Product/GDP (X5), income per capita (X6), total national customers (X14), network losses (X13), energy sold (X12) and energy production (X11) will increase the company's long-term debt (Y12).

ee. Decreasing value of in Indonesia's benchmark interest rate (X8) will increase the company's total debt (Y13)

ff. Increased value of state investment (X17) will increase the company's total debt.

gg. Increased consumption of electricity Kwh per capita (X10), number of new customers (X15), Gross Domestic Product/GDP (X5), income per capita (X6), number of national customers (X14), network losses (X13), energy sold (X12) and energy production (X11) will increase operating cash flow (Y14).

hh. An increased value of the Fed's benchmark interest rate (X9), electricity consumption Kwh per capita (X10), the exchange rate of Rupiah – US Dollar (X1), coal price per metric ton (X2), Gross Domestic Product/GDP (X5), income per capita (X6), the number of national customers (X14), network losses (X13), energy sold (X12) and energy production (X11) will reduce the company's free cash flow (Y15).

ii. An increased value of Indonesia's benchmark interest rate (X8) will reduce year-end cash flows (Y16).

jj. An increased value of the Fed's benchmark interest rate (X9), electricity consumption Kwh per capita (X10), the exchange rate of Rupiah – US Dollar (X1), the number of new customers (X15), Gross Domestic Product/GDP (X5), income per capita (X6), the number of national customers (X14), network losses (X13), energy sold (X12) and energy production (X11) will increase year-end cash flow (Y16).

1. The steps taken in this study for a series of formulating the business development strategy of PT XYZ (Persero)'s processes are as follows

a. Carry out a comprehensive assessment of the company's performance using various strategic management tools consisting of balance scorecard, PESTEL, Five porter model, SWOT, TOWS, Business Model Canvass, Financial Distress, benchmarking with similar industries at the Asian regional level, identification of business insights, key strategic issues, critical factor, VaR and stress testing validated by experts and company leaders.

b. Formulation of strategy proposals by determining the strategy profile, strategy theme based on the results of the assessment that has been carried out and based on the Sustainability Balanced Scorecard framework.

c. Determination of strategic objectives, strategy maps, targets / Key Performance Indicators to achieve strategic objectives, and determination of initiative strategies carried out with experts and company leaders in workshops.

d. Approval and preparation for implementation.

5.2 Suggestions

Based on the results of the research that has been done, suggestions can be given to the Academics, Business and Government (ABG) sector as follows:

1. Suggestions for further research for the Academics sector

- a. This research focuses on the stages of a comprehensive assessment of the existing conditions of operations and businesses run by the company in order to obtain a strategic offer that can support the company's business development in the present and in the future. However, in an effort to achieve the company's strategic objectives, the strategy needs to be complemented by programs that carry out regular

measurement, monitoring and evaluation.

- b. Stress testing with Value at Risk, Monte Carlo Simulation, Scenario analysis & Sensitivity analysis can be used to strengthen financial performance forecasting of non-financial companies in the future by considering risk factors supporting financial performance. In addition, to get more optimal results from the results of stress testing, backtesting should be carried out.
- c. The development of the electricity system has the potential to change rapidly due to technological transformation. In accordance with this, it is necessary to conduct a more in- depth study of the business model and use of technology in the electricity sector which is more relevant to the future so that there is a continuation of research that can support the sustainability of the company's business.

2. Suggestions for the Business sector (Company)

In order to support the company's sustainability in the future, the company needs to make efforts to strengthen the business as follows:

- a. Optimizing the efficiency and reliability of all business processes and company operations so as to increase the company's competitive advantage and so that the company is able to provide the basic needs of the community more economically.
- b.
 - b. Manage funding more carefully to maintain the company's liquidity so that the company can continue to grow and develop healthily in the future
- c.
 - c. Participate in supporting the government's future program, namely the transformation of the Republic of Indonesia based on electrical energy, to reduce the cost of subsidies and government imports of oil and gas, by creating various electrical equipment innovations including transportation facilities and their supporting systems. This then needs to be strengthened with programs and education to the public regarding electrifying (electric everything) which will help companies reduce the oversupply of electrical energy.
- d. Invest to develop products, services and business models that are more relevant to the electricity system in the future.

3. Suggestions for the Government sector

As one of the key stakeholders and shareholders who really determine the sustainability of energy management companies and guarantee energy sovereignty and security in Indonesia, the government should be able to support the company's growth by

- a. Optimizing and strengthening the Indonesian economy so that it can maintain the Rupiah Exchange Rate against the Dollar, Gross Domestic Product/GDP, Income per capita, Exchange rate, so as to increase the national per capita kWh electricity consumption.
- b. A review of the 35GW program target that has been set previously by considering the capacity and capability of Indonesia, so that the development and supply of electricity program can be carried out in a sustainable manner and does not cause heavy burdens in the future due to debts that exceed the repayment capacity of the Republic of Indonesia.
- c. Also present to ease the company's financial burden by (i). conducting studies or changes to the regulations that form the basis of TOP's cooperation with IPPs in Indonesia which have proven to be burdensome for the company and state finances in the end, (ii). Conduct studies or changes to mechanisms or procedures related to determining the basic electricity tariff, granting state investment as well as more friendly subsidies and compensation.
- d. Provide policies, regulations and decisions in a more objective manner that can support the company's sustainable growth and ensure the availability of electricity as a basic need of the Indonesian people, in order to carry out the mandate of the state which is contained in the basis of the state and to maintain the sovereignty and resilience of the Republic of Indonesia.

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DESIGN OF KAI ACCESS APPLICATION IMPROVEMENT BASED ON USABILITY ASPECTS AND QUALITY FUNCTION DEPLOYMENT (QFD)

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ABSTRACT

The KAI Access application is an option for ordering train tickets online via mobile phones. However, there are still many users who complain and give low scores to the KAI Access application. So this study aims to identify the preferences of users of the KAI Access application by adopting the attributes of the usability factor and make suggestions for improving the design of the KAI application according to user preferences so that it can improve the quality of its services. Customer perceptions and interests of each Usability attribute at each customer touch point will be processed to identify which attributes are prioritized for improvement using the Importance-Performance Analysis (IPA) method. Then these priority attributes are further processed using QFD. There are 11 of 33 valid and reliable attributes of service quality based on the Usability attribute which prioritizes to be improved. Based on these 11 priority attributes, it is designed to improve service quality into 5 technical response priorities, namely "Development of reservation, reschedule and cancellation features"; "Optimization of train ticket payment system"; "System optimization on the KAI Access application"; "Adding the KAI Access application operating guide"; and "Development of ticket payment transaction features". So that we get an improvement plan to improve the service quality of the KAI Access application.

Keywords: The KAI Access Application, Improvement Plan, Usability Attributes, Quality Function Deployment (QFD)

1. INTRODUCTION

The ease of access to technology is used by business owners to continue to develop their business, namely application-based businesses. Currently, many companies are starting to implement application systems. Every company must have a way to compete with other companies. In addition, companies must always update and follow changes in people's lifestyles, namely by appearing various types of mobile applications that can be used in buying food, delivery services, purchasing fashion goods, and in purchasing tickets. Mobile applications are software applications that are specifically made to run on tablets and smartphones (Peni, 2016). One of the developing mobile applications is a mobile application for purchasing e-tickets. Kereta Api Indonesia (KAI) Access is the official mobile application owned by PT. Kereta Api Indonesia, which aims to make it easier for prospective passengers to get information and book train tickets online. KAI Access is a relatively new information technology that was launched in 2014.

With the KAI Access application, it is hoped that it can assist customers in obtaining information related to train schedules and make it easier to place orders for local and long distance trains. During the covid-

19 pandemic at PT. KAI has adopted a policy that all bookings for train tickets, both local and long distance, are only allowed online, one of which is by using the KAI Access application. In this condition PT. KAI hopes that many will use the KAI Access application, so that more customers can be helped through this application without having to come to the station.

In 2020 the use of KAI Access is still not as effective as expected, it can be seen that there are still many customers who come to the station to ask for information regarding ticket purchases. In fact, there are still many customers who are reluctant to use the KAI Access application for reasons of difficulty in operating it. With this application, many users feel uncomfortable when using the application. Complaints that are often felt by customers include frequent errors not being able to log in, difficulties in the ticket booking process, difficulties in processing payments, no features to change and cancel local train tickets, etc.

The purpose of this study is to identify the preferences of users of the KAI Access application by adopting the attributes of the usability factor and provide suggestions for improving the design of the KAI application according to user preferences so as to improve the quality of its services. Customer perception and interest in each usability attribute at each customer touch point will be processed to identify which attributes are prioritized for improvement using the Importance- Performance Analysis (IPA) method. Then these priority attributes are further processed using Quality Function Deployment (QFD).

2. LITERATURE REVIEW

Initially KAI Access only offered the feature of booking long-distance and medium-distance train tickets, but now KAI Access has expanded to local train ticket reservations, cancellations, seat number changes, rescheduling, e-boarding/e-tickets, etc. Research conducted by Moh. A. Hamzah (2019), using the Unified Theory of Acceptance and Use of Technology (UTAUT) method when using the KAI Access information system there is a strong desire from individuals (interests) for the availability of supporting facilities in the implementation of KAI Access to information systems. The use of the KAI Access information system is influenced by the strong intention of each user of the system because it is based on a strong interest.

Quality management is a way to continuously improve performance at every level of operation or process, in every functional area of the organization, using all available human and capital resources (V. Gaspersz, 2009). The responsibility for quality management lies with all levels of management, but must be controlled by top management, and its implementation must involve all members of the organization. Software is instructions (computer programs) that when executed can perform certain functions, data structures that can make the program manipulate information, documents that describe the program (Kendall, 2006). Quality software must meet functional requirements and requirements to create user satisfaction (Juran, 1999).

Something can be said to be useful if failures in its use can be eliminated or minimized and provide benefits and satisfaction for its users (Rubin, J., & Chisnell, 2008). An application is called usable if its function can run effectively, efficiently, and satisfactorily (Nielsen, 1993). Usability evaluation is a process that involves users so that they can learn about and use the product to achieve user convenience aspects such as effectiveness, efficiency, and user satisfaction with the system as a whole (US Department of Health & Human Services, 2014).

- a. Efficiency is defined as the resources expended in order to achieve the accuracy and completeness of the objectives.
- b. Ease (learnability) defined how quickly users are proficient in using the system and ease of use as well as perform a function of what users want to meraka get.
- c. Memorability is defined how the ability of users to retain their knowledge after a certain period of time, the ability to remember is obtained from placing a menu that is always fixed.
- d. Errors and security (errors) are defined how many errors are made by the user, the error made by the user includes the discrepancy between what the user thinks and what is actually presented by the system.

- e. Satisfaction is defined as freedom from discomfort, and a positive attitude towards product use or subjective measures of how users feel about using the system.

Initially, Importance-Performance Analysis (IPA) by Martilla & James, (1977) was used to evaluate consumer acceptance of marketing programs. However, up to now its application can be extended as used for customer satisfaction analysis. Because IPA has a "performance" component that shows the size of the results or outcomes of a process or work. In addition, IPA has an "importance" component that indicates a measure of significance or value. "Importance" and "performance" are judged by the customer or user experiencing the service process. IPA results are displayed in 4 quadrants, namely:

1. Quadrant I (Concentrate Here)

Factors located in this quadrant are considered as very important factors by consumers but are currently in low performance.

2. Quadrant II (Keep Up The Good Work)

Factors located in this quadrant are considered in high performance so that management is obliged to ensure that the performance of the institution can maintain performance.

3. Quadrant III (Low Priority)

Factors located in this quadrant have low performance and at the same time are considered not very important for consumers.

4. Quadrant IV (Possible Overkill)

Factors located in this quadrant are considered not very important but in high performance so management needs to allocate resources related to these factors to other factors that have higher priority of care that still need to be improved.

Quality Function Deployment (QFD) is a planning method used to improve the production process through gathering information about consumer needs and wants. QFD provides a number of benefits for organizations seeking to increase their competitiveness by continuously improving their quality and productivity. The benefits of QFD include: customer focus, time efficiency, work orientation, and documentation orientation (Goestch and Davis, 2000). QFD is an implementation of total quality management that is used to translate customer needs and desires into technical design requirements (Akao, 1990). The House of Quality matrix is a tool used to use the QFD structure (Tony Wijaya, 2011).

House of quality is used in various fields to translate consumers (customer requests) both in companies, offices, and in the world of education to make it easier to carry out the planning needed by consumers and which must be improved in its implementation in the field while taking into account the level of efficiency in the use of funds, facilities, convenience, comfort, and priority. The results of research and benchmarking data become a number of priority technical targets (Gaspersz, 2002).

3. METHODS

The research flow is depicted in Figure 1. The research flowchart. The explanation of each stage is as follows:

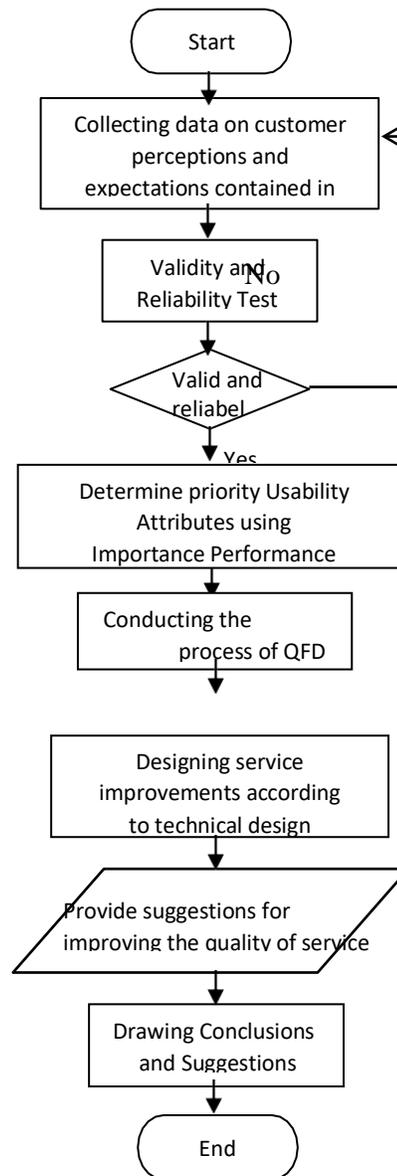


Figure 1. The research flowchart

The process carried out in this study is to collect data on customer perceptions and expectations on the Usability indicator. Furthermore, validity and reliability tests were carried out. If the indicators of customer perception and expectation data are valid and reliable, then proceed with collecting customer interest level data using valid and reliable Usability indicators. Then, determine which indicators are prioritized for improvement using the QFD method. After getting a prioritized technical response, it is continued by providing suggestions for improvement to improve service quality. Then, conclusions and suggestions can be drawn from this research. The indicators in the questionnaire according to the Usability aspect can be seen in Table 1.

Table 1. Usability Aspects in Determining Research Indicator Variables

1	Effectiveness
2	Learnability
3	Operability

4	Attractiveness
5	Memorability
6	Efficiency
7	Errors
8	Satisfaction

4. RESULTS

The results of the study based on usability attributes to determine the research indicator variables, there were 33 service quality attributes/statements that would be assessed by 300 respondents in the first phase of the questionnaire which was tested for validity and reliability. Validity and reliability tests in this study were carried out with the help of Microsoft Excel and Minitab applications. The research instrument in this case the attributes/questions/indicators in the questionnaire is said to be valid if the *r*-count is positive and greater than the *r*-table value. The value of *r* table for the number of respondents 300 and = 5% in this study is 0.113. The process of calculating the Pearson correlation for validity testing uses the Minitab 2017 application. The following table 4.6 is a summary of the results of the validity test of the perception data questionnaire on 33 attributes.

Table 4.6 Summary of Questionnaire Results Validity Test Results

No	Attribut	<i>r</i> count	Ket.	No	Attribut	<i>r</i> count	Ket.
1	L1	0.7313	Valid	19	Er4	0.6037	Valid
2	L2	0.6269	Valid	20	Er5	0.6052	Valid
3	L3	0.5942	Valid	21	Er6	0.63	Valid
4	L4	0.5761	Valid	22	S1	0.4691	Valid
5	E1	0.7524	Valid	23	S2	0.7856	Valid
6	E2	0.1929	Valid	24	S3	0.72	Valid
7	E3	0.4577	Valid	25	S4	0.4187	Valid
8	E4	0.5245	Valid	26	O1	0.5283	Valid
9	E5	0.524	Valid	27	O2	0.7233	Valid
10	M1	0.5569	Valid	28	At1	0.5908	Valid
11	M2	0.6044	Valid	29	At2	0.8123	Valid
12	M3	0.4325	Valid	30	Ef1	0.5211	Valid
13	M4	0.5395	Valid	31	Ef2	0.4411	Valid
14	M5	0.1844	Valid	32	Ef3	0.4275	Valid
15	M6	0.5552	Valid	33	Ef4	0.5295	Valid
16	Er1	0.4253	Valid				
17	Er2	0.3657	Valid				
18	Er3	0.1898	Valid				

The mean value (average) of customer perception, average customer expectation, and average level of importance was obtained from the total value of each attribute item divided by 300 respondents. The data collected from the importance level of the second stage of the questionnaire was no longer tested for validity and reliability because the attributes used were valid and reliable based on validity and reliability tests. After the data on customer perception, customer expectations, and importance level are collected, the next step is to analyze the usability attributes that are prioritized to be improved using the Important-Performance Analysis (IPA) method by visualizing customer perception data and importance level in a quadrant.

The results of the IPA process obtained usability attributes whose priority to be improved were those in quadrant I (High Importance, Low Performance) as many as 11 attributes, namely:

- Ease of remembering payment procedures
- Easy to use the application anywhere and anytime
- There are no failures in the ticket payment process
- The speed of learning to understand the application
- Easy to create a new account on the application
- There are no problems in the account creation process
- KAI Access application works according to customer expectations
- Easy for users to book train tickets
- There was no system error when booking tickets
- Ease of application operation in various circles
- Clarity of information related to train travel requirements

After obtaining a number of 11 priority attributes for improvement, the eleven attributes can be said to be the voice of the customer which is the customer requirements at the Customer Needs & Wants stage of the House of Quality QFD method. Then proceed with the planning stage or Planning Matrix. At this planning stage, the first is to calculate the average level of importance and the average customer experience perception of the services that have been obtained previously and then calculate the improvement ratio (IR). The results of these calculations are in Table 3.

Table 3. Stage of Planning (Planning Matrix) House of Quality

No	Kode Atribut	Persepsi EXQ	Goal EXQ	Kepentingan EXQ	Improvement Ratio	priority
		<i>a</i>	<i>b</i>	<i>c</i>	$d=(b/a)$	
1	L4	2.697	4.237	3.913	1.571	4
2	E3	2.350	4.29	4.107	1.479	5
3	E5	2.780	4.236	4.130	1.406	9
4	M4	2.527	4.617	4.027	1.965	1
5	Er1	2.397	4.543	4.067	1.674	3
6	Er2	2.703	4.073	4.127	1.465	6
7	S2	2.620	4.1	3.867	1.463	7
8	O1	2.620	4.187	4.270	1.368	10
9	At2	2.477	4	3.947	1.423	8
10	Ef3	2.713	4.233	4.017	1.675	2
11	Ef4	2.560	4.393	4.167	1.177	11

After carrying out the planning stage, it is continued by determining the technical response or technical response in the form of functional or design requirements. Functional requirements are made based on customer requirements, namely a number of 11 attributes that have been defined as the voice of the customer previously. Determination of this technical response through structured interviews with the relevant manager. The technical responses are:

1. Added KAI Access application operating guide
2. Added train list feature
3. Development of ticket payment transaction features
4. Integration of train ticket payment system
5. Added alert notification or order status
6. Improved system reliability in the KAI Access application
7. Development of reservation, reschedule and cancellation features

8. Flexibility of operating system on Andriod and IOS
9. Adding information on passenger requirements

After determining the technical response/functional requirements (hows) as an elaboration of the customer requirements (whats), the next step is to determine the relationship matrix. The relationship matrix is the relationship between functional requirements and customer requirements. Then determine the relationship between technical responses (“how’s”) and customer needs (“what’s”), the next step is to determine the relationship between technical responses (“hows”) with each other. After all the QFD stages are carried out, the results of the formation of the House of Quality according to the stages that have been carried out are as shown in Figure 2.

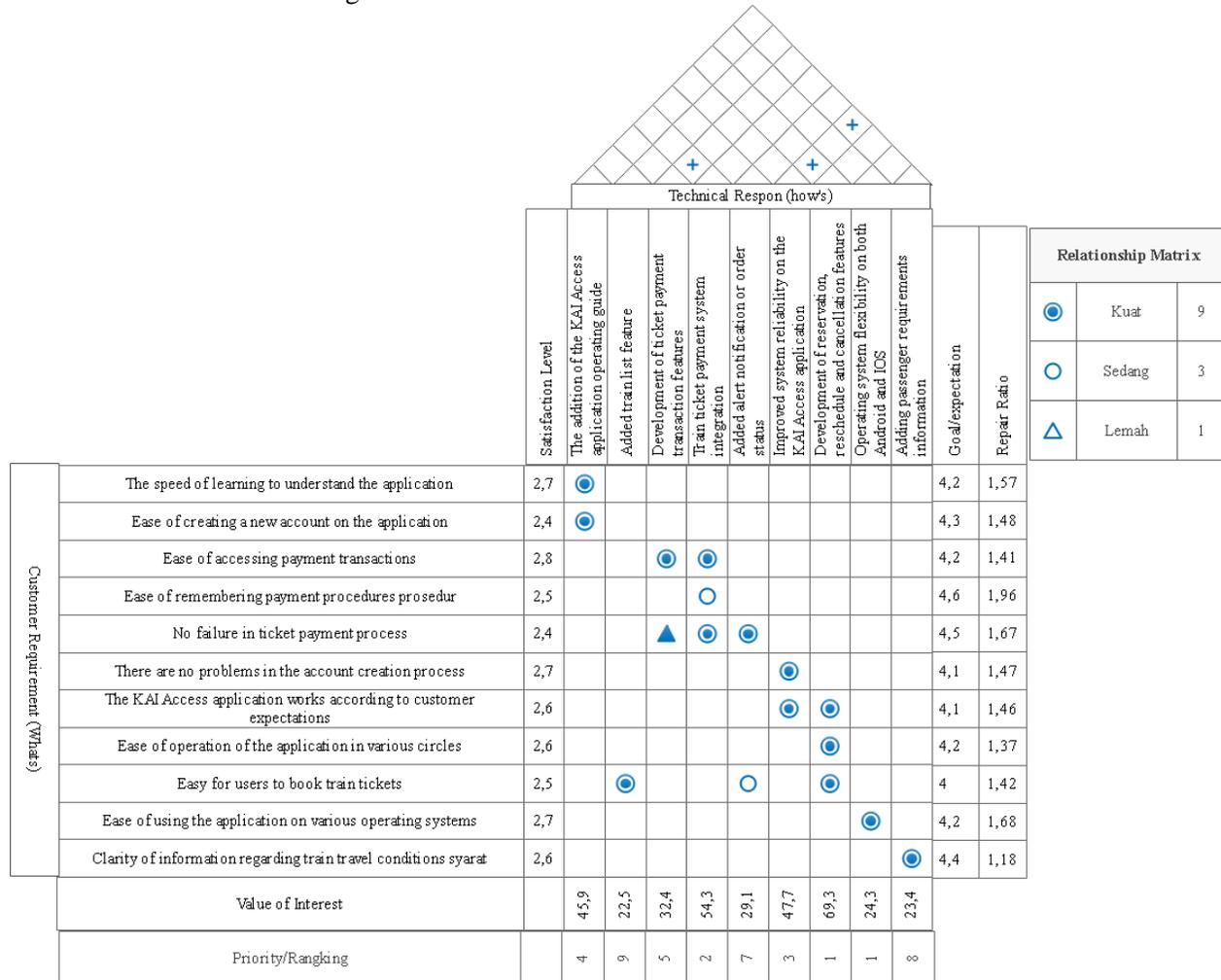


Figure 2. House of Quality KAI Access Application

6. CONCLUSIONS

Based on the results of the study, it can be drawn

The conclusion is that there are 3 priority technical responses and recommendations in improving service, namely:

- i. Development of reservation, reschedule and cancellation features
- ii. Optimization of the train ticket payment system
- iii. System optimization on the KAI Access application

Proposed improvements that are useful to improve the quality of application services for each priority

response or technical recommendation, among others: simplify the process of canceling intercity train tickets without having to match the identity of the account owner, adding rescheduling and cancellation features, changing the appearance of more booking features interesting and more understandable in various circles, changes in the identity of the first passenger on ticket reservations (not according to account identity) such as booking inter-city train tickets, etc.

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SELECTION OF GLOBAL LOGISTICS SERVICES

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ABSTRACT

The logistic and the transportation process are part of a supply chain that involves the movement and storage of materials and products along the chain. Considering the supply chain operates globally and the application of Just in Time (JIT), the high accuracy of the movement is needed. Management needs to consider the imperative of growth (improvement) in logistics and transportation. In this study, the logistic service provider will be selected based on criteria including costs, delivery schedules, efficient management, and the sustainability level of a service provider. Furthermore, the process of a logistic service provider selection will certainly increase the risks from each alternative. The potential logistic service provider in this study is coming from various countries. The company is expected to be able to choose a logistic service provider that match the company's business strategy, which will be processed using the ANP (Analytic Network Process). In the end, this study provides alternative recommendations, which Maersk is the preferred service provider for shipments from China, Japan, Korea, Philippines, Taiwan, Thailand. For OOCL provider for shipments from Singapore, Vietnam. While the Lunar provider for shipments from Hong Kong.

Keywords: Sustainable Supply Chain, Logistic, Analytic Network Process.

1. INTRODUCTION

The emergence of the sustainable aspect supply chain management leads to its rapid development over the next twenty years to decades. Strategy management and good practice of sustainable supply chain are the important foundations that affect the collaboration within the business partners, such as the supplier, intermediary, third-party service provider, and the end customer. In general, logistics and goods transportation processes are part of the supply chain that involves the movement and storage of materials and products along the supply chain. The logistics growth in environmental and social aspects will impact and accountable for the largest share of emissions related to the logistic processes.

The market demand for products from companies that spread across the world is very high, where companies in Indonesia are one of the two manufacturers in the world that provide the finished products. Therefore, the transportation function has a significant role in ensuring that the finished products can be delivered to customers on time with maintained quality. However, in 2020, shipments to each region experienced many delivery delays that lead to arrival delays of consumers' products. Thus, it would have a direct impact on product sales to consumers.

The delay in the delivery of materials has a major impact on the production process where it could stop the production line where the process cannot run because there is a shortage of material from the compilers of the product. The consequence of this circumstance is that the supply chain process to the customer is getting more and more delayed. Therefore, reliable logistic service providers of the

materials delivery process to manufacturing companies are needed. However, in the decision-making process, the company often faces some problems that involve not only one criterion, but apart from that, we are also faced with problems in deciding and determining an objective decision or decision problems that involve more than one decision. In the decision-making process to determine which the best logistics service provider from several logistics service providers available, the multi-criteria decision-making method is being used (MCDM).

The purpose of this study is to identify criteria and sub criteria that influence the decision-making process on selecting the global logistics service providers and determine the global logistics service providers that fit the company's strategy by integrating the DEMATEL-ANP method.

2. LITERATURE REVIEW

2.1 Logistic

Logistics systems consist of facilities, where one or more functional activities are performed (such as storage and distribution). A schematic representation of a logistics system in which the manufacturing process of a product is divided into a transformation phase and an assembly phase, which is carried out on site. Starting from the process of sending materials and components that support a manufacturing process, to the distribution system to each distributor center, then to regional distributors, which are finally connected to each branch in charge of serving consumers, called dealers or sellers (Ghiani, 2013).

2.2 Sustainable Supplier Selection

The process of determining the criteria definition is becoming the most critical phase in the decision-making process since this process is related to relative weight determination in the supplier selection process. (Mukherjee, 2017). After carrying out the identification process, the criteria are tabulated into a list that consisted of the information historical records of suppliers (Company's name, average business volume, type of activity, certification, etc.).

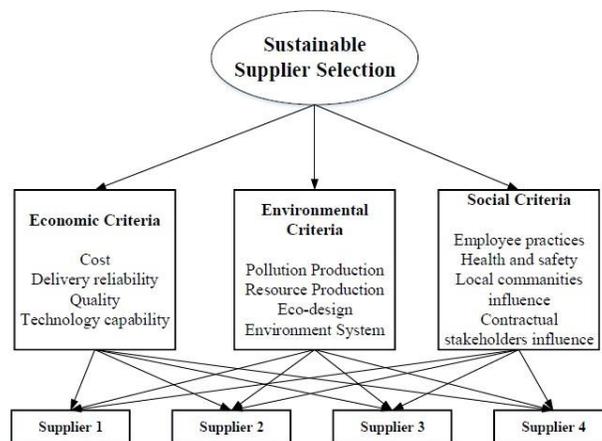


Figure 1. Hierarchical Structure of Decision Problems (Source: Govindan, 2013)

2.3 Decision-Making Trial and Evaluation Laboratory (DEMATEL)

Decision-Making Trial and Evaluation Laboratory or DEMATEL is a method for building and analyzing a structured model with a causal relationship between the factors (Saaty & Vargas, 2006). The DEMATEL method can identify factors that are interdependent or have a relationship through a causal

diagram. This diagram will illustrate the basic concepts of the relationship and the strength of influence between factors.

According to Uygun, Kaçamak and Atakan (2014), there are several steps to solving the DEMATEL method as follows:

1. Create a direct relationship matrix

Some experts will make a pairwise comparison matrix of the influence between criteria.

The DEMATEL method uses a comparison scale which can be seen in Table 1.

Table 1. DEMATEL Comparison Scale

Scale	Description
0	No influence
1	Low influence
2	Moderate influence
3	High influence
4	Very high influence

(Source: Uygun, Kaçamak and Atakan, 2014)

2. Normalization of direct relationship matrix

Considering the relationship matrix A, then the relationship of matrix X being normalized by using the following formula:

$$X = k . A \quad (1)$$

$$k = \frac{1}{\max_{1 \leq i \leq n} \sum_{j=1}^n a_{ij}} \quad (2)$$

3. Get the total relationship matrix

The total relationship matrix or T matrix denoted as an identity matrix, which can have obtained by using the following formula:

$$T = X(1 - X)^{-1} \quad (3)$$

4. Calculating the vector of dispatcher (D) and receiver (R)

Each dispatcher (D) and receiver (R) vector will correspond to the number of rows and columns in the T matrix. The value of D+R indicates the level of importance between a criterion and other criteria. D-R is negative; it indicates that one criterion accepts the impact of other criteria. Calculation of D and R using the following equation:

$$T = [t_{ij}]_{n \times n} \quad i, j = 1, 2, 3, \dots, n \quad (4)$$

$$D = \left[\sum_{j=1}^n t_{ij} \right]_{n \times 1} = [t_{ij}]_{n \times 1} \quad (5)$$

$$R = \left[\sum_{j=1}^n t_{ij} \right]_{1 \times n} = [t_{ij}]_{n \times 1} \quad (6)$$

5. Make a diagram of impact

The impact diagram is obtained by mapping the data from (D+R, D-R) with the horizontal axis D+R and the vertical axis D-R.

2.4 Analytic Network Process (ANP)

Analytical Network Process (ANP) is a process that can be used to solve any Multi- Criteria Decision Making (MCDM) problems. The ANP process is a developed Analytical Hierarchy Process (AHP) method, wherein the ANP method can determine the alternative decision by assessing the

interactions and linkages between each criterion and the reciprocity of each criterion within a cluster and between clusters (Saaty & Vargas, 2006).

The decision-maker will perform the pairwise comparisons of all elements in the ANP structure. Table 2 shows the rating scale that was being used in the pairwise comparisons. The results of pairwise comparisons can be used to determine the priority of each criterion. Then the results will be converted into a pairwise comparison matrix which can be seen in Table 2.

Table 2. ANP Fundamental Scale

Intensity of importance	Description
1	Equal importance
2	Weak or slight
3	Moderate importance
4	Moderate plus
5	Strong importance
6	Strong plus
7	Very strong or demonstrated importance
8	Very, very strong
9	Extreme importance

(Source: Saaty & Vargas, 2006)

3. METHODS

3.1 Data collection

At this stage, the researcher will collect the data following how the research want to be carried out and also determine what kind of data is needed in this research.

3.2 Screening and Filtering Stage Selected criteria

After collecting the data, the next step is to carry out the criteria selection process up to selected criteria is chosen by adjusting to the company's organizational strategy.

3.3 Criteria Categorization Stage and Sub Criteria Design

After the final criteria that are already in accordance with the company's organizational strategy are selected, the next step is to determine the criteria category whether included in the quantitative class or the quantitative class. Once it has been classified, then the sub-criteria for each selected criterion need to be designed.

3.4 Data Processing Stage

After getting some data, the next step is to process the data. Data processing is divided into two, namely data processing using DEMATEL-ANP.

4. RESULTS

4.1 Identifying Relationships Between Sub Criteria Using the DEMATEL Method

To find out what kind of relationship between the sub-criteria, it is necessary to use the DEMATEL method by making a questionnaire given to the respondents; the Logistics Department Manager and Logistics Department Senior Staff which can be seen in Table 3.

Table 3. Vector Value Calculation Results

Sub Criteria	D	R	D-R	D+R
Shipping Cost	1.9484	1.78232	0.166072	3.73072
Overnight Cost	0.6748	1.16611	-0.491318	1.84091
Delay delivery	1.0607	1.29234	-0.231642	2.35304
Lead Time	1.2425	0.71319	0.529301	1.95569
Complain	1.4401	1.83068	-0.390580	3.27078
Container Quality	1.2596	1.78556	-0.525961	3.04516
Cooperative relationship business	1.4931	1.68029	-0.187199	3.17339
Delay notice	0.9373	2.10601	-1.168712	3.04331
Bidding compliance	2.1756	1.53831	0.637283	3.71391
Communication system	1.3802	0.73874	0.641536	2.11902
Speed in booking	0.5646	2.14773	-1.583131	2.71233
Accuracy in booking	1.0382	2.24079	-1.202592	3.27899
Delivery capacity	1.1251	1.89823	-0.773138	3.02333
Health and safety practices	1.3775	1.80169	-0.424196	3.17919
OHSAS 18001	1.0949	1.97237	-0.877476	3.06727
Monthly report CO ² emissions	0.9473	2.03192	-1.084621	2.97922
Green technology	1.0510	2.01511	-0.964118	3.06611

The sub-criteria included in the dispatcher are Shipping Costs, Lead Time, Bidding Compliance, and Communication System which can be seen in Table 4.

Table 4. Sub Criteria Included in the Dispatcher

Dispatcher
Shipping Cost
Lead Time
Bidding compliance
Communication System

The sub-criteria included in the Receiver are overnight costs, delivery delays, errors / complaints, container quality, Cooperative relationship business, delay notices, speed in bookings, accuracy in bookings, capacity delivery, health and safety practices, OHSAS 18001, monthly report CO² emissions, green technology which can be seen in Table 5.

Table 5. Sub Criteria Included in the Receiver

Receiver
Overnight cost
Delay delivery
Complain
Container Quality
Cooperative relationship business
Delay notice

Speed in booking
Accuracy in booking
Delivery capacity
Health and safety practices
OHSAS 18001
Monthly report CO ² emissions
Green technology

To find out the influence of each criterion, then an Impact Diagram Map is prepared, this is used to determine the influence of the sub-criteria on the sub-criteria which can be seen in Table 6.

Table 6. Impact Diagram

Shipping cost			na ve	na ve	na ve	na ve	na ve	na ve	na ve	na ve	na ve		na ve	na ve	na ve	na ve		
Overnight cost					na ve				na ve									
Delay delivery				na ve				na ve	na ve			na ve	na ve					
Lead Time	na ve		na ve		na ve			na ve	na ve	na ve	na ve	na ve						
Complain	na ve	na ve				na ve		na ve	na ve	na ve				na ve				
Container quality	na ve				na ve			na ve	na ve	na ve				na ve				na ve
Cooperative relationship business	na ve	na ve	na ve		na ve	na ve		na ve	na ve	na ve				na ve	na ve	na ve	na ve	
Delay notice						na ve			na ve	na ve			na ve					
Bidding compliance	na ve	na ve	na ve	na ve	na ve	na ve	na ve	na ve		na ve		na ve		na ve	na ve	na ve	na ve	na ve
Communication		na ve			na ve	na ve	na ve	na ve		na ve	na ve	na ve						
Speed in booking								na ve		na ve								
Accuracy in booking	na ve				na ve			na ve	na ve	na ve								
Delivery capacity		na ve	na ve	na ve	na ve			na ve	na ve									
Health and safety practices	na ve	na ve	na ve		na ve	na ve		na ve	na ve	na ve					na ve	na ve		
OHSAS 18001	na ve				na ve	na ve		na ve						na ve				na ve
Monthly report CO ₂ emissions	na ve							na ve						na ve	na ve			na ve
Green technology	na ve					na ve		na ve						na ve	na ve	na ve		

4.2 Hierarchy of Analytic Network Process (ANP)

In the selection of global logistics services, the company PT. XYZ has several locations of

material sending countries which will later be processed by manufacturing. The origin countries come from the following countries, namely China, Hong Kong, Japan, Korea, Philippines, Singapore, Taiwan, Thailand, Vietnam. Logistics service providers available are Evergreen, Hapag lloyd, Lunar, Maersk, MSC, Nitsu, ONE, OOCL.

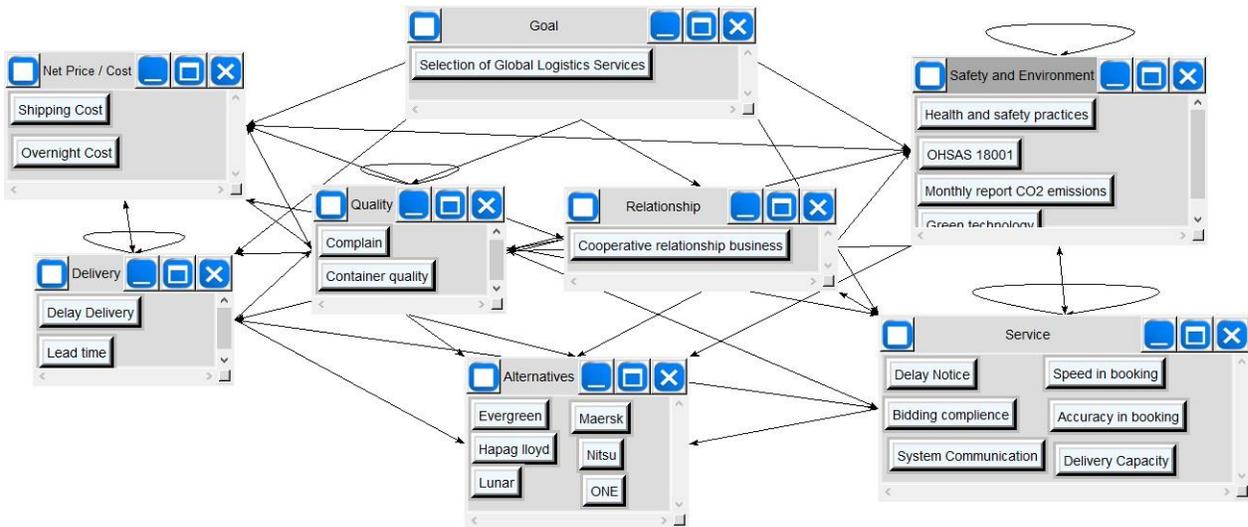


Figure 2. ANP Selection of Global Logistics Services

4.3 Pairwise Comparison Results Between Criteria

The weight of criteria and sub-criteria based on the logistic provider selection model hierarchy can be calculated by input the comparison value from the criteria that are interrelated. This calculation result can be seen in Table 7 and Table 8.

Table 7 Weight of criteria

Criteria	Weight
Net Price / Cost	0.29653
Delivery	0.19015
Quality	0.12644
Relationship	0.02354
Service	0.33276
Safety and Environment	0.02880

Table 8 Weight of sub criteria

Sub Criteria	Weight
Shipping cost	0.183897
Overnight cost	0.11264
Delay delivery	0.119625
Lead Time	0.070532

Complain	0.089268
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Table 9 Weight of sub criteria (cont.)

Sub Criteria	Weight
Container Quality	0.037173
Cooperation Relationship Business	0.025299
Delay notice	0.040019
Bidding compliance	0.115187
Communication system	0.124326
Speed in booking	0.015784
Accuracy in booking	0.016355
Shipping capacity	0.02109
Health and safety practices	0.015727
OHSAS 18001	0.006284
Monthly report CO ² emissions	0.002611
Green technology	0.004182

4.4 Selection of Global Logistics Service Provider

Based on the overall process that has been conducted, from the defining relations within the subcriteria, measuring the importance of each criterion, sub-criteria, and alternative, up to making decisions regarding the alternative logistics service providers in the Super Decision Software, In order to get the fittest logistics service providers, the company highlights the top 3 logistic service providers alternatives that later will be used for next year's alternatives in fulfilling the company's operational needs. The alternatives can be seen in Table 9.

Table 10 Alternatives of Global Logistics Service Providers

	Operational Carrier	Back up Carrier	Back up Carrier
China	Maersk	Lunar	Evergreen
Hong Kong	Lunar	Maersk	Evergreen
Japan	Maersk	MSC	OOCL
Korea	Maersk	Evergreen	Hapag lloyd
Philippines	Maersk	Lunar	MSC
Singapore	OOCL	Hapag lloyd	Evergreen
Taiwan	Maersk	Evergreen	Hapag lloyd
Thailand	Maersk	Lunar	Hapag lloyd
Vietnam	OOCL	Maersk	Hapag lloyd

6. CONCLUSIONS

The criteria and sub-criteria in the logistics service provider's selection are obtained from several literature review references that have been conducted on the selection of carriers or logistics service providers in electronic manufacturing companies. Based on several criteria and sub-criteria from the literature reviews and being reviewed by the experts, there are six selected criteria with a total of 17 sub-

criteria that will be used to obtain the alternative logistics service providers.

Based on this process, obtained the weights of criteria for service (0.33276), net price/cost (0.29653), delivery (0.19015), quality (0.12644), safety and environment (0.02880), relationship (0.0235). Sub-criteria were obtained shipping costs (0.1839), communication system (0.1243), delivery delay (0.1196), bidding compliance (0.1152), overnight cost (0.1126), error/complaint (0.0893), lead time (0.0705), delay notice (0.0400), container quality (0.0372), cooperative relationship business (0.0253), delivery capacity (0.0211), accuracy in booking (0.0164), speed in booking (0.0158), health and safety practices (0.0157), OHSAS 18001 (0.0063), green technology (0.0042), monthly report CO² emissions (0.0026).

The results of the weighted criteria and sub-criteria are used to determine the best alternative from each country. The results for China are Maersk, Lunar, Evergreen. While Hong Kong's are Lunar, Maersk, Evergreen. Japan's selected logistic service providers are Maersk, MSC, OOCL, and for Korea's are Maersk, Evergreen, Hapag Lloyd. Moreover, the selected providers for the Philippines are Maersk, Lunar, MSC. While Singapore's are OOCL, Hapag Lloyd, Evergreen. The selected providers for Taiwan are Maersk, Evergreen, Hapag Lloyd, and for Thailand's are Maersk, Lunar, Hapag Lloyd. The last one, Vietnam's selected providers are OOCL, Maersk, Hapag Lloyd.

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THE STRATEGY OF DEVELOPING SMART VILLAGES BASED ON CULTURAL TOURISM IN THE LAWAS MASPATI VILLAGES OF SURABAYA CITY

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ABSTRACT

The presence of the smart village concept is a new opportunity for current technological developments, especially the tourism sector. This research aims to identify the characteristics and factors, both internal and external, that influence the development of cultural tourism areas. In particular, it aims to formulate a smart village development strategy based on cultural tourism in Kampung Lawas Maspati. The method used in this study is a mixed method approach with a sequential explanatory design. In the sampling and interview techniques, the researcher used purposive sampling technique. While for the data collection techniques include: literature study, observation, questionnaires, interviews, and documentation. Furthermore, data analysis techniques include: confirmatory factor analysis, content analysis, and triangulation. From the results of research and analysis of EFAS and IFAS, it is concluded that the position of Kampung Lawas Maspati tourism is in cell I, which can be handled well through a growth strategy. This strategy can be achieved through vertical integration by means of backward integration (taking over the function of suppliers/suppliers) or by means of forward integration (taking over the function of distributors). This is the main strategy for businesses engaged in tourism with a strong market competitive position and high attractiveness.

Keywords: Strategic Management, Smart Village, Cultural Tourism, Kampung Lawas Maspati.

1. INTRODUCTION

A smart village can be said to be an ICT-based regional governance concept that has an area and community coverage that is not as wide or as large as a smart city. In an International Journal published in 2018 entitled "Smart Villages: Revitalizing Rural Services" it was emphasized that a smart village is a rural area and a community that builds on their current strengths and assets as well as new opportunities to develop added value and where traditional and new networks enhanced through digital communication technologies, innovation and better use of knowledge for the benefit of the population (The European Network for Rural Development, 2018).

Based on the journal, we can understand that the essence of a smart village concept is rural areas and communities that build them through existing strengths and assets, as well as new opportunities to develop added value. Where new traditional networks can be enhanced by means of digital communication technology, innovation and better use of knowledge for the benefit of its residents. Smart villages are also expected to be able to create a smart rural ecosystem that is able to integrate with technology. So that the

term digital ecosystem appears as shown in the following figure:

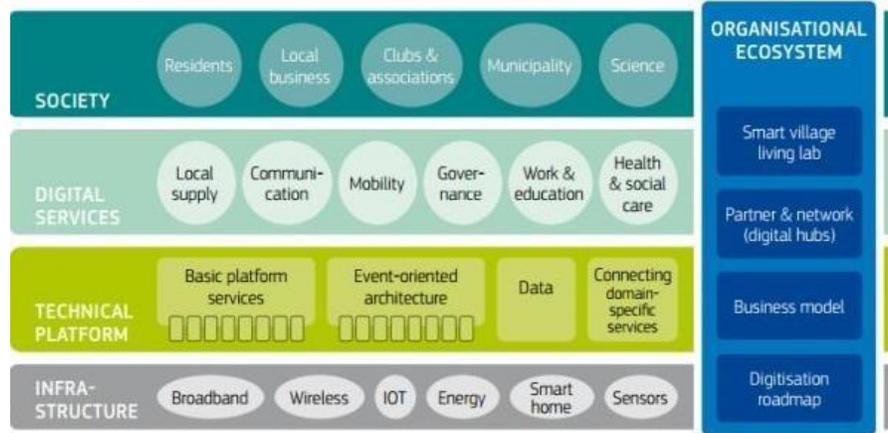


Figure 1. A Digital Ecosystem

The progress of the development of Smart villages in Indonesia can be seen from the results of several case study researches and also various applications of Smart cities in various cities in Indonesia. In 2019, the City of Surabaya as one of the largest cities in Indonesia won the Indonesian Smart City Index (IKCI) award in the Metropolitan City category with the highest score (Kompas.com, 2019). The big role in achieving this award is not only because of the city government and its staff, but also the contribution of the people of Surabaya. The development of the awareness and love of the people of the City of Surabaya for the region and its culture can be seen that there are still several identical villages which are then called villages because they still hold tightly to local wisdom, in the midst of the rapid development of modernization in the city of Surabaya.

Lawas Maspati Villages one of the cultural assets in the city of Surabaya which has historical value and various cultural attractions. Lawas Maspati Villages has the charm of historic buildings, beautiful surroundings, local products, and excellent community friendliness. Based on the initiative of local residents, this village was officially established by the Mayor of Surabaya together with Pelindo III, PT as Lawas Maspati Tourism Village. Cultural tourism that developed in Lawas Maspati Villages has three important positions. First, as a strategy to maintain the sustainability of cultural values that exist in the village. Second, as a medium to introduce the history of the city of Surabaya and local culture to the wider community. Third, tourism activities can drive the creative economy which directly has the potential to provide added value to the income of its citizens (B. Cros, H. D., & McKercher, 2015).

The management of Lawas Maspati Villages through a smart village approach in the midst of Surabaya's demands as a smart city, is of course interesting to explore in more depth where there is a slight difference with the existence of Lawas Maspati Villages which for years has maintained its local wisdom for the development of cultural tourism areas in the city of Surabaya. Where the characteristics of Lawas Maspati Villages are in the smart economy, smart environment, smart people, and smart tourism. This is as revealed by Komaruljannah (2018) in Kompasiana.com, that the results of the case study show that the smart economy and smart people can be seen from the efforts of residents in selling handicraft souvenirs. Meanwhile, the smart environment can be seen from the management of the toga plant which is processed into various superior products. There are even e-kios and e-UMKM which support technology in helping meet the needs of the community.

Then for smart tourism, it can be seen from the management of village streets and historic houses with the aim of continuing to preserve the cultural tourism area. However, there are challenges in managing Maspati Lawas Village as revealed by Larasati (2017) that some of the old buildings that have become

icons in the village are in a damaged and poorly maintained condition. In addition, as a relatively new cultural tourism destination, development through a cultural tourism approach is needed so that its existence amidst the development of an increasingly modern city can be maintained.

Based on these gaps, and as a value-added research. So this study focuses on analyzing the factors that influence the sustainability of cultural tourism with a smart village perspective. Where later the research results will be input in formulating a smart village development strategy based on cultural tourism in Lawas Maspati Villages, Surabaya City.

2. LITERATURE REVIEW

2.1 Strategic Management Concept

According to David (2011) strategic management is the art and science of formulating, implementing, and evaluating cross-functional decisions that enable an organization to achieve its goals. Sedjati (2019) explained that management is more focused on the process, which is a systematic way that has been determined to carry out activities or achieve targets as set. Meanwhile, strategy is a way to defend oneself and win business in intense competition, so that it can be interpreted differently in five ways, namely strategy as a plan, strategy as a leap, strategy as a pattern, strategy as positioning, and strategy as perception.

Based on some of the definitions above, it can be concluded that strategic management is the selection of the best strategy for the organization in all respects to support the success of the organization and is carried out continuously with the demands of conditions and situations in the field. This series of decisions becomes a determinant in the survival of an organization.

2.1.1 Strategic Management to Identify Internal and External Factors

To identify internal factors and external factors in this study using SWOT analysis. This analysis is used as an alternative strategy, which in this analysis can see how the analysis of internal strengths and weaknesses and external analysis (opportunities and threats). A SWOT analysis defines the main strengths, weaknesses, opportunities and threats that a program is likely to face during the planned timeframe. The following is a SWOT analysis as desired by Nasution in Indah (2015):

1. *Strengths*, Supporting factors for a program to achieve its goals consist of available resources, expertise or other advantages that can be obtained from other sources.
2. *Weakness*, the inhibiting factor for a program to achieve its goals can be in the form of facilities that are not fully available, lack of funding sources, lack of ability to manage, and lack of marketing expertise.
3. *Opportunity*, External factors that support a program in achieving its goals.
4. *Threats*, external factors that hinder a program to achieve its goals.

2.1.2 Smart Village Development Strategy based on Cultural Tourism

The development of cultural tourism can be done by fixing existing problems through the concept of solution handling. There are several factors that need to be considered in developing a tourism area. According to Zain in Larasati (2017) the factors that influence tourism development are as follows:

1. *Tourist attraction objects*: through increasing tourist attraction innovations to attract tourists' attention
2. *Tourism facilities*: development of facilities to meet the needs of visiting tourists such as the availability of lodging, culinary facilities, shops and public toilets.
3. *Human resources*: tourism management is needed which is influenced by human resources at a destination. This factor is needed to support the existence of tourism which is closely related to the implementation of better planned development
4. *Community/environmental conditions*: good community and environmental conditions are needed to support tourism development with the aim of making tourists more comfortable when visiting.

In this development strategy, selected through the QSPM matrix (Quantitative Strategic Planning Matrix)

to determine the priority strategy of several alternative strategies that will be used by the agency in running its business. David (2011) revealed that in this QSPM matrix, several alternative strategies were evaluated objectively based on the company's internal and external factors that had previously been identified. In this case, an entrepreneur must be able to determine a good strategy that suits the company's internal and external conditions. QSPM is also useful as a strategy determination whose relative attractiveness has been identified based on the company's internal and external factors. QSPM also has the privilege in which a series of strategies can be seen and observed sequentially based on the results of the TAS (Total Attractive Scores) scores and other features in the form of compilers or researchers being able to include strategic breakthroughs based on appropriate internal and external factors in the decision-making process.

2.2 Definition of Smart Village

A smart village or smart village as stated in the study center for decentralization and regional automation of regional administration institutions (2015), is a village that is able to solve problems effectively, innovatively and sustainably, and is able to transform resources productively, leading to outputs and outcomes that are good. high added value by relying on sevenpillars, namely: 1) Smart People; 2) Smart Government; 3) Smart Economy; 4) Smart Environment; 5) Smart Life; 6) Smart Mobility and 7) Smart Tourism. Each pillar or aspect of the smart village has its own indicators or sub-aspects that are interrelated with each other.

Each of these indicators is obtained through a process of extracting virtue values and local wisdom that grows in the village by identifying general or universal aspects and sub-aspects. The exploration of local values itself focuses on at least two main points. First, local creations or initiatives that lead to the realization of a smart village. Second, the steps taken by the village in describing the various local creations and initiatives so that they become a concrete action agenda within the framework of forming a smart village.

Smart village or Smart Village is an ecosystem consisting of various components. The concept of smart village is understood by experts as the integration of information technology in the life of rural communities, resulting in the benefit and sustainability of information technology and rural communities. Information technology in the context of smart villages is used as an element that encourages the relationship between the village government, the community and the rural environment so that it will be able to realize the goals of implementing rural life based on the use of information technology. So that the application of the smart village concept must be based on these three elements, including the character, role, and function of each element. The explanation is in the image below:

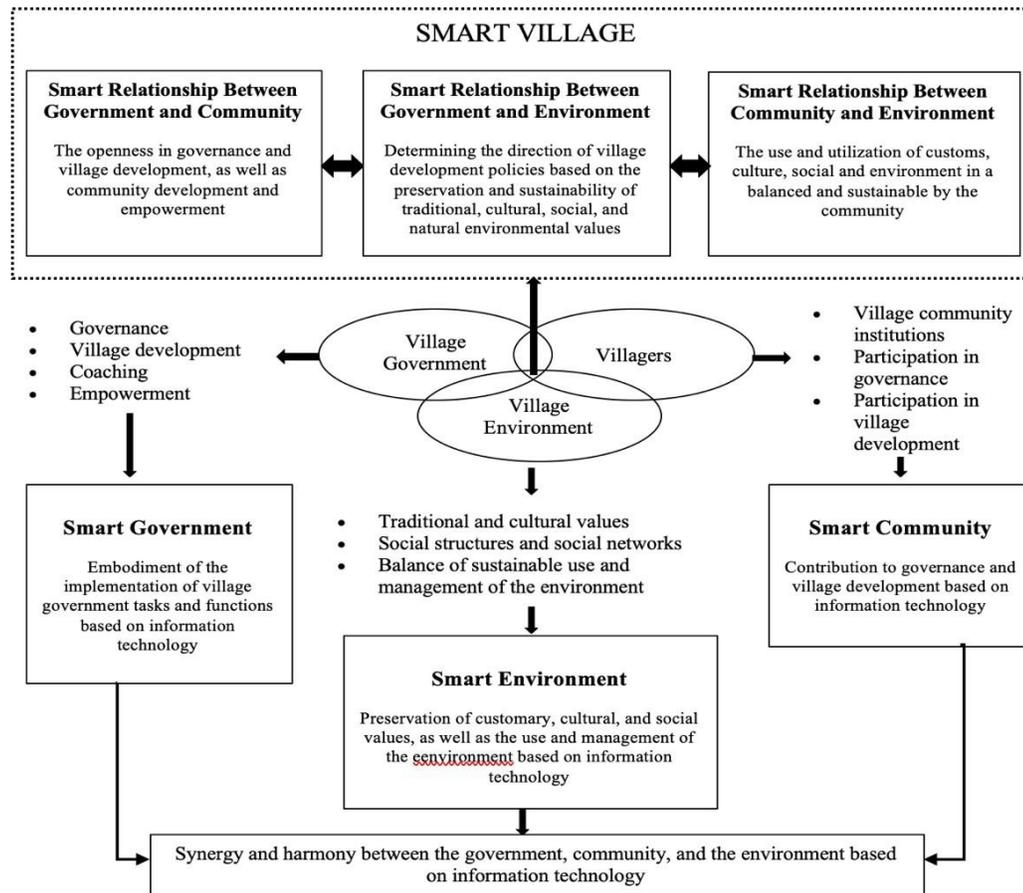


Figure 2. Alternative Model Smart Village

2.3 Definition of Tourism

John Richardson in his book entitled "Understanding and Managing. Tourism. Australia: Pearson Education", asserts that Tourism consists of activities or people, traveling to and living in places outside their usual environment for not more than one consecutive year for leisure, business and other purposes (Richardson, John and Martin Fluker , 2004). The opinion provides an understanding that tourism consists of activities or people, traveling to and staying in places outside their usual environment for not more than one consecutive year for leisure, business and other purposes.

Based on the understanding and essence of tourism, of course it is a variable that has its own classification in the form of types and models. Spillane (1987), distinguishes the types into the following:

1. *Tourism to Enjoy Travel (Pleasure Tourism)*

This type of tourism is carried out by people who leave their homes for vacations, to seek new fresh air, to fulfill their curiosity, to relax their nervous tension, to see something new, to enjoy the beauty of nature, or even to get peace and relaxation. peace in the suburbs.

2. *Tourism for Recreation (Recreation Tourism)*

This type of tourism is carried out by people who want to use their days off to rest, to restore their physical and spiritual freshness, who want to refresh their tiredness and fatigue.

3. *Tourism for Culture (Cultural Tourism)*

This type of tourism is carried out because of the desire to learn about the customs, institutions, and ways of life of the people of other regions, in addition to visiting historical monuments, relics of past

civilizations, art centers, religious centers, or to participate in festivals. art festivals, music, theater, folk dances, and others.

4. *Tourism for Sports (Sports Tourism)*

This type can still be divided into two categories;

- a. Big Sports Event, tourism that is carried out because of major sporting events such as the Olympic Games, World Cup, and others.
- b. Sporting Tourism of the Practitioner, namely sports tourism for those who want to practice and practice themselves, such as mountain climbing, horse riding, and others.

5. *Tourism for Business Affairs (Business Tourism)*

This business trip is a form of professional travel or travel because it is related to a job or position that does not provide the perpetrator with a choice of destination or travel time.

6. *Convention Tourism*

Conventions are often attended by hundreds and even thousands of participants who usually stay a few days in the host city or country.

3. METHODS

The research design used in this research is sequential explanatory, which collects and analyzes quantitative data and then collects and analyzes qualitative data. In this study, quantitative data were obtained through questionnaires with pre-determined respondents. Quantitative methods were used to obtain data on the characteristics of the development of cultural tourism areas and the factors, both internal and external, that could affect tourism development in Lawas Maspati Villages. While the qualitative method is used to formulate the strategy to be used by connecting the quantitative data that has been obtained previously. The qualitative method uses interviews with stakeholders who are directly involved as informants. The operational variables in this research are as follows:

Table 1. Withdrawal of Variables, Indicators and Parameters

No	Research Purposes	Variable	Operational Definition	Indicator	Parameter
1	Identifying the Characteristics of Developing a Cultural Tourism Area Using a Smart Village Approach in Lawas Maspati Villages,	<i>Smart Villages</i>	A village that has a tourism attraction with special characteristics, namely a smart village, which exists in the community and its environment	<i>Smart People</i>	<ol style="list-style-type: none"> 1. <i>Level of qualification</i> 2. <i>Affinity to life long learning</i> 3. <i>Social and ethnic plurality</i> 4. <i>Flexibility</i> 5. <i>Creativity</i> 6. <i>Open-mindedness</i> 7. <i>Participation in public life</i> (R. Giffinger dkk, 2007) 8. <i>Digital Mastery</i> (Santoso, A.D. dkk, 2019)
				<i>Smart Economy</i>	<ol style="list-style-type: none"> 1. <i>Innovative spirit</i> 2. <i>Entrepreneurship</i> 3. <i>Economic image & trademarks</i> 4. <i>Productivity</i> 5. <i>Flexibility of labour market</i> 6. <i>International embeddedness</i> 7. <i>Ability to transform</i> (R. Giffinger dkk, 2007) 8. <i>Public Funding for Research Development</i> 9. <i>Multisector Linkages</i> (Santoso, A.D. dkk, 2019)

	Surabaya City			<i>Smart Environment</i>	<ol style="list-style-type: none"> 1. Attractivity of natural conditions 2. Pollution 3. Environmental protection 4. Sustainable resource management (R. Giffinger dkk, 2007)
				<i>Smart Tourism</i>	<ol style="list-style-type: none"> 5. <i>Attraction</i> 6. <i>Tourism Interaction</i> 7. <i>Smart Tourism Economy</i> (Santoso, A.D. dkk, 2019)
2	Identifying Internal and External Factors Affecting the Development of Cultural Tourism Areas in Maspati Lawas Village, Surabaya City	Cultural Tourism	A village that has a tourism attraction with cultural potential, local wisdom, economy, and adequate facilities and infrastructure	<i>Attraction</i>	<ol style="list-style-type: none"> 1. Ticket prices 2. Cleanliness of tourist attractions 3. Tourist comfort (Yoeti, Oka A., 2008)
				<i>Accessibility</i>	<ol style="list-style-type: none"> 1. Availability of transportation 2. Availability of directions 3. Road conditions 4. Time to reach the destination (Yoeti, Oka A., 2008)
				<i>Amenity</i>	<ol style="list-style-type: none"> 1. Availability of clean water 2. Availability of public toilets 3. Parking area 4. Availability of gift shops (Yoeti, Oka A., 2008)
				<i>Anciliary</i>	<ol style="list-style-type: none"> 1. Availability of the community to be a tour guide 2. Community friendliness 3. Availability of cooperation with the government 4. Participate in maintaining cleanliness (Yoeti, Oka A., 2008)

As for data collection techniques in the context of this research: literature study, observation, questionnaires, interviews, and documentation. Furthermore, data analysis techniques include: confirmatory factor analysis, content analysis, and triangulation.

4. RESULTS

The EFE and IFE matrices were prepared based on interviews with 9 informants, including the Head of RT, Head of RW, Tourism Office, CSR Pelindo, and Villagers of Lawas Maspati Villages. The weighting is done by comparing each external factor and the internal factor of the old village of Maspati to get the factor that takes precedence. And the rating is done by looking at the response of the old

village of Maspati to the opportunities and threats that have been or will be faced.

Table 2. Matriks EFE dan IFE Lawas Maspati Villages

No	External Factors	Weight	Rating	Score
OPPORTUNITY				
1	Lawas Maspati village economic growth	0,092	8	0,737
2	Development of digital information technology	0,079	6	0,474
3	Tourist village with many awards	0,092	8	0,737
4	The development of new MSMEs	0,092	8	0,737
5	There is raw materials assistance for MSMEs	0,066	5	0,329
6	Certainty of funding assistance from CSR	0,079	6	0,474
THREAT				
7	Expensive ticket prices	0,092	8	0,737
8	High level of tourism and cultural competition	0,079	7	0,553
9	Threat of new competitors	0,066	5	0,329
10	The lack of tourists who come because of the pandemic	0,105	9	0,947
11	The lack of tourist area security system	0,066	5	0,329
12	Delay in CSR funding assistance	0,092	8	0,737
TOTAL		1,0	83,0	7,118

No	Internal Factors	Weight	Rating	Score
STRENGTH				
1	Service and welcoming guests in friendly and polite manner	0,090	8	0,718
2	Good promotional activities	0,103	6	0,615
3	It has historical buildings (heritage village)	0,077	7	0,538
4	It has unique cultural tourism	0,077	7	0,538
5	It has typical village souvenirs	0,077	7	0,538
6	There are tour guides who guide local and foreign tourists	0,090	8	0,718
WEAKNESS				
7	Less strategic location	0,077	7	0,538
8	Limited cultural attractions displayed	0,090	8	0,718
9	Low level of public education	0,064	6	0,385
10	Poor coordination between leaders and the community	0,090	8	0,718
11	Inadequate facilities and infrastructure	0,090	8	0,718
12	Not many outsiders who know about Lawas Maspati village	0,077	7	0,538
TOTAL		1,0	87,0	7,282

Total Average IFE Weighted

	Strong 7,0-9,0	Average 4,0-6,0	Weak 1,0-3,0
High 7,0-9,0	I	II	III
Medium 4,0-6,0	IV	V	VI
Low 1,0-3,0	VII	VIII	IX

Figure 3. Lawas Maspati Villages IE Matrix

The total weighting result of the IFE matrix is 7.282 and the EFE matrix is 7.118 then the results are mapped into the IE matrix where the x-axis comes from the total value of the IFE matrix and the y-axis is the total value of the EFE matrix. So that the value of the IE matrix above can be concluded that the position of Maspati old village tourism is in cell I, divisions that are included in cell I can be handled properly through the Growth strategy (concentration through vertical integration). Growth through concentration can be achieved through vertical integration by means of backward integration (taking over the functions of suppliers/suppliers) or by means of forward integration (taking over the functions of distributors).

Internal Factors	STRENGTH	WEAKNESS
	External Factors	<ol style="list-style-type: none"> Service and welcoming guests in a friendly and polite manner Good promotional activities Has historical buildings (heritage village) Typical cultural tour of the Lawas Maspati village Have a typical souvenir for tourists Have a tour guide for local and foreign tourists
OPPORTUNITY	STRATEGI SO	STRATEGI WO
1. Economic growth of the Lawas Maspati village	1. Looking for a wider and accessible market share (S1,S2,O2,O3,O6)	1. Maximizing land with adequate facilities and infrastructure through CSR assistance (W1,W5,O1,O6)
2. Development of digital information technology	2. Improving the economic strata of the Lawas Maspati village (S3,S4,S5,O1,O2,O4)	2. Creating more diverse cultural attractions (W2,O3)
3. Tourist village with many awards	3. Creating new job opportunities (S2, S3, S4, S5, S6, O1, O2, O4)	3. Carry out good coordination between officials in Maspati lawas and the community (W3, W4, O1, O4, O5)
4. The development of new MSMEs	4. Obtaining financial support for the development of village tourism (S1,S2,S6,O5,O6)	4. Conducting digital promotions for the introduction of village tourism (W6, O2, O3)
5. Availability of raw material assistance for MSMEs	5. Preserving cultural tourism and historical buildings (S3,S4,O3,O6)	5. Socialization in the community without exception regarding the village tourism program (W3, W4, O1, O4)
6. Certainty of funding assistance from CSR	6. Training in foreign languages and digital technology in the Lawas Maspati community (S1,S6,S2,S3)	6. The need for good financial management and transparency regarding village development (W4,W5,O1,O5,O6)
THREAT	STRATEGI ST	STRATEGI WT
1. Expensive ticket prices	1. Provide comfort for tourists and evaluate with questionnaires (S1,S6,T1,T2)	1. Improve brand culture in the form of cultural aspects of the community and old buildings that has hictorical characteristic (W2, W5, W6, T2, T3)
2. High level of tourism and cultural competition	2. Selecting tourism ambassadors for tourism promotion activities (S1,S2,S6,T2,T3,T4)	2. Build a brand slogan to communicate the brand more persuasively (W3,W4,W6,T1,T2,T3)
3. Threat new competitors	3. Participate in certain events and seek sponsorship with product introductions (S2,S4,S5,T2,T3,T6)	3. Adding digital destinations in the form of photo spots so that they can be uploaded to social media for promotion (W1,W5,W6,T2,T4)
4. The lack of tourists who come because of the pandemic	4. Create a mobile application to build city branding, especially the specific tourism (S2, S3, S4, S5, T2, T3, T4)	4. Improvement of parking and lodging facilities for the convenience of tourists (W1, W5, T5)
5. The lack of tourist area security system	5. Improvement of tourism security by targeting the acquisition of CHSE certificates and the application of 3M (S1,S2,S3,S6,T4,T5)	5. Cooperating with the government and CSR in city tour activities for tourism promotion (W1,W4,W6,T2,T3,T4)
6. Delay in CSR funding assistance	6. Socialization to tourists and residents of Lawas Maspati about the importance of implementing health protocols (S2, S6, T4)	6. Selling souvenirs with sponsorship name branding to get financial support (W6, T6)

Figure 4. Matriks SWOT

Table 3. Matriks QSP

No	Key Factors	Weight	Strategy 1		Strategy 5		Strategy 9		Strategy 13		Strategy 15		Strategy 22	
			AS	TAS	AS	TAS	AS	TAS	AS	TAS	AS	TAS	AS	TAS
STRENGTH														
1	Service and welcoming guests in friendly and polite	0.090	7	0.630	7	0.630	7	0.630	7	0.630	7	0.630	6	0.540
2	Good promotional activities	0.103	8	0.824	8	0.824	8	0.824	7	0.721	8	0.824	8	0.824
3	It has historical buildings (heritage village)	0.077	8	0.616	8	0.616	8	0.616	8	0.616	8	0.616	8	0.616
4	It has unique cultural tourism	0.077	8	0.616	8	0.616	7	0.539	8	0.616	8	0.616	8	0.616
5	It has typical souvenirs for tourist	0.077	6	0.462	8	0.616	6	0.462	6	0.462	6	0.462	6	0.462
6	Lawas Maspati has tour guide for local and foreign tourist	0.090	7	0.630	7	0.630	7	0.630	8	0.720	8	0.720	8	0.720
WEAKNESS														
7	Less strategic location	0.077	5	0.385	7	0.539	6	0.462	7	0.539	6	0.462	8	0.616
8	Limited cultural attraction displayed	0.090	6	0.540	6	0.540	7	0.630	6	0.540	5	0.450	6	0.540
9	Low level of public education	0.064	5	0.320	6	0.384	5	0.320	6	0.384	7	0.448	5	0.320
10	Coordination with community is not going well	0.090	7	0.630	7	0.630	7	0.630	7	0.630	8	0.720	6	0.540
11	Inadequate facilities and infrastructure	0.090	6	0.540	6	0.540	6	0.540	8	0.720	6	0.540	8	0.720
12	Not so many outsiders know about Lawas Maspati village	0.077	6	0.462	7	0.539	7	0.539	7	0.539	7	0.539	7	0.539
OPPORTUNITY														
1	The economic growth of the Lawas Maspati village	0.092	8	0.736	7	0.644	7	0.644	7	0.644	7	0.644	8	0.736
2	Development of digital information technology	0.079	7	0.553	5	0.395	7	0.553	6	0.474	6	0.474	6	0.474
3	Tourism village with many awards	0.092	8	0.736	7	0.644	8	0.736	8	0.736	6	0.552	8	0.736
4	The development of new MSMEs	0.092	7	0.644	6	0.552	7	0.644	7	0.644	7	0.644	7	0.644
5	Availability of raw material supports for MSMEs	0.066	6	0.396	5	0.330	6	0.396	6	0.396	6	0.396	6	0.396
6	Certainty of funding support from CSR	0.079	7	0.553	6	0.474	7	0.553	7	0.553	7	0.553	6	0.474
THREAT														
7	Expensive ticket prices	0.092	6	0.552	7	0.644	6	0.552	8	0.736	5	0.460	7	0.644
8	High level of tourism and cultural competition	0.079	7	0.553	7	0.553	6	0.474	7	0.553	7	0.553	7	0.553
9	Threat of new competitors	0.066	7	0.462	7	0.462	5	0.330	7	0.462	6	0.396	7	0.462
10	The lack of tourists who come because of the pandemic	0.105	6	0.630	6	0.630	6	0.630	6	0.630	6	0.630	6	0.630
11	Area security system is still lacking	0.066	5	0.330	5	0.330	6	0.396	8	0.528	6	0.396	8	0.528
12	Delay in CSR funding support	0.092	6	0.552	6	0.552	7	0.644	6	0.552	7	0.644	6	0.552
					13.352		13.314		13.374		14.025		13.369	13.882

From the QSP matrix, it can be concluded that from the alternative strategies, the 13th alternative was chosen, namely maximizing land with adequate facilities and infrastructure through CSR assistance (W1,W5,O1,O6). Because it has a total attractiveness value of 14,025, which is bigger than other strategies. In addition, there are five choices of marketing strategy alternatives that are superior for Maspati old village tourism including improving parking and lodging facilities for tourist comfort (W1, W5, T5), participating in certain events and seeking sponsorship with product introductions (S2, S4, S5,T2,T3,T6), Conducting good coordination between officials in old Maspati and the community (W3,W4,O1,O4,O5), Looking for a wider and accessible market share (S1,S2,O2,O3, O6), Preserving cultural tourism and historical buildings (S3,S4,O3,O6).

6. CONCLUSIONS

Based on the results of research using the Mix Method in the cultural tourism area in Lawas Maspati Villages, several main conclusions were obtained, namely:

- Attractions for tourists in the old village of Maspati can be categorized into tangible (historical buildings, local village products, traditional games, culinary, and patrol music) and intangible (tourism and community community).
- As a tourist village, Lawas Maspati Villages does not yet have facilities that support tourist activities, both local and foreign, such as public toilets and very limited parking spaces.
- The people in Lawas Maspati Villages have very strong social relations and a high level of community or harmony, this is also an attraction for foreign tourists, especially to Lawas Maspati Villages.
- Land use is dominated by housing with simple types, and has a function as a place for MSMEs and serves as a place of residence.

The results of the identification of internal and external factors that affect the sustainability of cultural tourism in Lawas Maspati Villages and the results of observations on target 1 obtained several strengths, weaknesses, advantages, and challenges which will then be used as input in the preparation of the SWOT matrix. Whereas in the EFAS and IFAS analysis, from the IE matrix value it can be concluded that the position of Maspati old village tourism is in cell I, divisions that are included in cell I can be handled properly through the Growth strategy (concentration through vertical integration). Growth through concentration can be achieved through vertical integration by means of backward integration (taking over the functions of suppliers/suppliers) or by means of forward integration (taking over the functions of distributors). This is the main strategy for MSMEs engaged in tourism by having a strong market competitive position in a highly attractive industry. The results of the SWOT matrix show that there is a selection of superior marketing strategy alternatives for Maspati old village tourism, including:

- a. Maximizing land with adequate facilities and infrastructure through CSR assistance
- b. Improvement of parking and lodging facilities for the convenience of tourists
- c. Participate in certain events and seek sponsorship with product introduction pengenalan
- d. Do good coordination between officials in lawas maspati and the community
- e. Looking for a wider and reachable market
- f. Preserving cultural tourism and historical buildings

From the actions that can be taken first by Lawas Maspati Tourism Villages in choosing an alternative strategy that is more superior, namely maximizing land with adequate facilities and infrastructure through CSR assistance, this is needed because funds for repairing facilities and infrastructure are limited, which by maximizing facilities and infrastructure can attract visitors or tourists. It is known that the existing infrastructure must be more complete, as in the interview there were obstacles for parking facilities and public toilet facilities which were still limited and some were even not maintained, this would disturb the comfort of visiting tourists.

