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Strategic Optimization in Distribution Centers: Leveraging Relocation, P-Median, and GIS-Based Routing for Enhanced Efficiency

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***Abstract*—In the realm of B2C (Business-to-Customer) company marketing, it is imperative to focus on sales and customer satisfaction. To uphold customer contentment, B2C enterprises must strategically position their delivery facilities to optimize efficiency and minimize both time and operational expenditures. PT ABC, a B2C entity specializing in the distribution of packaged goods, currently faces challenges in handling a substantial volume of requests, some of which are situated far from their distribution centers. This predicament leads to elevated fulfillment costs and an inefficient operational process. Consequently, the relocation of distribution center facilities becomes a necessity. The relocation process will be executed employing the P-Median method, facilitated by LINGO software. The P-Median analysis yielded three potential new locations: Cikupa, Jombang Wetan, and Bencongan Indah. Subsequently, further assessment was conducted through the resolution of the MTCVRP (Multitrip Capacitated Vehicle Routing Problem) with the aid of ArcGIS software. As a result, Jombang Wetan emerged as the optimal candidate, exhibiting a remarkable reduction of 165.7 kilometers or a 31.33% decrease in average mileage. This choice promises a more efficient and effective product distribution operation.**

***Keywords*: Business to Customer, Distribution Center, Multitrip Capacitated Vehicle Routing Problem, P-Median**

I. INTRODUCTION

B2C (Business to Customer) enterprises are those engaged in direct transactions with individual consumers. Marketing within this sector primarily hinges on emotional factors, underscoring that B2C entities must not solely prioritize sales but must also emphasize customer satisfaction(Rėklaitis&Pilelienė, 2019). It is incumbent upon B2C service providers to promptly address customer inquiries and requirements within their stipulated timeframes. To optimize their service offerings and uphold customer contentment, B2C corporations must meticulously manage their service durations, particularly product delivery times, ensuring they remain expeditious. Hence, B2C companies should diligently consider the placement of their distribution facilities to align with demand patterns. They must also implement efficient routing strategies to minimize both time and operational expenditures. Such challenges typically manifest for distribution centers or warehouses that cater to multiple retail locations.

Presently, the rapid expansion of B2C companies in Indonesia presents a highly promising opportunity. In the wake of the COVID-19 pandemic, B2C e-commerce is anticipated to experience a consistent growth rate of 15.56% from 2022 through 2026(BusinessWire, 2022). Online shopping has become an ingrained lifestyle choice, characterized by the preference for minimal physical interaction and the convenience of acquiring goods from the comfort of one's home. Within this landscape, each B2C enterprise must strive to establish a distinctive and appealing value proposition for its customers. One such crucial aspect is the provision of safe, expedient, and cost-effective logistics services. This strategic imperative aligns seamlessly with the issues observed in the subject of examination, namely a B2C company functioning as a distribution center for packaged products. The organization currently grapples with a multitude of customer requests dispersed across various locations, some of which are considerably distant from the distribution center's geographic hub.

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This predicament results in escalated distribution expenses and a suboptimal distribution workflow. Furthermore, the company operates a single transportation fleet with a maximum capacity of 2 tons and refrains from outsourcing delivery services. The influx of orders through the Manuva Retail application is characterized by high volume and diversity, rendering predictability challenging. In light of these challenges, the most suitable course of action to enhance the efficiency of the product distribution process is the relocation of the distribution center. Consequently, the pivotal step involves the systematic allocation of the new distribution center's location.

Fig 1. Existing Demand Points

Imperative to conduct a comprehensive literature review. This review serves several critical purposes: firstly, it facilitates the identification of the variables that warrant investigation; secondly, it enables the differentiation of prior research accomplishments; thirdly, it aids in pinpointing areas necessitating innovation and the infusion of fresh perspectives; fourthly, it fosters a profound comprehension of each theory slated for utilization within the research process; and lastly, it establishes the significance and interconnections between variables. These aspects collectively contribute to the realization of the research objectives, which pertain to devising a novel warehouse location solution for the Serang branch of PT ABC and optimizing routing to enhance the efficiency of distribution operations.

Regarding the resolution of the allocation location quandary, there exists a variety of methodologies at one's disposal, among which the P-Median method stands out. The P-Median approach finds utility not only in determining warehouse relocations(Zapata et al., 2020) but also in the establishment of distribution centers(Asmara &Ichtiarto, 2021), (Fadhil (Universitas Pertamina) et al., 2020). The implementation of P-Median can be accomplished via the utilization of software applications such as LINDO or LINGO(Zapata et al., 2020),(Pribadi&Permatasari, 2021). The initial step in ascertaining the novel site entails gauging the distances between potential facilities employing the Haversine Method, based on known coordinate data(Fadhil (Universitas Pertamina) et al., 2020). Subsequent research findings corroborate that the proposed locations determined by the P-Median method have the potential to curtail delivery distances(Zapata et al., 2020), consequently leading to a reduction in transportation costs(Fadhil (Universitas Pertamina) et al., 2020). It is worth noting that prior investigations into the application of P-Median typically present scenarios based solely on aggregated demand, yielding a solitary set of location proposals. Furthermore, these previous studies commonly lack subsequent analyses delineating distribution routes emanating from the selected candidate locations, a deficiency that this study endeavors to rectify.

Moreover, to enhance the precision of the relocation assessment, an in-depth analysis is conducted employing the Multitrip Capacitated

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Vehicle Routing Problem (MTCVRP) model. This model amalgamates the principles of the Multitrip Vehicle Routing Problem, as exemplified in studies by(Widyastiti&Awaludin, 2021), (Mingozzi et al., 2013),(Cattaruzza et al., 2018), and(Ramadhani et al., 2021). The Multitrip Vehicle Routing Problem encompasses scenarios in which the cargo volume or quantity surpasses the vehicle's carrying capacity, necessitating multiple vehicles to visit specific demand points.

Subsequently, this model is integrated with the Capacitated Vehicle Routing Problem (CVRP) model, as demonstrated in the research conducted by(Lukmandono et al., 2019),(A. Purnomo., 2017), (Kristina et al., 2020), and(Linfati& Escobar, 2018), which takes into account the vehicle's capacity constraints. The primary objective of employing the Multitrip Capacitated Vehicle Routing Problem (MTCVRP) is to minimize the distance traversed during the distribution of goods. The forthcoming research endeavors to deduce the optimal relocation site from the pool of three candidates, drawing comparisons based on the average mileage at the current location. It's noteworthy that previous research has not ventured into the fusion of the Multitrip Capacitated Vehicle Routing Problem and Capacitated Vehicle Routing Problem models, nor has it made use of a Geographic Information System (GIS). This study aims to bridge this gap by amalgamating these two models and employing a Geographic Information System (GIS) for its application.

When juxtaposed with preceding literature studies, the scientific innovation of this research centers on the introduction of case studies and the application of advanced analyses. Historically, studies focused on optimizing distribution in packaging distributor companies in Indonesia have been scarce and not extensively pursued. Contrastingly, packaging holds considerable significance in Indonesia, particularly for various industries, including the burgeoning food sector(A. N. Sari, 2022). Ensuring the timely and adequate availability of packaging materials is of paramount importance for logistics companies like this packaging distributor. Furthermore, in contrast to prior literature, no prior research has undertaken advanced analyses of the P-Median location problem with a simultaneous exploration of route optimization using the MTCVRP framework. Additionally, the utilization of the MTCVRP model remains relatively uncommon in case studies. Hence, the scientific novelty of this research entails the fusion of mathematical models encompassing multi-trip VRP and CVRP, tailored to the specifics of the case study. This distinctiveness underscores the research's novel approach, which involves the integration of two disparate methods as part of an advanced analysis, rather than merely employing them for comparative purposes.

$$x = (L_{2} - L_{1}) \times \cos\left(\frac{L_{2}+L_{1}}{2}\right) \quad (1)$$

$$y = L_{2} - L_{1} \quad (2)$$

$$d = \sqrt{(x \times x) + (y \times y)} \times R \quad (3)$$

I. METHODOLOGY

The problem-solving methodologies employed here are bifurcated into two categories: data collection methods and analytical methods. Data collection was carried out through interviews conducted with the Manuva Retail warehouse personnel. This interview yielded a comprehensive understanding of the problem at hand and provided essential data. The data encompassed various elements, such as the company's demand and demand allocation specifics, preferred candidate locations, and specifications concerning the company's transportation modes. The location data, upon acquisition, underwent initial processing to calculate the distance between various points. The Haversine method was the chosen approach for distance computation. The Haversine method employs an equation to ascertain the great circle distance (radius) between two points on the Earth's surface, taking into account their longitude and latitude coordinates. The requisite points for this study were sourced via the Google Maps search tool, which provided longitude and latitude coordinates(Fadhil (Universitas Pertamina) et al., 2020).

Notes:
x = Longitude
y = Latitude
d = Distance
R = Radius of Earth = 6.371 km
1 degree = 0.0174532925 radian

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Furthermore, the data obtained will be processed with the P-Median method to solve the warehouse transfer locations. The P-Median mathematical model used is as follows(Fadhil (Universitas Pertamina) et al., 2020).

P-Median Method

Inputs:

h_i = Demandat point i ∈ I

P = The number of ditribution centers to buld

$d_{ij} = D$

∈ Ia ∈ J

Decision Variabels:

$$Y_{ij} = \begin{cases} 1, & \text{Valued 1 if the demand at point i} \in I \text{ is met by distribution center j} \in J \\ 0, & \text{Valued 0 otherwise} \end{cases}$$

$$X_j = \begin{cases} 1, & \text{Valued 1 if the candidate facility is built at node j} \in J \\ 0, & \text{Valued 0 otherwise} \end{cases}$$

Objective Function:

$$M \quad \sum_{i \in I} \sum_{j \in J} h_i d_{ij} Y_{ij} \qquad (4)$$

Constraints:

Subject to

$$\sum_{j \in J} Y_{ij} = 1 \quad \forall i \in I \qquad (5)$$

$$\sum_{j \in J} X_j = P \qquad (6)$$

$$Y_{ij} - X_j \leq 0 \quad \forall i \in I; \forall j \in J \qquad (7)$$

$$X_{ij} \in \{1,0\} \quad \forall j \in J \qquad (8)$$

$$Y_{ij} \in \{1,0\} \quad \forall i \in I; \forall j \in J \qquad (9)$$

The objective function, denoted as(Asmara &Ichtiarto, 2021), stipulates the minimization of the product of the demand point and its distance to the nearest facility. Constraint(Fadhil (Universitas Pertamina) et al., 2020) enforces the requirement that each point i within set I is exclusively serviced by one facility j within set J. Constraint(Pribadi&Permatasari, 2021) mandates the establishment of a fixed number of P facilities. Constraint(Widyastiti&Awaludin, 2021)establishes a link between the facility location decision Xj and the allocation variable Yij, ensuring that the demand at point i within set I can solely be allocated to facility j within set J. Constraints(Mingozzi et al., 2013)and(Cattaruzza et al., 2018)are responsible for dictating that the decision variables X and Y assume binary values (0 or 1), while Y remains non-negative.

Multitrip Capacitated Vehicle Routing Problem (MTCVRP) Method

Objective Function

$$\text{Min} \quad \sum_k \sum_i \sum_j d_{ij} x_{ijk} \qquad (10)$$

With

$$x_{ijk} = \begin{cases} 1, & \text{if there is the visit from point i to to point j by vehicle k on the tth } t \\ 0, & \text{if not} \end{cases}$$

The objective function, as represented by equation(Ramadhani et al., 2021), articulates the objective of minimizing the transportation distance. Constraint(Lukmandono et al., 2019)guarantees the ability for vehicles to be utilized more than once, allowing for multiple trips. Constraint(A. Purnomo., 2017)establishes the flexibility for each demand point to be visited repeatedly by the vehicle. The constraint(Kristina et al., 2020)specifies that each vehicle's transportation capacity must not be exceeded during the routing process. Constraint(Linfati&

Subsequently, after selecting the candidate locations, the subsequent analysis revolves around determining the optimal routing through the application of the Multitrip Capacitated Vehicle Routing Problem (MTCVRP) methodology. This choice is motivated by its consideration of transportation capacity allocation for each customer to be served. The mathematical model for the Multitrip Capacitated Vehicle Routing Problem (MTCVRP), as sourced from(Kristina et al., 2020) and(Ramadhani et al., 2021), is as follows.

Constraints

$$\sum_j x_{ijk} \leq 1 \quad \forall t, k, i = 1 \qquad (11)$$

$$\sum_t \sum_k \sum_t x_{ijk} \geq 1 \quad \forall j \qquad (12)$$

$$\sum_t \sum_j L_j x_{ijk} \leq Q_k \quad \forall k \qquad (13)$$

$$\sum_t x_{ijk} - \sum_j x_{jik} \leq 1 \quad \forall k, t \qquad (14)$$

$$\sum_t x_{ijk} - \sum_j x_{jik} = 0 \quad \forall k, t \qquad (15)$$

$$x_{ijk} + x_{jik} \leq 1 \quad \forall i, j, k, t \qquad (16)$$

$$x_{ijk} \in \{0,1\} \quad \forall i, j, k \qquad (17)$$

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Escobar, 2018)underscores the necessity for the routing process to maintain continuity, signifying that vehicles departing from the depot must return to it. Additionally, Constraint(A. N. Sari, 2022)mandates that once a vehicle arrives at one customer location, it must proceed to another destination.

II. RESULTANDDISCUSSION

In this investigation, we employed three distinct sets of sample data, specifically, data pertaining to the day characterized by the highest demand observed on December 6, 2022, data representative of the average demand witnessed on December 9, 2022, and data indicative of the lowest demand experienced on December 7. These three distinct scenarios, each comprising three individual data samples, were deliberately selected from within the same calendar week, a measure implemented to account for the inherent uncertainty associated with consumer demand. Furthermore, this sampling strategy was implemented to prevent excessive aggregation of demand data, thereby mitigating the potential for generating assumptions that deviate significantly from the true situational context. The data acquired for these scenarios are presented in Tables 1, 2, and 3.

Table 1. The Most Demand Point Data

Date	Location	Demand(Kg)
6-Des-2022	Cibeber	275
	Cikupa	5500
	Citangkil	660
	Ciwaduk	1155
	Ciwedus	275
	Gunungsugih	275
	Harjatani	330
	Kebonsari	165
	Kramatwatu	55
	Lopang	330
	Randakari	110
	Tamansari	660
	Warnasari	385

Table 2. Average Demand Point Data

Date	Location	Demand(Kg)
9-Des-2022	Gedong Dalem	275
	JombangWetan	3190
	Kebondalem	220
	Kramatwatu	165
	Mekarsari	1485
	Panyaungan Jaya	55
	Sajira	1155
	Tamansari	1485

Table 3. The Least Demand Point Data

Date	Location	Demand(Kg)
7-Des-2022	Babakanlor	1375
	Bencongan Indah	10560
	Dalung	165
	Labuan	2530
	Serang	55
	Teluk	55

After the initial data collection, a series of computational procedures are applied to ascertain the spatial separation among prospective facility sites. In every scenario examined, each geographical point is regarded as a potential facility relocation candidate. The calculation of

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distances is executed employing the Haversein Method, requiring the conversion of longitude and latitude coordinates into radian units. The outcomes of these distance computations for each dataset are presented in Tables 4, 5, and 6.