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Parallel Session 2

Room K (12.10 – 13.55)

Moderator:

Category : Project Management

MODELING PROJECT CHARACTERISTICS ON CONSTRUCTION PROJECT PERFORMANCE BASED ON TIME COST AND QUALITY IN PT XYZ REGIONAL JABODETABEK

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ABSTRACT

PT XYZ is a railway transportation company. Many construction projects are implemented to support its business in Jabodetabek. The construction projects in the Jabodetabek are carried out with different characteristics and influenced by many variables. While the owner (PT XYZ) want that the aspects of project performance are achieved. Project performance can be measured from many things such as cost, quality, social impact, etc. The purpose of this study are to identify and modeling characteristics project to performance based on time cost and quality. Literature review from previous study and expert discussion are methode to find variables and indicators. this study finds that project characteristics have correlation to project performances. Furthermore, project characteristics variable are consist of project implementation system (X1) with 9 assessment indicators, the owner capability variable (X2) with 5 assessment indicators, the contractor capability variable (X3) with 10 assessment indicators and the project external condition variable (X4) with 3 assessment indicators. Meanwhile, time performance (Y1), cost performance (Y2) and quality performance (Y3) have 2 assessment indicators.

Keywords: Construction project characteristics, Construction project performance

1. INTRODUCTION

PT XYZ is railway transportation company. To support the rail transportation business, many construction projects have been carried out, especially in Jabodetabek such as, station revitalization, overcapping construction, construction of pedestrian, track, signaling, electricity etc. Construction projects are carried out with different characteristics starting from the tender process, type of contract, implementation method, technical specifications, environment, stakeholders etc. These differences in characteristics make different problems in each construction project implementation. While, the owner has the goal that the project has good performance based on time, cost and quality. Some contractors create projects with good project performance on time, cost and quality, but there are still contractors who produce

poor project performance. Time performance data for the construction project of PT XYZ in the Jabodetabek area in 2018-2020 can be seen in the figure 1.

Based on Figure 1.1, it can be seen that the total of 15 projects implemented, only 1 project was finished earlier and 4 projects were finished on time, this means that 10 projects were time overrun. Time overrun will also indirectly affect to the cost and quality of the project. In general, project performance is influenced by the characteristics of the project. For example, Chan and Kumaraswamy (1999), found that project time and cost performance were influenced by project characteristics, namely the procurement system, team performances, client representatives, contractors and environment. Molenaar and Songer (1998), analyzed the relationship between project characteristics : the nature of the project, owner, design and communication between stakeholders to the time and cost performance of the project. Kaming et al. (1997), identified the relationship between project characteristics : addendum requests, experience, and resources to project cost overruns using factor analysis.

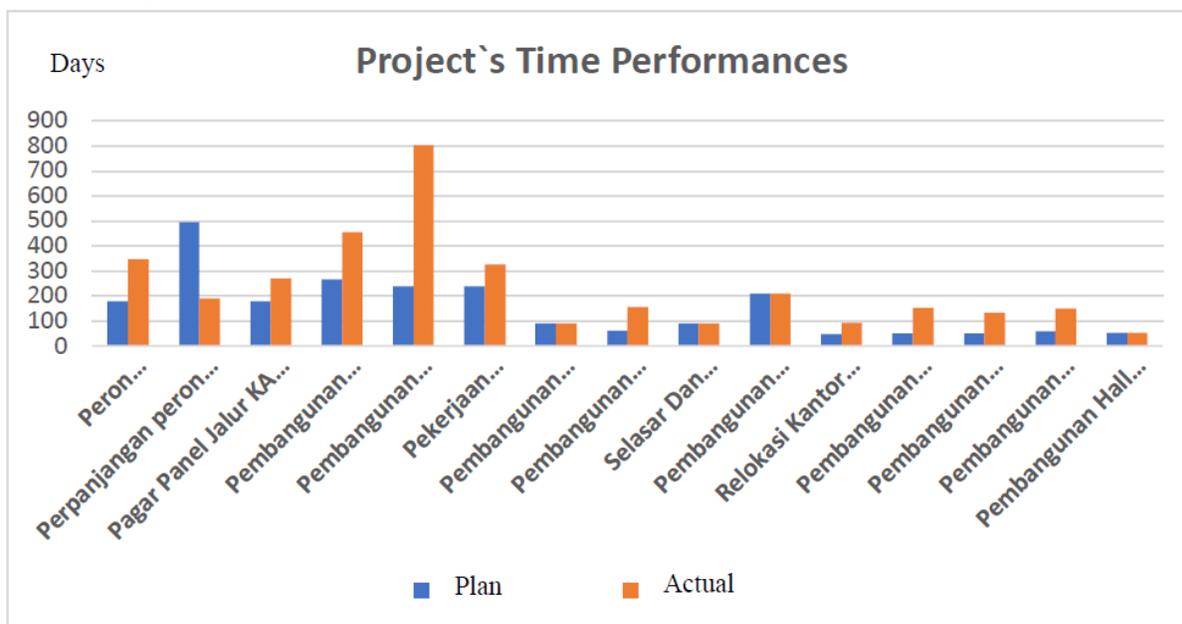


Figure 1. Time performance in 2018 – 2020

The implementation of PT XYZ construction project in the Jabodetabek is one of the main strategic investment activities. Part of the budget for investment activities comes from loan, therefore it is important to achieve PT XYZ's construction project performance as planned. Based on the problems that the performance of the resulting project is not as planned. The purpose of this study are to identify and modeling project characteristics project to performance based on time cost and quality using literature review.

2. LITERATURE REVIEW

Literature review in this study base on many previous studies. Many previous studies conducted an analysis of the factors that affect project performance. Several studies have also identified project characteristics. Previous research that is used as a reference in this study are as follows :

Chen et al. (2012) conducted a study of 62 critical success factors (CSFs) of construction projects. 62 (CSFs) refining to produce 46 (CSFs) by expert discussions. On the basis of the CSFs system, which consisted of three categories and ten subcategories, this study applied the structural equation model (SEM) to explore the interrelationships. Ten subcategories on this research are economic environment, owner`s

ability, political environment, natural environment, project characteristics, owner`s preference, owner`s expectation, project delivery characteristics, subcontractors characteristics and contractor`s characteristics.

Ling (2004), is identify key factors that affect 11 areas of design-build (DB) project performance. Using data from 42 public and private DB projects, this study finds that contractor characteristics are the key determinants that affect the most number of performance metrics. The most important variable is the contractor`s track record for completing projects on budget, on schedule and to acceptable level of quality. Other important determinants are contractors`s capability and adequacy of their resources.

Molenaar and Songer (1998), reports on the analysis of 122 case studies and the resulting automated tool for public sector design – build project selection. Models are developed for five performance criteria that correlate specific project characteristics to success. Performance criteria and associated models include budget variance, schedule variance, conformance to expectations, administrative burden, and overall user satisfaction. Project characteristics are categorized as project, owner, market and relationship variables.

Nyangwara and Evelyn (2015), This study analyzes the factors affecting the performance of construction projects to help owners, consultants and contractors to solve problems and improve project performance. Data were collected by questionnaire survey. 40 factors were identified and grouped into 8 groups, evaluated and ranked from the perspective of owners, consultants and contractors. The results show that the performance of construction projects is influenced by clients, contractors, consultants, stakeholders, regulators, the national economy, and others.

Construction Project Performance

construction project performance can be define as the result of work according the expectations and agreements of the stakeholders on contract. The concept of 'Iron Triangle', is a fundamental indicator for assessing and understanding construction project performance. The Iron Triangle is a representation of project success based on time, cost and quality. Thomas (2002) identified the performance of construction projects : financial stability, work progress, quality, safety, resources, client relations, consultant relationships, management capabilities, contract claims and disputes, relationships with subcontractors, reputation and number of subcontracts used. Cheung et al. (2004), identified project performance such as people, cost, time, quality, safety, environment, client satisfaction, and communication. Although many studies state that the 'Iron Triangle' time, cost and quality indicators cannot describe the overall performance of a construction project, until now these indicators are still the main aspect in assessing construction project performance against the plan (Pollack et al, 2018) .

a. Time Performance

Time performance is the process of comparing actual work with the schedule (Mattjik & Sumertajaya, 2011). The time performance of a construction project is measured based on the implementation time so that the project must be carried out in accordance with the specified time. Ensuring the project runs according to the specified time is very important because failure in time can cause additional project costs (cost overrun).

b. Cost Performance

In general, project cost is defined as the total cost required to complete the project. Project costs are determined based on quantitative calculations of project resource requirements such as labor, materials, logistics, etc. Performance of a construction project is good if the project cost is in accordance with the estimated budget cost. So the cost overrun can be estimated by dividing the change in the number of contracts by the number of initial contracts. Ling et al. (2004), said that the cost will increase with the acceleration of work, while increasing the duration will reduce costs.

c. Quality Performance

Success of the quality of a construction project is important to satisfaction of the project owner. The product or project results must meet the specifications and criteria required in the work agreement/ contract. Stojcetovic et al, (2014), the benefits of quality performance are customer satisfaction, reduced product costs, increased productivity and better competitiveness. Quality failure is a very common and serious

problem in construction projects because the expected quality is not met (Kaming & Olomolaiye, 1997). Failure to achieve the expected quality will have a significant impact on the cost and time of the project (Marosszeky et al, 2002)

Project Characteristics

Characteristics of construction projects are special inherit by each construction project. Turner and Muller (2002), stated that the project has three special characteristics: unique / no same project before and after, using a new process and temporary. There have been many studies that identify the characteristics of construction projects. Molenaar and Songer (1998), analyzed the relationship between project characteristics : nature of project, owner, design, and communication. Project performance : cost, time, etc. Correlation analisys use regression analysis and multivariate statistical analysis. Based on the previous literature study, the characteristics of the construction project in this study were determined below

a. Project Implementation System

Complexity of the project is always faced with many problems including cost, time, quality, social, stakeholder, type of project etc. Problem arises due to a lack of understanding of the project implementation system that can be developed to solve the problem. The project implementation system is a critical factor for project success : cost, and quality (Chen et al, 2012). The project implementation system is an activity that starts from the early stages of planning until the implementation of a construction project.

b. Owner capability

Owner is the person or entity that owns the project and provides work to the provider/ worker/ contractor. The owner has an important role in project implementation, based on project management knowledge the owner has control and responsibility for costs and revenues of project (Olsson & Johansen, 2016).

c. Contractor capability

Successful project performance is a fundamental issue for most government, private and organizational project implementations. A lot of literature discusses project performance which is influenced by several things, one of which is the capability of the contractor. Contractor capability factors that influence project success include: safety and quality, past performance, environmental management, technical management, resources, organization, experience with similar projects and financial condition. Chen et al, (2012) identified the criteria for contractor factors that determine project success, namely contractor experience, contractor's financial condition, reputation, capabilities, employees, technological and technical capabilities, working relationships, communication skills, availability of work materials and tools.

d. Project external condition

The implementation of a construction project is influenced by many factors, including internal and external conditions. Internal conditions come from the nature of the project while project external conditions are conditions outside the project that affect the implementation of a project. Many studies identify the external conditions of the project, Chen et al, (2012) identify the external factors of the project : economic conditions, political conditions and nature. Nyangwara and Evelyn, (2015) mention that the project environment includes economic, social, physical environments related to industry and technology. The process of running a construction project is influenced by the external environment, such as the environment, the influence of users, competitors, project location, climate, organization, social, culture, and anything that affects the success of the project (Wideman, 1990).

3. METHODS

This study use literature review on previous research and experts discussion method. Based on the literature review, We can found that project characteristics correlates with construction project performance based on time, cost and quality. This correlation is the basic research model. The objectives of the literature review are as follows:

- a. Identify variables and indicators on the characteristics of construction projects.
- b. Identify indicators on the construction project performance based on time, cost and quality

- c. Develop a conceptual model of project characteristics correlates with construction project performance based on time, cost and quality

The next step is the expert study. Expert studies is used to confirm that the variables and indicators from literature review are relevant. The expert study was conducted on five experts with a minimum education of a Bachelor's degree and a minimum 5 years of experience in the construction project of PT XYZ. The expert profile as shown in Table 1.

Table 1. Experts profile

Num.	Position	Education	Experience
1	Head of Division	Bachelor's degree of civil engineering	25 Years
		master's degree in business administration	
2	Project Manager	Bachelor's degree of civil engineering	15 Years
3	Project Manager	Bachelor's degree of architect	8 Years
4	Project Manager	Bachelor's degree of electrical engineering	10 Years
5	Project Manager	Bachelor's degree of civil engineering	20 Years
		Magister's degree of civil engineering	

4. RESULTS

Project Characteristics Variable

Based on the literature review on previous research and experts discussion, it were found that the project characteristics were formed by 4 variables namely project implementation system, owner capability, contractor capability and project external conditions. The project implementation system variable refers to the procurement process up to project implementation. The owner's capability variable relates to the technical/non-technical capabilities and the owner's experience in implementing the project. The contractor capability variable is related to the technical/non-technical capabilities and experience of the contractor in implementing the project. Variables of project external conditions refer to weather conditions, environment, force majeure, economic conditions and political conditions. Each variable has its own indicators as shown in Table 2.

Table 2. Project characteristic variables and indicators

Variables	Indicators	Source
Project implementation system	Project delivery system	(Chen et al, 2012)
	Tender method	
	Completeness of design documents before tender	
	Number of contractors participating in the tender	
	Type of contract used	
	Project location	
	Design complexity	
	Complexity of construction work	
	complete design	
Variables	Indicators	Source
Owner capability	Owner's ability to project complexity	(Ling, 2004)
	Owner's experience with similar projects	
	Availability of staff owned by the owner to oversee project implementation	
	Many projects have been done by the owner	
	Previous working relationship between owner and contractor	

Contractor capability	Contractor's experience with similar types of projects	(Chen et al, 2012)
	Contractor's financial condition	
	Contractor reputation	
	Project management skills of project manager	
	Ability of the staff/employees of the contractor	
	Contractor technology capability	
	Track Record of working relationship between contractor and owner	
	Contractor communication skills	
	The contractor's ability to provide work materials	
	Availability of work tools owned by contractors	
Project external condition	Weather conditions, environment and force majeure	(Chen et al, 2012)
	Political conditions (regulation, material taxes, war)	
	Economic conditions (inflation, rupiah exchange rate, fluctuations in material and labor prices)	

Construction Project Performance

Based on the literature review on previous research and experts discussion, it were found that project performance can be measured based on time performance, cost performance and quality performance variables with each indicator as shown in Table 3.

Table 3. Time, cost and quality performance variables and indicators

Variables	Indicators	Source
Time	Work according schedule / S curve made	(Cho et al, 2009)
	Time completion according to the initial contract	
Cost	Project costs according to budget plan	(Cho et al, 2009)
	Value of work according to initial contract	
Quality	Project quality based on specifications, design and contract documents	(Cho et al, 2009)
	No rework due to failure of work quality	

Conceptual Model

Conceptual models help understand the problem and ensure that the researcher builds a model that can represent the purpose of the research. This conceptual model built can later be used as the basis for making hypotheses to analyze the effect of project characteristics on the performance of time, cost and quality of the construction project of PT XYZ Jabodetabek Region. Based on the literature study and research objectives, a conceptual model was formed as shown in Figure 2.

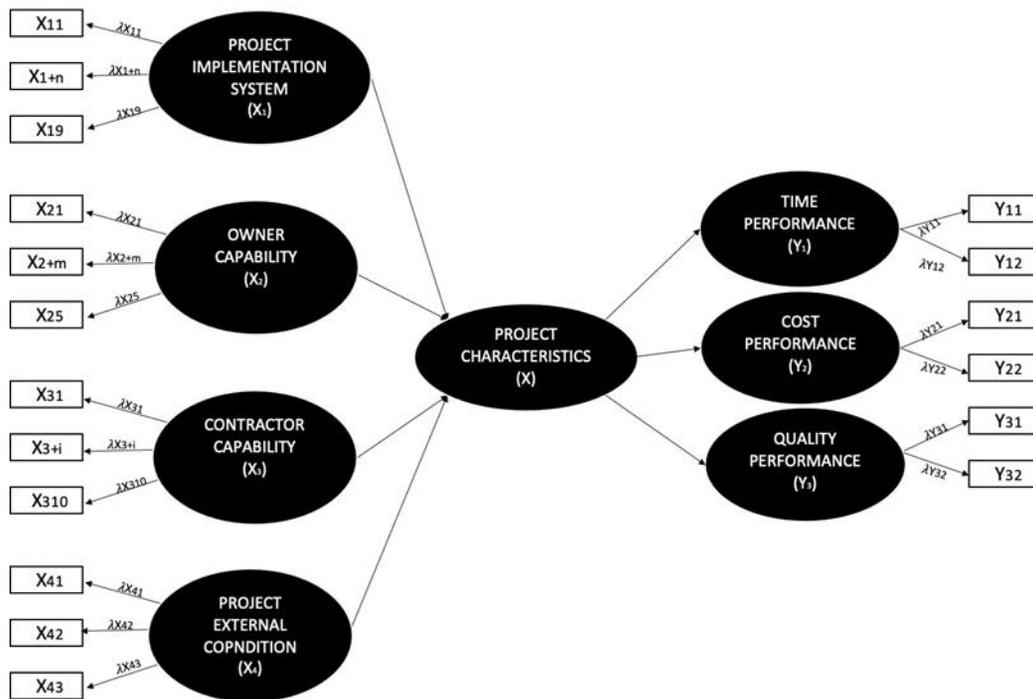


Figure 2. Conceptual Model

6. CONCLUSIONS

Based on the literature study on previous research and expert study, it was found that the project characteristic variables were formed by four variables with indicators, namely implementation system (X1) with 9 assessment indicators, the owner capability variable (X2) with 5 assessment indicators, the contractor capability variable (X3) with 10 assessment indicators and the project external condition variable (X4) with 3 assessment indicators. Meanwhile, time performance (Y1), cost performance (Y2) and quality performance (Y3) have 2 assessment indicators.

7. SUGGESTION AND FURTHERMORE

This conceptual model is the result of initial research. Researchers can use this conceptual model include variables and indicators to analyze the effect of project characteristics on the performance based on time, cost and quality of construction projects.

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IMPROVING PERFORMANCE THROUGH LEADERSHIP STYLE, ORGANIZATION CULTURE, AND COMMITMENT IN IMPLEMENTING DIVISION OF XYZ AGENCY

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ABSTRACT

Performance in one of the key indicators in a program and activity. Employee performance can be influenced by the leadership and organization culture that grows in the organization. Previous research state in addition leadership and organization culture, commitment also affect the employee performance. The involvement of employees is important in improving performance. Implementing Division of XYZ Agency is under auspices of Ministry of Public Works and Housing that has vision realize comfortable and sustainable urban housing through procurement of human settlement infrastructure. As stated in Regulation of Minister of Public Works and Housing No. 16 of 2020, the duties of the implementing division to carry out technical planning and analysis, technical control, monitoring and evaluation, preparation of agreement and performance reports, implementation and technical control of the human settlement infrastructure. Performance quality can be improved with human resource management through leadership, organizational culture, and commitment. This research will be conducted by giving questioners to 40 employees of Implementing Division of XYZ Agency. This research will be analyzed by using Structural Equation Modelling – Partial Least Square (SEM-PLS) method with SmartPLS software. The result of the research analysis show that leadership style and organization culture have a significant effect on performance, while commitment does not have significantly affect performance. In managerial implications that can be applied to organizations, it can be seen from the highest factor loading of indicator. Showing a participatory leadership style combined with transactional leadership style. The organizational culture showing hierarchy combined with community culture can improve the performance.

Keywords: Leadership, Organization Culture, Commitment, Performance, SEMPLS

1. INTRODUCTION

An organization consists of a group of people who have their own respective roles or duties in achieving the goals of the organization (Dessler, 2017). The organization expects their employees to work well and have high productivity and be able to describe the vision and mission that have been mutually agreed upon in order to achieve organizational goals (Lestari, 2016). The existence of employees in an organization will determine the success of the organization in achieving the their goals (Hakim, 2015). In achieving the goals, it is necessary to have a management process that can be obtained through the science of human resource management. Managing the organization properly absolutely brings more

benefits to the organization, such as minimizing the mistakes of each individual and achieving higher profits or better performance.

The purpose of improving performance can be conducted by a human resource approaches. Many researches said, leadership is the dominant factor which has influence on performance (Ilham, 2019; Eliyana et al., 2019; Samuel et al., 2017; Yuan & Lee, 2011; Zehir et al., 2012). Leadership is an important key in management to be able to assist maximizing work efficiency and achieve organizational goals. A leader makes major decisions in determining the company's goals and objectives, including managing employees, goods and services presented, to how to treat consumers (Yuan & Lee, 2011). Leaders are present to be able to motivate their employees in overcoming various existing problems and can lead to goals. Leadership includes knowing what the organization needs and being able to direct it to organizational goals (Larson & Gray, 2011). The success of leadership is based on how the division of labor can be conducted well to achieve goals (Rehman et al., 2020).

Based on Zehir, et al. (2011), leadership and organizational culture that grows in an organization can affect employee performance. Organizational culture is a system of norms, beliefs, and assumptions that bind people together that ultimately creates shared meaning. A conducive organizational culture can create job satisfaction and employee motivation, both of which will affect employee performance (Ilham, 2019). Leaders create a culture and the basic role of each employee that will affect many other aspects such as efficiency and performance (Yıldırım & Birinci, 2013). Leadership style and organizational culture are two variables that are significantly related to the performance of the building construction sector (Giritli et al., 2013).

Besides the leadership style and organizational culture, commitment is one of the important factors that affect performance (Zehir et al., 2012). The relationship between leadership style and employee performance is mediated by organizational commitment (Eliyana et al., 2019). Organizational commitment has an effect on employee performance and is a variable that has the same important role on employee performance as organizational culture (Hakim, 2015). A strong organizational culture will provide an identity for the members. The clearer the perception and purpose of an organization, the easier the identity of the organization is seen. Identity generates commitment to the organization and a reason for members to fight and remain loyal to the organization (Larson & Gray, 2011). Employees who are committed to their organization will focus on the goals of the organization if they adopt their organizational culture. In addition, the leadership variable is also an important component in the organizational commitment process (Acar, 2012).

The XYZ agency is a government agency under the auspices of the Ministry of Public Works and Public Housing whose vision is to create livable and sustainable urban settlements through the provision of creative infrastructure. In an effort to realize the existing vision, XYZ Agency has a Technical Implementation Unit (TIU) spread across every province. In each TIU, there is an Implementing Division. Each Implementing Division carries out technical planning and analysis, technical control, monitoring and evaluation, preparation of agreements and performance reports, implementation and technical control of five creative fields (Minister of Public Works and Public Housing Regulation No. 16 of 2020). From the discussion above, the author will conduct research on the effect of leadership style, organizational culture, and organizational commitment in order to improve employee performance in the work environment of the XYZ Agency's Implementation Division.

2. LITERATURE REVIEW

2.1 Performance

Based on Ilham (2019), Performance is the result of work in quality and quantity achieved by employees in conducting the tasks for which they are responsible. Performance can also be interpreted as a record of success resulting from the function of a job or activity during a certain period. Performance shows the level of task completion that describes how well employees meet job demands. So, performance is the stage of employee achievement as work performance. Based on Simanjuntak (2011)

quoted from Eliyana et al., 2019, factors that affect organizational performance are organizational support, management ability or effectiveness, and work performance of each individual in the organization. In the performance assessment in the public sector, it is regulated in Government Regulation no. 30 of 2019. Stated that the Employee Performance Target or abbreviated is an assessment that pays attention to performance behavior. The indicators are service orientation, integrity, commitment, discipline, cooperation, and leadership.

2.2 Leadership

In managing an organization, leaders interact with followers from various backgrounds resulting in different leadership styles (Rehman et al., 2020). Leadership means being a role model for behavior that requires change (Dessler, 2017). According to Nejad & Rowe (2009) cited from Semuel et al. (2017), Leadership is the ability of individuals to lead and direct a group that aims to achieve certain goals. Leadership is the main driver in the performance of an organization (Yuan & Lee, 2011). Although leadership types always evolve over time to find the best performance, there are two main categories of leadership styles according to Zehir et al. (2011), mechanistic based leadership and humanistic based leadership. The mechanistic based leadership focuses on the internal environment of the organization and places less emphasis on human resource practices with high commitment. While the humanistic based leadership prioritizes the quality of relationships with followers, for example with employees. Zehir et al. (2011) generates the types of leadership style based on the two main categories as transactional, participative, and supportive leadership.

Transactional leadership is a strategic leader works in an existing system or culture and tries to meet the needs of his followers by focusing on change, giving rewards, and paying attention to deviations that occur in the organization. This type of leader focuses on the performance of the company. Transactional leaders can be a competitive advantage because they try to make changes to improve the efficiency and performance of an organization (Yıldırım & Birinci, 2013).

Participative leadership is a leader often works more closely with his/her followers and involves all levels of organizational members in decision making. Participative leaders act as moderators or facilitators in providing guidance or keeping the discussion conducive. Members can discuss to give each other opinions in solving a problem, for example, although the decision-making remains in the hands of the leader, it is still based on the consideration of the opinions that have been discussed.

Supportive leader provides emotional, informational, and instrumental support, and rewards to followers. This type of leader prioritizes social support in the form of emotional support, such as sympathy, evidence of liking, caring, and listening. Supportive leaders pay attention to the desires and preferences of their followers when making decisions.

Leadership is one of the main drivers in the performance of an organization (Yuan & Lee, 2011). Several previous studies have stated that leadership style has a significant effect on organizational performance or employee performance (Ilham, 2019; Pawirosumarto et al., 2017; Semuel et al., 2017; Yuan & Lee, 2011). Transactional leaders focus on organizational performance and this leadership style empirically affects performance (Zehir et al., 2011). Thus, the proposed hypothesis is:

H1: Leadership style has significant effect on performance

2.3 Organizational Culture

According to Schein quoted from Zehir et al. (2011), organizational culture is a pattern of basic assumptions that are considered valid by a group after solving problems of external adaptation and internal integration, then taught to new members. Based on Robbins et al. (2007) cited from Ilham (2019), Organizational culture is a set of values, principles, traditions, and attitudes that affect the way members of an organization behave. According to Imran et al. (2010) quoted from Ogiamien & Izuagbe (2016), organizational culture determines employee performance and organizational success, because it gives

birth to innovation in individual employees. Each type of organization has something that binds, such as type of leader, measure of success, management style, and more. Based on Zehir et al. (2011), there are three dominant organizational cultures, as community, competitive, and hierarchy culture.

Community culture is such a big family based on loyalty and commitment to strong leaders, and a focus on developing cohesiveness through cooperation, consensus, and participation. The commitment of organizational members based on this culture is ensured through participation, organizational cohesiveness, and individual satisfaction rated higher than financial goals and market share. In community culture, leaders are considered as coaches, mentors, and parent figures.

Competitive culture focuses on achieving a goal under an aggressive and competitive leader, who measures success by taking advantage of peer institutions. Competitive culture is in stark contrast to the values expressed in clan culture. This culture emphasizes cohesiveness, participation, and teamwork.

Hierarchy culture is governed by procedures, policies, predictability, efficiency, and stability. This culture exhibits orders, rules, and regulations. Activities in a hierarchical culture in control of supervision, evaluation, and direction. This type of culture corresponds to a formal and systematic form of organization or workplace. In addition, business effectiveness is assessed from the consistency and achievement of the goals that have been set.

The survival of an organization depends more on the formation of a culture initiated by effective leaders. Zehir et al. (2011) stated that organizational culture has an effect on performance. Organizational culture has a strong effect on the long-term performance and effectiveness of the organization Yıldırım & Birinci (2013). So, the proposed hypothesis is:

H2: Organizational culture has significant effect on performance.

2.4 Commitment

Based on Dubin cited by Zehir et al. (2012), commitment is a condition in which members of the organization strive for and believe in the goals and values of the organization. Employee relationship with the organization has an impact on the decision to continue membership in the organization itself (Acar, 2012). Based on Acar (2012) which adopted from Meyer and Allen's (1991), concept of organizational commitment model has received support from various groups with cultural differences. The three components that become the model of organizational commitment are affective, continuance, and normative commitment.

Affective commitment belongs to those with high emotional for the organization. He/she has high desire to be involved in the organization and wants to continue to be in the organization Continuance commitment formed from consideration of what is gained and what is sacrificed. Staying in an organization is considered a fulfillment of needs. Normative commitment is a commitment due to responsibility to the organization. It is an obligation to be loyal to the organization.

According to Zehir et al. (2012), commitment is the driving force for the success of an organization. There is a positive relationship between commitment with efficiency, performance, and job satisfaction. Well managed commitment can increase the efficiency of the organization itself Khunsoonthornkit & Panjakajornsak (2018) The related hypothesis is:

H3: Commitment has significant effect on performance.

3. METHOD

In this research, designed online questionnaires using Google forms. Questionnaires would be distributed online to 40 employees of the XYZ Agency Implementation Section. The data sample consist of 26 men and 14 women, with varies of age is between 20 to 49. Mostly respondent still in productive age and well educated with 75% holding bachelor's degree, moreover 20% of them with master's degree.

The scale of the research construct adopted and revised from previous research. Response recorded using 5-point agreement scale. Indicator of leadership style adopted from Avolio et al. (1999).

Indicator of organizational culture variable adopted from Zehir et al. (2011). Indicator commitment adopted from Meyer & Allen (1991), Acar (2012). Indicator of performance variable adopted from Government Regulation no. 30 of 2019.

After data collected, tested the research model using Structural Equation Modeling-Partial Least Square (SEM-PLS). SEM is an analytical technique that assumes a series of dependent relationships among a set of constructs represented by various latent variables and formed into an integrated model (Malhotra, 2010). Cited by Ghozali (2021), Chen & Newsted (1999) stated that SEM with approximation PLS use variance based to change the orientation of analysis into prediction. Therefore, the purpose of using SEM-PLS method for analysis is prediction (Yamin & Kurniawan, 2019). The SEM-PLS model consists of two models, such as the measurement model and the structural model (Ghozali, 2021). In addition, the SEM-PLS model must be based on theory, because all relationships must be determined before the SEM-PLS model can be estimated.

This research conducted SEM-PLS analysis to test the developed hypotheses, confirm the validity and reliability, as well as examine the structural models and measurement models that have been studied in order to obtain the right model. This research used SmartPLS software to perform SEM-PLS analysis.

4. RESULT

This research conducted using four variables as leadership style, organization culture, commitment, and performance. In previous research, the model using leadership style, organization culture, and performance were conducted by Yuan & Lee (2011) and Zehir et al. (2011). The addition of commitment based on research of Acar (2012) and Zehir et al. (2012). Figure 1 shows the research model from SmartPLS software.

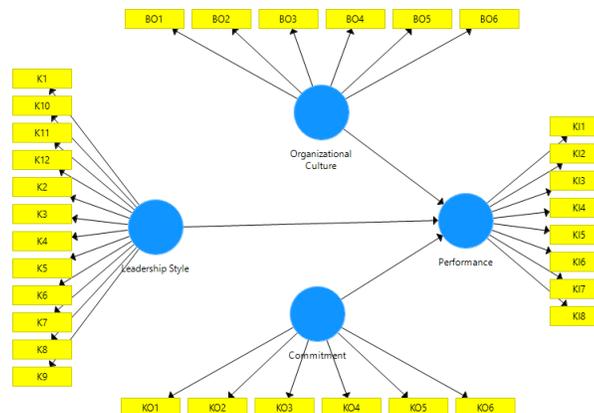


Figure 1. Research Model

4.1 Outer Model

In this section, based on Ghozali (2021) Confirmatory Factor Analysis (CFA) is used to estimate the measurement model and the number of construct and variable indicators are as expected based on the theory. The latent variable indicators have to meet the factor loading criteria, which is at least 0.6. The validity and reliability tests are met by showing the Average Variance Extracted (AVE) value more than 0.5 and Cronbach's Alpha and Composite Reliability (CR) more than 0.7. Table 1 below shows the result of validity and reliability test. The data is valid and reliable.

Table 1. Validity and Reliability Result

Variable	Indicator	Factor Loading	AVE	Cronbach's Alpha	Composite Reliability
	L1	0.778	0.591	0.932	0.94

	L2	0.822				
	L3	0.825				
	L4	0.707				
	L5	0.722				
Leadership Style	L6	0.83				
	L8	0.747				
	L9	0.794				
	L10	0.821				
	L11	0.68				
	L12	0.708				
	<hr/>					
	Organizational Culture	OC1	0.809	0.59	0.826	0.877
OC2		0.799				
OC4		0.703				
OC5		0.671				
OC6		0.842				
<hr/>						
Commitment	C1	0.759	0.599	0.833	0.881	
	C2	0.766				
	C3	0.901				
	C4	0.803				
	C6	0.615				
	<hr/>					
Performance	P1	0.786	0.546	0.861	0.893	
	P2	0.814				
	P3	0.771				
	P4	0.778				
	P5	0.694				
	P6	0.633				
	P7	0.678				
	<hr/>					

4.2 Inner Model

The purpose of this section is to evaluate the relationship between latent variables. The evaluate is looking at the value of R^2 . As show from the SmartPLS software result, value of R^2 is 0.303. This indicates 30.3% of performance can be explained by the latent variables such as leadership style, organization culture, and commitment.

4.3 Resampling Bootstrap

The test is conducted to evaluate the significance between variables using bootstrap method. Using 5% of significance level with a number of 500 bootstrap sample, the T value must be above 1.96. Table 3 below show the result of resampling bootstrap method. T statistic value of the organizational culture variable on performance is 2.188 above 1.96. that means organizational culture has a positive and significant effect on performance. T statistic value of the leadership style variable is 2.38 above 1.96, so this variable also has positive and significant effect on performance. Meanwhile, the commitment variable does not have significant effect on performance because thet statistic value is 1.606 below 1.96.

Table 2. Resampling Bootstrap Result

	<u>Original Sample</u>	<u>T Statistic</u>
Organizational Culture -> Performance	0.34	2.188

	5	
Leadership Style -> Performance	0.30	2.38
	6	
Commitment -> Performance	0.26	1.606
	5	

4.4 Managerial Implication

The final result show that leadership style has a positive influence on performance. From the analysis, the highest factor loading of indicator reflects a participatory leadership style then followed with indicator reflects a transactional leadership style. Although in theory participative and transactional in different style, these two things encourage efforts to improve performance. Based on Avolio et al. (1999), a good leader can actually show both transactional and participatory leadership style. Combining these two might be a good effort to improve the performance.

Showing organizational culture has a positive influence on performance, the highest factor loading of indicator reflect hierarchy culture then followed with indicator reflect community culture. A hierarchy culture can be formed because the Implementing Division of XYZ Agency is a government organization. Meanwhile, community culture can be formed because the role of leader in lead the organization. The role of the leader in community culture is as a guide (Zehir et al., 2011).

5. CONCLUSION

This research revealed a link between leadership style and organizational culture have significant effect on performance. While commitment does not have significant effect on performance. The dominant leadership style is participatory and transactional. Being a listener, involving employees in discussion and still caring about the project can be an effort to improve performance. A hierarchy culture has been firmly established in the organization which indicates that each individual will work in accordance with applicable regulations. In effort to improve performance, it is supported by the formation of cultural community. This culture can be formed from a participatory leadership style and also by creating a forum that can bond the employees.

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ANALYSIS OF DELAY IMPACT IMPLEMENTATION OF THE CIPUTRA WORLD SURABAYA PHASE 3 PROJECT BASED ON FIDIC MDB HARMONIZED EDITION

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ABSTRACT

The project can be completed well, then a construction project is required to have careful planning both in terms of quality and also in time efficiency. But various obstacles as of a lot of times when occurs during the course of the project had been running that causes a range of issues , one of the ways is was the delay. This obstacle also happened to the Project of Ciputra Wold Surabaya Phase 3, which in the construction of Soho Tower of about the delay of the during 69 day or up from plan. The main factors causing the delay are the delay in taking action by the Owner, the lack of supervision carried out by the Construction Management, the execution of the work by the Contractor not running smoothly, and the implementation of the work being not optimal by the Sub-Contractor. This resource has the purpose to analyze what impacts can be caused by delays in the Project of Ciputra Wold Surabaya Phase 3 for the constuction of Soho Tower based on FIDIC. The research method used is a questionnaire and FIDIC Contract Review where in determining the research variables in the form of delay factors used a questionnaire to experts in their fields, then to analyze the impact of the delay using study is based on FIDIC, and the last is to analyze the effect of the impact of the delay for the Owner or Contractor. The results show that the types of delays that occur in the Ciputra World Surabaya Project Phase 3 Tower Soho are included in the category of concurrent delay types, where the delay is caused by the Owner, namely being late in approving shop drawings and revising or approving design changes and also the Contractor, namely worker productivity. unstable, so that delays are a shared responsibility and do not result in claims or late fees.

Keywords: Project Construction, Impact Of Construction Project Delays, Questionnaire, FIDIC, Concurrent Delay

WORKING MENTAL LOAD ANALYSIS WITH NASA-TLX TO INCREASE PERFORMANCES IN ASSET PROJECT MANAGEMENT OFFICE

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ABSTRACT

All companies, both in the service and manufacturing sectors, strive to improve performance. One way of measuring performance is the quality of the product or service. The Asset Project Management Office (APMO) is one of the divisions of a national energy company that has a target in running a business. However, work performance in this business process is constrained by limitations on the availability of workers. APMO has the responsibility to manage the work of Non-Business Development (Non BD) investment projects in the field of building the Company's business support facilities. However, to do this work, APMO only has 3 available workers. For this reason, mental load analysis is needed to determine the mental workload carried out by the NASA TLX method. So it is hoped that it can provide recommendations for the ideal number of workers and recommendations for improvement so that the expected performance can run optimally and well.

Keywords: Mental work load, Work load analysis, NASA TLX.

1. INTRODUCTION

As it is known that human resources are the company's main asset in improving the quality of products or services. Effective workforce optimization can make a significant difference to the success of a company. However, with the increasing target companies, often the management of human resources is not the focus for the company which in turn can result in decreased performance and increased operational costs. Asset Project Management Office is a division of PT PM, a national energy company engaged in asset management with a network of branches in most parts of Indonesia. Currently, the APMO function is responsible for managing the work of Non- Business Development investment projects, as well as being an engineering center for buildings for both other business support functions and subsidiaries and providing advisory on the optimization of land and buildings on idle company assets. With the increasing number of project initiatives at Asset Management, especially for Non Business Development investment projects, as well as assistance to subsidiaries, there is also an increase in the number of requests for engineering support needed.

1. Increased workload, with a target to deliver results on time and with the best quality.
2. Regarding human resource management, currently there are only 3 permanent workers, namely 3 Senior Engineers and 1 administrative assistant, 1 HSSE assistant.

3. There are no quantitative tools (tools) that can provide a strong justification for making decisions to increase manpower or benchmarks to show the work load.

Even with these challenges, engineers are still required to maintain their quality and performance, along with the increasing tasks and tasking of each existing project coupled with the individual goals program from the company as a form of assessment for personal performance. For this reason, it is necessary to analyze effective workload planning by optimizing capacity in order to increase productivity (Berseneva et al., 2014). Figure 1.1 shows a report on the number of projects handled by the Asset Project Management Office during 2018 to 2020 and predictions for 2021.

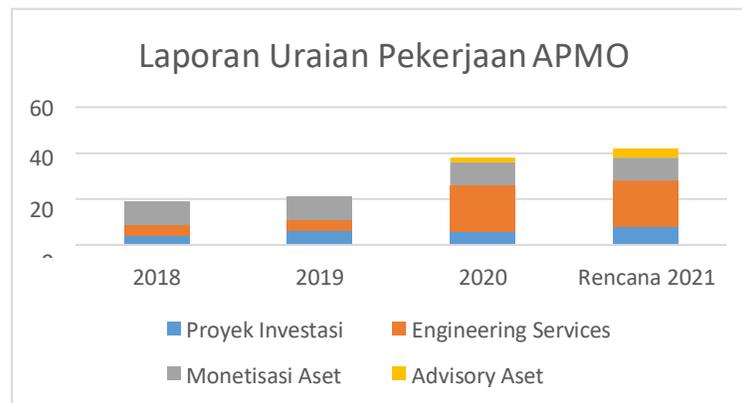


Figure 1.1 APMO Job Description Report (PM, 2020)

This planning also depends on the burden of both physical and mental workers. For this study, researchers focused on making an analysis for measuring the mental workload of workers. The method chosen is using NASA TLX. NASA TLX is a subjective method that is often used in measuring the mental workload of individuals in various industries (Widiah, 2019). The use of the six subscales of the NASA-TLX method to calculate overall workload scores has been found to reduce variability among subjects, relative to unidimensional workload ratings, and also provide diagnostic information about the source of the workload (Hart and Staveland, 1988). Measurement of work performance with this method can be the basis for companies to make decisions if they want to increase their human resources in the hope that by adding comfortable human resources, the performance rating of workers will increase thus the existing utility system will increase so that the company's performance will also increase. increased. For this reason, the researcher plans to make an 'Analysis of Mental Workload with the NASA-TLX Method and Analysis of the Root Causes of the Problem **To Improve Performance Performance in the Asset Project Management Office.**

2. LITERATURE REVIEW

This chapter describes the concepts and theoretical foundations, and previous research, which was used as reference material for the research. The literature review framework aims to help the framework of thinking make a literature review which is the basis for research theory.

2.1 Overview of the Asset Project Management Office (APMO)

The criteria for the scope and authority of APMO include:

1. Running a Non-Business Development Investment Project

2. Project Scale Per Area/building
3. Selecting Service Providers through the procurement process
4. Conducting Leads for the initiation, planning, implementation and closing processes carried out by APMO according to the Authority
5. Carrying out Advisory and supervision to subsidiaries, funding and full job responsibilities by the AP Jobs Board of Directors
6. Provide partial process or coordination support or project funds assisted by coordination by APMO
7. In accordance with the Directives of the Director of Asset Management that APMO focuses on area development, while projects that are operational in the Unit/Region are carried out by Operational Assets
8. Building technical planning is carried out by a building planning service provider who has a certificate in accordance with statutory regulations

2.2 Project management

A project is a temporary endeavor to produce a unique product, service or result (PMI, 2013). Its temporary nature indicates that each project has a clear schedule of when to start and when to end. Project termination occurs when the objectives of the project are achieved or because the objectives cannot be achieved or there is no need for the project. It is unique, where the output or process can be different from existing projects. Every project has three boundaries called the project constraint triangle, namely scope, time, and cost (Santosa, 2009). These boundaries are interconnected with each other, changes in a boundary, affect at least one other constraint. According to Kerzner (2009), project management is managing company resources, in project activities, within the specified time, cost, and performance constraints. If the project is aimed at external customers then there are other things that need to be considered, namely good relations with customers, to create sustainable business relationships.

2.3 Human Resources

Human resources are an integrated ability of the physical power and mental power of the individual. perpetrators and their nature is carried out by their descendants and their environment. While his work performance is motivated by the desire to obtain satisfaction (Hasibuan, 2003). Human resource management is the process of acquiring, training, appraising, and compensating employees, and paying attention to work relations, health and safety, and equity issues (Dessler, 2016). Human resource management refers to the policies, practices and systems that influence employee behavior, attitudes and performance (Noe, Hollenbeck, Gerhart, & Wright, 2011).

2.4 Expert judgment

In some literature related to estimating the cost and effort required for a project, the expert judgment (EJ) approach is widely practiced because of the issue of subjectivity in any attempt to estimate or estimate, although in general. *Expert judgment* is a term that refers specifically to an assessment technique that is made based on a specific set of criteria and/or expertise that has been acquired in the area knowledge specific, or field product, specific discipline, industry, etc. This knowledge base can be provided by a member of the project team, or multiple members of the project team, or by the team leader or team leader. However, usually expert assessment requires expertise that is not present in the project team and is, therefore, common for an outsider with a relevant set of specific skills or knowledge to bring to the consultation.

2.5 Mental Workload

Workload refers to the intensity of work assignments. This is a source of mental stress for employees.

Stress is an active state of mind in which humans face opportunities and obstacles (Robbins, 1999). There are various ways to detect the symptoms or outcomes of stress reflected in the workplace. In stress, the desired outcome of an employee is generally perceived as uncertain and important (Robbins, 1999). Assessment of mental workload is an important aspect in the design and evaluation of work tasks (DiDomenico and Nussbaum, 2011). Mental workload itself according to Zhang and Luximon (2005) is a demand on the brain and sensory systems (eyes, ears, and skin) due to the task. The levels of mental effort burden based on the number of mental needs needed are:

- (1) the need for concentration and conscious mental effort required is very small, the activities carried out almost do not require attention and the mental burden is too high so that the work can be said to be easy.
- (2) The need for concentration and conscious mental effort is moderate, this happens because of the complexity of activities that are classified as moderate to high inability to recognize so that it requires more attention to carry out these activities.
- (3) The concentration requirement required is very large because it is caused by complex work activities and requires total attention.

While the method of measuring mental workload subjectively according to Widyanti et al. (2010) is a measurement of mental workload based on the subjective perception of respondents/workers. Some of the methods used include: National Aeronautics and Space Administration Task Load Index (NASA-TLX)

2.6 NASA-TLX

NASA-TLX is a multi-dimensional rating method that is able to measure overall mental workload based on the average weight of 6 subscales, namely Mental Demands, Physical Demands, Temporal Demands, Own Performance, Effort and Frustration (NASA Performance Research Group, 1988). This method has a good level of sensitivity because the measurements are reviewed from 6 subscales and are comprehensive (Rubio, Diaz, Martin, & Puente, 2004, the steps that must be taken are:

1) Rating

In the first stage, respondents were asked to rate the six mental load indicators. The rating given is subjective depending on the mental burden felt by the respondent.

2) Weighting

In the second stage, respondents were asked to circle one of the two indicators that they felt were more dominant in causing mental workload on the job. The questionnaire given is in the form of pairwise comparisons consisting of 15 pairwise comparisons. From this questionnaire, the tally of each indicator that is felt to be the most influential is calculated. will be the weight for each indicator of mental load. Handini and Partiw (2013) stated that to get the NASA TLX mental load score, the weights and ratings for each indicator were multiplied then added and divided by 15 (the number of pairwise comparisons).

After knowing the scale used for each component, the next step is data processing until the workload is obtained (Hart and Staveland, 1988). The following are the steps of the NASA TLX method:

1. Calculate the product value by multiplying the rating by the factor weight for each dimension, so that there are 6 product values for each dimension (KF, KM, KW, PF, U, and TS)
2. Calculating the value of Weighted Workload (WWL), which is the workload caused by each dimension
3. Calculating the average WWL by dividing the WWL by the total number of weights which amounted to 15. The number of weights which amounted to 15 was obtained from the pairwise total which was carried out at the time of filling the weight questionnaire.

3. METHODS

This chapter contains a flow chart or flowchart of the stages in the preparation that in the early stages the authors identify problems, formulate problems and determine research objectives. At this stage the authors

brainstorm, discuss with supervisors to choose the title and method to be used and ask permission from the company to be analyzed. Furthermore, the authors began to collect literature study and set work units and data to be observed. This is then stated in a research proposal/thesis. Henceforth, the researcher began to collect data which was divided into two types of data, namely primary data and secondary data (A). After Collage Data, the implementation of the data collection process, it is carried out in two ways, namely by direct calculations using a stopwatch and or by recording the time during online activities. Time data was obtained, also filling out the NASA-TLX questionnaire and observing the work elements of each engineer. As for the secondary data that will be poured in the form of organizational profiles, data on the number of employees and job descriptions. Then the author will validate the data in the form of asking questions with experienced sources and already have authorization in determining the duties and responsibilities of workers. The questions asked about: Mental Needs, Physical Needs, Time Needs, Performance Performance, Frustration Levels, Physical and mental effort

The next step is to calculate the tally of each factor that affects performance which is then weighted into the calculation using the NASA-TLX method. Furthermore, the respondent will give a rating for 6 indicators of mental workload and then multiply the rating on each indicator with the weights that have been obtained previously. Furthermore, it was added with a paired comparison questionnaire to get the value of the mental load weight. In the analysis phase related to the results of data processing. The analysis given is the result of the NASA-TLX calculation method. From the data results, comparisons and correlations of the results obtained from the two methods will also be carried out.

4. RESULTS

3 (three) engineers with the position: Senior Engineer (I-III). Table 4.1. below is a data engineer recapitulation at APMO.

Table 4.1 Data Engineer

No	Name	Position	Age (years)	Work Experience (years)
1	A	Sr. Engineer III	38	15
2	B	Sr. Engineer I	35	14
3	C	Sr. Engineer I	32	11

In carrying out the activities of the APMO team, the project is also classified based on the duties and authorities of the APMO. Determination of this classification is based on the results of Focus Group Discussion with PM Management and experts (Expert Judgment).

1. Project Lead : The process of initiation, planning, implementation and closing is carried out by APMO according to the Authority
2. Project Support: Partial support of the process or coordination or project funds assisted by coordination by APMO
3. Project Advisory : Advisory and supervision of building construction carried out by Subsidiaries, funding and full responsibility for work by the Board of Directors of AP Works

For this matter the time division of each engineer, for operational ones, all engineers are involved in the meeting and divide the tasks according to the PIC of the work. As for those involving management issues,

the PIC will take the time to make meeting agendas, materials and other coordination. The next stage of data processing is calculating mental load using the NASA-TLX method. This method has six assessment indicators, namely: mental needs, physical needs, time requirements, work performance, frustration level, and mental and physical effort. Then these six indicators in pairs are given a rating weight and given a rating according to what the engineer feels. The questions on the questionnaire are shown in Table 4.2 with a scale of 1-5 starting from the lowest to the highest. As for the pairwise comparison questionnaire, it is set out in Table 4.3

Table 4.2. Indicator Weighting Questionnaire

Indicator	Question
Mental Needs (KM)	In your opinion, How much mental effort is required for your job?
Physical Needs (KF)	In your opinion, How much physical effort is required for your job?
Time Requirement (KW)	In your opinion, how much pressure do you feel regarding time for your job?
Work Performance (PK)	In your opinion, what is your success rate for doing your job?
Frustration Level (TS)	In your opinion, how much anxiety do you feel regarding time to do your job?
Physical and Mental Effort (U)	In your opinion, How much mental and physical effort is required for your job?

Paired Comparison Questionnaire

NO	INDIKATOR	KODE	✓	INDIKATOR	KODE	✓
1	Kebutuhan Fisik	KF		Kebutuhan Mental	KM	
2	Kebutuhan Waktu	KW		Kebutuhan Mental	KM	
3	Performansi Kerja	PK		Kebutuhan Mental	KM	
4	Usaha Fisik dan Mental	U		Kebutuhan Mental	KM	
5	Tingkat Frustasi	TS		Kebutuhan Mental	KM	
6	Kebutuhan Waktu	KW		Kebutuhan Fisik	KF	
7	Performansi Kerja	PK		Kebutuhan Fisik	KF	
8	Usaha Fisik dan Mental	U		Kebutuhan Fisik	KF	
9	Tingkat Frustasi	TS		Kebutuhan Fisik	KF	
10	Performansi Kerja	PK		Kebutuhan Waktu	KW	
11	Usaha Fisik dan Mental	U		Kebutuhan Waktu	KW	
12	Tingkat Frustasi	TS		Kebutuhan Waktu	KW	
13	Usaha Fisik dan Mental	U		Performansi Kerja	PK	
14	Tingkat Frustasi	TS		Performansi Kerja	PK	
15	Usaha Fisik dan Mental	U		Tingkat Frustasi	TS	

After knowing the scale used for each component, the next step is data processing until the workload is obtained (Hart and Staveland, 1988). The next steps in the NASA TLX method are calculating the Weighted Workload (WWL) value, which is the workload caused by each dimension and calculating the average WWL by dividing the WWL by the total number of weights totaling 15. The total weight of 15 is obtained from the total pairwise performed at the time of filling out the weight questionnaire. The NASA TLX method in this study was used as a method to determine the optimal number of employees in terms of mental load. The determination of this amount will be based on the average WWL score of

each employee. From the average value of WWL, the workload category of the person will be known. Recapitulation of Indicator Weights, namely the multiplication of ratings and weights which are then added up to get the WWL number.

Table 4.4 Questionnaire Recapitulation

No	Name	KM	KF	KW	PK	U	TS
1	A	5	1	4	1	5	3
2	B	3	3	4	3	3	4
3	C	3	3	3	3	3	3

Table 4.5 Indicator Weighting Recapitulation

No	Name	KM	KF	KW	PK	U	TS	WWL
1	A	425	90	320	75	300	210	1420
2	B	255	180	320	270	180	280	1485
3	C	210	180	300	270	240	255	1455

Furthermore, calculations for load recapitulation and workload categories are evaluated. Table 4.6 shows the level of workload of each engineer. The distribution of the WWL value range is as follows:

- 0-9 = low
- 10-29 = moderate
- 30-49 = rather high
- 50-79 = height
- 80-100 = very high

Based on the survey results, the indicators that most influence this mental load condition, seen from the weight given by the engineer, show that the highest load is Performance Performance Needs, Mental Requirements and Time Requirements. Then followed by the level of frustration, physical need and effort. Furthermore, from the results of data processing, a causal relationship will be analyzed so that conclusions can be drawn on these conditions.

Table 4.6 the level of workload of each engineer

No	Name	WWL/15 . value	Category
1	A	95	Very High
2	B	98	Very High
3	C	97	Very High

5. Mental Workload Analysis

After calculating the physical load from the engineer, then these six indicators in pairs are given an assessment weight and given a rating according to what the engineer feels. The three engineers are of the opinion that the current workload is very high, almost reaching the maximum load of 100. If an analysis is carried out with paired weights, it is found that the load factor is a matter of concern for the engineer. Figure 5.1 shows the weight factor taken from the average weight of the assessment.

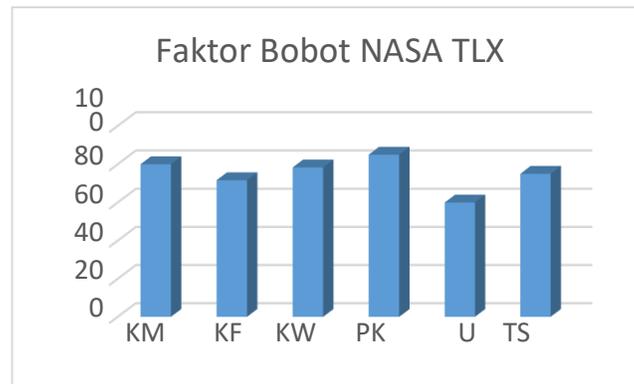


Figure 5.1 NASA-TLX . Weight Factor

From this weight it is quite interesting to analyze where based on the survey results, the most influencing indicator of this mental load condition shows the highest load is the Performance Needs of an average weight of 85, Mental Needs of an average weight of 80 and Time Requirements of an average weights 78.3. Then followed by the level of frustration with an average weight of 75, physical and business needs. physically and mentally with an average weight of 60. However, if you look at the questionnaire how much is done for the work of the engineers, the answer is that Performance Performance which is the highest weight of attention can still be overcome by engineers. The results of the researcher's analysis show that the engineers who work have the same expertise and experience in the field of management is quite good. Coupled with the engineers have educational backgrounds that are in line with work activities. It's just that to get good work performance, engineers also need other support. The other factors referred to are the Mental Needs and Time Needs. From the results of the questionnaire, it was found that the engineers thought that to keep working according to the mental and time targets of the engineers was quite time consuming. It is hoped that with additional personnel the time used by engineers to work will fall into the normal category. Regarding this level of frustration, the engineers did not appear to be under heavy pressure. This is indicated by the fact that every engineer can still overcome the density of work and work targets. Given that APMO has a role in project management and coordination,

6. CONCLUSIONS

The conclusions that can be drawn in this study are: The results of measuring mental workload with the NASA-TLX method show that the current workload is very high, almost reaching the maximum load number of 100, with details of engineers 1-3 namely 96.85 and 97. While the results In a weighting survey, the indicator that most influences the mental load condition shows that the highest load is Performance Needs with an average weight of 85, Mental Needs with an average weight of 80 and Time Requirements with an average weight of 78.3. Then followed by the level of frustration with an average weight of 75, physical and business needs. physically and mentally with an average weight of 60.

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INFLUENCE OF WORK ENVIRONMENT, MANAGEMENT SUPPORT, AND JOB SATISFACTION TO EMPLOYEE PERFORMANCE IN CONSTRUCTION PROJECT: A CASE STUDY IN PT. PP (PERSERO) Tbk.

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ABSTRACT

Companies in the construction sector, projects are the spearhead of achieving company profits and performance and this is what causes employees to be referred to as "profit makers". Thus, employee performance on construction projects has a major effect on the achievement of company performance. Quoted from PT. PP (Persero) Tbk. financial statements, the company's profit from 2018 to 2020 has decreased sequentially from Rp. 1,959 B in 2018, Rp. 819.46 B in 2019 and Rp. 128.75 B in 2020. In responding to this condition, the company must take strategic steps. One of the steps that can be taken is that the HR (Human Resource) division must evaluate the human resources referred to as the company's 'profit center', especially in projects. Work environment, management support and employee job satisfaction are 3 variables that will be identified whether affect employee performance. Total sample size of research is 99 employees in PT. PP (Persero) Tbk. (male = 83 and female 16). SPSS and Smart-PLS was used to analyze the data. Research examined that work environment and management support influence directly with job satisfaction. Other than that, work environment also have a positive and statistically significant relationship with employee performance.

Keywords: project management, work environment, management support, job satisfaction

1. INTRODUCTION

Human resources are assets of a company or business organization, these assets will assist the company in running the business so that it can achieve targets and maintain the sustainability of business processes. Companies in the construction sector, projects are the spearhead of profit achievement and company performance and this causes employees to be referred to as 'profit makers'. Thus, the performance of employees on construction projects has a major effect on the achievement of company performance. PT. PP (Persero) Tbk. is one of the largest State-Owned Enterprises called BUMN that is in the field of construction services in Indonesia. This makes the construction company highlighted by the public. In addition, according to the Regulation of the Minister of State-Owned Enterprises number:

PER-1/MBU/03/2021, BUMN in the form of a limited liability company whose capital is divided into shares which are wholly or at least 51% of the shares are owned by the Republic of Indonesia whose main purpose is to pursue profits. Thus, the company is required to increase profits every year. However, quoted from the financial statements of PT. PP (Persero) Tbk, the company's profit in 2018 to 2020 has decreased successively from Rp. 1,959 billion in 2018, Rp. 819.46 billion in 2019 and Rp. 128.75 billion in 2020. In responding to this, the company must take strategic steps. One of the steps that can be taken is that the HR (Human Resource) division must evaluate the human resources referred to as the company's 'profit center', especially in projects. Before making efforts to improve employee performance, the HR (Human Resource) division must know what can affect employee performance on the project. Conditions in construction projects are certainly different from conditions at the head office. Projects are unique and have a certain timeframe, besides that the project is also limited by the budget. Meanwhile, the head office is more operational in nature with the same activities every day, so the treatment or influencing aspects can be different, therefore it is necessary to do a special research on construction projects. This study explores the answer to the question research : How do the work environment, management support, and job satisfaction affect employee performance on construction projects?.

2. LITERATURE REVIEW

Work Environment on Employee Satisfaction

Fadlallah, 2015 in his research that involve all members of the teaching staff, said that the studied strongly agree that job satisfaction and performance will better if working conditions, salary and promotions, and work relations are better too.

Work Environment on Employee Performance

Physical factors in the project site such as poor layout or overcrowding can lead to common types of accidents such as tripping or bumping into objects. There are also several other factors that can affect employee performance such as noise which can cause discomfort to employees, thereby reducing employee productivity. An employee can be affected depending on the task assigned and also the environment in which they work. By having a good environment, employees can mobilize their full energy and attention to do work (Vischer, 2007). Research by Bushiri in 2014 concluded that the work environment plays an important role in motivating employees to carry out their duties. Because money is not a sufficient motivator in driving the workplace performance required in today's competitive business environment. The ability to attract, retain and motivate high performers is becoming increasingly important in today's competitive organizational environment. At the end of the study, it was realized that the work environment of employees greatly affects their productivity. Therefore, it is the responsibility of the organization to provide a friendly work environment that will influence employees to work comfortably and carry out their work.

Management support for Employee Performance

The immediate supervisor acts as an advocate for the employee, gathering and distributing the resources needed by the employee so that they can do a good job and provide positive encouragement for a job well done. As a work environment factor, the interpersonal role of supervisor is important to encourage positive relationships and increase employee confidence and in turn improve employee performance (Blau, 1964).

3. METHODS

This section will explain about the methodological strategy. Primary data that used in this research is questionnaire about variables. This research needed (97) respondents from construction company (PT. PP Persero Tbk.) that located in project and have a position below project manager. The composition between male and female are 83,8% (83 persons) and 16,2% (16 persons). Respondents

detail is consist of Site Engineer Manager (SEM) = 4, Site Operational Manager (SOM) = 3, Site Administration Manager (SAM) = 1, Engineering Staff = 58, Operational Staff = 11, Administration Staff = 12, Quality Control and HSE = 10. Research purpose is to identify the impact of work environment, management support, job satisfaction on employee's performance. A total of (99) filled questionnaires. Questionnaires must be answer with scale 1-5 in accordance with the respondent's agreement to each statement . The scaling is: (5 for strongly agree, 4 for agree, 3 for quite agree, 2 for disagree, and 1 for strongly disagree). Descriptive statistics and Partial Least Square-Structural Equation Modelling (PLS-SEM) analyze were used to test and analyze the data collected from respondents using SPSS and Smart-PLS software.

Research Hypothesis:

H1 : Work environment has a direct influence on job satisfaction H2

: Management support has a direct influence on job satisfaction

H3 : Work environment has a direct influence on employee performance in construction project H4 :

Management support has a direct influence on employee performance in construction project H5 : Job

satisfaction has a direct influence on employee performance in construction project

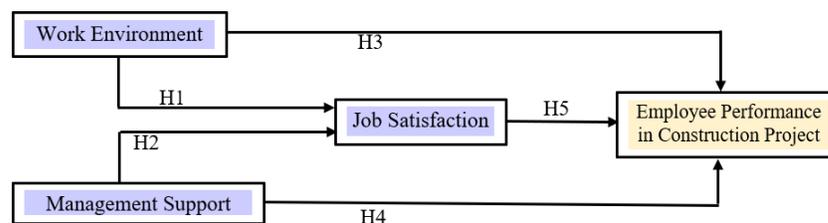


Figure 1. Research Model

4. RESULTS

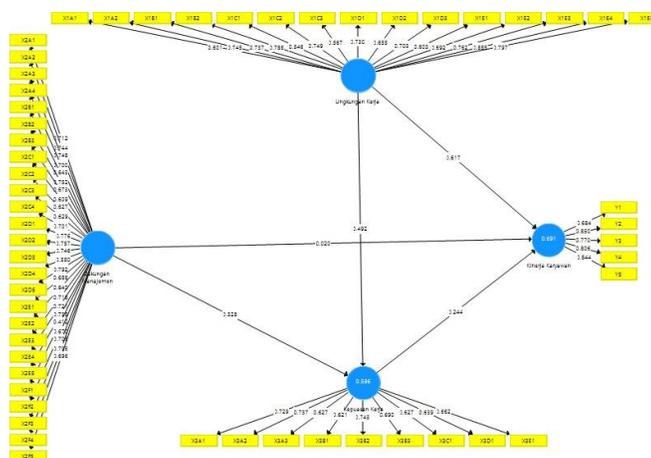


Figure 2. Measurement Model

Based on the results of hypothesis testing, the explanation of the results of hypothesis testing is obtained as follows:

1. H1: The work environment has a direct influence on job satisfaction

The results of testing hypothesis 1 at a significant level of 0.05 obtained a path coefficient value of

0.494. The results of the hypothesis test have a value of t arithmetic $> t(0.05/2, n-1)$ ($5.271 > 1.98$) or P Value < 0.05 . So, it can be concluded that H1 is supported, which means that the work environment has a direct influence on job satisfaction.

2. H2: Management support has a direct influence on job satisfaction

The results of testing hypothesis 2 at a significant level of 0.05 obtained a path coefficient value of 0.251. The results of the hypothesis test have a value of t arithmetic $> t(0.05/2, n-1)$ ($2.346 > 1.98$) or P Value < 0.05 . So, it can be concluded that H2 is supported, which means that management support has a direct influence on job satisfaction

3. H3: The work environment has a direct influence on employee performance in construction projects

The results of testing hypothesis 3 at a significant level of 0.05 obtained a path coefficient value of 0.525. The results of the hypothesis test have a value of t arithmetic $> t(0.05/2, n-1)$ ($4.569 > 1.98$) or P Value < 0.05 . So, it can be concluded that H3 is supported, which means that the work environment has a direct influence on employee performance in construction projects

4. H4: Management support has a direct influence on employee performance in construction projects

The results of testing hypothesis 4 at a significant level of 0.05 obtained a path coefficient value of 0.118. The results of the hypothesis test have a value of t count $> t(0.05/2, n-1)$ ($1.379 < 1.98$) or P Value > 0.05 . So, it can be concluded that H4 is not supported, which means that management support does not have a direct effect on employee performance on construction projects

5. H5: Job Satisfaction has a direct influence on employee performance in construction projects

The results of testing hypothesis 5 at a significant level of 0.05 obtained a path coefficient value of 0.235. The results of the hypothesis test have a value of t arithmetic $> t(0.05/2, n-1)$ ($1.874 < 1.98$) or P Value > 0.062 . So, it can be concluded that H5 is not supported, which means that job satisfaction has no direct effect on employee performance on construction projects

6. CONCLUSIONS

Research examined that work environment and management support influence directly with job satisfaction. Other than that, work environment also has positive and statistically significant relationship with employee performance. Therefore, Human Resource Development in PT. PP (Persero) must pay attention with job environment in project. They must evaluate and improve every indicator of the work environment such as Managerial Recognition, Employee Value Recognition, Personal Belonging, Co-worker Belonging and Personal Competence.

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COMMUNICATIVE ONLINE PROMOTION STRATEGIES BASED ON MILLENIAL PREFERENCES FOR CO-LIVING PROPERTIES

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ABSTRACT

Corona virus in early 2020 has changed the way peoples doing their activities, for example the way of people working, from work from office to work from home (remote) One type of property that can facilitate these changes is the co-living property. Co-living is a rental residence with a co-working space facilities in it, However, this property is not yet popular, especially in Surabaya. Restrictions on human movement due to the pandemic also have an impact on the model of property promotion. Previously, providing a real property sample is an effective method for promotion. This study aims to explore the possibility to increase recognition of co-living properties, especially those according to the preferences of the target market, the millennial generation. Additionally, if digital is their working plafond, what is the most communicative online promotion strategy based on their preferences, This is a quantitative research. The results of this study showed that the most preferred online media is Instagram with a percentage of 52%. Meanwhile, the largest age group of social media users who are effective in following property advertisements is between 25-29 years, with the preferred property ad format is Virtual 360.

Keywords: online marketing, co-living, millennial

1. INTRODUCTION

Promotion aims to make consumers aware to the existence of a product or service, one of which is online promotion. According to Philip Kotler (2002) the use of the internet for marketing activities has significance for two parties, namely the seller and the buyer. For consumers, with booking services, information, and reference prices for property products 24 hours whenever and wherever they are, so that they can make it easier to choose the property they like because they are limited by lifestyle changes, working at home and restrictions on going out of the house during the covid-19 pandemic. While for businesspeople, property can reduce property advertising costs to stay afloat.

To make this easier, it is necessary to have an appropriate character for online marketing strategy

target market. A communicative online marketing strategy is needed to attract the target market, namely the millennial generation who have a character close to technology (Bencsik, Csikos and Juhez, 2016). Online marketing strategies can utilize digital marketing including through online media, social media, and SEO (search engine optimization) in various formats that use technological features.

2. LITERATURE REVIEW

According to Pranata and Pramudana (2018), brand awareness is knowledge and understanding obtained by consumers about a company's products. To increase product awareness, several property marketing strategies can be used, namely: advertising, publicity, personal selling, direct marketing, and interactive media (Rosa, Lesmana, 2005). To maximize this marketing strategy, good content marketing is needed because according to Kotler (2017) content marketing is one of the marketing strategies in which marketers plan, create, and distribute communicative content to attract consumers on target.

Digital advertising may encompass the following digital activities: websites, social media (Facebook, Instagram, YouTube, and Tiktok), and real estate portals. According to Miles, ME (2015), advertising resources should be directed toward the media outlets most frequently accessed by the target market. This is done to maximize the effectiveness of property advertisements that will be installed, as they can target clients based on their demographics such as age, profession, and personal interests (Sandhu, Bibek, 2015). (Yogesh K. D, 2021).

Then, pay close attention to the visibility of ad formats such as virtual 360-degree show units, video testimonials, animated movies, and project profile videos in order to improve the likelihood of consumers receiving appealing impressions (Adshead. Stephen, et al., 2019). To strengthen customer bonds, online publications such as live streaming discussion programs, community meetings, and partnerships with other companies on online events are required (Pulizzi. Joe, Ritchi. Anna, 2013). Additionally, interactive internet events are used to persuade customers to buy real estate goods, such as online unit selection, virtual open houses, live streaming discussion shows, and live unit launching.

3. METHODS

This research method uses a quantitative approach that aims to identify appropriate digital activities to assist the right and communicative property marketing strategy according to the preferences of the millennial generation. The analysis used is descriptive statistics with the help of crosstabulation validation to find the most preferred online marketing strategy by consumers.

This research used literature review by collecting data obtained from various sources such as books, journals, and official websites that discuss property promotion strategies that can be used during the covid-19 pandemic. As well as a questionnaire that is a close-ended question with several alternative answers to determine millennial preferences in using internet technology to determine the preferred property.

The population of the research object based on data from the Central Statistics Agency of Surabaya in 2020, the number of people working at the millennial generation is 729,158 people with the main jobs in agriculture, manufacturing, and services. Then by calculating the Slovin formula from the population, a sample of 100 respondents was taken. The research variables used are digital advertising media, ad formats, online publications, and online to get a communicative marketing strategy that suits consumer preferences to increase awareness of co-living product.

4. RESULTS

4.1 Preferred social media platform for property ad serving.

Table 1. crosstabulation of the use of online media advertising by gender

		Preferred online media platform in property ad serving				Total
		Facebook	Instagram	Youtube or Tik tok	Portal real estate (rumah.com, mamikos.com)	
Gender	Male	5	19	9	17	50
	Female	0	33	0	17	50
Total		5	52	9	34	100

Based on the table 1, the most preferred online media is Instagram with a percentage of 52%. Of the Instagram platforms, 64% of them are dominated by women and the remaining 36% are dominated by men. Next there is a real estate portal in second place with a percentage of 34%. Then online social media platforms are in video format with a percentage of 14%.

Based on the data above, it was also found that the chi-square value was 0.000 or less than 0.05. So, it can be concluded that there is a dependency between gender and the ideal online social media platform in property ad serving preferences.

Reason for selection

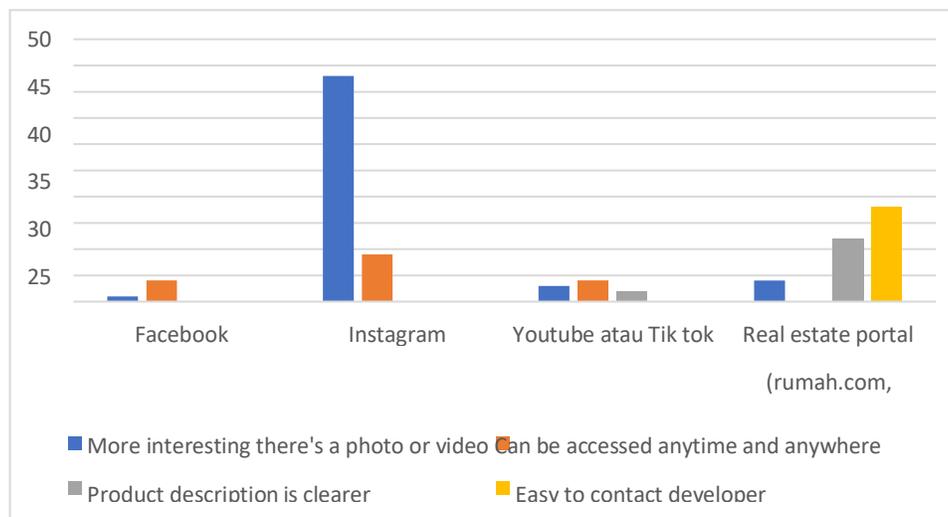


Figure 1. Preferred online media platform in property ad serving.

The impact of age on the choice of preferred social media for serving commercial property ads

Table 2. use of online media advertising by age.

	Preferred online media platform in property ad serving	Total
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		Facebook	Instagram	Youtube atau Tik tok	Portal real estate (contoh rumah.com, mamikos.com)	
Age	20-24 years old	0	12	2	6	20
	25-29 years old	1	18	5	12	36
	30-34 years old	1	14	2	9	26
	35-39 years old	3	8	0	7	18
Total		5	52	9	34	100

Based on the table above, the dominance of Instagram in serving property ads can be divided into several age groups. Users from the age group of 25-29 years old are 35%, users from the age group of 30-34 years old are 27%, 23% are in the age group 35-39 years old and age 20-24 years old are 15%. Meanwhile, real estate portal users from the age group of 25-29 years old are 35%. Users from the age group 30-34 years old by 26%, users from the age group 35-39 years old by 21% and users from the age group 20-24 years old by 18%.

4.2 Effective property ad format

Table 3. age crosstabulation with ad delivery format

		Communicative ad delivery format				Total
		Virtual 360 show unit	Video Testimonials	Animated Videos	Video profile project	
Age	20-24 years old	13	3	4	0	20
	25-29 years old	22	4	6	4	36
	30-34 years old	15	1	4	6	26
	35-39 years old	3	1	0	14	18
Total		53	9	14	24	100

Based on the table above, the effective property ad formats according to respondents are the Virtual 360 Show unit format by 53%, the project profile video format by 24%, the animation video format by 14% and the testimonial video format by 9%.

Reason for selection

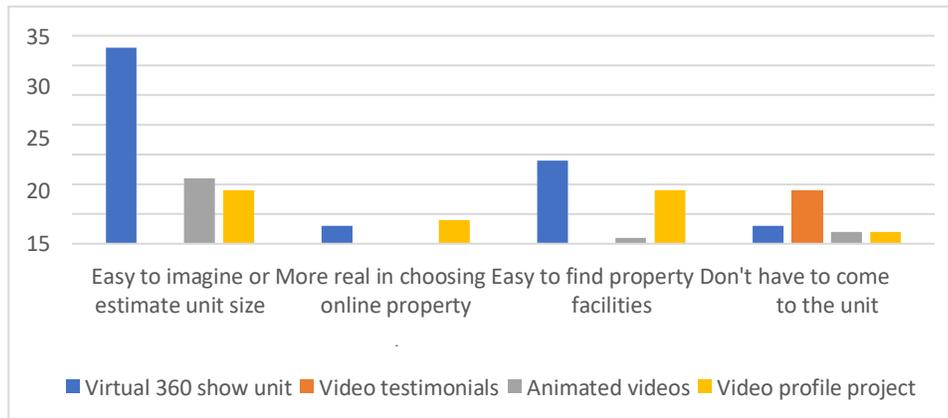


Figure 3. reasons for choosing property ad formats.

From the 100 respondents, 33 people stated that it was easy to imagine or estimate the size of the unit with a virtual 360 show unit.

4.3 Interactive online events

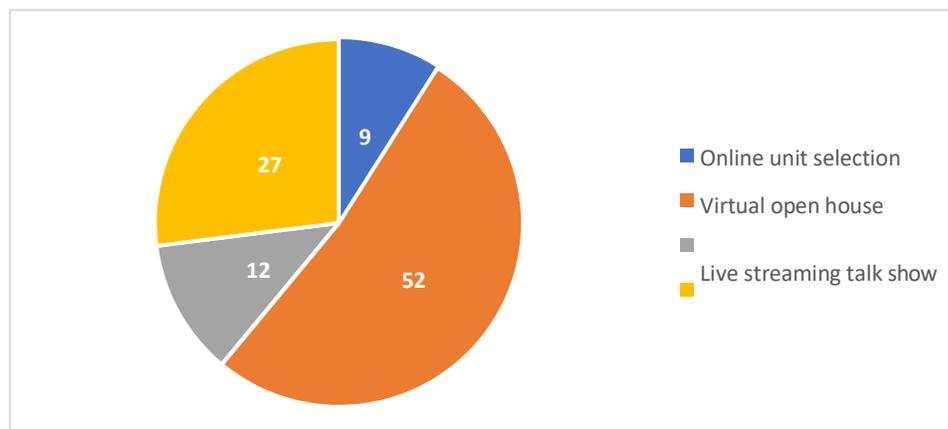


Figure 4. more interactive online events.

Due to the limitations of the covid-19 pandemic, an online event is needed that can attract the desire to choose/buy a property. Based on the diagram above, interactive online events that are most chosen by respondents are virtual open house by 52%, live launching unit by 27%, live streaming talk show 12%, and online unit selection by 9%.

4.4 Communicative online publication

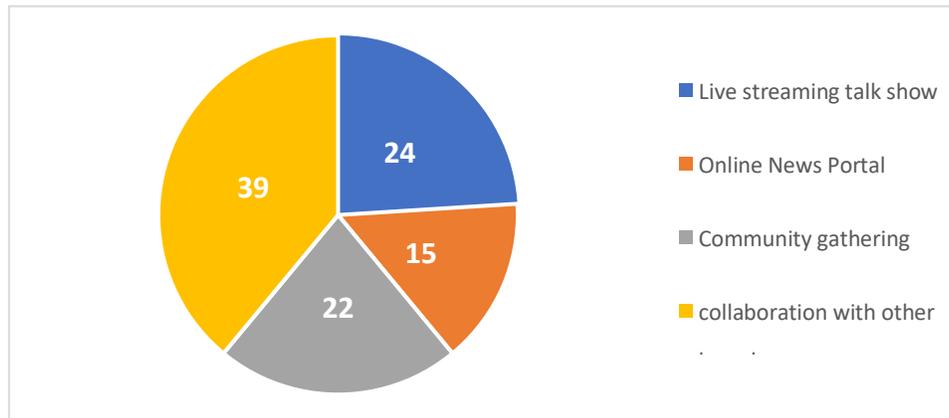


Figure 5. more communicative online publication

The millennial character who likes to collaborate also affects online publication preferences based on pictures as many as 39 respondents choose collaboration with other brands as communicative online publications. This has the advantage of expanding the market to increase awareness of a new property product.

6. CONCLUSIONS

From the results of this study, to increase awareness property such as co-living it can be concluded that the preferred online social media platform during the covid-19 pandemic in delivering communicative property ads is Instagram. The main reason for choosing Instagram is because Instagram is considered more attractive in displaying photos or videos about properties. The dominance of Instagram users is women, meanwhile the largest age group of social media users who are effective in following property advertisements is between 25-29 years. This may possible because at that age independence in choosing property has started to become their priority in their life.

The preferred property ad format is Virtual 360 Show because it is easy to imagine or estimate the unit size. This becomes important when the covid-19 pandemic we cannot come directly to see the unit. Meanwhile, according to respondents, the most effective online publication is collaboration with other brands. Because brands that usually act as promoters of publication events will maintain their brand names to remain trusted by their consumers who will at the same time become potential consumers of the property products they partner with. Suggestions for collaboration with other brands on co-living products can be done with furniture brands or smart home systems that are preferred by the millennial generation.

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THE EFFECT OF FACADE DESIGN ON CONSUMER PREFERENCES FOR SUSTAINABLE HOUSING

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ABSTRACT

Interest in buying a house in the City of Kediri is currently increasing, it turns out to have a good impact with the increasing variety of house models offered. In choosing a house, the facade design is a major concern because it is closely related to the function of the building. Therefore, an analysis was carried out on the effect of house facade design on consumer preferences who made changes to the facade of the house after being occupied to maintain the sustainability of the house, the research location was in Puri Kedaton Housing, Kediri City. This study uses a correlational research strategy, on post-positivism research paradigm, because this study reviews the occupants and then collects data related to the influence of facade design. The results obtained between a certain type of house and the consumer's desire to make changes, namely a negative relationship on the type 54/60 and a positive relationship on the type 80/100.

Keywords: facade design, consumer preferences, sustainability.

1. INTRODUCTION

According to the RP3KP of the City of Kediri in 2012-2032, housing development by the private sector or developers is growing rapidly and the housing being built is increasingly being filled by new residents, according to the number of home buyers in Kediri City is currently increasing, apparently this has a good impact on the increasingly diverse housing models offered. This affects the sustainability of the dwelling that has been occupied by the occupants for a certain period of time. According to Murwanti (2009), residents are interested in buying a dwelling because of the product attributes in the form of price, design, facilities, and location. In this study, we want to review housing, especially housing that has been built and inhabited by new or old residents, whether or not there is a change in the design, especially the facade of the house, it can be in the form of improvements to the material when it is associated with the visual character of the occupants (Ching, 2008).

Based on data on the Handover Status of Infrastructure, Facilities, and Public Utilities of Housing in the City of Kediri in 2020, it is known that the total housing in the City of Kediri reaches 80 housing. One

of the housing that has been built at this time which will be reviewed is the Puri Kedaton Housing which is located in Kota District, because until this research was carried out, most of the houses still had the shape and design of the facades that were well maintained by the residents, from those built by the developer PT. Kembang Jawa Permai which is one of the well-known developers in the city of Kediri. In this regard, the researcher wants to review the promotional sentence in the Puri Kedaton Housing brochure which emphasizes the point "When comfort and prestige come along with promising investments". So that from the promotional promise, three points can be reviewed, namely convenience, prestige, and investment, design promises that ensure occupant satisfaction.

2. LITERATURE REVIEW

Based on the theory of Architectural Composition (Krier, 2001), the facade is the outermost or exterior physical element of a building that forms the face of the building and exhibits the existence of a building to the public. There are several facade elements that can be observed in the building and those reviewed in this study include gates, windows and entrances, facade ornaments, railings, and roofs.

Then the consumer preference according to Assael (1992) is a thing that is formed by consumer preferences of perceptions of the product. Reinforced from Bilson (2004) states consumer preference is an act of consumers in choosing an item according to the level of need. The preference in this study is in relation to consumers in making changes to aspects of the facade of the house that can be influenced because they want their houses to be sustainable in the long term.

3. METHODS

In obtaining research data, it is necessary to review the occupants of the house and from the developer, so the paradigm used is post-positivism with an ethical approach. This study uses an ethical approach because the researcher plays a full role, namely the object of the case study will be observed from afar or close to the use of intermediary questionnaires given to respondents.

The strategy used is correlation research, because it looks for the relationship between two or more variables. The type of correlation research applied is causal comparative, the researcher selects a comparable group of people or a comparable physical environment and then collects data on various relevant variables (Groat and Wang, 2013). The correlation strategy is used because the main objective of this research is to find the relationship between the influence of facade and interior design on the aspect of housing consumer preferences.

The sampling technique used is stratified random sampling, which is sampling by first grouping the population according to certain characteristics (Tika, 2006). The population reviewed in this study are consumers or residents who live in Puri Kedaton housing, so that the number of samples that will be carried out in this study reaches 32 respondents who live in the housing from several types of prominent houses.

4. RESULTS

4.1 Respondent Profile Diagram

The respondents were almost balance in gender, 20 men and 12 women, and all of them were married. The job profiles of the respondents were varied, although mostly self-employed with a total of 14 people, private employees in a total of 11 people, and civil servants for a total 7 people. The income obtained by the respondent in real income or as a whole which is from basic salary and other income, obtained that the average resident earns 2 to 5 million rupiah for a total of 18 people and more than 5 million rupiah for a total of 14 people. Respondents are residents in four types of houses, such as type 54 houses (10 people), type 60 (5 people), type 80 (10 people),

and type 100 (7 people).

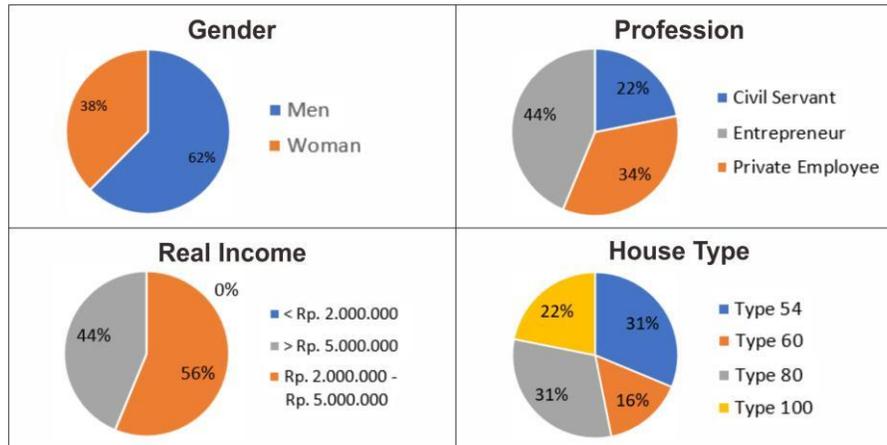


Figure 1. Respondent Profile Diagram

4.2 The Effect of the Visual Character of the Facade of Housing on Preference

In this study, we review the style or building style in the form of house designs at Puri Kedaton Housing, including type 54, type 60 design 1, type 60 design 2, type 80, and type 100. The design assessment uses a score of 5-1 with 5 as highest score and 1 as the lowest score.

Table 1. Assessment of the Façade Visual Character at the Puri Kedaton Housing

NO	AESTHETIC OF FACADE DESIGN	SCOR E				
		1	2	3	4	5
1	 Type 54	7 (21,9%)	13 (40,6%)	2 (6,3%)	6 (18,8%)	4 (12,5%)
2	 Type 60 (I)	15 (46,9%)	4 (12,5%)	6 (18,8%)	6 (18,8%)	1 (3,1%)
3	 Type 60 (II)	3 (9,4%)	7 (21,9%)	3 (18,8%)	13 (40,6%)	3 (9,4%)
4	 Type 80	5 (15,6%)	3 (9,4%)	13 (40,6%)	6 (18,8%)	5 (15,6%)
5	 Type 100	1 (3,1%)	3 (9,4%)	4 (12,5%)	6 (18,8%)	18 (56,3%)

From the analysis of the visual character of the façade on the preference of the respondents, the

order of preference from the best to the worst is as follows; house type 100, house type 60 (II), house type 80, house type 54, and house type 60 (I).

Based on the results above, it is known that the best facade design is in the type 100 house, and the worst is the type 60 house design 1. Based on the results of the visual quality assessment of the facade, it can be seen that in accordance with what Sudarman (2004) and Indarto (2001) explained. If consumers have sufficient interest and knowledge of the object (housing design), then consumers can make an assessment on the choice they like the most.

4.3 Statistical calculation of the results

The variables in the facade design are classified into three parts, namely facade elements, space-forming elements, and the visual character of the facade. The effect of facade elements on consumer preferences can be described from the theory expressed by Krier (2001) with the help of Microsoft Excel software, analysis of the influence of facades and building exteriors can be seen statistically in the results in the following table.

Table 2. Quantitative calculation results of facade elements

		Gate and entrance	Windows and building entrance	Facade ornaments	Railing	Roofs and building endings
N	Valid	32	32	32	32	32
	Missing	0	0	0	0	0
Mean		4,22	4,03	4,31	4,16	4,25
Median		4	4	4	4	4
Mode		4	4	4	4	4
Sum		135	129	138	133	136

It can be seen in Table 2, that the most influential and most taken into account by consumers is the facade ornament. This is in accordance with what Krier (2001) said that the facade is related to the visualization of the building.

4.4 Analysis of the Effect of Facade Design on Consumer Preference

To determine the effect of facade design aesthetics on consumer preferences, an analysis was carried out using a Scatter diagram, using Microsoft Excel software. The analysis was carried out on the facade design variables with attribute variables on the product in relation to consumer preferences in the aspect of psychological mindset. The attribute approach is based on the assumption that consumer considerations are in the aspect of a psychological mindset. The attribute approach is based on the assumption that consumer considerations in choosing an item/service are based on the attributes attached to the item or service. Attributes of an item include all services resulting from the use or possession of the item. The results of the regression analysis of the two variables can be seen in Figure 2.

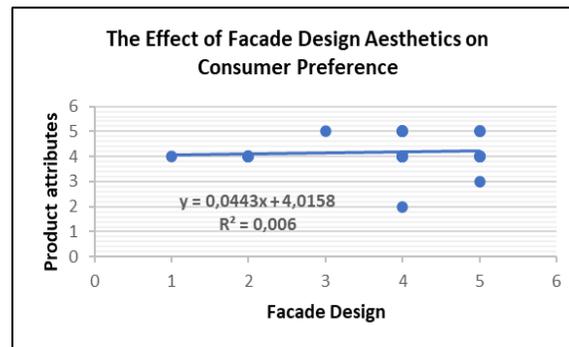


Figure 2. Regression diagram of facade design variables with product attributes

The picture above shows several things, including the facade design has a positive relationship with attributes on the product in relation to consumer preferences even though it looks not so significant and the increase or increase in consumer preferences which in this case is influenced by attributes on the product depends on the addition of the facade design.

From the results of the questionnaires that have been distributed, data is obtained regarding the type of house chosen when buying and the factors that influence consumers in making changes. To find out the relationship between the two, an analysis of the effect of the type of house on the desire to make changes will be carried out in the following pictures.

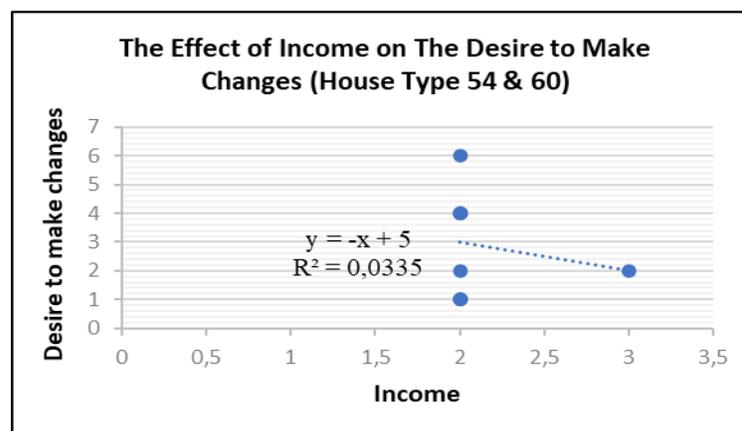


Figure 3. Regression diagram of income effect on type 54 and 60

In the picture above (Figure 3) shows the results of the analysis that has been carried out on respondents who inhabit types 54 and 60 which can be concluded that the consumer income variable has a negative relationship with the consumer desire variable to make changes. Then in Figure 4 shows the results of the analysis on different types, namely houses type 80 and 100 which are types that are more expensive than before.

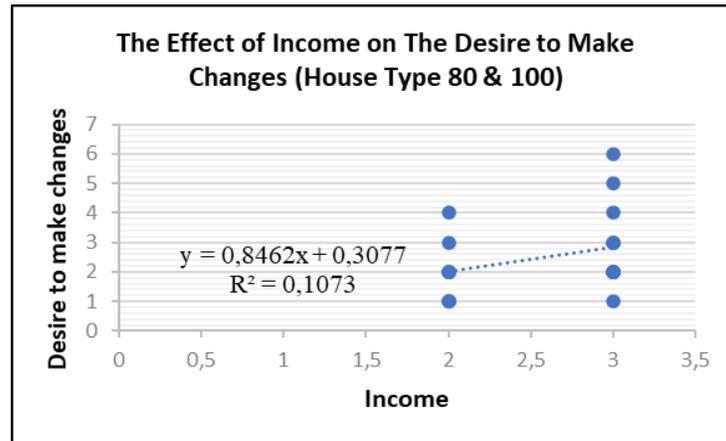


Figure 4. Regression diagram of income effect on type 80 and 100

In Figure 4 obtained several things that can be understood, namely; income has a positive relationship with consumers' desire to make changes to the 80 and 100 types, the increase or increase in consumer desire to make changes for sustainability depends on the addition of income.

CONCLUSIONS

Based on the results of the research conducted, it can be understood that the elements most considered by respondents in choosing house's design and their relationship to it's sustainability, can be seen from the grouping of the influencing aspects; namely facade ornaments, furniture, and colors. According to the respondents, the best design is on house type 100 and the worst is house type 60 (I), therefore no needs to be renovated and still in its design.

A positive relationship was obtained on the facade design affecting consumer preferences for sustainable housing in the City of Kediri, especially Puri Kedaton, which means that if the facade design variable increases then consumer preferences will increase and sustainability can be persisted. Then obtained two different relationships between the type of house and the consumer's desire to make changes, the type 54 and 60 got negative results, and types 80 and 100 got positive results. It can be understood that in the lower type of house the desire to change the facade tends to be low because it is influenced by low income, in contrast to the upper type house, the desire to change the facade tends to be high because of sufficient income or more so that it can make changes to maintain sustainability in the future of the house.

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Parallel Session 2

Room L (12.10 – 13.55)

Moderator:

Category : Operation Management

DEFECT ANALYSIS OF POWER TRANSFORMERS TANK USING THE SIX SIGMA APPROACH IN TANK FABRICATION

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ABSTRACT

A transformer is an integral part of the reliability of the electric power system in Indonesia. Loss of work on the transformer can cause Power system failures due to problems with the quality of the transformer tank itself. Based on data from one of the Tank Fabrication customers, namely Transformer Fabrication, there are tank quality discrepancies, and there has been no severe repair to resolve the problem. Bad quality of the tank cause leakage and the appearance of rust, so that it will affect the quality of the transformer as a whole. There are many defects in the results of internal inspections, so process improvements are needed. The problems should be analyzed more deeply. Inconsistency in a quality necessitates the need for an effective and efficient improvement method. According to a priority scale, the Six Sigma approach method is a systematic improvement method to parse problems and solve them. Tank Fabrication sigma level based on customer complaint data is only 2.76. Based on complaint data from Transformer Fabrication, the most dominant problem comes from the welding and painting process, namely 77.1%, where under spec painting thickness defects are the most prevalent, followed by welding defects in the form of incomplete fusion, porosity, and spatter. The identification results can be a point where Tank Fabrication improves the production process to reduce customer complaints. The company can reduce rework costs, the company's sigma value will increase, and customer confidence will be better.

Keywords: Tank, transformer, pareto, six Sigma

1. INTRODUCTION

The transformer is one of the most vital elements in the reliability system of electricity supply to all customers throughout Indonesia. Problems in transformers, especially power transformers in the network system, will generally cause widespread interference problems. One power transformer measuring 60 MVA can supply electrical power in almost one district or city in Indonesia. In addition, several other

state-owned and private companies also use transformers for the continuity of their production. The emergence of problems in the transformer will cause the company's operations to stop to suffer no small amount of losses. This problem causes the vitality of a transformer in the electricity system throughout Indonesia.

Six Sigma is a very rigorous process that helps us focus on developing and delivering a product or service. Implementation stages of Six Sigma have five steps: the DMAIC cycle method (Define, Measure, Analyze, Improve, and Control (Evans and Lindsay, 2007). Six Sigma has developed and used several ways at each stage. Six Sigma uses the DMAIC method in this study to find out defects in tank fabrication and reduce these defects to improve the quality of the transformer tanks. This study will use several tools like Pareto

diagrams, cause-effect diagrams, control charts, and Failure Mode Effect Analysis (FMEA). Analyzing some of these methods will later become material for suggestions for improvements in the production process related to existing customer complaints.

2. LITERATURE REVIEW

Six Sigma is a very rigorous process that helps us focus on developing and delivering a product or service. Six Sigma is a statistical term that measures how the process deviation occurs towards perfection (Jacobs, Chase, and Aquilano, 2004). The main idea in six Sigma is how we can measure how significant the defect is in the process, find out how to systematically eliminate the defect, approach zero defect as much as possible. A process must produce no more than 3.4 defects in a million occasions to achieve Six Sigma Quality. The opportunity in question is the opportunity for a discrepancy or not following the required specifications. It means we have to be close to the perfect position in executing key processes. Six Sigma itself consists of several key concepts (Jacobs, Chase, and Aquilano, 2004). Six Sigma, a quality improvement implementation, has five steps: the DMAIC cycle method (Define, Measure, Analyze, Improve, and Control) (Evans and Lindsay, 2007).

It was implementing the Six Sigma method requires statistical tools and methods. The control chart is a graphical depiction of data over time that describes the upper and lower limits of the process that we will control (Heizer and Render, 2008). The control chart depicts data that changes from time to time but does not indicate the reason for the deviation. The control chart is a statistical control tool used to identify and detect processes in an uncontrolled state. DPMO (Defect Per Million Opportunities) is a failure value calculated based on the number of failures per one million opportunities. DPMO also gives a simple description of the quality and capability of a process. Six Sigma can form of the continuous effort to reduce diversity and prevent defects in a process by using statistical tools and techniques to reduce defects until there are no more than three or four defects per million opportunities (DPMO) to achieve overall customer satisfaction (Creveling, Hambleton, and McCarthy, 2006). A Pareto diagram is a diagram to map the causal factors, and then problem-solving must focus and prioritize 80% of the dominant causes (Montgomery, 2007). By using the Pareto helpful diagram to show which factors are dominant. The usefulness of the Pareto diagram is that it can analyze and find out the description of the causes of the problems that are the initial focus to be solved. According to Montgomery (2009), a cause-and-effect diagram is a helpful tool for identifying potential causes of the effects of a problem. This

diagram shows the factors that are the cause and effect of the decline in quality caused by these causal factors. Critical To Quality (CTQ) can be a critical attribute of a process and directly influences achieving quality following customer standards (Gaspersz, 2002). CTQ is a method of measuring product or process standards and following what is desired by the customer. The level of customer satisfaction is an added value to obtain CTQ. This study selects the characteristics that cause defects so that the observed product is said to be a failure.

3. METHODS

The research method solves problems that arise. The systematic steps used in this study are:

1. Data Collection

Data collected through observation, interviews, and documentation methods to meet data needs to solve problems; they are primary and secondary data.

2. Data Processing

After identifying the problems and studying the existing literature, use the Six Sigma approach to process data.

a. Define

In the define stage, the proportion of defective products is determined to be the most significant cause of defects that are the source of production failure. The steps taken are as follows:

- 1) Identify and determine Critical to Quality (CTQ)
- 2) Define Defect Opportunity, which is the assessment criteria for non-conformance of goods
- 3) Classification of defect data based on predetermined defect opportunities
- 4) Identification of production process flow using SIPOC diagram

b. Measure

The steps taken at the measuring stage are:

- 1) Calculate the Defect per Million Opportunities (DPMO) value, which is the number of defects in one million events.
- 2) Calculate the sigma value to determine the process capability based on Defect per Million Opportunities (DPMO), Defect Opportunity, and the number of units or samples measured.
- 3) Classify the type of defect based on the place of the process where it appears. After that, the value of the most significant defects determined Pareto diagram to determine the type of it based on the classification of the process for further analysis in the next stage.

c. Analyze

It will focus on the problem with the Pareto value in the measuring stage. The process that becomes the main concern is classifying according to the type of defect. In addition, analysis using control charts is also carried out on each process with the most significant value based on the Pareto diagram. The classification result based on the process defects will be re-made a Pareto diagram to determine the most dominant type of defect in the process. The most dominant defect in each process is then analyzed using a cause-effect diagram to find out the root cause of each type of defect. At this stage, the results of the Pareto analysis are helpful to find the root cause of the problem.

4. RESULTS

From September 2020 to April 2021, Tank Fabrication has produced more than 30 units of transformer tanks and sent 26 of them to one of the customers who became the object of this research, namely a company engaged in transformer manufacturing in the Ngoro area, Mojokerto. Every day, Jombang Tank Fabrication receives customer complaints in NCR (Non-Conformance Release) form or non-conformance reports if found discrepancies in each item sent. The NCR system itself was issued based on existing findings so that one tank unit has more than one NCR. For the NCR data itself from one of the Tank Fabrication customers who became the object of research with a delivery time duration of September 2020 to April 2021

Define

Tank Fabrication has several processes, from receiving material generally in metal plates form and then processing it to become a tank complete with conservators and existing accessories. Table 1 shows each section has a supplier in each process and the full details.

Table 1. SIPOC table of Tank Fabrication

<i>Supplier</i>	<i>Input</i>	<i>Process</i>	<i>Output</i>	<i>Customer</i>
<i>Metal plate Store Paint store</i>	<i>Metal plate Welding material</i>	<i>Material pull and certificate check</i>	<i>Material report</i>	<i>Cutting section</i>
<i>Cutting section</i>	<i>Base metal</i>	<i>Cutting</i>	<i>Cutting report</i>	<i>Beveling</i>
<i>Beveling</i>	<i>Plate cut</i>	<i>Beveling</i>	<i>Beveling report</i>	<i>Tack Welding</i>
<i>Tack Welding</i>	<i>Beveled plate</i>	<i>Tack Weld and temporary fitting</i>	<i>Tack weld report</i>	<i>Full Welding</i>
<i>Full Welding</i>	<i>Tack weld plate</i>	<i>Full weld</i>	<i>Full welded report</i>	<i>Assembly</i>
<i>Assembly</i>	<i>Full weld part</i>	<i>Temporary assembly/full fitting Pneumatic test NDT test</i>	<i>Full fitting report Pneumatic test report NDT test report</i>	<i>Painting</i>
<i>Painting</i>	<i>Full weld part</i>	<i>Blasting and painting</i>	<i>Painting report</i>	<i>Packing and shipment</i>
<i>Packing and shipment</i>	<i>Main tank Cover Conservator Loose part Accessories</i>	<i>Transport to Customer</i>	<i>Packing list</i>	<i>Transformer manufacturer</i>

Critical to Quality (CTQ)

A transformer tank is a container for a voltage transformer and oil as insulation and coolant. Due to its construction, the transformer tank must be able to store transformer oil continuously without leakage. The

weight of the transformer oil will cause pressure in the tank, so the tank must also be strong enough to withstand it caused by the weight of the transformer oil. Several general criteria determine whether or not a transformer tank on the customer side is good, namely: 1. The transformer tank does not leak, 2. The transformer tank is not rust, 3. Good tank visuals, 4. All parts are easy to install, 5. Completeness, 6. Safe delivery

A transformer tank certainly has very complex parts, so that to meet these six criteria, each part of the transformer must meet many parameters. The total Defect Opportunity in the construction of one unit transformer tank is 149 parameters. This parameter is based on the division of the inspection area for one tank unit consisting of cover, wall tank, bottom tank, radiator valve, conservator, and accessories. In addition, the quality parameter itself is determined based on the quality of the material, welding, painting, fitting, delivery, and several other small parameters.

the transformer must meet many parameters. Based on interviews with Supervisors and product quality inspectors from Tank Fabrication customers, the number of failure parameters was determined or usually referred to defect opportunities, as shown in the table in the attachment.

The total Defect Opportunity in the construction of one unit transformer tank is 149 parameters. This parameter is based on the division of the inspection area for one tank unit consisting of cover, wall tank, bottom tank, radiator valve, conservator, and accessories.

Table 2. Sigma Level

Total Deffect	358
Total sample	23
Defect Opportunity	149
DPO	0.1045
DPMO	104464.5463
Level σ	2.756515603

Measure

A transformer tank certainly has very complex parts, so that to meet these six criteria, each part of The sigma level is still in the range of 2.76, where the level is still the average industrial sigma level in Indonesia.

The discrepancy data grouped by Defect Opportunity, the number of discrepancies in 23 tank units is 358 defects. The defects are classified following the process. The data can be seen in a Pareto diagram, as shown in Figure 1.

Based on the Pareto, there are two categories of failures caused by the process dominated by the painting and welding process with 161 defects and 115 defects or 44.97% and 32.12% or 77.09% being the cause of the emergence of non-conformance findings in customers. These two categories will be analyzed further in the next stage.

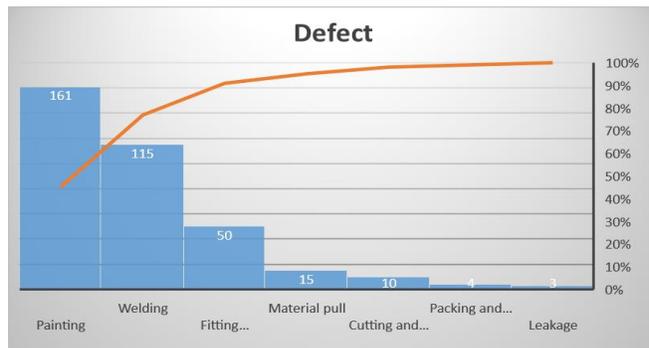


Figure 1. Pareto diagram of defects

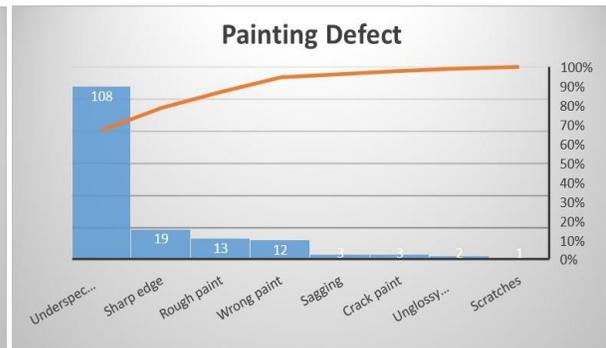


Figure 2. Pareto diagram of painting defect

Analyze

The previous stage determined the most significant portion of defects that contributed to the number of defects in customer complaints. Two highlighted processes and improvements related to the data: the

painting and welding process. They are analyzed using a control chart to see the possible factors that cause it. A Pareto diagram will determine the priority of the existing problems.

Painting Process

The next stage is to find the priority of the problem to be solved using a Pareto diagram. Forty defect opportunities whose source of issues are due to the painting process can be grouped based on the type of defect. Under spec thickness of painting are very dominant if we see Figure 3, reaching 90% of the total defect data due to the painting process. The focus of improvement will be on these problems related to the painting process.

Based on discussions and interviews with the production team and the QC team of the Tank Fabrication, several possible causes of this defect can be defined. Figure 3 can illustrate it. The analysis of the causal diagram above obtained several potential root causes of this defect: 1. Measurement sampling method, 2. Working/painting method, 3. Standards or measurement criteria used, 4. Equipment used 5. an insufficient working area, 6. The material used is not suitable, 7. Lack of skilled operators due to the pandemic period, 8. Pursuing delivery targets

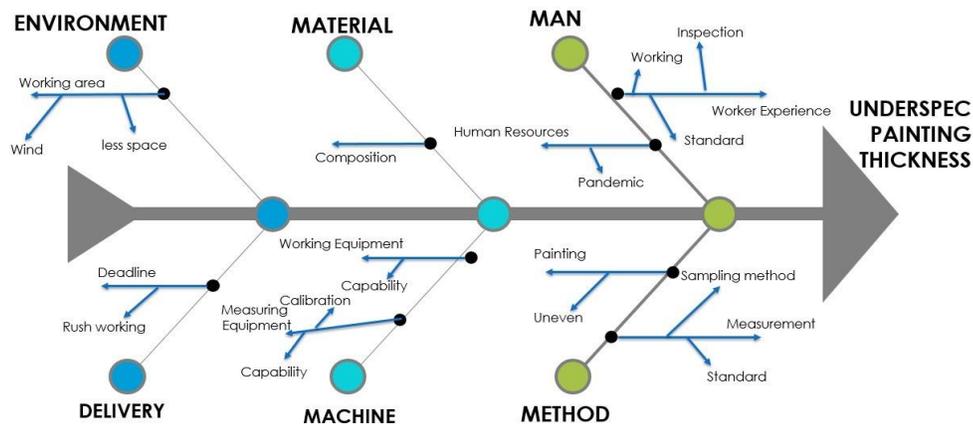


Figure 3. Cause-effect diagram of under spec painting thickness

Welding Process

The welding process is the primary process in fabricating this tank, then the painting and fitting process. The welding process is the process with the 2nd largest defect after the painting process. Almost all the processes of joining steel plates using the welding method.

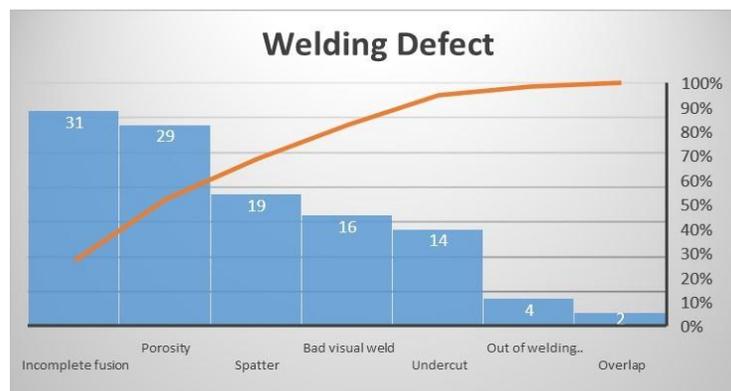


Figure 6. Pareto chart of welding defect

Table 3. Potential root causes of welding problem

No	Potential Causes of Welding Problems	Incomplete Fusion	Porosity	Spatter
1	Less experience of QC Operator and Welder	√	√	√
2	Welding parameters are not completely good	√	√	√
3	The welding machine used is inadequate	√	√	√
4	Rushed work due to delivery deadlines	√	√	√
5	The material used is not up to standard	√	√	√
6	The checking procedure is not understood	√		
7	The standard of defects used is not appropriate	√		
8	Layout and lighting in the welding area is not supportive	√		√

9	Insufficient checking and repair procedures		√	
10	Wind and humidity conditions in the welding area		√	
11	Less cleaning and checking procedures			√

The three types of defects have a percentage of 68.70% of the total welding defects that occur. These defects are incomplete fusion, porosity, and spatter. The three defects were analyzed using a cause-effect diagram as before. The analysis yields several points of potential problem causes in each defect, like in table 3. Due to the Pareto chart in Figure 6, the subsequent analysis will use the three most important data to be the main priority in finding potential causes and solving problems.

5. CONCLUSIONS

The main problem from September 2020 to April 2021 is the painting and welding process, with a total defect caused by the process as many as 276 findings or around 77.1% of the total defect findings. The biggest problem in Tank Fabrication is the problem of painting thickness that comes from the painting process. Incomplete fusion, porosity, and spatter issues come from the welding process. There are 187 defects out of 358 defects, and the company's sigma level is only 2.76. The potential causes of the problem are analyzed using a cause-effect diagram to find the root cause of the problem. Eight potential root causes in the under spec painting thickness defect are measurement sampling method, working/painting method, Standards or measurement criteria used, equipment used, insufficient working area, the material used, lack of skilled operators, and pursuing delivery targets. Eleven potential root causes in the three most significant welding defects. They have less experience as QC operator, and welder, welding parameters, welding machine rushed work due to delivery deadlines, the material used, checking procedure, the standard of defects, the layout of the working area, check and repair procedures, wind, and wind humidity conditions, and cleaning procedures. These root causes can be a point where Tank Fabrication improves the production process to reduce customer complaints. The company can reduce rework costs, the company's sigma value will increase, and customer confidence will be better.

This research is the first step in solving problems that occur in Tank Fabrication. Several improvement proposals still require analysis and follow-up for completion. One of the problems in the painting process is the high variation in thickness values on all sides of the transformer tank. There is a need for further research using the Design of Experiment method to determine the parameters that can be changed to get a more precise painting result on the entire surface of the tank. The welding process or welding is also very possible to do a Design of Experiment related to the welding parameters carried out to get good welding results visually and according to existing standards. For further research, improve and control stages with more complete data following the recommendations for improvement.

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DISTRIBUTION PLANNING OF DAIRY PRODUCTS AT UD BA WITH LINEAR PROGRAMMING METHOD

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ABSTRACT

UD BA, which is located at Pujon Kidul village, is a small-medium enterprise producing a dairy product. UD BA distributed its products directly to consumer. To cope with its prospective growth, UD BA planned to add some products and the number of consumers. This will consequently raise some cost. Some of the costs are shipping cost: from production center to consumer, from production center to selling center, and from selling center to consumer. In addition to shipping cost, there is a holding cost which will incur when the product from some production period, were used to fulfill the demand of the next period. Linear programming frequently used for a method to find some optimal solution, with minimize cost or maximize profit as a goal. In this study, linear programming was used to find the optimal number of products that will be shipped to consumer or to the selling center with minimum cost of fulfilling demand. This study showed that minimum cost of fulfilling demand is Rp 5.386.982.000. It present, moreover, the distribution flows of the products from the production center to consumer.

Keywords: Dairy production, distribution planning, linear programming, optimization.

1. INTRODUCTION

UD BA is a small-medium enterprise that produce a dairy product. The products are milk stick, milk crackers, “kuping gajah”, milk candy, pasteurize milk, yogurt, and ice cream.

Currently UD BA produce only in one production center. From that production center, they ship the products directly to several consumer in Batu City, and in the other cities. According to the plan, they want to expanding their business by adding some consumer. Therefore, they need to make some new production center to fulfilling the demand.

By expanding the number of production center and consumer, they raise some costs, especially the shipping cost. The shipping is whether from production center to consumer directly, production center to selling center, and from the celling center to the consumer. Other than shipping cost, there are a holding cost. A holding cost occurred when some product in one production period were used to fulfill the demand in the next period.

Using linear programming, this study will look for a minimum cost, and the optimum products that ship from the production center to the consumers. There will be about 10 production center, 10 consumers, and 2 selling center. They are located at some cities in East Java. The production period and demand period are set for four weeks, so that it can used for a month planning.

Linear programming frequently used by the researcher to looking for some optimal solution. Wirma (2018) used the linear programming method for looking an optimal flour production. The authors found that using the method, it can reduce the production cost up to 20%. On the other hand, Wasesa (2017) using the method for looking an optimal allocation zone to reach a maximum cost from the land rental. Both of researcher prove that linear programming is capable to resolve a problem that related to optimization.

There are some limitations in this study. This study only discuss about the distribution process. The costs that affect in this study are delivery cost and holding cost. The production centers are considered capable to produce without affected by manhour. The products are hold only one week in each production centers.

2. LITERATURE REVIEW

2.1. Aggregate Planning

Aggregate planning is process by which company determines ideal levels of capacity, production, subcontracting, inventory, stockouts, and even pricing over a specified time (Meindl & Chopra, 2006). By using aggregate planning, we can fulfill demand and maximize profit or minimize cost. Moreover, we can optimize the production facilities and can adjust the production levels due to demand fluctuation.

2.2. Operation Research

Wirma (2018) said that operation research is a method that frequently used for resolve the complex problem. The important steps that used for doing operation research is define the problem, make a math model, resolve the model, validating the model, and implementation. Operation research is the simplest method that used to resolve some problems.

2.3. Forecasting

Forecasting is a process to estimate something in the future by the data and the pattern in the past. Frequently, forecasting is used for looking some demand levels. Satyabhakti (2017) used ARIMA method to looking the ink demand. In this research, Winter's method is used for estimating the products demand for four weeks planning.

2.4. Linear Programming

Luenberger & Ye (2016) describe that linear programming is without doubt the most natural mechanism for formulating a vast array of problem with modest effort. Linear programming has a linear objective function with unknown value, and has some constraint in the form of linear equation or linear inequalities. Four main components included in a linear programming are decision variable, goals, constraint, and parameter. Wirma (2018) is using the four components to describe the factory condition in a mathematical model.

3. METHODS

3.1. Problem Identification

In identification step, we investigate the problem, either in the present time or in the future. We identify at UD BA, and then adjust with the future plan, which is expanding their business. Some of the past studies are used for the reference in this study.

3.2 Collecting Data

We collected all the data that connected with the study. Either data from UD BA directly, or the data from other parties that linked to the distribution process. Some of the data are shipping cost, holding cost, demand level, production capacities, inventory capacities, packaging capacities, and the demand from the selling center.

3.3 Mathematical Models Formulation

In this step, the math model is created based on the real condition. Several things did in this step are make a decision variable, determine the goals, and determine the constraints.

3.4 Model Verification and Validation.

Right after we makes the mathematical model, the verification and validation must be done. A verification intends to test is the model has a feasible solution or not. A validation is to make sure that the model appropriate with the real condition.

3.5 Solution and Analysis

After the model validate and verified, we do an optimization with the Lingo software, to find the optimal value of decision variable. Then, we analyze the result that come out from the process.

4 RESULTS

4.2 Naming the Products, Production Center, Selling Center, and Consumer Location

For the decision variable, the index for its name was made first. The indexes are for products (i), production period (j), production center (kk for real production center, and ss for selling center), demand period (l), and consumer (mm for the real consumer, and ss for the selling center as a product receiver).

Table 4.1 Index for Products

i	Products
1	Pasteurize milk
2	Milk stick
3	Milk crackers
4	Kuping Gajah
5	Candy
6	Yogurt
7	Ice cream

Table 4.2 Index for Production Center, Consumer, and Selling Center Location

Explanation	Index	Location
Production center (<i>ii</i>), selling center (<i>ss</i>)	01	Pujon
	02	Pacet
	03	Kediri (1 st selling center)
	04	Batu
	05	Krian
	06	Malang
	07	Pasuruan (2 nd selling center)
	08	Probolinggo
	09	Lumajang
	10	Jember
	11	Situbondo
	12	Bondowoso
Consumer (<i>mm</i>), selling center (<i>ss</i>)	01	Ponorogo
	02	Madiun
	03	Kediri (1 st selling center)
	04	Tulungagung
	05	Blitar
	06	Nganjuk
	07	Pasuruan (2 nd selling center)
	08	Lamongan
	09	Gresik
	10	Sidoarjo
	11	Bangkalan
	12	Surabaya

As we can see at **Table 4.2**, it has two selling centers. 1st selling center cover up the consumer number 01, 02, 04, 05, and 06. The others are covered by 2nd selling center. For the production period (*j*) and demand period (*k*) are 1 to 4 because the analyze just for four period.

4.3 Adjusting the Shipping Cost and Holding Cost

The shipping cost is based on shipping capacities, and the distance. The further the distance, it will cost higher. Inverse, the higher shipping capacities, it will reduce the cost. For example, product 1, made in 1st production period in production center 1, fulfill 1st demand period for consumer 1 has shipping cost Rp 280.000. However, the shipping capacities are 500 boxes. Hence, we can calculate that shipping cost per box are Rp 560. For other products and distribution flow, we can use the same calculation based on the distance and shipping capacities.

The holding cost is based on monthly cost on the production center. The monthly cost

is divided by four weeks, and then divide again by the ratio of hold products. For example, monthly cost is Rp 550.000. The weekly cost is Rp 137.500, and then divided again by the ratio of hold products. The holding costs are served at **Table 4.3**

Table 4.3 Holding Cost per Product

No	Products	Holded Products		Holding cost per week (Rp)	Holding cost per box (Rp)
1	Pasteurize milk	130	11172	11000	85
2	Milk stick	320	27500	27500	86
3	Milk crackers	320	27500	27500	86
4	Kuping Gajah	320	27500	27500	86
5	Candy	320	27500	27500	86
6	Yogurt	130	11172	11000	85
7	Ice cream	60	5156	5500	92
Total		1600	137500	137500	

4.4 Forecasting Demand

From the data, demand in one year has a seasonal pattern as seen at **Figure 4.1**. Then, winter's method is used to forecast the demand.

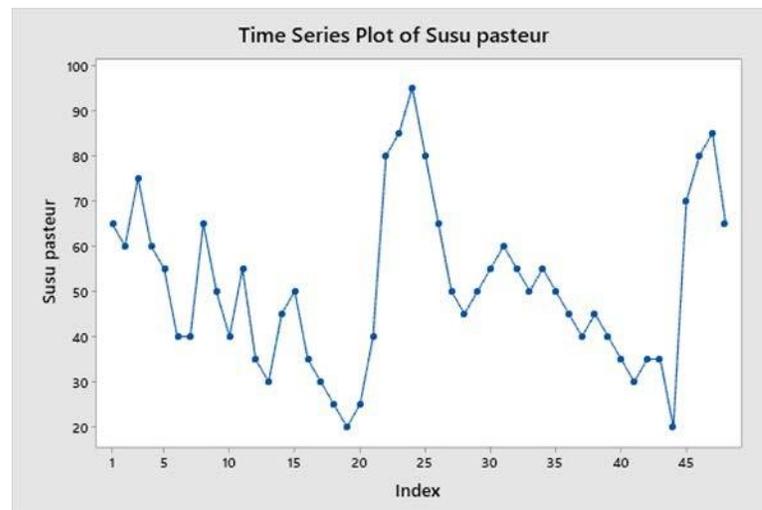


Figure 4.1 Time Series Plot of Product 1 in a Year

With Minitab, we forecast the demand using winter's method for the product. The result is given in **Table 4.4**.

Table 4.4 Forecasting for Product 1

Products	Week 1	Week 2	Week 3	Week 4
Pasteurize milk	74	62	61	51

Milk stick	72	59	52	50
Milk crackers	4	5	3	5
Kuping Gajah	65	60	60	66
Candy	4	3	4	5
Yogurt	54	53	58	57
Ice cream	14	12	10	11

3.2. Determine the Decision Variable

The decision variables at this research are

X_{ijkk}^{lmm} : number of product i , produced at production period j , at production center kk , fulfilling demand period l , for consumer mm (boxes/week).

Y_{ijkk}^{lss} : number of product i , produced at production period j , at production center kk , fulfilling demand period l , for selling center ss (boxes/week).

Y_{ijss}^{lmm} : number of product i , produced at production period j , at selling center ss , fulfilling demand period l , for consumer mm (boxes/week)

3.3. Determine the Goals

For this research, the goals are resolve the minimum distribution cost with given constraints and data. The goal formulas are

$$\begin{aligned} \text{Min } C = & \sum_{i=1}^n \sum_{j=1}^o \sum_{k=1}^p \sum_{l=1}^q \sum_{m=1}^r \alpha_{ik}^m \cdot X_{ijk}^{lm} + \sum_{i=1}^n \sum_{j=1}^o \sum_{k=1}^p \sum_{m=1}^r \beta_{ik} \cdot X_{ijk}^{(j+1)m} \\ & + \sum_{i=1}^n \sum_{j=1}^o \sum_{k=1}^p \sum_{l=1}^q \sum_{s=1}^t \delta_{ik}^s \cdot Y_{ijk}^{ls} + \sum_{i=1}^n \sum_{j=1}^o \sum_{s=1}^t \sum_{l=1}^q \sum_{m=1}^r \varepsilon_{is}^m \cdot Y_{ijs}^{lm} \end{aligned}$$

From the formulas, we can use the data to make the goal.

$$\begin{aligned} \text{Min} = & 560 \cdot X_{1101101} + 600 \cdot X_{1101102} + 240 \cdot Y_{1101103} + 660 \cdot X_{1101201} + \\ & 700 \cdot X_{1101202} + 340 \cdot Y_{1101203} + 273 \cdot Y_{1103101} + 327 \cdot Y_{1103102} + \\ & 560 \cdot X_{1201201} \\ & + \\ & \cdot \\ & \cdot \\ & + 580 \cdot X_{7406412} + 445 \cdot Y_{7407412} + 606 \cdot X_{7408412} + \end{aligned}$$

$$859 * X_{7409412} + 1204 * X_{7410412} + 1742 * X_{7411412} + 1362 * X_{7412412};$$

3.4. Determine Constraints

3.4.1. Demand Constraint

$$\sum_{j=l-1}^l \sum_{k=1}^p X_{ijk}^{lm} + \sum_{j=l-1}^l \sum_{s=1}^t Y_{ijs}^{lm} \geq D_{ilm} \quad |i = 1, \dots, n; l = 1, \dots, o; m = 1, \dots, r|$$

With the formulas and data, one of the demand constraint is

$$X_{1101101} + X_{1102101} + Y_{1103101} + X_{1104101} + X_{1105101} + X_{1106101} + X_{1108101} \\ + X_{1109101} + X_{1110101} + X_{1111101} + X_{1112101} > 74;$$

3.4.2 Production Capacity Constraint

$$\sum_{l=j}^{j+1} (X_{1jk}^{lm} + Y_{1jk}^{ls}) + \gamma_{ik} \sum_{i=2}^n \sum_{l=j}^{j+1} \sum_{m=1}^r (X_{ijk}^{lm} + Y_{ijk}^{ls}) \leq KP_{1k} \quad |j = 1, \dots, o; k = 1, \dots, p|$$

With the data and the formula, one of the production capacities constraint is

$$X_{1412401} + X_{1412402} + Y_{1412403} + X_{1412404} + X_{1412405} + X_{1412406} + Y_{1412407} \\ + X_{1412408} + X_{1412409} + X_{1412410} + X_{1412411} + X_{1412412} + \\ (2256/1504) * (X_{2412401} + X_{2412402} + Y_{2412403} + X_{2412404} + X_{2412405} + \\ X_{2412406} \\ + Y_{2412407} + X_{2412408} + X_{2412409} + X_{2412410} + X_{2412411} + X_{2412412}) + \\ (2256/215) * (X_{3412401} + X_{3412402} + Y_{3412403} + X_{3412404} + X_{3412405} + \\ X_{3412406} \\ + Y_{3412407} + X_{3412408} + X_{3412409} + X_{3412410} + X_{3412411} + X_{3412412}) + \\ (2256/1504) * (X_{4412401} + X_{4412402} + Y_{4412403} + X_{4412404} + X_{4412405} + \\ X_{4412406} \\ + Y_{4412407} + X_{4412408} + X_{4412409} + X_{4412410} + X_{4412411} + X_{4412412}) + \\ (2256/215) * (X_{5412401} + X_{5412402} + Y_{5412403} + X_{5412404} + X_{5412405} + \\ X_{5412406} \\ + Y_{5412407} + X_{5412408} + X_{5412409} + X_{5412410} + X_{5412411} + X_{5412412}) + \\ (2256/1289) * (X_{6412401} + X_{6412402} + Y_{6412403} + X_{6412404} + X_{6412405} + \\ X_{6412406} \\ + Y_{6412407} + X_{6412408} + X_{6412409} + X_{6412410} + X_{6412411} + X_{6412412}) + \\ (2256/430) * (X_{7412401} + X_{7412402} + Y_{7412403} + X_{7412404} + X_{7412405} + \\ X_{7412406}$$

$$+ Y_{7412407} + X_{7412408} + X_{7412409} + X_{7412410} + X_{7412411} + X_{7412412}) \\ < 2256;$$

3.4.2. Inventory Capacity Constraint

$$\left\{ \sum_{m=1}^r (X_{1jk}^{(j+1)m}) + \sum_{s=1}^t Y_{1jk}^{(j+1)s} \right\} + \delta_{ik} \sum_{i=2}^n \left\{ \sum_{m=1}^r (X_{ijk}^{(j+1)m}) + \sum_{s=1}^t Y_{ijk}^{(j+1)s} \right\} \leq KS_{1k}$$

$|j = 1, \dots, o; k = 1, \dots, p|$

Using the data and the formula, one of the constraint is

$$\begin{aligned} & X1101201 + X1101202 + Y1101203 + X1101204 + X1101205 + X1101206 + Y1101207 \\ & + X1101208 + X1101209 + X1101210 + X1101211 + X1101212 + \\ & (100/300)*(X2101201 + X2101202 + Y2101203 + X2101204 + X2101205 + \\ & X2101206 + Y2101207 + X2101208 + X2101209 + X2101210 + X2101211 + \\ & X2101212) + (100/300)*(X3101201 + X3101202 + Y3101203 + X3101204 + \\ & X3101205 + X3101206 + Y3101207 + X3101208 + X3101209 + X3101210 + \\ & X3101211 + X3101212) + (100/300)*(X4101201 + X4101202 + Y4101203 + \\ & X4101204 + X4101205 + X4101206 + Y4101207 + X4101208 + X4101209 + \\ & X4101210 + X4101211 + X4101212) + (100/300)*(X5101201 + X5101202 + \\ & Y5101203 + X5101204 + X5101205 + X5101206 + Y5101207 + X5101208 + \\ & X5101209 + X5101210 + X5101211 + X5101212) + (100/100)*(X6101201 + \\ & X6101202 + Y6101203 + X6101204 + X6101205 + X6101206 + Y6101207 + \\ & X6101208 + X6101209 + X6101210 + X6101211 + X6101212) + \\ & (100/50)*(X7101201 + X7101202 + Y7101203 + X7101204 + X7101205 + \\ & X7101206 + Y7101207 + X7101208 + X7101209 + X7101210 + X7101211 + \\ & X7101212) < 100; \end{aligned}$$

3.4.3. Packaging Capacity Constraint

$$\sum_{l=j}^{j+1} (X_{1jk}^{lm} + Y_{1jk}^{ls}) + \tau_{ik} \sum_{i=2}^n \sum_{l=j}^{j+1} \sum_{m=1}^r (X_{ijk}^{lm} + Y_{ijk}^{ls}) \leq KK_{1k} \quad |j = 1, \dots, o; k = 1, \dots, p|$$

Using the data and the formula, one of the constrain is

$$\begin{aligned} & X1412401 + X1412402 + Y1412403 + X1412404 + X1412405 + X1412406 + Y1412407 \\ & + X1412408 + X1412409 + X1412410 + X1412411 + X1412412 + \\ & (1100/733)*(X2412401 + X2412402 + Y2412403 + X2412404 + X2412405 + \\ & X2412406 \\ & + Y2412407 + X2412408 + X2412409 + X2412410 + X2412411 + X2412412) + \\ & (1100/105)*(X3412401 + X3412402 + Y3412403 + X3412404 + X3412405 + \\ & X3412406 \\ & + Y3412407 + X3412408 + X3412409 + X3412410 + X3412411 + X3412412) + \\ & (1100/733)*(X4412401 + X4412402 + Y4412403 + X4412404 + X4412405 + \\ & X4412406 \\ & + Y4412407 + X4412408 + X4412409 + X4412410 + X4412411 + X4412412) + \\ & (1100/105)*(X5412401 + X5412402 + Y5412403 + X5412404 + X5412405 + \\ & X5412406 \\ & + Y5412407 + X5412408 + X5412409 + X5412410 + X5412411 + X5412412) + \\ & (1100/629)*(X6412401 + X6412402 + Y6412403 + X6412404 + X6412405 + \\ & X6412406 \end{aligned}$$

$$\begin{aligned}
 &+ Y6412407 + X6412408 + X6412409 + X6412410 + X6412411 + X6412412) + \\
 &(1100/210)*(X7412401 + X7412402 + Y7412403 + X7412404 + X7412405 + \\
 &X7412406 \\
 &+ Y7412407 + X7412408 + X7412409 + X7412410 + X7412411 + X7412412) < 1100;
 \end{aligned}$$

3.4.4. Transshipment Constraint

$$\sum_{j=l-1}^l \sum_{k=1}^p Y_{ijk}^{ls} - \sum_{j=l-1}^l \sum_{s=1}^t Y_{ijs}^{lm} \geq B_{ils} \quad |i = 1, \dots, n; l = 1, \dots, o; s = 1, \dots, t|$$

With the data and formulas, one of the constraint is

$$\begin{aligned}
 &Y1101103 + Y1102103 + Y1104103 + Y1105103 + Y1106103 + Y1108103 + Y1109103 \\
 &+ Y1110103 + Y1111103 + Y1112103 - (Y1103101 + Y1103102 + Y1103104 + \\
 &Y1103105 + Y1103106) > 15;
 \end{aligned}$$

3.4.5. Production Balance Constraint

$$KP_{11} \sum_{i=1}^n \sum_{l=j}^{j+1} \sum_{m=1}^p X_{ijk}^{lm} - KP_{1k} \sum_{i=1}^n \sum_{l=j}^{j+1} \sum_{m=1}^p X_{ij1}^{lm} = 0 \quad |j = 1, \dots, r; k = 2, \dots, p|$$

Using the data and the formulas, one of constraint is

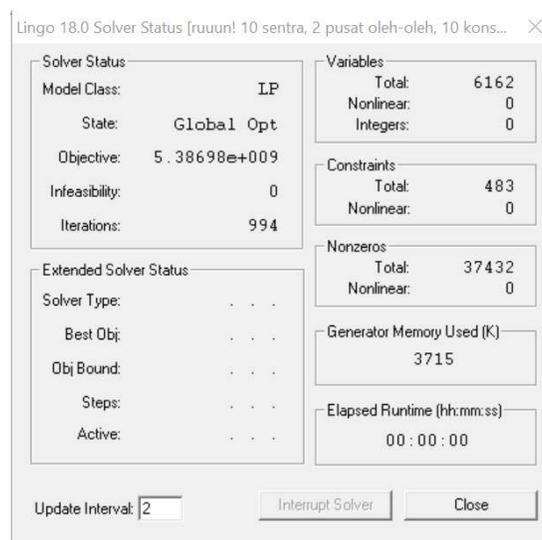
$$\begin{aligned}
 &630*(X1412401 + X1412402 + Y1412403 + X1412404 + X1412405 + X1412406 + \\
 &Y1412407 + X1412408 + X1412409 + X1412410 + X1412411 + X1412412 + \\
 &(2256/1504)*(X2412401 + X2412402 + Y2412403 + X2412404 + X2412405 + \\
 &X2412406 \\
 &+ Y2412407 + X2412408 + X2412409 + X2412410 + X2412411 + X2412412) + \\
 &(2256/215)*(X3412401 + X3412402 + Y3412403 + X3412404 + X3412405 + \\
 &X3412406 \\
 &+ Y3412407 + X3412408 + X3412409 + X3412410 + X3412411 + X3412412) + \\
 &(2256/1504)*(X4412401 + X4412402 + Y4412403 + X4412404 + X4412405 + \\
 &X4412406 \\
 &+ Y4412407 + X4412408 + X4412409 + X4412410 + X4412411 + X4412412) + \\
 &(2256/215)*(X5412401 + X5412402 + Y5412403 + X5412404 + X5412405 + \\
 &X5412406 \\
 &+ Y5412407 + X5412408 + X5412409 + X5412410 + X5412411 + X5412412) + \\
 &(2256/1289)*(X6412401 + X6412402 + Y6412403 + X6412404 + X6412405 + \\
 &X6412406 \\
 &+ Y6412407 + X6412408 + X6412409 + X6412410 + X6412411 + X6412412) + \\
 &(2256/430)*(X7412401 + X7412402 + Y7412403 + X7412404 + X7412405 + \\
 &X7412406 + Y7412407 + X7412408 + X7412409 + X7412410 + X7412411 + \\
 &X7412412)) \\
 &X3401410 + X3401411 + X3401412) + (630/420)*(X4401401 + X4401402 +
 \end{aligned}$$

$$\begin{aligned}
 &Y4401403 + X4401404 + X4401405 + X4401406 + Y4401407 + X4401408 + \\
 &X4401409 + X4401410 + X4401411 + X4401412) + (630/150)*(X5401401 + \\
 &X5401402 + Y5401403 + X5401404 + X5401405 + X5401406 + Y5401407 + \\
 &X5401408 + X5401409 + X5401410 + X5401411 + X5401412) + \\
 &(630/360)*(X6401401 + X6401402 + Y6401403 + X6401404 + X6401405 + \\
 &X6401406 + Y6401407 + X6401408 + X6401409 + X6401410 + X6401411 + \\
 &X6401412) + (630/180)*(X7401401 + X7401402 + Y7401403 + X7401404 + \\
 &X7401405 + X7401406
 \end{aligned}$$

$$+ Y7401407 + X7401408 + X7401409 + X7401410 + X7401411 + X7401412)) = 0;$$

4.7 Result

With the models and combined with the data, we run it with Lingo. At 994 iterations, it showed that the minimum cost for the distribution planning is Rp 5.386.982.000 as seen in **Figures 4.2**.



Figures 4.2 Result from Lingo

6. CONCLUSIONS

From the analyze, it can be seen that total minimum cost for distribution process are about Rp 5.386.982.000. Moreover, choosing Probolinggo as a 2nd selling center does not have much impact for distribution flow to consumer 08, 09, 10, 11, and 12. Other than that, almost all of the production center does not need to keep the product to fulfill the subsequent demand period. It can be seen that there is only one decision variable showed that the product from one production period were inventoried for next demand period. Moreover, the study showed that linear programming can used for resolve the problem at UD BA.

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WASTE REDUCTION IN CONICAL TAPER HEAD BOLT PRODUCTION AT PT. ROLLER WITH LEAN SIX SIGMA METHOD

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ABSTRACT

Lean Six Sigma (LSS) is an essential tool for process improvement, especially in the manufacturing industry. LSS optimizes the production process, product quality, and productivity through the Define, Measure, Analyze, Improve, and Control (DMAIC). The study discusses the conical taper head bolt because the production value is 60% of the total bolt nut set produced every month. P.T. The Rollers reached an average production rate of 2300 sets per month from the target of 3000 sets per month. One of the factors that affect production results and production lead time is waste. P.T. Roller reducing waste is LSS with the DMAIC method. This study aims to identify the causes of waste, classify waste, and analyze the effect of waste on the conical-taper-head-bolt production process using the DMAIC method so that the bolt-nut workshop production process runs optimally. The critical waste was waiting with an average weight of 0.292. with an inconsistency value of 0.077, the cause of waste based on analysis using Root Cause Analysis (RCA) it is known that there is a lack of evaluation of the forging mold design, lack of checking on blackening production equipment, lack of attention to the heat treatment process and experienced personnel in the field of heat treatment. The recommendations for the improvement are: to evaluate the mold design starting from material changes, changes in dimensions to changes in clamp installation so that shear and repeated welding processes do not occur, to reduce setting time by 20%, replacing the LPG regulator with a blower so that it can increase the heating speed up to 50% better than the LPG regulator and recruiting experts in the heat treatment process to redesign the system and use the sampling process to reduce waiting time in the inspection process and can reduce lead time in the process heat treatment by 50%.

Keywords: DMAIC, Lean Six Sigma, Waste.

1. INTRODUCTION

Lean Six Sigma (LSS) is an essential tool for strategic business improvement, especially in Manufacture industries. Wilson (2010) said that a particular process is lean if the process proper to operate with minimal material, investment, inventory, and resources. LSS that effectively optimize the production process, product quality, and productivity are Define, Measure, Analyze, Improve, and Control (DMAIC). This method helped improve the system at a particular business until decrease the defect close to zero (Gazper & Fontana, 2015).

P.T. Roller had a competitive market in bolt nut production and needed the production target of 3000 sets

per month. Besides that, P.T. Roller just reached the production rate of 2300 set/month at the production operation. Every month, the high ratio in production was conical taper head bolts with a production ratio of 60 % from the total bolt nut set produced every month. One of the factors that affect production outcome and production lead time was wastes. Based on that problem, one of the tools to improve the process and decrease the wastes was LSS with the DMAIC method. This research purpose was identification the cause of the wastes and make the classification of wastes.

In the implementation, thorough research with the LSS method has been done. Smetkowska et al. (2018), in their research, to improve the quality of the production process, draw particular conclusions such as decreased lead time to increase quality service to the customer. This method can decrease the production cost and give some profit to the company. Hill et al. (2017), in their implementation in the Maintenance, Repair, and Overhaul (MRO) industry, explain that this method can increase operational performance until near the specific target and decrease lead time. We researched reduction waste at production conical taper head bolt with the LSS method based on that research. This research purpose was to identify the cause of wastes, analyze the cause of waste to conical taper head bolt's production process with DMAIC method, and give the alternative improvement to the optimization production process of conical taper head bolt in P.T. Roller.

2. LITERATURE REVIEW

2.1. Lean Six Sigma Implementation

Wilson (2010) has said that a process can lean if the process can operate with minimal material, investment, inventory, and resources. Level sigma saw with DPMO. **Table.1** shows the level of sigma.

Lean Six Sigma (LSS) Method refers to the DMAIC process and is helpful for the business's improvement until the defect decreases close to zero. (Gazper & Fontana, 2015) :

1. *Define*

This phase was the first phase that works to define the problem and the target. This method is used for improvement that has been done in the particular research relate to stakeholders' wants.

2. *Measure*

This phase measured a company's performance, such as the level of sigma of the company, and measured the process capability. The target of this phase was to measure the critical point of the improvement process.

3. *Analyze*

This phase has been done with analysis to determine critical waste for the production process. In this phase, we did the analysis, and after that, we can determine the critical thing of improvement process at production.

4. *Improvement*

In this phase, we will be given several alternatives to improve the improvement process at the production line. That improvement will be effected to the production process. Eventually, the impact of improvement was not necessarily given the excellent effect at the other production process

5. *Control*

The end of the Six Sigma process was a control that related to control of improvement process to decrease the probability of failure.

Table 1. Level Sigma

A percentage that reaches specification	DPMO	Level Sigma	Remarks	COPQ (Cost of Poor Quality)

31 %	691.462	1- <i>sigma</i>	It is not very competitive	It cannot be measured
69.20 %	305.538	2 – <i>sigma</i>	Average in Indonesian industries	It cannot be measured
93.32 %	66.807	3 – <i>sigma</i>		25-40 % from selling
99.38%	6.210	4 – <i>sigma</i>	Average in USA Industries	15-25 % from Selling
99.98 %	233	5 – <i>sigma</i>		5-15% from Selling
100.00 %	3	6 - <i>sigma</i>	World Class Industries	<1% from Selling

(Source : Wilson, 2010)

2.2 Value Stream Mapping

Base on an explanation of Womack and Jones (2013) that Value Stream Mapping (VSM) was the group of activities to make a product. There were three crucial things that we must know about VSM according to Locher (2008) :

1. The knowledge of the process. If the process cannot be determined, the lead time of production cannot be fast, So as otherwise
2. Lead time at the process. Increase the lead time that makes the time waste for doing the process at the process mapping.
3. Experience from VSM maker about the organization and the operating of the production process.

2.3 Waste Classification

Seven wastes are activities that cannot make the value of the production process in the production scheme. Based on Ohno (1988), there was seven waste such as :

1. Transportation

The waste comes from the change of place of material from one side to the other side. The waste comes from a process or a replacement line and the product that distributes to the customer.

2. Waiting

Waiting is an activity where the worker did not do the works, i.e., waiting for the production process line and waiting for raw material or broken production machine.

3. Over Production

Over-production is one of the more affected waste than the other waste because overproduction can decrease the product's value.

4. Defect

This waste is usually called scrap. This waste source was from a product that has a defect in the production process. Not only losing the time because of repair or make the replacement product. But also, effort and energy was losing to make a replacement and repair

5. Inventory

Inventory and material were waste except for the final product that distributes directly to the

customer. Then, the products' ongoing process was also wasted.

6. *Movement*

Waste with movement with the purpose will not increase the value. Such as finding the tool or take the material at a certain distance. Usually, do it in a workshop. One of the steps of improvement was making a workstation.

7. *Excess Processing*

Waste from the excess process making, so it is not matching with customer needs. This problem cause was the engineers were not proper to make a design in product, and machine or raw material was not feasible.

2.4 Analytical Hierarchy Process (AHP)

Thomas L Saaty developed AHP. This method works with decision-making and effectivity about the complex problem and makes it easy to make decisions. Saaty (1988), the AHP method helped solve the complex problem with the structure and the criteria hierarchy.

Based on Saaty (1988), there were six steps to measure AHP. The step such as :

1. Identifying the problem and make the best solution
2. Make the hierarchy from the problem
3. Make the appraisal about the priority from criteria and alternative
4. Make the pairs of matrix
5. Determine the result of priority from the weighting
6. Consistency test

2.5 Five Why

Based on Wilson (1933), Root Cause Analysis (RCA) is one finding the fundamental reason for the occurred problem. One of the tools for RCA was five why. 5 why probable to ask at the problem deeper. Later, it can determine the source of the problem. Five why have been used to Toyota production at 1970. With the cause classification such as

1. Why 1: symptom
2. Why 2: excuse
3. Why 3: blame
4. Why 4: cause
5. Why 5: root cause

3. METHODS

3.1 First step of identification

This first step divides into two steps such as :

1. *Field Studies*

Field studies were performed at shift 1 (07.00-15.00) with the Conical taper Head Bolt production. To identifying some problems in the field and observing such activity in the production process at once. Besides that, we must know about the lead time of the production process

2. *Problem Identification*

After the literature studies and observing the works environment. We must identify the problem

that happens. After one of the problems can be determined, we take the best topic to solve the problem. After that, we choose the title of the research. Next, we determined the formulation of the problem to get the purpose of the research

3.2 Define and Measure Phase

This phase divide into two LSS processes such as :

1. Define

The steps of this process such as :

1. Make the detail about the production process with the scheme and make the explanation at every process
2. Make VSM draw the step of production
3. Identifying the wastes with AHP Method with the specific steps such as :
 - a. Make the questionnaire based on a hierarchy from 7 wastes in **Figure 2**.

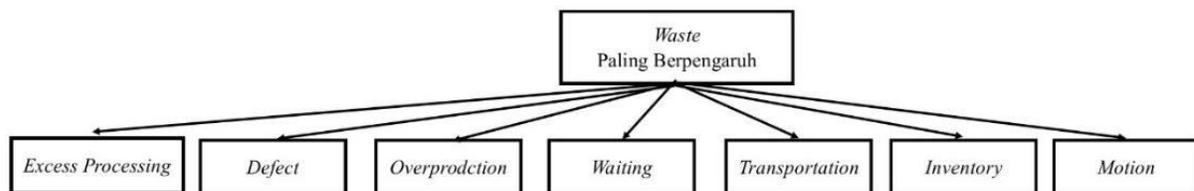


Figure 2. Hierarchy of 7 Wastes

- b. The questionnaire was shared with three essential people at conical taper head bolt production such as :
 1. Production Supervisor Fastener as a person in charge of the production process at fastener workshop
 2. Q.C. section head as the person in charge of fastener's quality
 3. SCM Section Head as the person in charge of the procurement of material, transportation, saving and shipment of raw material and finish product
- c. Weighting from the questionnaire and measure with expert choice software
- d. The average of weighting obtained at every wastes and consistency results
- e. Waste identification based on the highest weighting rate with the AHP results

2. Measure

The step of this phase such as :

- a. Defect identification at the production process
- b. Collect inspection data of conical taper head bolt from Q.C.
- c. Measure the data with Minitab to measure the process capability
- d. From the result, measure the level sigma from process capability

3.3 Analyze and Improve phase

1. Analyze

After that, based on critical wastes defined, analyze with five why to get the root cause of a problem that occurred on a production line to formulate the alternative improvement.

2. Improve

In this phase, choose the several recommendations based on analyses that have alternative options for the conical taper head bolt production. That was given several results to choose for an alternative of improvement.

Conclusion and suggestion phase

After the research, some conclusions are drawn based on the purpose of the specific research. Next, the suggestion has been made for evaluation in the research process and several options to continue researching the other topic.

4. RESULTS

4.1 Define

1. Production Process of Conical Taper Head Bolt

In **Figure 3**. Has shown the production process of conical taper head bolt at fastener Workshop :

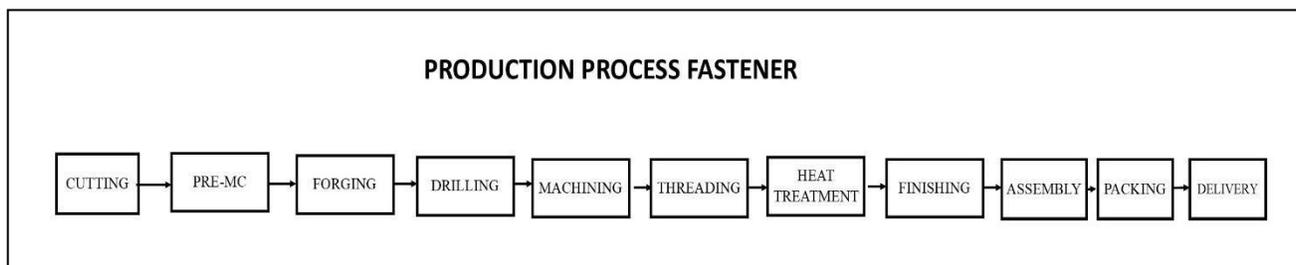


Figure 3. The Production Process of Fastener Making

2. Value Stream Mapping

at this process, VSM has made conical taper head bolt production and has shown the lead time at every production process entirely in **Figure 4**.

3. Waste Identification

We take the AHP method to determine the critical waste at the production process of the fastener. At the weighting process, we must rate with the rule :

- 1 = same effective
- 2 = a little more effective
- Five = more effective

than
Seven =
the most
effective

2,4,6 = the point if it has desirable to choose which one more effective

The questionnaire, after we took from respondents, have measured by expert choice and give several results. After the data has collected, we got the weighting rate and the rate of the critical waste. With the measurement in **table 1**.

Based on **table 1**. The critical wastes that were chosen by measurement were waiting with the rate of weighting by 0.292. for the consistency measurement of AHP, we get 0.077. based on Saaty's (1988) theory, a hierarchy can be called feasible if the consistency rate under 0.1, and if the rate inconsistency above 0.1, the hierarchy were not feasible. So, based on that theory, the weighting based on that questionnaire was feasible because of the rate under 0.1 with an amount of 0.077.

From the weighting on the AHP method, we can declare that waste must improve waiting and improving the process. It can be processed in the next step at analysis to analyze the root cause of the critical waste.