Table 4. Distance Matrix between Facilities on Most Demand Point Data

Facility Candidate	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	0	15	41	19	17	17	27	14	10	8	3	24	28	22
2	15	0	56	5	3	4	14	2	6	7	13	11	14	8
3	41	56	0	60	58	58	67	55	61	49	43	65	67	63
4	19	5	60	0	2	3	11	6	2	11	17	8	11	3
5	17	3	58	2	0	2	11	4	3	10	16	9	12	5
6	17	4	58	3	2	0	10	4	4	10	16	8	13	6
7	27	14	67	11	11	10	0	14	9	19	24	4	15	9
8	14	2	55	6	4	4	14	0	7	6	12	11	15	9
9	20	6	61	2	3	4	9	7	0	12	19	6	10	2
10	8	7	49	11	10	10	19	6	12	0	7	17	20	14
11	3	13	43	17	16	16	24	12	19	7	0	22	27	20
12	24	11	65	8	9	8	4	11	6	17	22	0	13	6
13	28	14	67	11	12	13	15	15	10	20	27	13	0	9
14	22	8	63	3	5	6	9	9	2	14	20	6	9	0

Table 5. Distance Matrix between Facilities on Average Demand Point Data

Facility Candidate	1	2	3	4	5	6	7	8	9
1	0	18	17	19	8	51	22	48	28
2	18	0	3	2	10	66	27	64	11
3	17	3	0	2	9	66	25	63	12
4	19	2	2	0	11	67	26	65	10
5	8	10	9	11	0	58	21	55	20
6	51	66	66	67	58	0	67	49	74
7	22	27	25	26	21	67	0	46	35
8	48	64	63	65	55	49	46	0	74
9	28	11	12	10	20	74	35	74	0

Table 6. Distance Matrix between Facilities on the Least Demand Point Data

Facility Candidate	1	2	3	4	5	6	7
1	0	47	49	6	51	21	49
2	47	0	83	42	5	35	6
3	49	83	0	51	88	69	88
4	6	42	51	0	46	19	44
5	51	5	88	46	0	37	3
6	21	35	69	19	37	0	35
7	49	6	88	44	3	35	0

Following the calculation of distances between potential facility sites, the subsequent phase entails data processing through the utilization of LINGO software to derive an optimal location for a new distribution center. The methodology applied for determining this new distribution center's location is the P-Median approach.

Below is the LINGO formula corresponding to the scenario characterized by the highest

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demand points:

```
!P-MEDIAN MODEL;
SETS:
SET_I/1..14/:H;
SET_J/1..14/:X;
LINK_IJ(SET_I,SET_J):D,Y;
ENDSETS
DATA:
D=
```

0	15	41	19	17	17	27	14	10	8	3	24	28	22
15	0	56	5	3	4	14	2	6	7	13	11	14	8
41	56	0	60	58	58	67	55	61	49	43	65	67	63
19	5	60	0	2	3	11	6	2	11	17	8	11	3
17	3	58	2	0	2	11	4	3	10	16	9	12	5
17	4	58	3	2	0	10	4	4	10	16	8	13	6
27	14	67	11	11	10	0	14	9	19	24	4	15	9
14	2	55	6	4	4	14	0	7	6	12	11	15	9
20	6	61	2	3	4	9	7	0	12	19	6	10	2
8	7	49	11	10	10	19	6	12	0	7	17	20	14
3	13	43	17	16	16	24	12	19	7	0	22	27	20
24	11	65	8	9	8	4	11	6	17	22	0	13	6
28	14	67	11	12	13	15	15	10	20	27	13	0	9
22	8	63	3	5	6	9	9	2	14	20	6	9	0

```
;
H= 0 5 100 12 21 5 5 6 3 1 6 2 12 7;
P=1;
ENDDATA
MIN =
@SUM(SET_I(I):@SUM(SET_J(J):H(I)*D(I
,J)*Y(I,J)));

@FOR(SET_I(I):@SUM(SET_J(J):Y(I,J))=
1);
@SUM(SET_J(J):X(J))=P;
@FOR(SET_I(I):@FOR(SET_J(J):Y(I,J)-
X(J)<=0));
@FOR(SET_J(J):@BIN(X(J)));
@FOR(SET_I(I):@FOR(SET_J(J):@BIN(
Y(I,J))));
```

In light of the outcomes generated from the data processing associated with the day featuring the greatest demand points, the optimal site for the distribution center is determined to be X3 (Candidate Location Three), as indicated in Table 7 below. This selection aligns with the data presented, designating Cikupa as the third location candidate.

Table 7. Facility Candidates at the Most Demand Points

Candidate	Location
K1	Dapur Sunda
K2	Cibeber
K3	Cikupa
K4	Citangkil
K5	Ciwaduk
K6	Ciwedus
K7	Gunungsugih
K8	Harjatani
K9	Kebonsari
K10	Kramatwatu
K11	Lopang
K12	Randakari
K13	Tamansari
K14	Warnasari

Subsequently, an analogous set of procedures is executed using data reflecting average demand points. Presented below are the mathematical formulations employed in LINGO for datasets characterized by average demand points.

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```
!P-MEDIAN MODEL;
SETS:
SET_I/1..9/:H;
SET_J/1..9/:X;
LINK_IJ(SET_I,SET_J):D,Y;
ENDSETS

DATA:
D=
```

0	18	17	19	8	51	22	48	28
18	0	3	2	10	66	27	64	11
17	3	0	2	9	66	25	63	12
19	2	2	0	11	67	26	65	10
8	10	9	11	0	58	21	55	20
51	66	66	67	58	0	67	49	74
22	27	25	26	21	67	0	46	35
48	64	63	65	55	49	46	0	74
28	11	12	10	20	74	35	74	0

```
;
H= 0 5 58 4 3 27 1 21 27;
P=1;
ENDDATA
MIN =
@SUM(SET_I(I):@SUM(SET_J(J):H(I)*D(I
,J)*Y(I,J)));

@FOR(SET_I(I):@SUM(SET_J(J):Y(I,J))=
1);
@SUM(SET_J(J):X(J))=P;
@FOR(SET_I(I):@FOR(SET_J(J):Y(I,J)-
X(J)<=0));
@FOR(SET_J(J):@BIN(X(J)));
@FOR(SET_I(I):@FOR(SET_J(J):@BIN(Y(I
,J))));
```

Following the data processing conducted on the day marked by the highest demand points, the determination of the new distribution center's location identifies X3 (Candidate Location Three) as the optimal choice, corresponding to the third location candidate, JombangWetan, as substantiated in Table 8 below.

Table 8. Facility Candidate at Demand Point Average

Candidate	Location
K1	Dapur Sunda
K2	Gedong Dalem
K3	JombangWetan
K4	Kebondalem
K5	Kramatwatu
K6	Mekarsari
K7	Panyaungan Jaya
K8	Sajira
K9	Tamansari

Ultimately, the process of site selection is executed using the dataset featuring the lowest demand points. Presented below is the LINGO formula relevant to datasets characterized by the minimal demand point.

```
!P-MEDIAN MODEL;
SETS:
SET_I/1..7/:H;
SET_J/1..7/:X;
LINK_IJ(SET_I,SET_J):D,Y;
ENDSETS

DATA:
D=
```

0	47	49	6	51	21	49
47	0	83	42	5	35	6
49	83	0	51	88	69	88
6	42	51	0	46	19	44
51	5	88	46	0	37	3
21	35	69	19	37	0	35
49	6	88	44	3	35	0

```
;
H= 0 25 192 3 46 1 1;
P=1;
ENDDATA

MIN =
@SUM(SET_I(I):@SUM(SET_J(J):H(I)*D(I
,J)*Y(I,J)));

@FOR(SET_I(I):@SUM(SET_J(J):Y(I,J))=
1);
@SUM(SET_J(J):X(J))=P;
@FOR(SET_I(I):@FOR(SET_J(J):Y(I,J)-
X(J)<=0));
@FOR(SET_J(J):@BIN(X(J)));
@FOR(SET_I(I):@FOR(SET_J(J):@BIN(Y(I
,J))));
```

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Following the outcomes of the data processing conducted on the day with the highest demand points, the optimal site for the distribution center is determined to be X3 (Candidate Location Three), in alignment with the dataset displayed below, with the third location candidate identified as Bencongan Indah, as illustrated in Table 9 below.

Table 9. Facility Candidates at the Least Demand Point

Candidate	Location
K1	Dapur Sunda
K2	Babakanlor
K3	Bencongan Indah
K4	Dalung
K5	Labuan
K6	Serang
K7	Teluk

Following the acquisition of three prospective distribution center locations, specifically Cikupa, JombangWetan, and Bencongan Indah, the subsequent phase entails routing optimization employing ArcGIS software. The company possesses a single fleet with a maximum cargo capacity of 2,000 kg. Consequently, the routing problem addressed in this investigation is the Multitrip Capacitated Vehicle Routing Problem (MTCVRP), as it incorporates constraints related to vehicle load capacity. Utilizing ArcGIS, data processing was conducted for each of the three candidate facility locations. The routing outcomes, should the distribution center remain in Serang, are depicted in Figure 2.

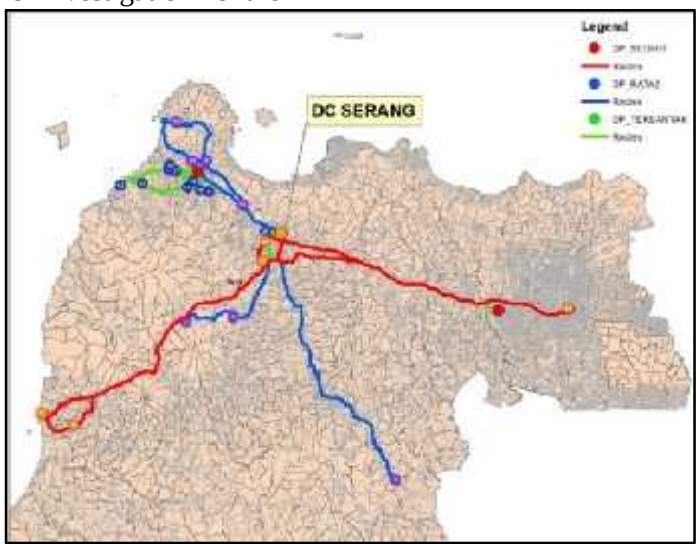

Fig 2. Existing Distribution Routes

The distribution routing analysis is performed for three distinct scenarios derived from the prior data samples, specifically, routing for the day characterized by the highest, average, and lowest demand points. The routing outcomes, along with the corresponding cargo capacity achievable when utilizing the distribution center located in Serang, are presented in Table 10. Notably, the average distance covered across these three scenarios from the current distribution center location amounts to 528.95 kilometers.

Table 10. Routing Details with Distribution Center in Serang (Baseline)

Routes with the Most Demand Points			
No.	**Routes**	**Quantity (kg)**	**Distance (km)**
1	DC – Cikupa - DC	1500	80,68
2	DC – Cikupa - DC	2000	80,68
3	DC – Cikupa - DC	2000	80,68

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4	DC - Kramatwatu - Harjatani - Cibeber - Ciwedus - Randakari - Gunungsugih - Warnasari - DC	1705	68,82
5	DC - Citangkil - Kebonsari - Ciwaduk - DC	1980	48,36
6	DC - Tamansari - Lopang - DC	990	41,00
	Total	10175	400,23
	Routes with Average Demand Points		
1	DC - Panyaungan Jaya - Tamansari - DC	1540	55,91
2	DC - Sajira - DC	1155	108,43
3	DC - JombangWetan - DC	2000	37,46
4	DC - Gedong Dalem - Mekarsari - Kebondalem - DC	1980	65,93
5	DC - JombangWetan - Kramatwatu - DC	1355	37,80
	Total	8030	305,52
	Route with Fewest Demand Points		
1	DC - Labuan - DC	2000	119,87
2	DC - Bencongan Indah - DC	2000	103,61
3	DC - Bencongan Indah - DC	2000	103,61
4	DC - Bencongan Indah - DC	2000	103,61
5	DC - Bencongan Indah - DC	2000	103,61
6	DC - Bencongan Indah - DC	2000	103,61
7	DC - Labuan - Teluk - Babakanlor - DC	1960	125,06
8	DC - Bencongan Indah - Dalung - Serang - DC	780	118,11
	Total	14740	881,10

Furthermore, distribution routing is carried out by setting up a distribution center in Cikupa. The routing results with the Cikupa candidate location can be seen in Fig 3.

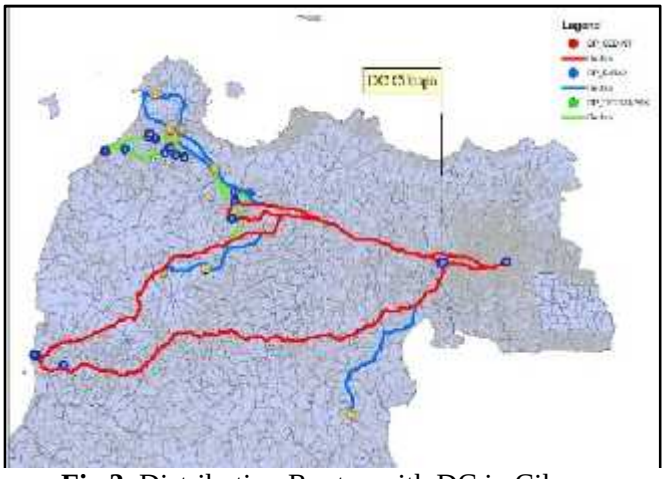

Fig 3. Distribution Routes with DC in Cikupa

For the Cikupa location candidate, the routing analysis yielded three distinct routes corresponding to three different scenarios. The routing outcomes, in conjunction with the cargo capacity achievable when utilizing a distribution center situated in Cikupa, are detailed in Table 11. It is noteworthy that the average distance covered across these three scenarios, originating from the current distribution center location, amounts to 387.79 kilometers.

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Table 11. Routing Details with the Distribution Center in Cikupa

No	Routes	Quantity (kg)	Distance (km)
	Routes with the Most Demand Points		
1	DC - Harjatani - Cibeber - Ciwedus - Randakari - Gunungsugih - Kebonsari - DC	1430	146,57
2	DC - Kramatwatu - Ciwaduk - Lopang - DC	1540	118,22
3	DC - Citangkil - Warnasari - Tamansari - DC	1705	153,70
4	DC - Cikupa - DC	1500	0
5	DC - Cikupa - DC	2000	0
6	DC - Cikupa - DC	2000	0
	Total	10175	418,49
	Routes with Average Demand Points		
1	DC - JombangWetan - DC	2000	116,49
2	DC - Gedong Dalem - Mekarsari - Kebondalem	1980	144,97
3	DC - JombangWetan - Kramatwatu - DC	1355	116,83
4	DC - Tamansari - Panyaungan Jaya - DC	1540	124,54
5	DC - Sajira - DC	1155	84,54
	Total	8030	587,38
	Route with Fewest Demand Points		
1	DC - Labuan - DC	2000	189,20
2	DC - Babakanlor - Labuan - Teluk - DC	1960	193,40
3	DC - Dalung - Serang - Bencongan Indah - DC	780	116,68
4	DC - Bencongan Indah - DC	2000	26,74
5	DC - Bencongan Indah - DC	2000	26,74
6	DC - Bencongan Indah - DC	2000	26,74
7	DC - Bencongan Indah - DC	2000	26,74
8	DC - Bencongan Indah - DC	2000	26,74
	Total	14740	632,96

Subsequently, distribution routing was executed, establishing a distribution center at the JombangWetan location. The routing outcomes associated with the JombangWetan candidate site are visually presented in Figure 4.

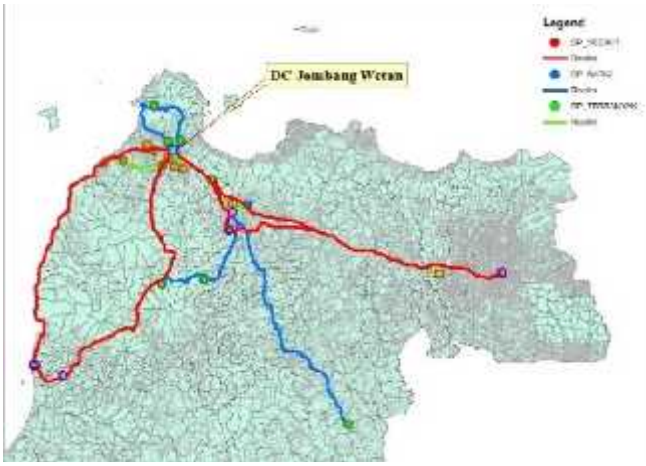

Fig 4. Distribution Routes with DC in Jombang Wetan

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Through routing analysis utilizing the JombangWetan location as the candidate site, three distinct routes were generated based on the three previously selected daily data samples. The routing outcomes, inclusive of the cargo capacity achievable when utilizing a distribution center situated in JombangWetan, are comprehensively documented in Table 12. Notably, the average distance traveled across these three scenarios, originating from the current distribution center location, amounts to 363.26 kilometers.

Table 12. Routing Details with the Distribution Center in Jombang Wetan

No	Routes	Quantity(kg)	Distance (km)
	Routes with the Most Demand Points		
1	DC - Cikupa - DC	2000	116,49385
2	DC - Cikupa - DC	2000	116,49385
3	DC - Ciwedus - Randakari - Gunungsugih - Citangkil - Warnasari - Kebonsari - DC	1870	32,829668
4	DC - Ciwaduk - DC	1155	4,460563
5	DC - Cibeber - Harjatani - Tamansari - DC	1265	70,799946
6	DC - Kramatwatu - Cikupa - Lopang - DC	1885	118,16214
	Total	10175	459,24002
	Routes with Average Demand Points		
1	DC - Panyaungan Jaya - Tamansari - DC	1540	77,137906
2	DC - Sajira - Kramatwatu - DC	1320	141,978
3	DC - Gedong Dalem - Mekarsari - Kebondalem - DC	1980	32,868774
4	DC - JombangWetan - DC	1190	0
5	DC - JombangWetan - DC	2000	0
	Total	8030	251,98468
	Route with Fewest Demand Points		
1	DC - Bencongan Indah - DC	2000	139,42314
2	DC - Bencongan Indah - DC	2000	139,42314
3	DC - Bencongan Indah - DC	2000	139,42314
4	DC - Bencongan Indah - DC	2000	139,42314
5	DC - Bencongan Indah - DC	2000	139,42314
6	DC - Labuan - DC	2000	121,78889
7	DC - Teluk - Labuan - Babakanlor - DC	1960	132,79524
8	DC - Bencongan Indah - Dalung - Serang - DC	780	147,88025
	Total	14740	1099,5801

No	Routes	Quantity (kg)	Distance (km)
	Routes with the Most Demand Points		
1	DC - Cikupa - DC	2000	116,49
2	DC - Cikupa - DC	2000	116,49
3	DC - Ciwedus - Randakari - Gunungsugih – Citangkil - Warnasari - Kebonsari - DC	1870	32,83
4	DC - Ciwaduk - DC	1155	4,46
5	DC - Cibeber - Harjatani - Tamansari - DC	1265	70,80
6	DC - Kramatwatu - Cikupa - Lopang - DC	1885	118,16
	Total	10175	459,24

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	Routes with Average Demand Points		
1	DC - Panyaungan Jaya - Tamansari - DC	1540	77,14
2	DC - Sajira - Kramatwatu - DC	1320	141,98
3	DC - Gedong Dalem - Mekarsari - Kebondalem - DC	1980	32,87
4	DC – Jombang Wetan - DC	1190	0
5	DC – Jombang Wetan - DC	2000	0
	Total	8030	251,98
	Route with Fewest Demand Points		
1	DC - Bencongan Indah - DC	2000	139,42
2	DC - Bencongan Indah - DC	2000	139,42
3	DC - Bencongan Indah - DC	2000	139,42
4	DC - Bencongan Indah - DC	2000	139,42
5	DC - Bencongan Indah - DC	2000	139,42
6	DC - Labuan - DC	2000	121,79
7	DC - Teluk - Labuan - Babakanlor - DC	1960	132,80
8	DC - Bencongan Indah - Dalung - Serang - DC	780	147,88
	Total	14740	1099,58

In the final phase, the distribution routing process is undertaken, establishing a distribution center at the Bencongan Indah site. Detailed routing results about the BenconganIndah candidate location are depicted in Figure 5.

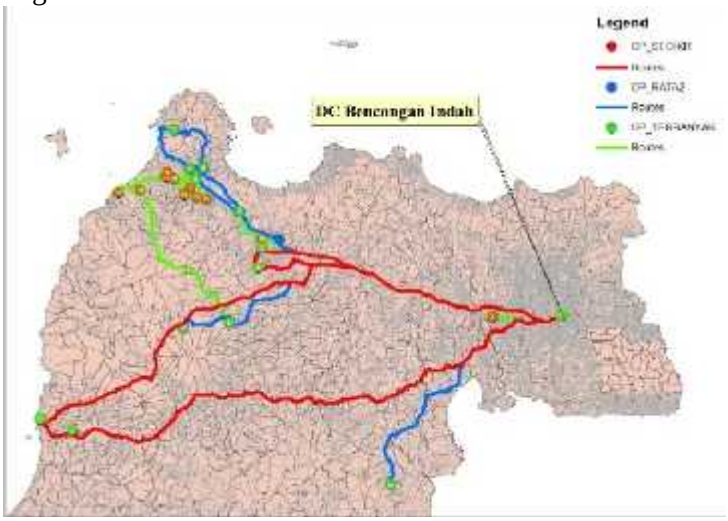

Fig 5. Distribution Routes with DC in Bencongan Indah

Through the routing analysis conducted using Bencongan Indah as the candidate site, three distinct routes were derived based on the previously selected daily data samples. The routing outcomes, in conjunction with the cargo capacity attainable for the distribution center located in Bencongan Indah, are presented comprehensively in Table 13. Notably, the average distance covered across these three scenarios, starting from the current distribution center location, amounts to 473.77 kilometers.

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Table 13. Routing Details with Distribution Center in Bencongan Indah

No	Routes	Quantity (kg)	Distance (km)
	Routes with the Most Demand Points		
1	DC - Ciwaduk - DC	1155	139,476061
2	DC - Cikupa - DC	1500	26,73612195
3	DC - Cikupa - DC	2000	26,73612195
4	DC - Kramatwatu - Warnasari - Citangkil - Ciwedus - Cibeber - Harjatani - DC	1980	155,6513095
5	DC - Tamansari - Randakari - Gunungsugih - Kebonsari - Lopang - DC	1540	188,4615738
6	DC - Cikupa - DC	2000	26,73612195
	Total	10175	563,7973102
	Routes with Average Demand Points		
1	DC - JombangWetan - DC	2000	139,4231366
2	DC - Gedong Dalem - Mekarsari - Kebondalem - DC	1980	167,895004
3	DC - JombangWetan - Kramatwatu - DC	1355	139,76065
4	DC - Tamansari - Panyaungan Jaya - DC	1540	147,474793
5	DC - Sajira - DC	1155	107,0029329
	Total	8030	701,5565165
	Route with Fewest Demand Points		
1	DC - Labuan - DC	2000	212,133526
2	DC - Babakanlor - Labuan - Teluk - DC	1960	216,9896324
3	DC - Dalung - Serang - DC	220	114,7800153
4	DC - Bencongan Indah - DC	560	0
5	DC - Bencongan Indah - DC	2000	0
6	DC - Bencongan Indah - DC	2000	0
7	DC - Bencongan Indah - DC	2000	0
8	DC - Bencongan Indah - DC	2000	0
9	DC - Bencongan Indah - DC	2000	0
	Total	14740	543,9031736

Consequently, the obtained outcomes can be succinctly summarized by Table 14, facilitating a comparative analysis of the travel distances for each route depicted in Figure 6 below.

Table 13. Route Length / Travel Distance Comparison

	Baseline	**Relocation: Cikupa**	**Relocation: Jombang Wetan**	**Relocation: Bencongan Indah**
Route Length on the Day with the Most Demand Points (km)	400,23	418,49	459,24	563,80
Difference (km)		**18,26**	**59,01**	**163,57**
Route Length on Day with Average Demand Points (km)	305,52	587,38	251,98	701,56
Difference (km)		**281,86**	**-53,54**	**396,03**
Route Length on the Day with the Fewest Demand Points (km)	881,10	632,96	1099,58	543,90
Difference (km)		**-248,14**	**218,48**	**-337,20**
Average Route Length of Three Scenarios (km)	528,95	387,79	363,26	473,77
Difference (km)		**-141,16**	**-165,70**	**-55,18**

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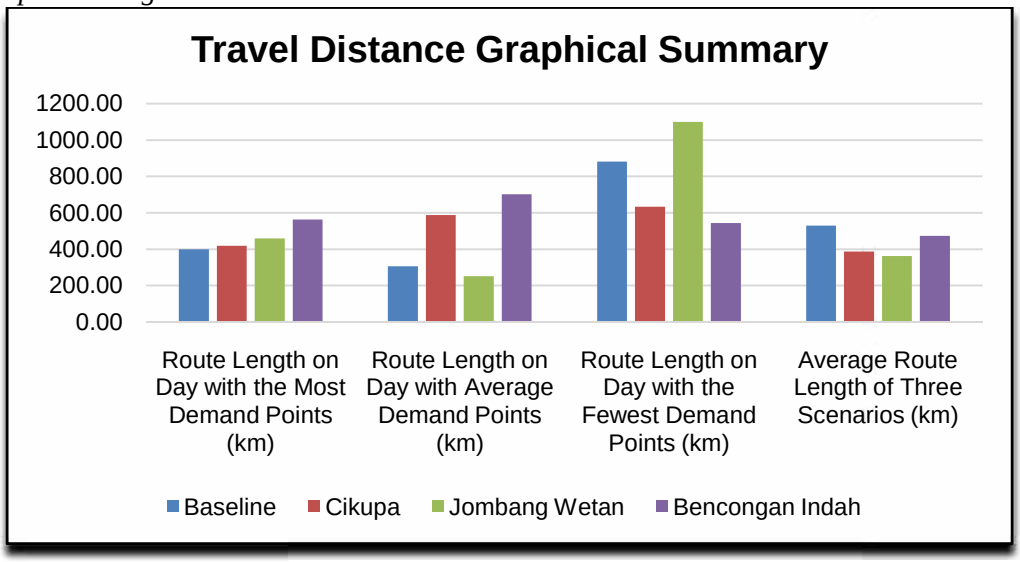

Fig 6. Travel Distance Graphical Summary

Based on the preceding comparative analysis, it is evident that, on the day characterized by the highest demand points, the current baseline scenario already exhibits the shortest travel distance. However, when confronted with a day featuring average demand points, the most favorable position with the shortest travel distance is secured by the company if it relocates to Jombang Wetan. Conversely, on a day characterized by the lowest demand points, Bencongan Indah emerges as the distribution center location yielding the shortest travel distance. Upon averaging the travel distances across these three routing scenarios, it becomes apparent that all proposed relocation sites outperform the baseline scenario, as each of them offers shorter distances. Nonetheless, when considering this average route length, the most recommendable relocation point is Jombang Wetan. This choice is substantiated by the fact that relocating to Jombang Wetan, on average, results in a reduction of 31.33% in travel distance, or an average savings of 165.7 kilometers compared to the baseline scenario. These savings surpass that achieved by relocating to Cikupa, which yields an average mileage reduction of only 10.43%, and Bencongan Indah, which achieves an average mileage reduction of 26.69%. The relocation to Jombang Wetan is thus preferred due to its potential to enhance the efficiency of the product distribution process.

I. CONCLUSION

Based on the conducted data processing and analysis, two primary conclusions can be drawn as follows: Utilizing the P-Median method for determining the optimal location of the new distribution center, it is advisable to consider relocating the distribution center to the Cikupa area when analyzing data with the highest demand points, the Jombang Wetan area when dealing with data reflecting average demand points, or the Bencongan Indah area for data featuring the lowest demand points.

On average, all three of these relocation options present more favorable routing scenarios than the baseline scenario, as they consistently exhibit shorter travel distances. Among these alternatives, Jombang Wetan emerges as the most advantageous relocation point, given its capacity to yield the greatest mileage savings (31.33% or 165.7 kilometers) when compared to other scenarios.

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Application of the Wheat Processing Circle Quality Control Method in Raw Wheat Bin Silos to Reduce Defective Products

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***Abstract*—The food industry is an industry that ranks first in Indonesia because it is a primary need. The food industry sub-sector, at 38.38%, breaking the USD 21.35 billion mark, supported the GDP of the non-oil and gas processing industry in the second quarter of 2022. The largest investment was in the food sector, including the bakery, flour, and palm oil industries. PT. XYZ is the largest company in Indonesia in the field of milling wheat into flour. This company experienced a problem in the screening area, namely Raw Wheat Bin silos with a lot of husks in a month there were 20 incidents so it reached 80%. To overcome these problems, the QCC method approach is used. From the results of the analysis using the QCC method, it was found that the failure rate of raw wheat bin silos with lots of husks decreased from 20 in April to 0 in June by applying the standardization that had been obtained.**

Keywords: **Wheat, QCC, Failure, *Silo Rwb***

I. INTRODUCTION