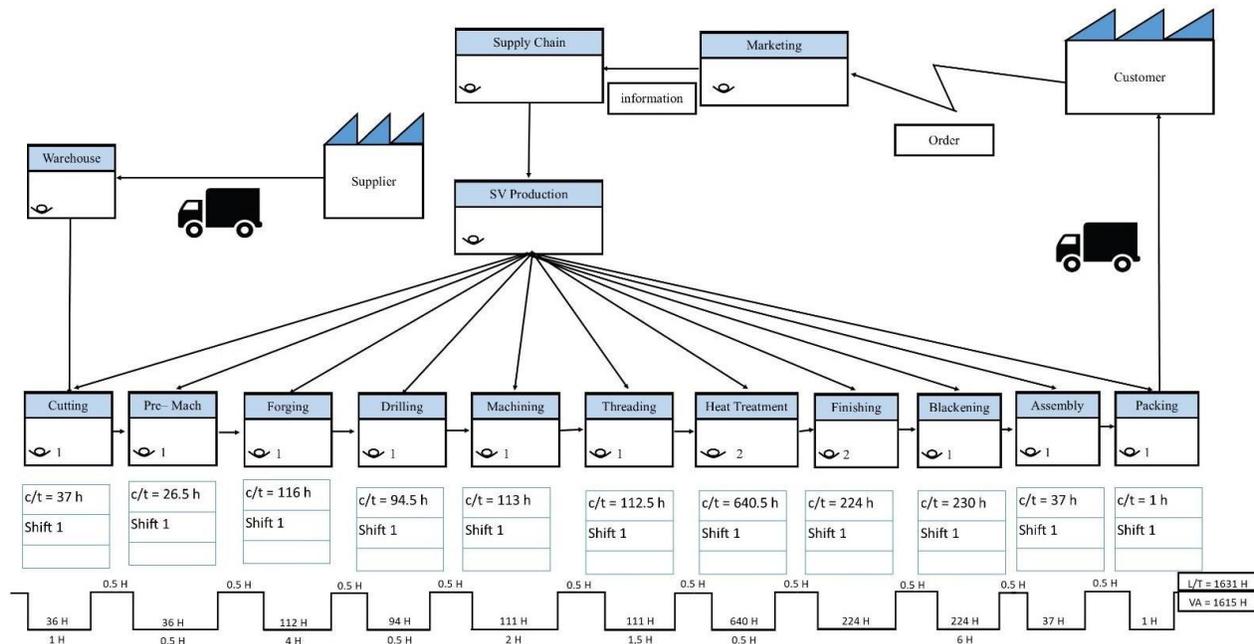


Figure 4. VSM from conical taper head bolt production

Table 2. Processing data from AHP

Waste Name	Resp. 1	Resp. 2	Resp. 3	mean
<i>Defect</i>	0.203	0.189	0.113	0.168
<i>Overproduction</i>	0.106	0.136	0.109	0.117
<i>Waiting</i>	0.295	0.248	0.334	0.292
<i>Tranportation</i>	0.063	0.079	0.082	0.075
<i>Inventory</i>	0.042	0.062	0.062	0.055
<i>Motion</i>	0.028	0.062	0.068	0.053
<i>Excess Processing</i>	0.263	0.223	0.232	0.239
<i>Inconsistency</i>	0.07	0.09	0.07	0.077

4.2 Measure

At this step, the data was measured to get the process capability based on the defect found in the inspection process. the inspection was performed by Quality control from the heat treatment inspection until finishing the inspection. The inspection at heat treatment process such as hardness measurement with hardness test tool and calculating the defected product must be re-heated for this process. Then the next inspection was about the dimension inspection to calculate the critical thing of production nuts such as length of the material, thread diameter on the bolt, and the nut.

1. Capability process measurement

After the data was collected, the data was measured by Minitab software. Because of data did not in a normal distribution. So the data transformed into Minitab with box-cox transformation

(Henderson, 2011). The next step was to measure the capability process to get the sigma level. The results were :

1. Long of material bolts give the rate Cpk by 0.95 with Z- Branch by 2.80, so the sigma level by 4.3 and this process need improvement.
2. Thread diameter of bolts gives the rate Cpk by 0.29 with Z- Branch by 0.86, so the sigma level by 2.36, and this process needs improvement.
3. Thread diameter of nut gives the rate Cpk by 0.38 with Z- Branch by 1.14, so the sigma level by 2.64, and this process needs improvement.
4. The hardness of the bolt gives the rate Cpk by 0.35 with Z- Branch by 1.06, so the sigma level by 2.56, and this process needs improvement.
5. Heat treatment defect gives the defect rate 27.57 % with Z number by 0.595, so the sigma level was 2.095, and this process needs improvement.

4.3 Analyze

At this phase, analyze with a particular tool and the analytical result to formulate the alternative solution.

1. Value Stream Mapping Analysis (VSM)

The VSM diagram shows the cycle time for the conical taper head bolts 500 sets with a lead time of 1631 hours. From the total time at the activity of value added by 1615 hours. From the total of the presentation that probable the waste about 1 % for improvement process. Or the 99

% from a total of cycle time. VSM has shown that necessary non-value-added activity was setting in the forging process and preparing natrium liquid at the blackening process.

2. Critical Waste Analysis.

In this step, the AHP method was chosen to share the questionnaire and weighting waste with three response that influences the production process. The data has shown the waiting waste the priority of improvement.

It is very relevant about the analysis before, that waiting like waiting on setting the mold or the preparation liquid natrium until boiled give the meaningful impact for the production process

3. Capability Process analysis and sigma level

The measurement with measure the Cpk the results of all inspection showed that the improvement was needed to improve with cpk under 1. So, based on the inspection sheet, we must improve the process to cut for the bolt long, the threading process to make a thread and the heat treatment process for increasing the hardness. For level sigma showed that all the process has feasible industries in Indonesia and there was one that can match with American industries based on **Table 2**. at the cutting process, we just need the uniformity to get the best results and increase the process capability.

4. Analysis of the Cause of Waste

Based on waste identification that the critical waste was waiting. So, we need to analyze the five why to get the cause of waiting at **Table 4**.

Tabel 4. Five Whys the cause of waste

<i>kind waste</i>	Why 1	Why 2	Why 3	Why 4	Why 5
<i>Waiting</i>	The setting time too long	To set the mold need gouging and welding	Ketika di <i>punch</i> The mold was broken the operate with a punch	The dimension of the mold different from the pattern in the machine	Lack of evaluation in dimension design of the mold and the dimension of a pattern at forging machine
	The preparation time of blackening so long	The boiling of Natrium liquid takes time so long	Lack of fire to make Natrium liquid boiled faster	The boiled liquid still using LPG with old regulator	Lack of checking at production tool for blackening process

	<p>Inspection process in fastener for heat treatment process takes time so long</p>	<p>The check perform 100 % for every product</p>	<p>Inspection procedure from management</p>	<p>Customers want 100 % check because the customer often found the low hardness</p>	<p>Lack of attention at heat treatment process and lack of an experienced man in heat treatment.</p>
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Based on that analysis, there are three root causes for the problem for finding the waste cause such as :

- a. Lack of evaluation at mold design in forging process
- b. Lack of checking at production tool at blackening process
- c. Lack of attention on heat treatment and the experienced man to handle the heat treatment process

4.4 Improve

Based on the analysis for the step of improvement, there are several solutions for improvement process in line products such as :

1. *Improvement Recommendation*

Several improvement recommendations to increase the production process at fastener workshop such as

1. Evaluate mold design by changing the material, dimension, and setting clamp. With this suggestion, it can decrease the setting time by 20 % because there are no-slip and slide
2. Change the LPG regulator with a blower to boil faster until 50 % faster than the old LPG Regulator.
3. Recruit the experience on heat treatment process to redesign production system and do the sampling method to decrease the waiting time for the inspection process and decrease the lead time on heat treatment about 50 %

2. *Comparison of an existing condition and after improvement condition*

Based on the recommendation for alternative improvement, the change that occur in the production process such as :

1. Decrease the setting time from 4 hours to 3,2 hours, so the total lead time decrease by 1630,2 hours.
2. Decrease the lead time of setting in blackening by 50% by the time needed to set 6 hours to decrease to 3 hours. So the total lead time decrease by 1627,2 hours.
3. With the sampling system, the decision making is faster, and the heat treatment process time can make faster, then with the change of heat treatment design process can speed up the heat treatment process about 50 % so, the process that runs for 540,5 hours decrease to 320,25 hours, and it can make the production lead time decrease to 1306,95 hours

5. CONCLUSION

Based on research results, there are several conclusions from the paper such as :

1. The critical waste was waiting with the weight rate of 0.292. with inconsistency value by 0.077.
2. The analysis in 5-Whys showed that the cause of the defect was lack of evaluation on forging mold design, tool of blackening process and heat treatment process time and need the attention for recruit new experience man for handle head treatment.'
3. After the research, several improvement recommendations that needed to improve the production process such as, change the mold design and clamp for decreasing the setting time by 20 %, change the LPG regulator with the blower to increase the speed of boiling liquid until 50 % more compatible than LPG old regulator and recruit the experienced man for heat treatment to redesign system production and make sampling method for inspection to decrease the lead time of heat treatment by 50%.

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MOTIP 03

THE 3rd INTERNATIONAL CONFERENCE
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INNOVATION, AND PROJECT

ADVANCING
HUMANITY



KAIZEN QUALITY IMPROVEMENT TO REDUCE INTERNAL DEFECT AT PT XYZ

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ABSTRACT

The automotive industry is growing in line with the high demand from the market. This growth makes some supplier companies compete each other to get higher orders from the market. The higher the orders, the higher the potential for instability. In PT XYZ, the occurrence of claims from customers for 2 consecutive months with bad products made customers' trust in the company's products decrease. The company fault to reduce gap between the actual internal defect and the target internal defect of 13.86% and the actual cost defect gap between the actual and the target of 17.36 million. Due to claims and defect problems within the company, it is necessary to identify and investigate the root cause so that there are no more claims. The purpose of this study is to identify and find the root cause of the defect problem that occurs in the company, and to reduce the defect ratio in accordance with the company's target and determine the effect of reducing defects on productivity and cost saving. The initial stage in the research is to identify and determine the priority of the problem using Pareto Diagrams to find out the defects that need to be improved. Furthermore, to determine the factors and root causes of the problem using the QA Matrix Diagram and Ishikawa Diagram methods. The results of data collection and data processing is the factors that affect the defect are Methods, Machines, Humans. From the results of the improvement that has been done, there is a decrease in customer claims by 50% (4 claims to 2 claims). In addition, internal defects decreased by 90% from the target of 75% (18.15% to 1.60%). Furthermore, the results of the improvement also affect the productivity of mold/hour which increased from 74.51 molds/hour to 90.01 molds/hour (Up 17%). And the results of the improvement resulted in a saving cost of Rp. 18.388.690 per month and Rp. 220.664.280 per year.

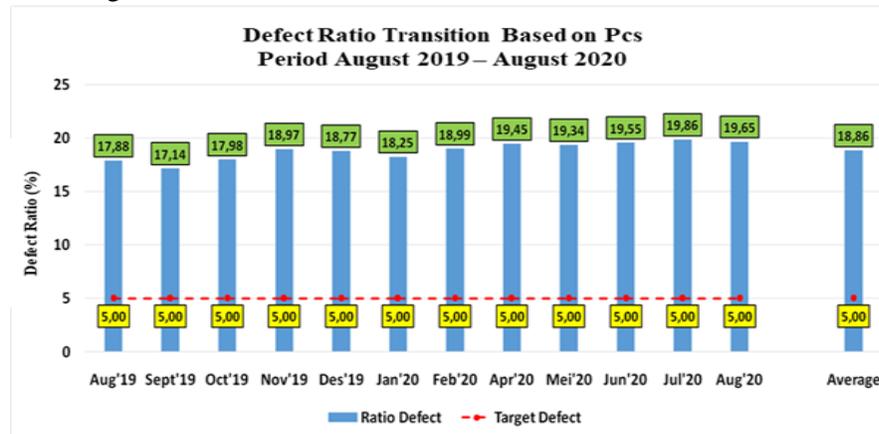
Keywords: Total Quality Management, Kaizen, PDCA, Pareto Diagram, QA Matrix Diagram, Ishikawa Diagram.

I. INTRODUCTION

The need for transportation, especially in Indonesia, increases every year. This is based on the public's increasing mobility, significant number of infrastructure constructions in Indonesia, and the development of transportation for both people and goods. The government's program to accelerate the economic and handle everything demand growth must to be fast and precise. Distribution of needs for clothing, food, and

Figure 1. Customer Claim Transition Period 2020

Figure 2. Internal Defect Blowhole Transition Period 2020

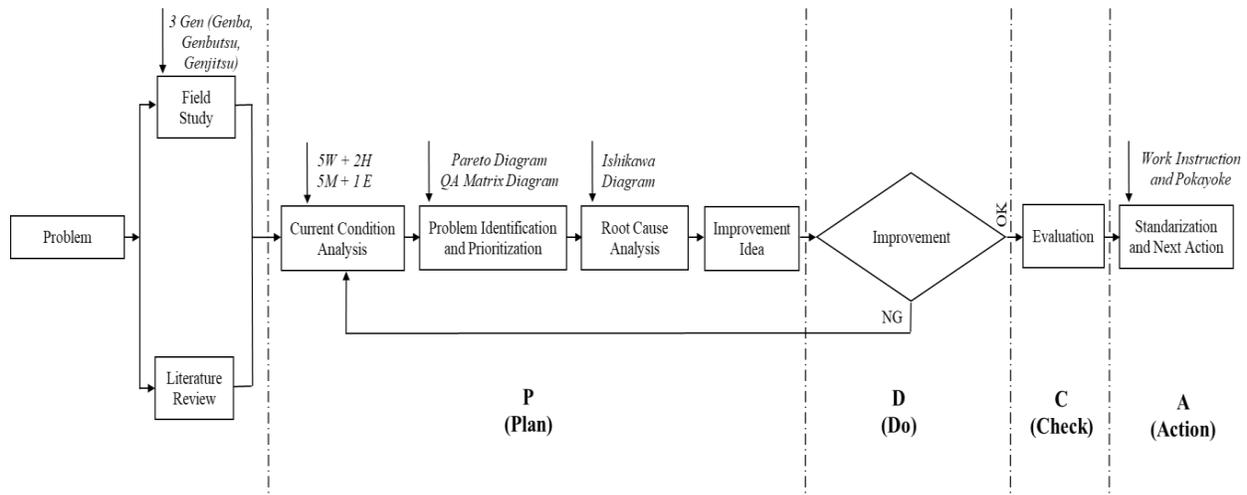


Improvement process is a valuable foundation that helps the company survive and running in the strict global competition. (Vante, 2016). It is a highly needed process to support a company's survival. Improvement is a management process that forms a cycle commonly called as PDCA (Plan, Do, Check, and Action) cycle, which consists of: Plan (make an improvement plan), Do (improvement activity), Check (evaluation of the improvement results), and Action (making a standard in order to have effective future improvements with no repeated mistakes). After improvement is carried out, it is entered to the QC Circle Story in order to record the information and steps taken for a future reference (Vijayaram, 2005).

II. METHOD

This study used PDCA cycle as the method (Vargas, 2018). The stages in PDCA method include: **1) Plan** (starts with identifying the problem, followed by analyzing the root cause of each problem, and continued until the improvement ideas are aligned with cause-effect analysis), **2) Do** (implementation of improvement from each problem root in accordance with cause-effect analysis. If improvements show positive results, proceed to evaluation and standardization. If it shows negative, analysis on the condition of the problem root must be carried out), **3) Check** (evaluation during improvement implementation, in which all improvement parameters are recorded and used as recommendation in the standardization), and **4) Action** (standardization and follow-up: standardization is improvements performed based on the evaluation results, which eventually will be a reference for improvement in other production lines and avoid repeated quality issues; follow-up is further improvement steps to lower quality issues).

Figure 3. Research Flow Diagram

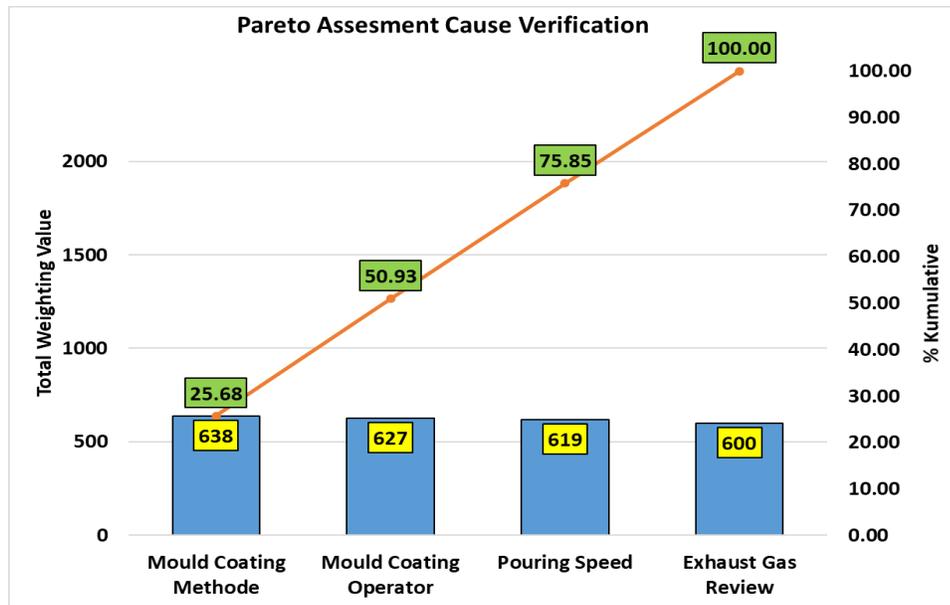


III. RESULTS AND DISCUSSION

III.1 DATA COLLECTION

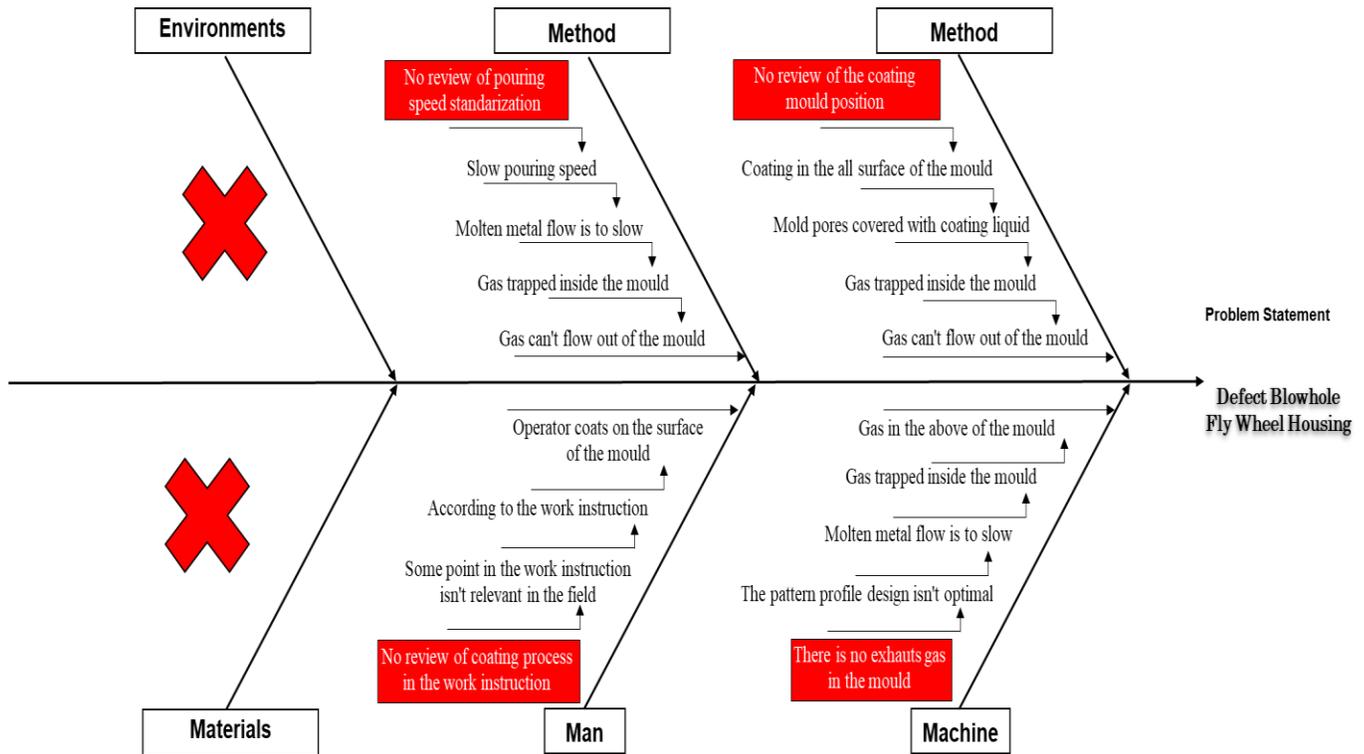
III.1.1 PLAN

The plan stage begins with analyzing and patrolling on *genba* (field). This patrol is carried out to find abnormalities occurring in the production line. After analysis on field, the next step is to conduct an analysis to determine the correlation of defects with the process. Figure 4 shows a QA matrix diagram showing the correlation between processes and sub-processes with the defects (Juran, 1993). In the QA matrix diagram there are several symbols, i.e.: ⊙ symbol that indicates strong correlation, ○ symbol that indicates there is correlation but not too strong, and Δ symbol that indicates little correlation or almost no correlation. Results show that the ⊙ symbol with strong correlation scored 20, ○ symbol with less strong correlation scored 4, and Δ symbol with little correlation scored 6.



Gambar 5. Pareto Diagram

From the results of the Pareto diagram analysis above, it can be concluded that the coating process is the most dominant cause of defects blowhole. Blowhole is gas trapped in the mould (Chaudhari, 2014). Next factors are the pouring process and the exhaust gas. Therefore, an analysis using a cause-effect diagram is necessary to find out what factors are the cause of the defect. (Joshi, 2014)

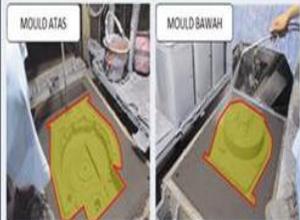
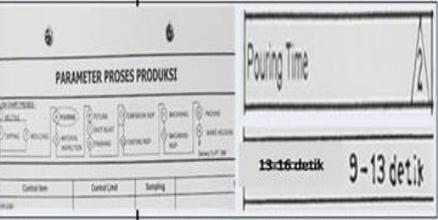
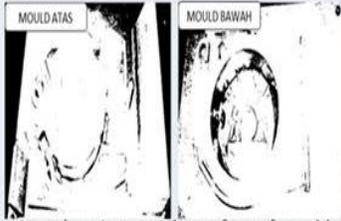
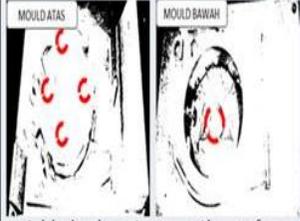


Gambar 6. Fishbone Diagram / Cause Effect Diagram

III.2 DATA PROCESSING

After cause-effect analysis using the Ishikawa Diagram, ideas and suggestions for improving defects are made to reduce internal defects and customer claim cases. The ideas and proposed improvements are sorted by the cause of defect according to the Pareto diagram in Figure 5. The proposed defect improvement for fly wheel housing items is shown in table 2.

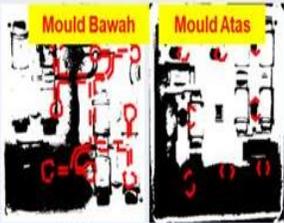
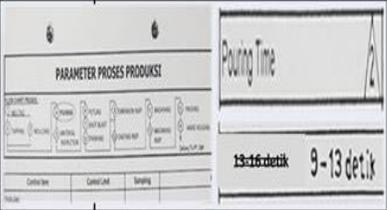
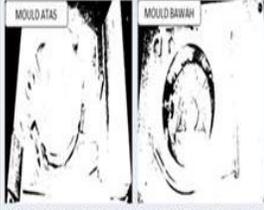
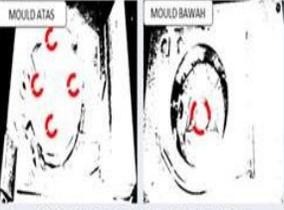
Table 2. Improvement Idea

What (Root Cause)	How (Improvement Idea)	FAKTOR	WHERE	WHY	HOW MUCH	WHEN	PIC
 Coating on the all surface of the mould	 Coating on the critical area	Method	PMS Moulding	Coating applied in critical area so that gas can flow out from the mould	-	January 4 2021	Teguh T
 Work instruction of coating proses isn't relevant in the field	 Revision of coating process work instruction	Man	PMS Moulding	Revision of work instruction and trained to field operator	-	February 22 2021	Yusuf
 Slow pouring speed	 Revision of pouring speed parameter	Method	PMS Moulding	Revision pouring speed parameter from 13-16 s to 9-13 s	-	February 1 2021	Erdin
 No exhaust gas on the surface of mould	 Added exhaust gas on the surface	Machine	Workshop Pattern	As a place for gas disposal in moulding	Rp 185.000 ,00	March 10 2021	Salim F

III.2.1 DO

Based on the ideas and suggestions for improvement in accordance with table 2, further improvements are made, as in table 3. The cause of the first defect is repaired with a coating process in certain areas. From the first improvement there was a decrease in average defects from previously 19% to 3%. Furthermore, from the second and third improvements by reviewing the work instructions for the coating process and revising the production process parameters for the liquid pouring process, reduction in defect was found, from previously 3% to 2%. Furthermore, from the fourth improvement by adding exhaust gas to the pattern, reduction in defect occurred from 2% to 0.5%.

Table 3. Improvement Activity

FAKTOR	WHAT (ROOT CAUSE)	HOW (IMPROVEMENT)	WHERE	HOW MUCH	WHEN	PIC	IMPROVEMENT RESULT
Method	 Coating on the all surface of the mould	 Coating on the critical area	PMS Moulding	-	January 4 2021	Teguh T	 Defect down from average 19% → 3%
Man	 Work instruction of coating proses isn't relevant in the field	 Revision of coating process work instruction	PMS Moulding	-	February 22 2021	Yusuf	 Defect down from average 19% → 3%. Then down until after second improvement 2%
Method	 Slow pouring speed (13-16 s)	 Revision pouring speed parameter to 9-13 s	PMS Moulding	-	February 1 2021	Erdin	 Defect down from average 19% → 3%. Then down until after second improvement 2%
Machine	 No exhaust gas on the surface of mould	 Added exhaust gas on the surface	Pattern Setting	Rp 185.000,00	March 10 2021	Salim F	 Defect down from average 19% → 0.5%

III.2.2 CHECK

Based on the repair results in accordance with table 3, there is an effect of decreasing defects on several factors, namely; safety, quality, productivity and cost, as shown in Figure 7. Reduced defects have no effect on safety because in 2019-2021 there were no work accidents. Furthermore, from the quality factor, there was a decrease in defects from an average of 18.60% in 2019-2020 to 1.60% in 2021. From the productivity factor, there was an increase in mold/hour number, from an average of 78.31 mold/hour in 2019-2020 to 90.02 mold/hour in 2021. From the factor of defect repair cost, the saving cost per month is Rp285,776,616 per year as shown in table 4. Defect repairs also have an impact on reducing customer claim cases, from 2019 with an average of 4 cases to 2 cases at the end of 2020 and 2021. There is a 50% decrease compared to the previous claims, as shown in Figure 8.



Figure 7. Effect of Defect Reduction on Safety, Quality, Productivity Factor

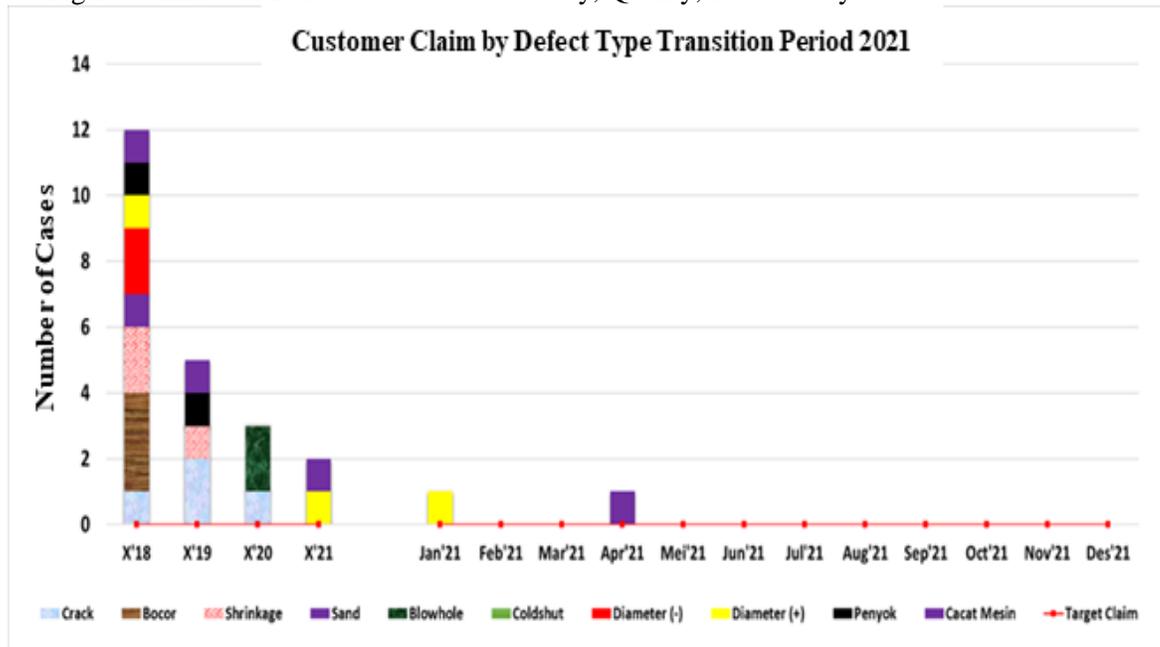


Figure 8. Customer Claim Transition Period 2021

Table 4. Saving Cost Calculation

Defect Saving Cost / Unit Price (A)	DEFECT BLOWHOLE	Before KAIZEN	After KAIZEN
	Total Production (Pcs)	7665	4310
	Blowhole Defect (Pcs)	1481	63
	Blowhole Defect (%)	19.32	1.46
	Blowhole Defect (Pcs) / Month	87	13
	Unit Price (Rp)	Rp 318.663	
	Price Total of Blowhole Defect / Month	Rp 27.761.171	Rp 4.015.154
	Rp 23.746.017		
Coating Consumption Saving Cost (B)	Coating Consumption	Before KAIZEN	After KAIZEN
	Coating Consumption (Liter)	1401	151
	Coating Consumption (Liter) / Month	82	30
	Coating Consumption Price	Rp 55.711.314	Rp 5.997.766
	Coating Consumption Price / Month	Rp 3.277.136	Rp 1.199.553
	Saving Cost Coating Consumption	Rp 3.277.136 - Rp 1.199.553	
	Rp 2.077.583		
	Coating	Before	After KAIZEN

	Consumption	KAIZEN		
Improve ment Cost (C)	Cost Produksi (Foundry & Mc) / Month	Rp 2.750.000		
	Added Exhaust Gas	Rp 185.000		
	Cost Man Power (Rp 4.500.000)	Man Power Cost (2 Opr)	Man Power Cost (1 Opr)	
		Rp 9.000.000	Rp 4.500.000	
	Total Improvement Cost	Rp 2.750.000 + Rp 185.000 + Rp 4.500.000		
Rp 7.435.000				
Cost Saving Total				
Per Month	{(A+B) - C}	{(Rp 23.746.107 + Rp 2.077.583) - Rp 7.435.000}		
		Rp 18.388.690		
Per Years	Rp 220.664.280			

III.2.3 ACTION

After analyzing the effect of defects on safety, quality, productivity and cost factors, the standardization was established and set forth in the work instructions, process parameters, OPES (One Point Education Sheet). This rule is used to prevent defects from happening again and as a *poka-yoke* (mistake-proofing) for process control in the production line. The standardization is as follows:

1. Work instructions for mold coating process
2. Compliance check sheet for mold coating process
3. Standard work instructions for using ladle, temperature pouring, pouring speed
4. OPES for pouring process *poka-yoke*

IV. CONCLUSION

1. The improvements that have been made have an impact on reducing customer claims by 50%, from an average of 4 cases in 2019 to mid-2020 to 2 cases from the end of 2020 to mid-2021.
2. From the improvements, in accordance with the QA Matrix, Pareto Diagram and observations using the principles of *Genba*, *Genbutsu* and *Genjitsu*, the factors that influence the occurrence of blowhole defects are Method, Machine and Human.
3. The improvements have an effect on the quality of the resulting product. Defects have decreased from an average of 18.15% to 1.60%, which is lower than the Target Defect of 5%. This means that there is a 90% decrease from the targeted 75% decrease.
4. The improvements have an effect on the level of mold productivity per hour. After improvement, the productivity level increased by 17% from 74.51 mold/hour to 90.02 mold/hour. The target is 84 mold/hour.
5. The improvements also affect the cost saving. In 1 year, the cost saved from defect repair is Rp 220.664.280.

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IMPLEMENTATION OF *LEAN* CONCEPT IN *CHANGEOVER* PROCESS IN THE FISH FEED INDUSTRY

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ABSTRACT

Currently, the global competition in the fish feed industry is very tight, where quality, operational costs and fulfillment of delivery deadlines are the main factors in winning competence. PT. CI is a multinational company whose one of its business units is fish feed products. PT.CI uses Overall Equipment Efficiency as an indicator of the overall efficiency of the production process. There are 4 production machines, the Extruder 2 machine has the lowest average OEE value of 65% where the largest losses occur due to Availability losses of 22%. The search results know this is caused by frequent changeovers. The impact of low availability is the loss of production time of 58.2 hours or equivalent to 247 tons of product in one month and there is a 33% difference with the forecast. Process Activity Mapping and Spaghetti diagrams are used to identify waste in the changeover process, Root Cause Analysis uses 5 why's to find the root cause of waste occurrence, Single Minutes Exchanges of Dies to reduce production setup time, 5S to create a neat, clean and productive work area, Impact & Effort matrix to determine priority improvement recommendations. The recommended solution using SMED can save setup changeover time by 45.1% for size changeovers and 42.5% for formula changeovers. The estimated increase in OEE is 14% using 3 methods of recommended solutions.

Keywords: Fish feed industry, Lean concept, Overall Equipment Efficiency (OEE), Process Activity Mapping (PAM), Spaghetti diagram, Root Cause Analysis (RCA), 5 why's, Single Minutes Exchanges of Dies (SMED), 5S, Impact & Effort matrix.

1. INTRODUCTION

PT.CI at Serang-Banten has 4 machines to produce 2 types of fish feed, namely floating and sinking. Pellet 1 and Pellet 2 machines for sinking product then Extruder 1 and Extruder 2 machines for floating product. Table 1 shows the forecast for December 2020.

Table 1 Forecast PT.CI on December 2020

Feed type	Machine	Forecast in Dec 2020 (SKU)	Gaps forecast (SKU)	% Gaps forecast
Sinking	Pellet 1	21	6	29%
	Pellet 2	19	5	26%
Floating	Extruder 1	7	1	14%
	Extruder 2	36	12	33%

Based on **Table 1**, the difference in forecasts for the Extruder 2 machine is the largest, which is 33%. Forecasts are made based on orders that come in every month, forecasts are made to guide the production team to make fish feed every day.

PT.CI implements an Overall Equipment Effectiveness (OEE) system to monitor how manufacturing resource time is allocated and identify the margins available for improvement. In particular, OEE is calculated from the initial operational environment and then monitored periodically, to evaluate the presence and effectiveness of improvements, which are implemented and consolidated from year to year, as suggested by the Total Quality Management (TQM) approach. Furthermore, OEE is especially useful when the production of new items is carried out using existing resources and in which operating conditions should be modified as little as possible. As described in (Gamberini 2017), changes in the operating conditions of manufacturing resources incur costs, related to the acquisition of less knowledge, the implementation of new work procedures, the implementation of new maintenance operations and the setting up of new workstations. Therefore, OEE is a tool to evaluate the future performance of manufacturing resources and compare it with the initial situation by considering alternative operational scenarios. In particular, processes with high standards of quality and yield are addressed.

Three factors that influence OEE indicators are equipment availability (Availability), performance (Performance) and quality in production (Quality). The following is Figure 1 of the OEE trend report in the PT.CI.

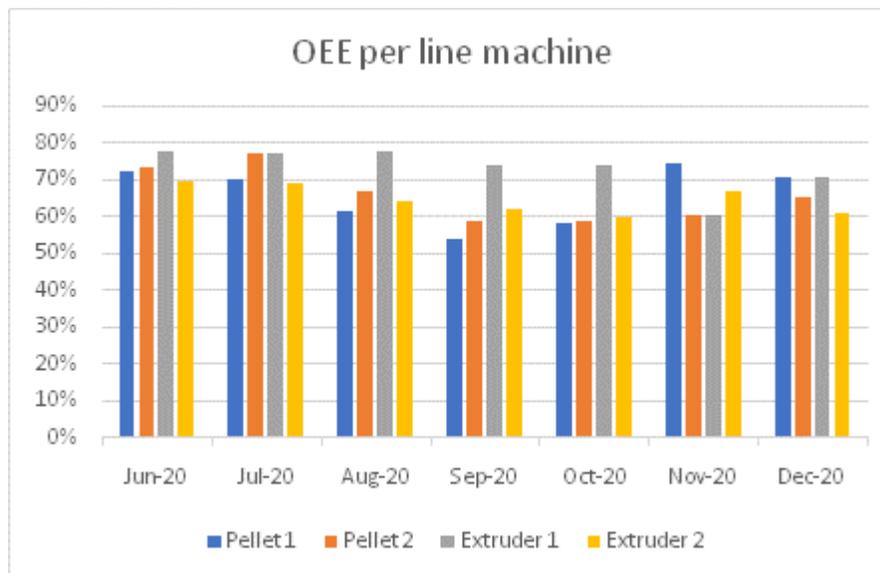


Fig 1 OEE trend from Jun'20 to Dec'20

Based on data from **Fig 1**, the average OEE value for each machine from June to December 2020 are Pellet 1 = 66%, Pellet 2 = 66%, Extruder 1 = 73%, and Extruder 2 = 65%. The trend of Extruder 2 is the smallest compared to other production machines. The trend for Extruder 2 is the smallest compared to other production machines, so this research focuses on the extruder 2 machine, then find out the data losses/downtime contained in December 2020 such as forecast data in **Fig 2** as follows:

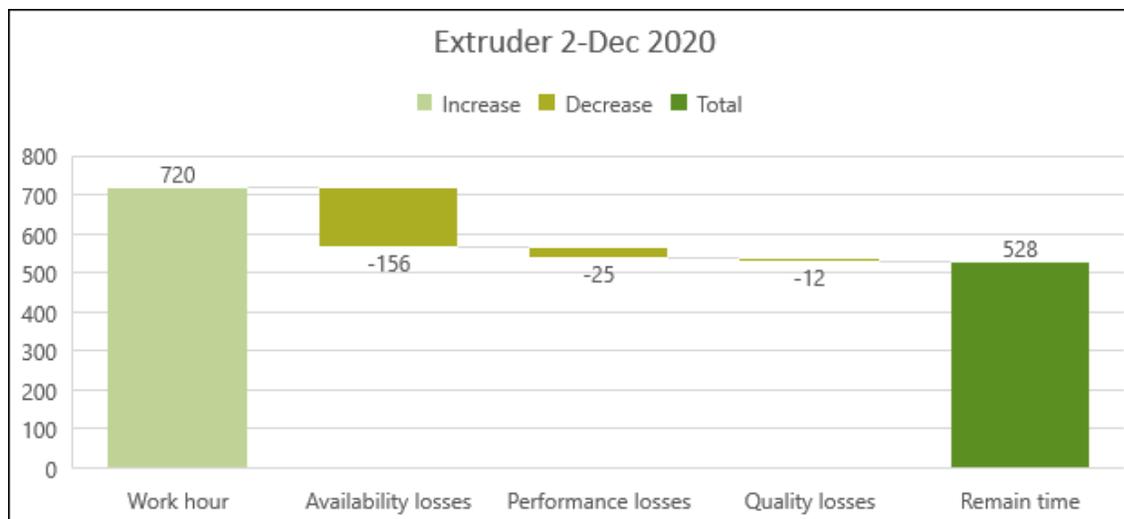


Fig 2 Data losses at Extruder 2 in December 2020

Fig 2 explains the 3 losses in OEE, namely Availability losses, Performance losses and Quality losses, and the biggest losses is Availability of 156 hours. The operation of the Extruder 2 machine is 24 hours a day for 30 days, so the total working hour is 720 hours. 22% losses are obtained from the Availability. The remaining operating time of the Extruder 2 machine is 528 hours so that 192 lost hours are considered as downtime. The output of the Extruder 2 machine is 4.25 tons/hour, so the total product lost or cannot be produced by the Extruder 2 is 816 tons. Based on the 192 lost hours, the researchers checked and analyzed using the Pareto chart in **Fig 3** as follows:

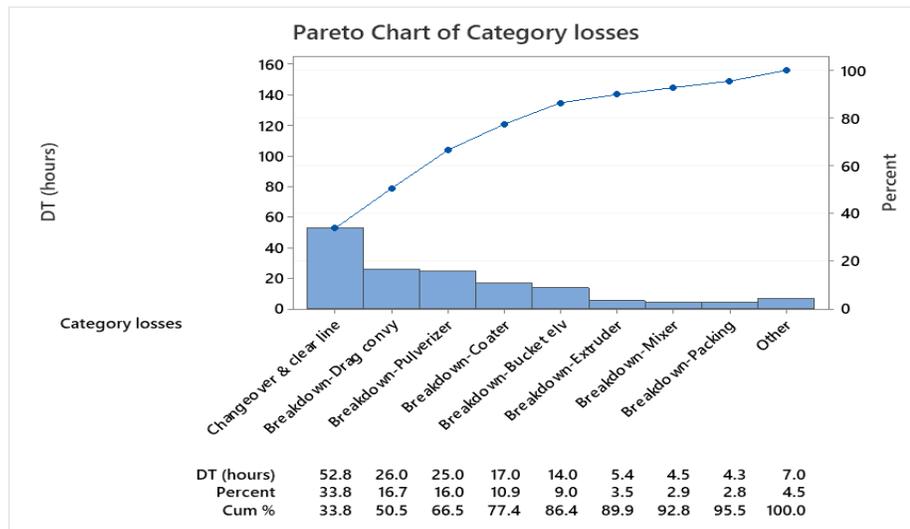


Fig 3 Pareto chart of 192 lost hours

Based on Fig 3, Availability losses in the Changeover category is the first order with a total of 52.8 hours. Changeover is an activity that must occur every month because the production process in extruder 2 has a large variety of products for sizes and formulas, as shown in **Table 2** which shows changeover data that occurred in December 2020.

Table 2 Changeover data at Extruder 2 in December 2020

Date	Size	Form ula	Size & Form ula	Tim es	Origi n	dest 1	dest 2	dest 3
4-Dec-20	0	1	1	2	RT 994	AB 554	APSER S 3	
5-Dec-20	0	2	1	3	APSER S 3	INFINIT Y 3	PRESTI GE 3	APSE RS 2
6-Dec-20	0	3	0	3	APSER S 2	PRESTI GE 2	AL 622	AB 553 2
7-Dec-20	0	0	2	2	AB 553 2	SF 111	APSER S 3	
8-Dec-20	0	1	0	1	APSER S 3	INFINIT Y 3		
10-Dec-20	0	0	1	1	INFINIT Y 3	VP 3812		
11-Dec-20	0	0	1	1	VP 3812	VP 3315		
12-Dec-20	0	0	2	2	VP 3315	APSER S 3	INFINIT Y 4	

13-Dec-20	0	0	1	1	INFINIT Y 4	PROFIS H 3		
14-Dec-20	0	1	0	1	PROFI SH 3	INFINIT Y 3		
15-Dec-20	0	0	2	2	INFINIT Y 3	APSER S 4	APSER S 2	
16-Dec-20	0	2	0	2	APSER S 2	AB 522	AL 622	
17-Dec-20	0	0	1	1	AL 622	APSER S 3		
18-Dec-20	0	0	1	1	APSER S 3	AB 554		
19-Dec-20	0	0	1	1	AB 554	PRESTI GE 3		
20-Dec-20	0	1	2	3	PRESTI GE 3	APSER S 4	AL 611	AL 611L
21-Dec-20	0	0	2	2	AL 611L	APSER S 4	FT 922	
22-Dec-20	0	0	2	2	FT 922	SF 111	PT 734	
23-Dec-20	0	0	1	1	PT 734	APSER S 3		
24-Dec-20	1	0	0	1	APSER S 3	APSER S 2		
25-Dec-20	0	0	1	1	APSER S 2	INFINIT Y 3		
26-Dec-20	0	0	2	2	INFINIT Y 3	AB 522	INFINIT Y 4	
27-Dec-20	0	1	0	1	INFINIT Y 4	RT 994		
31-Dec-20	0	1	1	2	RT 994	AL 622	PRESTI GE 2	

From **Table 2** obtained data: CO formula = 13 times, CO size = 1, and CO formula and size = 25 times. Thus the total changeover in December 2020 is 39 times (with a total duration of 52.8 hours). If taken the average time to make a changeover is 1.35 hours or 81 minutes.

2. LITERATURE REVIEW

The data used in this research are primary data and secondary data. Primary data is obtained through direct observation or observation in the field, while secondary data is obtained from the results of company report related to the changeover process. The main objective of the lean concept is to reduce and eliminate waste from non-value-added activities that impact costs by creating an efficient system with minimal waste.

The Lean concept used in this study is supported by the use of Process Activity Mapping (PAM) tools and Spaghetti diagrams to identify and map changeover activities that are not added value, and Root Cause Analysis (RCA) to identify the root causes of non-value added activities, 5S (Seiri, Seiton, Seiso, Seiketsu, Shitsuke) and Single Minute Exchange of Die (SMED) were used to make recommendations for improvement. In practice, SMED is a set of techniques aimed at reducing machine setup time. When applied correctly, it allows less time for installation, providing more flexibility in the process flow. SMED is proposed as a tool that focuses on low cost on the basis of kaizen improvement involving the shopfloor team (Pablo Guzman, 2013).

3. METHODS

The stages carried out in this research are the Identification stage of waste, Find out the root cause of waste, Determine improvement/solution recommendations, and Determine priority of improvement/solution recommendations as in **Fig 4**.

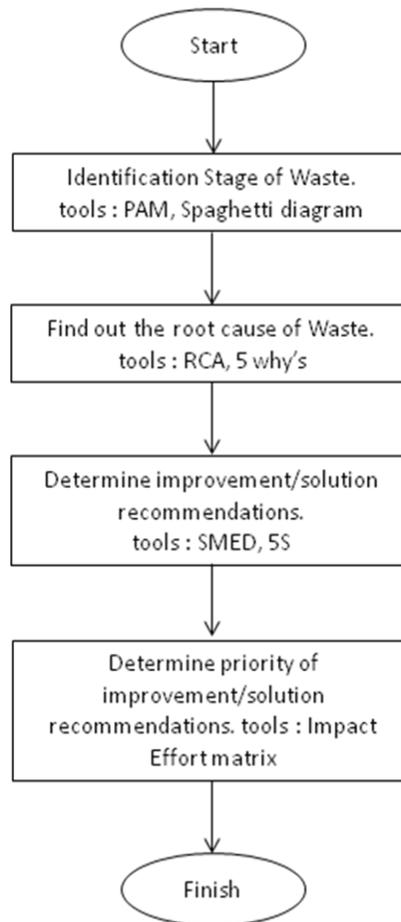


Fig 4 Research Flowchart

4. RESULTS

Process Activity Mapping (PAM) method that has been carried out on the two changeover activities, namely changeover size and changeover formula, can then be analyzed. The analysis includes how long the total processing time is from the start of the activity to the completion of the changeover activity, namely from stopping the Extruder machine until the product is released to the packing line. And an analysis will also be carried out on the percentage of time from the

classification results for activities including VA, NNVA and NVA (waste) referring to the lean concept category. **Table 3** shows the results of mapping changeover activities using PAM by classifying activities into five criteria, namely operation (O), transportation (T), inspection (I), storage (S), and delay (D). Of the 5 types of activities, they are further divided into 3 categories, namely value added activity (VA), non-value added but necessary activity (NNVA), and non-value added activity (NVA).

Table 3 Process Activity Mapping (PAM) result

Activity	Total activity	Percentage of activity	Classification by time (minute)			
			Total	VA	NNVA	NVA
Changeover size						
Operation (O)	30	42 %	34,34	27,54	5,5	1,3
Transportation (T)	25	35 %	30,11	11,62	0,2	18,29
Inspection (I)	8	11 %	6,25	0	6,25	0
Storage (S)	0	0%	0,45	0	0	0
Delay (D)	8	11 %	12,41	2,2	4,26	5,95
Total			83,11	41,36	16,21	25,54
Percentage of classification				49,8 %	19,5 %	30,7 %
Changeover formula						
Operation (O)	28	44 %	34,14	27,44	5,4	1,3
Transportation (T)	21	33 %	28,31	11,62	0,2	16,49
Inspection (I)	7	11 %	5	0	5	0
Storage (S)	0	0%	0	0	0	0
Delay (D)	8	13 %	12,41	2,2	4,26	5,95
Total			79,86	41,26	14,86	23,74
Percentage of classification				51,7 %	18,6 %	29,7 %

PAM in this research can provide consideration for companies to prioritize which process activities are included in the waste category for further action, such as the results of the analysis in this study. Identification stage of waste is carried out based on the results of the preparation of process activity mapping (PAM), spaghetti diagrams, direct observations, and interviews and brainstorming with the company. **Table 4** shows Identification stage of waste in changeover size and formula activities.

Table 4 Waste in changeover activities

Waste type	#	Real condition explanation	Source of information
Transportation	W1	Walk to die rack	Based on PAM, spaghetti diagram and direct observation
	W2	Walk to MCC room to take LOTO tools with a distance of 5 meters	
	W3	Walk to Extruder machine	
	W4	Walk to Tools box	
	W5	Walk to Control room	
	W6	Walk & move the screen of Hammer Mill from 0m elevation to 30m elevation	
	W7	Walk to 3rd floor, 20m elevation	
	W8	Walk to 2nd floor, 12m elevation	
	W9	Returning non-conforming die to die rack	Based on PAM and direct observation
	W10	Returning non-conforming knife head to tool rack	
Waiting	W11	Call security office	Based on PAM and direct observation
	W12	Go to store room to take screen of Hammer Mill	
Over processing	W13	Shifting the flushing tub to avoid water spill out	Based on PAM and direct observation
	W14	Take flexible hose for flushing	
	W15	Installing flexible hose and directing it to sewer	
Motion	W16	Open & close valve of steam and water	Based on PAM and direct observation

After knowing the waste in the changeover activity, then the root cause of the problem is known using the RCA method. **Table 5** is the stage of looking for solution recommendations by implementing SMED is carried out, namely simplifying setup activities carried out in changeover activities. By simplifying the setup activity, the time used to perform size changeover and formula changeover activities will be reduced.

Table 5 SMED result

Activity	Set-up (before)				Set-up (after)			
	Internal		External		Internal		External	
	Qty	Mins	Qty	Mins	Qty	Mins	Qty	Mins
Changeover size	58	73,07	13	10,04	29	40,08	41	43,03
Changeover formula	51	69,82	13	10,04	29	40,08	34	39,78

Based on **Table 5**, it is known that there is a reduction in setup time that occurs in size changeover and formula changeover activities by implementing SMED. This is caused by the shifting of internal setup activities to external setup activities. So that the time to do the size changeover activity was reduced from 73.07 minutes to 40.08 minutes, resulting in a 45.1% saving in setup time while the formula changeover activity was reduced from 69.82 minutes to 40.08 minutes, resulting in savings in setup time. by 42.5%. In addition to reducing internal set-up activities to external set-up, improvements are also made in the work area where improvements are made based on the 5S concept so that waste resulting from irregularities in the work area can be eliminated. **Fig 5** shows an example of the implementation of “Seiton”, namely arranging the items used and given an identity so that they are easy to identify and track.



Fig 5 Implementation of 5S

Determine the priority of solution recommendations using the Impact Effort Matrix which is specially designed for the purpose of determining the priority of the various proposed solution recommendations. Using this method will help make it easier to select the recommendations that require the least effort and have the most impact. The categories used are Quick wins, Major projects, Fill-ins, and Tankless tasks. The determination of the category is based on impact and effort, impact is based on how much impact is produced, namely the reduced time for changeover activities and effort is based on the effort spent, namely the cost and implementation time to make improvements to the solution. There are 18 recommended solutions in this study, 7 items are Quick wins, 5 items are Major projects, 3 Fil-Ins item and 8 items are Thankless tasks.

6. CONCLUSIONS

1. Waste that occurs in the production process consists of 16 wastes identified through direct observation, interviews with company stakeholders, and mapping the production process using process activity mapping (PAM) and spaghetti diagrams. The 16 wastes are classified into 7- waste which is then carried out by root cause analysis to determine the root cause of the waste in the production process.
2. The root causes of transportation waste are the location of placement of die racks, LOTO

equipment, equipment for changeover activities that are not in easily accessible positions or close to the Extruder machine 2. In addition, there is no storage rack and lifting system for HM screens, which greatly affects time implementation of changeover activities. The next is the absence of standards for the type and size of the die and knife head to be used and the unavailability of a sigmat ruler on the storage rack.

3. The root causes of waiting waste are ineffective communication tools, professionalism of security officers, lack of attention to the timing of changeover activities and the unavailability of HM screens in the area near the machine.
4. The root cause of waste over processing is the unavailability water drainage system for flushing on Extruder 2 machine.
5. The root cause of the waste motion is that the operation of the valve for flushing activities is manual.
6. Application of lean concept for solution recommendation using SMED can save setup changeover time by 45.1% for size changeover and 42.5% for formula changeover.
7. Executing the fastest and most appropriate solution is to create a project and start it at the same time it will save total repair time.
8. The estimated increase in OEE using 3 methods recommended solutions is 14%.

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THE INFLUENCE OF DEMOGRAPHIC AND WORK ENVIRONMENT FACTORS ON THE DYNAMICS OF THE PERSONALITY DEVELOPMENT PATTERN IN THE MANUFACTURING INDUSTRIES COMMUNITY

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ABSTRACT

Personality is an important factor and determines the qualifications of someone who plays a role in industry manufacturing activities. Personality is more about humans as workers and as industrial subject. Classification of workers requires a personality measurement tool. One of the personality measurement tools is the Big Five Inventory. Changes in attitudes and personality of workers in the form of depression or stress, negative affection and anger traits, shirking action, social loafing, not contributing energy, frustration has a negative impact and must be minimized. So far, personality development has only been described, not simulated in a dynamic system. In manufacturing industry communities, changes in worker attitudes and personalities are more common due to shifts between workers compared to other industrial communities. Personality development so far has only been described, has not been simulated in the dynamic system. This research is based on an expert system based on the fuzzy big five inventory personality, making a dynamic system model of worker personality, filling in a dynamic system model with a questionnaire to 8 psychology experts and 36 workers. In this research, a dynamic model that represents the personality of industrial workers is successfully built. The model was successfully verified and validated with the reality of the behavior and personality treatment of industrial workers, both from the fuzzy nature and the results of the tendency of the worker personality dimensions. The scenarios were implemented in the form of (1) mentor guidance, (2) company reorientation every year, and (3) job rotation every four years. The best result is the simultaneous application of the three scenarios with an average agreeableness personality dimension of 0.81 or "active" workers in discussions to reduce sympathy and work empathy and neuroticism by 0.47 or workers can control the level of depression while maintaining enthusiasm and enthusiasm for working with work challenges.

Keywords: Personality of manufacturing industries community, Big Five Inventory, Dynamic System, Fuzzy Expert System

1. INTRODUCTION

Human personality has an important role in everyday life, like in social experience, in society, and working world, because concept of personality is related to human behavior which is general and unique in nature. Personality is a major subject in the field of psychology. One of psychology disciplint is

industrial psychology. Industrial psychology applies the fundamentals of psychology in environment work. The goal of industrial psychology is to improve the performance of employees and organizations where they work by developing knowledge about human behavior. Industrial Psychology includes several fields, namely personnel psychology, organizational psychology, and human factors or ergonomics (Aamodt, 2010).

In the working world, especially in the manufacturing community, psychopathology or deviant behavior often occurs compared to other industrial communities. Some of the psychopathologies that occur in working world are negative affection and trait anger (Maruish, 2004), avoid the obligation (shirking action), social loafing, and not contributing energy (free raider) (Kidwell & Bennett, 1993), frustration, which can rise the depression, feeling unfair (perceptions of injustice), and citizenship behavior (Bannett & Robinson, 2000). Deviant behavior occurs because there are interactions between individuals or interactions between personality factors that occur within workers. This is what underlies the need for a worker personality model based on *big five theory* by paying attention the factors that influence personality as well as paying attention to changes in personality from time to time.

This research aims to build a model that can represent human personality based on *big five theory* so it is able to see the movement of workers' personalities in the manufacturing industry society as an object so they do not experience personality disorders or psychopathology and provide several scenarios or treatments for developed models as personality human representation which relate the best time to do the scenario.

To achieve the goals above so this research using *fuzzy expert systems* and dynamic system. *Fuzzy expert system* is used to convert top five inventory answers into membership values which will be used as dimensional stock values, while the simulation program will use a dynamic system.

2. LITERATURE REVIEW

There has been a lot of research on personality. However, personality research is still rare to look personality in a systemic context. It is important to see Systemic thinking because many factors that influence each other in shaping a person's personality, one of example is the using of a dynamic systems methodology with integrative approach so it can produce a personality dynamics model that using three parameters, namely basic personality, variability personality, and attraction personality (Sosnowska, Kuppens, Fruyt, & Hofmans, 2019), research that produces complex- system models in a personality approach that pays attention in coherent and incoherent personality (Fajkowska, 2014), and theoretical research which based on personality as a dynamic system by paying attention in someone variation (Nowak, Vallacher, & Zochowski, 2005). From several research that have been conducted, it is found that the development of personality models that has been done is quite a lot, but there are few people who pay attention in modeling personality into a forecasting model, especially on *big five theory* measuring scale and the development of personality models in dynamic systems or complex systems is still seeing personality as a state that changes immediately when having problems or interacting with personalities who have higher attractiveness. So, personality is not seen as a level or percentage which can rise and fall dynamically, it is depending on its constituent factors.

Personality as a science with a taxonomy that has been developed can be seen as an expert, namely "someone" who has the ability to assess a person's behavior through answers in question items to a problem in classifying a person's personality (Marlina & Hidayat, 2012). Classical set theory is not suitable for personality problems because a person is not really member of a side of the personality dimension, so it would be more suitable to use *fuzzy set theory* approach. Therefore, *fuzzy expert system*

was chosen because personality requires a basic thought of expertise people, so, formed model can describe well the existing real conditions, while the use of *fuzzy* logic has high flexibility, so, it can adapt with the changes that occur and the uncertainty which accompany problem.

Personality has constituent factors which cannot stand alone and have dependency. Starting from this, the personality with its own factors can be approached by a thinking system. This is appropriate with the opinion of Fajkowska (2014), namely elements from thinking system have been used very successfully in both theoretical and applied branches of psychology such as in cognitive psychology, existential psychology, work psychology, family psychology, or engineering psychology. One of the components or parts in thinking system is a dynamic system. According to Allport (1937), personality is dynamic. Personality is a psychological organization that coordinates experiences and behavior (Sosnowska, Kuppens, Fruyt, & Hofmans, 2019), and according to Nowak (2005), dynamic perspectives emerge as paradigms that affect almost all fields of contemporary psychology. Dynamic systems are a mathematical modeling technique that used to understand and discuss complex issues, problems, and systems using the terminology of causal-loops and stock-flow diagrams.

Dynamic systems are used as a tool to study dynamic complexity (Sterman, 2000) such as personality complexity. Dynamic systems are used because this model can see the movement or dynamics of personality in the dimension of time and can control dynamic movement as desired (Sterman, 2000). This system also understands the sources of policy resistance and designs more effective policy (Sterman, 2000).

3. METHODS

This study is divided into six main stages, namely problem identification and formulating initial hypotheses, contextualizes big five inventory, constructing fuzzy expert system, developing dynamic system model, analyzing data from the output of simulation, and drawing conclusions and suggestions. Problem identification begins by looking at the problems that occur in the manufacturing industry, especially in the field of worker personality. The number of interactions between workers, both with other workers and with the tasks performed, makes the personality of workers change over time. The lack of research on personality simulations that are run simultaneously raises the initial hypothesis, namely: changes in the personality patterns of workers in the manual manufacturing industry that can be seen in the scope of time. After determining the initial hypothesis, researchers consulted with psychologists about personality types, personality theories, and various personality measurement tools so that a personality inventory was selected that could reveal the personality of manual manufacturing industry workers. The personality inventory is Big Five Inventory. After determining the personality inventory, the researcher contextualizes the big five inventory so that it can be understood by manual manufacturing industry workers.

In the basic process of expertise in fuzzy expert system, the big five inventory are selected. This process is based on *Big Five Inventory* which contains 44 statement items with five degrees of conformity to the behavior of respondents or workers. Each dimension is calculated by fuzzy membership function. Then a program was made in order to make more easily identify workers into the personality dimensions that best match the answers to the 44 items in *big five inventory*. The program uses the C++ language by presenting 44 big five inventory items to the respondent, and the calculation is carried out automatically which shows the percentage of respondent's personality into the big five personality. The results of this stage were used as personality stocks in the dynamic system that was build.

The development of a dynamic systems model starts with identifying the factors that influence the

personality of the worker. The factors obtained are demographic factors, work environment factors, personality dimensions of Extraversion, Agreeableness, Conscientiousness, Neuroticism, and Openness to Experience. The factors above are arranged in a causa-loop diagram and in a stock-flow diagram. Based on stock-flow diagram, was found parameter value of identified factors. Filling in the parameters on the stock-flow diagram is done with the results of the questionnaire from eight personality experts (psychology lecturers and psychologists) and the questionnaire results from 36 respondents consisting of HRDs and manufacturing industry employees (having a validity degree above 0.258). Assessment of the expert and HRD and employee questionnaires based on the *Likert* scale and its combination using a weighting of two weight for the value of the HRD and employee questionnaires and one for personality experts.

The results that have been obtained are then analyzed in two ways, namely analysis of existing model and analysis of scenario model. The analysis of the existing model is carried out by looking at the changes in the value of the personality dimension from time to time, the age of fixation of the personality of the manual manufacturing industry workers. The analysis of the scenario model is carried out by collecting possible scenarios to be implemented for manual manufacturing industry workers. Scenario model analysis is done by collecting possible scenarios to be implemented for manual manufacturing industry workers. The simulation results of several scenarios are then compared with the values of the existing model. The comparison made is the average dimension value between the models and then the best model is selected

The next process is drawing conclusions and suggestions. In this process the research is concluded and several suggestions are formulated for future research development. An overview of the process of doing this research can be seen in the following flowchart diagram in **Figure 1**.

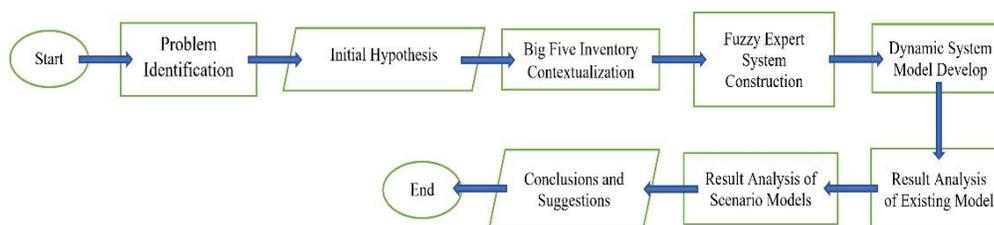


Figure 1. Research Flowchart

The results are divided into two, namely the results of model simulation and model analysis as follows.

3.1 Model result

The result is the membership value of each personality dimension used or referred to. The respondent personality result is $\mu_{\text{Extraversion}} = 0.281$, $\mu_{\text{Agreeableness}} = 0.444$, $\mu_{\text{Conscientiousness}} = 0.806$, $\mu_{\text{Neuroticism}} = 0.344$, dan $\mu_{\text{Openness to Experience}} = 0.875$.

The personality results above are the first stock wick used in stock flow model and added parameters of age 26 years old and education 4, the results are as follows.

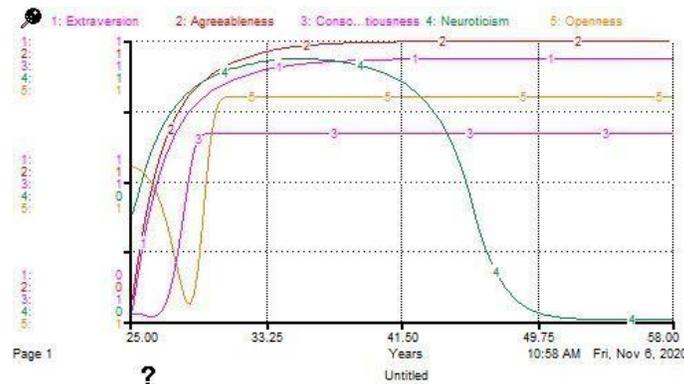


Figure 2. Simulation Result of The *Stok Flow* Model

From these results, then do verification and model validation process. The model verification process is carried out by: (1) using the tools that provided by the dynamic systems program (STELLA 9.1.3). The results show that the model which made is fully the verification process because the model units that built are consistent and using mathematical formula which used is verified automatically by testing the consistency of this unit. (2) viewing the results of five personality dimensions simulation with the results of the personality dimensions within the defined personality range according to *fuzzy* logic (between 0 and 1). (3) Statistical test of age fixation of personality with dimensional results The personality of extraversion and neuroticism is the same as the results that occur in processing industry workers while the other three dimensions are different. And finally, (4) a comparison test of the tendency of the personality dimensions that exist in the processing industry community with the results that there is a similarity in the five personality dimensions between the simulation results and the real conditions obtained from the literature (Chan & Lim, 2017), so it can be concluded that the tendency In the existing model, it can capture the real conditions in the manufacturing industry community or manufacturing industry workers. Based on the results in the first to fourth processes, it can be said: that the model made meets the verification process both in terms of units on the built model, statistical test of the model, as well as theory test (*fuzzy*) and literature.

The process of model validation is carried out by following the terminology of predicting investment returns. In terms of predicting investment returns, there are two types, namely *Ex-Ante* dan *Ex-Post* (Corporate Finance Training, 2020). *Ex-Ante* is the process of estimating the return on an investment before it is made, while *Ex-Post* is the process of comparing the investment return after it is made. Validation with *Ex-Post* terminology is a suitable method for validating social science models, especially psychology.

Therefore, the validation process used in the personality system model of manual processing industry workers is *Ex-Post* validation or validation after the model is implemented in the manual processing industry sector. This is done by recording the results of changes in the personality of workers for further comparison with the simulation results predicting the pattern of changes in the personality of workers in the model.

3.2 Model Discussion

The discussion is carried out by analyzing the results and differentiating into two, namely result analysis of existing dynamic system model and the result analysis of scenario model.

3.2.1 Result Analysis of Existing Model

Analysis of existing model can be divided into five according to the number of personality dimensions in *big fives* as follows.

a. Extraversion Personality Dimensions

Based on two different time, increasing that occurs in the extraversion dimension has decreased slowly, it is 0.54 (age 26 to 29 years), 0.12 (age 29 to 32 years), 0.04 (age 32 to 35 years), 0.01 (age 35 up to 38 years), and 0.01 (age 38 to 41 years). After 40 years old, there was no change in the extraversion personality dimension. This results make 40 years old, the extraversion personality dimension of the worker experiencing fixation or renewal of personality and traits towards the dominant trait of this personality dimension. The age of the extraversion personality dimension fixation is not different with reality that occurs in manufacturing industry workers.

b. Agreeableness Personality Dimensions

Based on two different time, increasing in the agreeableness dimension decreased slowly, namely 0.42 (age 26 to 29 years), 0.09 (age 29 to 32 years), 0.03 (age 32 to 35 years), 0.01 (age 35 to with 38 years), and 0.01 (aged 38 to 41 years). After 38.75 years old, there was no change in the agreeableness personality dimensions. This resulted in 38.75 years old, the *agreeableness* personality dimension of the worker experiencing fixation or renewal of personality and traits towards the dominant trait of this personality dimension. The age of the agreeableness personality dimension fixation is not different with reality that occurs in manufacturing industry workers.

c. Conscientiousness Personality Dimensions

Based on two different times, increasing that occurred in the conscientiousness dimension decreased slowly, namely, 0.1 (age 26 to 29 years) and 0.09 (age 29 to 32 years). After 30 years old, there is no change in the personality dimension of conscientiousness. This results in 30 years old, the conscientiousness personality dimension of workers experiencing fixation or fusion of their personality and traits towards the dominant personality dimension. Age of conscientiousness personality fixation is different from the reality that occurs in manufacturing industry workers.

d. Neuroticism Personality Dimensions

Based on two different times, there was an increase in the neuroticism dimension although this increase gradually decreased, namely 0.37 (age 26 to 29 years), 0.1 (age 29 to 32 years), and 0.03 (age 32 to 35 years). At the age of 35 to 38 years, there is no change in the neuroticism personality dimension. After nothing increase and in stagnant condition, there is a decreasing in the neuroticism personality dimension due to positive interactions with colleagues so the presence of co-workers helps workers reduce the levels of neuroticism personality dimensions. The decrease in the neuroticism dimension initially increased, it is 0.04 (age 38 to 41 years), 0.1 (age 41 to 44 years), and 0.39 (age 44 to 47 years). But after this increase there was a decrease, namely 0.27 (47 to 50 years old), 0.03 (50 to 53 years old), and 0.01 (53 to 56 years old). After the age of 53.5 years, there is no change in the neuroticism personality dimension. This make the age of 53.5 years, the neuroticism personality dimension of workers experienced a fixation of their personality and traits towards emotional stability (recessive traits from this personality dimension). The age of conscientiousness personality fixation is same with the reality that occurs in manufacturing industry workers.

e. Openness to Experience Personality Dimensions

Based on two different times, it is 0.2 (age 26 to 29 years) and 0.32 (age 29 to 32 years). After the 31.5 years old, there is no change in the openness personality dimension.

This case makes 31.5 years old, the openness personality dimension of workers experienced fixation or fusion of their personality and traits towards the dominant trait of this personality dimension. The age of fixation of the openness personality is different from the reality that occurs in manufacturing industry workers. The difference that occurs between the age of dynamic system model which built and the reality that occurs in manufacturing industry workers is due to the limited scope of the model to demographic factors and the work environment.

3.2.2 Result Analysis of Scenario Model

The dynamic system model scenario which developed is the result of modification of the existing model building to see the behavior of the worker's personality performance towards the treatment of the personality model. One of developed model scenarios is adding motivation in the dynamic system model as a converter. The selection of additional motivation as a converter refers to several literature of developmental psychology theory, which states that human personality is closely related to motivation. Motivation in question includes providing goals, encouragement, and self-conditioning of workers at the work place or environment, as well as providing a memory containing a representation of the work being done (Corr & Krupić, 2017). Motivation aims to provide a reference that can affect the cognitive and emotional side of workers (Corr & Krupić, 2017). Based on above opinions, making scenario are includes providing motivation in the form of (1) guidance from mentors and input on the problems faced employees, (2) reorientation of understanding of the company's vision and mission, and (3) assignment of new positions or jobs (job rotation), and (4) guidance, job reorientation and job rotation are carried out simultaneously.

The results of the comparison of each scenario were divided into two, they are agreeableness and neuroticism personality dimensions. Comparisons are made by finding the average model simulation results, namely the existing model and scenario model. Table 1 shows the results of the mean comparison of the personality dimensions of agreeableness.

Table 1. Average of Agreeableness Comparison Dimension in several models

<i>Agreeableness</i>					
Existing (Without Mentoring, Reorientation company and Workers Rotation)	Reorientation		Rotation		Simultaneous (Mentoring, Reorientation company and Workers Rotation)
	Once a year	Twice a year	Every 4 years	Every 5 years	
0.958217	0.823488	0.712636	0.939767	0.942016	0.81

From the table above, it can be concluded that the use of company reorientation twice a year gives the smallest value but makes greater expenses financially and in time. Simultaneous use of the three scenarios is recommended because it is financially and time efficient compared to the reorientation of workers twice a year and gives better results than the existing model.

Table 2 shows the comparison of the mean dimensions of neuroticism personality from the models that have been made.

Table 2. Average of Neuroticism Comparison Dimension in several models

<i>Neuroticism</i>			
		Work Rotation	Simultaneous

Eksiting (Without Mentoring, Reorientation company and Workers Rotation)	Mentoring	Every 4 years	Every 5 years	(Mentoring, Reorientation company and Workers Rotation)
0.493566	0.399535	0.61876	0.584574	011.471783

Based on the table above, it can be concluded that the use of mentoring provides the smallest value of the neuroticism personality dimension. The average level of neuroticism personality dimension is 0.399535, indicating that workers in carrying out their duties and responsibilities are easily bored and have less challenges. Simultaneous use of the three scenarios is recommended because it makes the personality dimensions of neuroticism more awake, neither too high nor too low.

4. CONCLUSIONS

Based on the results of this research, it can be concluded that (1) the dynamic system model of the personality of manufacturing industry worker being developed can represent the actual condition of the personality of manufacturing industry worker. This is based on the range of personality dimension simulation and the results are between 0 to 1 and the results of the personality dimension trend according to the research of Shiau Wei Chan and Hui Ting Lim (Chan & Lim, 2017) on and 2) Four model improvement scenarios have been applied on the existing model. The results showed that the scenario with the application of guidance, company reorientation once a year, and job rotation every four years simultaneously obtained an average agreeableness personality dimension of 0.81 or "active" workers in discussions to reduce sympathy and work empathy and neuroticism by 0.47 or workers can control the level of depression while maintaining enthusiasm and enthusiasm for working with work challenges giving a better average result compared to other scenarios.

The results of this research are not final because it is still use a limited scope, namely dimensions of personality in terms of demographics and work environment. This dynamic personality system model needs to be developed in order becomes more comprehensive model with adding existing models, such as family module and the neighborhood. The scenario model in this research is only based on the motivation of manufacturing industry community. There are still many scenarios that can be explored to avoid deviations that occur in manufacturing industry community.

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Parallel Session 2

Room M (12.10 – 13.55)

Moderator:

Category : Risk Management

ANALYSIS OF ENVIRONMENTAL QUALITY BASED ON BIRD HABITAT AT SENSITIVE AREAS OF PT. PHE WMO

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ABSTRACT

This research is focused on the analysis of environmental quality based on bird habitat at sensitive area of West Madura Offshore Oil Company, which is determined by Environmental Sensitivity Index (ESI) mapping study. As the area will be most likely impacted by the main activities of company, condition at Mangrove Education Park (TPM) in Labuhan Village should be maintained as a requirement of fulfillment of UU No. 32 of 2009. This study uses bird banding technique for primary data compilation and uses pairwise comparison method for develop optimum modeling instrument of accuracy measurement APHB (Accuracy of Bird Habitat Assessment). The bird banding technique has the concept of catching birds with a mist net, marking them with a rings and conducting a physical examination, then releasing the birds back into nature. Through this technique, the maximum variable extracted from each species is 11 (eleven) parameters, including visual, physical, advance and environmental indicator. The accuracy of bird habitat per species can be assessed using the APHB instrument with an increasing trend of accuracy from 2019-2020 in average of 97.76%. The difference in the accuracy of the bird banding technique against bird watching and camera trap technique is 79.9% and 66.7% respectively. This instrument is combined with the biodiversity index to obtain environmental quality success criteria in the company's sensitive areas.

Keywords: Environmental quality, Bird Habitat, Sensitive area, bird banding, pairwise comparison.

1. INTRODUCTION

The space occupied by living things with living and inanimate objects is called the environment. Juridically, the definition of environment was first formulated in UU no. 4 of 1982 (abbreviated as UULH-1982) concerning Basic Provisions for Environmental Management, which were then reformulated in UU no. 23 of 1997 (abbreviated as UUPLH-1997) concerning Environmental Management and most recently in Law no. 32 of 2009 (abbreviated as UUPPLH- 2009) concerning Environmental Protection and Management. The basic difference in the definition of the environment according to the UUPLH-2009 with the two previous laws is not only to maintain the continuity of life and welfare of humans and other living things, but also the continuity of nature itself.

West Madura Offshore Oil Company is one of the Indonesian Oil and Gas PSC Contractors. In relation to company business, company also provides AMDAL documents that have been approved for production development projects such as oil drilling which is planned on a regular basis. With an AMDAL study as a requirement at the beginning of a project, and a mapping study of the ESI (Environmental Sensitivity Index) during an ongoing activity which aims to provide a basis for controlling the hazards of an activity carried out, especially the economic and social impacts on the surrounding community, the main activity of company will not have a negative impact on the surrounding environment and in case this happens it can be resolved immediately.

Based on the results of the ESI mapping study, one of the sensitive areas (the area will be most likely impacted by the main activities of company) is the Mangrove Education Park (TPM) in Labuhan Village. To determine the quality of the success of environmental management, there must be evidence of environmental quality indicators measurement. One approach to determine indications of environmental quality in the aspect of biodiversity is to look at the presence of consumers in the food pyramid, by observing bird community's habitat.

There are several main reasons why birds were chosen as an indicator of success. First, birds are a good indicator for assessing biodiversity in an area, according to Djuwantono et al. (2013) they can occupy large habitats as well as near the top of the food chain. Second, birds are animals that are very sensitive to environmental changes. Third, bird watching can be carried out in a broad spectrum because birds are very mobile, so Gregory et al. (2005) state it is easier for researchers to make a link bird reaction to specific changes in environmental conditions. Fourth, the changes in the environment can be seen directly from the morphological/ physical characteristics in birds. (Martínez, Javier Cotín. 2012)

Internal West Madura Offshore Oil Company has implemented an environmental management approach with ISO 14001: 2015 standards and has been succeed achieve Gold proper award in 2020. So, one of the innovation to kept the quality of environmental management is implementation of bird banding technique in order to measure the accuracy of enviro quality indication via APHB (accuracy of bird habitat assessment).

2. METHOD

The research was conducted in one of sensitive area of West Madura Offshore Oil Company, the local call it Mangrove Educational Park, located at Labuhan Village, Sepulu sub- district, Bangkalan regency, Madura island, East Java province.

Data primer was collected using bird banding technique, bird banding is a technique for catching birds using a mist net and providing specially coded ring markings and color flags for migratory birds on the bird's feet. This technique begins with determining the location of the netting, where the birds are often performed activities. Then continued with performed the mist net installation refer to SOP issued by the Charles Darwin University Animal Ethics Committee (Freegard et al, 2017). Next step is tag the bird with a specially coded ring in order to avoid the possibility of double data occurred. After that, perform the measurement and physical examination of the birds. By holding the bird directly, the advantage is that the bird's condition can be checked more detail. With this technique we have all of 11 completed measurement variables including: species name, protection status, migrant/resident status, numbers of bird caught, gender, re-trap, brood patch, age, morphometry, moult score and fault bar.

By using MCDM the 11 variables are categorized into 4 first level hierarchy (visual, physical, advance, enviro indicators), then continued by performing synthesis of priority to get optimum modeling instrument of accuracy measurement.

In accordance with Thomas L Saaty that the results of MCDM are valid if the consistency

which is measured by the consistency ratio must be less than 10%, and in this study we determine that the error must be less than 5%.

The results of the optimization of the APHB instrument will be used as additional criteria for the success of environmental quality indications, which so far have only used the biodiversity index (H) developed by Shannon Wiener.

2.1 Data Collection

Data type will be divided into two with detail:

1. Primary Data, it is obtained or collected directly in the field by the person conducting the research or those concerned who need it. It can be obtained from observations in the field or interviews with direct sources. In this study the primary data obtained by bird banding activities. Through bird banding technique we can collect maximal 11 variables:
 - A. Species name, to obtain identification of bird species names and observing the presence of bio-indicator species.
 - B. Protection status, to determine both national and international status based on existing regulations.
 - C. Migrant/ resident, to determine the type of bird whether it is migratory or resident bird according to the study literature.
 - D. Number of individuals, to count the number of birds caught in order to determine their composition in each species.
 - E. Gender, to determine whether the birds caught are male or female in order to know the sex ratio and reproductive trend.
 - F. Re-trap, the bird that has been tagged can be recaptured at a different time to know roaming range of the bird
 - G. Brood patch, seeing the presence of feathers on the bird's stomach as a sign of incubating an egg. This can also be used as a reference of the mating season
 - H. Age levels, to divide the age levels of birds whether juvenile, immature or adult types so that the life cycle of these birds can be monitored
 - I. Morphometry, weighing and measuring parts of the bird's body to find out the bird's anomaly condition
 - J. Moulting score, to detect the condition of the feathers whether normal or not and to assess the primary feathers on the bird's wings
 - K. Fault bars, the transverse lines on the tail feathers of birds as an indication of environmental damage
2. Secondary data, the collection of similar project history data (enviro observation activities) at West Madura Offshore Oil Company in the period of 2019 and the study literature related to bird banding, camera trap and bird watching.

Data collection will be divided into four stages with details: The first stage is secondary data obtained from literature reviews and historical data from previous activities using bird watching and camera trapping techniques to ensure that the maximum number of attributes or quality variables produced is five and six.

The second stage is performed FGD (focus group discussion) to ensure that the maximum number of parameters or quality attributes produced by the bird banding technique is eleven. The third stage is collecting primary data by implementing environmental observation activities in Mangrove Educational Park area using the bird banding technique. The fourth stage of data collection is the justification of expert judgment by giving questionnaires to experts of bird observation with the respondent's profile as follows:

Table 2. 1 Profile of Respondents as External/Internal Experts

External Expert	Number of Respondents	Bird Banding Activities Experiences (years)
National Bird Bander Class A IBBS LIPI	1	>15
Foundation manager of Eksai (Ekologi Satwa Liar Indonesia)	1	12
Member of Atlas Burung Indonesia (ABI) dan Birdpacker Community	1	13
National Bird Bander Class B IBBS LIPI	1	10

Respondents in table 2.1 are expert involved in the bird banding project inside and outside of West Madura Offshore Oil Company.

After conducting a focus group discussion, the researcher does the re-recording for further re-verification so that the definition of the researcher from the results of the focus group discussion can be justified to be in line with the objectives of the research.

2.2 Data Analysis

Data processing was carried out on 11 attributes or variables resulted from bird banding activity with the pairwise comparison method as part of the MCDM method (multi criteria decision making). MCDM is a decision-making method to determine the best alternative solution from a number of alternative solutions based on certain criteria / variables / attributes. For various problems, according to Franek, J., & Kresta, A. (2014), a scale of 1 to 9 is the best scale for expressing opinions as per Saaty development. The value and definition of a qualitative opinion from comparison scale can be measured using a table as shown in the following table:

Table 2. 2 Saaty Rating Scale

Intensity of Importance	Definition	Explanation
1	Equal importance	Two elements contribute equally to the objective
3	Moderate importance	Experience and judgment slightly favor one element over another
5	Strong importance	Experience and judgment strongly favor one element over another
7	Very strong importance	One element is favored very strongly over another
9	Absolute importance	One element is favored absolute strongly over another
2, 4, 6, 8	Intermediat values between the two adjacent e judgments	When compromise is needed
Reciprocals	Multiplicative inverse	The evidence favoring one element over another is one of the highest possible affirmation

In MCDM the relative decision level of a criterion is called priority and weight, priority refers to sorting the criteria by importance, while weights are used to distinguish the importance of several criteria with different priorities. One of the methods in MCDM that is used to assess the level of importance with many criteria is AHP (Analytical Hierarchy Process). With AHP, problems will be solved in an organized mind frame so that the decisions can be made. The basic principles and stages in AHP are:

- a. Decomposition, dividing the criteria that have been identified into hierarchically levels. In this study, it was identified that the APHB instrument had 4 quality criteria from 11 variables.
- b. Comparative judgments, the assessment on the preparation of the importance scale referring to table 2.2 will produce an assessment in the form of numbers in the matrix format. In this study, according to the decomposition in the first stage, a 4x4 matrix and an 11x11 matrix were obtained, while the 6x6 and 9x9 matrices were used as comparisons.
- c. Synthesis of priority, by calculating the value of eigenvectors in the pairwise comparison matrix. Eigenvectors (λ) are obtained by averaging the normalized values for each row in each row matrix.
- d. Consistency test, measuring consistency with a consistency ratio (CR) by dividing consistency index (CI) by ratio index (RI), with a value below 10%, the result is consistent or the error is still within tolerance.

$$(CI) = (\lambda - n) / (n - 1) \dots\dots\dots (1)$$

$$(CR) = (CI) / (RI) \dots\dots\dots (2)$$

3. RESULTS AND DISCUSSION

3.1 Decomposition

Decomposition process determined by set up optimum modeling instrument of accuracy measurement as the main goal. The primary data obtained from bird banding technique categorized into 4 quality criteria in the first hierarchy and in the second level hierarchy it is categorize into 11 variables as seen in table 3.1.

Table 3. 1 Decomposition Instrument APHB variables

Level 1 Parameter APHB	Level 2 Parameter APHB	Code
Visual Indicators	Species name	A
	Protection status	B
	Migrant/ resident	C
	Number of individuals	D
	Gender	E
	Re-trap	F
Physical Indicators	Brood Patch	G
	Age levels	H
	Morphometry	I
Advance Indicator	Moult score	J
Environmental Indicator	Fault Bar	K

Also from the table 3.1 it can be proposed the equation of APHB instrument as follows: APHB

$$= (W*(A+B+C+D+E+F)) + (X*(G+H+I)) + (Y*J) + (Z*K)$$

The W, X, Y and Z notations represent the weights of the measurement variables obtained from pairwise comparison which is can be determined into 4x4 ordo matrix and 11x11 ordo matrix.

3.2 Pairwise Comparison

Pairwise comparison matrices were filled in from a perception questionnaire to a number of experts to make judgments about the relative importance of the two elements. Since it was taken from 4 (four) experts so there are 4 matrices resulted, pairwise comparisons produced from both matrix ordo 4x4 and ordo 11x11 are as follows:

Table 3. 2 Result of matrix 4x4 from all respondents

	1	2	3	4
1	1	0.50	0.20	0.14
2	2.00	1	0.33	0.17
3	5.00	3.00	1	0.50
4	7.00	6.00	2.00	1

	1	2	3	4
1	1	0.50	0.33	0.25
2	2.00	1	0.50	0.33
3	3.00	2.00	1	0.50
4	4.00	3.00	2.00	1

	1	2	3	4
1	1	0.50	1.00	0.33
2	2.00	1	2.00	0.33
3	1.00	0.50	1	0.33
4	3.00	3.00	3.00	1

	1	2	3	4
1	1	0.50	0.25	0.20
2	2.00	1	0.50	0.33
3	4.00	2.00	1	0.50
4	5.00	3.00	2.00	1

Table 3. 3 Result of matrix 11x11 from all respondents

	1	2	3	4	5	6	7	8	9	10	11
1	1	0.50	0.50	0.50	0.50	0.50	0.25	0.25	0.25	0.14	0.11
2	2.00	1	0.50	0.50	0.50	0.50	0.25	0.25	0.25	0.14	0.11
3	2.00	2.00	1	0.50	0.50	0.50	0.25	0.25	0.25	0.14	0.11
4	2.00	2.00	2.00	1	0.50	0.50	0.25	0.25	0.25	0.14	0.11
5	2.00	2.00	2.00	2.00	1	0.50	0.25	0.25	0.25	0.14	0.11
6	2.00	2.00	2.00	2.00	2.00	1	0.25	0.25	0.25	0.14	0.11
7	4.00	4.00	4.00	4.00	4.00	4.00	1	1.00	1.00	0.33	0.20
8	4.00	4.00	4.00	4.00	4.00	4.00	1.00	1	1.00	0.33	0.20
9	4.00	4.00	4.00	4.00	4.00	4.00	1.00	1.00	1	0.33	0.20
10	7.00	7.00	7.00	7.00	7.00	7.00	3.00	3.00	3.00	1	0.50
11	9.00	9.00	9.00	9.00	9.00	9.00	5.00	5.00	5.00	2.00	1

	1	2	3	4	5	6	7	8	9	10	11	
1	1	0.17	0.17	0.17	0.17	0.17	0.14	0.14	0.14	0.12	0.11	
2	6.00	1	1.00	1.00	1.00	1.00	0.50	0.50	0.50	0.33	0.25	
3	6.00	1.00	1	1.00	1.00	1.00	0.50	0.50	0.50	0.33	0.25	
4	6.00	1.00	1.00	1	1.00	1.00	0.50	0.50	0.50	0.33	0.25	
5	6.00	1.00	1.00	1.00	1	1.00	0.50	0.50	0.50	0.33	0.25	
6	6.00	1.00	1.00	1.00	1.00	1	0.50	0.50	0.50	0.33	0.25	
7	7.00	2.00	2.00	2.00	2.00	2.00	1	0.50	0.50	0.33	0.25	
8	7.00	2.00	2.00	2.00	2.00	2.00	2.00	1	0.50	0.33	0.25	
9	7.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	1	0.50	0.33	
10	8.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	2.00	1	
11	9.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	3.00	2.00	1

	1	2	3	4	5	6	7	8	9	10	11
1	1	0.17	0.33	0.12	0.11	0.14	0.14	0.12	0.14	0.12	0.11
2	6.00	1	3.00	0.50	0.33	0.50	0.50	0.33	0.50	0.33	0.25
3	3.00	0.33	1	0.20	0.17	0.25	0.25	0.20	0.25	0.20	0.17
4	8.00	2.00	5.00	1	0.50	2.00	2.00	1.00	1.00	1.00	0.50
5	9.00	3.00	6.00	2.00	1	2.00	2.00	1.00	2.00	1.00	1.00
6	7.00	2.00	4.00	0.50	0.50	1	0.50	0.50	1.00	0.50	0.33
7	7.00	2.00	4.00	0.50	0.50	2.00	1	0.50	1.00	0.50	0.33
8	8.00	3.00	5.00	1.00	1.00	2.00	2.00	1	1.00	1.00	0.50
9	7.00	2.00	4.00	1.00	0.50	1.00	1.00	1.00	1	0.50	0.33
10	8.00	3.00	5.00	1.00	1.00	2.00	2.00	1.00	2.00	1	0.50
11	9.00	4.00	6.00	2.00	1.00	3.00	3.00	2.00	3.00	2.00	1

	1	2	3	4	5	6	7	8	9	10	11
1	1	0.50	0.25	0.33	0.25	0.50	0.25	0.20	0.17	0.14	0.12
2	2.00	1	0.33	0.50	0.33	1.00	0.50	0.25	0.20	0.17	0.14
3	4.00	3.00	1	2.00	1.00	3.00	1.00	0.50	0.33	0.25	0.20
4	3.00	2.00	0.50	1	0.50	2.00	0.50	0.33	0.25	0.20	0.17
5	4.00	3.00	1.00	2.00	1	2.00	1.00	0.50	0.33	0.25	0.20
6	2.00	1.00	0.33	0.50	0.50	1	0.33	0.33	0.20	0.17	0.14
7	4.00	2.00	1.00	2.00	1.00	3.00	1	0.50	0.33	0.25	0.20
8	5.00	4.00	2.00	3.00	2.00	3.00	2.00	1	0.50	0.33	0.25
9	6.00	5.00	3.00	4.00	3.00	5.00	3.00	2.00	1	0.50	0.33
10	7.00	6.00	4.00	5.00	4.00	6.00	4.00	3.00	2.00	1	0.50
11	8.00	7.00	5.00	6.00	5.00	7.00	5.00	4.00	3.00	2.00	1

3.3 Synthesis of Priority

The next process is compiling attribute weighting according to the resulting matrix. This process is carried out in the following steps:

1. Counting the number of each column in the matrix.
2. Create a new matrix in the form of the quotient between the old value and the number of the column.
3. Sum the new elements in each row.
4. The result of the new column is divided by the total column to get the priority (weight).
So that the following results are obtained, like seen in table 3.6 and 3.7 below:

Table 3. 4 Matrix weighting 4x4

Cat	Priority	Cat	Priority	Cat	Priority	Cat	Priority
1	A-F (VISUAL) 6.2%	1	A-F (VISUAL) 9.5%	1	A-F (VISUAL) 13.6%	1	A-F (VISUAL) 8.1%
2	G-I (PHYSICAL) 10.3%	2	G-I (PHYSICAL) 16.0%	2	G-I (PHYSICAL) 23.2%	2	G-I (PHYSICAL) 15.4%
3	J (ADVANCE) 29.4%	3	J (ADVANCE) 27.7%	3	J (ADVANCE) 13.6%	3	J (ADVANCE) 28.8%
4	K (ENVIRO) 54.1%	4	K (ENVIRO) 46.7%	4	K (ENVIRO) 49.5%	4	K (ENVIRO) 47.7%

Table 3. 5 Matrix Weighting 11x11

Cat	Priority	Cat	Priority	Cat	Priority	Cat	Priority
1	A (VISUAL) 2.0%	1	A (VISUAL) 1.3%	1	A (VISUAL) 1.3%	1	A (VISUAL) 1.8%
2	B (VISUAL) 2.3%	2	B (VISUAL) 5.4%	2	B (VISUAL) 4.8%	2	B (VISUAL) 2.7%
3	C (VISUAL) 2.6%	3	C (VISUAL) 5.4%	3	C (VISUAL) 2.3%	3	C (VISUAL) 6.1%
4	D (VISUAL) 3.0%	4	D (VISUAL) 5.4%	4	D (VISUAL) 10.7%	4	D (VISUAL) 3.9%
5	E (VISUAL) 3.4%	5	E (VISUAL) 5.4%	5	E (VISUAL) 14.6%	5	E (VISUAL) 5.9%
6	F (VISUAL) 3.9%	6	F (VISUAL) 5.4%	6	F (VISUAL) 6.9%	6	F (VISUAL) 2.8%
7	G (PHYSICAL) 9.7%	7	G (PHYSICAL) 8.3%	7	G (PHYSICAL) 7.8%	7	G (PHYSICAL) 5.9%
8	H (PHYSICAL) 9.7%	8	H (PHYSICAL) 9.5%	8	H (PHYSICAL) 11.8%	8	H (PHYSICAL) 9.3%
9	I (PHYSICAL) 9.7%	9	I (PHYSICAL) 11.2%	9	I (PHYSICAL) 8.2%	9	I (PHYSICAL) 14.1%
10	J (ADVANCE) 21.2%	10	J (ADVANCE) 17.4%	10	J (ADVANCE) 12.5%	10	J (ADVANCE) 20.0%
11	K (ENVIRO) 32.5%	11	K (ENVIRO) 25.1%	11	K (ENVIRO) 19.2%	11	K (ENVIRO) 27.6%

3.4 Consistency Test

The next step is calculating the eigenvalues and test the consistency from consistency ratio. The process can be carried out in the following steps:

1. Determine the consistency vector by dividing the value of the weighted sum vector by the value of the evaluation factor that has been obtained previously.
2. Determine Eigen/ lambda (λ) and Consistency Index (CI).
3. Calculate the Consistency Ratio.

So that the following results are obtained as seen below:

Table 3. 6 CR table for 4x4 matrix of all respondents

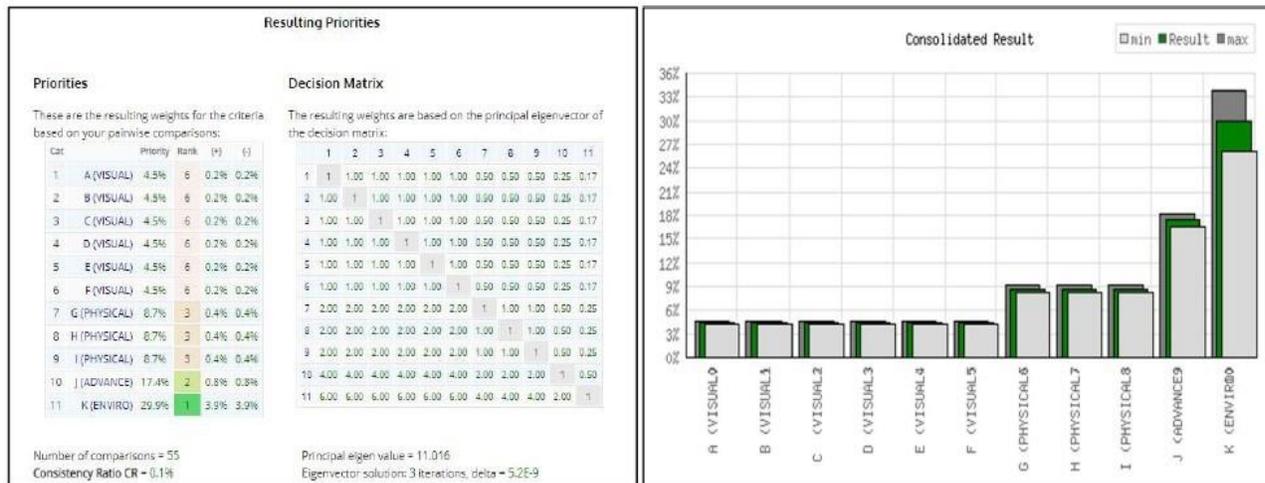
Expert A	Expert B	Expert C	Expert D	Average s
λ : 4,028	λ : 4,031	λ : 4,061	λ : 4,021	λ : 4,035
CR: 1,05%	CR: 1,1%	CR: 2,2%	CR: 0,8%	CR: 1,0%

Table 3. 7 CR table for 11x11 matrix of all respondents

Expert A	Expert B	Expert C	Expert D	Average s
λ : 11.537	λ : 11.349	λ : 11.291	λ : 11.330	λ : 11,377
CR: 3.6%	CR:2.3%	CR:1.9%	CR:2.2%	2,5%

Furthermore, through the AHP priority calculator application, optimization is carried out by conducting as many experiments as possible up to twenty times to get the smallest CR and eigen max. The most optimum results were obtained at 11.016 eigenvectors and 0.1% CR. The full result of optimization process can be seen below:

Table 3. 8 Full result of Optimization Process



So, from table 3.8 the most optimal modeling APHB (Bird Habitat Assessment Accuracy) instrument can be formulated as follows:

$$APHB = (4.5*(A+B+C+D+E+F)) + (8.7*(G+H+I)) + (17.4*J) + (29.9*K)$$

3.5 Data Analysis

After APHB instrument is obtained, the next step is to determine the accuracy scale and categorizing the data obtained into ordinal data with the criteria that if the data can be obtained through bird banding then input 1 (one) and if the data cannot be obtained then input 0 (zero). The determination of the APHB accuracy scale is based on research from Wibisono (2005) on the criteria for weighting the environmental quality of plankton biota. The accuracy scale is determined as follows:

Table 3. 9 The Accuracy Scale Table

APH B	Criteria Value	Data Availability
Very Low Accuracy	0-25	Incomplete
Low Accuracy	26-50	Sufficiently Complete
Medium Accuracy	51-75	Complete
High Accuracy	76-100	Very Complete

The next process is to perform calculations from the database obtained by the bird banding technique using the instrument APHB. The summary result is the average of accuracy with 6 batches of retrieval during the period Q4 2019 to Q3 2020 since using the bird banding technique is an average of 97.76%. The difference of the accuracy of the bird banding technique against bird watching and camera traps, respectively, was obtained at 79.9% and 66.7%. All of it can be seen in the table 3.12 and figure 3.1:

Table 3. 10 Accuracy Averages in 2019-2020

Periode/Batch	A	B	C	D	E	F	G	H	I	J	K	APHB
	4,468	4,468	4,468	4,468	4,468	4,468	8,659	8,659	8,659	17,319	29,858	
Q1 Jan-Mar 19	1	1	1	1	0	0	0	0	0	0	0	17,872
Q2 Apr-Mei 19	1	1	1	1	0	0	0	0	0	0	0	17,872
Q3 Jun-Jul 19	1	1	1	1	1	0	0	1	0	0	0	30,999
Q4 Oct 19	1	1	1	1	1	0	1	1	1	1	1	95,533
Nov 19	1	1	1	1	1	0	1	1	1	1	1	95,533
Q1 Jan 20	1	1	1	1	1	0	1	1	1	1	1	95,533
Q2 Mei 20	1	1	1	1	1	1	1	1	1	1	1	100,001
Jun 20	1	1	1	1	1	1	1	1	1	1	1	100,001
Q3 Jul 20	1	1	1	1	1	1	1	1	1	1	1	100,001

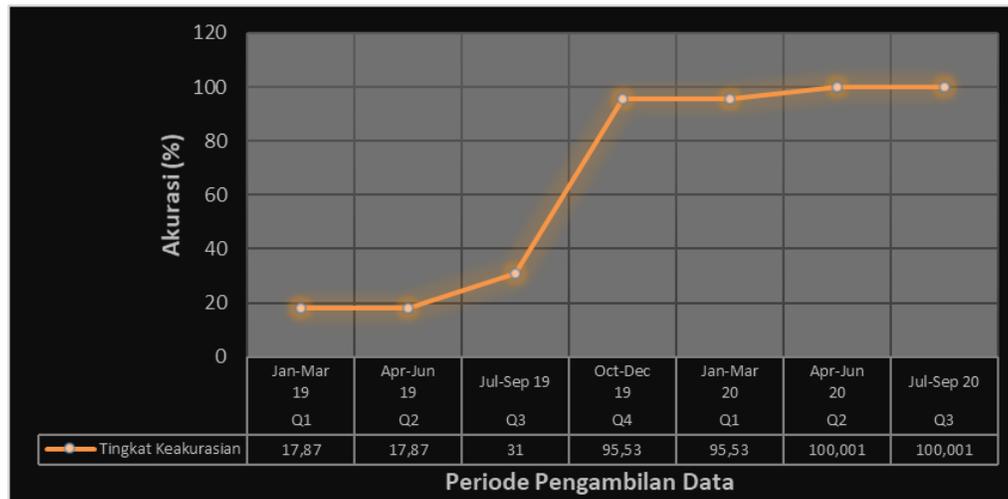


Figure 3. 1 Chart Average of Accuracy in 2019-2020

Furthermore, from the bird banding database, the Shannon Wiener (H') biodiversity index is calculated with the formula:

$$H = - \sum_{i=1}^s P_i \ln P_i$$

The P notation is taken from the database variable D (number of individuals) on the APHB instrument with the range of values calculated for the biodiversity index in three level ranges, if: $H > 3$: high species diversity; $1 < H < 3$: moderate species diversity and; $H < 1$: low species diversity. So that the overall biodiversity index as an aspect of environmental quality in sensitive areas of West Madura Offshore Oil Company is obtained as follows:

Table 3. 11 Shannon Wiener Index Calculation

Batch Sampling Period		Shannon Winner Index (H)
Q1	Jan-Mar 2019	3,224

Q2	Apr-May 2019	3,302
Q3	Jun-Aug 2019	3,227
Q4	Sep-Dec 2019	3,380
Q1	Jan-Mar 2020	3,169
Q2	Apr-May 2020	2,752
Q3	Jun-Aug 2020	3,169

By using Shannon Wiener index (H) and combined with implementation of the APHB instrument, the indications of environmental quality in sensitive area get success criteria with the following formulation as seen in table 3.12.

Table 3. 12 Environmental Quality Success Criteria with APHB Implementation

Success Criteria		Biodiversity Index	Data Completeness	Biased Data	EnviroCarrying Capacity
H>3	APHB high	biodiversity high	Very complete data	No biased data	Very easy to be recorded
H>3	APHB medium	biodiversity high	Quite complete data	Low biased data	Easy to be recorded
H>3	APHB low	biodiversity high	Less complete data	Adequate data	Moderately to be recorded
H>3	APHB very low	biodiversity high	Incomplete data	Lack of data	Hard to be recorded
1<H<3	APHB high	biodiversity medium	Very complete data	No biased data	Very easy to be recorded
1<H<3	APHB medium	biodiversity medium	Quite complete data	Low biased data	Easy to be recorded
1<H<3	APHB low	biodiversity medium	Less complete data	Adequate data	Moderately to be recorded
1<H<3	APHB very low	biodiversity medium	Incomplete data	Lack of data	Hard to be recorded
H<1	APHB high	biodiversity low	Very complete data	No biased data	Very easy to be recorded
H<1	APHB medium	biodiversity low	Quite complete data	Low biased data	Easy to be recorded
H<1	APHB low	biodiversity low	Less complete data	Adequate data	Moderately to be recorded
H<1	APHB very low	biodiversity low	Incomplete data	Lack of data	Hard to be recorded

With the formulation of success criteria, indication of environmental quality in the sensitive area of West Madura Offshore Oil Company can be classified into index H>3 and high score of APHB, which is can be explained that:

- Indications of environmental quality from the aspect of biodiversity are maintained with very complete of data collected so that a more in-depth analysis can be carried out.
- The carrying capacity of the environment can be determined by APHB, from variable C (migrant/resident status) it can give an idea that birds can survive in a long period in this area because the place is rich in food, variable G (broadpatch) gives a guidance that the place is suitable for breeding and variable K (fault bar) can show that birds are not stressed or threatened living in the area.
- The existing bias from the Shannon Wiener index (H) towards the possibility of double data because it only uses variable D (number of individuals) can be reduced and eliminated. Data bias is eliminated by implemented the bird banding technique.

4. CONCLUSION

From the discussion of research on environmental quality analysis based on bird habitat in sensitive areas of West Madura Offshore Oil Company with a pairwise comparison approach on the APHB model instrument (Accuracy of Bird Habitat Observation) concluded as follows:

01. The bird marking/bird banding technique was chosen because it can produce a maximum of 11 parameters that cannot be fulfilled by camera trap and bird watching techniques.
02. The priority weights obtained for each parameter from the pairwise comparison method can scientifically validate the developed APHB instrument. The developed instrument APHB has received validation from the Eksai Foundation (Indonesian Wildlife Ecology) and the Directorate General of Intellectual Property Rights certificate and also in progress of the patent claim registration stage.
03. Indications of bird habitat quality per species in sensitive areas of West Madura Offshore Oil Company can be assessed with the APHB instrument with an increase in accuracy in 2020 with an average of 97.765%. This increase in average accuracy proves that data collection by bird banding technique is more accurate 79.9% against bird watching and 66.7% against camera trap.
04. Instrument APHB provides additional success criteria for environmental quality indication from the Shannon Wiener index (H')

There are also some suggestions for analyzing the quality of the environment based on bird habitat in sensitive areas of West Madura Offshore Oil Company such as:

01. For further research, it is recommended to combine the dominance index (C) and evenness index (E) with the APHB instrument for further improvement of the success criteria of environmental quality analysis on aspects of biodiversity.
02. The visual parameter values obtained from these 11 parameters are for environmental indicator parameters from visual observations. While the bird's visual observation is still in level 1 or initial diagnosis. To increase the accuracy of the diagnosis of environmental indications based on bird habitat, it can be deepened with 3 other types of observations to support the APHB formula, namely:
 - Observation of clinical symptoms (seeing from disorders experienced by birds such as respiratory problems and/or digestive disorders)
 - Blood and oil specimen's laboratory test
 - Abiotic and biotic supporting components test

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VERBAL SAFETY MODELING FOR IMPROVE WORKPLACE SAFETY OF HIGH RISE BUILDING PROJECT IN EAST JAVA

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ABSTRACT

The increasing number of high-rise building projects in recent years has increased the number of work accidents where high-rise building projects are running, while in the construction industry one of the keys to reducing work accidents to zero fatal accidents is the communication from the management and understood by the workforce. However, the temporary nature and separation of management from the workforce in the field makes the lack of supervision of the workforce to carry out the security program created by management. The purpose of this research is to find out how was to determine the verbal safety relationship model in a multi-story building project so that and to what extent verbal safety carried out by work safety management and supervised by occupational safety experts affects other variables that shape work safety behavior, disciplined attitude, and improve work safety to achieve zero fatal accidents. This research will use previous research with variables related to verbal safety to increase the level of safety in the workplace. This study will analyse existing research to see the relationship of variables that support the improvement of safety performance. Finally, we summarize the contributions and limitations of our research, arguing that further analysis is needed regarding the model that has been summarized, to determine the effect of verbal safety on other variables.

Keywords: verbal safety, safety climate, workplace safety, safety behavior, safety performance, workplace

1. INTRODUCTION

The construction industry is an industry with a fairly high level of risk related to worker safety issues, with the increasing number of developments in the infrastructure sector, the Ministry of Manpower noted that in 2019 the number of work accidents was 114,000 accidents. While in 2020 there will be 177,000 accident cases.

The construction industry has characteristics that are very different from other industries, the construction industry has differences ranging from the initial implementation of procurement, which is quite complex, diverse organizational structures that are tailored to the needs of the construction industry that do not have standards, as well as changes in work locations, and different work environments. Zhang & Fang, (2013) and generally have some similarities with the manufacturing industry, namely the behavior of workers is not disciplined and violates

regulations so that it is considered not according to standards (Geller, 2002) this causes conditions that are relatively difficult to control. In addition, the location of construction workers is always separate from supervisors and management, so workers are always looking for their own solutions and decisions to immediately resolve the problems they are facing in the workplace (Olson & Austin, 2001). The safety system can be a solution and a means of monitoring all risks and hazards quickly and accurately in the construction industry directly and up to date (Zhang, et al., 2017). According to the Central Statistics Agency, the workforce in the construction sector reached 8.3 million people, about 13.04% of the total national workforce as of 2018. According to LPJK data as of August 2020, the number of construction workers who have registered reached 627,276 people. The number of skilled workers reached 494,682 people, while 171,566 experts. Based on these data, the construction sector has a very important role in contributing to the achievement of the national development goals that are the vision of the country, especially in terms of providing employment opportunities that will certainly absorb new workers in the construction world as well. Over time, the growth in the number of workers in the construction sector is increasing every year, thus increasing the number of work accidents that occur in the workplace. The rate of work accidents is increasing because work in the construction sector is carried out continuously. resulting in physical and mental fatigue for workers having the potential for accidents in the workplace.

Safety improvements have increased with the efforts of owners, contractors, subcontractors, and designers to find proper workspace for workers to be safe when performing planned work. This research study wants to see aspects of the variables that are the relationship between Verbal Safety, especially in the field of sustainable safety to improve Safety Performance. The application of communication for safety can have a positive influence on safety (Swuste, et al., 2019). The safety management system, which is supported by the company culture and employees, through a safety climate so that the company's safety behavior can affect the safety culture (Geller, 2002). Beverly variables become very important in the construction industry, the relationship between variables that have been studied can improve safety performance (Zhang & Fang, 2013). Safety work through continuous improvement of the relationship of variables and processes with the total involvement and dedication of each individual and management employing a structured approach to improvement.

This research is based on previous research that sees variables such as verbal safety can have an influence on safety climate, safety culture, and safety behavior. The relation between these variables is based on policies, procedures, and work safety practices by the owner and management in the work environment which cannot be separated from these variables (Neal & Griffin, 2000). This research wants to see another model of the relationship of these variables, considering the relationship of each variable is very closely related. This model will see how the variables related to safety will have an effect on safety performance, involving existing variables to get customer satisfaction and continuous improvement can provide a competitive advantage for companies that implement it, by building a safer workplace that leads to increased organizational performance (Agwu, 2012)

2. LITERATURE REVIEW

Based on Jiang, et al. (2018) communicating with the aim of getting a sense of security and knowledge about safety in the work environment through motivation, knowledge, and exchanging ideas to get preventive and prevent accidents, we can see at Figure 1, communication is a sub- indicator of safety character and competence which will be one of the positive impacts on safety behavior. Intense communication will have a positive impact on orientation to work safety. The obedient attitude of the workforce tends to follow the company hierarchy and in the

work environment (Kines, et al., 2010). From Figure 1 we can study the meanings, attitudes, values, interpretations of the rules and procedures undertaken by workers who uphold safety (Guldenmund, 2000). Unsafe condition behavior is divided into three levels, namely: skill-based error, errors that occur in the habits and expertise of workers, ruled-based errors, errors that occur if you do not follow applicable procedures, and knowledge-based errors, errors that occur due to lack of knowledge (Reason, 1990).

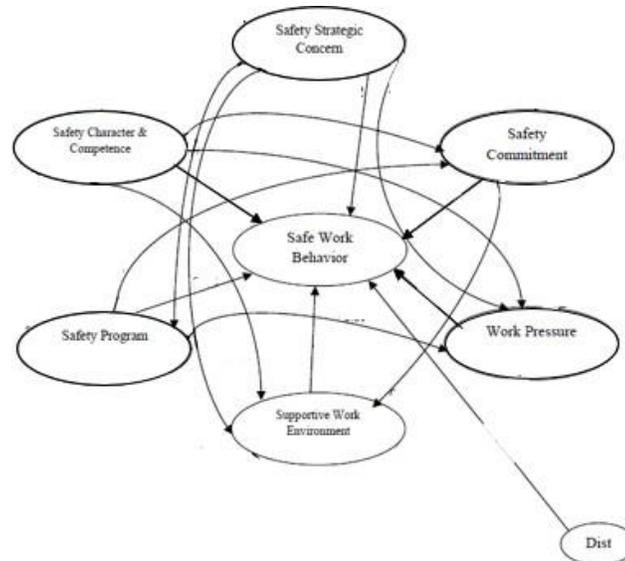


Figure 1. The Model of total safety management, safety culture, and safe work behavior (Farooqui, 2011)

Previous research obtained by the perception of workers in the work environment against the limits of the rules that have been agreed upon for workers on the right behavior and changing the behavior of workers according to their duties, to give rise to interpretations of the work environment, and they call it safety climate (Clarke, 2006). Cooper et al., (2004) explain that safety climate is felt related to workers' perception about the importance of Environment, Health, and Safety how it can be implemented within the organization or company, related to policies, procedures, and work safety practices in the work environment (Neal & Griffin, 2000) so that preventive actions need to be improved so that repair costs will not be wasted. The sustainable organization takes time and effort because it defines several elements such as values, beliefs, norms, and rules (Schein, 2017) in general this process lasts for several years, the steps shown in Figure 2 to creating a safety culture that is sustainable and continuous in improving the process in creating a culture, a relationship where three factors are needed (Geller, 2002) and this is closely related to a leadership spirit that is committed to producing safety performance (Kines et al., 2010).

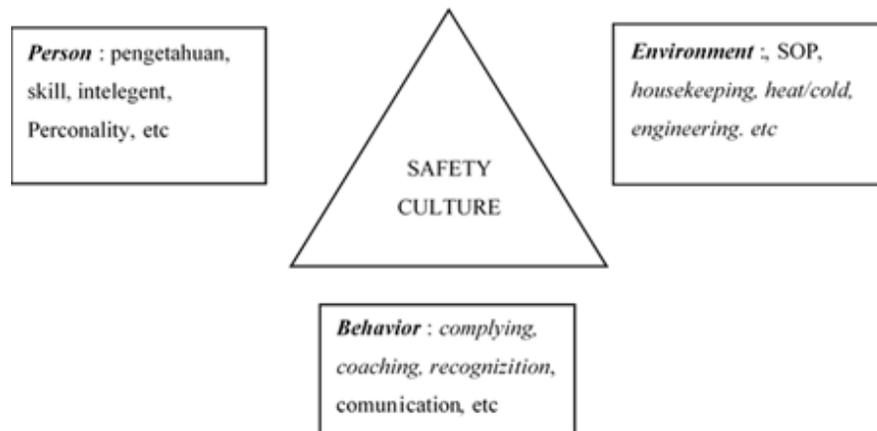


Figure 2. Three factors that contribute to the formation of a safety culture (Geller, 2002).

Previous research looked at the relationship between several variables that formed the shape of safety performance, namely safety behavior, safety climate, and safety culture. In the relationship that we can see from Figure 1, verbal safety cannot be separated from competence which has become the basis of safety in the workplace (Farooqui, 2011).

Table 1. Previous Research and Variable of Safety

No	Journal	Author	Year	Variable				
				SC	SB	SCL	SP	VS
1	Voices carry: Effects of verbal and physical aggression on injuries and accident reporting	Jiang, Lixin., Probst, Tahira M., Benson, Wendi., Byrd, Jesse	2018	V	V	V	V	V
2	Improving construction site safety through leader-based verbal safety communication	Pete Kines, Lars P.S. Andersen, Soren Spangenberg, Kim L. Mikkelsen, Johnny Dyreborg, Dov Zohar	2010	V		V		
3	The nature of safety culture: A review of theory and research	Guldenmund, F. W	2010	V		V		

4	A continuous Behavior-Based Safety strategy for persistent safety improvement in construction industry	Zhang, M., & Fang, D.	2013		V	V		
No	Journal	Author	Year	Variable				
				SC	SB	SCL	SP	VS
5	Safety climate in an automobile manufacturing plant: The effects of work environment, job communication and safety attitudes on accidents and unsafe behavior	Clarke, S.	2006		V	V		
6	Perceptions of safety at work: a framework for linking safety climate to safety performance, knowledge, and motivation	Griffin, M. A., & Neal, A.	2000			V	V	
7	Behavior-Based Safety and Working Alone	Olson, R., & Austin, J.	2001	V	V			
8	Supervisor-focused behavior-based safety method for the construction industry: Case study in Hong Kong.	Zhang, P., Li, N., Fang, D., & Wu, H.	2017		V	V		V

information

1. SC = Safety Culture
2. SB = Safety Behavior
3. SCL = Safety Climate
4. SP = Safety Performance
5. VS = Verbal Safety

We can see from Table 1 that a small number of previous studies have mapped how the safety variables are related. This research, of course, has filled the space from previous studies and how they try to relate variables to one another, of course, the methods used are also different. From Table 1 number 8, it can be seen that the relationship between safety behavior can affect the safety climate in the construction industry, of course, with supervisors who have good verbal competence.

3. METHODS

The research was conducted by identifying knowledge gaps from previous research. Previous research has researched safety in the construction project environment, but in this researcher developed a variable relationship model that provides an increase in safety performance. Based on the variables that have been stated in previous studies with a combination of variable modifications that have never been presented in previous studies as hypothesis testing by knowing the relationship between variables related to safety problems in the workplace. Research by exploring the relationship between variables can be known through theories set out in previous research on verbal safety, safety behavior, safety culture, safety climate and its application in the construction industry, the objectives of the literature study include:

1. Identifying previous research related to work safety variables.
2. Find indicators that match the variables and see the relationship between indicators for each variable.
3. Formulation of the model based on the theory that has been developed in previous research by looking at the variables and indicators that have been found.

The researcher wants to see the variables that relate verbal safety to safety behavior, safety culture, safety climate to improve safety performance.

4. RESULTS

Based on the existing literature we can see at Table 1, the safety performance variable can be improved through safety behavior, safety culture, and safety climate (Zhang, et al., 2017). The results of the elaboration of the results of previous research relationships indicate that the verbal safety variable can be recognized and can be included as a variable in the model to be studied. Verbal safety influences the safety climate where this will be the process of forming safety policies and programs that will be carried out in the workplace environment (Fang, et al., 2013).

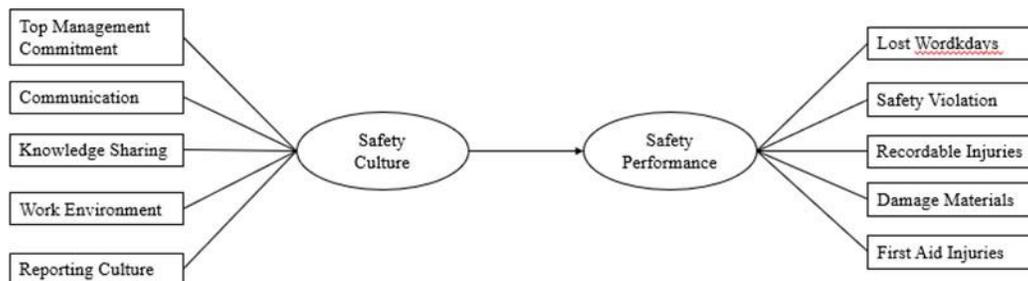


Figure 3. Modelling for safety culture to improve safety performance (Aytac & Dursun, 2019)

Figure 3 shows the influence of safety culture on safety performance with indicators of Top Management, Communication, Knowledge Sharing, Work Environment, and Reporting Culture (Aytac & Dursun, 2019). Other indicators can be reviewed concerning Figure 2 where the relationship of safety behavior becomes the point of growth of safety culture and becomes a link with other variables. So it can be noted that safety culture has a relationship with safety performance with indicators covering work culture from the workplace. This grouping can be a link between indicators of each variable, we can see this in Figure 4 where we group indicators for each variable.

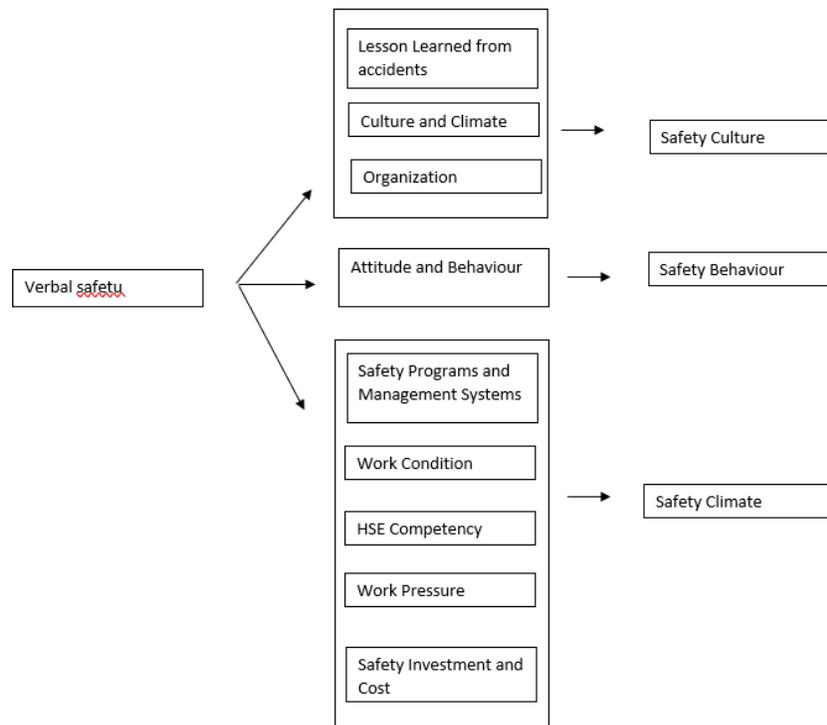


Figure 4. Indicators for verbal safety to improve safety performance

We can see the indicators that have been elaborated in Figure 4 how indicators from previous studies have a relationship with variables that lead to safety performance. Then the verbal safety indicators, namely Verbal Informing, Motivation, Influencing, Safety Supervision, and Safety Discussion become the benchmark for determining the relationship of the variables that are tied to safety performance. Therefore, from the grouping of these variables, look for references from the research in Table 1 as the indicators for each variable are as follows:

Table 2. Indicators for each Variable

No	Variable	Indikator	Journal
			Source
1.	Verbal Safety	Verbal Informing, Motivation, Influencing, Safety Supervision, Safety Discussion	(Zhang, et al., 2017) (Jiang, et al., 2018)
2.	Safety Climate	Visionary Leadership, Feedback and Recognition, Safety Training, Safety Evaluation, Safety Procedure Management	(Clarke, 2006) (Zhang, et al., 2017) (Neal & Griffin, 2000)

No	Variable	Indikator	Journal
			Source
3.	Safety Culture	Informing Culture, Unsafe Condition, Nearmiss, Sharing Knowledge	(Olson & Austin, 2001) (Kines, et al., 2010)
4.	Safety Behavior	Personal Protective Equipment, Hygiene, Safety Attitude, Safety Obedience, Safety Ensurement	(Zhang, et al., 2017) (Zhang & Fang, 2013)
5.	Safety Performance	First Aid Injuries, Recordable Injuries, Safety Violation, Severity, Lost Workdays	(Neal & Griffin, 2000)

After searching and elaborating and mapping out previous research and the relationship between each variable, a new model was formed to seek an increase in safety performance. This model is also supported by research by Al Tamimi et al., (2017) which states that communication can be done with the presence of safety behavior in the work environment so that it can improve work safety when in the work process. Kontogiannis et al., (2017) stated in their research that even the right environment will make safety culture and safe behavior a good influence for the workplace so that it can encourage the formation of a zero-accident vision for management to solve safety problems in the construction workspace. Therefore, the model designed through the verbal security variable affects the three variables. The modelling results obtained are as shown in Figure 5:

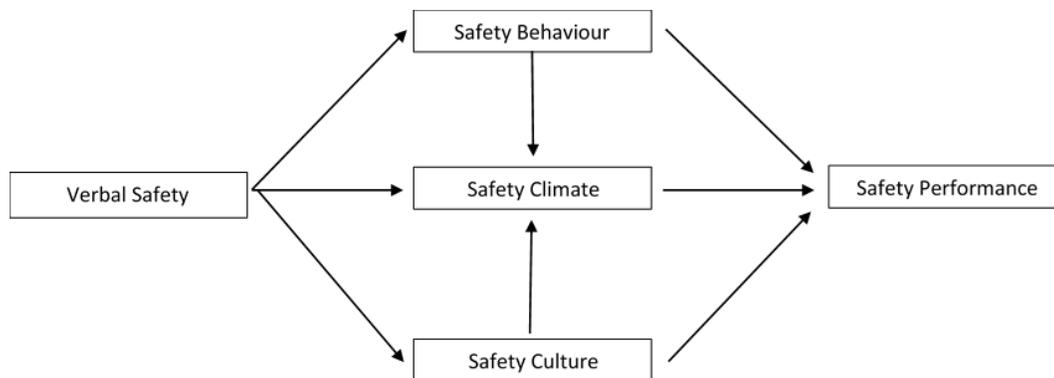


Figure 5. Modelling for verbal safety to improve safety performance.

5. CONCLUSIONS AND FUTURE RESEARCH

The researcher presents a modelling framework of the relationship between verbal safety variables on safety behavior, safety climate, and safety culture variables to bridge the improvement of

safety performance in high-rise building construction workspaces. Previous research looked at the relationship between safety behavior and safety culture variables to improve safety performance, finally, the researchers added a variable that was not much different from increasing safety performance as the main goal, namely the addition of verbal safety variables where these variables are basic competencies for occupational safety actors. Modelling is made based on research that has been done after knowing the indicators that have been stated by previous researchers. In this case, Verbal Safety has 5 (five) indicators, namely Verbal Informing, Motivation, Influencing, Safety Supervision, Safety Discussion which are also found in previous research. Researchers designed another alternative model related to experimental variables to measure improvements in safety performance through verbal safety. In the future, it is necessary to measure this model by analysing each variable and its relationship with existing methods so that it can see how much impact it has on other verbal safety variables.

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RISK ASSESSMENT IN PURIFIED WATER SYSTEM (PWS) USING FMEA AND FUZZY PRIORITIZATION AT PHARMACEUTICAL COMPANY

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ABSTRACT

Purified Water System (PWS) is an equipment which produce water that is mechanically filtered or processed to remove impurities and make it suitable for use. PT XYZ is a pharmaceutical company that uses water as the main basic material to produce medicine. The water quality to be used must meet the requirements given by the United States Pharmacopeia (USP) and the Indonesia Food and Drug Administration (BPOM), regarding three parameters, namely conductivity, TOC and microbiology. There have been some problems during the existing operation of PWS consist of not optimal flow process, filter blocking which causes growth of microorganism, inaccurate chemical adjustment during operation. We use the same approach to risk assessment in the Pharmaceutical industry conducted by Yücenur, Çataltepe, and Sakin (2020). This paper aims to assess potential risks that might occur as well as formulating risk control to a new purified water system using Failure Mode and Effect Analysis (FMEA) and Fuzzy Prioritization. FMEA has been extensively used for examining potential failures in products, processes, designs, and services. It integrates a quantitative process for assessing risk based on three indicators consists of Severity (S), Occurrence (O), and Detection (D). Fuzzy FMEA is the development of the FMEA method which provides flexibility to accommodate uncertainty due to the vagueness of the information possessed or subjective preference elements used in the assessment of the failure mode that occurs. It was used to evaluate the failures and to formulate prevention action based on Risk Priority Number (RPN). There are 22 risks that have been identified and according to the analysis had an RPN value which are higher than 72. These 22 risks need to be controlled by mitigation measures during the implementation of the new PWS life cycle process.

Keywords: Purified Water System (PWS), Failure Mode and Effect Analysis (FMEA), Fuzzy Prioritization.

1. INTRODUCTION

Water is a major part of the pharmaceutical industry and water is used to prepare sterile and non-sterile product materials, wash hands during production and before the drug production process (Sandle, 2015). Since water is one of the critical factors in the pharmaceutical industry, microbiological control of the water used is very important. Because in water, every level of its

parameters used in the pharmaceutical industry has the potential to cause contamination from microbiology when not controlled properly (Geldreich, 1985). The main source of water used in the pharmaceutical industry to make medicines is water produced from the purification process using the Purified Water System (PWS). As our case study is in one of the pharmaceutical companies in Indonesia, which is the water quality to be used must meet the requirements given by the United

States Pharmacopeia (USP) and the Indonesia Food and Drug Administration (BPOM). Therefore a prior to the PWS installation process, it is necessary to carry out a risk assessment to ascertain what potential risks may occur, so that risks can be minimized. One method is using Failure Mode and Effect Analysis (FMEA) combined with Fuzzy. Fuzzy FMEA is the development of the FMEA method which provides flexibility to accommodate uncertainty due to the vagueness of the information possessed or subjective preference elements used in the assessment of the failure mode that occurs (Braglia et al. 2003).

2. LITERATURE REVIEW

2.1. Purified Water Systems (PWS) in Pharmaceutical Industry

This purified water system is a critical unit of equipment in the pharmaceutical industry. It has the main function in producing Purified Water (PW) with the provisions according to the parameters (as shown in Table.1) of the conductivity, TOC, and Microbiology level of purified water system in the pharmaceutical industry (Kartono et al. 2014). In general, for the system, namely pretreatment, particle filtering, and water treatment, the main thing is Reverse Osmosis (RO), with conductivity control after the sterilization process through Ultraviolet (UV) Rays. Based on the literature review that has been presented, the basic technology of the purified water system (Mazzola, 2006). The water purification process technology in the pharmaceutical industry is in accordance with the Velio Pharmaceutical Pure Water Guide, consisting of an initial purification stage where the main goal at this stage is to remove impurities from the water source to be treated. At a minimum, it can filter the growth of bacteria. In addition, at this stage, it is necessary to consider the quality of the water source. Therefore, that it can ensure the right unit to be installed to reduce operating costs for the repair and replacement process due to some tool components have high prices. Treatment units in purified water systems can be divided into 3, namely: 1. Basically, the reaction of chemical processes often occurs simultaneously coagulation and flocculation. In water treatment facilities, the coagulant will be added to the water and will quickly mix. Therefore, coagulants will be circulated and filter to get free water over particle contamination (Peterson, 2001). 2. Membrane process technology for Purified Water (PW). It utilizes a Reverse Osmosis (RO) membrane. Which is used to remove contaminants with a diameter of less than 1 nm. RO is able to remove 90 to 99% of ionic contaminants, the majority of which are organic contaminants and some particulate contamination from the water source to be treated (Paul, 2002). The last process is Electrode ionization (EDI). In accordance with the Velio Pharmaceutical Pure Water Guide, the EDI is one that combines an ion exchange resin and ion-selective membrane using the direct current to remove ionized species from water EDI is widely used in purified water generation which is implemented in the pharmaceutical industry. Due to its "clean" non-chemical properties and constantly produced high quality water. Each stage of the treatment unit in the purified water system process needs identification, analysis, and response to the potential risk using the Quality Risk Management Principle.

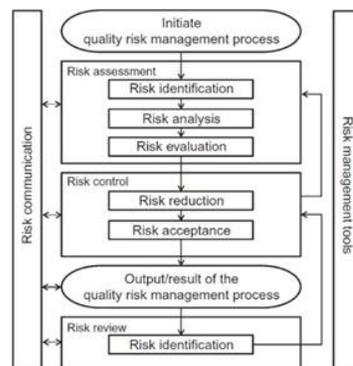
Table 1. Pharmacopeia (USP) Requirements for Purified Water (PW)

Properties	USP
Conductivity	< 1.3 μ S / cm with temperature 25 ⁰ C
TOC	< 500 ppb

Microbiology	< 100 CFU / ml
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2.2. Quality Risk Management

Quality Risk Management (QRM) regulated according to International Conference on Harmonization (ICH) Q9 is a systematic process for the assessment, control, communication, and review of risks to the quality of the drug (medicinal) product across the product life cycle. Furthermore, the concept of QRM relies on an understanding of the terms Quality and Risk. The term quality means the extent to which a set of inherent properties of a product, system, or process meets the requirements (ICH Q9) and according to ISO (the International Organization for Standardization) / IEC (the International Electrotechnical Commission) Guide 51. While the term risk means the combination of the likelihood of a hazard occurring and asking what could cause the



hazard to occur. According to Figure 1, it starts from the initiation process, proceeds to the Quality Risk Assessment (QRA) stage which consists of identification, analysis, and risk evaluation, then proceeds to the risk control stage.

Figure 1. Quality Risk Management process according to ICH Q9

At the risk control stage, it is necessary to determine whether the risk will be accepted or reduced by mitigate action. If risk control has been determined, there needs to be a risk assessment process to ensure that each mitigation that has been determined can efficiently reduce the level of risk identified (Mellisa et al. 2019). Risk Management tool is use Failure Mode and Effect Analysis (FMEA). It works by analyzing all the failures that may occur during processing and service of a product.

2.3. Failure Mode and Effect Analysis

The company has identified and prevented possible failures, this will increase customer satisfaction. In addition, it can reduce unwanted costs during the production process when the failure occurs. When developing new products, companies must minimize risk. The purpose of FMEA is to analyze potential risks that may occur, before the commercial process or during the design process, production process, distribution, and determination of the type of failure that will be carried out during the process stages. It integrates a quantitative process for assessing risk based on three indicators consists of Severity (S), Occurrence (O), and Detection (D) (Spreatfco et al. 2017). As describe by Wang (2009), Occurrence is the probability of an event due to a failure and the type of cause of the failure while the product is in use. Level of severity due to the potential for failure to impact the customer and the risk of damage incurred by the consequences of the failure that occurs. Detection of the possibility when the failure occurs so that it does not reach the customer by using existing controls (Wang et al.2009). Meanwhile Risk Priority

Number (RPN) is a quantitative method for determining the level of risk by multiplying the severity, occurrence and detectability rankings of the failure or event used Eq. (1) (Liu,2012).

$$RPN = Severity \times Occurrence \times Detection \quad (1)$$

2.4. Fuzzy Prioritization Method

According to the results of the literature review conducted by Yücenur (2019), fuzzy numbers are used to prioritize RPN values with the Analytic Hierarchy Process (AHP) step (Özfiat, 2014). In recent years Fuzzy AHP (F-AHP) is a very useful methodology for important applications in multi-criteria decision-making problems under fuzzy operate (Wang et al. 2011), due to human thinking and preferences are inherently imprecise, vague character hence it can be modeled with fuzzy theory easily. In one method, the decision maker's judgment is treated by pairwise comparison and finding the priority vector (Yu, 2002 and Bisso, 2014). Fuzzy comparison matrix is used to evaluate the degree of Occurrence, Severity, and Detection. The F-AHP method is divided into 2 types, namely extent analysis and geometric mean. Extent analysis is an analytical method that does not represent the relative importance of the criteria in which the method compares the convex fuzzy with k convex fuzzy to calculate the relative importance level (Wang et al. 2008). Meanwhile Geometric mean is a method applied to calculate the priority of criteria using the geometric calculation $G1 = (li, mi, ui)$ (Kuzairi et al. 2017). Where l represents lower, m represents middle, and u represents upper. In the AHP method, the comparison between the criteria uses a scale of 1-

9. While the F-AHP must transform the TFN (Triangular Fuzzy Number) as shown on Table 2 to the AHP scale (Ansori, 2012 and Adnyana et al. 2016).

Table 2. Linguistic scale for the relative importance

Linguistic Scales	Symbols	Triangular fuzzy numbers	
		Number	Conjugate
Equally Important	EI	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, 1/2, 2/3
Very Strongly more important	VSI	5, 2, 3, 7/2	2/7, 1/3, 2/5
Absolutely important	A I	7/2, 4, 9/2	2/9, 1/4, 2/7

3. METHODS

To confirm the effectiveness of the research tool in the evaluation and analysis of the causes and risks of potential faults in the new Purified Water System, this study bases the identification, analysis, and risk control settings using Failure Mode and Effect Analysis (FMEA). This refers to the Quality Risk Management process under ICH Q9.

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 obtained approval from the decision makers. The team will conduct a Focus Group Discussion (FGD) to conduct a Failure Mode and Effect Analysis (FMEA) in identifying risks. The team involved is the same person in conducting risk assessment and control on the old, purified water system, which consists of Quality Assurance Personnel, Engineer, Analyst from the laboratory, QRM Facilitator, and Production Supervisor. FMEA consists of three stages (Yücenur, 2019), in the beginning and defining stage, operational flow chart is specified and information about the process is explained, the type and reason of failure is defined. In analysis and assessment stage, risky situations are defined, potential reasons of failure are classified in order to reach the best quality goals with the least possible cost, and in decision-making stage the priorities and actions of FMEA analysis are defined.

3.2.1. Identifying risks and fuzzy comparison matrixes for occurrence, severity, and detection

According to Özfirat (2014)'s study, in FMEA model firstly the risk factors are identified, then fuzzy comparison matrixes are generated for occurrence, severity and detection. The Criteria of Severity, Occurrence and Detection in our case study as shown on Table 3, Table 4, and Table 5.

Table 3. Criteria of Severity

Category	Quality/Regulatory	Patient Safety
Catastrophic	Significant quality impact such that the effects may cause a Health Authority to suspend the Manufacturing/Marketing Authorization.	Effects may cause serious adverse health consequences, permanent disability, or death.
Critical	Failure to meet product quality specifications. Effects may lead to serious/critical regulatory observations and/or lead to a product recall.	Effects may cause a significant impact to patient health (e.g., temporary or medically reversible health problem or disability).
Major	Effects may lead to nonconformance with internal quality standards, procedures or regulatory requirements, leading to product quality impact or to major regulatory observations.	Effects are noticeable by user and may make product unusable; requires medical intervention.
Moderate	Effects may lead to minor nonconformance with internal quality standards, procedures or regulatory requirements with no product quality impact. May result in minor observations or recommendations in regulatory inspections.	Effect is noticeable by user and may make product difficult to use; does not require any medical intervention.
Minor/Negligible	Effects will not lead to nonconformance with internal quality standards, procedures, or regulatory requirements. No product quality impact.	Effects will have negligible to no impact to patient health.

Table 4. Criteria of Probability of occurrence

Category	Criteria	Customization Notes for Probability of Occurrence (if used)
Very High	Certain to occur routinely	More than 14 events within last 2 years

High	Occurs frequently	9 - 14 events within last 2 years
Moderate	Occurs occasionally	5 - 8 events within last 2 years
Low	Has not occurred often	1 - 4 events within last 2 years
Remote	Extremely unlikely to occur	No event since last 2 years

Table 5. Criteria of Detection

Category	Criteria
Remote	There is no established inspection, testing, or monitoring in place to detect the failure.
Low	There is limited inspection, testing, or monitoring in place. Detection is delayed and multiple failures may go undetected between consecutive steps.
Moderate	Some inspection, testing, or monitoring is in place. Detection is delayed and single failure could go undetected between consecutive steps
High	Inspection, testing, or monitoring is in place. There is a high probability that the failure will be detected within the step.
Very High	Consistent inspection, testing, or monitoring is in place to immediately and consistently detect the failure.

The questionnaire can be performed for the comparison of the importance or preference of risk according to others for understanding the importance degree of the risks for each other. Based on the Triangular fuzzy number according to Table 2, then evaluate the determination of the degree of Severity, Occurrence and Detection with the Cheng's (1996) model through an extent analysis approach. Based on the Triangular fuzzy number according to Table 2, then evaluate the determination of the degree of Severity, Occurrence and Detection with the Cheng's (1996) model through an extent analysis approach. Determine the object, namely $X = \{x_1, x_2, \dots, x_n\}$ and the goal is $U = \{u_1, u_2, \dots, u_m\}$. 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)

$$M_{g_i}^1, M_{g_i}^2, \dots, M_{g_i}^m, i=1, 2, \dots, n, \quad (2)$$

While the triangular fuzzy value is $M_{g_i}^j (j=1, 2, \dots, m)$. (3)

From the description above, the next steps are:

a. Fuzzy synthetic extent

$$S_i = \sum_{j=1}^m M_{g_i}^j \otimes \left[\sum_{i=1}^n \sum_{j=1}^m M_{g_i}^j \right]^{-1} \quad (4)$$

After that calculate, $\sum_{j=1}^m M_{g_i}^j$, for additional fuzzy operations on m extent analysis,

$$\sum_{j=1}^m M_{g_i}^j = \left(\sum_{j=1}^m l_j, \sum_{j=1}^m m_j, \sum_{j=1}^m u_j \right), i=1, 2, \dots, n \quad (5)$$

And get, $\left[\sum_{i=1}^n \sum_{j=1}^m \sum_{g_i}^j M \right]^{-1}$, for additional fuzzy operations on $M_{g_i}^j (j=1, 2, \dots, m)$.

$$\sum_{i=1}^n \sum_{j=1}^m M_{g_i}^j = \left(\sum_{i=1}^n l_i, \sum_{i=1}^n m_i, \sum_{i=1}^n u_i \right) \quad (6)$$

Inverse Vector Calculation, $\left[\sum_{i=1}^n \sum_{j=1}^m M_{g_i}^j \right]^{-1} = \left(\frac{1}{\sum_{i=1}^n u_i}, \frac{1}{\sum_{i=1}^n m_i}, \frac{1}{\sum_{i=1}^n l_i} \right)$ (7)

b. Determination of the degree of probability

$$M_2 = (l_2, m_2, u_2) \geq M_1 = (l_1, m_1, u_1) :$$

$$\text{is } V(M_2 \geq M_1) = \sup_{y \geq x} [\min(\mu_{M_1}(x), \mu_{M_2}(y))] \quad (8)$$

or similar with Eq. (9)

$$V(M_i \geq M_j) = \mu_{M_i \cap M_j} = \mu_{m_i}(d) = \begin{cases} 1 & \text{if } m_i \geq m_j \\ 0 & \text{if } l_i \geq u_j \\ \frac{l_i - u_j}{(m_i - u_j) - (m_j - l_i)} & \text{otherwise} \end{cases} \quad (9)$$

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 fuzzy numbers

$$M_1 (I = 1, 2, \dots, k) \text{ is } V(M \geq M_1, M_2, \dots, M_k) = V[(M \geq M_1) \text{ and } (M \geq M_2)$$

$$\text{and } \dots (M \geq M_k)] = \min V((M \geq M_i), (i=1, 2, \dots, k)) \quad (10)$$

assumption that

$$d'(A_i) = \min V(S_i \geq S_k) \quad (11)$$

Which $k = 1, 2, \dots, n$; $k \neq i$. then weight vector is

$$W' = (d'(A_1), d'(A_2), \dots, d'(A_n))^T \quad (12)$$

where, $A_i (i=1, 2, \dots, n)$, n is elements.

d. Normalization of the value of the weight vector

$$W = (d(A_1), d(A_2), \dots, d(A_n))^T \quad (13)$$

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 fuzzy prioritization 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)

$$W^{Occurrence} = (w_1^O, w_2^O, w_3^O, \dots, w_n^O) \quad (14)$$

$$W^{Severity} = (w_1^S, w_2^S, w_3^S, \dots, w_n^S) \quad (15)$$

$$W^{Detection} = (w_1^D, w_2^D, w_3^D, \dots, w_n^D) \quad (16)$$

3.1.2. Converting the importance coefficients (weight vectors) into FMEA degrees

According to Wang (2009) that 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 scoring can be seen in the following Table 6 - 8 (Özfiat, 2014).

Table 6. Severity coefficient conversion using fuzzy prioritization method into FMEA

A	B	C	D
Risk	Weight Vector for Severity	Severity (The highest value from Table 3)	Degree by according to coefficients
R ₁	w_1^S	S ₁	S ₁
R ₂	w_2^S	-	S ₁ . (w_2^S / w_1^S)
.....	-
R _n	w_n^S	-	S ₁ . (w_n^S / w_1^S)

Table 7. 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_1^O	P ₁	-	O ₁
R ₂	w_2^O	-	P ₁ . (w_2^O / w_1^O)	O ₂
.....	-
R _n	w_n^O	-	P ₁ . (w_n^O / w_1^O)	O _n

Table 8. Detection coefficient conversion using fuzzy prioritization method into FMEA

A	B	C	D
Risk	Weight Vector for Detection	Detection (The highest value from Table 5)	Degree by according to coefficients
R ₁	w_1^D	D ₁	D ₁
R ₂	w_2^D	-	D ₁ . (w_2^D / w_1^D)
.....	-
R _n	w_n^D	-	D ₁ . (w_n^D / w_1^D)

3.1.1. 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 72 then there is no need for precaution. However, if RPN value ≥ 72 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 study, the FMEA technique has been used, and how at engineering services department to operating the purified water system (PWS) processes were studied. The problems were defined and how these problems affect the workflow was also found out. The risk identified as shown in Table 9.

Table 9. Identification Risk

Risk Code	Process	Failure Mode (Risk)	Potential Cause of Failure	Potential Effect
R1	Ultrafiltration	Filter replacement is not done according to schedule (Preventive Maintenance)	There is no procedure in the filter replacement process	The filter is clogged causing microbial contamination in the water
R2		Incorrect filter diameter pore size	Wrong order process	The filter is clogged causing microbial contamination in the water
R3		Valve on the water inlet from the backwash is failed	The Valve design is incorrect	The filter is clogged causing microbial contamination in the water
R4		Backwash flow cycle frequency is inconsistency	The design of the auto backwash system that is not in accordance with the drawing.	The filter is clogged causing microbial contamination in the water
R5	Filtering process with a size of 100 microns	Filter replacement is not done according to schedule (Preventive Maintenance)	There is no procedure in the filter replacement process	The filter is clogged causing microbial contamination in the water
R6		Incorrect filter diameter pore size	Wrong order process	The filter is clogged causing microbial contamination in the water
R7		Contaminated feed water sources	The feed water in the chlorinated tank is not suitable	Microbial contamination in water
R8		Inproper regeneration process	Inadequate salting procedure due to valve opening and closing	Increased water hardness and pH is out of specification
R9	Chemical adjustment (Duplex softener)	Resin is not active	Inadequate routine maintenance and preventive maintenance	Increased water hardness and pH is out of specification
R10		Inproper regeneration process	Inproper salt water quality	Increased water hardness and pH is out of specification
R11		Low salt water content	No sensor to detect salt water level	Increased water hardness and pH is out of specification
R12		Water distribution is not channeled according to the initial design	Lack of inlet design	Increased water hardness and pH is out of specification
R13	Reverse Osmosis (RO)	Less water flow in (in feed)	Low water distribution needs	Generates biofilm in the process causing microbial contamination
R14		O-ring leak at pipe joint	Inadequate routine maintenance and preventive maintenance	Micro parameter out of specification
R15		Reverse Osmosis membrane damage and oxidized	Inadequate routine maintenance and preventive maintenance	Micro parameters and differential pressure are out of specification
R16		Inadequate sanitation	Inadequate routine maintenance and preventive maintenance	Clogged Reverse Osmosis Membrane
R18	Filtration storage tank	Excessive pressure in the tank	Inproper ventilation design	Cracked tank causing leakage
R19		Level control failure	The process of maintenance and prevention is inadequate.	Water in the tank is microbial contamination
R20	Distribution Tank	Damage to the pipe connection (broken)	Inproper installation at pressure setting and not according to parameters	Leaks in the channel resulting in microbial contamination and the presence
R21		Ventilation filter failure	The O-ring on the pipeline is damaged and the installation is not correct	Leaks in the channel resulting in microbial contamination and the presence
R22		Failed to detect the quality of water sampled at each valve	Inproper sampling plan	Purified Water out of specification
R23	Sampling	There is a leak in the valve	Aging on the inside and outside of the tank for the duration of use	Purified Water out of specification

Risk	W-Occurrence	W-Severity	W-Detection
R1	0.04	0.08	0.06
R2	0.04	0.07	0.06
R3	0.04	0.06	0.04
R4	0.06	0.06	0.06
R5	0.05	0.06	0.05
R6	0.05	0.06	0.05
R7	0.05	0.05	0.05
R8	0.05	0.05	0.04
R9	0.05	0.05	0.04
R10	0.05	0.04	0.04
R11	0.07	0.04	0.04
R12	0.05	0.04	0.04
R13	0.04	0.04	0.03
R14	0.04	0.04	0.04
R15	0.06	0.03	0.05
R16	0.04	0.05	0.05
R17	0.04	0.03	0.05
R18	0.04	0.05	0.05
R19	0.03	0.03	0.03
R20	0.03	0.03	0.03
R21	0.03	0.02	0.03
R22	0.02	0.01	0.03
R23	0.02	0.01	0.03

4.4. Converting importance coefficients into FMEA degrees and calculating RPN values

The importance coefficients which are given in Table 10 is converted FMEA degrees as shown on Table 11.