The economy in Indonesia is largely influenced by increased consumption of household needs. One industry that is currently growing rapidly is the food industry because it is one part of the primary/basic needs. The food industry sub-sector, which reached 38.38%, breaking the USD 21.35 billion mark, supported the GDP of the non-oil and gas processing industry in the second quarter of 2022 [1].The largest investment is in the food sector, including the bakery, flour, and palm oil industries. Wheat flour ranks second in the food sector with the most demand from consumers. Therefore it must be followed by quality innovations that must be improved. Wheat flour is the basic ingredient for the manufacture of food products. In 2021 the consumption of wheat flour will reach 28% and is expected to continue in 2045 to reach 50% of the total staple food [2].

Flour Mills is a division of PT. XYZ which is engaged in milling wheat into flour[3]. The company has three mills based in Jakarta, Cibinong, and Surabaya. PT. XYZ produces various brands of wheat flour -to make bread, noodles, pasta, and biscuits. This company fulfills consumer needs for about 70% of wheat flour. Mills is one of the departments responsible for cleaning the wheat, both 1st and 2nd cleaning, as well as milling wheat into flour according to predetermined specifications [4]. First cleaning aims to separate the grain from impurities that are smaller in size than the impurities in pre-cleaning. The first cleaning process starts from the raw wheat bin to the buffer bin. Wheat stored will be removed using a volumetric by adjusting the capacity of wheat discharge from the raw wheat bin based on volume weight (tons/hour). The second cleaning machine used is the scourer and TRR (Tarara) to clean and separate the dust or wheat husk which is peeled off and still attached to the wheat from the previous process [5].

With increasing consumer demand, it is hoped that the company will be able to meet consumer demand precisely and quickly. The production process requires one of which is the smooth use of the machine. However, in reality, there were several problems faced by this company, which occurred in the screening area, including lots of husk RWB silos, turbolizer belts breaking, bucket elevator belts breaking, metal bushings wearing out, and combi sieve frequently breaking. So it results in spec flour (dirty) which results in material losses and manufacturing costs. In analyzing repairs at PT. XYZ, the authors apply the QCC (Quality Control Circle) method. QCC is a concept to improve work quality and productivity by utilizing all of the company's assets [6]. This method will produce recommendations for solving problems so that they can be more effective. Research that was carried out by [7]with the title "Application of the

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QCC Method to Analyze the Causes of Damage to CD-type Cover Sifters" by establishing a standard operating procedure for cleaning and gluing damaged CD-type cover sifters, to reduce losses. Research by [8]using the QCC method can improve the effective time on the manpower factor increasing from 80.66% to 86.89%. Research conducted by [9]analyzes the quality control of flour products to reduce consumer returns using the QCC method.

II. RESEARCH METHOD

The method used in this study is the Quality Control Circle (QCC) approach. This method is for discussing and solving work problems to improve quality by implementing Quality Control Groups (GKM) [10]. Several steps to carry out quality control are determining the theme of the problem, setting targets, analyzing conditions in the field, cause and effect analysis, improvement plans, corrective actions, evaluation of results, standardization, and next steps.Metode yang dilakukan pada penelitian ini menggunakan pendekatan *Quality Control Circle* (QCC).

III. RESULT AND DISCUSSION

There is a lot of husk in the raw wheat bin, so the cleaning machines cannot run normally. The machines include grain weighing and combi cleaner machines. The problem starts with the valve opening on the wheat scale not meeting the target and the combi cleaner machine cannot accommodate the amount of wheat because it exceeds the engine capacity. So the combi cleaner separator is full of husks, wheat cannot pass through, and more impurities come out through the pathway.Here is a picture of the wheat in the raw wheat bin and the metal bin with lots of husks.

Figure 1. Wheat in Raw Wheat Bin and Metal Bin lots of husks

Step 1: Determine the Theme

Indicators of success in the screening process include screening machines running normally, wheat is not contaminated with other materials, and wheat moisture being on target. The following is a table and graphical images of constraint indicators in the screening area.

Table 1. Problems in the Screening Area

No.	*Problem*	Frequency (/month)	%
1.	*Rwb silos have a lot of husks*	20	80
2.	*Turbolizer belt broken*	1	4
3.	*The bucket elevator belt broke*	2	8
4.	*Worn metal bushings*	1	4
5.	*Sieve combi often breaks*	1	4
	Total	25	100

The following is a graph of the problems in the screening area.

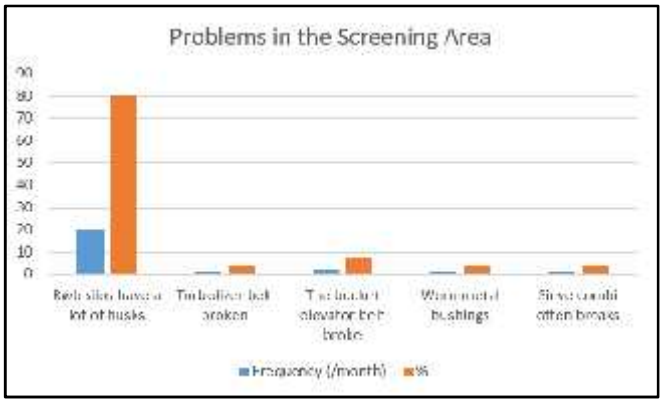

Figure 2. Problems in the Screening Area

From the problem data in the screening area, the most common is rwb silo with a lot of husks in a month, there are 20 incidents so it reaches 80%.

Step 2: Setting Targets

Determination of this target is based on April 2023 (chaff in the raw wheat bin and cleaning process of ± 2%.

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Table 2. Target Setting

Element	Factor
Specific	*Rwb silos have a lot of husks*
Measurable	Chaff in silo raw sheat bin more than 5%
Achievable	In June silo raw wheat bin husk ±2%
Reasonable	Affects the cleaning process is not optimal
Time-Based	Completed within 1 month

Setting targets in the analysis of raw wheat bin silo problems using the SMART method approach.

Step 3: Analysis of Existing Conditions

Analysis of the condition of PT. XYZ by approaching several factors, namely man, method, material, machine, and environment. Below is a table explaining the analysis of the conditions that exist in the company.

Table 3. Condition Analysis

Factor	Items	Standard	Check Method	Actual	%	Remark
Man	Rarely pay attention to the condition of the silo outlet pipe	Rwb silo rotation	Field observation	Silo rotation if there is a new stamp with 2 or 3 types of wheat	0	No problem
Method	The capacity of the 1st cleaning wheat scale is not reduced at the start of filling wheat	Weighing capacity reduced	Field observation	The capacity of the balances at the start of the screening process is not understated	1000	Problem
	There is no silo rotation	Silo rotation 1 week 3 times	Field observation	Rarely move silos	100	Problem
Material	Wheat broke	Whole wheat	Field observation	Wheat is not broken	0	No problem
	Wheat a lot of husks	Chaff not more than 2%	Field observation	Wheat much husk more than 5%	100	Problem
Machine	Combi's sparator rear full of husks	No dead ends	Check the combi cleaner machine	Normal combi cleaner	0	No problem
	Problem cleaning machine	The cleaning machine runs optimally	Field observation	Optimum engine	0	No problem
Environment	Humid and high temperature	-	Field observation	Temperature 42 °C	1000	Problem

It can be seen from the table above that there are problems with items including method factors (the capacity of the 1st cleaning wheat scale is not reduced at the start of grain filling and there is no silo rotation), material (wheat has lots of husks), and environment (humid and high temperatures).

Step 4: Cause and Effect Analysis

The next step is to make a causal diagram to analyze the factors that cause a lot of husk silos.

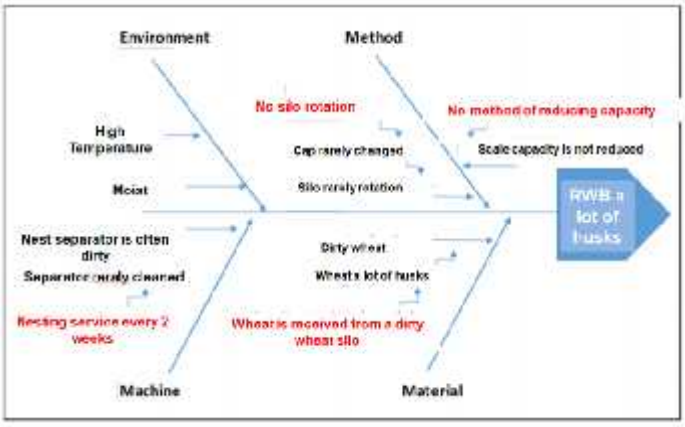

Figure 3. Cause and Effect Diagram

The table below is an explanation of the explanation of the cause and effect diagram, 5 root causes are obtained from silo RWB with lots of husks.

Table 4. Explanation of Root Causes

No.	Root Cause	Description	Validation
1.	No silo rotation	No rotation for 1 month	Yes
2.	Decreased capacity at the start of the screening process	There is no decrease in the capacity of the scales	Yes
3.	Servicing once every 2 weeks	The separator cleaning distance is too long	Yes
4.	Wheat received from dirty WS	Wheat a lot of husks	No
5.	Humid and high-temperature	High temperatures affect humidity	No

After validation, it turned out that there were 3 root causes, namely the absence of an rwb silo rotation method, decreased capacity at the start of the screening process, and servicing nests once every 2 weeks.

Step 5 : Maintenance Plan

After obtaining the root cause of the silo with lots of husks, the next step is to carry out an improvement plan using the 5W + 1H analysis.

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Table 5. Improvement Plan

No.	What	Why	How	Who	When	Where
1.	Silo rotation 1 week 2 times	To reduce the amount of husk in the silo	Create a silo rotation work procedure	*Screening-man*	June	Mill EF
2.	Reduce the capacity of the balance at the start of the screening process	So that at the start of the screening process, the combi cleaner engine runs normally	Make cleaning process work procedures	*Screening-man*	June	Mill EF
3.	Perform cleaning of the separator nest	So that the screening machine runs smoothly	Make a schedule for cleaning/ servicing the machine	*Screening-man*	June	Mill EF

There are 3 improvement plans to overcome rwb silos in the EF Mill screening area which was carried out in June.

Step 6: Corrective Action

To implement the improvement plan there must be a next step, namely corrective action for problem 1.

Table 6. Corrective Action on Problem 1

No.	What	Why	How	Who	When	Where
1.	Silo rotation 1 week 2 times	To reduce the amount of husk in the silo	Create a silo rotation work procedure	*Screening-man*	June	Mill EF

Procedure for raw wheat bin silo rotation

1. Ensuring the wheat used is according to the RTP.
2. Ensure silos are filled with grain to be used.
3. If the grist used in a week uses 3 types of wheat, then to fill the silos next week please rotate.
4. For grist in a week use 2 types of wheat or 1 type of wheat, then in a week you need to rotate 2 times.

Table 7 below describes the corrective actions that must be implemented in problems 2 and 3.

Table 7. Corrective Actionsthere are Problems 2 and 3

No.	What	Why	How	Who	When	Where
2.	Reduce the capacity of the balance at the start of the screening process	So that at the start of the screening process, the combi cleaner engine runs normally	Make cleaning process work procedures	*Screening-man*	June	Mill EF
3.	Perform cleaning of the separator nest	So that the screening machine runs smoothly	Make a schedule for cleaning/ servicing the machine	*Screening-man*	June	Mill EF

Cleaning process work procedures

1. Start all cleaning machines
2. Wait until the metal bin is full to the high-level
3. Reduce wheat weighing capacity to 50% of the target (target 17 tons/hour)
4. Start wheat scales 1st cleaning

Step 7 : Evaluation of results

Evaluate the before and after results of several factors including quality, cost, productivity, delivery, safety, and moral factors.

Table 8. Evaluation of Results

Factor	Improvement		
	Before	After	Results
Quality	Silos a lot of husks	No husks	OK
Cost	Wheat repass fee IDR 10.000.000,-	No wheat is repassed	OK
Productivity	Wheat has a lot of husks	Wheat has no husk	OK
Delivery	Grain transfer for the cleaning process is hampered	Grain transfer for a smooth cleaning process	OK
Safety	There is a potential for work accidents when going up and down stairs	No potential for work accidents	OK
Moral	Screeningman has difficulty when the cleaning machine does not run smoothly	Screeningman works easier and more convenient	OK

The results obtained from the improvement of the raw wheat bin silo meet the improvement standards.

Step 8: Standardization and Next Steps

The next step for the company is to standardize it so that there is no husk in the raw wheat bin silo and the cleaning machine runs smoothly which has been explained in table 9 below.

Table 9. Standardization

No.	Improvement	Target	Socialization
1.	Rwb silo rotation according to procedure	There is no husk in rwb silos and cleaning machines run smoothly	Via word of mouth between screening man and mill ward reports
2.	The screening process goes according to the procedure	There is no husk in rwb silos and cleaning machines run smoothly	Via word of mouth between screening man and mill ward reports
3.	Combi cleaner machine services are carried out 1 week 2 times	There is no husk in rwb silos and cleaning machines run smoothly	Via word of mouth between screening man and mill ward reports

After implementing the QCC method approach, the failure rate of silo raw wheat bins with lots of husks decreased from 20 to 0.

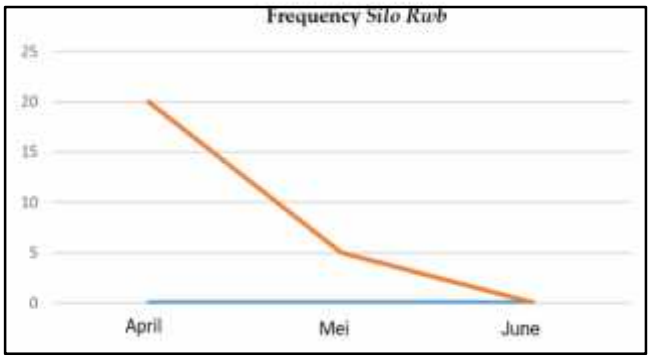

Figure 4. Frequency Silo Rwb

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IV. CONCLUSION

Based on the raw wheat bin silo analysis using the QCC method, the following conclusions are obtained:

1. Making standardization so that there is no husk in the silo raw wheat bin and the cleaning machine runs smoothly, namely the silo rwb rotation according to the procedure, the screening process goes according to the procedure, and the combi cleaner machine is serviced twice a week.
2. For delivery of standardization orally between screening man and mills work reports.
3. The failure rate of silo raw wheat bin, which has lots of husks, has decreased from 20 in April to 0 in June.

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Applied of The Simulation of The Queue System in Restaurant Mie Gacoan Branch Gresk Using Arena 14.0

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Abstract—**A system design certainly cannot be separated from the term simulation. There is no need to calculate the simulation manually because a system called the Arena application is available. The Arena is a Windows-based simulation software used to simulate and analyze a system. This study aims to enable the practitioner to know and run a queuing system simulation into the tools in the Arena 14.0 software, which in turn can be applied in real conditions to the queuing system at Mie Gacoan Restaurant Gresik Branch. The method used in this case is the simulation queuing method. The queuing model consists of 2 single servers consisting of a general queue and an online ojek queue. The simulation queuing presentation uses the FIFO (first in, first out) rule. That is, consumers who come first to make payments are the first to be served by the system. The analysis results show that the queue rate on server 2 (online ojek queue) has a slightly longer time difference than on server 1 (general queue).**

Keywords: Simulation System, Queue, Arena 14.0

I. INTRODUCTION

Talking about a system design cannot be separated from the term simulation. In any system, experiments or simulations are required first to get an idea of how the system will run, whether or not it is necessary to repair or feel that it is following the system's main purpose.Like the relationship between students and BAA counter staff, during taking care of KRS, all students will come in droves and take care of the re-registration of their lectures at the BAA office. Of course, there will be student queues, more than on usual days. Assuming the average service for each student is 5 minutes, trying out several alternative systems is necessary. Such as service with one counter clerk or three counter clerks. By simulating several alternative systems, decision-making with the best solution will be obtained.

Making simulations does not need to be calculated manually along with very rapid technological developments, so it is considered not difficult. However, the developing technology has a great influence on changing human life. One of the technological developments implemented in changing the order of human life is the Arena 14.0 application, which assists in the process of making system simulations.

Arena 14.0 is a Windows-based simulation software used to simulate and analyze a system. Arena 14.0 provides a good combination of usage, flexibility, and modeling of a real system to make it look more realistic. Important things that need to be considered in making a real system model are related to system operation, material flow, resource work, operation logic, and work trajectories. The output displayed in the Arena when performing the simulation is an animated activity, and the results are in the form of tables and graphs. The tables or graphs that are displayed make it easier to analyze the system created by the model. Thus, as an industrial engineering student, it is necessary to learn how to simulate a system because this knowledge will be very useful to be applied in the company where you work. As for the intricacies of the ProModel software, it will explain the steps for completing some early-stage exercises

II. LITERATURE REVIEW

a. System Basic Concept

The system is interpreted simply as a collection (set) of elements, organized variables, and components, interacting with each other, dependent on each other, and integrated(Wang*et.al*, 2014).In general, the elements that represent the system are input, process, and output.

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Another concept that can describe the system is the concept of synergy. This concept provides an understanding in the form of the total output produced in an organization which is expected to be greater than the individual output and the output of each part(Ucer*et.al*, 2019).The system is a term that is still common and widely used. The system is formed from integrated components to achieve goals(Bahadori *et.al*, 2014). In line with the general understanding of the system, the components in the system become a single unit starting from the input, process, to the output(Stanford*et.al*, 2014). Therefore, the system concept can be directly applied to information systems design.

b. System Characteristics

The system must have certain characteristics or properties (Wulandari*et.al*, 2021):

1. Component consists of several components that interact with each other, several sub-systems or sub-sections(Guo*et.al*, 2014).
2. The boundary is between the system and the external environment(Kurniawan *et.al*, 2023).
3. Output is the result of the energy processing process and is grouped into useful results and discarded waste. Output can be ideas for other sub-systems or super-systems(Rinaldi*et.al*, 2015).
4. The process of a system has a processing section or the system itself that acts as a processor. This processing process converts input into output(Aksin *et.al*, 2022).
5. The environment outside the system (Environment) is anything outside the system's boundaries that can affect the system's operation. The environment outside the system can be beneficial or detrimental to the system(Ilyas*et.al*, 2017).
6. A Liaison System is a medium that connects one sub-system with other sub-systems. Connectors open options for the possibility of processing the flow of data sources from one sub-system to another(Yang*et.al*, 2014).
7. Input is the energy entered into the system—input in the form of improvement of input and signal input(Berhan, 2015).
8. Goals and Objectives of the System A system must have goals and objectives. A system that does not have a target will make the system's operation useless(Rondini*et.al*, 2017).

c. Components System

Components that must be understood in the system, including(Wulandari*et.al*, 2021):

1. The entity is part of the system, which becomes an important component and becomes the main concern of the real system situation for further identification and processing(Wang*et.al*, 2014).
2. Attributes are characteristics or properties of an entity whose characteristics are uniquely attached to the entity(Bahadori *et.al*, 2014).
3. An event is a condition that can change the condition of the system in a short time. However, events can also be interpreted as temporary conditions that result in significant state changes in the system(Rinaldi*et.al*, 2015).
4. Activity is a process that changes the system, which also affects changing entities and attributes(Stanford*et.al*, 2014).
5. State of Variables are variables that gather to describe the system over time and are not uniquely attached to entities(Ilyas*et.al*, 2017).

d. Basic Concept of Model

Simulations are not known to many people and are difficult to do. However, simulation can predict the system's behavior observed at a certain time, producing observational data(Rondini*et.al*, 2017). More broadly, simulation is not just a solution to a problem created by a model (miniature or data) in such a way as to produce the expected value. Instead, prediction results from system simulation can be used as a reference in making important decisions regarding problems in the simulation model(Berhan, 2015).

The system contains elements or elements that function as components of a real situation by grouping interrelated studies. Selection is made on the system maker's components based on the study's purpose(Koeswara*et.al*, 2018). Therefore, the system is a miniature of a simple form under real conditions.

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e. Basic Concept of Simulation

Simulation is a method of describing or duplicating features, characteristics, and appearances based on a real system(Guo*et.al*, 2014; Ucer*et.al*, 2019). Based on this, simulation is considered the right tool to be implemented to find the best comments from system components when conducting experiments.The system's behavior must be described in detail regarding how the existing components interact and have interrelationships so that the model truly describes the behavior in the system(Yang*et.al*, 2014). If the model has been confirmed to be following real conditions, the model that has been made can be transformed into a computer program to create a simulation with a clearer picture.

f. Simulation Model Application

Simulation models can be applied to several things, including(Aksin *et.al*, 2022):

1. Design and analysis of manufacturing system.
2. Hardware and software requirements on the computer system.
3. The process of evaluating weapons systems in the military field.
4. Set up the inventory system.
5. Design the transportation system.
6. Create a communication system design.
7. Evaluating the banking service system.
8. Evaluating the financial and economic system.

g. Activity Cycle Diagram

The activity Cycle Diagram describes the interaction between entities in the system as outlined in the form of a conceptual model(Berhan, 2015; Rinaldi*et.al*, 2015).In the queue simulation process, several types of graphs can describe the existence of the system as a whole(Koeswara*et.al*, 2018; Wulandari*et.al*, 2021):

1. For example, the Q (t) graph shows the number of queues.
2. Graph B(t) is a graph of the existence of the server
3. Graph S(t) is a graph depicting the two conditions above

h. Event graph

*An event graph*is a graph used to describe discrete events in a simulation model(Wang*et.al*, 2014; Rondini*et.al*, 2017). These charts are known as "Simulation Graphs" and have a minimalistic design with one point type and two border types that can provide three different options(Kurniawan *et.al*, 2023).

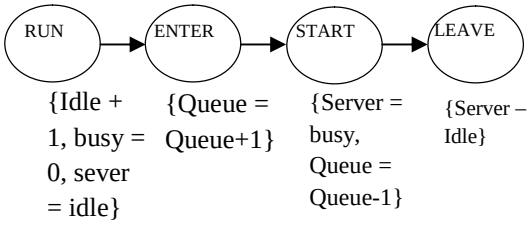
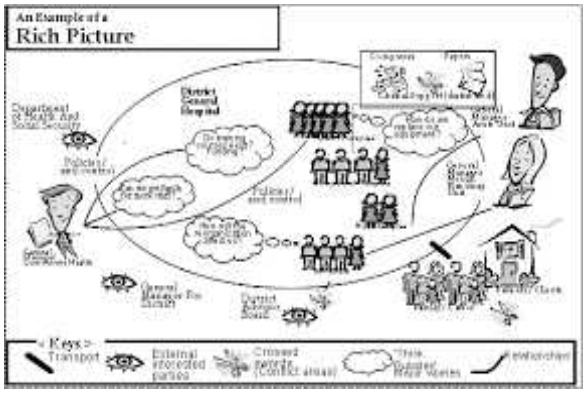


Figure 1. Event Graphs

i. Rich Picture

A rich Picture is one of the media that describes a situation, problem, or model in a cartoon format based on a summary that the model maker has known to the system described with a brief description (glance description)(Yang*et.al*, 2014).

Figure 2. Rich Picture



j. Software Arena 14.0

Software Arena is software published by the System Modeling Corp. that serves to assist humans in creating simulation models. The Arena software base is object-oriented, providing templates and modifiable alternatives to the graphical simulation model(Bahadori *et.al*, 2014; Ilyas*et.al*, 2017).Software Arena uses a drag-drop system and can create 2D animations with good compatibility. In addition, animations in Arena can be supported using files from other applications such as AutoCAD. Software Arena was created specifically to solve Discrete System Simulation problems. The Arena can process statistical data even though it is incomplete, in addition to preventing model damage by predicting consequences based on new

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conditions, rules, and implementation strategies(Stanford*et.al*, 2014).

Figure 3. Sofware Arena 14.0

k. Queue Theory

Queuing theory is a model theory of queues and waiting for lines related to mathematical studies(Guo*et.al*, 2014; Aksin *et.al*, 2022). Waiting is a phenomenon that arises due to the randomness of facility service operations. Generally, the customer's service time and the next time are unknown(Ucer*et.al*, 2019). Therefore, the queuing situation involves the basic elements: the customer and service (server).

When explained with the basic concept of the system, the queue system has input in the form of customers who come at a constant or variable rate to get service, or customers will wait to get service if the server is still busy, then processed with service, and has an output where the customer will leave the system. after receiving service(Berhan, 2015).

l. Calculation Formulas

1. Average Inter–Arrival Time

$$= \frac{t \quad ti \quad b \quad a}{(n \quad o \quad c \quad) - 1}$$

2. Average Processing Time

$$= \frac{t \quad p \quad ti}{n \quad o \quad c}$$

3. Average Customer Waiting Time (Queue Time)

$$= \frac{t \quad q \quad ti}{n \quad o \quad c}$$

4. Average Process Waiting Time (Delay Time)

$$= \frac{t \quad p \quad d \quad ti}{n \quad o \quad c}$$

5. Average Queue Length

$$= \frac{n \quad o \quad c \quad whic \, c}{t \quad s \quad ti}$$

6. Average Customer Time in the System

$$= \frac{t \quad c \quad ti \quad i \; the \; s}{n \quad o \quad c}$$

7. Probability of Customers Waiting in System

$$= \frac{t \quad c \quad q \quad g}{n \quad o \quad c}$$

8. System Utilities

$$= 1 - \frac{t \quad s \quad d \quad ti \quad 1}{t \quad o \quad ti}$$

III. RESEARCH METHOD

The stages carried out in conducting research, namely identifying problems and setting goals, field studies, literature studies, data collection, data processing, and data analysis, then simulating the proposed model and its analysis.

a. Problem identification and Goal Setting
   In identifying problems from observations that will be made to answer problems from the formulation of existing problems and achieve the desired goals related to systems, models, and simulation approaches.
b. Field Study
   This observation is carried out directly in the field on an object to be observed to obtain data based on facts which are then processed and analyzed. We conducted a field study at the Gacoan Noodle Restaurant on Jl in this system, model, and simulation approach. Panglima Sudirman No. 161, Kramatandap, Gapurosukolilo, Kec. Gresik, Gresik Regency, East Java.
c. Study of Literature
   In addition to direct observations, we also conduct literature studies by reading and collecting theories related to this problem on the internet.
d. Data Collection
   The data in this study are primary data taken by the observation method, namely by collecting data by observing directly in the field on the observed research object. Observation results can be used as a reference in analyzing and making decisions. The data collected in the observations are as follows:

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1. Customer Arrival Time Data
2. Service Start Time Data
3. Service End Time Data

e. Data Processing

Data processing is carried out by calculating the data obtained from observations at Mie Gacoan Gresik according to the calculation stages in the literature study. The calculations carried out include, among others, calculating the average time between arrivals, calculating the average service time, calculating the average customer waiting time, calculating the average server waiting, calculating the average queue length, calculating the average customer time in the system, calculate the probability of customers waiting in the system, and calculate system utility and in addition, making a model of the customer service queuing system at Mie Gacoan Gresik with the help of the Arena 14.0 software and then simulating it to get the average queue results and so on.

f. Data Analysis

The results of customer service attrition system data processing at Mie Gacoan Gresik using Arena 14.0 software were analyzed based on the values of instantaneous resource utilization, resource number busy, and so on and then interpreted descriptively using numbers so that it could be known specifically the results obtained from processing data at the queue system. Mie Gacoan Gresik customer service. The final result of the data analysis is concluded to make it easier to read the research results.

This observation was carried out at the Gacoan Noodle Restaurant on Jl. Panglima Sudirman No. 161, Kramatandap, Gapurosukolilo, Kec. Gresik, Gresik Regency, East Java.On Tuesday, May 17, 2022, it will take approximately 1 hour, starting at 18:30 WIB – 19:25 WIB.The type of data used in this study is quantitative data in the form of numbers or the form of numbers so that it can be calculated or measured in the optimal facility path, the service time performance at the optimal level when ordering food at Mie Gacoan, more precisely on Jl. Panglima Sudirman No. 161, Kramatandap, Gapurosukolilo, Kec. Gresik, Gresik Regency, East Java.

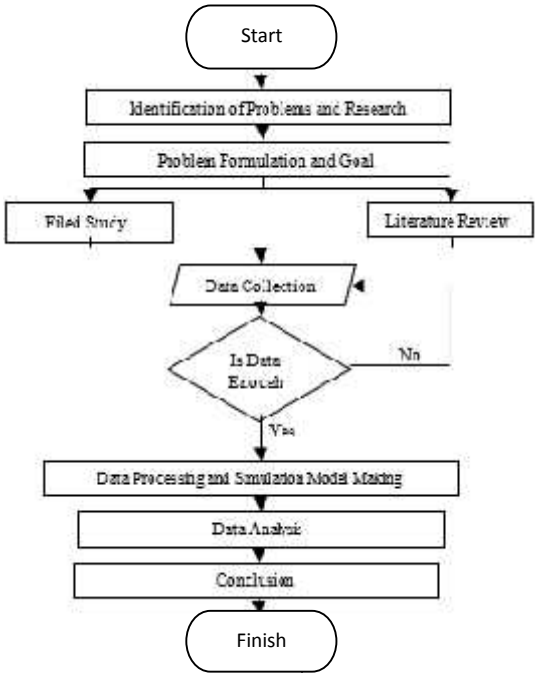

Figure 3. Research Flowchart

IV. RESULT AND DISCUSSION

a. *System Description*

The queuing system observed at Mie Gacoan Restaurant, more precisely at the Gresik branch, is the food ordering service system at Mie Gacoan. In this system, 2 servers will perform customer service, namely normal customers and online customers. This queuing system serves consumers starting from 09.00 WIB - 21.00 WIB.

The queuing system found at the Mie Gacoan Restaurant Gresik branch is included in the Multi-channel - single phase queue model, which has two servers with one service using FIFO (first in, first out) discipline, namely consumers who come first to make payments, then the first to be served by the system.

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b. *System Components*

Table 1. System Components

System	Entity	Attribute	Activities	Event	State of Variables
Mie Gacoan Service	Chasier Restaurant Mie Gacoan (*Permanent*)	1. ID card 2. Uniform 3. Cash register Receipt	The server processesorders that consumers want	Service	Numbers of servers busy serving