Table 11. Computing occurrence, severity, detection degrees

Risiko	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)	W-Detection	Detection (The highest value)	Detection by coefficients	Degree (According to Table Scoring Criteria)
R1	0.04	0.80	-	8	0.08	0.80	-	6	0.06	0.6	-	6
R2	0.04	0.80	0.80	8	0.07	0.80	0.74	6	0.06	0.6	0.57	4
R3	0.04	0.80	0.80	8	0.06	0.80	0.73	6	0.04	0.6	0.42	4
R4	0.06	0.80	1.14	10	0.06	0.80	0.78	6	0.06	0.6	0.81	8
R5	0.05	0.80	0.75	6	0.06	0.80	0.75	6	0.05	0.6	0.57	4
R6	0.05	0.80	0.75	6	0.06	0.80	0.75	6	0.05	0.6	0.57	4
R7	0.05	0.80	0.75	6	0.05	0.80	0.75	6	0.05	0.6	0.57	4
R8	0.05	0.80	0.88	8	0.05	0.80	0.75	6	0.04	0.6	0.54	4
R9	0.05	0.80	0.80	8	0.05	0.80	0.75	6	0.04	0.6	0.60	6
R10	0.05	0.80	0.80	8	0.04	0.80	0.75	6	0.04	0.6	0.60	6
R11	0.07	0.80	1.12	10	0.04	0.80	0.75	6	0.04	0.6	0.60	6
R12	0.05	0.80	0.54	4	0.04	0.80	0.75	6	0.04	0.6	0.60	6
R13	0.04	0.80	0.61	6	0.04	0.80	0.75	6	0.03	0.6	0.50	4
R14	0.04	0.80	0.75	6	0.04	0.80	0.75	6	0.04	0.6	0.71	6
R15	0.06	0.80	1.32	10	0.03	0.80	0.75	6	0.05	0.6	0.72	6
R16	0.04	0.80	0.61	6	0.05	0.80	1.24	10	0.05	0.6	0.60	6
R17	0.04	0.80	0.80	8	0.03	0.80	0.47	4	0.05	0.6	0.60	6
R18	0.04	0.80	0.80	8	0.05	0.80	1.31	10	0.05	0.6	0.60	6
R19	0.03	0.80	0.52	4	0.03	0.80	0.45	4	0.03	0.6	0.42	4
R20	0.03	0.80	0.75	6	0.03	0.80	0.76	6	0.03	0.6	0.51	4
R21	0.03	0.80	0.78	6	0.02	0.80	0.50	4	0.03	0.6	0.60	6
R22	0.02	0.80	0.73	6	0.01	0.80	0.73	6	0.03	0.6	0.60	6
R23	0.02	0.80	0.73	6	0.01	0.80	0.73	6	0.03	0.6	0.60	6

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 12. Some RPN values shown in these tables are higher than 72. That's mean we have to suggest proactive and reactive precautions (mitigating action) for these risks.

Table 12. RPN Values and mitigating action

Risk Code	Severity	Occurrence	Detection	RPN	Risk Response	Mitigating action
R1	6	8	6	288	Mitigation	Establish maintenance and preventive procedures to ensure the autobackwash is working properly. Create a qualification process procedure for operators who will operate Purified water systems Create a procedure for operating the backwash ultrafiltration.
R2	6	8	4	192	Mitigation	Make maintenance and preventive process procedures regarding how to replace filters on ultrafiltration. Ensure the filter membrane specifications before the installation process Create a qualification process procedure for operators who will operate Purified water systems to handle filter membrane changes.
R3	6	8	4	192	Mitigation	Establish maintenance and preventive procedures for backwash valve maintenance. Ensure backwash valve specifications. Create a qualification process procedure for operators who will operate Purified water systems handling backwash valve handlers
R4	6	10	8	480	Mitigation	Establish maintenance and preventive procedures to ensure the autobackwash works properly. Ensures ultrafiltration, pressure control and autobackwash specifications. Create a qualification process procedure to qualify someone to check autobackwash
R5	6	6	4	144	Mitigation	Make daily inspection process procedures Create a qualification form procedure to meet the requirements of people in carrying out daily inspections Ensure filter specifications are 100 microns mikro
R6	6	6	4	144	Mitigation	Ensure filter availability. Create a qualification form procedure to meet the requirements of people in carrying out daily inspections
R7	6	6	4	144	Mitigation	Create a qualification form procedure to meet the requirements of people in conducting daily feed water level checks (Feed Water)
R8	6	8	4	192	Mitigation	Ensure softener specifications and critical alarms (hardness level parameters in water). Establish qualification process procedures to qualify people to maintain autoregeneration (operations and maintenance). Make maintenance process procedures to check the regeneration system for softener.
R9	6	8	6	288	Mitigation	Ensure Resin specifications Establish a qualification process procedure to qualify people for resin replacement in the treatment process
R10	6	8	6	288	Mitigation	Obtaining a special value for the salt content of water by conducting a validation process in laboratory tests Make daily inspection process procedures to check the level of salt content in water
R11	6	10	6	360	Mitigation	Ensure salt sensor level specifications for Softener Create a qualification process procedure to maintain levels, flow meters, and salt pumps for Softener (operations and maintenance).
R12	6	4	6	144	Mitigation	Ensure softener specifications. Create a qualification process procedure to qualify someone to maintain softener (operations and maintenance). Make maintenance and preventive process procedures to maintain softener performance.
R13	6	6	4	144	Mitigation	Make procedures for the treatment and prevention process for the regeneration system in the softener. Create a qualification process procedure to qualify someone to maintain softener regeneration (operation and maintenance).
R14	6	6	6	216	Mitigation	Create maintenance process procedures to check performance and replace O-ring RO Establish qualification process procedures to qualify people to monitor O-ring RO
R15	6	10	6	360	Mitigation	Check RO membrane performance and determine membrane replacement schedule Establish qualification process procedures to qualify people to maintain RO membrane membran Ensure RO membrane specifications
R16	10	6	6	360	Mitigation	Checking performance of sanitation RO Establish qualification process procedures to qualify people to inspect RO sanitation (operations and maintenance). Ensure RO sanitization process specifications and availability of information if sanitization fails.
R17	4	8	6	192	Mitigation	Checking performance of sanitation RO
R18	10	8	6	480	Mitigation	Ensure the filtrate tank and ventilation system are operating properly Create a qualification process procedure for the operation and maintenance of the filtrate tank and ventilation system. Create a maintenance process procedure to ensure the maintenance of the filtrate tank ventilation.
R19	4	4	4	64	Accepted	-
R20	6	6	4	144	Mitigation	Establish maintenance and preventive process procedures to check for ruptured discs. Establish qualification process procedures (operations and maintenance) to qualify people to inspect ruptured discs. Ensure the pressure control specifications work optimally.
R21	4	6	6	144	Mitigation	Create a maintenance process procedure to check the performance of the ventilation filter. Establish a qualification process procedure (operational and maintenance) to qualify people in the ventilation filter inspection
R22	6	6	6	216	Mitigation	Ensure pressure control and ventilation filter specifications. Establish qualification process procedures to qualify people to inspect sampling valves (operation and maintenance).
R23	6	6	6	216	Mitigation	Establish maintenance and preventive process procedures to check valve quality and aging in sampling. Establish qualification process procedures to qualify people for quality checking and aging checking of valves (Aging) during the sampling process (operation and maintenance). Ensure the valve specifications for sampling.

5. CONCLUSIONS

In this paper, we applied FMEA technique with fuzzy prioritization method for a pharmaceutical company. Failures and risks were determined in a Focus Group Discussion by QRM Teams. For all potential risk's severity, detection and occurrence values were determined. As a result, 22 Risk identified for new purified water system an RPN value which are higher than 72. Risk reduction or control actions are required. Risk control recommendations for all high and medium risks must be reviewed and approved by Decision Makers. Proposed risk control actions and individual or group responsibilities for these actions must be documented. If a high risk cannot be further reduced, formal acceptance must be documented and approved by Site Quality and Operations Head. This process can be realized by investments to be made on the equipment, employees, and supplier.

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RISK MANAGEMENT OF CONTRACTOR FULLPREFINANCED CONTRACT ON TOLLROAD PROJECT IN INDONESIA

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ABSTRACT

The Contractor Full Pre-Financed (CPF) contract scheme is a contract scheme where the main contractor uses his financial capability to execute the project. This contract is possible to transfer risks from owner to contractor. The CPF contract has the same basic principles as the Engineering, Procurement, Construct (EPC) contract and the Turnkey contract where the owner / client works with the main contractor who will carry out the design until the operation is then handed back to the owner for use. In the construction process, the contractor has to complete the project based on predetermined costs, quality and time. These three main components are always haunted by risks that can occur at every stage of the project. The CPF contract is the solution for the owner where the risk can be transferred to the main contractor. However, the financial condition of the contractor is crucial in the project implementation process. Risk management by contractors must be well designed to deal with potential risks that arise in the construction process using the CPF scheme. This study aims to identify risks and determine the main risks that occur in the CPF contract scheme and propose response / mitigation solutions to the risks that occur. The questionnaire is the main research instrument for collecting data from respondents who are experienced in using the CPF contract scheme in construction. In this study, risk analysis data were obtained from a risk probability and impact assessment using the QRA (Qualitative Risk Analysis) sheet using a weighting scale from the Probability Consequence Matrix to determine risks that have a significant impact. The result shown that three highest risks are contractor financial problems, delay in design revision and economic conditions.

Keywords: CPF Contract, Risk Identification, Risk Mitigation.

1. INTRODUCTION

According to the Committee for the Acceleration of Priority Infrastructure Provision (KPPIP) there are 223 projects and 3 programs included in the National Strategic Project (PSN) with a total investment value of Rp. 4.183 trillion (KPPIP 2019). Toll road is one of PSN and it is categorised as prioritised project as it supports logistic path. In the implementation process, projects in the construction services sector face three main obstacles, namely cost, time, and quality. These three constraints can be interpreted as project targets where the implementation is right on cost, on time, and with right quality. The successful implementation of a project carried out by a construction company to what extent these three objectives can be met.

The Contractor full prefinanced (CPF) scheme provides a much higher chance of return using a standard payment contract system. However, the risk remains that it requires large funds at the beginning of the contract. For projects that have a long duration, the risk will be even greater, especially in terms of resources. In a bid process, a large amount of capital is needed from the contractor, in the form of Financial capability evidence (SKN). The technical risk that arises is that if there are changes that result in an increase in construction costs, the risk will be borne by the contractor. Identification of potential risks and risk allocation from the outset are needed to address the risk of changes and differences between the planning and construction stages.

This study is aimed to identify risk factors that might be happened during the project through risk management mechanisms. Risk management is an activity carried out to response the known risks, with the aim of minimizing risks that may occur. Where then can be known adverse effects that are not expected to these risks (Cooper and Chapman, 1993). Risk management provides an integrated picture for risk assessment, treatment, control, and monitoring. The risk management includes identification, assessment, and mitigation stage. Identify the level of importance of the risk and the main potential risks are the most important part to determine the most appropriate mitigation.

2. TURNKEY AND CPF CONTRACT

Under a turnkey contract, the contractor is assigned to undertake full responsibility for everything required for the construction, completion, commissioning, and handover of the project. The main difference that distinguishes turnkey projects is that they combine products and services to meet the unique needs of individual customers (Brady et al. 2015). The contractor's involvement in formulating the project scope is very high and may also provide maintenance or life cycle services after project delivery to the customer. As contractors become highly involved in the early phases of delivering ready-made projects (Bakr et al 2012), the importance of close transacting inter-organizational relationships is emphasized. The presence or absence of inter-organizational trust also influences the selection of contractors for future projects (Hellgren and Stjernberg 1995). According to Adnan and Osman (2018), the basic philosophy in the CPF contract or also called a turnkey contract is that this contract system provides one responsibility in the process of design, construction, project procurement, and project delivery during the project lifecycle. A turnkey contract or CPF itself can also be called an Engineer, Procure, Construct (EPC) turnkey contract where the owner of the project delegates the authority to design, procure, build to one party or organization in this case the contractor (Bakr et al 2012). In simple terms, Branconi and Loch (2004) state that there are 8 main keys that must be defined and explained and regulated in the contract.

3. RESEARCH METHODS

Variable Synthesis is the part where the variables used in previous research in risk management on CPF contracts are collected and will then be used as variables in the study. Table 1 will provide a synthesis of the variables used

Table 1. Synthesis of Risk Management Variables in CPF/Turnkey/EPCM Contracts

No	Risk Category	Risk	Bakr Dkk 2012	Hossen Dkk 2014	Ke dan Xu 2015	Picha dkk 2015	Adnan dan Rosman 2018	Yap Dkk 2020
1		Delay in completing work	v		v	V		v

2	Client	Too many changes	v	v	v	V	v	v
3		Slow in decision making	v	v	v			v
4		Less effective communication with other stakeholders	v	v	v		v	v
5		Economic and financial difficulties	v	v	v		v	v
6		Changes in specifications and materials during construction		v	v	V		v
7		The complexity of the project		v	v	V		v
8		Contract duration				V	v	v
9		Contractor	Poor planning and scheduling	v			V	v
10	Incompetent sub-contractor			v	v		v	v
11	Work errors and construction failures		v	v		V		v
12	Poor project management and supervision							V
13	Contractor financial problems		v		v	V	v	v
14	Poor coordination with other parties		v	v	v		v	v
15	Inexperienced contractor			v	v			v
16	Delay in pre-construction							v
17	Consultant	Design revision delay						v
18		Design error		v	v	V	v	v
19		Poor communication between stakeholders	v	v	v		v	v
20		Different scope of work			v	V	v	v
21	Materials, Labour and Tools	Low consultant productivity	v					v
22		Lack of expert	v	v				v
23		Lack of required material	v	v				v
24		Difficulty in getting materials	v	v	v			v
25		Drastic price change	v					v
26	poor material quality			v			v	
27	Other Factors	Weather	v		v			v
28		political and regulatory conditions	v	v	v	V	v	v
29		Economic conditions (inflation, Fund Loans)	v	v	v	V	v	
30		Unforeseen project site conditions	v	v	v			v
31		Construction working accident						v
32		Force majeure	v				v	v
33		Lack of quality control						v
34		Differences in working culture		v	v		v	

Questionnaire survey was conducted to collect respondent's perception related to risk of CPF contract. The data was collected using purposive sampling to 45 respondents, all of whom had a background as contractors as previously determined, while the interview involved 6 participants, namely: 1 main director, 3 general managers, 1 bureau manager and 1 project manager of the CPF project. The six participants came from state owned enterprise (BUMN) contractors who had implemented CPF contracts. Respondents in this study were targeted at respondents who work in construction service companies. Of all respondents, 3 people have experience < 5 years, 6 people have experience 5-10 years, 7 people have experience 10-15 years, 15 people have experience 15-20 years, and 14 people have experience more than 20 years. Based on the results of the questionnaire distribution 10 people have

never used CPF contracts, 27 people have experience using CPF contracts under < 5 years, 7 people have experience using CPF contracts for 5-10 years, and only 1 person has experience using CPF contracts for more than 1 year. In this study, the respondent's position is in a company engaged in construction services. Their positions are 17 project managers, 16 managers, 5 vice presidents, 3 directors, and 2 site managers and 2 staff.

4. RESULT AND DISCUSSION

The risk level was derived from frequency and consequences. Therefore, the first step was assessing risk frequency of each risk variables, which show the frequency of occurrence of risk variables. The respondents gave their perception related to frequency and impact of each risk variables using Likert scale. The order of the dominant risk variables or the order of importance of the existing variables is based on the respondents' answers. Frequency is an assessment of how often the risk variable occurs when using a CPF contract. Table 2 gives the following results.

Table 2. Risk frequency (descending order)

No	Risk	Frequency
1	Contractor financial problems	3.911
2	Design revision delay	3.889
3	Delay In Pre-construction	3.711
4	Economic conditions (inflation, loans, funds)	3.689
5	Weather	3.667
6	Incompetent sub-contractor	3.644
7	Poor planning and scheduling	3.533
8	Drastic price change	3.533
9	Low consultant productivity	3.511
10	Poor coordination with other parties	3.356
11	Lack of experts	3.333
12	Political and regulatory conditions	3.311
13	Differences in job scope	3.289
14	Poor project management and supervision	3.222
15	Unexpected project site conditions	3.222
16	Natural disaster/force majeure	3.222
17	Differences in working culture	3.067
18	Working errors and construction failures	3.000
19	Design error	3.000
20	Poor stakeholder communication	3.000
21	Lack of quality control	3.000
No	Risk	Frequency
22	Construction accident	2.911
23	Poor material quality	2.889
24	Difficulty in getting materials	2.800
25	Lack of required material	2.756
26	Inexperienced contractor	2.733

Secondly, assessing the impact of the risk variable. The order of the dominant variables or the order of importance of the existing variables is based on the respondents' answers. Impact is a consequence of the

risk variable if the risk occurs during the use of the CPF contract. Table 3 gives the following results.

Table 3. Order of Variables on Risk Impact

No	Risk	Consequences
1	Contractor financial problems	3.756
2	Poor planning and scheduling	3.667
3	Drastic price change	3.667
4	Economic conditions (inflation, loans, funds)	3.667
5	Delay in pre-construction	3.600
6	Design revision delay	3.600
7	Natural disaster/force majeure	3.556
8	Incompetent sub-contractor	3.533
9	Work errors and construction failures	3.511
10	Design error	3.511
11	Differences in job scope	3.444
12	Unexpected project site conditions	3.444
13	Difficulty obtaining materials	3.422
14	Weather	3.378
15	Lack of quality control	3.356
16	Political and regulatory conditions	3.333
17	Poor project management and supervision	3.311
18	Inexperienced contractor	3.311
19	Poor stakeholder communication	3.311
20	Construction accident	3.311
21	Low consultant productivity	3.289
22	Lack of required tools	3.267
23	Poor material quality	3.267
24	Poor coordination with other parties	3.200
25	Less Experts	3.156
26	Differences in working culture	2.911

Table 2 shows the ranking order of the frequency of risks that most often arise in the use of CPF contracts in construction projects. Based on the table, the contractor's financial problems are the main risks that are considered the most frequent by respondents with a mean value of 3,911. The inexperienced contractor variable is the risk that has the lowest frequency based on the respondent's response with a mean value of 2,733.

Based on risk assessment, the risk level was obtained by this formula: Risk = frequency x consequences. Frequency was measured by calculating the average of respondent's answer in the questionnaire survey, as well as the consequences. Then, the risk level is determined based on this probability impact matrix.

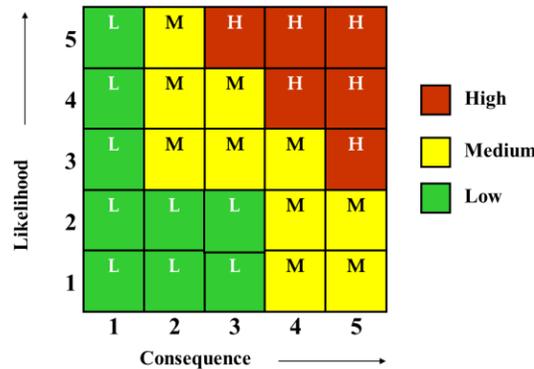


Figure 1. Probability Impact Matrix

Table 4. Risk level

Risk	Risk Level	Risk
Contractor Financial Problems	14.68	H
Design Revision Delay	14	H
Economic Conditions (Inflation, Loans, Funds)	13.53	H
Delay In Pre-construction	13.36	H
Poor Planning and Scheduling	12.96	H
Drastic Price Change	12.96	H
Incompetent Sub-Contractor	12.88	H
Weather	12.38	H

In this study, because it focuses on the contractor's perspective, internal risks are risks that come from project implementation and internal contractors, for example sub-contractor, financial and scheduling risks. However, even so, there are several conditions, an internal risk variable can be classified as an external risk variable, because it is caused by parties outside the contractor, for example pre-construction delays caused by delays in land acquisition. Meanwhile, other external risks are weather and project team.

Subsequently, the mitigation was determined to all risks. Risk mitigation is the process of reducing the risk by reducing the impact of the risk if it should occur or reducing the probability of it occurring. Risk acceptance is simply agreeing to accept the consequence that a risk brings if it occurs. In general, there are four options of risk mitigation, namely: accept, transfer, reduce, and avoid risks. The risk mitigation is shown in Table 5.

Table 5. Risk Mitigation of Risk Variables

No	Risk Variable	Mitigation			
		A	B	C	D
1	Poor planning and scheduling		V		
2	Incompetent sub-contractor				V
3	Work Errors and construction failures				V
4	Poor project management and supervision		V		
5	Contractor financial problems		V	V	

6	Poor coordination with Other Parties		V		
7	Inexperienced contractor				V
8	Delay on pre-construction		V	V	
9	Design revision delay		V	V	
10	Design error				V
11	Poor stakeholder communication		V		
12	Differences in job scope		V		
13	Low consultant productivity				V
14	Less experts		V		
15	Lack of required tools		V		
16	Difficulty obtaining materials			V	
17	Drastic price change			V	
18	Poor material quality				V
19	Weather	V	V		
20	Political and regulatory conditions	V			
21	Economic conditions (inflation, loans, funds)		V	V	
22	Unexpected project site conditions		V		
23	Construction accident				V
24	Natural disaster/force majeure	V			
25	Lack of quality control		V		
26	Differences in working culture		V		

Note:

- A. Accept the risk
- B. Reduce risk
- C. Transfer/allocation of risk
- D. Avoid risk

One of highest risk is contractor financial problem. During the construction period, there were unforeseen condition that the contractor did not get complete information, for example technical problems including geological problems or problems with incomplete land utility availability and poor coordination between agencies. Social problems such as community resistance that trigger demonstrations and so on are also problems that were not identified at the time of the initial survey. This will result in additional costs and time that have an impact on the contractor's finances. This problem has the potential to not be claimed by the owner because it is considered the full responsibility of the contractor. Adnan and Rosman (2018) mention that unclear project scope is one of the sources of risk, so the contract clause needs to be regulated if there are conditions that are different from the initial project scope. This is the reason why, the risk mitigation could be categorised as risk transfer.

It means that this risk can be minimized by adding to the contract clause, by stating that if there is additional or less work, because there are things that are unknown and unpredictable by both the contractor and the owner, a claim will be made to the owner. Economic conditions are categorized as a major risk according to the respondents through the questionnaire. The results of this study are in accordance with previous studies (Bakr, 2012; Hossen et al., 2014; Ke & Xu, 2015).

At the risk of delays in the design revision, the difference in the form of this contract will affect the form of mitigation and opportunity analysis. In design build contracts, design revisions can be mitigated by reducing risk in the form of good coordination with the planning team. Based on interviews with respondents, there are 2 major risks that can be claimed to the owner, including price changes (escalation) and changes in methods or designs.

6. CONCLUSIONS

Risks that occur in construction projects with Contractor Full Pre-financed (CPF) contract schemes these are:

- Contractor Financial Problems
- Design Revision Delay
- Economic Conditions (Inflation, Loans, Funds)
- Delay In Pre-construction
- Poor Planning and Scheduling
- Drastic Price Change
- Incompetent Sub-Contractor
- Weather

The majority risk response is on the transfer or allocation of risk and reducing risk. Matters related to finance will be allocated to third parties, one of which is financial institutions. Meanwhile, technical related variables will be mitigated by reducing risk, namely by making scheduling arrangements more effectively.

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RISK ASSESSMENT ON THE NEW SHIPBUILDING PROCESS (CASE STUDY THE INDONESIAN NAVY HOSPITAL AID SHIPAT PT. PAL INDONESIA (PERSERO))

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ABSTRACT

In the process of building a new ship, there are potential risks that affect each other which causes the shipbuilding process to be delayed and the resulting impact is a penalty or even termination of the contract. Therefore, a risk assessment needs to be carried out on the construction of a new ship to determine the necessary mitigation measures. This study aims to develop a mitigation strategy for potential priority risks in the construction of the Navy Hospital Aid Ship in the 2020/2021 budget year. This research was conducted through 3 stages. First is identify the potential risks with a questionnaire to stakeholders who are influential and have an interest in PT. PAL Indonesia (Persero). Second is assess the potential risk that has the highest Risk Priority Number (RPN) through the Failure Mode and Effect Analysis (FMEA) method. Last stage is identifying the mitigation strategy through the Focus Group Discussion (FGD) process, risk and mitigation priority determined using the Analytical Hierarchy Process (AHP) method. As result, four risk were determined for each step of shipbuilding process with first priority are risk of material delay (RPN value: 36.18) has 4 mitigation, second are risk of delays in the production work process (RPN value: 21.76) has 4 mitigation, third are risk of changing the specifications of medical equipment (RPN value: 64) with 6 mitigation and least priority are risk of limited skill worker in the field for installation & commissioning of medical equipment (RPN value: 48) has 4 mitigation.

Keywords: ship newbuilding, risk analysis, failure mode and effect analysis, analytical hierarchy process.

1. INTRODUCTION

The construction of new ships in Indonesia is still very much needed to meet the many domestic needs as Indonesia is one of the maritime countries where most of its territory is the ocean. The need for domestic ships tends to increase every year in line with sea transportation mode to meet logistics and other needs to all corners of the country. As a maritime country, ships are one of the transportation modes where the Indonesian Navy also has a role in dealing with and overcoming the inaccessibility of the population living outside Java, especially in the small islands of Indonesia whose conditions are still very underdeveloped, which can be said to still need assistance especially health assistance Rianto, FS. et al (2017). This is in line with the mandate of Law Number 34 of 2004 concerning the Army in the task of Military Operations

Other than War (MOOTW), including humanitarian tasks for health services. The role of hospital aid ships in MOOTW tasks must be optimized by taking into account environmental conditions and strategies related to geography and demography in contemporary conditions, especially the demands of the community for health care facilities with global standards. The hospital ship owned by the Indonesian Navy is KRI Dr. Soeharso 990. Previously, this ship was a Personnel Assistance Ship named KRI Tanjung Dalpele 972 and was built in South Korea in 2003. Then this ship changed its function to a Hospital Aid Ship.

In early 2020, PT. PAL Indonesia (Persero) has won the trust to build the first Hospital Aid Ship in Indonesia which from the beginning was designed as a hospital to meet the need for improving health services. The shipbuilding process takes an average of one to two years depending on the type of ship and the dimensions to be made, the new shipbuilding process consists of ship design, purchase of materials and equipment in accordance with technical specifications and assembly production services of the ship before completed and handed over to the buyer.

39T For the construction of new ships in the country, there are several problems that cause the ship to back off from the schedule that has been given or even stop, these obstacles are usually caused by several things such as repair work due to inappropriate results, late design drawings provided, delays in material logistics that must be completed. Some of them were imported from abroad because they were not available domestically, plus during the COVID-19 pandemic it increased the risk of the problems mentioned above, this Hospital Aid Ship of Indonesian Navy contract has made an addendum for completion from 30 months to be 32 months from the predetermined schedule. Therefore, it is necessary to analyze risk management in the shipbuilding industry.

39T Risk management in the shipbuilding industry, especially in new construction activities needs to be discussed and analyzed further. Project risk is an uncertain event or condition, if it occurs it will have a positive or negative impact on the project objectives. According to Basuki, M. et al (2008), the risk in building a new ship is having the same risk to other project fields. One of the factors is the increase in steel prices which affect the national shipbuilding industry. This is because the need for steel reaches 30% of the total cost of shipbuilding. High demand for steel and price increases that cannot be controlled will affect the late risk faced by PT. PAL Indonesia (Persero) related to the fulfillment of the delivery of ships that are not on schedule so that PT. PAL Indonesia (Persero) will reschedule the delivery of the ship to the buyer. There is a risk that the trust level of ship buyers will decrease Basuki, M & Widjaja S. (2008). Every risk has a cause and if it occurs it can bring consequences or impact on costs that will increase and the schedules that will experience delays Santosa B, (2009).

39T Several studies have discussed risk management by looking at various perspectives of risk categories. Lu & Tang (2000) stated that the risk categories for the shipbuilding industry includes shipbuilding prices, changes in interest rates, inflation, new taxes, delays in material supply, energy inefficiency, contracts, shipbuilding cycles, inventory control and labor costs. This is contrast to Moyst and Das (2005), who argued that project conditions, market conditions, design and requirements, construction management, labor, government policies, education and training are risk categories faced in the shipbuilding industry. This research will identify risk problems, especially during the Covid-19 pandemic faced by the shipping industry in terms of building Hospital Aid Ships.

39T To identify the risk in the shipbuilding industry, the analysis can be carried out by several methods, the Failure Mode and Effect Analysis (FMEA) method used to get the risk priority number. Mitigation measures to reduce existing risks are discussed through Focus Group Discussion (FGD). A pairwise comparison method to determine the priority of risk and mitigation strategy. The available data then process with Analytical Hierarchy Process (AHP) method to find the priority arrangement of risk and mitigation steps.

2. LITERATURE REVIEW

39T According to the Project Management Body of Knowledge (PMBoK) Guide sixth edition (2017),

project risk management includes the process of carrying out risk management planning, identification, analysis, response planning, and controlling risks in projects. The goal of project risk management is to increase the likelihood and impact of positive events and to reduce the likelihood and impact of negative events in the project. Based on the existing risk management procedures at PT. PAL Indonesia (Persero) it refers to the standards of ISO 9001, 14001 and 45001 with a risk map as shown.

Occurrence		Severity				
		Insignificant	Minor	Medium	Major	Disaster
		1-20%	21-40%	41-60%	61-80%	81-100%
5	Very big	Middle Risk 5	Middle Risk 10	High Risk 15	Extreme Risk 20	Extreme Risk 25
4	Big	Middle Risk 4	Middle Risk 8	High Risk 12	Extreme Risk 16	Extreme Risk 20
3	Medium	Low Risk 3	Middle Risk 6	Middle Risk 9	High Risk 12	High Risk 15
2	Small	Low Risk 2	Middle Risk 4	Middle Risk 6	Middle Risk 8	High Risk 10
1	Very small	Low Risk 1	Low Risk 2	Low Risk 3	Middle Risk 4	High Risk 5

Source: SOP 39TRisk Management Working Mechanism of PT. PAL Indonesia (Persero)

Figure 1 Risk Map ISO 9001, 14001 and 45001 PT.PAL (2021)

Based on Prihandono et al (2017), Basuki, M & Choirunisa, B (2012); Fendi, A & Yuliawati, E(2012), every stage of the new ship construction has risks. The following are the risks identified based on the literature for each stage of shipbuilding.

3. METHODS

Primary data obtained by distributing questionnaires to key respondent to obtain a list of risks that occur and assess risks based on FMEA at the research location. In addition, secondary data is also needed in the form of ship plan documents, Risk Management Work Mechanism documents of PT. PAL Indonesia (Persero). This research was conducted through 3 stages. The first stage is done by identify the potential risks with a questionnaire to stakeholders who are influential and have an interest in PT. PAL Indonesia (Persero). The second stage is assessing the potential risk that has the highest Risk Priority Number (RPN) through the FMEA method, the risk map ISO 9001, 14001 and 45001 as reference were used for FMEA process with detection criteria. Last stage is identifying the mitigation strategy through the FGD process, risk and mitigation priority then determined using the AHP method.

Table 1 Risk Identification

39T Design and Administration planning stage	Technical Planning	39T Procurement of Materials and Tools (Supply Chain)	Production
<p>R 1. Delay of design drawing (Basic Design, Key plan & Yard plan)</p> <p>R 2. Revision of drawing</p> <p>R 3. Difficulty in fulfilling contract term</p> <p>R 4. Difficulty to do billing</p> <p>R 5. Not enough Cashflow</p> <p>R 6. Late payments to suppliers and others</p> <p>R 7. Weakness in memorandum of agreement, cannot claim to Insurance</p> <p>R 8. Fluctuation in the exchange rate of the rupiah to dollar</p> <p>R 9. Inaccurate material rete reference</p> <p>R 10. Long approval process</p> <p>R 11. Risk of compliance with mandatory rules which are hierarchically above the contract documents</p> <p>R 12. Risk of changing specification of the medical equipment</p> <p>R 13. Addition of specification features due to national situation</p> <p>R 14. Customer requests on material specifications that are not detailed in the</p>	<p>R 16. Calculation of material inaccurate</p> <p>R 17. Lack of Coordination between department</p> <p>R 18. Production planning changing</p> <p>R 19. A sudden request</p> <p>R 20. There is no long-term planning</p> <p>R 21. Long technical evaluation and the need of budget adjustment</p> <p>R 22. Determination of equipment specification that is not clear</p> <p>R 23. 39TRisk of limited worker skills in the field of installing & commissioning Medical Equipment</p>	<p>R 24. Material delay</p> <p>R 25. Large quantity of material requirements</p> <p>R 26. Large variety of equipment</p> <p>R 27. The quality of equipment from suppliers are not in accordance with quality standard</p> <p>R 28. Transporter/Crane damage</p> <p>R 29. Supplier going bankrupt</p> <p>R 30. Incorrect quantity of materials</p> <p>R 31. Incorrect equipment specification</p> <p>R 32. No clear specifications for request of equipment</p> <p>R 33. Does not have a comparison price</p> <p>R 34. Age of equipment / old equipment</p> <p>R 35. Dependence to only one source (supplier)</p> <p>R 36. Verification of request of equipment is incorrect</p> <p>R 37. Scarcity of materials</p> <p>R 38. Mistakes in appointing a supplier</p>	<p>R 40. Many of competent employee the resign or move to other company</p> <p>R 41. Environmental pollution</p> <p>R 42. Worker strike</p> <p>R 43. Wrong procedure</p> <p>R 44. Fire</p> <p>R 45. Delay on production process</p> <p>R 46. Force majeure / bad weather (flooding, storm)</p> <p>R 47. Electricity supply cut from energy supplier</p>

<p>contract R 15. Organizational dynamics/ change of officials (officials & provider) during the duration of the contract implementation</p>		<p>R 39. Long process of Custom Clearance</p>	
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4. RESULTS

1. Risk Identification

There were 41 potential failure mode(risk) that has been set following previous research, from the respondent then found additional 6 risk which is relevant with the existing condition of this Hospital aid ship newbuilding project. A total 47 risk were identified. Where not all respondent thinks that the risk that were set in the beginning is relevant to the particular function and component,

therefore the Severity, Occurrence, and Detection value were not included in the final average value of RPN

2. Higher Risk Priority Number (RPN)

RPN is a measured when used to assess the risk to help identifying "*critical failure modes*" which related to design or process. Using FMEA, RPN is used to guide risk assessment. The following is the formula for calculating the RPN.

$$RPN = Severity \times Occurrence \times Detection$$

3. 39TDetermination of Mitigation Strategy

39T Mitigations strategy is planned for each risk identification to reduce the risk, 4 risk has been chosen from the highest RPN value taken from each area.

4. 39TDetermination Priority of Risk and Mitigation Strategies

39T Priority of risk39 T is determined a39T fter identifying the highest risk and mitigations for each function and component, the next step is to determine the weight of the risk and mitigations strategy that should be prioritized. Risk and mitigation weight calculation is done by Analytical Hierarchy Process. Five respondents to determine the weight of risk and mitigations strategy at four risk areas. The five respondents have equal weight in determining risk and mitigation priorities. Furthermore, Determination of the final weight using the following formula.

$$Risk\ weight = \sum_{i=1}^5 (respondent\ risk\ weight \times respondent\ weight)_i$$

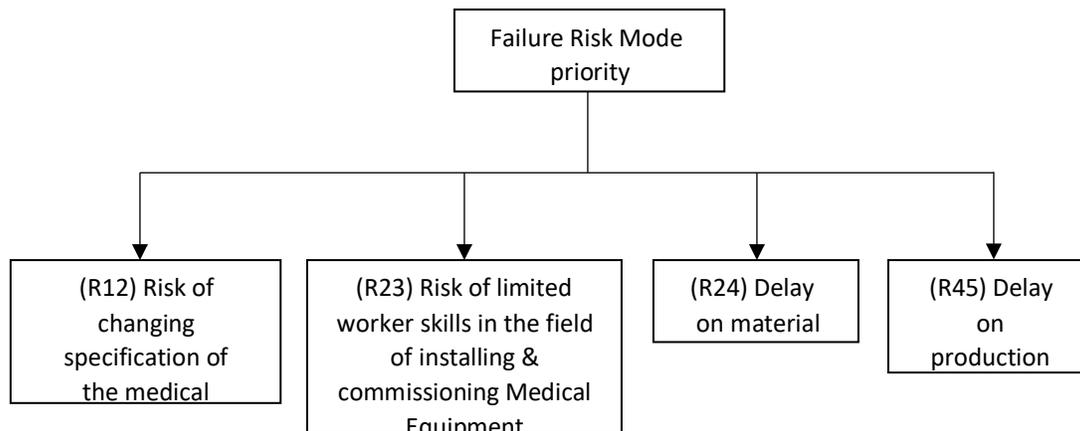


Figure 2 Hierarchy of Risk Weight

The risk priority result from AHP found that final risk weight for R12 = 0.181, R23 = 0.1368, R24 = 0.461 and R45 = 0.2208.

Table 2 Calculation of Risk Weight

Risk ID	Risk Weight	Respondent Weight	Final Risk Weight
	0.6		

R12	0.092	0.2	0.181
	0.052		
	0.114		
	0.047		
R23	0.266	0.2	0.1368
	0.052		
	0.116		
	0.033		
	0.217		
R 24	0.094	0.2	0.461
	0.577		
	0.573		
	0.414		
	0.647		
R 45	0.039	0.2	0.2208
	0.278		
	0.259		
	0.439		
	0.089		

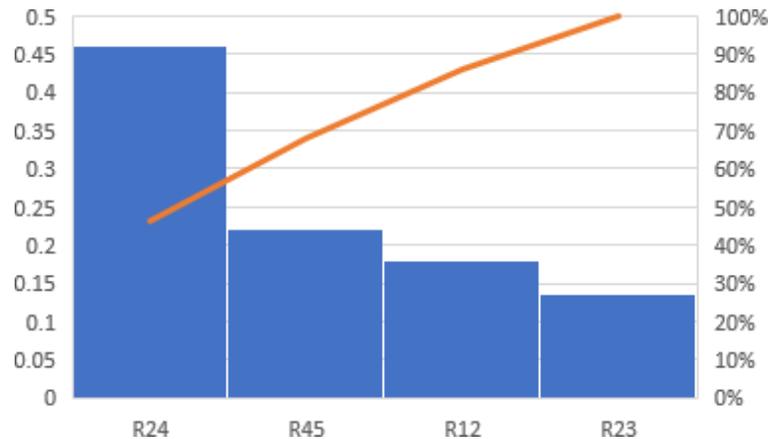


Figure 3 Pareto Failure Risk Mode Priority

39T From Pareto chart above that of the four priority risks for each function & component, R24, namely the risk of material delays, is the risk that must be most prioritized because it accounts for 46% of all priority risks for each function & component with a final weight of 0.461.

39T Priority mitigation strategy determined after risk mitigation identification were discussed from FGD process with the same respondents, each mitigation then prioritized within one priority risk in each area where 39 Tweight of mitigation is determine, data then being process using AHP method.

39TDetermination of the final weight using the following formula.

$$Mitigation\ weight = \sum_{i=1}^n (respondent\ mitigation\ weight \times respondent\ weight)_i$$

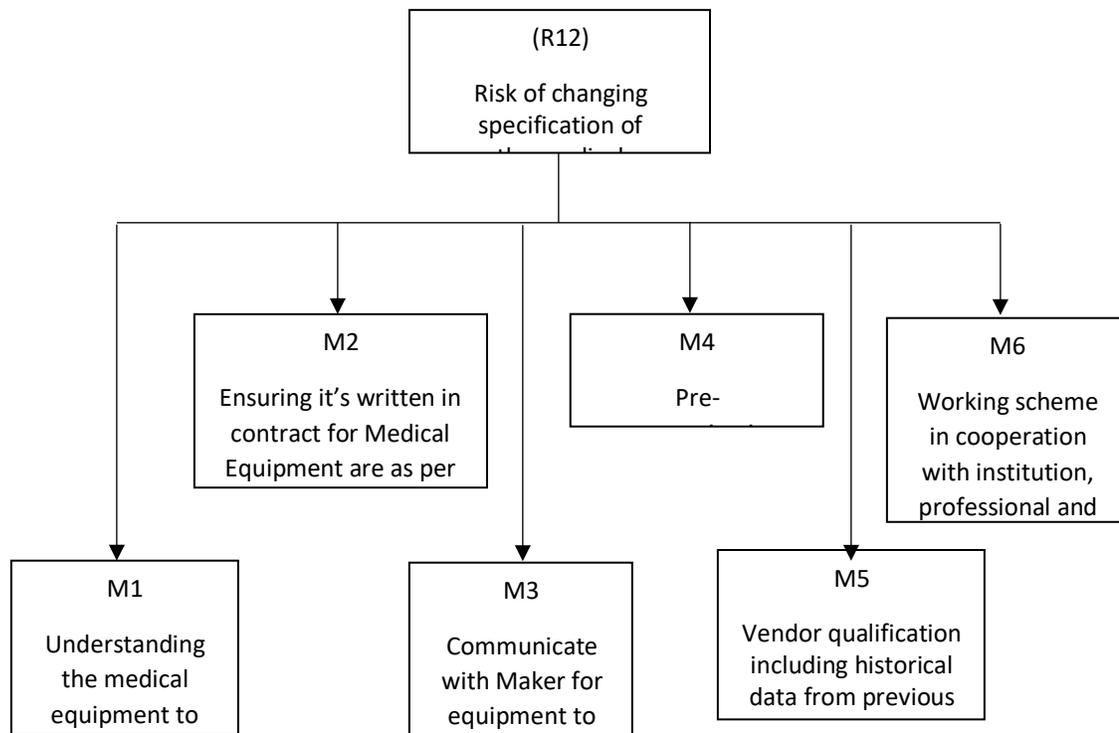


Figure 4 Hierarchy of Mitigation Weight

Same process then repeated for each priority mitigation strategy on each priority risk for. Final priority as shown below

Table 3 Priority of Risk and Mitigation Strategy

	Risk Priority			
	1	2	3	4
	(R24) Material delay	(R45) Delay on production process	(R12) Risk of changing specification of the medical equipment	(R23) Risk of limited worker skills in the field of installing & commissioning Medical

					Equipment
Mitigation Priority	1	The equipment installed must be with LR class approval	Production drawing must be final without conflict. Must coordinate with design before work commence	Ensuring it's written in contract for Medical Equipment are as per Maker specification	Ensuring the equipment installed as per design
	2	Specification changing must be avoided in the middle of the running project	Ensuring adequate skill and training for worker and sub-contractor	Understanding the medical equipment to be installed	Pre-communication with Maker for manual Installation, testing and commissioning
	3	Avoid long lead time by bringing Maker during negotiation with owner	Well calculated working hour and request for additional worker when needed	Working scheme in cooperation with institution, professional and expert	Experience Sub-contractor for medical equipment to be installed
	4	Ensuring the equipment to be order are as per specification to avoid mistake in delivery	To ensure the material use are available	Pre-communication with the vendor	Adequate training for equipment to be installed
	5	Applying delivery one shipping dan avoiding trans-shipment for Main Equipment	Step of work are suitable and appropriate coordination with another department	Communicate with Maker for equipment to be installed	
	6			Working scheme in cooperation with institution, professional and expert	

1. CONCLUSIONS

There are 47 risks from risk identification process, calculation of weight risk using FMEA found 4 risks with highest RPN value from taken from each stage through FGD process that consider affecting for the delay of the project. R12 with RPN:64, R23 with 39TRPN:48,39T R24 with RPN:36.18 and R45with RPN:21.76. 39TThe risk of changes in medical device specifications is affecting other risk events, where the existing contract must then be changed, the drawing design also be adjusted and re-approved to the Classification Society. The delay in the drawing will cause delay in the process of submitting a material request which resulting in delay of required material. The limitations of worker skills in the installation & commissioning

of medical devices will also affect the production process which will eventually lead to the delay of the project.

Priority Risk and Mitigation was done using AHP with result as per Table 3, even though result FMEA method showing the highest RPN value however in this research is not priority risk for management. Result from AHP method showing different priority for risk from RPN of FMEA method

At new construction process of a shipbuilding industry especially for a prototype ship there is possibility of a new risk arise that has to be considered and anticipated to avoid delay or even penalty, It is advise that all new equipment specifications going to be installed has to be approved by Classification Society and future owner of the ship, the equipment also has to be available in the market to avoid changing in specifications.

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RISK MANAGEMENT TO PLAN CHANGES IN FEEDER VALVE LINE PROJECT AT PT. IPBS BY PT. KAMANJAYA TEKNIK INDONESIA AS CONTRACTOR USING RFMEA

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ABSTRACT

PT. IPBS is one of the power generation plant industry company which produces electricity using boiler with combustion of coal for energy production. Modification of feeder valve line, which is a part of boiler system unit has made during operational process. In this system line, combusted fly ash is distributed through pipes with a layer of material that matches the characteristics of the material. To execute the project, PT. IPBS has been cooperated with PT Kamanjaya Teknik Indonesia as contractor. There are several of potential risks of modification feeder valve line. Therefore, risk management is needed to perform as well as to mitigate the high risk. The objective of this thesis is to identify risks of feeder valve modification using Risk Failure Mode Effect Analysis (RFMEA). The process includes risk assessment by doing FGD to determine the likelihood, impact and detection of each risk with output of the RFMEA is Risk Priority Number (RPN), then Pareto will be used to rank the risk priority. Chipped ceramic coating, changing fly ash silo tank pipeline, and new pipe not conforming to standards and easily detached are risks with the highest RPN with scored 800, 720, and 432 respectively and need mitigation. Finally, risk mitigation in the form of risk transference will be conducted to the critical risks to minimize impact to project cost, project schedule, and technical issue.

Keywords: Feeder Valve, Risk Failure Mode Effect Analysis (RFMEA), Risk Management.

1. INTRODUCTION

As a company that supplies electrical power needs, PT. IPBS requires heat to be used to heat water. Heat is supplied from a section called the Combustion Boiler, while combustion will remove the combustion gases that contain a lot of dust. Considering that the fuel used is coal, the remaining combustion products in the form of the flue gas are discharged into the air. This can result in air pollution.

One way that is used to overcome the dangers of air pollution is to use a system that can filter the flue gas from coal combustion called fly ash so as not to cause air pollution. In modern coal-fired power plants, fly ash is generally captured by an electrostatic precipitator before the flue gases reach the chimney. In the performance of moving the fly ash material, it is often also called a transporter. An illustration of the performance of the Flowline feeder valve is that the Feeder valve is in the open position. With the help of an ID fan, fly ash will flow through an 8-inch diameter pipe to the feeder valve in a certain density position. The feeder valve will open with pneumatic control so that the fly ash will flow into the holding tank and then flow back with a 4-inch pipe to the final reservoir.

PT. IPBS which is engaged in the electricity industry has experienced problems in handling fly ash from the utilization of the boiler unit used, namely the feeder valve pipe from the boiler unit, which needs to be repaired and replaced. If an error occurs in changing the feeder valve pipe, it can generate electricity. Therefore PT. IPBS to execute this project has collaborated with one of the contractors, namely PT. Kamanjaya Teknik Indonesia in handling the utility system from the coal processing used. One of them is in handling fly ash from the existing boiler operation. Thus, to minimize the risk to costs, schedules and identified technicalities can be controlled and supervised by PT. IPBS and PT. Kamanjaya Teknik Indonesia following risk management on a project.

This study will calculate Risk Priority Number based on likelihood, impact, and detection score for each risk and later determine the critical risks. After finding the critical risks, will be determined the mitigation strategies for each critical risk.

The objectives of this study are: (i) analyzing the risks arising from changes to pipe planning on the Feeder Valve, (ii) analyzing the frequency, impact, and magnitude of the risk to the project on material changes and changes from the pipe on the Feeder Valve Line in the Electricity Industry of PT. IPBS by Contractor PT. Kamanjaya Teknik Indonesia, and (iii) determining risk mitigation in planning changes in the Feeder Valve Line project in the Electricity Industry of PT. IPBS by Contractor PT. Kamanjaya Teknik Indonesia.

2. FEEDER VALVE LINE

Fly ash from coal combustion discharged from power plants will be distributed through feeder valve pipes, where feeders are generally classified into two main categories, volumetric and gravimetric. Volumetric feeders, such as screw, brush, and rotary valve feeders, dispense particle volume as a function of time, while gravimetric feeders, such as belts and vibrating devices, weigh the mass of the delivered particles. Each type of feeder has advantages and disadvantages related to feed rate sensitivity, feed rate capacity, construction difficulty, simplicity of operation, maintenance, and cost (L.Tang, 1999; C.Parker, 2000).

The operation of the conventional rotary valve feeder is based on the injection of free flowing granular particles from the hopper into the fluid stream or process line by means of a rotary valve. The rotary valve feeder is one of the widely used volumetric type feeders due to the advantages of low cost, easy construction, reliability for high and low feed rates, and simplicity of operation. However, there are some drawbacks, such as; feeder is unstable, especially at low feeding rates (M. Scheibe, et al. (1997); M. Ayik (1990), particles stick to valve pockets (M.Y. Gundogdu, 1995), interlocking or cohesive loops of particles formed in over the valve in the hopper (J. Marinelli and JW Carson, 1992), and the repulsion of low density particles back into the hopper when the material level in the hopper drops below a critical value (M. Ayik, 1990; M.Y. Gundogdu, 1995). Feeder Valve Line can be seen in the figure below.

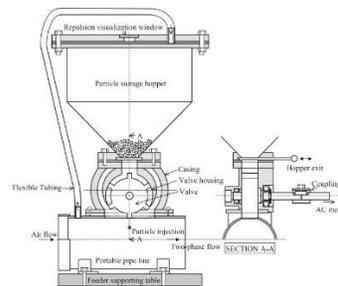


Figure 1. Feeder Valve Line

3. PROJECT RISK FMEA

3.1 Risk Management for Project

The main objective of risk management is to reduce the negative impact of risks that occur by recognizing and managing threats to prevent potential losses and increase the organization's responsiveness to risks that occur. Risk management specifically aims to increase transparency regarding risk (Sanchez et al., 2009), improve decision-making (McFarlan, 1981), and increase risk management capacity (Lee et al., 2009).

Project risk is defined as the uncertainty of an event or condition which if it occurs has a positive or negative effect on the project objectives (PMI, 2000). Today, managing risk effectively is an essential element of successful project management. Proper risk management can help project managers to reduce known and unexpected risks in all types of projects. Failure to carry out effective risk management can result in projects going over budget, behind schedule, missing critical performance targets, or exhibiting a combination of problems.

Indeed, there are several factors that determine the success or failure of a project, but it seems that failure to carry out adequate risk management will increase the likelihood of failure. The old axiom, "failing to plan means planning to fail," seems to apply to risk. Having an effective method for planning and managing project risk that is easy for the project team to understand, use and implement is essential. As projects increase in complexity and size, taking a multidisciplinary approach to project management requires proper attention to risk management. One of the simple risk management is Risk FMEA which has proven to be useful for managing risk in a project and increasing project success.

3.2 Definition of RFMEA

Project RFMEA is a tool to identify, measure, and eliminate or reduce risk in a project environment versus with product technical aspects as identification on FMEA. RFMEA is used in conjunction with FMEA which is developed for product design, process development, and service deployment. The standard FMEA sample and form RFMEA in the "failure mode" column are replaced with "risk events". Second, "occurrence" are called "likelihood". Third, "severity" is called "impact". Likelihood, impact, and detection values are set by the project team based on standard tables, unlike those provided for standard FMEA. However, the definition of impact attributes can be modified for the project environment (Graves, 2000). The RPN value is the multiplication of likelihood, impact, and detection values.

4. ANALYSIS OF RFMEA

4.1 General Information of PT. Kamanjaya Teknik Indonesia

PT. Kamanjaya Teknik Indonesia is a company headquartered in Surabaya, geographically it is very strategic to become an industrial city, which refers to these conditions PT. Kamanjaya Teknik Indonesia has the prospect of realizing its mission, which is to become one of the companies that transfer technology to partners in every industry and provide jobs for self-employers, thereby increasing welfare and maintaining customer satisfaction, and always supporting innovation and technology to keep up with the times. Forecast turnover of PT. Kamanjaya Teknik Indonesia per year is Rp 20 billion obtained from the core business of mechanical construction and fabrication as well as machine installation.

4.2 Data Collection

Focus Group Discussion research is a systematic effort in collecting information and data. This method relies on obtaining information or information from an interaction of experts based on the results of the dialogue in a group that focuses on carrying out discussions in solving certain problems.

There is a team that conducts FGD to conduct Risk Failure Mode and Effect Analysis (RFMEA) in identifying risks. The team involved is the same person in conducting risk assessment and control on boilers at PT IPBS previously, consisting of 1 Quality Assurance Personnel, 7 Engineers, 1 Production

Supervisor. The following is a table of FGD results.

Table 1. FGD Results

No.	Risk Identification	Sub-Activity	Risk Events
1	Work Drawing Correction	Change radius at elbow is shorter	Blocking occurs at the elbow
		Change of valve type from PN 16 to PN 10	Valve performance down
		Change to Y pipe	Y Pipe is blocked
		Change of existing pipe for flands	The new pipe is not up to standard and comes off easily
		The angle change at the elbow is narrower	Blocking occurs at the elbow
2	Comparison of Work Drawing and the Actual Unit	Change in height of fly ash silo tank	The fly ash storage silo tank pipeline changed
		Change of pipe joints from flanks using welding	The ceramic coating is peeling off
3	Bill of Quantity Correction	Miscommunication to detail the number of components	There is a lot of miscommunications between the owner and the contractor
		Partly no pipe connecting material	The pipe will erode quickly

The data obtained from the FGD is then calculated for the event data and the various risk events/hazards that are handled. PT. Kamanjaya Teknik Indonesia already has procedures to identify risks/hazards, conduct risk assessments, and control which includes a format for its activities. All these risks are tabulated and combined with their risk weights to determine the RFMEA method and determine the Likelihood, Impact, and Detection values. The determination of these three values will determine the critical risk and PT. Kamanjaya Teknik Indonesia has its own standards for rating likelihood and impact and these standards are used in this study.

4.3 Data Processing

After the risks are identified, the likelihood, impact and detection values will be determined to calculate the Risk Priority Number (RPN). Following are the criteria and description of the Likelihood (L), Impact (I), and Detection (D) values.

Table 2. Criteria and Description of Likelihood Value

Likelihood of Risk	Possible Risk Level	Rating
Very high: failure is almost inevitable	\geq of 2	10
Very high	1 of 3	9
Repeated failure	1 of 8	8
High	1 of 20	7
High enough	1 of 80	6
Likelihood of Risk	Possible Risk Level	Rating
Moderate	1 of 400	5
Relatively low	1 of 2000	4
Low	1 of 15,000	3
Isolated	1 of 150,000	2

Almost impossible	1 of 1,500,000	1
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Table 3. Criteria and Description of Impact Value

Impact	Criteria: Severity of Impact	Rating
Hazardous	Hazardous risk and occurs without warning. May suspend the operation of the system and/or involve non-compliance with the government	10
Seriously	Risk involves dangerous outcomes and/or non-compliance with government regulations or standards	9
Extreme	The appliance cannot be operated with loss of the main function. The system cannot be operated	8
Major	Tool performance is severely affected but it works. The system may not operate	7
Significant	Device performance decreases. Convince function may not operate	6
Medium	Moderate effect on tool performance and requires improvement	5
Low	Minor effect on tool performance and does not require repair	4
Minor	Minor effect on device or system performance	3
Very small	Very little effect on device or system performance	2
None	No consequences	1

Table 4. Criteria and Description of Detection Value

Detection	Criteria: Likelihood of Detection by Design Control	Rating
Absolute Uncertainty	Design controls do not detect risk causes; or no design control	10
Very Isolated	Very unlikely, design controls will detect the cause of the risk	9
Isolated	Opportunity remote design control will detect the cause of risk	8
Very low	Very low probability, design controls will detect the cause of the risk	7
Low	Low probability that design controls will detect the cause of the risk	6
Moderate	Moderate chance, design control will detect the cause of risk	5
High enough	A high enough chance that design controls will detect the cause of the risk	4
High	Most likely the design controls will detect the cause of the risk	3
Very high	Very high probability, design controls will detect the cause of the risk	2
Almost Sure	Design controls will almost certainly detect the cause of the risk	1

From the data for the three parameters, a new tabulation can be made to determine the RPN value obtained with the following formula:

$$RPN = Likelihood (L) \times Impact (I) \times Detection (D)$$

Getting the value of the RPN is an important step in determining the level of risk with RFMEA method because of the value of the RPN will be known priority risks including critical risk. The value of the RPN obtained as shown in Table 5 below.

Table 5. Likelihood, Impact, Detection, and RPN Values

No	Risk Events	L	I	D	RPN
1	Blocking occurs at the elbow	6	7	4	168
2	Valve performance down	9	7	4	252
3	Y Pipe is blocked	6	9	6	323
4	The new pipe is not up to standard and comes off easily	6	8	9	432
5	Blocking occurs at the elbow	6	9	5	270
6	The fly ash storage silo tank pipeline changed	10	8	9	720
7	The ceramic coating is peeling off	10	8	10	800
8	There is a lot of miscommunications between the owner and the contractor	10	9	4	360
9	The pipe will erode quickly	4	5	5	100
RPN TOTAL					3425

Based on the data from Table 5, a Pareto diagram can be made to rank the RPN as shown in Figure 2.

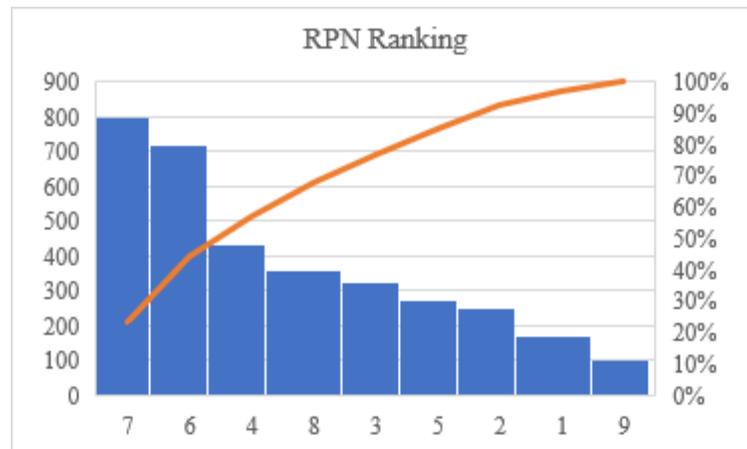


Figure 2. RPN Rating Graph with RFMEA Method

Figure 2 shows the risk codes sequentially starting from the highest RPN value to the lowest. Based on the risks that have been registered and the value of each RPN is known, the critical risk can be determined. A risk is categorized as critical risk if it has an RPN above the critical value. The critical RPN value is determined from the average RPN value of all risks.

$$RPN \text{ Critical Value} = \frac{\text{Total RPN}}{\text{Number of Risks}} = \frac{3425}{9} = 380,55$$

Based on the critical value above, three critical risks are also obtained. The RPN value of the three risks is above 380.55 which is the critical value of the RPN. Critical risk can be seen in Table 6.

Table 6. Critical Risks Based on RFMEA

No	Risk Events	L	I	D	RPN
4	The new pipe is not up to standard and comes off easily	6	8	9	432

6	The fly ash storage silo tank pipeline changed	10	8	9	720
7	The ceramic coating is peeling off	10	8	10	800

4.4 Mitigation Planning for Critical Risks

Risk mitigation planning is the process of developing options and actions to increase opportunities and reduce threats to a project's objectives. After getting the three critical risks in the previous subchapter, it is necessary to plan mitigation for the three critical risks.

To plan risk mitigation starts from making a risk map. The risk map is created using the likelihood and impact scores of critical risks. Of the three critical risks, it is necessary to map them to determine the mitigation plan. Below is a risk map for the three critical risks.

Table 7. Risk Map for Mitigation

Likelihood		Impact				
		Not Significant	Minor	Medium	Major	Catastrophic
		1	2	3	4	5
5	Almost Certain				Risk 6 Risk 7	
4	Likely					
3	Possible				Risk 4	
2	Unlikely					
1	Rare					

The fly ash storage silo tank pipeline changed risk and the ceramic layer peeling off risk are in the red zone, while the new pipe is not up to standard and comes off easily risk is in the yellow zone. These three risks need to be mitigated in the form of risk transference, which in mitigating these risks is handled by a third party in mitigation which in this case is handled by PT Kamanjaya Teknik Indonesia as the contractor.

5. OBSERVATION AND DISCUSSION

Assessing the impact of risk mitigation is not easy to do because there is no easy way to know for sure the impact of risk if the team does not handle it with a contingency plan. In this project, from a total of 9 identified risks, PT. Kamanjaya Teknik Indonesia handles 3 critical risks. The 3 critical risks are obtained from the results of data processing using RFMEA.

The 3 critical risks are the ceramic layer peeling off, the fly ash storage silo tank pipeline changed, and the new pipe is not up to standard and comes off easily of sub-activities change of pipe joints from flanks using welding, change in height of fly ash silo tank, and change of existing pipe for flands respectively.

After determining which risks are critical, the next step is risk mitigation. Of the four risk mitigation strategies, which are risk acceptance, risk limitation, risk avoidance, and risk transference, the

three critical risks are mitigated in the form of risk transference because these three risks are in the red zone of risk mitigation and need to be handled by a third party, namely PT. Indonesian Engineering Headquarters.

RFMEA has been used in several subsequent short-lived projects and projects lasting more than one year. This method has been applied to facility closures, facility expansions, business process development, process transfers, as well as several new product development projects. The risk management knowledge area is critical to the project management process, and organizations must make concerted efforts to ensure the tools they use provide them with the level of insight and value they need.

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A LITERATURE REVIEW: IMPLEMENTATION OF KRALJIC'S MATRIX PORTFOLIO AS A PROCUREMENT STRATEGY IN VARIOUS SECTORS

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ABSTRACT

Procurement as part of the main functions of SCM plays an important role in increasing the competitiveness of companies in the global order nowadays. The principle of procurement which was originally administrative and passive over time has turned into strategic role for the company. The percentage of material costs that more than 50% of the total production cost of a product makes efficiency in procurement can increase long-term profits and enable companies to keep up with increasingly fierce and competitive global competition. On the other hand, the procurement strategy in government agencies is oriented to the principle of good governance to provide the best service for the public. One of the procurement strategies that has been widely researched is the Kraljic Matrix Portfolio. This matrix provides a portfolio approach to purchasing goods by considering two dimensions, namely the importance of purchases to the company's profit and the complexity of the supply market. This paper aims to provides a literature review about strategic procurement literature focusing on procurement strategy and Kraljic Matrix. This study is the initial step of further work in developing a framework on procurement strategies in the higher education field using the Kraljic Matrix.

Keywords: Supply Chain Management, Procurement strategy, Kraljic's Matrix Portfolio

SECTION 1: INTRODUCTION

This review is expected to encourage more studies on procurement in education sector. There are many studies on procurement strategies in the private sector, but there is still very little discussion about procurement in the education sector, including its procurement strategy. In many studies, procurement research in the private sector has been carried out in various sectors. Basically, the procurement of goods and services is attached to the manufacturing company for

the purchase of raw materials and product components. The 1980s were a time when procurement activities were considered as part of the company's strategic activities. This is influenced by the views of experts who see that increasingly fierce business competition makes business actors need efficiency and value creation on all lines, not only the production department, but also the procurement department (Pujawan and Er, 2017). Not surprisingly, the procurement strategy has become one of the crucial factors that can affect the performance of a company or organization (Padhi et al., 2012). In terms of costs, not a few manufacturing companies spend on the purchase of materials and components that reach 50-70% of every sales dollar (van Weele, 2005). This has become one of the most important activities in the manufacturing business, thus influencing the key strategies to achieve high quality, high variety, low cost, and fast delivery of the final product (Lee and Drake, 2009). The relevance of this procurement role becomes increasingly important considering that material costs which can reach 50-70% of the cost of the final product can mean that the cost of these raw materials can exceed the added value during the production process. This is a strong signal that efficiency in the procurement department can make a real contribution to increasing company profits (Pujawan and Er, 2017).

In contrast to the goals of profit-oriented private companies, the procurement of goods and services within government agencies is carried out as a form of obligation to provide good service to the public. In addition, the strategy for the procurement of goods/services within the government is based on accountability and transparency as part of efforts to utilize the state budget in supporting the implementation of the main tasks and functions of agencies by prioritizing the provision of added value to organizations related to the interests of service improvement. Therefore, the government is required to realize good governance by increasing efficiency and effectiveness in the process of procurement of goods/services through appropriate procurement strategies as an effort to achieve the vision and mission of government organizations in the interest of public services (Sopian, 2012).

Procurement of government goods/services is an activity that plays an important role in the implementation of national development in order to improve public services and develop the economy both nationally and regionally. Based on article 1 number 1 of Presidential Regulation Number 16 of 2018 concerning Government Procurement of Goods/Services, government procurement of goods/services is defined as “the activities of procuring goods/services by Ministries/Institutions/Regional Apparatuses financed by the APBN/APBD whose process begins with the identification of needs, until the handover of the work. The implementation of public procurement which has also been regulated in Presidential Regulation Number 16 of 2018 includes the provision of goods in the form of tangible or intangible, movable or immovable objects that can be traded, used, used or utilized by Property Users, Construction Works, Consulting Services, and Other Services which are non-consulting services or services that require equipment, special methodologies, and/or skills (Perpres No. 16/2018, article 1 paragraph 29-32). Meanwhile in Article 20 paragraph 1 it is stated that the packaging of the procurement of goods/services is carried out with an orientation to: output/results, volume of goods/services, availability of goods/services, capability of business actors, availability of budget.

Research on procurement strategies in the private sector using a portfolio model approach to two elevator manufacturers in South Korea found that the procurement portfolio model is an effective tool in developing different procurement strategies but still aligned with the business strategy despite some limitations (Lee and Drake, 2010). Meanwhile, a study on public procurement strategies, namely on new university projects in South Africa, was conducted to determine the relationship between procurement strategies and their results (Laryea, 2018). The results show that a suitable procurement strategy developed by an experienced client team and proactively executed by an integrated delivery team working collaboratively is most likely to achieve the desired project outcome. This study only

focuses on the construction sector and does not use quantitative measurement variables. Other research on procurement strategies for facilities and infrastructure in universities using a portfolio model was carried out with a case study at Diponegoro University (Aditya et al. 2018). This study uses the Kraljic Purchasing Portfolio Model in determining the strategy for the procurement of office and construction facilities.

SECTION 2: SUPPLY CHAIN MANAGEMENT AND PROCUREMENT

As stated earlier, this research is a literature review on the application of the Kraljic Matrix as a strategy for procurement or purchasing of goods or materials as part of supply chain management in various sectors, both private and government agencies. Discussions about procurement strategies for companies have been carried out with various advantages and disadvantages, but articles on procurement strategies in the government sector, especially universities are still limited so that journal databases come from various accesses. This study uses a qualitative approach by elaborating the results descriptively.

2.1 Supply Chain Management

Before discussing supply chain management, it is necessary to understand the meaning of supply chain first. According to Pujawan and Er (2017), supply chain is a network of companies that work together to create and deliver a product into the hands of end users. These companies include suppliers, manufacturers, distributors, stores or retailers, and supporting companies such as logistics service companies. From the above definition, it can be seen that the supply chain of a product consists of several streams that must be managed. Usually this supply chain has 3 types of flows that must be processed, namely the flow of goods flowing from upstream to downstream, the flow of money and the like flowing from downstream to upstream, and finally the flow of information that can occur from upstream to downstream or vice versa. The three streams have their respective interests, but what plays a very vital role is the flow of information. The company's ability to manage the flow of information transparently and accurately will result in good supply chain performance. For example, information on product inventory in stores, information on supplier production capacity, and delivery status information for both raw materials and finished products, all of which, if available and can be accessed with precision, will enable interested parties to monitor for more accurate planning purposes. In the end, the relationship scheme between all these companies forms a network that is widely known in the world as the supply chain.

So, how to define Supply Chain Management (SCM)? Quoting from Pujawan and Er (2017), the term SCM was originally proposed by Oliver & Weber in 1982 (Oliver & Weber, 1982; Lambert et al. 1998). SCM is a method, tool, or approach to supply chain management as a physical network of companies involved in supplying raw materials, producing goods, or distributing them to end users. The methods applied must be integrated with the basic concept of the spirit of collaboration between various elements. Another definition of SCM is given by the Council of Supply Chain Management Professional (CSCMP), namely:

“Supply Chain Management includes the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third party service providers, and customers. In essence, Supply Chain Management integrates supply and demand management within and across companies.”

From the definitions above, it is clear that the spirit of coordination and collaboration between elements of the company, both internal and external, whose main goal is to satisfy end consumers by making products that are acceptable to customers, is not only in terms of quality, but also in terms of price and on time delivery. If you look at the job responsibilities, especially in manufacturing companies, in general SCM has a coverage area with six main parts, namely product development, procurement, planning & control, operations/production, delivery/distribution, and returns.

2.2 A Brief History of the Strategic Role of Procurement

Within the SCM coverage area, there are main activities, one of which is related to procurement. Procurement activities can be defined as all activities in providing input in the form of goods or services needed in carrying out production activities or other activities within the company. There is a slight difference in the role of the procurement department in retail and manufacturing companies. If a retail company assigns a task to the procurement department to obtain goods (merchandise) to be sold, while a manufacturing company divides the purchase of goods into several classifications such as components and raw materials for production needs, production support equipment (machinery and so on), and materials for maintenance, repair, and operational activities in the form of office stationery, machine parts, and others (Pujawan and Er, 2017)

The era of the 1970s was a time when these purchasing/procurement activities were considered only as supporting activities. This can be seen from the company leaders placing low-qualified people both at the staff level and the leadership of the procurement department so that the procurement department plays a passive role in the company's business line (Amer, 1974). Many other authors support this opinion and state that procurement is only an administrative activity without strategic content so that procurement managers are usually not involved in decisions that are strategic for the company. It wasn't until the late 1980s that this perception began to shift and change. Competition is increasingly competitive and many manufacturing companies are competing to become world-class manufacturers accompanied by continuous improvement in terms of cost efficiency, product quality improvement, and with a distribution system that is responsive to customers (Morgan, 1989). This can happen because the role of the procurement department changes to the involvement of suppliers in creating product and service innovations that will be produced by the company, for example in the telecommunications industry that provides competitive and innovative services that are very dependent on the process of product innovation in the upstream and cooperation between those in the upstream sector. upstream and downstream of the telecommunications industry to design innovative new products (Carter et al., 2007). Not to mention in terms of material costs which reach 40%-70% of the cost of a final product, it can be said that the cost of raw materials is greater than the added value that exists when the product is in the production process.

Another aspect that is also influential is the quality of the product which will be better if the procurement department is able to obtain sources of high quality raw materials and components by bridging good relationships with suppliers so that they can jointly improve quality. Such a strategic role, of course, cannot make the procurement department only administrative in nature but must have negotiating skills, have the ability to interpret the company's strategic objectives into technical and operational supplier selection and evaluation so as to create long-term collaboration with relevant suppliers in terms of design. new products, can evaluate supply risks, and so on (Pujawan and Er, 2017).

2.3 Procurement of goods and services

Procurement can be defined as: "acquiring by various means (eg loan, transfer, lease purchase) inventory and servicing with or without consideration" (Compton and Jessop, 1995). While another definition of procurement is as follows: "all the activities required to get the product from the supplier and bring it to the place where the product is actually used. It includes the functions of purchasing, storage, traffic and transportation, inbound inspection, and quality control and assurance. Some companies also include salvage and management of environmental issues (as they relate to materials) in their procurement" (Van der Weele and Rozemeijer, 1996). Procurement can also be interpreted as "purchasing, contracting, and logistics where logistics is considered as inventory control, warehousing, transportation, quality assurance, and control. The difference between buying and contracting is that contracting is usually a major job-related buying activity" (Quayle et al., 2000).

The term “procurement” is often used primarily when it involves the purchase of goods/services by the government. Explanation of specific purchasing activities, “Participation in the development of requirements and specifications; managing value analysis activities; conduct supply market research; managing supplier negotiations; carry out traditional purchasing activities; manage purchase contracts; managing supplier quality; and buy inbound transportation.” (Dobler, 1990).

2.4 Procurement Type

There are two types of procurement, namely private procurement and public procurement. Public procurement usually already has very standard rules issued in the form of laws and regulations or government regulations. The implementation of this public procurement itself has been regulated in Presidential Regulation of the Republic of Indonesia Number 16 of 2018 which has now been revised into Presidential Regulation No. 12 of 2021. A complete explanation of the types of goods and services, orientation of procurement packages, methods for obtaining goods and services, and others can be seen in the presidential regulation.

One of the studies on public procurement is presented in a study on the decision- making process related to the provision of facilities management services in the public sector, which refers to local authorities. This paper identifies, based on a literature review, the author's experience, and direct interviews with top managers of companies directly involved in the provision of public and private facilities management services, taking into account significant variables when facing decisions about outsourcing of facilities management in the public sector for both multi-service companies. public or private suppliers (Ancaran and Capald, 2005).

After playing a strategic role in the company, the procurement department is no longer limited to routine purchasing activities but also aims to provide goods and services at low prices (but not cheap), quality, and delivered on time. Therefore, the tasks of the procurement department can be explained as follows, namely designing appropriate relationships with suppliers, selecting suppliers (especially key suppliers and suppliers located abroad who have the potential to establish long-term relationships), selecting and implementing appropriate technology, maintain data items needed (including supplier data), negotiate and purchase, and evaluate supplier performance (Pujawan and Er, 2017).

SECTION 3: KRALJIC MATRIX PORTFOLIO

Kraljic (1983) introduced a portfolio approach to purchasing in which purchased goods are classified on the basis of two dimensions, the importance of the purchase and the complexity of the supply market. Items are classified by evaluating and positioning them into one of the four quadrants of the two-dimensional portfolio model. The quadrants represent different buying strategies. Gelderman (2003) defines a portfolio model as a tool that uses two or more dimensions to define heterogeneous categories that provide different strategic recommendations. The purchasing portfolio model allows a business to identify the purchased items as more important from a purchasing strategy point of view, helping it achieve a sustainable competitive advantage and high profitability (Wagner and Johnson, 2003).

The Kraljic matrix has become the standard in the field of purchasing portfolio models, although there are other suggestions with slightly varying nuances (Lamming & Harrison, 2001), (Gelderman, 2003). The portfolio approach to purchasing considers the dimensions of strategic impact (internal) and supply risk (external) which not only allows management to gain a better perception of bargaining power and consequently choose an adequate strategy but also reduces the company's risk exposure (Kraljic, 1983). Strategic importance can be measured by material

cost/total cost, value added profile or profitability profile while supply risk through factors such as number of suppliers available for a particular product, monopoly or oligopoly conditions, rate of technological progress, barriers to entry, logistics costs, complexity, etc. Every organization, even though it has met the best fit between the matrix as a tool and the reality, must choose its particular criticality. Given multiple purchase portfolios, each product can be grouped according to similarities with respect to supply characteristics, and then ranked by different critical factors (Ferreira and Kharlamov, 2012).