	Customer (*Temporary*)	Food and drinks on the mie can menu	Make the payment according to the amount stated on the receipt	Arrivals and departures	Number of customers waiting in line

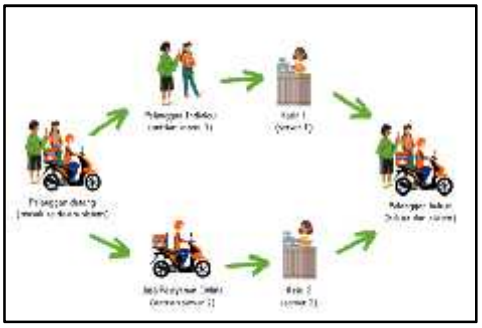
Components systemsconsist of entities, attributes, activities, activities, and the number of variations of the variables. For example, the Mie Gacoan service system has entities like cashiers and consumers. The cashier has attributes such as an ID Card, uniform, cash register, and purchase receipt. Consumers have attributes in the form of various foods and beverages on the menu. The activity carried out by the cashier is processing orders, while the activities carried out by consumers are payments based on orders that have been made. The main activity of the cashier is to provide services to consumers and consumers in the form of arrivals and departures from the system. The number of variables at the cashier is determined by the number of busy servers, while the consumer is the number of consumers waiting in line.

c. *System Process*

The following system processes that occur in the queue system at Mie Gacoan Restaurant Gresik Branch are as follows:

1. First, consumers come and enter a queue.
2. Next, consumers choose a server and enter the type of service they want.
3. Finally, consumers mention the desired food menu.
4. The server enters the data that consumers want to buy
5. Consumers make payments to the server
6. The server provides a receipt as a valid proof of payment
7. The cashier or restaurant employee provides a table number to make it easier for the waiter to deliver food (if choosing a server to eat on the spot)
8. Consumers get out of line

d. *Rich Picture*



Picture 4. *Rich Picture Diagram of Gacoan System*

The following is a system process that occurs in the queue system at Mie Gacoan Restaurant Gresik Branch as follows:

1. First, consumers come and enter the queue.
2. Next, consumers choose one of the servers as needed, and then enter the queue.
3. Finally, consumers say what menu they want.
4. The server enters the menu that consumers want
5. Consumers make payments to the server
6. The server provides a purchase receipt as valid proof of payment to the buyer.
7. Consumers get a table number to make it easier for waiters to deliver food.
8. Consumers get out of line.

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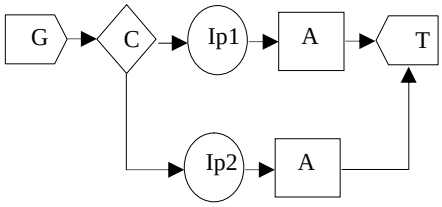
e. ***Activity Cycle Diagram (ACD)***

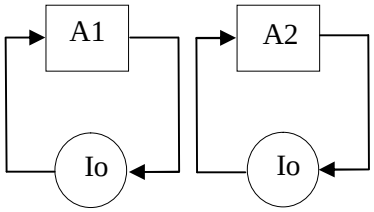
1. ACD (*Activity Cycle* Diagram) *Temporary*



Picture 5. *Activity Cycle Diagram*

Information:
G = consumer arrival
C =Possible alternatives
Ip =Idle/waiting for customer
A_1 = Server service process1
A_2 = Server service process 2
T = The customer leaves the server

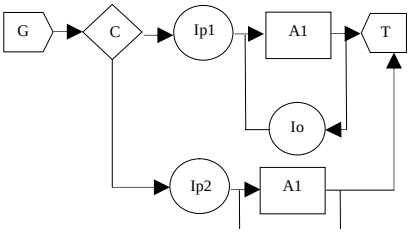
2. ACD (*Activity Cycle* Diagram) *Permanent*



Picture 6. Activity Code Diagram

Information:
A_1 = Server service process 1
A_1 = Server service process 2
I_o = Idle / waiting for operator

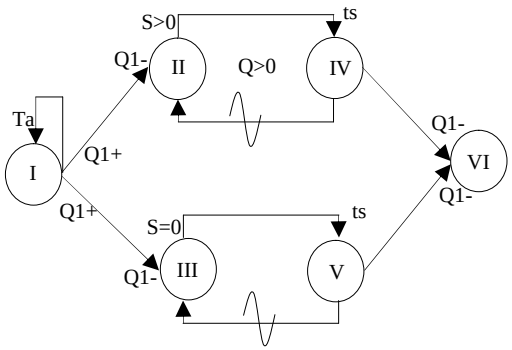
3. ACD (*Activity Cycle* Diagram) *System*



Picture 7. Activity Cycle Diagram

Information:
G = Customer arrival
C = Possible alternative
I_o = Idle / waiting for operator
I_p = Idle / waiting for the first customer
I_k = Idle / waiting for a second customer
A_1 = Server service process 1
A_2 = Server service process 2
T = Indicates the consumer leaves the system

f. ***Event Graphs***



Picture 8. *Event Graphs*

Information:
I = Customer arrival
II = Start server 1
III = Start server 2
IV = End server 1
V = End server 2
VI = Outgoing customer
ta = Show customer arrival time

S>0 = Indicates server started service
Q>0 =Indicates the occurrence of a queue
Q1+ =The first customer queue
Q1- = No queue
Ts = Show operator activity time
= Operator who is interrupting

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g. *Data Collection*

Table 2. Observation Data of Mie Gacoan Queue System Gresik Branch

Time of Arrival	WAD (s)	Server 1			Server 2			Queue Time (s)		Delay Time(s)		Consumers' Time in the System (s)
		WMP	WSP	WP (s)	WMP	WSP	WP (s)	Server 1	Server 2	Server 1	Server 2	
18:29:47	0:00:00	18:34:17	18:34:38	21	18:39:23	18:40:10	47	270	576	7	2	68
18:30:12	0:00:25	18:34:45	18:35:16	31	18:40:12	18:40:49	37	277	600	7	1	68
18:30:34	0:00:22	18:35:23	18:36:01	38	18:40:50	18:41:25	35	289	76	5	8	73
18:32:24	0:01:50	18:36:06	18:36:32	26	18:41:33	18:42:42	69	222	549	8	3	95
18:34:00	0:01:36	18:36:40	18:37:20	40	18:42:45	18:43:35	50	160	525	5	27	90
18:34:17	0:00:17	18:37:25	18:38:25	60	18:44:02	18:44:55	53	188	585	5	3	113
18:34:17	0:00:00	18:38:30	18:41:39	189	18:44:58	18:46:02	64	253	641	33	4	253
18:34:58	0:00:41	18:42:12	18:42:42	30	18:46:06	18:47:02	56	434	668	6	3	86
18:35:27	0:00:29	18:42:48	18:42:53	5	18:47:05	18:48:34	89	441	698	3	12	94
18:37:24	0:01:57	18:42:56	18:43:22	26	18:48:46	18:49:21	35	332	682	8	3	61
18:40:32	0:03:08	18:43:30	18:44:03	33	18:49:24	18:49:58	34	178	532	3	4	67
18:40:48	0:00:16	18:44:06	18:44:42	36	18:50:02	18:52:11	199	198	554	63	3	235
18:41:13	0:00:25	18:45:45	18:46:12	27	18:52:14	18:53:11	57	272	661	5	40	84
18:41:56	0:00:43	18:46:17	18:48:58	161	18:53:51	18:55:09	78	450	715	7	2	239
18:42:36	0:00:40	18:49:05	18:51:01	116	18:55:11	18:58:02	171	650	95	2	2	287
18:43:04	0:00:28	18:51:03	18:51:48	45	18:58:04	18:59:36	92	479	900	24	3	137
18:43:55	0:00:51	18:52:12	18:53:11	59	18:59:39	19:01:24	105	497	944	4	1	164
18:47:32	0:03:37	18:53:15	18:54:07	52	19:01:25	19:03:12	107	343	833	3	5	159
18:50:31	0:02:59	18:54:10	18:55:15	65	19:03:17	19:04:58	101	219	766	8	2	166
18:52:42	0:02:11	18:55:23	18:56:08	45	19:05:00	19:06:14	74	161	738	5	2	119
18:52:55	0:00:13	18:56:13	18:57:55	102	19:06:16	19:08:32	136	198	801	15	2	238
18:52:58	0:00:03	18:58:10	18:58:48	38	19:08:34	19:09:13	39	312	936	13	3	77
18:53:13	0:00:15	18:59:01	19:02:31	390	19:09:16	19:12:08	172	348	963	4	4	562
18:53:28	0:00:15	19:02:35	19:03:25	50	19:12:12	19:13:26	74	547	1124	3	3	124
18:53:56	0:00:28	19:03:28	19:04:46	78	19:13:29	19:13:58	29	572	1173	2	7	107
18:54:22	0:00:26	19:04:48	19:06:01	73	19:14:05	19:16:38	153	626	1183	9	3	226
18:54:47	0:00:25	19:06:10	19:07:32	82	19:16:41	19:17:48	67	683	1314	6	4	149
18:55:34	0:00:47	19:07:38	19:09:11	93	19:17:52	19:18:13	21	724	1338	2	4	114
18:56:21	0:00:47	19:09:13	19:09:58	45	19:18:17	19:20:14	117	772	1316	5	2	162
18:56:49	0:00:28	19:10:03	19:11:04	61	19:20:16	19:22:34	138	794	1407	0	0	199

The data collected includes consumer arrival time, service start time, and service end time. In addition, the data produces processed calculations of inter-arrival time, length of service time on each server, consumer time when waiting in line, lag time, and the total time required by consumers in the system.

h. *Data Processing*

1. Data Calculation
   a) The average time between arrivals

$$= \frac{t \quad ti \quad b \qquad a}{(n \quad o \quad c \qquad) - 1} \frac{1}{(6)-1}$$

$= 27{,}49$

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b) Average service time
   a. Servers 1
      = $\frac{t \quad s \quad s_i \quad ti \quad 1}{t \quad s \quad c \quad 1}$
      = $\frac{2}{3}$
      = 70,57 seconds/person
   b. Servers 2
      = $\frac{t \quad s \quad s_i \quad ti \quad 2}{t \quad s \quad cu: \quad 2}$
      = $\frac{2}{3}$
      = 83,3 seconds/person

c) Average customer waiting (queue time)
   a. Servers 1
      = $\frac{t \quad q \quad ti \quad s \quad 1}{ni \quad o \quad c \quad s \quad 1}$
      = $\frac{1}{3}$
      = 396,3 seconds/person
   b. Servers 2
      = $\frac{t \quad q \quad ti \quad s \quad 2}{ni \quad o \quad c \quad s \quad 2}$
      = $\frac{2}{3}$
      = 796,43 seconds/person

d) Average server wait (delay time)
   a. Servers 1
      = $\frac{t \quad d \quad ti \quad s \quad 1}{ni \quad o \quad c \quad s \quad 1}$
      = $\frac{2}{3}$
      = 9 *seconds*
   b. Servers 2
      = $\frac{t \quad d \quad ti \quad s \quad 2}{ni \quad o \quad c \quad s \quad 2}$
      = $\frac{1}{3}$
      = 5,4 seconds

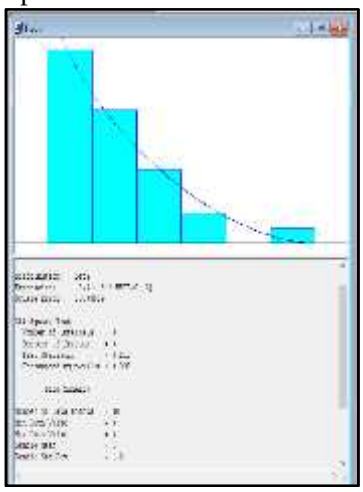
e) Average queue length
   a. Servers 1
      = $\frac{ni \quad o \quad c \quad q \quad f \quad s \quad 1}{t \quad s \quad ti \quad f \quad s \quad 1}$
      = $\frac{3}{2}$
      = 0,*012*person/seconds
   b. Servers 2
      = $\frac{ni \quad o \quad c \quad q \quad f \quad s}{2t \quad ls \quad ti \quad f \quad s \quad 2}$
      = $\frac{3}{2}$
      = 0,*0013*person/second

f) Average customer time in the system
   = $\frac{t \quad c \quad ti \quad li \quad the \quad s}{ni \quad o \quad c}$
   = $\frac{4}{6}$
   = 76,93 seconds/person

g) Probability of customers waiting in the system
   a. Servers 1
      = $\frac{t \quad c \quad q \quad s \quad 1}{ni \quad o \quad c}$
      = $\frac{3}{6}$
      = 50%
   b. Servers 2
      = $\frac{t \quad c \quad q \quad f \quad s \quad 2}{ni \quad o \quad c}$
      = $\frac{3}{6}$
      =50%

h) System Utilities
   a. Servers 1
      = 1 - $\frac{t \quad s \quad d \quad ti \quad 1}{t \quad o \quad ti}$
      = 1 - $\frac{2}{3}$
      = 0,91
   b. Servers 2
      = 1 - $\frac{t \quad s \quad d \quad ti \quad 2}{t \quad o \quad ti}$
      = 1 - $\frac{1}{3}$
      = 0,95

2. Simulation using*Sofware* ARENA 14.0
   a) Inter–Arrival Time Analyzer (WAD) Input Result



Picture 9. Input Analyzer WAD

The data entered in the input analyzer is obtained from the time between the arrivals of the consumers. The results show that the inter-arrival time data that we collect is distributed in Beta with the expression -0.5 + 6 * BETA(0, 0) and Square Error: 0.003529

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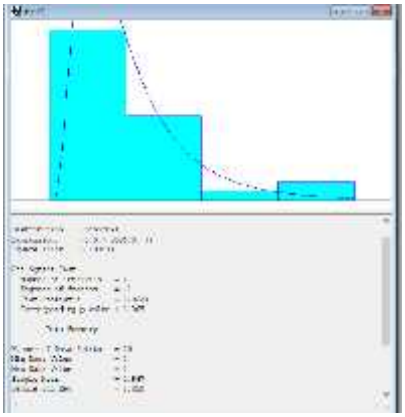
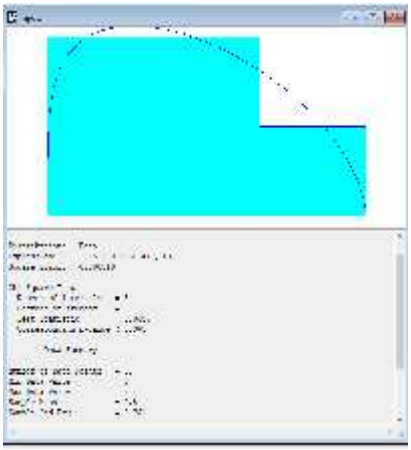
1. Server Service Time 1



Picture 10. Server Service Analyzer Input Result 1

Then the data entered in the input analyzer is obtained when the customer service server 1 is. The result is that the inter-arrival time data that we collect has a Lognormal distribution with Expression -0.5 + LOGN(0, 0) and Square Error: 0.003574

2. Server Service Time 2

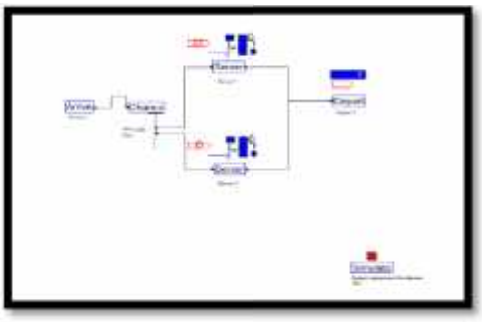


Picture 11. Server Service Analyzer Input Result

Then the data entered in the input analyzer is obtained when the customer service server 2 is obtained. The result is that the inter-arrival time data that we collect is distributed in Beta with Expression -0.5 + 3 * BETA(0, 0) and Square Error: 0.000510

3. Queue System Model on ARENA14.0. Software

The following shows the overall queuing system in the Arena 14.0 application.



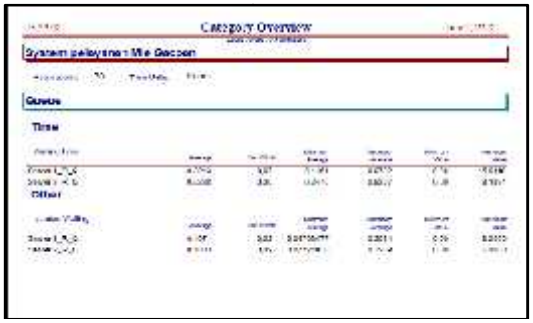
Picture 12. ServiceQueue System for Mie Gacoan Gresik Branch

i. ***Result of ARENA 14.0 Software***

Picture 13. Key Performance Indicator Result

From the results of running the service simulation model at the Mie Gacoan Restaurant, Gresik Branch, the following results were obtained:

Number Out, on average, is 333 entities that come out of the system, meaning that from the queue data sample that we took and then processed, this service system, on average, can serve 333 visitors in a unit of time



Picture 14. Result of Service Queuing System for Mie Gacoan Gresik Branch

From the picture above, it can be seen that the Queue Waiting time, from the simulation results of ARENA - the average waiting time on server 1 is 0.3243 seconds. So on server 1, the

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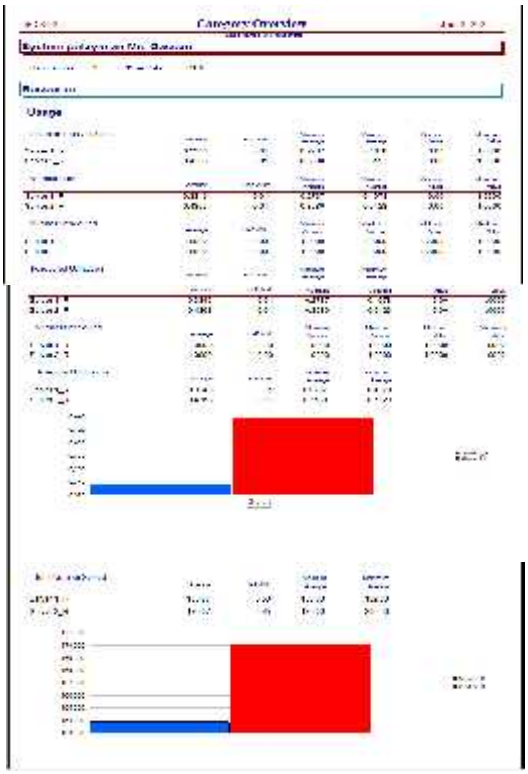
average customer queues for 0.3243 seconds. While the waiting time on server 2 is 0.5238 seconds, meaning that on server 2, the average customer queues for 0.5238 seconds.



Picture 15. Result of the Service QueueSystem for the Mie Gacoan Gresik Branch

1. Resource Instantaneous Utilization, from the ARENA simulation results, the average queue on server 1 is 0.3346 people, and the average queue on server 2 is 0.4363
2. Resource Number Busy from the ARENA simulation results, the average queue on server 1 is 0.3346 people, and the average queue on server 2 is 0.4363
3. Resource Number Scheduled from the ARENA simulation results, the average queue on server 1 is 1 person, and the average queue on server 2 is 1 person.
4. Resource Scheduled Utilization, from the ARENA simulation results, the average queue on server 1 is 0.3346 people, and the average queue on server 2 is 0.4363
5. Resource Total Number Seized, from the ARENA simulation results, the average queue on server 1 is 163.87 people, and the average queue on server 2 is 170.07 people.

V. CONCLUSION

Based on the results obtained from observing the service at the Mie Gacoan Restaurant, Gresik Branch, more precisely on Jl. Panglima Sudirman No. 161, Kramatandap, Gapurosukolilo, Kec. Gresik, Gresik Regency, East Java 61111, the following conclusions can be drawn: The average inter-arrival time is 27.49 seconds. The average service time on server 1 is 70.57 people/second and on server 2 is 83.3 people/second. The average customer wait (queuing time) on server 1 is 396.3 seconds, and on server 2 is 796.3 seconds. The average server wait (delay time) on server 1 is 9 seconds and on server 2 is 5.4 seconds. The average queue length on server 1 is 0.012 seconds/person and on server 2 is 0.0013 seconds/person. The average customer time in the system is 76.93 seconds/person.

The probability of a customer waiting in the system on server 1 is 50% and on server 2 is 50%. System availability on server 1 is 0.91 and on server 2 is 0.95

VI. SUGGESTION

Suggestions for further practitioners so that research can run smoothly are as follows:

1. Read more literature or references related to the system to be observed so as not to experience confusion when taking data in the field so that the data taken is appropriate and sufficient.
2. Pay attention to the assistant's explanation of the mechanism and method of implementation as well as how to operate the ARENA 14.0 software so that there are no problems when managing data.
3. Understand the ARENA 14.0 software that is used to assist data processing at the time so that it is easy to model the queue system simulation

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Implementation of LEAN Warehousing to Reduce Waste in Warehouse CV.X

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***Abstract*— CV. X is a company engaged in the manufacturing of various types of clothing. CV. X produces various types of clothing such as shirts, jackets, pants, and accessories. The warehouse at CV. X shows an increase when storing warehouse goods. There is waste in the form of waiting caused by goods waiting for operators to move them. There is another indication of waste in the form of a high level of transportation activities in the warehouse. This research aims to help the company minimize waste in the warehouse process. This research uses the Lean Warehousing method, and improvement proposals involve implementing the 5S methodology. From the waste in the warehouse process at CV. X, the highest type of waste is waiting, with an average weighting score of 4.4, followed by excess inventories with an average weighting score of 4, and transportation with an average weighting score of 3.6. One improvement proposal suggested is to clean and rearrange the items stored in the warehouse.**

Keywords: **Warehouse, Lean warehousing, 5s.**

I. INTRODUCTION

In today's modern and highly competitive industry, there is tight competition that leads to an increased role of warehousing functions in production activities, especially in planning and managing warehouse systems. Warehousing has a crucial function, namely storing products(Rizkya et al., 2021), anticipating fluctuating demand patterns(Nurhasril et al., 2023), maintaining price stability(Wang & Wang, 2019), preserving product quality (Kamali et al., 2019), ensuring product securities, especially for food(Prananingtyas & Zulaekhah, 2021; Van Geest et al., 2021), and serving as a place for consolidation among buyers(Ding & Kaminsky, 2020; Lin et al., 2020). One of the actions that companies can take is to analyze and minimize waste that occurs in the warehouse (Purba et al., 2021).

A warehouse is a place designed to store goods, typically raw materials going through production activities or finished products ready to be distributed to consumers(Saputra & Sihombing, 2020).

CV. X is a manufacturing company that produces various types of clothing, such as shirts, jackets, pants, and accessories. CV. X has a brand named "Lee Conti," usually marketed in stores like Ramayana, Matahari, and several other clothing outlets. The warehouse at CV. X involves several activities. The first activity is product receiving, where newly arrived goods are accepted. The second activity is product inspection, where specifications, quantity, and the condition of the goods are checked. Following that is the product storage process, where goods are stored in the warehouse. Next is the order fulfillment process, where orders needed by the production division are fulfilled. Finally, there is the delivery process, which involves shipping ordered goods from the production division to respective workstations.

The warehouse at CV. X shows an increase in storage activities, including storing unnecessary items in the warehouse. This leads to a full warehouse and makes it difficult for warehouse operators to find space for newly arrived goods. There is waste in the form of waiting, caused by goods waiting for operators to move them. Waiting for waste also occurs when goods are waiting for warehouse operators to find available space in the warehouse for storage.

Another indication of waste is the high level of transportation activities in the warehouse. One issue is related to manual material handling performed by operators. The

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movement of goods is done without using tools, requiring more time and energy. By conducting Lean Warehousing analysis at the warehouse in CV. X, it is hoped that the company can minimize waste. Lean warehousing is a concept aimed at minimizing waste in the upstream or downstream supply chain (Prasetyo et al., 2021).

II. METHODOLOGY

There are several stages to be conducted in the Lean Warehouse method, including:

A. Data Collection

The data collected in this research includes information related to types of waste and can be seen in Table 1.

Table 1 Types of waste

Types of waste	Respondent					Average	Ranking
	1	2	3	4	5		
Waiting	5	4	4	5	4	4,4	1
Excess Inventories	4	4	5	4	3	4	2
Transportation	4	4	3	3	4	3,6	3
Excess Processing	4	4	3	3	3	3,4	4
Unnecessary Motion	3	2	3	4	3	3	5
Defect	3	3	3	2	3	2,8	6
Overproduction	2	3	3	3	2	2,6	7

B. Preparation of Initial Big Picture Mapping

Big Picture Mapping serves to visually illustrate production activities and the flow of information within the company (Hafiz & Budiawan, 2019). Initial big picture mapping in CV. X's warehouse can be seen in Figure 1 below

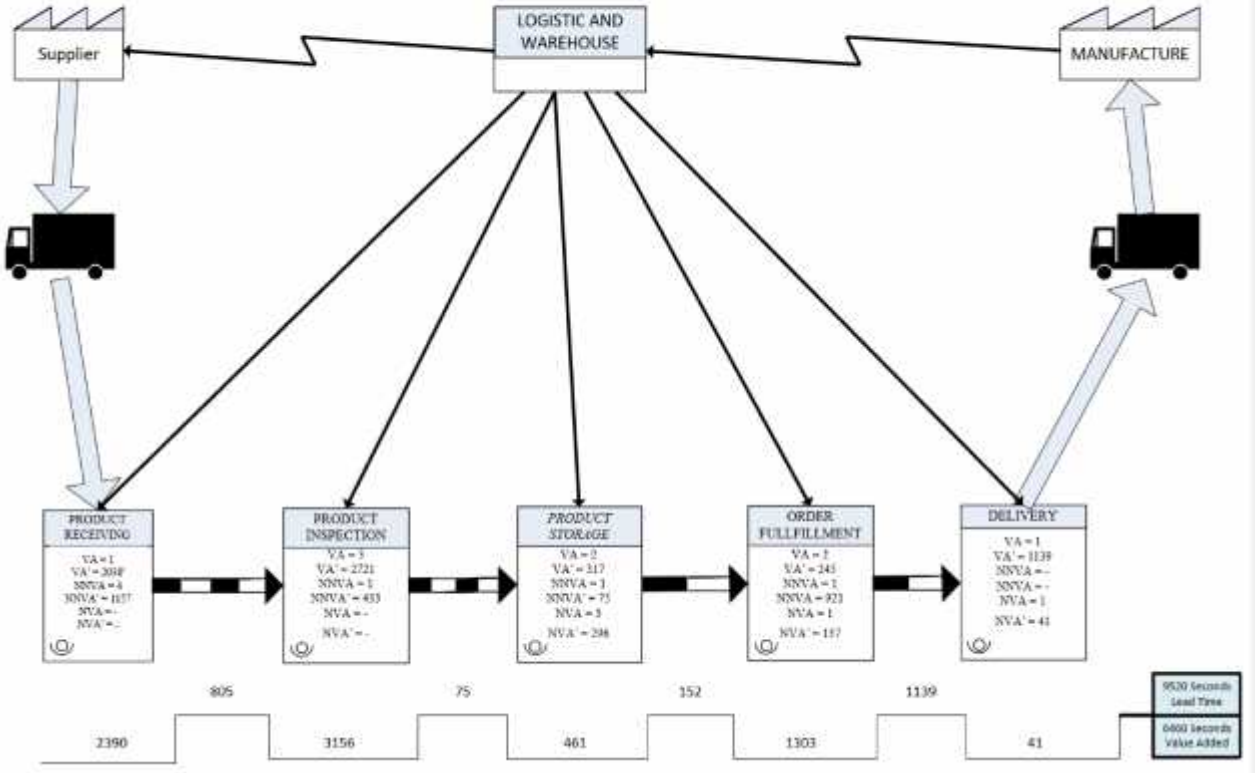

Figure 1. Initial Big Picture Mapping

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C. Data Processing Using VALSAT

Value Stream Analysis Tools (VALSAT) is a tool designed to select tools from the identification of process flow maps that will be used as a reference for identifying waste (Ariska & Aryanny, 2023).

D. Preparation of Process Activity Mapping (PAM)

Process Activity Mapping (PAM) is a tool used to identify the stages of a process, enabling the identification and minimization of waste (Pogowonto & Amrina, 2020).

E. Creation of Fishbone Diagram

A cause-and-effect diagram or fishbone diagram is a tool used for analyzing factors causing a problem to occur (Armyanto et al., 2020).

F. Improvement proposal using5S

5S is a method designed to organize the workplace by policies and standards, while improving discipline levels (Aulia, 2021).

III. RESULT AND DISCUSSION

A. Data Processing Using VALSAT

Table 2 shows the results of the Valsat score calculation that has been conducted.

Table 2 Valsat score calculation

Types of waste	Weight	VALSAD						
		PAM	SCRM	PVF	QFM	DAM	DPA	PS
Defect	2,8	2,8	-	-	25,2	-	-	-
Overproduction	2,6	2,6	7,8	-	3	7,8	7,8	-
Waiting	4,4	39,6	39,6	4,4	-	13,2	13,2	-
Transportation	3,6	32,4	-	-	-	-	-	3,6
Unnecessary inventory	4	12	36	12	-	36	12	4
Unnecessary motion	3	27	3	-	-	-	-	-
Overprocessing	3,4	30,6	-	10,2	3,4	-	3,4	-
Total		147	86,4	26,6	31,6	57	36,4	7,6

B. Preparation of Process Activity Mapping (PAM)

The PAM result can be seen in Table 3 and the mapping of activity categories can be observed in Table 4.

Table 3 PAM Result

Activity	Freq	Percentage	Time (s)	Percentage
Operation	9	45%	3.323	34,91%
Transportation	4	20%	2.171	22,8%
Inspection	3	15%	3.642	38,26%
Storage	1	5%	165	1,73%
Delay	3	15%	219	2,3%
Total	20	100%	9.520	100%

Table 4 Activity percentage

Types of act.	Freq	Percentage	Time (s)	Percentage
VA	8	40%	6.460	67,86%
NVA	5	25%	428	4,5%
NNVA	7	35%	2.632	27,64%
Total	20	100%	9.520	100%

C. Creation of Fishbone Diagram

The fishbone diagram for the three highest waste can be seen in Figure 2-4.

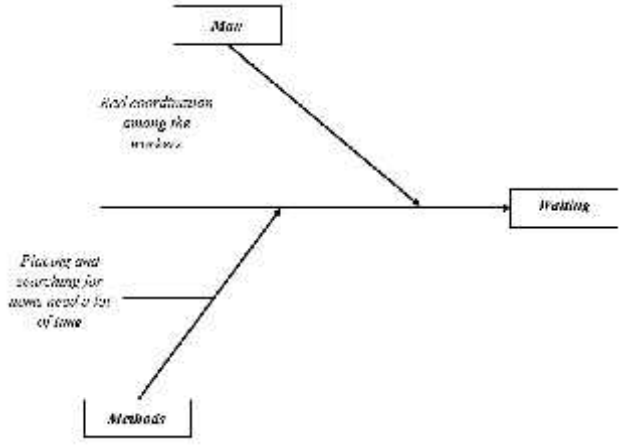

Figure 2. Fishbone for waste Fishbone Diagram for Transportation

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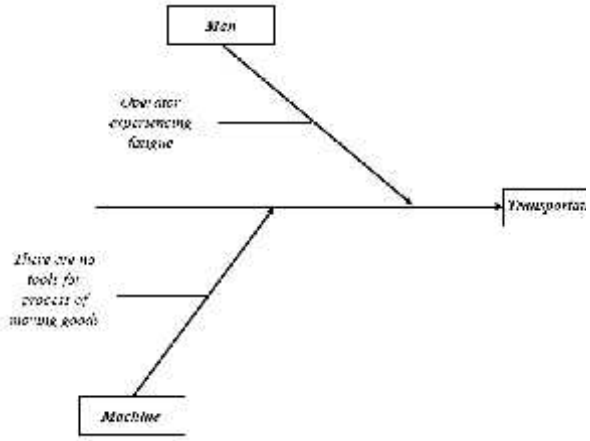

Figure 3. Fishbone for transportation

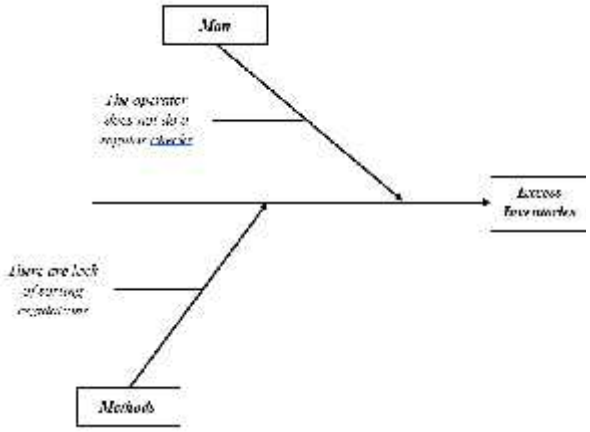

Figure 4. Fishbone for excess inventory

D. Improvement proposal using5S

The improvement proposals provided using the 5S method can be seen as follows:

1) Seiri (Sorting) Activities can be divided into several stages. In the first stage, a thorough cleaning is performed in the warehouse area. In the second stage, stratification management is conducted to identify the importance of each item. In the third stage, red labeling is applied.
2) Seiso (Sweeping) In Seiso (sweeping), macro-cleaning or comprehensive cleaning of the warehouse area is carried out, as well as micro-cleaning, which involves cleaning the stored items in the warehouse.
3) Seiton (Systematic Arrangement) In Seiton (systematic arrangement), the classification of item usage frequency is performed, storage locations are determined, and labels are applied to the items.
4) Seiketsu (Standardization) In Seiketsu (standardization), the creation of standardization in the warehouse area is undertaken, and daily inspections are conducted to ensure the previous 3S are functioning well.
5) Shitsuke (Sustaining) In Shitsuke (sustaining), the creation of visual displays, the development of 5S checklists, and training for the implementation of 5S are carried out.

E. Proposed Big Picture Mapping

After the improvement proposals were implemented using 5S, the creation of the proposed big-picture mapping was carried out to determine the total time savings obtained after minimizing the arising wastes.The proposedbig-picture mapping can be seen in Figure5 below. From the picture below we can conclude that the warehouse process lead time has decreased from the initial 9,520 seconds or 159 minutes to 8,878 seconds or 148 minutes.

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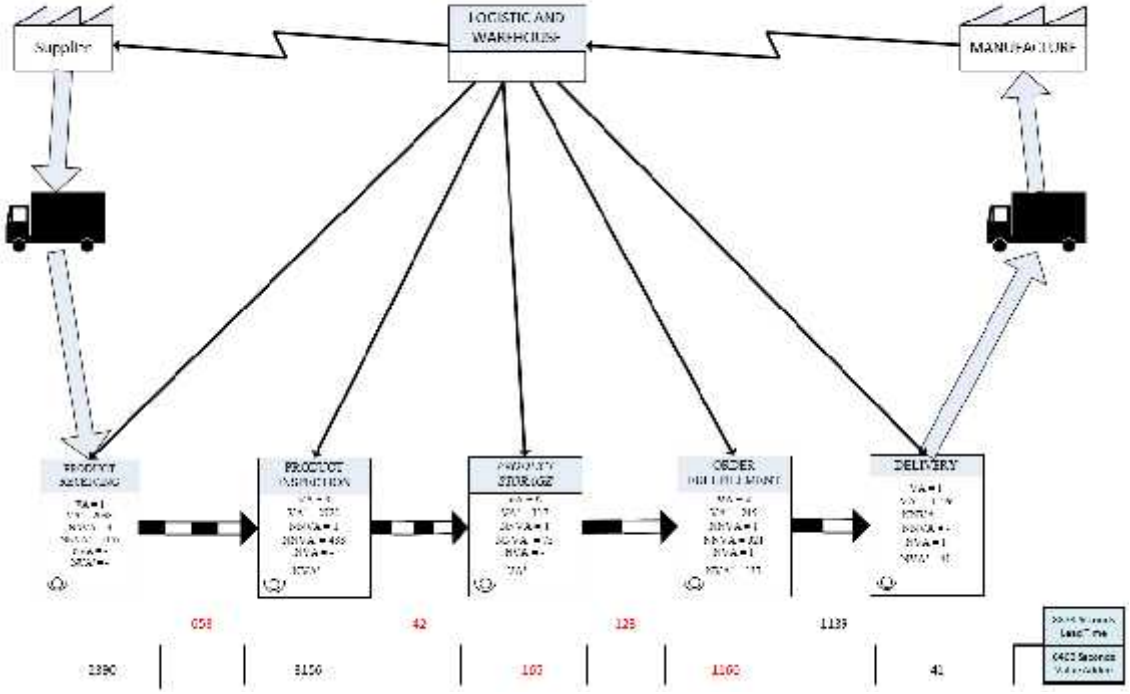

Figure 5. Proposed Big Picture Mapping

IV. CONCLUSION

From the waste in the warehouse process at CV. X, the highest type of waste is waiting with an average weighting score of 4.4, followed by excess inventories with an average weighting score of 4, and transportation with an average weighting score of 3.6.There is a reduction in the warehouse process time resulting in time savings of 6,9%. In the Seiri (Sorting) phase, a massive cleanup, stratification management, and red labeling were carried out. In the Seiso (Sweeping) phase, macro or comprehensive cleaning of the entire warehouse and micro-cleaning of items in the warehouse were performed. In the Seiton (Systematic Arrangement) phase, the classification of item usage frequency, determination of storage locations, and labeling of items were implemented. In the Seiketsu (Standardization) phase, the creation of standardization in the warehouse area and daily inspections to ensure the previous 3S (Seiri, Seiso, Seiton) were functioning well were conducted. In the Shitsuke (Sustaining) phase, visual displays, the development of 5S checklists, and training for the implementation of 5S was carried out.

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Planning of Marketing Strategy based on the Results of Analysis of Profitability Ratios and Activity Ratios (Case Study: PT Semen Indonesia Tbk)

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Abstract - PT. Semen Indonesia (Persero) Tbk is a manufacturing company engaged in cement production. This product is widely used for infrastructure development, so good cement quality is expected. Producers are expected to produce cement according to consumer expectations and needs. The aim is to obtain high sales turnover. To meet sales targets, a good strategy is needed that is based on real conditions in the field. One of them is financial performance. Based on the financial performance report, especially the profit and activity ratios, will be analyzed and used as a reference in determining sales strategies. The results of the financial performance analysis and SWOT analysis can formulate a sales strategy design.

Keywords: Financial Performance, profit ratio, activity ratio, SWOT, IFE, EFE

I. Introduction

Financial achievements are the result of the company's operational activities which are displayed in the form of financial numbers. The company's financial operating results for the current period can be compared with the following three points (Karyoto, 2017).

1) Economically last season's performance.
2) balance sheet and income statement.
3) the average financial results of similar companies.

Meanwhile, according to Sujarwen (2019) measuring financial performance also means comparing standards influenced by the company's financing performance, there are 5 (five) indicators used to evaluate a company's financial performance including liquidity ratios, solvency/leverage ratios, activity ratios, profitability/profit and market value.

PT. Semen Indonesia (Persero) Tbk is a manufacturing company engaged in cement production. Cement is a product used for infrastructure development, so the cement quality is expected to be good. Producers are expected to produce cement according to consumer expectations and needs so that consumers feel satisfied. Therefore, PT. Semen Indonesia (Persero) Tbk produces various types of high-quality cement to meet consumer needs.

Through its resources and expertise, PT. Semen Indonesia (Persero) Tbk is always ready to provide the best service. Through sustainable technological discoveries, high-quality building material products, and solutions to professional services from start to finish.

The object of this research is a company active in the cement industry thatwas listed on the Indonesia Stock Exchange (BEI) in 2009-2016, namely PT Semen Indonesia Tbk. This research was conducted to analyze financial reports, especially cash flows and financial report notes.Financial reports are required to describe all relevant sales financial data for a certain period and procedures have been established by the provisions so that financial reports can be compared so that the level of accuracy of the analysis can be justified. Analysis of financial reports from 2018-2022 will be the main subject of research because they have been published by the company concerned. The sales financial data is analyzed further so that information will be obtained regarding income increases that affect or reduce the company's bottom line so that it

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can be used for decision-making (Arsita,2021).

Financial reports are said to be insufficient to accurately assess company performance, therefore, a thorough analysis of financial reports for decision-making is needed to evaluate financial illustrations to assess the company's solvency, leverage, and profitability so that decisions are informed (Hutabarat, 2021). Based on the existing report, the problem of this research refers to how to analyze the utility and efficiency of asset use in decision-making activities in a company using activity and profitability ratios. The decision in question is planning a sales strategy to increase sales turnover.

II. Method

The data analysis in this research uses calculations of financial data on product sales in determining sales strategies by analyzing financial performance ratios, including the profile ratio and the activity ratio. The financial report used is the 2018-2022 financial report. The sales financial data is analyzed further so that information will be obtained regarding income increases that affect or reduce the company's bottom line so that it can be used for decision-making.

In the financial data process of PT. Semen Indonesia (Persero) Tbk is based on 2 calculation methods to determine the best sales strategy, namely the profile ratio and the activity ratio. The financial stability profile ratio to find the best value of company profits between 2018, 2019, 2020, 2021, and 2022 based on the results of the company's financial stability calculations, in the financial activity ratio to find the efficiency of the use of company assets between 2018, 2019, 2020, 2021, and 2022 is the best based on the results of activity calculations. The calculation results are used as a basis for determining sales strategies using SWOT analysis.

Profitability Ratio

The profitability ratio is used to calculate profits and the activity ratio is used to calculate the use of assets in considering company decisions to determine sales strategies (Elly, 2018). According to Kasmir (2011) in Alfitri (2018), the profitability profile ratio is the ratio used to assess the stability profile of a company. The profitability ratio also measures the effectiveness of corporate governance. The level of the financial ratio is depicted by the cumulative profit from sales and investment income (Desmayenti, 2021). This is related to the efficiency of bills. According to Syahrial (2013), Rasio profitability measures the ability to generate profits from a business through the use of assets or capital.Profitability ratios include:

a. Return On Aset
   Return on assets is used to calculate how much of a company's assets can be used to generate profit or profit.

$$r = \frac{\text{Net Profit After Tax}}{\text{Total assets}}$$

b. Net ProfitMargin
   Net Profit Margin is a profit measure that compares profit after interest and taxes with sales. The more NPM is used, the better the company's performance will be, Rhamadana, (2016ua $i = \frac{NPAT}{S}$