Lee and Drake (2009) explain that the purchasing portfolio model has received a lot of attention in the academic and business fields. this purchasing portfolio model is easy to understand and provides practical guidance on how to manage various purchased goods, suppliers, and supplier relationships (Dubois and Pedersen, 2002). The survey found that 74% of Dutch buyers (Gelderman, 2003) and 55% of French buyers (Kibbeling, 2005) in the manufacturing and engineering sectors used purchasing portfolio analysis. In a survey of 122 UK firms across manufacturing, services and other industries, purchasing portfolio analysis was found to be the second most used of 65 purchasing and supply tools, with vendor ranking preferred (Cox and Watson, 2004).

According to Garzon et al. (2019) in the classic Kraljic Model, the items to be purchased are placed on two axes: Strategy and Risk. The meaning of these axes is: the profit impact of a particular inventory item can be defined in terms of volume purchased, percentage of total purchase cost, or impact on product quality or business growth. Supply risk is assessed in terms of availability, number of suppliers, competitive demand, make-or-buy opportunities, and storage risk and possible substitution. Using this criterion, the company sorts all purchased goods into the categories shown in Figure 1: strategic (high profit impact, high supply risk), bottleneck (low profit impact, high supply risk), leverage (high profit impact, low supply risk), and non-critical (low profit impact, low supply risk).

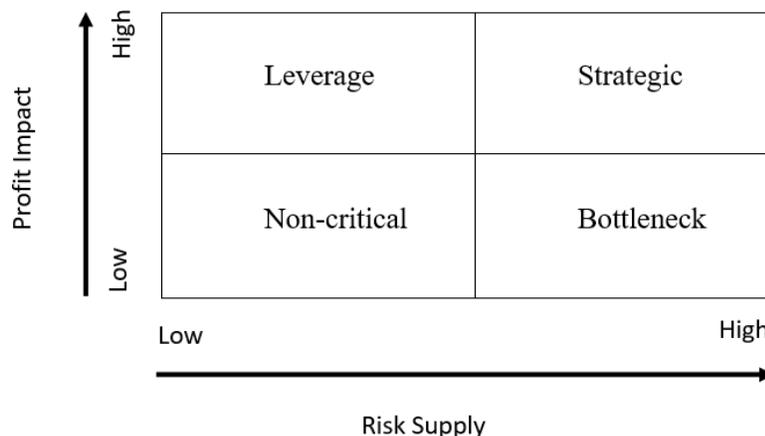


Figure 1. Kraljic Matrix (Kraljic, 1983)

Each of these four categories requires a different buying approach, the complexity of which is outweighed by the strategic implications. Companies may need to support strategic supply decisions with a wide range of analytical techniques, including market analysis, risk analysis, computer simulation and optimization models, price forecasting, and other types of microeconomic analysis. Decisions about bottleneck items may require specific market analysis and decision models for resolution, while vendor and value analysis, price forecasting models and decision models may play a role in issues affecting leveraged materials. When it comes to non-critical items, a simple market analysis, policy decision, and inventory optimization model may usually suffice (Garzon et al., 2019).

SECTION 4: RESEARCH OPPORTUNITY - A DISCUSSION

Literature review was conducted using textbooks and journal databases through various accesses. Table 1 shows the various implementations of the Kraljic Matrix in procurement strategies in both the private sector and government agencies. The procurement strategy using the Kraljic Matrix in the private sector can be said to be successful with various models that have been adapted to each company. The purchasing portfolio model used by Kraljic can complete the search for material purchases such as the purchase of certain spare parts, selection of suppliers according to the company's wishes, availability of company policies related to procurement, reduction of waiting time for critical supply chains, etc.

However, from the various sectors shown, research related to procurement strategies in the education sector can be said to be very limited. A detailed search of the literature reveals very few comprehensive studies examining procurement strategies in the educational environment. This raises a separate question regarding the implementation of a procurement strategy using the Kraljic Portfolio Matrix model in the education sector.

With slightly different orientations and objectives between the private and government sectors, the procurement strategy using Kraljic's Matrix Portfolio at this university will be made several adjustments considering that procurement at government agencies is strictly and formally regulated. However, the final goal of the organization remains in purchasing the right goods or services with the right method.

Thus, important questions to have further research are:

Q1: Does the procurement of goods and services in government agencies, particularly the education sector, require a specific procurement strategy?

Q2: How will it affect the results of the project for the procurement of goods and services?

Table 1. Implementations of the Kraljic Matrix Portfolio as a Procurement Strategy in the Various Sectors

Writer	Objectives	Method	Results
Zemmy & Setiyowati (2021): "Strategic Framework Supply Chain through Kraljic Purchasing Portfolio in O&M Power Plant Company"	Determine a flexible and extensible model (strategic framework) in classifying material / service requirements as a guide for the procurement of power plants providing the company's operation and maintenance (O&M) services.	a. Describe the company's supply chain b. Determine procurement targets c. Performing a purchasing/ procurement portfolio analysis using the Kraljic Matrix	a. Specific spare parts supply chains with limited suppliers can be identified and strategies are implemented in the form of partnerships. b. Improvement of critical equipment supply chain by reducing waiting time for critical equipment spare parts.
Garzon et al. (2019): "A green procurement methodology based on Kraljic Matrix for supplier's evaluation and selection: A case study from the chemical sector"	Develop a Green Supply Chain Management (GSCM) framework and propose a green procurement methodology for selecting and evaluating suppliers through a sustainable approach including considering social, ecological, and economic criteria.	a. Analyzing raw materials with Kraljic Matrix b. Using Kraljic Matrix to select suppliers c. Comprising the suppliers for a particular product d. Comprising the suppliers for several products in different Kraljic quadrants	a. Selection of the best supplier can be done by classifying items on the Kraljic matrix and combining them with an aggregation method based on the amount weighed. b. The application of the methodology proves the subjectivity of certain methodological phases, namely weighting by decision makers and risk evaluation, on a scale of 1 to 10.
Ghanbarizadeh et al. (2019): "A purchasing portfolio model for the commercial construction industry: a case study in a mega mall"	Develop a purchasing portfolio model based on the Kraljic model in the context of multi-criteria decision making to overcome the complexity of the purchasing process from various items and their suppliers.	Using the DEMATEL-ANP-VIKOR hybrid technique to weigh and enter one of the main requirements in the Kraljic Portfolio Matrix (strategic, leveraged, bottleneck, and non-critical categories).	a. Provide a purchasing portfolio model that examines the relationship between criteria and determines the level of influence and permeability of each criterion to each other. b. Provides purchasing policies for organizations that are based on a price index to assess the buying process. c. The proposed model of this paper has high implementation potential.

Writer	Objectives	Method	Results
Bianchini et al. (2018): "Supply chain redesign for lead-time reduction through Kraljic purchasing portfolio and AHP integration"	Provides a flexible and extensible model for supplier classification, in purchasing guidelines and market trends from a small Italian company, a leader in the production of street lamps. This model is applied to identify critical supply chains with the ultimate goal of reducing lead times.	<ol style="list-style-type: none"> Describing the company and its supply chain Analyzing purchasing portfolio using Kraljic Matrix Analyzing Lead-time 	<ol style="list-style-type: none"> A systemic and flexible model for classifying suppliers in terms of their relevance and for identifying the existence of several critical relationships. Identify critical supply chains in response to the company's need to reduce lead times and consequently to develop new business opportunities.
Montgomery et al. (2018): "A quantified Kraljic Portfolio Matrix: Using decision analysis for strategic purchasing"	Provide a new approach to objectively and quantitatively positioning products and services within KPM. Provide an approach to decision makers to identify products and services that are optimal candidates for initiating strategic sourcing initiatives.	<ol style="list-style-type: none"> Analyzing the decision multi-objectives Measuring the Product and Service Codes (PSC) attributes Plotting each PSC on the organization's modified KMP Analyzing Multi-attribute value function 	<ol style="list-style-type: none"> By implementing strategic sourcing through a purchasing portfolio framework, organizations can more aggressively increase their purchasing power and choose appropriate sourcing strategies and tactics With Kraljic's portfolio matrix serving as a diagnostic and prescriptive purchasing portfolio framework, it provides purchasing managers with an objective quantitative approach to identify products and services that are ripe for strategic procurement initiatives.
Aditya et al. (2018): "Determining the strategy for the procurement of office and construction facilities at Diponegoro University using Kraljic's Purchasing Portfolio Model"	Develop a procurement strategy using the Kraljic Matrix in procuring office and construction items at Diponegoro University	<ol style="list-style-type: none"> Data collection through focus group discussions Calculation of the weight of each decision criterion using the Analytic Hierarchy Process Grouping procurement items into four quadrants of the Kraljic Matrix 	<ol style="list-style-type: none"> Different groups of items are divided into four quadrants of the Kraljic Matrix according to their respective weight values The implementation of the procurement strategy is appropriate and has been adjusted to the applicable regulations in <u>India</u>

Writer	Objectives	Method	Results
Saueressig et al. (2017): "Strategic Materials Positioning Matrix: An Application in the Automotive Industry in Southern Brazil"	Describes the implementation of the Strategic Materials Positioning Matrix (SMPM) on two groups of goods (bolts and plastic finishing) purchased by a company focused on the automotive industry in Southern Brazil.	<ol style="list-style-type: none"> Using the ABC approach to classifying Stock Keeping Units in industrial companies Using the Kraljic Matrix in purchasing management Improving the Kraljic Matrix model into a Strategic Materials Positioning Matrix 	A significant reduction in the number of shortages observed in the assembly line, and the number of storage facility units required for warehousing.
Lee & Drake (2010): "A portfolio model for component purchasing strategy and the case study of two South Korean elevator manufacturers"	Develop purchasing strategies aligned with competitive priorities as a new approach to purchasing portfolio modeling based on the Kraljic Matrix	<ol style="list-style-type: none"> Defining the dimensions for the matrix Measuring the two dimensions with AHP Using Kraljic Matrix Portfolio and Purchasing Portfolio Model <u>Beusson</u> 	<ol style="list-style-type: none"> Purchasing with a portfolio model is an effective tool for developing a buying strategy that is different but aligned with the business strategy. The positioning of purchases on the 'component value' scale has been made systematic by the application of the AHP to consolidate the qualitative measures of the competitive priorities into a single quantitative measure of a component's impact on the value of the end-product.

SECTION 5: CONCLUSION

This study reviews the literature to provide an overview of procurement in the private and public sectors. This paper can be viewed as an introduction to research or procurement practice and not as a complete documentation of all research activities in procurement strategy. Selection and empowerment of procurement strategies can be a competitive advantage in the portfolio of a material purchasing project. Each model and strategy produced will differ from project to project even within the same sector. In the various case studies that have been discussed, the identification of certain spare parts and their supply chain will provide an accurate picture of the strategy to be taken (Zemmy & Setyowati, 2021), obtaining the best supplier selection against the Green SCM framework (Garzona et al., 2019), Ghanbarizadeh et al., 2019), can reduce waiting times and develop new business opportunities (Bianchini

et al., 2018), have the opportunity to more aggressively increase the purchasing power of the company and choose appropriate sourcing strategies and tactics (Montgomery et al., 2018), etc. Another objective of this study is the initial step in a thesis research that wants to develop a framework on procurement strategies in the university environment as part of procurement in the public sector using the Kraljic Matrix. The focus of the thesis research is on how the Kraljic Matrix can assist the procurement department in implementing the recommended procurement strategy in accordance with the university leadership work program to support the project and ensure success.

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Parallel Session 2

Room N (12.10 – 13.55)

Moderator:

Category : Miscellaneous Topics

ACCEPTANCE ANALYSIS OF VIDEO CONFERENCE TECHNOLOGY IN EAST JAVA PROVINCIAL GOVERNMENT INSTITUTION USING UNIFIED THEORY OF ACCEPTANCE AND USE OF TECHNOLOGY 2 (UTAUT2)

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ABSTRACT

Communication technology continues to develop, especially in the audio visual sector. However, at this time, the Covid-19 pandemic is in full swing and this has caused the government to be aggressive in implementing various new policies such as physical distancing to lockdown. This new policies forces all government agencies in Indonesia to implement a new work system adjustments accordingly. By using video conferencing as a meeting and communication medium, government agencies in Indonesia should be able to adapt to the policies and run office work even though they are far away. However, even though the video conferencing application has quite a number of users, using this application still feels different from meeting face to face. Some people still prefer to hold meetings face-to-face rather than using video conferencing. This is due to several things, such as difficulties in monitoring participants because participants can turn off the camera and microphone, reduced meeting effectiveness due to too many participants, and the highly fluctuating internet connection in various rural areas. This study aims to conduct an analysis to find out factors affecting the acceptance of video conference technology in a government agency in Indonesia in order to provide strategies and acceptance models that can be applied to increase the acceptance of video conference technology in government agencies. The model used to analyze these factors is the Unified Theory of Acceptance and Use of Technology (UTAUT2) which has been adapted in accordance with the problems in this study. This study aims to obtain factors influencing the acceptance of video conferencing technology, especially in government agencies in East Java Province and identify the strategies needed to increase the level of user acceptance.

Keywords: Government, Unified Theory of Acceptance and Use of Technology 2 (UTAUT2), Video Conference

1. INTRODUCTION

People's lifestyles have changed along with the development of information technology, especially in the audio visual field, thus creating many opportunities to do things that are usually constrained by distance such as video calls and video conferencing. The use of video calls allows users

to communicate directly with the other person, while video conference allows users to hold meetings remotely with several people so as to reduce transportation costs, time, and so on.

Currently, the coronavirus or Covid-19 outbreak is ravaging the world. The first case in Indonesia was reported on March 2, 2020, and until June 2021, the number of confirmed cases in Indonesia reached 2,256,851 cases with 60,027 people dying (KPCPEN, 2021). The Minister of Health of the Republic of Indonesia has stipulated the Decree of the Minister of Health of the Republic of Indonesia (Kemenkes) Number HK.01.07/MENKES/328/2020 concerning guidelines for the prevention and control of the corona virus disease 2019 (Covid-19) in offices and industry in supporting business continuity in a pandemic where the 1 meter minimum distance regulation policy is imposed between workers to work from home arrangements (Kemenkes RI, 2020). In addition, based on the Circular Letter of the Governor of East Java Number 800/120/204.3/2021 regarding the work system during the PSBB period for state civil servants within the East Java Provincial government, it is necessary to adjust the work system which is divided into 50% of employees working in offices (WFO/Work From Office) and the rest working at home (WFH / Work From Home) (GUBJATIM, 2021). Therefore, the use of video conferencing in government agencies is one of the safest ways to avoid the corona virus.

Several video conferencing services such as Zoom, Google Meet, and so on are starting to be widely used as a substitute for physical meetings. Although the video conferencing application already has quite a number of users, some users who have used this application still feel the difference by meeting face to face. Some people still prefer to hold meetings face-to-face rather than using video conferencing. Therefore, this study conducted an analysis to determine the factors that influence the acceptance of video conferencing technology users in government agencies in Indonesia, especially East Java Province using the Unified Theory of Acceptance and Use of Technology (UTAUT2). It is hoped that with UTAUT2, the factors that influence the acceptance of video conference technology, especially in government agencies in East Java Province, can be obtained so that strategies can be carried out to increase the acceptance of video conferencing.

2. LITERATURE REVIEW

2.1 VIDEO CONFERENCE

Video conferencing is a communication technology that allows users to hold meetings or meetings at different locations at the same time. Of course, in the use of video conferencing, it is necessary to look at the quality and stability of the speed and reliability of the network signal connection. Users can use the camera on a laptop, computer, tablet, or smartphone (Kagan, 2019). Some video conferencing service providers are Zoom, Google Meet, Skype, and so on.

2.2 TECHNOLOGY ACCEPTANCE

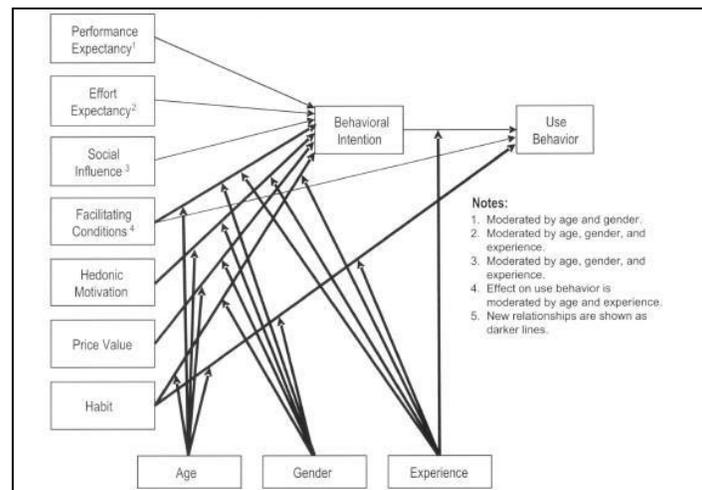
The development of information technology continues to increase so that it is able to make up-to-date applications with high economic value. However, in the development of a technology, developers need to overcome technical obstacles in order to create or make updates in the applications that are made. Therefore, researchers need to do a better understanding in an effort to think of practical methods of evaluating technology and being able to predict how users will react to technology information. Thus, it is hoped that research can create methods that can increase user acceptance (Siregar, 2011)

2.3 UNIFIED THEORY OF ACCEPTANCE AND USE OF TECHNOLOGY 2 (UTAUT2)

In 2012, Venkatesh, Thong, and Xin Xu conducted further research on the UTAUT model in 2003. The purpose of the Unified Theory of Acceptance and Use of Technology 2 (UTAUT2) is to understand consumers in the acceptance and use of technology. In UTAUT2 there are 3 (three)

new variables, namely hedonic motivation, price value, and habit and eliminating 1 (one) moderator namely voluntariness of use. Therefore, in UTAUT2 there are only 3 moderators (age, gender, and experience) that moderate the effect of behavioral intention and use behavior constructs.

Figure 1. UTAUT2 Model



2.4 PARTIAL LEAST SQUARE STRUCTURAL EQUATION MODELING (PLS-SEM)

Structural Equation Modeling (SEM) aims to examine the relationship between variables in a model, either between indicators and their constructs or between constructs (Anuraga et al., 2017). The basic concept is that there are latent variable and manifest variable. Latent variable (unobserved variable) is a variable that cannot be measured directly except by one or more manifest variables where the latent variables are divided into two, namely exogenous latent variables (independent variables) and endogenous latent variables (dependent variables). Manifest variable (observed variable) is a measurable variable to explain or measure a latent variable (Ginting, 2009).

In Structural Equation Modeling (SEM) there are two approaches, covariance-based SEM (CB-SEM) and variance-based SEM (VB-SEM) with Partial Least Square (PLS-SEM) technique. The difference between PLS-SEM and CB-SEM is that CB-SEM focuses more on making methods aimed at explaining the covariances of all construct indicators, while PLS-SEM has a predictive purpose and is more suitable because it assumes that all variance measures are useful variances to explain. (Anuraga et al., 2017). In implementing PLS-SEM, there are processes that must be followed; (Hair Jr et al., 2014) model specifications, evaluation of the outer model, and evaluation of the inner model. In Table 1, the assessment criteria for the PLS model are shown.

Table 1. Inner Model dan Outer Model Evaluation

Criteria	Explanation
OUTER MODEL	
Reflective Measurement Model	
<i>Loading Factor</i>	The loading factor value must be greater than 0.7
<i>Average Variance Extracted (AVE)</i>	AVE value must be above 0.5
<i>Discriminant Validity</i>	The square root value of AVE must be greater than the correlation value between latent variables
<i>Cross Loading</i>	It is expected that each indicator block has a higher loading for each measured latent variable compared to indicators for other latent

	variables
<i>Composite Reliability</i>	Composite reliability must be above 0.6
<i>Cronbach's Alpha</i>	Cronbach's alpha value must be above 0.7
Criteria	Explanation
OUTER MODEL	
Formative Measurement Model	
Significance of Weight Value	The estimated value for the formative measurement model must be significant. This significance level was assessed by a bootstrapping procedure prosedur
Multicollonierity	The manifest variable in the block must be tested for multicollines. The value of the variance inflation factor (VIF) can be used to test this. A VIF value above 10 indicates multicollis.
INNER MODEL	
Estimated path coefficient	The estimated value for the path relationship in the structural model must be significant. This significance value can be obtained by bootstrapping procedure.
R-Square (R2) for endogenous latent variables	The results of R2 of 0.75, 0.5, and 0.25 for endogenous latent variables in the structural model indicate that the model is "good", "moderate", and "weak"

1.1 EAST JAVA GOVERNMENT INSTITUTION

The Circular Letter of the Governor of East Java Number 800/120/204.3/2021 concerning the Work System During the PSBB Period for State Civil Apparatus in the East Java Provincial Government contains adjustments to the work system which is divided into 50% of employees working in the office (WFO / Work From Office) and the rest work at home (WFH / Work From Home) (GUBJATIM, 2021). Therefore, during this Covid-19 pandemic, the East Java Provincial Government has imposed restrictions, especially in terms of official travel or holding meetings or offline meetings. This policy makes all governments in East Java make adjustments using information technology, one of which is changing meetings to online. However, several agencies still haven't switched all their meetings to online applications because there are several issues, such as security issues from video conferencing applications, copies of recordings that Zoom reported to other countries which resulted in teleconferences being monitored by unauthorized parties, as well as concerns about the leakage of application user data.

2. METHODS

2.1 SAMPLING

The sample collected has limitations due to limited cost and time and a large population. Samples were collected using the accidental sampling method where this method is a non-probability sampling technique that determines samples based on chance, so that researchers can take samples to anyone they meet without any prior planning (Sugiyono, 2015).

Samples were obtained from State Civil Apparatus employees who were in government

agencies in East Java Province with the provision that they had used video conferencing technology with a total sample of 205.

2.2 DESIGN

To find out the factors related to the acceptance of video conferencing technology in government agencies in East Java Province, the study was conducted using quantitative research with a survey approach. Based on the information on the variables to be studied. This study uses 14 variables consisting of:

- 9 independent variables, namely performance expectancy, effort expectancy, hedonic motivation, social influence, facilitating condition, price value, habit, trust, and learning value.
- 3 moderator variables, namely gender, age, and experience.
- 2 dependent variables, namely use behavior and behavioral intention

2.5 RESEARCH METHOD

Details of the research method are as follows.

1. Identify the problem and understand the methods used.
2. Research planning (determining variables, number of respondents and research hypotheses).
3. Questionnaire planning.
4. Collecting data from online questionnaires in government agencies in East Java Province.
5. Data processing, analysis, and interpretation with the following details.
 - a. Conducting questionnaire analysis to see the feasibility of the questionnaire results.
 - b. Identify the characteristics of each variable.
 - c. Performing data processing analysis using the PLS-SEM method where the steps taken are as follows.
 - i. Designing the outer model to represent the relationship between indicator variables and construct variables.
 - ii. Designing the inner model to represent the relationship between latent variables.
 - iii. Data collection and examination to be able to proceed with PLS-SEM estimation.
 - iv. Estimating the parameters of the PLS-SEM path model in order to provide an overview of the relationship between the construct and its indicators consisting of estimated path coefficient, loading, and weight.
 - v. Evaluating the Goodness of fit used in evaluating the outer model and inner model.
 - vi. Perform hypothesis testing based on the t-value or p-value.
 - vii. Interpret the obtained model.
 - d. Formulate strategies that fit the model on the basis of relevant/existing empirical research.
 - e. Conduct analysis of results and draw conclusions.

4. ANALYSIS AND RESULTS

Questionnaires related to the acceptance of video conferencing technology in East Java Provincial government agencies have been distributed through online media with the help of google forms. For approximately one week, there were 205 respondents who had filled out the questionnaire.

4.1 INITIAL ANALYSIS

Of the 205 respondents, 1 respondent data is not used because the respondent is a student and/or not an employee of a government agency. Therefore, only 204 respondents data used in the research.

4.2 DESCRIPTIVE STATISTICAL ANALYSIS ON RESPONDENT DEMOGRAPHICS

Descriptive statistical analysis is used to provide an overall picture of the demographics of the respondents. Of the 204 respondents, 53% or 109 respondents were female while the remaining 95 respondents were male. The difference in the number of respondents aged less than 36 years and those aged over 36 years does not have a wide range. Of the 95 male respondents, 49 of them were less than 36 years old and the remaining 46 respondents were more than 36 years old. Similar data also shown with the female respondents. The education of the respondents was in the S1/D4 category, which was 135 respondents, then continued with the S2/S3 category, which was 52 respondents. A total of 17 respondents have education equivalent to SMA/SMK and D1/D2/D3. 74% or 151 respondents are Civil Servants (PNS) while the remaining 53 respondents are Non-Permanent Employees (PTT).

4.3 QUESTIONNAIRE VALIDITY AND RELIABILITY TESTS

The first 65 respondents were taken to test the validity and reliability in order to provide an overview of the questions on the questionnaire that were less valid and reliable. The criteria for determining valid and reliable variables are based on the value of Cronbach's Alpha, Composite Reliability, and Average Variance Extracted with a minimum value of 0.7 each; 0.7; 0.5.

Table 2. Questionnaire Validity and Reliability Tests

Variabel	Cronbach's Alpha	Composite Reliability	Average Variance Extracted (AVE)
Performance Expectancy	0,837	0,898	0,748
Effort Expectancy	0,927	0,948	0,820
Social Influence	0,885	0,929	0,814
Facilitating Conditions	0,895	0,927	0,763
Hedonic Motivation	0,718	0,838	0,634
Price Value	0,876	0,923	0,801
Habit	0,817	0,915	0,843
Learning Value	0,941	0,958	0,851
Trust	0,890	0,917	0,733
Behavioral Intention	0,939	0,961	0,892

4.4 RESULTS

Based on the results of the analysis, the following results were obtained.

Table 3. Result of Hypothesis Test

No	Variable	Hypothesis	Description	Result	Note
1	x_1 Performance Expectancy ()	H1a	Performance Expectancy has a significant effect on Behavioral Intention	Unsignificant	p -value (0,235) $>$ α
2		H1b	Age significantly moderates the effect of Performance Expectancy on Behavioral Intention	No further testing	H1a no significant effect
3		H1c	Gender significantly moderates the effect of Performance Expectancy on Behavioral Intention	No further testing	H1a no significant effect

4		H1d	Experience significantly moderates the effect of Performance Expectancy on Behavioral Intention	No further testing	H1a no significant effect
5	Effort Expectancy ()	H2a	Effort Expectancy has a significant effect on Behavioral Intention	Unsignificant	$p\text{-value} (0,250) > \alpha$
6		H2b	Age significantly moderates the effect of Effort Expectancy on Behavioral Intention	No further testing	H2a no significant effect
7		H2c	Gender significantly moderates the effect of Effort Expectancy on Behavioral Intention	No further testing	H2a no significant effect
8		H2d	Experience significantly moderates the effect of Effort Expectancy on Behavioral Intention	No further testing	H2a no significant effect
9	Social Influence ()	H3a	Social Influence has a significant effect on Behavioral Intention	Significant	$p\text{-value} (0,000) \leq \alpha$
10		H3b	Age significantly moderates the influence of Social Influence on Behavioral Intention	Unsignificant	$p\text{-value} (0,887) > \alpha$
11		H3c	Gender significantly moderates the influence of Social Influence on Behavioral Intention	Unsignificant	$p\text{-value} (0,140) > \alpha$
12		H3d	Experience significantly moderates the influence of Social Influence on Behavioral Intention	Unsignificant	$p\text{-value} (0,771) > \alpha$
13	Facilitating Conditions ()	H4a	Facilitating Conditions have a significant effect on Behavioral Intention	Significant	$p\text{-value} (0,040) \leq \alpha$
14	Facilitating Conditions ()	H4b	Age significantly moderates the effect of Facilitating Conditions on Behavioral Intention	Unsignificant	$p\text{-value} (0,440) > \alpha$
15		H4c	Gender significantly moderates the effect of Facilitating Conditions on Behavioral Intention	Unsignificant	$p\text{-value} (0,980) > \alpha$
16		H4d	Experience significantly moderates the effect of Facilitating Conditions on Behavioral Intention	Significant	$p\text{-value} (0,000) \leq \alpha$
17		H4e	Facilitating Conditions have a significant effect on Use Behavior	Unsignificant	$p\text{-value} (0,848) > \alpha$
18		H4f	Age significantly moderates the effect of Facilitating Conditions on Use Behavior	No further testing	H4e no significant effect
19		H4g	Gender significantly moderates the effect of Facilitating Conditions on Use Behavior	No further testing	H4e no significant effect
20		H4h	Experience significantly moderates the effect of Facilitating Conditions	No further	H4e no significant

			on Use Behavior	testing	nt effect
21	Hedonic Motivation ()	H5a	Hedonic Motivation has a significant effect on Behavioral Intention	Significant	$p\text{-value} (0,003) \leq \alpha$
22		H5b	Age significantly moderates the effect of Hedonic Motivation on Behavioral Intention	Unsignificant	$p\text{-value} (0,847) > \alpha$
23		H5c	Gender significantly moderates the effect of Hedonic Motivation on Behavioral Intention	Unsignificant	$p\text{-value} (0,185) > \alpha$
24		H5d	Experience significantly moderates the effect of Hedonic Motivation on Behavioral Intention	Unsignificant	$p\text{-value} (0,785) > \alpha$
25	Price Value ()	H6a	Price Value has a significant effect on Behavioral Intention	Unsignificant	$p\text{-value} (0,408) > \alpha$
26		H6b	Age significantly moderates the effect of Price Value on Behavioral Intention	No further testing	H6a no significant effect
27		H6c	Gender significantly moderates the effect of Price Value on Behavioral Intention	No further testing	H6a no significant effect
28	Price Value ()	H6d	Experience significantly moderates the effect of Price Value on Behavioral Intention	No further testing	H6a no significant effect
29	Habit ()	H7a	Habit has a significant effect on Behavioral Intention	Unsignificant	$p\text{-value} (0,264) > \alpha$
30		H7b	Age significantly moderates the influence of Habit on Behavioral Intention	No further testing	H7a no significant effect
31		H7c	Gender significantly moderates the influence of Habit on Behavioral Intention	No further testing	H7a no significant effect
32		H7d	Experience significantly moderates the influence of Habit on Behavioral Intention	No further testing	H7a no significant effect
33		H7e	Habit has a significant effect on Use Behavior	Significant	$p\text{-value} (0,001) \leq \alpha$
34		H7f	Age significantly moderates the influence of Habit on Use Behavior	Significant	$p\text{-value} (0,001) \leq \alpha$
35		H7g	Gender significantly moderates the influence of Habit on Use Behavior	Unsignificant	$p\text{-value} (0,473) > \alpha$
36		H7h	Experience significantly moderates the influence of Habit on Use Behavior	Unsignificant	$p\text{-value} (0,320) > \alpha$
37	Learning Value ()	H8a	Learning Value has a significant effect on Behavioral Intention	Significant	$p\text{-value} (0,009) \leq \alpha$
38		H8b	Age significantly moderates the effect of Learning Value on Behavioral Intention	Unsignificant	$p\text{-value} (0,706) > \alpha$
39		H8c	Gender significantly moderates the effect of Learning Value on Behavioral Intention	Unsignificant	$p\text{-value} (0,415) > \alpha$

40		H8d	Experience significantly moderates the influence of Learning Value on Behavioral Intention	Significant	$p\text{-value}$ (0,002) $\leq \alpha$
41	Trust ()	H9a	Trust has a significant effect on Behavioral Intention	Significant	$p\text{-value}$ (0,008) $\leq \alpha$
42	Trust ()	H9b	Age significantly moderates the effect of Trust on Behavioral Intention	Unsignificant	$p\text{-value}$ (0,182) $> \alpha$
43		H9c	Gender significantly moderates the effect of Trust on Behavioral Intention	Unsignificant	$p\text{-value}$ (0,674) $> \alpha$
44		H9d	Experience significantly moderates the effect of Trust on Behavioral Intention	Significant	$p\text{-value}$ (0,007) $\leq \alpha$
45	Behavioral Intention (Y_1)	H10a	Behavioral Intention has a significant effect on Use Behavior	Unsignificant	$p\text{-value}$ (0,456) $> \alpha$

- Effect of Performance Expectancy on Behavioral Intention

Based on Table 3, there is no significant effect between performance expectancy and behavioral intention. In other words, although the majority of respondents agree that the use of video conferencing technology is useful and helps their work efficiently, this does not affect the individual's level of desire to use video conferencing applications, especially in government agencies.

- Effect of Effort Expectancy on Behavioral Intention

Based on Table 3, there is no significant effect between effort expectancy and behavioral intention. In other words, although the majority of respondents agree that the use of video conferencing applications is easy to use, the usability of using video conferencing has no effect on the level of desire of employees to use video conferencing applications.

- Effect of Social Influence on Behavioral Intention

Based on Table 3, there is a significant relationship between social influence and behavioral intention. However, based on hypothesis testing on the moderating variables of age, gender, and education, there is no relationship between social influence and behavioral intention. This shows that the majority of respondents agree that the environment and people around greatly affect the level of employee desire in using video conferencing applications, especially in government agencies.

- Effect of Facilitating Conditions on Behavioral Intention

Based on Table 3, there is a significant influence between facilitating conditions and behavioral intention. In other words, the majority of respondents agree that the facilities needed for the use of video conferencing applications such as data packages, webcams, or even meeting rooms are able to support the level of desire of employees to use the application. This is supported by the education variable that significantly influences the relationship between facilitating conditions and behavioral intention. It can be said that the supporting factors in supporting video conferencing are also motivated by the education of each user.

- Effect of Facilitating Conditions on Use Behavior

Based on Table 3, there is no significant effect between facilitating conditions and use behavior. In other words, it can be concluded that although the majority of respondents agree that the existence of supporting facilities can increase the desire of employees to use video conferencing applications, this does not affect the intensity of use from individuals.

- Effect of Hedonic Motivation on Behavioral Intention

Based on Table 3, there is a significant relationship between hedonic motivation and behavioral intention. However, based on hypothesis testing on the moderating variables of age, gender, and

education, there is no relationship between social influence and behavioral intention. In other words, the majority of respondents feel happy in using video conferencing applications. However, the indicators/variables x5.2 and x5.3 indicate respondents' disagreement in using the application as a necessity. This means that employees who are happy or comfortable in using video conferencing applications will increase the employee's desire to use the application.

- **Effect of Price Value on Behavioral Intention**

Based on Table 3, there is no significant effect between price value and behavioral intention. This means that although the majority of respondents agree that the use of video conferencing applications has greater benefits than the costs incurred, this does not affect the level of employee desire in using video conferencing applications, especially in government agencies.

- **Influence of Habit on Behavioral Intention**

Based on Table 3, there is no significant relationship between habit and behavioral intention. In other words, although the majority of respondents agree that the use of video conferencing applications has become a habit and a common thing in the current era, this does not affect the desire of employees to use the application, especially in government agencies.

- **Influence of Habit on Use Behavior**

Based on Table 3, there is a significant relationship between habit and use behavior. However, the moderating variable of age significantly affects the relationship between habit and behavioral intention. The influence of age means that the difference in the age of each employee in government agencies will significantly affect the habits of employees in the intensity of using video conferencing applications.

- **Effect of Learning Value on Behavioral Intention**

Based on Table 3, there is a significant relationship between learning value and behavioral intention. This indicates that the majority of respondents agree that the use of video conferencing technology makes it easier for respondents to gain knowledge and practice their ability to quickly learn. In addition, the education variable significantly influences the relationship between learning values and behavioral intention. This indicates that the level of education also significantly affects the learning ability of employees in using video conferencing applications.

- **Effect of Trust on Behavioral Intention**

Based on Table 3, there is a significant relationship between trust and behavioral intention. From the results of the questionnaire, it was found that the majority of respondents still doubted that the video conferencing technology service provider could be trusted in terms of data security. In addition, the moderating variable of education significantly affects the relationship between trust and behavioral intention. This indicates that education affects employee trusts in the use of video conferencing.

4.5 STRATEGY

Referring to Tabel 3, strategies needed to increase the acceptance of video conferencing technology especially in East Java Provincial government agencies is to focus on matters relating to facilitating conditions, hedonic motivation, habit, learning values, and trust.

According to Jun Kun Park et al (2019), Social Influence is able to make individuals who do not understand technology feel afraid to use a new technology. Thus, the right strategy to increase social influence, especially for employees who work in government agencies, is to provide socialization regarding the advantages of using video conferencing. In addition, because every government employee who holds or attends meetings both in town/out of town (other than his own office) gets incentives, employees who attend/hold meetings using video conferencing applications also need to get incentives to increase employee interest.

A strategy that can help facilitating conditions is to provide qualified facilities in the use of video conferencing applications such as the availability of wi-fi/internet packages, video devices and

speakers, laptops/PCs, and soundproof rooms.

According to Jong-Hyeon Kim (2019), for someone to believe in using a new technology is to show that with that technology, the work to be done becomes less and/or easier. This strategy can be done by making online meetings easier than offline by using the features provided by video conferencing service providers, some of which include automatic scheduling and recording.

According to Jong-Hyeon Kim (2019), the way for someone to get used to using a technology is to introduce the person to easy-to-use technology that makes their work easier. One way is to introduce new technology to the individual slowly so that it will be easier to introduce other technologies to the individual later.

To increase learning value, the strategy that can be used is to provide free training/courses and study time for employees so that they can better understand the use of video conferencing.

Providing socialization related to digital data security along with the advantages of using video conferencing in its security is a strategy to increase trust. In addition, according to Gibson and Cohen (2003), communication in a certain way is an effective strategy to increase trust, such as open communication, mutual responsibility for the credibility of other employees, and sustained interactions where the same person often attends virtual communications together, so they can get to know each other and be more caring in a virtual environment. Another strategy to increase trust in service providers is to do partnerships with the providers.

5. CONCLUSIONS

This research has produced a model to be applied in the context of acceptance of video conferencing technology in the government of East Java Province, where the model consists of facilitating conditions, hedonic motivation, habit, learning values, and trust with the level of predictive power of this research model reaching 60.3%. Based on the rule of thumb, the value of 60.3% indicates that this research model has a predictive level to determine the level of desire to use video conferencing technology moderately, so that this research model can be said to be suitable for research in the context of receiving video conferencing technology in government agencies in East Java Province. For further research, more varied respondents can be added.

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ANALYSIS OF THE EFFECT OF INTERIOR DESIGN ELEMENT ON CUSTOMER SATISFACTION AT DAOP 8 RAILWAY STATION

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ABSTRACT

The station is the main point that accommodates many service activities, such as a spot for the passengers to get on and off and unload goods to commercial business activities. This research was conducted in the Daop 8 area as one of the operational areas of PK T with complete assets and has the same complexity as the Daop 1 Hub of PT K; thus, it can represent the entire Daop of PT K. The method used in the data analysis of this study is Partial Least Square (PLS) which is a structural equation modeling analysis, or Structural Equation Modeling (SEM) with a variant basis to evaluate the measurement model using SmartPLS software simulation simultaneously. This research is expected to prove the influence of interior elements that are in accordance with user activities and interior elements that are less than ideal in fulfilling activity needs according to user perceptions and expectations.

Keywords: Customer Satisfaction, Interior Design, Public service Facilities

1. INTRODUCTION

Railway transportation is one that many of the selected community to become a public transport to travel out of the city. PT K is a company which take care of, manage, and provide services freight train fire. The station is the main place that accommodate the number of train services such as the place up and down his passenger and loading and unloading goods. The increasing number of the activities in the station demanding PT K. to maximize the function of space with land that are available through adjustment to the interior elements such as the fabric of space, lighting, ventilation, sound, and pattern color.

One of the main objectives in doing business with a company that is customer satisfaction (Ardhianto, 1996; McDougall and Levesque, 2000). In the field of marketing, customer satisfaction is seen as the main element of the performance of the market where increasing customer satisfaction has the potential led to increased sales in a short span of time or a long time held the loyalty of the customers (Tjiptono et al, 2008). As a user of the station, the customer PT K. in directly felt the service through the facilities of the space is used, so that the determination of the elements of the interior of the ideal expected to support services through the optimal facilities that are perceived directly by the passenger, which is no direct effect in improving the performance of the

company PT K. in the eyes of the community.

Based on the previous analysis should be conducted to determine the factors the design of the interior which actually affect the user satisfaction of the station train. This study will fill the gap of previous research, where the research before investigating the satisfaction of the user station based on the elements interior design separately Ghosh (2017), Wu (2019), Han (2016) and also Hoeven (2016). This study identifies what elements of interior design affect user satisfaction of the station. Daop 8 is the Area of the Operation have a complete asset among all the Daop as well as the complexity of the partner with Daop 1 (Regional Operation Center), so the specifics of the research focus of the user station DAOP 8 Surabaya is considered to be mewakili5 the condition of the station in PT K. It encourages the need for research associated with the practice of the determination of the elements of interior design that is optimal viewed from the perspective of the user station.

2. LITERATURE REVIEW

2.1 Interior Design

Interior design is the art and science in idealize interior the room with the intent to make the healthy and the more artfully for users of the room. Interior design is the art and science to understand human behavior in creating a functional space while also studying the design of the space in the planning and layout in a building. Physical form pursued can meet basic human needs as shelter, but it also an interior design influencing perception, mood as well as private residents (Crespi, 2020). The elements contained in the interior design as follows: Layout, Furniture, Lighting, Aesthetics, Thermal Comfort

2.2 Customer Satisfaction

Customer satisfaction is the target of all the company, a condition in where the expectations and needs of consumers can be met. Cronin et al., (2000) deciphering customer satisfaction from the point of view the ability of the service, the value of profit, the image of the brand as well as the expectations of consumers with high and low service quality.

2.3 The Test Of The Research Instrument

The research method used is the sampling and carried out a survey on some of the research object called as a sample. The tool used for the survey is a research instrument in the form questionnaire. Research instrument used as data collection tools, and instruments that are commonly used in research are some of the list of questions in the form of questionnaires delivered and given to each respondent in the study sample at the time of observation and interview (Sugiyono, 2016).

2.4 The method of Partial Least Square (PLS)

Partial Least Square (PLS) is a method of estimation of alternative models used to process the method of Modeling the Structure of the equations (Structural Equation Modelling / SEM). Draft PLS compiled in order to resolve the limitation limitation at SEM. The SEM method requires data in large quantities, has a normal distribution, there is no missing value and no multicollinearity, however the method of PLS wear the estimation of the distribution free where data free from assuming following a specific distribution. Partial Least Square is usually also used for small sample sizes.

3. METHODS

Steps of research in analyzing the data are as follows.

1. Questionnaires conducted to obtain information in the form of primary data from the respondents regarding the perception of against the interior of the building at the Station Daop 8. The sampling technique used for the data on the online questionnaire is a technique of panel recruited sampling mean that the taking of the respondents obtained by recruiting respondents online through social media.
2. Data dari hasil wawancara dengan kuesioner dalam penelitian ini kemudian diolah dengan tahapan: data editing, tabulation, analysis, descriptive statistics, test validation and reliability

with vector loading and cronbach's alpha, analysis of structural equation modelling-partial least square (SEM-PLS), the discussion of the results of the analysis.

4. RESULTS

Based on the results of trials that have been conducted, the research model proposed indicates that the variable of customer satisfaction can be explained by 71,4% of the the research model while the rest 29,6% is explained by other variables outside the researched.

Table 1. Hypothesis Testing Research (Bootstrapping)

Hypothesis	Original Sample	T Statistics	P Values
Layout (X1) → Customer Satisfaction (Y)	0,275	3,013	0,003
Furniture (X2) → Customer Satisfaction (Y)	0,075	0,804	0,421
Lighting (X3) → Customer Satisfaction (Y)	0,247	1,980	0,048
Aesthetics (X4) → Customer Satisfaction (Y)	0,231	2,248	0,025
Thermal Comfort (X5) → Customer Satisfaction (Y)	0,204	2,317	0,021

From the results of structural modeling, the obtained model equations for the variable satisfaction customer is shown as follows:

$$\text{Customer satisfaction} = 0,275 \text{ layout (X1)} + 0,075 \text{ furniture (X2)} + 0,247 \text{ lighting (X3)} + 0,231 \text{ Aesthetic(X4)} + 0,204 \text{ thermal Comfort (X5)}$$

Based on the results of trials that have been conducted, the research model proposed indicates that the variable of customer satisfaction can be explained by 71,4% of the the research model while the rest 29,6% is explained by other variables outside the researched. From table 1 of 5 hypothesis 1 hypothesis which is not significant as well as 4 the hypothesis of a significant other to the model.

6. CONCLUSIONS

Briefly write the conclusions of your study. Preferably it is in the form of paragraphs. At the end of your conclusion, it is customary to briefly describe the managerial implications of your work.

REFERENCES

The interior design elements that significantly influence the satisfaction customer station DAOP 8 is the layout, the lighting, the aesthetics of the space, and comfort. Each of these elements has a positive effect in significant impact on customer satisfaction. While the elements of the furniture is not positive effect there were significant to satisfaction of the customer station DAOP 8. The value of R-square at 0.714 show that the model is able to predict customersatisfaction based on the variables that exist in the research by 71,4% while 29,6% the rest is explained by other variables outside the research.

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ANALYSIS OF PUBLIC TRUST IN PT PLN (PERSERO) IN THE MIDDLE OF ELECTRICITY BILL INCREASEMENT ISSUE DURING THE COVID-19 PANDEMIC (Case Study on Customers of PT PLN (Persero) UP3 Sidoarjo)

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ABSTRACT

Presidential decree about determination of the Non-Natural Disaster for the Spread of Corona Virus Disease 2019 (COVID-19) as a national disaster published on April 13, 2020, has an impact on the performance of PT PLN (Persero) UP3 Sidoarjo as one of the companies that provides electricity needs for the people of Sidoarjo. Many industries, SMEs, schools, and public facilities reduce their activities, so that electricity consumption in this sector decreases, on the other hand, household consumers experience an increase in electricity consumption due to WFH (Work From Home) policies. The existence of Large- Scale Social Restrictions (PSBB) has resulted in several PT PLN (Persero) field operational officers not performing their usual duties, including billman officers who have the task of recording the customer's kWh meter each month, therefore calculating the electricity consumption of postpaid customers PLN is done by set an average usage rate of 3 months before the pandemic. This policy caused turmoil in the community marked by increasing consumer complaints of PLN up to 594% and affecting the level of public trust in PLN so that research is necessary. This research aims to obtain 1). Effect of Service Quality on public trust, 2). Effect of Service Quality on public trust by through customer value, 3). Effect of Customer Knowledge on public trust and 4). Effect of Service Quality on public trust by through customer satisfaction. The research method used is a survey research method with a purposive sampling technique of 100 respondents and is an research explanation which will prove the causal relationship between the independent variables namely service quality and customer knowledge, the mediating variable namely customer value and customer satisfaction and the dependent variable namely trust (trust). The results of this research indicate that the exogenous variable has a positive and significant effect on the endogenous variable, namely customer trust, either directly or mediated by the variable customer value and customer satisfaction.

Keywords: service quality, customer value, customer knowledge, trust

1. INTRODUCTION

PT PLN (Persero) is a company that fully fulfills the needs of the public by providing services for the distribution and sale of electric power to the wider community. As a service company, the profits

obtained do not only rely on the number of sales units, but must be oriented to trust in a long time (long term satisfaction) (Sudikan, 2010:1) The condition of the covid-19 pandemic which has been set as a national disaster since April 13, 2020 has an impact on PT PLN (Persero). Public electricity consumption in several sectors such as industry, MSMEs, schools, and public services has decreased due to social restrictions, while electricity consumption in the household sector has increased due to the work from home policy. This has caused turmoil in the community due to changes in electricity bills triggered by difference in electricity consumption trend during the COVID-19 pandemic which were not realized by the public and suspicion of cross subsidies. The situation is further exacerbated by the transition of PT PLN (Persero)'s policy in determining the public's electricity bill, which previously carried out account readings by officers in the field, replaced with an average account calculation during March - May 2020.

PT PLN (Persero) UP3 Sidoarjo experienced an increase in public complaints in June 2020 with a percentage of 594% which made many postpaid consumers delay paying their electricity bills. This shows the reduced level of public trust in PT PLN (Persero) UP3 Sidoarjo. Household consumers sector of PT PLN (Persero) UP3 Sidoarjo are the largest consumer sector with a percentage of 92%.

The level of public trust is influenced by several factors. Customers who are satisfied with the services provided by the company will create a sense of trust or positive thinking toward the company (Nuraeni, 2016). Another effort to increase customer trust is by focusing on marketing product and service with an orientation to the benefit provided by product and service to consumer or customer value. PT PLN (Persero) must be able to educate its customers about the product being sold, especially the policy for reading accounts. Customer who have more knowledge about the goods or service offered by the company, then they will be wise in purchasing an item or service (Sumarwan, 2004).

The purpose of this study were to determine the effect of the variables of service quality, customer value, customer satisfaction, and customer knowledge on the level of consumer trust to PT PLN (Persero) UP3 Sidoarjo using the Structural Equation Modeling (SEM) method. The result of this research expected for assisting the management of PT PLN (Persero) to determine the company's policy towards the crisis of public trust in the middle of electricity bill increasement issue due to the COVID-19 pandemic.

2. LITERATURE REVIEW

Trust
Trust is a measure of the fulfillment of expectation for the performance of a product and satisfaction with a service provided to consumers (Costabile (2001) in Suhardi, 2006, pp51-52). Trust is very important for a company because if a consumer already believes in the product or service provided, consumers will not hesitate to make repeat purchase or repeat order to the company (Alharthey, 2019).

According to Shamdasani and Balakrishnan (2000, p421) customer trust is measured using indicators of integrity and reliability and he finds that customer trust is influenced by contact personnel and physical environment.

Service Quality

Service quality is defined as a number of continuous interaction activities between service providers and consumers to provide solutions to problems faced by consumers, including physical resources, non-physical resources, financial and other elements involved in the fulfillment of these services (Gronroos, 1994). Parasuraman (in Lupiyoadi, 2001) divides Servqual's service quality into five dimensions, namely: physical evidence, reliability, responsiveness, assurance, and empathy.

Customer Knowledge

According to Rollins et al (2005) customer knowledge is the level of customer understanding of a company, trends, company goals and company needs. Customer knowledge is very useful

information for company because it can help in improving the quality of product or service to be offered to the market (Wang et al., 2016).

There are three ways that can be done to measure customer knowledge about a product or service according to Fen and Lian (2007), namely subjective knowledge, objective knowledge, and experience-based knowledge.

Customer Value

Customer value is defined as the exchange between consumer perception of the quality and benefit of a product and the sacrifice made by consumer through payment of product price (Monroe (1990) in Siringoringo (2018)). Wahyuningsih, (2004) states that there are two main components in the concept of customer value, namely product benefit and sacrifice made by consumer. The value of benefits and sacrifices can be divided into three dimensions, namely social values, quality values and emotional values

Customer Satisfaction

Customer satisfaction is a situation where the wants, needs and expectations of customers can be achieved through a product purchased by consumers (Fen and Lian, 2007). According to Tjiptono (2004) the measurement of customer satisfaction level can be done through four concepts, namely: overall customer satisfaction, repurchase interest, confirmation of expectations, and availability of recommends.

Hypothesis

According to Alharthey (2019) through a research entitled "Impact Of Service Quality On Customer Trust, Purchase Intention And Store Loyalty, With Mediating Role Of Customers' Satisfaction On Customer Trust And Purchase Intention: Study Of Grocery Shopping" explains that customer trust is influenced by attitudes, morality and credibility of company employees in providing services to consumers, further explained when consumers get a product or service that is not good then they can switch from the product to several other alternatives. Consumers switch because they are dissatisfied or the quality of service provided cannot meet their expectations.

Based on the theoretical explanation and the results of previous research regarding service quality above, the authors draw the hypothesis:

H1: Service Quality has a positive and significant effect on Customer Value.

H2: Service Quality has a positive and significant effect on Customer Satisfaction

H3: Service Quality has a positive and significant effect on Trust

H7: Service Quality has a positive and significant effect on Trust through Customer Value

H8: Service Quality has a positive and significant effect on Trust through Customer Satisfaction

According to Gebert et al. (2003) in Jusoh (2014), customer knowledge can be grouped into three types, first is knowledge from customers, knowledge for customers and knowledge about customers. Jusoh's research (2014) explains that there is a relationship between customer knowledge and purchase intention and loyalty mediated by customer trust.

H6: Customer Knowledge has a positive and significant effect on Trust

Mosunmola et al., (2018) explained about utilitarian value and hedonic value in online shop consumers. There is a difference between the perceived and expected value of utilitarian and hedonic consumers, utilitarian consumers generally seek information about product functions and benefits before making a transaction, on the other hand hedonic consumers focus more on online product searches based on beauty, store visual design and shopping enjoyment while playing. . The availability of product

information and features as well as a good online store design will certainly affect consumer confidence to make product purchases. In the research of Mosunmola et al., (2018) explaining the existence of consumer trust in online stores which is predicted by consumer utilitarian and hedonic values.

H4 : Customer Value has a positive and significant effect on Trust

Norhermaya (2016) stated in his research that to win the online business competition, companies need to pay full attention to customer satisfaction, this will have a positive impact on the company. Customers who are satisfied when making transactions or shopping will create feelings of trust in the company and trigger repeat purchases. According to Achim Walter (2012) in Norhermaya (2016) states that customer satisfaction has a significant effect on customer trust (Trust). Customer satisfaction is a customer attitude that is based on the customer's past transaction experience where this practice encourages the customer's perceived trust in the company.

H5: Customer Satisfaction has a positive and significant effect on Trust

From the literature review, the conceptual model in this study can be formulated as follows:

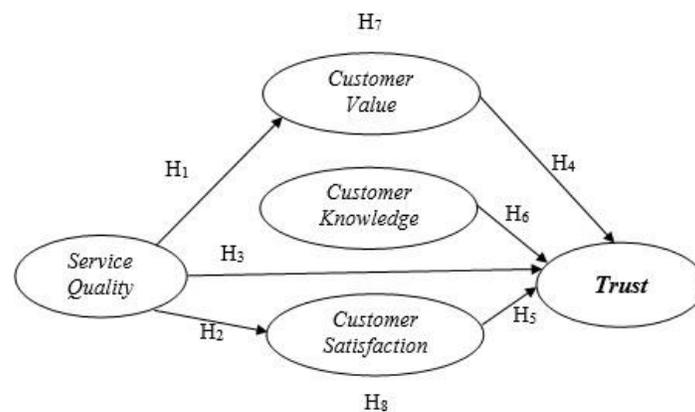


Figure 1. Research conceptual model

3. METHODS

The type of research used is explanatory which intends to explain the positions of the variables studied and the relationship between one variable and another. The population in this study were all non-subsidized household tariff PLN customers who entered the work area of PT PLN (Persero) UP3 Sidoarjo and experienced an increase in electricity bills in the period April, May and June 2020 totaling 37,598 customers. The number of samples is 100 respondents. The sampling technique used was purposive sampling, namely direct sampling with predetermined sample characteristics. Customers qualify as samples in this study if the electricity bill payments in May, June and July are more than one hundred thousand rupiah. The research instrument used a questionnaire with Likert scale from 1-5. The analysis technique using SPSS and SEM with AMOS 2.6 program consists of: classical assumption test, validity test, reliability test, frequency distribution analysis, and structural equation model analysis.

4. RESULTS

Estimation Technique Selection

After the model is specified in full, the next step is select the appropriate input type. When tested is the causality relationship then The input type used is covariance (Hair et al, 1995) in Waluyo (2009: 67). The estimation technique used in this study are maximum likelihood estimation method which has become the default of the program AMOS.

Data Quality Test

The quality of research data on a hypothesis is highly dependent on the quality of the data used in the study. Quality and research is determined by the instruments used to collect data to produce applicable data. The tests used to test the quality of the data in this study were the classical assumption test, validity and reliability, and evaluation of data outliers.

Data Normality

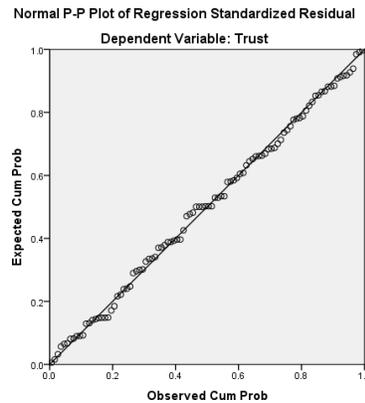


Figure 2. P-P Plot of Regression

Based on Figure above, it can be seen that the results of the p-p plot of data show a pattern following the normal line. Therefore, it can be concluded visually that the data used in this study has a multivariate normal distribution, this is reinforced by the results of the One-Sample Kolmogorov-Smirnov Test with a significance result of 0.983 and the results of the univariate normality test using SEM Amos found that the Critical Ratio value was not more than ± 2.58 (Ferdinand, 2013), therefore it can be explained that the distribution of the data used is normal.

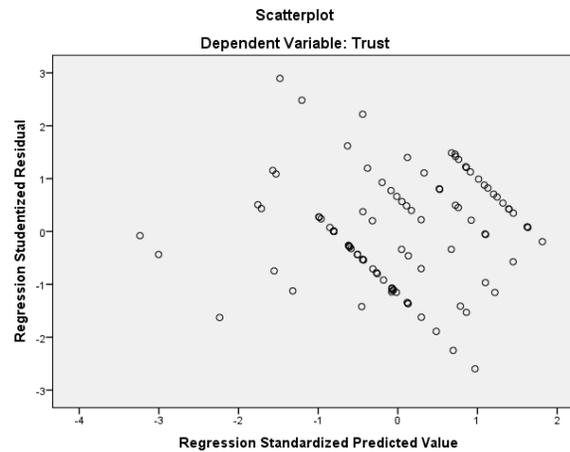
Multikolinearitas Test

Variabel	Collinearity Statistics	
	Tolerance	VIF
SrvQual	0,85	1,18
CustValue	0,54	1,85
CustKnowledge	0,55	1,81
CustSatisf	0,62	1,62

In table above it can be concluded that there are no symptoms of multicollinearity in the research data, this is due to the fulfillment of the tolerance value > 0.1 and the variance inflation factor (VIF) < 10 for all research variables.

Heteroskedastisitas Test

Figure 3. Scatterplot



In Figure above, it can be seen that there is no clear pattern (wavy or widened to narrow) and the data points spread above and below the number 0 on the Y axis, it can be concluded that the research data does not show symptoms of heteroscedasticity.

Linearity Test

Table 2. Linearity Test

Variabel	Nilai Ambang	Sig. n from Linearity	Deviatio
Trust - SrvQual	>0,05	0,57	
Trust - CustValue	>0,05	0,52	
Trust - CustKnowledge	>0,05	0,06	
Trust - CustSatisf	>0,05	0,08	

Based on the linearity test which can be seen in table 4.10, it is known that the significance value of deviation from linearity is > 0.05 , so it can be concluded that there is a linear relationship between the independent variable and the dependent variable in this study.

Validity Test Exogen Variable

Table 3. Validity Test Exogen Variable

Eksogen Variable	Estimate
SQ ₅ <--- Service_Quality	,795
SQ ₄ <--- Service_Quality	,816
SQ ₃ <--- Service_Quality	,791
SQ ₂ <--- Service_Quality	,764

SQ 1	<---	Service_Quality	,742
CK1	<---	Customer_Knowledge	,95
CK2	<---	Customer_Knowledge	,86
CK3	<---	Customer_Knowledge	,65

In table above it can be seen that the value of the loading factor (estimate) shows a value greater than the critical value of 0.5. Therefore, it can be explained that each indicator is a significant indicator to explain exogenous variables.

Validity Test Endogen Variable

Table 4. Validity Test Endogen Variable

Endogen Variable			Estimate
CV1	<---	Customer_Value	,751
CV2	<---	Customer_Value	,739
CV3	<---	Customer_Value	,804
CS4	<---	Customer_Satisfaction	,64
CS3	<---	Customer_Satisfaction	,81
CS2	<---	Customer_Satisfaction	,639
CS1	<---	Customer_Satisfaction	,72
Tr1	<---	Trust	,814
Tr2	<---	Trust	,813
Tr3	<---	Trust	,810
Tr4	<---	Trust	,853

In table above it can be seen that the value of the loading factor (estimate) shows a value greater than the critical value of 0.5. Therefore, it can be explained that each indicator is a significant indicator to explain endogenous variables.

Reliability Test

Table 5. Reliability Test

Variable	CR Value	VE Value
Service Quality	0,887	0,612
Customer Knowledge	0,868	0,691
Customer Value	0,809	0,586

Customer Satisfaction	0,801	0,503
Trust	0,893	0,677

Based on the results of the analysis, it is known that the value of construct reliability (CR) > 0.7 and the value of variance extract (VE) > 0.5, so it can be explained that the variables used have good reliability.

Model fit test

Table 6. Model Fit Test

Kriteria Goodness of Fit		Hasil Uji Model	Nilai Kritis	Kesimpulan
Absolute Fit Indices	Probability Chi-square	0,000	$\geq 0,05$	<i>Poor fit</i>
	Csquare/df	1,884	$\leq 2,00$	<i>Good fit</i>
	GFI	0,786	$\geq 0,90$	<i>Poor fit</i>
	RMSEA	0,095	$\leq 0,08$	<i>Marginal fit</i>
Incremental Fit Indices	TLI	0,863	$\geq 0,95$	<i>Marginal fit</i>
	CFI	0,883	$\geq 0,95$	<i>Marginal fit</i>
Parsimony Fit Indices	AGFI	0,722	$\geq 0,90$	<i>Poor fit</i>

The next testing stage is to test the fit of the research model, in table 4.16 it can be seen that there are four good of fit criteria that are met. The first criterion is C-square/df with a value of 1.884, according to Schermelleh-Engel et al., (2003) in Adam (2018) the criterion is a good fit if it is in the range of 0 Csquare/df 2, the two Tucker-Lewis Index (TLI) criteria with a value of 0.863, according to Wijanto (2008) and (Mustafa et al., 2012) in Adam (2018) the size of the criteria is said to be marginal fit or acceptable if it is in the range of 0.8 TLI 0.9, the three Comparative Fit Index (CFI) criteria with a value of 0.883, according to Wijanto (2008) and Mustafa et al. . (2012)in Adam (2018) the criterion size is said to be marginally fit or acceptable if it is in the range of 0.8 CFI 0.9, the fourth criterion is the Root Mean Square Error of Approximation (RMSEA) with a value of 0.095, according to Browne & Cudeck (1993).) and MacCallum et al., (2011) in Adam (2018) the criterion size is said to be marginal fit or acceptable if it is in the range of 0.08 RMSEA 0.1. Based on the explanation above, the model is said to be fit and can be tested for hypotheses.

Coefficient of Determination Test

Table 7. Coefficient of Determination Test

Variable	Squared Mult. Correlation	Explanation
Kepercayaan (Trust)	0.77	Moderate

Based on the results of the R-Square Test, it shows that the value of the dependent variable Trust is 0.77, meaning that it shows that Trust can be explained by 77% of the research model, while the remaining 23% is explained by other variables outside the model studied.

Hypotesis Test

Direct Effect Variable

Table 8. Direct Effect Variable

Variable			Std. Estimate	Sig.	Explanation
Service Quality	→	Customer Value	0,421	0,003	significant
Service Quality	→	Customer Satisfaction	0,409	0,005	significant
Customer Value	→	Trust	0,464	0,002	significant
Customer Satisfaction	→	Trust	0,386	0,002	significant
Customer Knowledge	→	Trust	0,353	0,001	significant
Service Quality	→	Trust	0,233	0,081	significant

Based on the table above, it can be seen that the variables of service quality, customer value, customer satisfaction and knowledge have a positive and significant effect, its indicated by the std estimate value and the significance is less than 0.10 or below the degree of error determined in the study, which is 10%.

Indirect Effect Variable

Testing the indirect effect between service quality variables on trust mediated by customer value and customer satisfaction variables was carried out by looking at the bootstrapping test value through the two-tailed significance test type on the Amos software. Based on the test, the following results were obtained:

Table 9. Indirect Effect Variable

Influence between Variables	Std. Estimate		Sig.	
	Direct Effect	Indirect Effect	Direct Effect	Indirect Effect
ServQual - Trust	0,233	0,353	0,081	0,001

The significance value shown in the indirect effect test is $0.001 < 0.1$, so it can be explained that service quality has a significant effect on trust through the mediating variables of customer satisfaction and customer satisfaction. The value of the coefficient of indirect influence is 0.353 while the direct effect is 0.233, both are significant and have the same direction of influence, so it can be said to be

complementary mediation.

6. CONCLUSIONS

Based on the results of research that has been carried out on the analysis of factors influencing public trust in PT PLN (Persero) by involving the independent variables, namely service quality, customer value, customer satisfaction, and customer knowledge, the following conclusions can be drawn:

1. The results of the analysis of the quantitative test, namely the Structural Equation Modeling (SEM) test with the Amos-23 software, showed that the independent variable had a significant positive effect on the dependent variable, in this case, trust. The independent variable succeeded in explaining 77% of the research model on the analysis of the level of public trust in PT PLN (Persero), while 23% was explained by other variables outside of this study.
2. There is a positive and significant influence between service quality variables on trust directly or indirectly, mediated by customer value and customer satisfaction variables, this supports the accepted hypothesis H1,H2,H3,H4,H5,H7,H8, and H9 in this research .
3. There is a positive and significant influence between the customer knowledge variable on trust directly, this supports the hypothesis H6 is accepted in this study.

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ANALYSIS OF THE EFFECT OF SERVICE QUALITY ON CUSTOMER SATISFACTION USING THE SERVQUAL AND IPAMETHODS AT BTN SYARIAH SURABAYA

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ABSTRACT

The concept of customer satisfaction is one of the critical factors in determining the level of service quality. Good service quality will get positive feedback on customer satisfaction. The tight competition in the banking industry brings companies to compete to meet customer needs through service quality. In overcoming these challenges, Bank BTN Syariah needs to make a strategy to improve service quality. The company has never known the voice of the customer so far on the quality of its service, so it is necessary to measure the quality of service by distributing questionnaires and processing them using the Service Quality (SERVQUAL) method. This method uses gap analysis to determine whether there is a gap in customer perceptions and expectations regarding service. Then filter and classify the attributes of the SERVQUAL measurement results using the Importance Performance Analysis (IPA) method. This method aims to determine which prioritized attributes for improvement. Based on the study results, the attributes included in quadrant A are the attributes of the 'bank operations under the punctuality of opening and closing hours for counter services. These attributes are the main priority for research improvement assisted by fishbone diagrams.

Keywords: Customer Satisfaction, Importance Performance Analysis (IPA), Service Quality (SERVQUAL).

1. Introduction

Banking services have a significant role in the economic life of a country. Banks act as payment instruments and provide efficient mechanisms for customers. In the era of industrial revolution 4.0, the banking industry is becoming more competitive than before. Each company develops strategies to outperform its competitors in the common market, either through the types of product variations offered, the promised facilities, and the services provided to customers. According to Shen et al. (2000), service quality fulfills customer expectations to a certain extent until finally, the customer can assess the quality of a product or service (Auka et al., 2013). Consumers assess the quality of a product or service by evaluating service quality by comparing what they expect with the service they get (Berry et al., 1998; Auka et al., 2013). It aims to measure

how the quality itself. Parasuraman, Zeithaml, and Berry (1988) argue that service quality is an attitude given by consumers, but it is different from satisfaction, where this satisfaction results from comparing customer expectations with the service received. Therefore, service quality compares two main factors, namely, the customer's perception of the service received (perceived service) and the actual service expected (expected service).

The object of this research is Islamic banking, namely Bank BTN Syariah. Bank BTN Syariah has a total of 25 sharia branch offices and 53 sharia sub-branches in Indonesia. One of the BTN Syariah Banks that is the focus of the research is Bank BTN Syariah Surabaya. Based on the pre-survey results in the form of brief interviews, 13 customers out of 20 total customers interviewed stated that they were still not satisfied with the overall service provided by Bank BTN Syariah Surabaya. After the author validates with the management, measuring employee performance in serving customers by top management is in Ghost or Mystery Shopping. The bank is routinely carrying mystery shopping, but the results could not answer customer complaints that still occur. So that management needs new measurements to find out how far the performance of services to customers.

2. Literature Review

Service Characteristics

According to Tjiptono (2008), service is an activity, benefit, or satisfaction sold to other parties. Services have several unique characteristics; namely, intangibles do not result in the transfer of ownership or rights, and there are transactions between service providers and service recipients (Permana, 2011). According to Zeithaml and Bitner (2006:21), the main characteristics of services are intangible, inseparable, varied, and perishable. According to the American Society for Quality Control in Priyadi & Suwitho (2018), quality is the overall characteristic and nature of a product or service that influences the ability to satisfy customer needs, expressed or implied. According to Parasuraman et al. (1985) in the research of Priyadi and Suwitho (2018), the two main factors that influence service quality are as follows.

- If the service received (perceived service) is under the expectation, then the service quality is perceived as good and satisfactory.
- If the service received exceeds the customer's expectations, then the service quality is perceived as an ideal quality

Sharia Banking

According to Law no. 21 of 2008, Islamic banking is related to Islamic Banks and Sharia Business Units, including institutional activities, business activities, and operational methods and processes in carrying out their activities. Sharia banking is a bank that carries out operations, starting from operating procedures to the products and services offered to run by sharia principles and the provisions of the Islamic religion, including Hadith and Al-Quran (Fitriani, 2019). According to Law no. 21 of 2008, Islamic banking aims to support national development through equitable distribution of people's welfare, justice, and togetherness.

Service Quality

According to Kotler and Keller (2009), service is an intangible performance from one party to another but does not result in any ownership (Agbor, 2011). Based on this definition, service can only be felt (intangible) between one party and another party (the company and the customer) but results in the absence of any service ownership. Therefore, quality can be associated with the offer's

value, where this offer will generate the value of customer satisfaction or dissatisfaction with the product or service offered. According to Abdullah (2005), satisfactory service quality can provide a competitive advantage with its competitors and differentiate between two or more industrial companies engaged in the same field (Widikusyanto & Hidayah, 2019).

In the banking sector, the development of service quality measurement dimensions has evolved from time to time. Parasuraman, Zethaml, and Berry (1988) developed the SERVQUAL method. Cronin and Taylor proposed this method in 1992 and 1994 based on the SERVQUAL method, where this method only assesses service quality performance without comparing the customer perception gap.

Customer Satisfaction

According to Daryanto (2014), Kanten and Darma (2017), Ginantra et al. (2017), customers who buy or are users of a product must be satisfied (Silviana & Gede, 2020). When consumers or customers are satisfied with a product or service received, it can be called satisfaction. According to Agbor (2011), there is no specific definition related to customer satisfaction, but many researchers define customer satisfaction over time and research development. Of the many definitions of customer satisfaction, Oliver (1997) defines that the most dominant and frequently used customer satisfaction definition is the disconfirmation paradigm (Dharmayanti, 2016). In this paradigm, customer satisfaction is evaluating customer perceptions of the performance or selected product, whether it has met their expectations or not. The existence of customer satisfaction with performance or product received will make customers tend to repurchase (repurchasing) and reuse services at the company when the exact needs in the future arise.

Relationship Between Service Quality and Customer Satisfaction

According to Ting (2004), some researchers believe that service quality will influence customer satisfaction, but others believe the opposite (Shanka, 2012). Research by Lee et al. (2000), Gilbert and Voloutsou (2006); Siulieman (2011); and Buttle (1996) revealed that service quality would affect the level of customer satisfaction (Shanka, 2012). Some researchers suggest that the process of providing services to customers should be better because the higher the quality of service provided, the higher the probability of a high level of customer satisfaction (Shanka, 2012). According to Clemes (2008) and Shanka (2012), quality is one of the dimensions that determines customer satisfaction, where satisfaction itself is one aspect that greatly influences the perception of the quality of a company in the future. According to Hazlina et al. (2011), service quality is an essential measuring tool to measure customer satisfaction. This empirical study shows that the quality of the services offered is related to overall customer satisfaction. In measuring service quality, the researchers used the dimensions of service quality measurement, where the dimensions of service quality measurement were adjusted according to each researcher's objectives and research objects so that there were many dimensions of service quality measurement.

SERVQUAL

The SERVQUAL model is a service quality measurement dimension used to define the relative importance of each service quality attribute provided by the company to customers' overall perception of quality (Auka et al., 2013). Parasuraman, Zethaml developed the SERVQUAL model and Berry in 1985, and then the SERVQUAL model developed again in 1988, 1990, 1991, 1993, until 1994. The aim is to evaluate the quality of service provided by the company to its customers based on these dimensions—measurements (Dharmayanti, 2016; Othman & Owen, 2001). According to Zetaml (2006), SERVQUAL has five measurement dimensions: reliability,

responsiveness, assurance, empathy, and tangibles, where the five dimensions represent the criteria for assessing service quality by customers (Auka et al., 2013). The five dimensions are:

1. *Reliability*

This dimension measures reliability is the company's ability to provide services to customers as promised accurately. This dimension is known as right at the first time, where the meaning of the motto is providing excellent and accurate service at the first time the service as requested.

2. *Responsiveness*

According to Mengi (2009), the responsiveness dimension has a positive relationship between service quality and customer satisfaction. This dimension defines the readiness or willingness of employees to help customers to meet their needs. In other words, this dimension assesses how quickly and willing employees are to respond to customer needs through the services provided.

3. *Assurance*

This dimension relates to the company's guarantee of the skills and knowledge of employees in providing services to customers to foster a sense of customer trust in the company. Attributes in this dimension determine the extent to which consumers trust the company as a service provider and whether they have confidence that the services provided are safe and competent.

4. *Empathy*

This dimension refers to the personal care and attention that employees give to their customers. In this dimension, it is possible to have employee skills in recognizing customer needs and employee sensitivity to customer needs.

5. *Tangibles*

According to Ananth et al. (2011), this aspect also considers customer convenience to the facilities and the layout of the facilities provided by the company. This dimension relates to the physical aspects or services physically related to the physical facilities provided, the appearance of the equipment used, the appearance of employees in serving, the convenience of facility layout, ease of access to facilities, interior, and exterior decoration. Assessment is a method to compare the gap between customer expectations of a product or service with the quality of service or product received. According to Parasuraman, quoted by Porter and explained in the research of Suhaella et al. (2019), the concept of consumer gap or gap includes five gaps or differences. According to Dumillah's research (2015), the five gaps include:

1. Gap 1: Gap between customer expectations and management perceptions of a company.
2. Gap 2: The gap between the company's perception of customer expectations and the quality of service specification.
3. Gap 3: The gap between service quality specifications and the services provided to customers.
4. Gap 4: The gap between the services provided and external communication to customers.
5. Gap 5: The gap between the service expected by the customer and the actual service received by the customer.

Importance Performance Analysis (IPA)

Martilla and James (1977) proposed the IPA method in their article entitled "Importance Performance Analysis" and published it in the Journal of Marketing (Siyamto, 2017). This method aimed to a framework for understanding customer satisfaction and translate as a function of expectation (importance) related to attributes and customer ratings of company performance (performance). In this method, respondents rate the company's performance based on their level of importance, then the level of importance and performance of the company will be analyzed using the Importance Performance Matrix. In this matrix, the X-axis will represent customer perceptions,

and the Y-axis will represent customer expectations. The following are the four quadrants of Importance Performance Analysis (Supranto, 2006; Winarno & Absor, 2017).

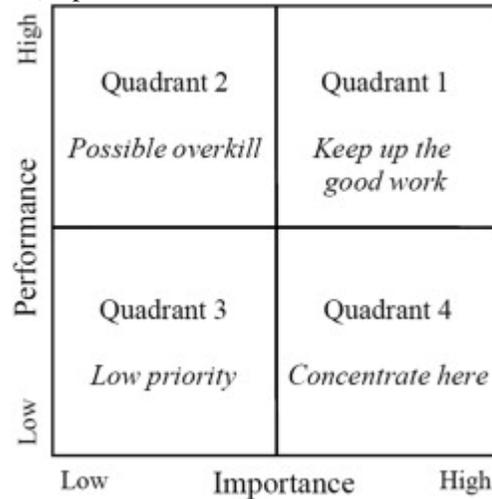


Figure 1. *Importance Performance Matrix*

Source: Supranto (2006); Winarno dan Absor (2017)

A. Concentrate Here

Attributes of factors in this quadrant are considered essential and expected by customers, but the company's performance on these attribute factors has not been satisfactory.

B. Keep Up The Good Work

The attributes of the factors in this quadrant are considered necessary by customers and support customer satisfaction even though they are not the main factors.

C. Low Priority

The factor attributes in this quadrant have a low level of actual performance, are considered not too important, and are not too expected.

D. Possibly Overkill

Attribute factors in this quadrant are considered unimportant and are not too expected by customers to support service satisfaction.

3. Research Methods

This research was conducted at Bank BTN Syariah Surabaya, which is located at Jalan Diponegoro No. 29, Surabaya City. The research data gathered from February 2021 to completion. The variables tested in this study are the SERVQUAL variable (reliability, responsiveness, assurance, empathy, tangibles) and Importance Performance Analysis (IPA). The SERVQUAL method determines the gap between customer expectations and the quality of service received by the customer. Then a mapping was carried out based on the IPA method, where this mapping aimed to determine the positioning of each attribute to the company in the four IPA quadrants and then analyzed the attributes based on each quadrant with the help of a fishbone diagram.

4. Data Collection

The data gathered from February 2021 to March 2021, where the data collection stage began by identifying the dimensions and indicators of the research based on the literature review and then

discussing and validating with the management. Furthermore, the authors conducted interviews with the management regarding customer arrivals and other information related to the research. Then a pre-survey was conducted on 20 customers through brief interviews to find out the general condition of customers regarding customer satisfaction with the company's performance. Based on the pre-survey results, 13 of the 20 customers interviewed are not satisfied with the company's current performance. Therefore, the authors measured service quality using a closed questionnaire to 50 customers who came to the office of Bank BTN Syariah Surabaya. A sample of 50 customers is determined based on a non-probability sampling technique using purposive sampling and judgment sampling methods. The sampling technique was taken in a limited manner to a specific target group and based on the results of consideration with the management.

5. Result And Discussion

The research instrument was determined based on a literature review and discussion with management as a form of validation. This study uses as many as 22 item variables used in the measurement. The following is the research instrument used, as shown in Table 1.

Tabel 1. Research Instrument

Variable	Instrument
<i>Reliability</i>	<ol style="list-style-type: none"> 1. Employees can serve customers as promised 2. Customers are easy to get services anywhere 3. The types of products and services offered by banks 4. Employees provide accurate information
<i>Responsiveness</i>	<ol style="list-style-type: none"> 1. Bank operations are following the punctuality of opening and closing hours of counterservices 2. Employees are always responsive in serving customers 3. Quick employee response to customer needs and complaints 4. The services provided by employees are fast and efficient
<i>Assurance</i>	<ol style="list-style-type: none"> 1. Banks can guarantee the confidentiality of customer data 2. Employees can serve politely 3. Employees have extensive knowledge of the company's products and services 4. Employees can provide services that create a sense of security and trust in the company 5. Banks can guarantee the safety of customer funds
<i>Empathy</i>	<ol style="list-style-type: none"> 1. Employees can listen to customer complaints properly and attentively 2. Submission of employees in providing was excellent and informative 3. Employees can understand what customers need with our detailed explaining 4. Employees can provide information regularly to customers
<i>Tangibles</i>	<ol style="list-style-type: none"> 1. Office condition is neat, clean, and smells good 2. Employees in a net condition while serving 3. Has a comfortable office interior design 4. Availability of a large and adequate parking lot 5. The strategic location of the bank office and easy to reach

The customer's instrument is assessed, where the customer assesses it based on the company's expectations and performance using a predetermined Likert scale. Customers used as research respondents come to the Bank BTN Syariah Surabaya office and carry out their banking activities in front-office services (teller service, customer service, and financing service).

5.1 Numerical Research Results

Validity dan Reliability Testing

Statistical testing to test the validity and reliability of data with the help of SPSS software. While on the company's performance data, based on the test results, it found that the data is valid and reliable with criteria that meet, namely the r-count value on each variable is worth more than r-table (0.279) with $df = 50 - 2 = 48$, and 5% significance level and Cronbach's alpha value is more than 0.7, which is 0.970. The test results found that the data on customer expectations is valid and reliable, where the r-count value for each variable is worth more than the r-table (0.279) with $df = 50 - 2 = 48$ an. In addition, the value of Cronbach's alpha is more than 0.7, which is 0.921. Therefore, in the customer's expectation data, there are no eliminated attributes because their values have met the criteria. Therefore, in the company's performance data, no attributes are eliminated.

Service Quality Analysis (SERVQUAL)

Gap assessment is utilizing the average value of the company's performance minus customer expectations. We then calculated the gap value based on the recap of the questionnaire scores with the average on each variable. The following are the results of the gap calculation shown in Table 3.

Tabel 2. Gap Value

No.	Instrument	Expected	Perceived	Gap	Rank
Reliability					
1	Employees are ables to serve customers as it promised	4,6	3,96	- 0,64	6
2	Customers are easy to get services anywhere	4,32	3,86	- 0,46	13
3	The types of products and services offered by banks are variated	4,16	3,74	- 0,42	16
4	Employees provide accurate information	4,32	4	- 0,32	18
Responsivene ss					
5	Bank operations are in accordance with the punctuality of opening and closing hour	4,58	3,86	0,72	2
6	Employees are always responsive in serving customers	4,74	4,18	- 0,56	9
7	Quick employee response to customer needs and complaints	4,56	3,92	- 0,64	7
8	The services provided by employees are fast and efficient	4,28	3,8	- 0,48	12
Assurance					
9	Banks are able to guarantee the confidentiality of customer data	4,28	3,68	-0,6	8
10	Employees are able to serve politely	4,3	3,62	- 0,68	3
11	Employees have extensive knowledge of the company's productsand services	4,3	3,64	- 0,66	4
12	Employees can provide services that create a sense of securityand trust in the company	4,4	3,5	-0,9	1
13	Banks are able to guarantee the safety of customer funds	4,56	4,38	- 0,18	20
Empathy					

14	Employees are able to listen customer complain's properly and attentively	4,58	4,22	-0,36	17
15	Submission of employees in providing was good and informative	4,4	4,12	-0,28	19
16	Employees can understand what customers neet without detail explaining	4,44	4	-0,44	14
17	Employees are able to provide information regularly to customers	4	3,96	-0,04	22
Tangibles					
No.	Instrumen	Expecte	Perceive	Gap	Ran
18	Office condition is neat, clean, and smells good	4,14	3,94	-0,2	21
19	Employees in a net condition while serving	4,02	3,58	-0,44	15
20	Has a comfortable office interior design	4,3	3,76	-0,54	10
21	Availability of a large and adequate parking lot	4,58	3,92	-0,66	5
22	The strategic location of the bank office and easy to reach	4,46	3,96	-0,5	11

Based on the table above, it shows that the gap value on all indicators is negative or less than zero (gap value < 0) so that the conclusion is a gap or gap between customer expectations and current customer performance or perceptions so that the above indicators are considered unable to satisfy customers. The most significant gap value in the measured indicator is in the assurance indicator dimension X34, namely "Employees can provide services that create a sense of security and trust in the company," while the smallest gap value in indicator number X44 is "Employees can provide information regularly to customers."

5.2 Graphical Research Result

Importance Performance Analysis (IPA)

Authors map the Importance Performance Analysis method. The following are the stages of preparation using the IPAmethod.

1. Calculating the level of conformity between the value of customer expectations and company performance (Tki):

$$Tki = \frac{Xi}{Yi} \times 100\%$$

2. Calculating the total level of conformity (Tki Total):

$$Tki Total = \frac{\sum Xi}{\sum Yi} \times 100\%$$

3. Making a cartesian Diagram:

$$\bar{X} = \frac{\sum_{i=1}^n \bar{X}_i}{k} \quad \bar{Y} = \frac{\sum_{i=1}^n \bar{Y}_i}{k}$$

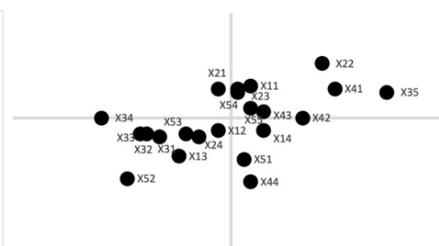


Figure 2. Importance Performance Analysis

Based on the mapping results above, the factor attributes included in quadrant A are considered essential and expected by customers. However, the company's performance on these factor attributes is not satisfactory enough. The factor attributes in this quadrant need prioritization for improvement, namely the X21 factor attribute (bank operations following the punctuality of opening and closing hours of counter service). The cause of the problem from the X21 factor attribute is the cause-and-effect diagram (fishbone). In this study, the identified factors are man, machine, and environment. The following is a fishbone diagram used in research based on identification in the field and discussions with management.

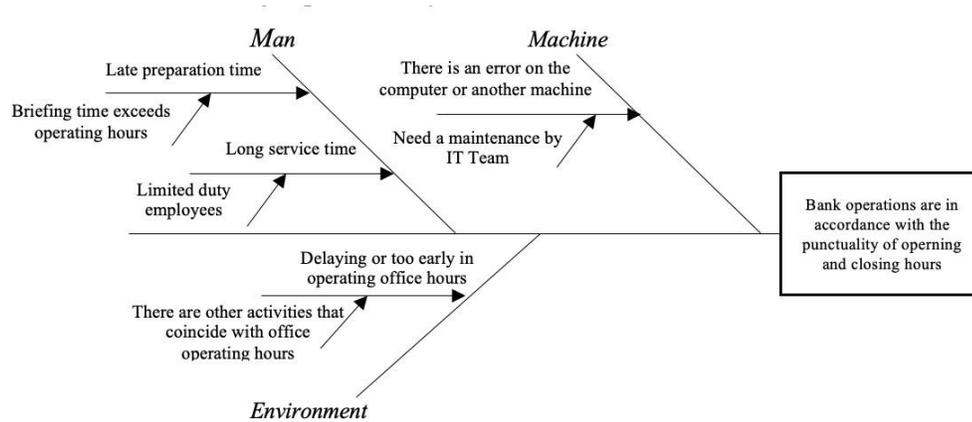


Figure 3. Fishbone Diagram

The analysis of the cause-and-effect relationship found two sub-factors in the man factor or the human itself that indicated to affect the main problem, namely long or late preparation times and long counter service times. One of the reasons was employee briefing time being delayed or exceeding the operating hours. Late preparation times usually occur at the beginning of the counter opening or early in the morning. As for the sub-factor of long service time, it can be triggered by the limited number of employees on duty so that at closing and opening hours, there are delays due to work carried out only by a few resources.

Furthermore, one subfactor is identified in the machine factor: an error or debugging on the computer or machine used during the service. The last factor is the environmental factor, where this factor has one sub-factor, namely the occurrence of delays or acceleration of counter operating hours than usual. This delay can happen at any time so that they cannot predict exact time; so it is necessary to carry out maintenance on computers and machines used daily in the service to reduce the chance of errors occurring during peak hours.

5.3 Research Recommendations

After being identified using a fishbone diagram, the cause of the discrepancy in bank operating time on counter services caused by human, machine, and environmental factors, the design proposed in the study by considering the results of the fishbone diagram, what can create additional features that aim to communicate to customers regarding service hours at the counter. The new design adds features to m-banking or i-banking related to the location of the nearest counter, calculated from the location tracking distance on each customer's smartphone so that customers can find out which counter is closest to their

current location at what time the operational hours start or end. This additional feature can be updated every day so that customers can check the operating hours of the counter before deciding to come to the counter. This requires consistent support and maintenance from the management by always ensuring that the data provided is up to date and on time so that the resulting output is optimal and on target.

6. Conclusion

In this study, conclusions that can be drawn based on the results of the discussion are as follows:

1. The dimensions of service quality at Bank BTN Syariah Surabaya are reliability, responsiveness, assurance, empathy, and tangibles, wherein the reliability dimension there are four items, the responsiveness dimension is four items, the assurance dimension is five items, there are four items of empathy dimension, and five items of tangibles dimension.
2. Attribute variables of improving service quality at Bank BTN Syariah Surabaya resulted in the Importance Performance Analysis method, namely the attributes that are in quadrant A where this quadrant is considered essential and expected by customers. However, the company's performance on these attribute factors is not satisfactory enough. The factor attributes in this quadrant need prioritization for improvement, where the attribute is the X21 attribute (bank operations are following the punctuality of opening and closing hours of counter services).
3. The design proposed in the research is the creation of additional features that aim to communicate to customers regarding service hours at the counter. This design can add features to m-banking or i-banking related to the location of the nearest counter, calculated from the location tracking distance on each customer's smartphone so that customers can find out which counter is closest to their current location and at what time the operational hours. This additional feature can be updated every day so that customers can check the operating hours of the counter.

Suggestion

1. The addition of research respondents so that the desired results can be more accurate and represent the conditions in the field.
2. There is a method that is better able to explain the cause-and-effect relationship accurately in further research.
3. There is further evaluation and consideration by the management on the implementation of the suggested improvement design.

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SENSITIVITY OF INVESTMENT CRITERION CHANGE IN PROBOLINGGO – BANYUWANGI TOLL ROAD PROJECT

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ABSTRACT

The need for capital for road infrastructure development is an obstacle for the government, so the government involves the private sector through public-private-partnership with a build - operate - transfer scheme. This research aims to determine the factors that most impact in the Net Present Value (NPV) and Internal Rate of Return (IRR) in the Probolinggo - Banyuwangi toll road investment from private company perspective, and to determine the limits that make changes in criterion investment decision. With sensitivity analysis, simulations are carried out to increase initial investment costs by 10%, 20%, 30%, 40% and 50%, delays in land acquisition for 1 year, 2 years and 3 years, and revenue is not achieved by 10%, 20%, 30%, 40% and 50%. The calculation results from the scenario of changing factors, it is found that the non-achievement of the toll revenue target is the most influential factor on the investment decision criteria. For every 10% of the toll revenue target that is not achieved, there will be a decrease in NPV of Rp. 8,756,251,122,331 and a decrease in IRR of 0.86%. While the limits that make the decision on investment criteria change are an increase in initial investment costs by 92,0206%, delays in land acquisition for 15 years and not achieving revenue by 42.5491%. Besides that, from 144 condition, there are 65 chances that the change of investment criterion may occur.

Keywords: Build-Operate-Transfer, Sensitivity, Toll Road, Investment, Project.

1. INTRODUCTION

One of the things that can increase productivity and competitiveness in a country is road construction. Roads are one of the facilities and infrastructure that support the economic growth of a country. In addition, roads can support the existing potential of the two regions. Increasing and improving the quality and network of roads in a place, it can improve the economy in that place. This also applies the other way around. where rapid economic growth triggers demand for road infrastructure development (Wang et al, 2019).

Infrastructure development requires capital that tends to exceed the government's ability. One solution taken by the government in overcoming this is to involve the private sector in the infrastructure development process. The involvement of the private sector is through a collaboration between the government and the private sector known as the Public Private Partnership (PPP) (Wang et al, 2019). The Build – Operate – Transfer is one of the solutions for public-private-partnership in adding to the road network. In this scheme, the government has given permission to the private sector to be able to build and operate roads in certain places using their own funds. Refunds for the costs incurred are obtained from toll revenues from road users for several years, then the roads are returned to the government (Tsai

et al, 2003). In the Public- private Partnership project process, each party has different expectations and indicators of investment success (Ahmadabadi et al, 2019). The purpose of the cooperation for the government is that the construction of toll roads is carried out to develop the potential and improve the economy of a region. While the goal of private companies that collaborate with the government is return on investment and profits in the future (Song et al, 2018). The collaboration between the government and the private sector is influenced by several criteria on the cooperation that has a concession period. Several factors that can impact the investment criteria are the total initial investment cost, construction completion time, toll rates, traffic volume, maintenance costs and interest rates (Shen and Wu, 2005). In addition, delays in land acquisition, increasing initial investment costs and uncertainty in revenue are factors that must be faced in road infrastructure investment (Thomas et al, 2005).

The Trans-Jawa toll road is scheduled by the Indonesian Government to be completed in 2019. In fact, there is still one 172 KM section that has not been completed. The section is the Probolinggo – Banyuwangi section whose concession rights are owned by PT. Jasamarga Probolinggo Banyuwangi. In the initial plan, this toll road required an investment of Rp 23.3 trillion with a concession period of 35 years. However, the construction of this toll road has been delayed from the initial completion schedule due to delays in land acquisition. Therefore, the potential for increased investment costs, changes in revenue projections and a shorter operating period may occur. This condition can affect the investment criteria of the Probolinggo – Banyuwangi toll road project.

Based on the possibility of the challenge above, research about the sensitivity of changes in investment criteria on the Probolinggo – Banyuwangi toll road is needed. This research is to find out most impact variable that can change investment criteria decision. It can be used as an early warning when investment not met the expectation and as a basis for negotiating the extension of the concession period.

2. LITERATURE REVIEW

2.1 The Investment

Investment is an expenditure by a party in the present mass as a purchase of real assets or financial assets with the aim of obtaining greater results in the future (Haming and Basalamah, 2003). Investment is also said to be a commitment from the use of any resources or assets that can be used for economic activities with the hope of getting profits in the future (au et al, 1992, Gitman et al, 2017). However, in making an investment one must also consider the existence of uncertainty in the future (Reily et al, 2012).

The expenditure of funds used in financing an investment plan depends on the type and scale of the project being implemented. Investment costs are costs invested by investors to prepare business needs to be ready to operate properly. The amount of funds used in investment is divided into initial investment funds or initial investments, working or operational capital funds, and maintenance costs (Haming and Basalamah, 2003). Initial investment is a fund that is prepared to procure capital goods such as machinery, land, project roads, and office buildings. In general, these costs are incurred at the beginning of large-scale project activities and have a long-term impact on the smooth running of the project (2017). Furthermore, working, or operational capital funds are funds used to finance operating activities after the project enters the commercial operation phase (Haming and Basalamah 2003). Finally, maintenance funds are the power used to maintain and ensure the performance of the equipment or facilities used so that their use is always optimal and ready to be operated in the process of implementing a project (Giatman, 2017).

One of the main activities in the early stages of investment planning is the estimation of funds. Estimated funds for a project implemented are calculated based on the physical form that results from

the process of the project being implemented. Examples are bridges, buildings, towers, ports, roads, factories, and so on. There are 2 approaches in calculating the estimated investment funds, namely bottom-up and top-down. The bottom-up approach is an estimate of funds based on a work breakdown structure. While the top-down approach is the opposite of the bottom-up approach. This approach is most often used in the process of estimating investment funds (Ibrahin and Rinieta, 2020). In toll road projects, the estimated funds consist of the project initiation, planning, environmental assessment, design, land acquisition, auction, construction, and operational stages (Hassanein, 2016).

2.2 Public – Private Partnership

Cooperation between the government and the private sector generally arises because of the increasing need for public advice, increasing economic activity and creating added value in improving the quality and quantity of public services. But Government finances are extremely limited to finance these needs. The private party in this partnership acts as an investor. The investor has the right to a return on capital for the investment he has made (Noor, 2017). Characteristics of Public-Private-Partnerships in the transportation infrastructure sector include management contracts, lease contracts, concessions on existing infrastructure, and concessions on new infrastructure (Cormona, 2010). For this collaboration to be carried out properly, it requires excellent coordination and efforts to integrate each party. The government is responsible for regulations throughout the project life cycle, including delivery methods, selection of partner, contract specifications and monitoring (Carmona, 2010)

2.3 Toll Road Investment

Private companies invest in infrastructure development due to the increasing need for economic growth and the limited government budget. Some examples of infrastructure development needed by the community include power plants, airports, national roads (highways), bridges, ports, tunnels, and clean water treatment. The Indonesian government itself provided an opportunity for private companies to invest in toll roads for the first time in 1987 (Wibowo and Kochendorfer, 2005). Private companies as investors will get a return on investment and profits and revenues from tolls paid by road users during the operation period (Wang et al, 2019). As in other countries, Public-Private-Partnership in road construction also applies a contract with a Build-Operate-Transfer scheme.

The construction of toll roads is a form of cooperation between the government and the private sector in the infrastructure sector that implements a Build-Operate-Transfer scheme. In the Build-Operate-Transfer (BOT) scheme, the private company has the obligation to build and operate the road during the concession period. The concession period can be divided into two phases, namely the construction and operation phases. In the construction phase, private companies are asked to build roads according to the capacity and quality set by the government (Zhang et al, 2018). Furthermore, in the operation phase, the government gives permission to private companies to charge reasonable fees to road users as a return on investment that has been made at the beginning for a certain period (Song et al, 2018). At the end of the concession,

the private sector must hand over the toll road to the government (Tsai et al, 2003). The relationship between investment valuation and the present value method over the concession period is illustrated in Figure 1.

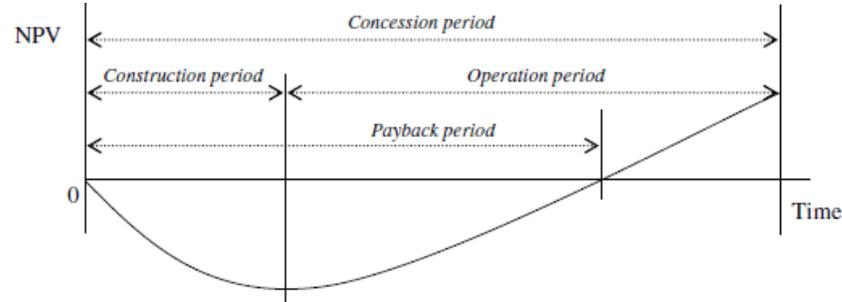


Figure 1. Net Present Value Investment Valuation in the Concession Period (Ng et al, 2007)

2.4 Risk in Build-Operate-Transfer Investment

Another factor that is especially important and becomes a consideration in making investment decisions is risk and uncertainty. Basically, investment decisions are taken for something that is uncertain in the future (Pujawan, 2019). The difference between risk and uncertainty lies in the amount of information or knowledge about future conditions in investment (Pujawan, 2012). Risk is an unwanted event, something that happens outside the original purpose or the possibility of something detrimental happening. Therefore, the investment risk is not achieving the investment objectives or the non-occurrence of the expected monetary benefits (Noor, 2017). Investment risk can arise because of the long-term duration of investment.

There are several uncertainties that often occur in investments with Build-Operate-Transfer schemes, especially in the toll road sector in Indonesia. These uncertainties include construction costs, construction completion time, the initial toll rate and during the concession period, traffic volume and macroeconomic conditions. In Indonesia, the main factor that causes delays in the completion of toll road construction is delays in land acquisition. This can reduce the period of operation to earn revenue. Meanwhile, the uncertainty of the toll rate and traffic volume can affect the amount of revenue during the operation period (Wibowo and Kochendorfer, 2005).

3. METHODS

The approach used in this research is quantitative finance. The input data in this research are initial investment costs, delays in land acquisition and revenue. Meanwhile, the output data are net present value (NPV) and internal rate of return (IRR). Sensitivity analysis is carried out to determine how much a change in an input can affect the output value. The research model is described according to Figure 2.

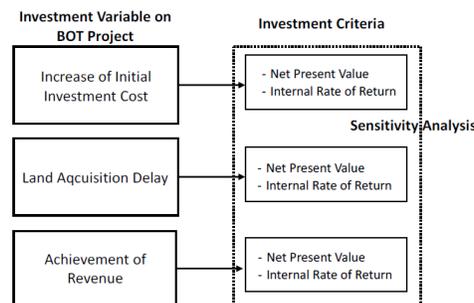


Figure 2. Research Model

This research was controlled by analysing the sensitivity of the independent variables (NPV dan IRR) that would adapt the investment appraisal criteria. The data used in this research was secondary data from the concession holder of the Probolinggo – Banyuwangi toll road, namely PT. Jasamarga Probolinggo Banyuwangi. The data prerequisite are initial investment data, project implementation schedule, concession period, projected revenue, estimated operating and maintenance costs during the concession period, and the expected rate of return by the concessionaire. The data obtained were then analysed. The analysis carried out in this research applies financial modelling and simulation.

4. RESULTS

PT. Jasamarga Probolinggo Banyuwangi is a private company that cooperates with the Government in building and operating the Probolinggo - Banyuwangi toll road with a concession period of 35 years. Table 3. Shows technical data from the Probolinggo – Banyuwangi toll road project.

Table 1. Probolinggo - Banyuwangi Toll Road Technical Data

No	Description	Information
1	Toll Road Length	172, 91 KM
2	Number of Lanes Initial Stage	2 x 2 Lanes
3	Number of Lanes Final Stage	2 x 3 Lanes
4	Lane Width	3,60 m
5	Outer Shoulder Width	3,00 m
6	Inner Shoulder Width	1,50 m
7	Number of Interchanges	7 pcs
8	Number of Overpass	162 pcs
9	Number of Underpasses	3 pcs
10	Number of Box Culvert	91 pcs
11	Number of Bridges	36 pcs
12	Number of JPO	45 pcs
13	Lane Pavement	Rigid Pavement
14	Inner Shoulder Pavement	Rigid Pavement
15	Outer Shoulder Pavement	Asphalt Treated Base / ATB

Source: Toll Road Regulatory Agency, 2017

4.1. Investment Criteria Analysis

Analysis of the investment criteria used in this research is the Net Present Value (NPV) and the Internal Rate of Return (IRR) from the perspective of the concession holder or private company. The investment variables that measured are initial investment costs, time for completion of land acquisition, and revenue.

The Probolinggo – Banyuwangi toll road construction project was targeted to start in December 2017 and finish in December 2019. Land Acquisition scheduled to be complete within 18 months and construction scheduled to be complete in 24 months. So that in December 2019, the Probolinggo – Banyuwangi toll road can operate. The initial investment cost of this project estimate Rp. 23,391,192,000,000, rate of interest 6,66% and concession period for 35 years.

The return on investment and profits in the toll road sector is attained from the traffic volume multiplied by the toll rate set by the governments. Throughout the concession period, the government can adjust a toll fee of 10% every two years. In addition, it is projected that there will be an increase in traffic volume between 6.51% and 6.84% every year.

Private companies should organize toll roads under the Minimum Service Standards (SPM) set by the Government, through the concession period. The government sets the standard for the status of retreat and ease services on toll roads to be higher than on public roads. With this standard, private companies must incur operational costs. These costs consist of toll collection cost, cost of service for toll user and maintenance costs.

Based on calculation, with Rp. 23,391,192,000,000, of investment initial cost, rate of interest 6.66%, and concession period of 35 years, the Net Present Value of the Probolinggo – Banyuwangi toll road project is Rp. 37,257,088,486,335, - and the Internal Rate of Return is 11.01%.

4.2. Sensitivity Analysis

Sensitivity analysis was accompanied to regulate the sensitivity of changes in variables that impacted the worth of the investment decisions criteria. In this research, the variables established were initial investment costs, land acquisition duration, and revenue. The results of the sensitivity analysis can be shown in Figure 3 and Figure 4

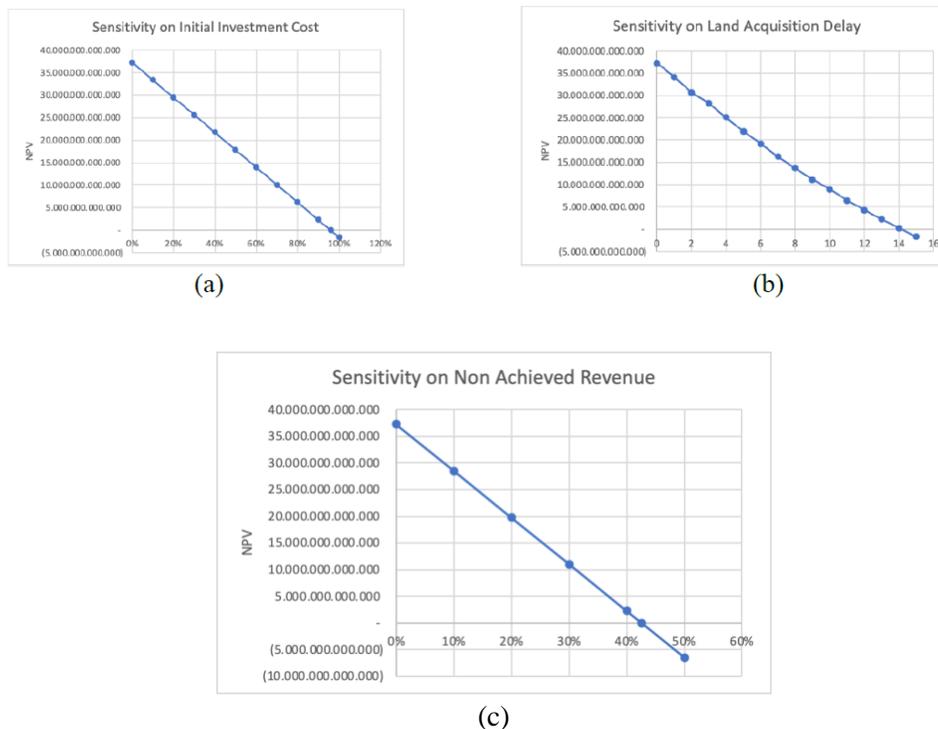


Figure 3. Graph of Sensitivity Between (a) NPV for Increase in Initial Investment Cost, (b) NPV for Delays in Land Acquisition, and (c) NPV Against Non-Achievement of Revenue.

Initial Investment Cost	NP V	IR R	Sensitivity on NPV	Sensitivity on IRR
0%	37.257.088.486.335	11,01%	(3.880.115.544.348)	
10%	33.376.972.941.987	10,33%	(3.880.115.544.348)	-0,59%
20%	29.496.857.397.638	9,74%	(3.880.115.544.348)	-0,53%
30%	25.616.741.853.290	9,21%	(3.880.115.544.348)	-0,48%
40%	21.736.626.308.942	8,73%	(3.880.115.544.348)	-0,44%

50%	17.856.510.764. 593	8,29%	(3.880.115.544 .348)	-0,40%
60%	13.976.395.220. 245	7,88%	(3.880.115.544 .348)	-0,37%
70%	10.096.279.675. 897	7,51%	(3.880.115.544 .348)	-0,35%
80%	6.216.164.131.5 48	7,17%	(3.880.115.544 .348)	-0,32%
90%	2.336.048.587.2 00	6,84%	(2.336.048.587 .200)	-0,18%
96,0206%	0	6,66%	-	
100%	(1.544.066.957. 148)	6,54%		

Land Acquisition Delay	NP V	IR R	Sensitivity on NPV	Sensitivity on IRR
0	37.257.088.486. 335	11,01%	(3.106.603.04 1.385)	-0,0528%
1	34.150.485.444. 950	10,95%	(3.443.706.23 7.161)	-0,1298%
2	30.706.779.207. 789	10,82%	(2.467.386.73 2.127)	-0,0667%
3	28.239.392.475. 662	10,76%	(3.136.652.23 1.985)	-0,1611%
4	25.102.740.243. 677	10,59%	(3.125.930.57 0.590)	-0,1956%
5	21.976.809.673. 087	10,40%	(2.824.801.19 3.453)	-0,2063%
6	19.152.008.479. 633	10,19%	(2.862.346.05 6.945)	-0,2557%
7	16.289.662.422. 688	9,94%	(2.594.690.39 7.566)	-0,2742%
8	13.694.972.025. 122	9,66%	(2.600.519.11 3.908)	-0,3353%
9	11.094.452.911. 214	9,33%	(2.120.592.28 5.290)	-0,2081%
10	8.973.860.625.9 23	9,12%	(2.578.184.73 1.284)	-0,5990%
11	6.395.675.894.6 39	8,52%	(2.107.377.32 3.880)	-0,4839%
12	4.288.298.570.7 59	8,04%	(2.110.481.57 6.713)	-0,5987%
13	2.177.816.994.0 47	7,44%	(1.944.450.77 8.448)	-0,6851%
14	233.366.215.59 9	6,75%	(1.907.618.35 5.818)	-0,8457%
15	(1.674.252.140. 219)	5,91%		

Revenue	NP V	IR R	Sensitivity on NPV	Sensitivity on IRR
0%	37.257.088.486. 335	11,01%	(8.756.251.122 .331)	-0,86%
10%	28.500.837.364. 004	10,15%	(8.756.251.122 .331)	-0,93%
20%	19.744.586.241. 674	9,21%	(8.756.251.122 .331)	-1,04%
30%	10.988.335.119. 343	8,18%	(8.756.251.122 .331)	-1,18%
40%	2.232.083.997.0 12	6,99%	(8.756.251.122 .331)	-1,40%
42,5491%	0	6,66%	(0)	-6,66%
50%	(6.524.167.125. 319)	5,59%		

Figure 4. Calculation Result of Sensitivity Analysis

In a condition, investment also tolerate changes in variables at the same time. So that sensitivity analysis is also carried out by changing all the variables to be tested in combination of changes of all variables. Based on the simulation results with simplified values (NPV value divided by 1,000,000,000,000), the data was obtained as shown in Table 2.

Table 2. The Conditions of a Change in Investment Criteria

Initial Investment Cost Increase	0%						10%						20%					
	0%	10%	20%	30%	40%	50%	0%	10%	20%	30%	40%	50%	0%	10%	20%	30%	40%	50%
Decrease in Revenue																		
Land Acquisition Delay																		
0	37	29	20	11	2	(7)	25	16	7	(2)	(10)	29	21	12	3	(6)	(14)	
1	33	24	16	8	(0)	(9)	21	12	4	(4)	(12)	25	17	8	0	(8)	(16)	
2	31	23	15	7	(0)	(8)	19	11	4	(4)	(12)	23	15	8	(0)	(8)	(16)	
3	27	19	12	5	(3)	(10)	16	8	1	(6)	(13)	19	12	5	(3)	(10)	(17)	

Initial Investment Cost Increase	30%						40%						50%					
	0%	10%	20%	30%	40%	50%	0%	10%	20%	30%	40%	50%	0%	10%	20%	30%	40%	50%
Decrease in Revenue																		
Land Acquisition Delay																		
0	26	17	8	(1)	(9)	(18)	13	4	(5)	(13)	(22)	18	9	0	(8)	(17)	(26)	
1	21	13	5	(4)	(12)	(20)	9	1	(7)	(16)	(24)	14	5	(3)	(11)	(19)	(28)	
2	19	12	4	(4)	(12)	(19)	8	0	(8)	(15)	(23)	12	4	(4)	(11)	(19)	(27)	
3	16	8	1	(6)	(14)	(21)	5	(3)	(10)	(17)	(25)	8	1	(6)	(14)	(21)	(28)	

6. CONCLUSIONS

From calculation of the various scenarios, the most impact factor that change investment criteria on Probolinggo – Banyuwangi toll road project is non achievement of target toll revenue. For every 10% of the toll revenue target that is not achieved, there will be a decrease in NPV of Rp. 8,756,251,122,331 and a decrease in IRR of 0.86%. While the limits that make the decision on investment criteria change are an increase in initial investment costs by 96,0206%, delays in land acquisition for 15 years and not achieving income by 42.5491%. Besides that, from 144 condition, there are 65 chances that the change of investment criterion may occur.

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EVALUATION OF OUTSOURCING EMPLOYEE PERFORMANCE APPRAISAL SYSTEM WITH ALTERNATION RANKING AND BORDAMETHOD (STUDY AT BADAN PENGELOLAAN KEUANGAN DAN PAJAKSURABAYA)

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ABSTRACT

Badan Pengelolaan Keuangan dan Pajak Daerah (BPKPD) or Regional Government Internal Auditor in Surabaya is a governmental company that manages local taxes in Surabaya. The performance of civil servant in the company are demanded to continuously focused to achieve government's goal to maximize the government's revenue from the tax sector. In Surabaya Mayor's Regulation number 20 of 2014 concerning Technical Guidelines for Evaluation of Government Company Performance Accountability Reports (LAKIP) Regional Apparatus Work Units within the Surabaya Government, this government agencies independently plan, implement, measure and monitor performance and report it to the higher institutions. Field data collection is carried out by processing the internal data which supported by employee performance appraisal report in this company at the Revenue Sector within 6 months. There are two methods used in this research, Alternation Ranking method and Borda method. Alternation Ranking method to specify best performance employee, Borda method complete the precious method with weighting process for each specified criterion. The Authorized Officer determines which criteria that will be used as the benchmark for employee performance. The result of this research brings out the employee names ranked from the best to the worst, as well as their performance appraisal. Furthermore, this result can identify the causes of low grades happened to the lowest-ranking employees. Hopefully this result can be used as an evaluation of the employees involved and also improvements in human resource management at BPKPD.

Keywords: Human Resource Management, Alternation Ranking Method, Borda Method, Performance.

1. INTRODUCTION

Badan Pengawasan Keuangan dan Pajak Daerah (BPKPD) or Regional Government Internal auditor in Surabaya is an company under the supervision of the Regional Government which plays arole in the financial income for Surabaya through the payment of local taxes. The taxes covered include Pajak Bumi dan Bangunan (PBB) or Tax for Land and Building, Bea Perolehan Hak Tanah dan Bangunan (BPHTB) or Tax for Rights Acquisition Fee for Land and building, moreover Taxfor Advertising, Restaurant, Entertainment, Parking, Ground Water, and Street

Lighting. The sector of PBB and BPHTB have the highest contribution to the total Pajak Asli Daerah (PAD) or Regional Original Tax for the Government. In 2018, PBB and BPHTB contributed about 63% of total revenue 3.817.402.592.324 IDR or 3.817 Trillion Rupiah. Sub Division of Revenue and Determination is a special division in BPKPD which in charge to maximize revenue and make determinations the submitting requests for PBB and BPHTB services. There are 119 outsourcing employees who are coordinated by eight Pegawai Negeri Sipil (PNS) or Government Employees.

According to Surabaya Mayor's Regulation number 20 in 2014 concerning Technical Guidelines for Laporan Akuntabilitas Kinerja Instansi Pemerintah (LAKIP) or Evaluation of Government Performance Accountability Reports, Regional Apparatus Work Units within the Surabaya Government, improving governance and management systems is an important agenda in government reform that is being carried out by the government. BPKPD independently plans, implements, measures and monitors performance and reports it to the higher institutions.

The strategies used to improve employee performance in BPKPD are increasing employee loyalty and cohesiveness between co-workers with activities such as outbound and employee gatherings. Beside that, this institution improves the quality of employee knowledge based on their respective fields of work. However, The measureable and systematic employee performance appraisal is not available yet.

According to Surabaya Mayor's Regulation number 73 in 2015 concerning Freelance Daily Workers in Surabaya Government, there are detailed guidelines for performance appraisal encompasses 7 assessment criteria: Loyalty, Initiative, Responsibility, Obedience, Honesty, Cooperation, and Activeness. The appraisers are the employee who has higher level (supervisors or senior) or the other employee on the same level. But in fact, there has never been an assessment based on this rule. Therefore, the author wants to conduct a performance assessment based on the applicable rules and relevant method according to the company. This assessment is expectedly used on BPKPD for a more systematic and sustainable performance assessment. In addition, the research is expected to provide input to the Authorized Officials in providing standardized performance values for outsourced employees.

2. METHODS

2.1 Alternation Ranking

Performance appraisals are designed to help companies to achieve organizational goals and motivate employee performance. There are several methods that can be applied for company to evaluate the employee's performance, (Dessler, 2016):

- Graphic Rating Scale Method
- Alternation Ranking Method
- Paired Comparison Method
- Forced Distribution Method
- Critical Incident Method
- Behaviorally Anchor Rating Scale (BARS)
- Management by Objectives (MBO)

The researcher had already compared each applicable method according to company conditions. There are several concerns for performance appraisal process: length of time required, the amount of the subject assessed, the development of long-term assessment, the objectivity of the assessment, and the last is the amount of costs required. This picture below is a consideration towards BPKPD.

Table 1. Method Selection Comparison

	Comparison
--	------------

Method	Time	Number of Employees	Long Term Development	Subjectivity	Cost
Graphic Rating Scale	√	√	X	X	√
Alternation Ranking	√	√	√	X	√
Paired Comparison	√	X	√	X	√
Forced Distribution	√	X	√	√	√
Critical Incident	X	X	√	√	√
Narrative Forms	X	√	X	√	√
BARS	X	√	X	√	√
MBO	X	X	√	√	X

As shown in the table above, the Alternation Ranking method is the most suitable method applied according to researcher consideration, but this method potentially triggers non-subjectivity in the assessment. Alternation Ranking Method, one of performance appraisal method that is carried out by employees rank from the best to the worst in one of many criterias, Dessler (2016). In order to create an objective and measurable assessment, the determination of the assessment criteria will be determined according to Mayor's Regulation and the authorized official. Furthermore, the weighting will be carried out using the Borda method to provide an accurate assessment of each criterion.

2.2 Borda

The Borda Method was invented by Jean-Charles de Borda in the 18th century. This is a voting method which is used for group decision making for single winner or multiple winner election. Borda determines the winner by presenting a certain number of points for each candidate. In addition, the winner will be determined by the total number of points that has been collected by the candidate (Cheng and Deek, 2009).

The basic principle of Borda method is to determine the rank to existing alternatives (Bouyssou, 2006). The alternative that has the highest rank is given the highest score, and so on for the rank below is given a lower score until the lowest rank is scored 0 or 1. The idea of the Borda method to require the voters to give a rank for each candidate, and give a score for each rank (Silva, 2009). Assessment of the importance of criteria based on ranking method. The most important will be in the rank number 1. The next unimportant in the ranking number 2. Rank 1 changed to weighted rank $m-1$. Rank 2 changed to weighted rank $m-2$. Rank to m becomes weighted rank $m=0$.

$$R_1 = \sum_{j=1}^n R_{1j}$$

The weights are obtained as:

$$W_l = \frac{R_l}{\sum_{l=1}^m R_l}$$

R_l = the sum of the weighted rankings for all criteria l . R_{lj} = evaluated ranking by j for criteria l . W_l = weight of criteria l for evaluators n . Borda method will be applied to determine the weight of each employee's performance criteria.

3. RESULTS

According to Dessler (1992) there are five factors in performance appraisal, that is Quality of work (including: acquisition, accuracy, appearance and acceptance of output), Quantity of work (including: volume of output and contribution), Required Supervision (including: providing for advice, instruction, or improvement), Attendance (including: regularity, trustworthy or reliable and accuracy time). After processing the data based on Dessler's theory, the provisions of the criteria according to mayor's regulation, and BPKPD condition, 10 criteria were obtained, that is Loyalty, Initiative, Responsibility, Obedience, Honesty, Cooperation, Activeness, insight on Standard Operating Procedures (SOP), insight on legal basis and applicable policies, and also insight on public services. The data was collected through direct interviews with the employee's supervisor and the employee knowledge test.

3.1 Borda Method Weighting

The Borda method is used to weighed the employee's performance appraisals. There are 15 panel experts as respondent who will give weight to each criterion, the respondents are experts in human resources area. The following is a recapitulation of the weighed of each criterion.

Table 2. Criteria Weighting Table

Panel Expert	Criteria									
	Regulation of Mayor							Work Knowledge		
	Loyal ty	Initiativ e	Respo n- sibilit y	Obedie nce	Hones ty	Cooperat ion	Activen ess	SOP	Legal Basis and Policies	Publi c Servic es
R1	3	5	1	6	2	4	8	9	7	10
R2	3	9	2	4	5	7	10	8	1	6
R3	10	5	3	9	4	7	8	1	6	2
R4	1	4	2	8	6	3	9	7	10	5
R5	8	3	1	2	5	4	10	7	6	9
R6	10	3	2	5	1	9	8	4	6	7
R7	9	7	2	1	5	6	10	4	3	8
R8	4	2	1	6	5	3	10	8	7	9
R9	2	5	1	7	4	3	10	6	8	9
R10	10	5	6	4	3	9	1	2	7	8
R11	4	2	1	7	5	3	8	9	6	10
R12	10	9	2	3	1	8	4	6	7	5

R13	6	5	1	4	2	3	9	7	8	10
R14	5	6	1	2	3	4	9	8	10	7
R15	7	4	1	6	3	8	10	2	5	9

This picture below (**Figure 1**) is the result of weighting for each criterion in a percentage value. This data will be used for the assessment of each employee.

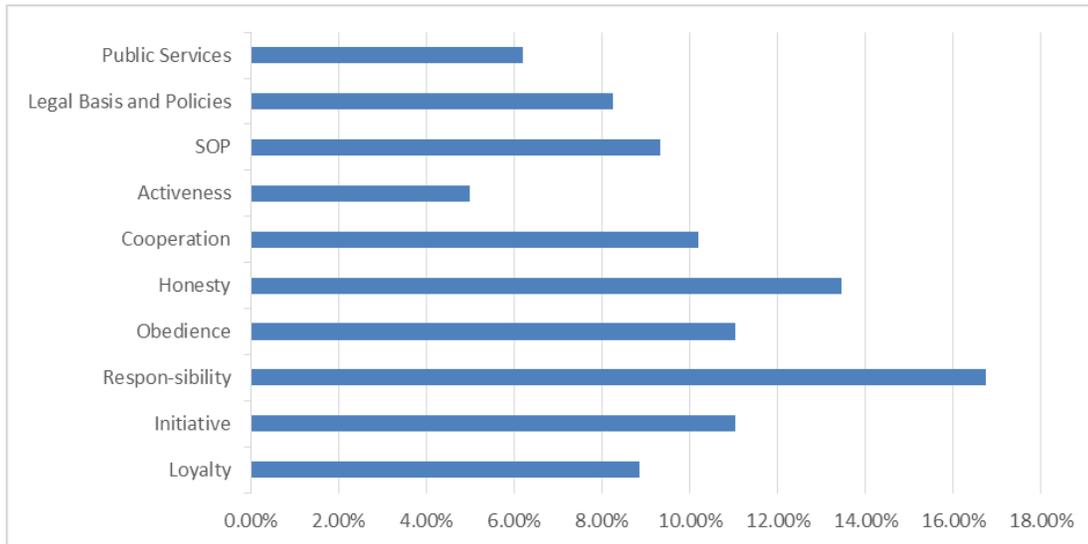


Figure 1. Criteria Weight Result

3.2 Borda Method Calculation

On the analyzed subject, there are 119 employees at Sub Division of Revenue and Determination. Every employee is scored according to 10 criteria that have been determined. The 6 assessment criterias given by the coordinator are stated as numerical scale. The classification of rating score range according to mayor's regulation. Furthermore, 3 assessment criterias are obtained through job knowledge test with 100 total score. The last criteria using employee attendance data with 100 maximum score. The following results (**Table 3**) are the six samples taken from total 119 employee assessment.

Table 3. Assessment of Each Criterion

Employee	Criteria									
	Responsibility	Honesty	Obedience	Initiative	Cooperation	Loyalty	SOP	Legal Basis and Policies	Public Services	Activeness
A1	75.0	85.0	70.0	80.0	90.0	75.0	61.5	69.2	65.5	99.2
A10	95.0	90.0	85.0	85.0	90.0	90.0	75.6	62.8	69.0	100.0
A2	80.0	85.0	85.0	80.0	90.0	80.0	64.1	52.6	53.6	100.0
A3	75.0	85.0	85.0	80.0	90.0	85.0	51.3	71.8	65.5	100.0
A4	80.0	80.0	85.0	80.0	90.0	90.0	75.6	53.8	67.9	100.0

A5	95.0	85.0	95.0	90.0	90.0	85.0	34.6	33.3	22.6	100.0
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The comparison table for the selection of assessment methods described in Tabel 3 is then processed by calculating the weighting for each criterion, it will produce the final value (**Table 4**).

Table 4. Assessment Result with Weights

Employee	Criteria										Score
	a										
	Responsibility	Honesty	Obedience	Initiative	Cooperation	Loyalty	SOP	Legal Basis and Policies	Public Services	Activeness	
	17%	13%	11%	11%	10%	9%	9%	8%	6%	5%	100%
A1	12.55	11.43	7.72	8.82	9.16	6.64	5.74	5.70	4.05	4.93	77
A10	15.89	12.11	9.38	9.38	9.16	7.97	7.06	5.18	4.27	4.97	85
A2	13.38	11.43	9.38	8.82	9.16	7.08	5.98	4.33	3.31	4.97	78
A3	12.55	11.43	9.38	8.82	9.16	7.52	4.78	5.92	4.05	4.97	79
A4	13.38	10.76	9.38	8.82	9.16	7.97	7.06	4.44	4.19	4.97	80
A5	15.89	11.43	10.48	9.93	9.16	7.52	3.23	2.75	1.40	4.97	77

All scores on each criterion are calculated according to their weighting. the sum of all criteria scores will be the performance value of each employee.

3.3 Alternation Ranking

In this method, the results of the assessment of each employee are sorted from the highest to the lowest. The results of this sequence become the final result that can be re-evaluated by the authorized official for observing employee performance for the next fiscal year. The following results (**Table 5**) are the six samples taken from total 119 employee assessment.

Table 5. Assessment Score with Ranking

Employee	Score	Rank
IT6	92	1
IT10	92	2
IT13	92	3
IT15	91	4
AI2	91	5
IT12	90	6

The final results (**Table 6**) of the assessment are classified into several groups, the following are the results.

Table 6. Performance Appraisal Rating Range

Index	Excellent	Very Good	Good	Average	Below Average
Score	>91	81-90	76-80	61-75	<60
Number of Employee	4	87	27	1	0
%	3.4%	73.1%	22.7%	0.8%	0.0%

There are 4 excellent employees, 87 very good employees, 27 good employees, and 1 average employee. There are no employees with below average results. Most employees 73.1% get very good scores on this performance appraisal.

Table 7. Lowest Performance Ranking

Employee	Responsibility		Honesty		Obedience		Initiative		Cooperation		Loyalty		SOP		Legal and Policies		Public Services		Activeness		Total
	Score	16.7%	Score	13.5%	Score	11.0%	Score	11.0%	Score	10.2%	Score	8.9%	Score	9.3%	Score	8.2%	Score	6.2%	Score	5.0%	
A5	95.0	15.9	85.0	11.4	95.0	10.5	90.0	9.9	90.0	9.2	85.0	7.5	34.6	3.2	33.3	2.7	22.6	1.4	100.0	5.0	76.8
A1	75.0	12.5	85.0	11.4	70.0	7.7	80.0	8.8	90.0	9.2	75.0	6.6	61.5	5.7	69.2	5.7	65.5	4.0	99.2	4.9	76.7
PX5	70.0	11.7	75.0	10.1	90.0	9.9	77.0	8.5	85.0	8.7	95.0	8.4	51.3	4.8	53.8	4.4	60.7	3.8	99.5	4.9	75.2

There are 3 employees with the lowest scores A5, A1, and PX5 (**Table 7**). Employee A5 obtained a moderate score 90 point on the assessment criteria carried out by the supervisor. In addition, A5 employees are very disciplined because for 6 months they have never been late or are absent from work, this can be seen from the activeness 100 points. However, this employee got a very bad score, a mean score 30.2 point on the work insight test. Furthermore, A1 employees get a moderate score 79.2 point on the supervisor's assessment and a moderate score 65.4 point on the work insight test. The score of this employee activeness is good because it gets 99.2 points. PX5 employees get a moderate score 82 point on the supervisor's assessment and a moderate score 55.3 on the work insight test. The score of this employee activeness is good because it gets 99.5 point.

Based on the analysis of the 3 employees with the lowest performance scores. They have very good activeness scores, but have no effect on the overall score because the weight of this criterion is very small (4.97%). Although having very good scores on 6 criterias with the greatest weight, employee A5 got very bad scores on 3 criterias of the job insight test, this made employee A5 ranked in the bottom 3. The cause of the low score on this criterion is that A5 employees do not take the work insight test for 3 month; April, May, and June. The A1 employee does not have a score below 60 point, but the overall score obtained is not high so that this employee is in the bottom 2. PX 5 employees became the worst performing employee because he got scores below 71 point on 2 criteria, and scores below 61 point on 2 criteria, then got a total score 75.2 point.

This research helps to set a measurable performance assessment standard. The term of the minimum performance appraisal standard can be discussed further by the authorized official and can be

used as standard of employee performance effectiveness in the next period of time. If the company needs employee efficiency, this research will help to find suitable employee candidates. Moreover, analyzing the factors which cause the low value of the employee can help the company to improve employee performance. Not only helped to control the attendance and the work processes, but this performance appraisal will also indirectly improve the quality of work for every employee. Proper knowledge of the job will minimize waste or errors in the work process.

4. CONCLUSIONS

The Conclusion based on this study, the assessment who reviewed by the higher level employee than the employee that has been assessed are dominantly high ranked. The assessment criteria based on employee responsibility (16.73%). This criterion is the most considered on employee performance. Next most important criteria, Honesty of employees at work (13.45%). The third and fourth ranks have the same weight, that is obedience and initiative criteria (11.03%). The next ranking is cooperation criteria (10.18%) and loyalty (8.85%). The assessment criteria based on the job knowledge test have a lower weight rate, that is SOP insight (9.33%), legal and policy basis (8.24%) and knowledge of public services (6.18%). Lastly, the lowest weight criteria is activeness of absence (4.97%).

Performance assessment on 119 employees in the Sub Division of Revenue and Determination at BPKPD was classified as good result. There were no employees below the average on the index value determined by the mayor's regulation. The score of employee is dominated with a good index (73.1%). The employee with the highest score is IT6 with 92.26 point, the employee with the lowest score is PX5 with 75.2 point, and an overall mean score is 83.43 point.

With this research, BPKPD can evaluate employee performance. The causes of increase or decrease employee performance can be analyzed specifically. In order to develop human resources, BPKPD can improve employee performance more efficiently.

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APPLICATION SIX SIGMA TO IMPROVE BOTTLENECK IN THE EXPORT WAREHOUSE WORKSTATION IN CARGO HANDLING COMPANY SOEKARNO HATTA AIRPORT

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ABSTRACT

Air cargo transportation is one of goods distribution with high cost and high safety standard. PT XYZ is one of ground handling company in Soekarno Hatta International Airport where one of its businesses is cargo handling in export warehouse. One of the processes in the export warehouse is loading cargo into ULD (Unit Load Device) or build up in the workstation. Bottleneck often occurs in the workstation and it affects the build up process, weighing process, reporting, and cargo towing to the aircraft is late. The research was aiming to solve the problem in the workstation. The research used six Sigma DMAIC (Define, Measure, Analyze, Improve, and Control) methodology to solve the problem. The define phase roll out the project charter and the team involved. On the measure phase reveals that the sigma level of the workstation was on $\sigma = 3.18$. The analysis was conducted using fishbone method and the main causes of the bottleneck were capacity and build up scheduling. On improve phase, brain storming was carried out to solve the issue and capability analysis was made to make sure no recurrence on suggested improvement. The result of Build up scheduling implementation reduced congestion by 28% and improved sigma level 0.58 point.

Keywords: Air Cargo, workstation, Six Sigma, DMAIC.

1. INTRODUCTION

Air cargo transportation takes important role in global goods distribution. Suryani (2012) stated that 40% of world trade are sent by air. Air cargo transportation connected world trade and supply chain in fast and reliable way (Wasesa, 2015). The warehouse capacity and the activities inside are important thing to maintain the competitiveness of the cargo terminal (Wasesa, 2015).

PT XYZ is one of the cargo handling company in Soekarno Hatta International Airport. PT XYZ serves 21 International airlines on their warehouse both import and export warehouses. On handle these customers, all procedures must be comply both Airline regulations, IATA and Government regulations.

The processes in the warehouse are Cargo Acceptance process, Storage process, Build up process, manifest process and dispatch process. Build up process is activity loaded cargo into Unit Load Device (ULD). All build up process are done in the Export Workstations.

With 21 airlines, bottleneck often occurs in the workstation. It is important that the failure on build up can affect to on time performance issue, offload cargo or delay flight. Yulin (2019)

and Han (2006) stated late cargo towing to the aircraft can result in flight delay and raises additional costs from aircraft handling and reduces service quality

2. LITERATURE REVIEW

2.1 Air Cargo

The research related air cargo transportation can be found on many journals. But when we search on specific area at export process, the researches were very limited. The area of the research as on Table 1. The research related workstation only can be found by Lau and Zhao (2006), but the research was about scheduling at Automated Cargo Handling System (ACHS) and this equipment was not used at Soekarno Hatta Airport.

Table 1. Research related Air Cargo

No	Author	Journal	Research Area
1	Rizaldy, Majid & An	The effectiveness of warehouse utilization at Soekarno Hatta International Airport	Storage
2	Brandt & Nickel	The air cargo load planning problem – a consolidated problem definition and literature review on related problems	Literature review related cargo handling
3	Lau & Zhao	Joint scheduling of material handling equipment in automated air cargo terminals	ACHS in workstation
4	Yan, Lo & Shih	Cargo container loading plan model and solution method for international air express carriers	Loading / build up planning
5	Pacquay, Schyns & Limbourg	A mixed integer programming formulation for the three dimensional bin packing problem deriving from an air cargo application	Build Up
6	Nobert & Roy	Freight handling personnel scheduling at air cargo terminals	Personnel scheduling
7	Tang & Yen	Airline unit load device dispatching considering service level and violation days	Unit Load Device
8	Lau, Chan, Tsui, Ho & Choy	An AI approach for optimizing multi pallet loading operations	Loading / Build up
9	Bischoff & Ratcliff	Issues in the development of approaches to container loading	Loading / Build Up
10	Yan, Chen & Chen	Long term manpower supply planning for air cargo terminals	Manpower
11	Wu	Modeling containerization of air cargo forwarding problems	Cargo loading /Build up

2.2 Six Sigma

There many researches using six sigma model. Shaikh (2015) researched that six sigma DMAIC (Define, Measure, Analyze, Improve and Control) method was often being used on operation management, production and engineering. On air cargo, the research which used Six Sigma DMAIC was not found. With this gap, the research of workstation bottleneck will be carried out and using six sigma methodology.

3. METHODS

The research of bottleneck in the workstation was carried out using Six Sigma DMAIC phases. The research was divided on five steps those are:

- Define

On define phase, project charter was used as guidance on doing research. Personnel who involve on the research will be defined to ensure the research will run smoothly.

- Measure

The measure phase, data related workstation will be collected. Data is collected from two sources. Those data are historical data which collected from Cargo System and collect data from direct observation on workstation. On workstation, the process will be defect if staff must wait more than 5 minutes to commence build up process. Observation was conducted for 4 weeks to obtain complete data regarding bottleneck on each hour and day.

- Analyze

Data will be analyzed on this phase. Analysis will use fishbone method and basic statistic Minitab.

- Improve

Improvement was made by looking the result of the analysis. Supervisor and duty manager will involve to do brain storming to get agreed improvement decision.

- Control

The last phase is control the improvement that will be carried out by the staff to avoid bottleneck on the workstation.

4. RESULTS

4.1 Define the problem

On this phase, the research was started with creating project charter. Build up staff who involve on the research were briefed to make sure the purposes of the research were well informed to them. Integrity must take precedence to ensure the data were valid.

4.2 Measuring the data

The field observation was conducted for four weeks to collect the data. Observation was started on 7 June 2021 until 6 July 2021. The first phase of the observation was carried out from 7 June – 20 June 2021 at 08.00 until 23.00. The second phase of the observation was on 22 June 2021- 6 July 2021 at 23.00 until 08.00. The result of the measurement as on below sub sections:

4.2.1 Build up time

Build up is the process to load cargo into ULD. Build up time measurement was calculated start from build up staff put the ULD on the workstation until the process was done. From total 2328 build up process, the average time that used by the staff as on Table 2.

Table 2. Build up time average

ULD type	Total Sample	Build Up Time Average	ULD Name
ULD Type 1	1514	1.01 Hours	AAC,AAF,AAP,AAX,AMA,AMD,AMF,AMP, PAG,PAJ,PMC,PMF,RAP
ULD Type 2	14	5.23 Hours	PGF,PGA
ULD Type 3	159	40 Minute	ALF.DQF,FQA,PLA,PLB

ULD Type 4	641	24 Minute	AKE,AKL,AKN,AVA,PKC,QKE,XKN
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1.1.1 Measuring time defect

From total 2328 build up process, the occurrence of the staff queue more than 5 minutes was 109 times. Using discrete data Minitab, performance of the workstation was on level $\sigma = 3.18$.

1.1.2 Workstation and staging area density

When build up process was done, usually the ULD are moved to staging area at air side. ULD were stored at pallet dollies and placed at staging area. Staging area is an area for dispatcher staff prepare ULD that ready to be uplifted on aircraft. Gantt chart was used to map ULD density on workstation and staging area.

Currently, the workstations only can accommodate 77 ULDs. On the first measurement on 7 June – 20 June 2021, the density would be high at 08.00 until 15.00. The density will be decline after 16.00 as shown on Figure 1. Base on date data, the density was high on 13, 15 and 20 June 2021, or mostly long would be high on the weekend (figure 2).

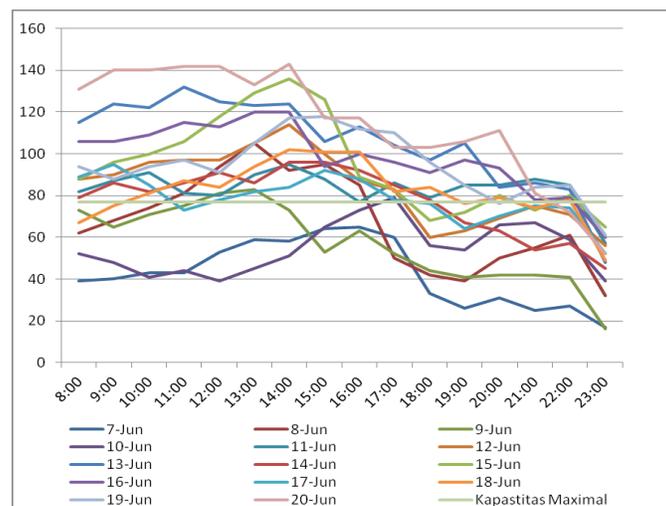


Figure 1. Hourly density 7 – 20 June 2021 at 8.00 – 23.00

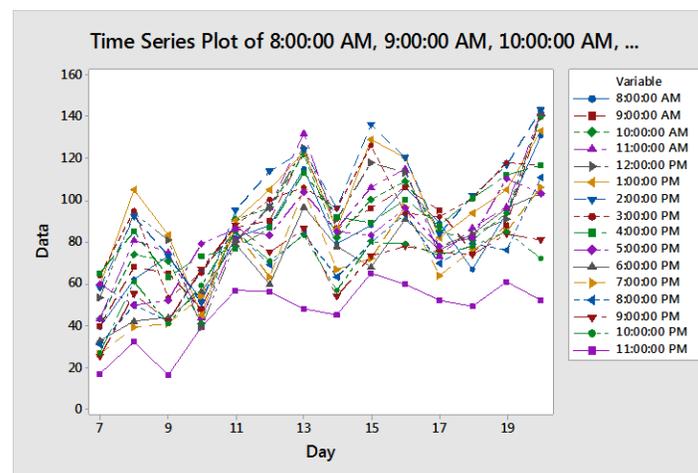


Figure 2. Daily density 7-20 June 2021 at 08.00 – 23.00

On the second measurement on 22 June – 6 July 2021 at 23.00 until 08.00. The density was stable since staff prepared the cargo for afternoon flights as shown on Figure 3. On daily, the density was high on 26 and 27 June 2021 (Figure 4)

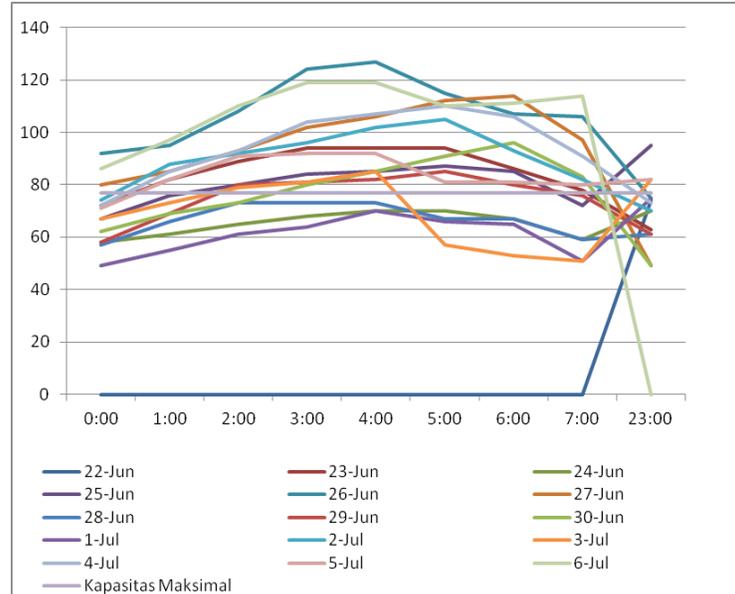


Figure 3. Hourly Density 22 June – 6 June 2021 at 23.00 – 07.00

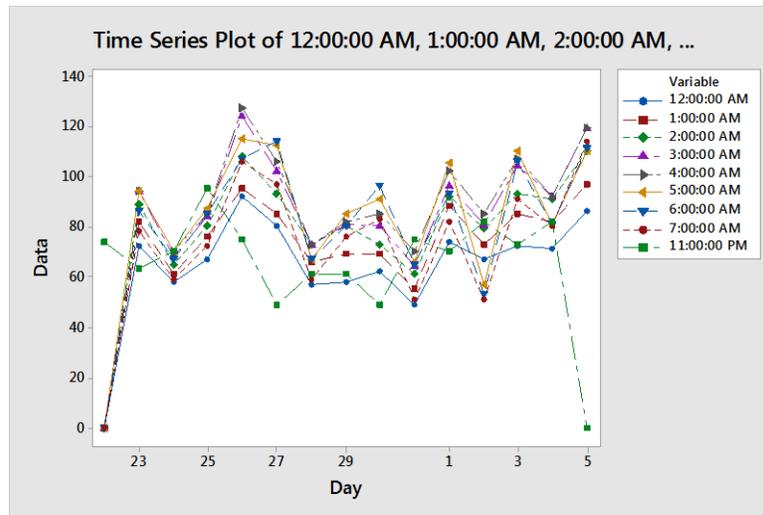


Figure 4. Daily density 22 June – 6 July 2021 at 23.00 – 07:00

4.2.2 Idle Unit Load Devices

Idle ULD is ULD which already loaded with cargo but not uplifted soon when build up process complete. Based on build up record from 7 June – 6 July 2021, from total 3236 ULDs, total ULD which laying more than 25 Hours at workstation and staging area were 390 ULDs or 12.05% from total ULD. These idle ULDs were uplifted to the aircraft in 25 Hours until 13 days after build up.

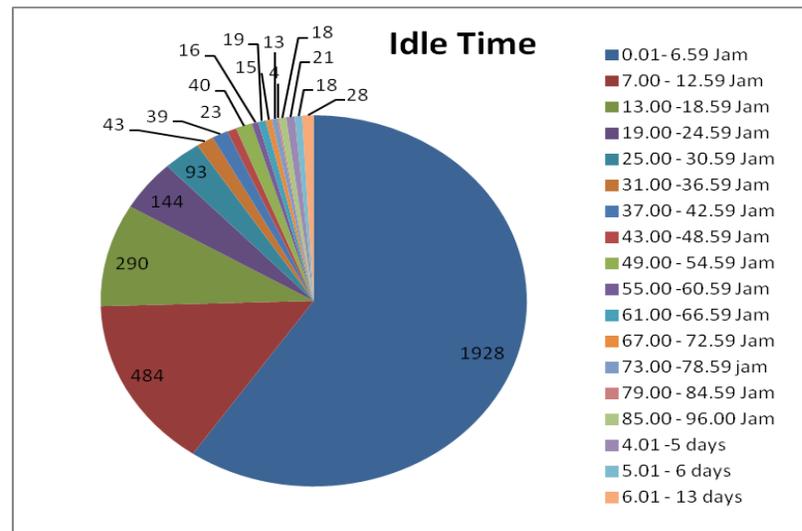


Figure 5. Idle ULD

4.3 Analysis of the problem

4.3.1 Fishbone Analysis

During observation, the number of queue staff to commence build up staff was high. On measurement phase, workstation capacity was the main issue. Currently, pallet dollies are used to accommodate ULD overflow in the workstation. When the density are high, sometimes staging/dispatcher area is not sufficient to accommodate those overflow.

Beside workstation capacity, scheduling is main factor that affect to the workstation bottleneck. From the research, there were 12.05% idle ULD that not fly soon after the build up done. Open build up is related to build up process that not finish and take long time process.

Operator who operates main workstation must also be available all the time during high capacity. The staff main job is operate transfer vehicle (TV) to manage ULD movement in the workstation. Dispatcher staff who move ULD from workstation also very important. Their job isto make sure empty space are available in the workstation. Using fishbone analysis on Figure 6, the root causes of the bottleneck were identified.

4.3.2 Correlation analysis

During research periods from 7 June – 6 July 2021, PT XYZ handled 531 flights. On these flights, total 5975 ULDs were uplifted on the aircraft and carrying cargo 7.556.095 Kg. Analysis was made to identify correlation between the number of flights, total ULD and the weight of cargowere uplifted on the flight. The result of the correlation analysis was positive correlation between those three variabels. This correlation can be used for duty manager make staff schedule based on total flight that handled by PT XYZ

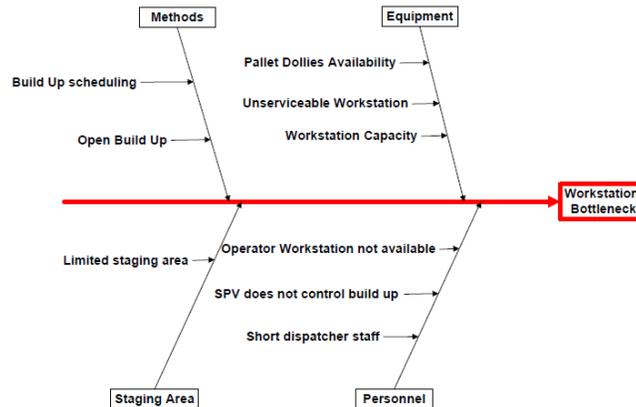


Figure 6. Fishbone Analysis

4.4. Improvement

Supervisor and Duty Manager were involved to make improvement of the problem. Brain storming was used to solve the problem from root causes analysis. The result of the brain storming there was three improvement periods which are suggested for PT XYZ management.

4.4.1 Short term improvement

Short term improvement is applied to operational matter. There are two improvement suggestion those are build up scheduling and staff scheduling

1. Build up scheduling

With 12.05% idle ULD, scheduling is needed to reduce congestion in the workstation. Between PT XYZ and Airlines signed Service Level Agreement (SLA) that build up process must be completed 2 hours before schedule time of departure (-2Hours STD). Table 2 is used to identify time needed for build up process (Build up time). The formula of build up staff can commence build up process is below:

$$\text{Build Up Start} = \text{STD} - \text{SLA requirement time} - (\text{Number of ULD} \times \text{Build up time})$$

On build up scheduling implementation on 18 July 2021. The result was compared to data on 13 June 2021. Build up scheduling could reduce congestion average 28% and sigma level change was 0.58 point, this result was day to day comparison. The table of congestion reduction ason Table 3.

Table 3. Congestion comparison on 13 June and 18 July 2021

Tanggal	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00
13-Jun-21	115	124	122	132	125	123	124	106	113	104	97	105	84	86	83	48
18-Jul-21	87	83	91	84	95	106	106	85	88	87	65	61	60	54	54	32
Percentage	28%	41%	31%	48%	30%	17%	18%	21%	25%	17%	32%	44%	24%	32%	29%	16%

2. Staff scheduling

With correlation result on sub bab 4.3.1 when make staff schedule, Duty manager can referto total flight which handled by PT XYZ. The sufficiency of dispatcher staff is very important to make sure, space availability in the workstation.

4.4.2 Medium term improvement

Currently, inside the warehouse partner of PT XYZ there are inactive 10 workstation. The

workstation was installed for two years and no activities on it. PT XYZ export warehouse can accommodate 5 new workstation from warehouse partner. This new workstation can reduce overflow on main workstation. Since this additional workstation is manual workstation, the current operational procedure would not be changed.

4.4.3 Long term improvement

With limited workstation capacity, PT XYZ has to consider ULD cargo staging availability. Two airlines were handled in the warehouse's partner and two airlines were still not operate due to Covid 19 pandemic. Considering future plan management to move back those airlines to PT XYZ warehouse, ULD cargo staging calculation was made.

The mapping of ULD distribution was made using Gantt chart, and the need of staging based on the maximum ULD Tipe 1 configuration on the aircraft. Hourly, The maximum total ULD cargo handling was 149 Units. With implementation of build up scheduling and new additional workstation PT XYZ should provide 67 ULDs cargo staging.

4.5 Control phase

With build up scheduling, control can be taken to make sure the build up process was done as per schedule. Using process capability analysis, it can be identified whether the process runs on track or not.

5. CONCLUSIONS

From PT XYZ workstation bottleneck research, PT XYZ undergo over capacity on its workstation in current situation. Besides workstation capacity, build up scheduling was another cause of the bottleneck. On measurement phase, sigma level of the workstation was on $\sigma = 3.18$.

Build up scheduling implementation was conducted with day to day comparison. The sample was taken with same total flights, total ULDs and total weight of cargo weight were almost the same. The result of the implementation was the congestion reduced by 28% and sigma level was improved 0.58 point.

The above suggestion to PT XYZ can be consideration on PT XYZ management taking future planning for their airlines customers and better service related workstation, build up and over flow. Future research might be able to see whether implementation of build up scheduling in the workstation will affect to cargo storage in PT XYZ export warehouse.

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