Activity Ratio

According to Prihadi (2012), activity ratiomeasures the efficient use of company assets. The financial ratio is often called the turnover ratio. In general, the higher the turnover, the more efficient the use of company assets. According to Harahap (2010), the activity ratiodefines the activities carried out to carry out its activities related to sales, purchases, and other activities. According to Kasmir (2011) in Alfitri (2018), the activity ratio refers to how the efficiency of asset use in a company can be measured. The use of a company's assets can be analyzed according to the relationship

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between the amount of profit that can be formulated about the various assets used to generate profits (Andy, 2016). The activity ratio includes:

1. Total Asset Turnover
   Total Asset Turnover is a ratio used to calculate the efficient use of a company's total assets. The higher the ratio, the better it is. On the other hand, if the ratio goes down, then the results will get worse.

$$\text{Total Asseturnover} = \frac{\text{Sales}}{\text{Total Assets}}$$

2. *Inventory Turnover*
   According to Wijaya (2017), Inventory Turnover is the turnover of inventory that shows how often inventory is sold and held in each financial period.

$$In \quad Tu \quad = \frac{S}{S}$$

Internal Environmental Analysis

According to Umar (2008) in Indri et al (2020), the external environment is a process carried out by strategic planning to monitor the external environmental sector in determining opportunities and threats for the company. Within the company, several internal factors can influence the implementation of marketing strategies at PT. Semen Indonesila (Persero) Tbk. The various types of internal factors are strengths and weaknesses.

External Environmental Analysis

According to David (2010) in Indri et al (2020), the internal environment is the company's strengths and weaknesses in financial functional areas, including management, marketing, finance/accounting, and management information systems. Within the company, several external factors can influence the implementation of strategic marketing at PT. Semen Indonesila (Persero) Tbk. The various external factors are opportunities and threats.

SWOT analysis

SWOT analysis is the analysis of various factors systematically to formulate a company strategy, the analysis is based on logic that can maximize strengths and opportunities but simultaneously can minimize weaknesses and threats based on Rangkuti (2001). The financial analysis is based on the assumption that an effective strategy will maximize existing strengths and opportunities and minimize weaknesses and threats. The enormous impact of the design of a successful strategic and environmental analysis of business provides the information needed to identify opportunities and threats within the company.

IV.Results and Discussion

Analysis of financial data of PT. Semen Indonesia (Persero) Tbk uses 2 calculation methods to determine the best sales strategy, namely the profile ratio and the activity ratio. In the financial profile ratio, the financial stability ratio is used to find the company's profit value, while in the financial activity ratio, it is used to find the efficiency of the use of the company's assets.

Profitability Ratio

Profitability Ratio is a measuring tool used by a company to assess or measure the effectiveness of management performance (Erica, 2018) andErica,2016).

a. Return On Asset (ROA)

Return on assets is used to calculate how much of a company's assets can be used to generate profit or profits. Return On Assets PT. Semen Indonesia (Persero) Tbk can be seen in the following table 1.

Table 1*Return On Asset*

Year	Net profit	Total Assets	ROA
2018	3.085.704	51.155.890	0,060
2019	2.371.233	79.807.067	0,030
2020	2.674.343	78.006.244	0,034
2021	2.082.347	76.504.240	0,027
2022	2.499.083	82.960.012	0,030

Source: Company data and data processing

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Based on the calculations in Table 1 above, it can be seen that ROA fluctuates from year to year. From 2018 to 2019 ROA decreased by 0.30. From 2019 to 2020 ROA experienced an increase of 0.04. From 2020 to 2021 there was a decrease of 0.07. And from 2021 to 2022 ROA will increase by 0.03. So, from year to year, the ROA value experiences normal changes, namely increases and decreases in the ROA value each year.

Figure 1 *Return on assets*

b. Net ProfitMargin

Net Profile Margin is a profit measure that compares profit after interest and tax with sales. The more NPM is used, the better the company's performance will be. Net Profit Margin PT. Semen Indonesia (Persero) Tbk can be seen in the following table 2.

Table2*Net ProfitMargin*

Year	Net Profit	Capital	NPM
2018	3.085.704	32.736.296	0,094
2019	2.371.233	33.891.924	0,070
2020	2.674.343	35.653.335	0,075
2021	2.082.347	39.782.883	0,052
2022	2.499.083	47.239.360	0,053

Source: Company Data

Based on Table 2 and above, it can be seen that NPM fluctuates from year to year. From 2018 to 2019, NPM decreased by 0.24. From 2019 to 2020 NPM experienced an increase of 0.05. From 2020 to 2021 there was a decrease of 0.23. And from 2021 to 2022 the NPM will increase by 0.01. So, from year to year, the NPM value experiences a significant change, which occurs from 2020 to 2021, namely the decrease in the NPM value at that time, and for other things, there is a spike and a normal decrease in the NPM value.

Activity Ratio

The activity ratio is the level at which a company uses and optimizes company assets.

a. Total Asset Turnover

Total Asset Turnover is a ratio used to calculate the efficient use of a company's total assets. Total Asset Turnover PT. Semen Indonesia (Persero) Tbk can be seen in the following table 3.

Table 3*Asset Turnover*

Year	Sales	Total Assets	Asset Turnover
2018	4.880.635	51.155.890	0,095
2019	6.185.043	79.807.067	0,077
2020	5.648.243	78.006.244	0,072
2021	4.974.004	76.504.240	0,065
2022	4.625.474	82.960.012	0,056

Source: Company Data

Based on Table 3 above, it can be seen that asset turnover fluctuates from year to year. From 2018 to 2022 there was a decrease in the level of interest to 0.39. There is no change in the value of asset turnover each year to increase, but it experiences a decrease each year.

Figure 2 *Asset Turnover*

b. Inventory Turnover

Inventory Turnover is an inventory turnover that shows how often inventory is sold and stored in each financial period. Inventory Turnover PT. Semen Indonesia

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(Persero) Tbk can be seen in the following table4.

Based on Table 4 above, it can be seen that asset turnover fluctuates from year to year. From 2018 to 2019 there was an increase of 0.66. From 2019 to 2022 there was a decrease of 0.126. The largest value of the investment turnover value occurred in 2019 amounting to 0.371 and the smallest value of the investment turnover value occurred in 2022 amounting to 0.245.

Table 4 Inventory Turnover

Year	Sales	Inventory	Inventory Turnover
2018	4.880.635	16.007.686	0,305
2019	6.185.043	16.658.531	0,371
2020	5.648.243	15.564.604	0,363
2021	4.974.004	15.270.235	0,326
2022	4.625.474	18.878.979	0,245

Source: Company Data

Internal Environmental SWOT

In an industrial company, several internal factors can influence the implementation of sales strategies at PT. Semen Indonesia (Persero) Tbk. The various types of external internal factors are strengths and weaknesses. The explanation is as follows:

a. *Strength*
   1. Abundant stock of raw materials.
   2. Guaranteed product quality.
   3. Distribution reach throughout Indonesia which has strategic company locations and is supported by distributors to guarantee the entire market share.
   4. Consumers see the inherent brand image.

b. *Weakness*
   1. The company still has excess cement supply in several distribution areas.
   2. Lack of promotional services to the community.
   3. Price policy still depends on daily market price movements.
   4. There are differences of opinion regarding determining retail cement prices.

SWOT External Environment

In a commercial company, several external factors can influence the implementation of strategic sales at PT. Semen Indonesia (Persero) Tbk. The various external external factors are opportunities and threats. The explanation is as follows:

a. *Opportunities*
   1. Abundant supply of raw materials at any time when needed.
   2. Offer product prices below competitors.
   3. There are huge business opportunities in the logistics industry for subsidiaries.
   4. Increase domestic demand and increase market share.

b. *Threats*
   1. There have been trade wars between local and foreign competitors on a large scale.
   2. Unstable political development.
   3. Limited supply of natural limestone raw materials.
   4. Limited government regulations through anti-monopoly laws regarding market share expansion

IFE Matrix

The IFE Matrix shows the company's internal characteristics in the form of strengths and weaknesses which are calculated based on ratings and weights. In the ILFE Matrix calculations calculate the weight using the formula

$$B = \frac{\text{Rating}}{\text{Total Rating}}$$

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Table 5. IFE Matrix (*Internal Factor Evaluation*).

Factor Internal	Code	Weight	Rating	Skor Bobot
Strength				
1. Stocks of raw materials are abundant.	S1	0,125	3	0,375
2. Guaranteed product quality.	S2	0,125	3	0,375
3. Distribution reach throughout Indonesia which has strategic company locations and is supported by distributors to guarantee the entire market share.	S4	0,167	4	0,667
4. Consumers see the inherent brand image.	S5	0,167	4	0,667
Total 1				2,083
Weakness				
1. The company still has excess cement supply in several distribution areas.	W1	0,125	3	0,375
2. Lack of promotional services to the community.	W2	0,083	3	0,375
3. Pricing policy still depends on daily market price movements.	W3	0,083	2	0,167
4. Limited government regulations through anti-monopoly laws regarding expanding market share.	W4	0,125	2	0,167
Total 2				1,083
Total		1		1

Evaluate PT's strength factors and weakness factors. Semen Indonesia (Persero) Tbk uses the Internal Factor Evaluation (ILFE) model. The aim is to identify the relationship between the company's strengths and weaknesses. Based on Table 5, the total weight of the ILFE matrix results is 1, and the weight score is 1. For detailed results, the strength weight score is 2,083 and the weakness weight score is 1,083 (Strengths > Weaknesses). Shows that the strength assessment results obtained by PT. Semen Indonesia (Persero) Tbk is still better than its weaknesses.

The final strength factor can be known as the strength measured by PT. Semen Indonesia (Persero) Tbk is in first place in distribution distribution throughout Indonesia which has a strategic company location and is supported by distributors to guarantee the entire market share and brand image attached to consumers with a calculated score of 0.667. Then the second and final ranking is abundant raw material stock and guaranteed product quality with a score of 0.375. Meanwhile, the weaknesses are that in first place the company still has an excess supply of cement in several distribution areas and a

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lack of promotional services to the community with a score of 0.375. The second and last place is the price policy which still depends on market price movements every day and there are differences of opinion in determining retail cement prices with a score of 0.167.

EFE Matrix

The EFE matrix is used to determine the magnitude of the influence of the company's external factors. The EFE matrix describes the company's opportunities and threats which are calculated based on ratings and weights. In calculating the IFE Matrix to calculate the Weight using the formula

$$Weight = \frac{\text{Rating}}{\text{Total Rating}}$$

$$Score = Weight \times Rating$$

Table 6. EFE Matrix (*Eksternal Factor Evaluation*).

Factor Eksternal	Code	Weight	Rating	Weight Score
Opportunities				
1. Abundant supply of raw materials at any time when needed.	O1	0,125	3	0,375
2. Offer product prices below competitors.	O2	0,167	4	0,667
3. There are huge business opportunities in the logistics sector for subsidiaries.	O3	0,125	3	0,375
4. Increasing domestic demand and increasing market share.	O4	0,125	3	0,375
Total 1				1,792
Threats				
1. There have been trade wars between local and foreign competitors on a large scale.	T1	0,167	4	0,667
2. Unstable political development.	T2	0,125	3	0,375
3. Limited supply of natural limestone raw materials.	T3	0,083	2	0,167
4. Limited government regulations through anti-monopoly laws regarding expanding market share.	T4	0,083	2	0,167
Total 2				1,375
Total		1		0,417

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Figure 3 IE matrix shows the results of IFE and EFE calculations for the company.

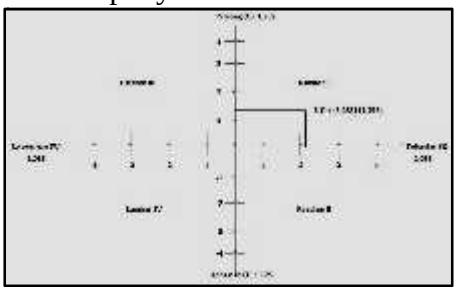

Figure 3 SWOT Analysis Quadrant Diagram

The results of the analysis place the position point of PT. Semen Indonesia (Persero) Tbk in quadrant I of the SWOT analysis diagram. The position in Quadrant I explains that PT. Semen Indonesia (Persero) Tbk has great opportunities and strengths so that it can take advantage of existing opportunities. This condition supports aggressive growth policies (growth-oriented strategy). So it does not rule out the possibility of PT. Semen Indonesia (Persero) Tbk to expand the market share of cement products that can be offered.To see the strengths used to take advantage of the opportunities that PT. Semen Indonesia (Persero) Tbk which can shape the company's marketing strategy in this way:

1. Utilizing abundant raw material stocks to be able to produce at any time.
2. Utilize strategic locations to increase distribution reach to meet domestic demand and market share.
3. Increase product promotion by utilizing brand image, and product quality that offers prices below competitors to become a business opportunity in the logistics sector for subsidiaries.

V. Conclusion

The calculation of the profit profile ratio which is based on return on assets (ROA) shows the highest value that occurred in 2018 where the net profit reached 3,085,704 with capital of 51,155,890 and ROA reached 0.060, and the net profile margin (NPM) which has the highest value in 2018 where the net profit reached 3,085,704 with capital of 32,736,296 and NPM reached 0.094. In the calculation of the activity ratio based on total asset turnover, the highest value was recorded in 2018, where total sales reached 4,880,635 with total assets of 51,155,890 and asset turnover reached 0.095, and inventory turnover was the highest value in 2019 before Covid-19. 19 where total sales reached 6,185,043 with an inventory of 16,658,531 and inventory turnover reached 0.371.

Marketing strategy at PT. Semen Indonesia (Persero) Tbk is:

1. Utilizing abundant stocks of raw materials to be able to produce at any time.
2. Utilizing strategic locations to increase distribution reach to meet domestic demand and market share.
3. Increasing product promotion by utilizing brand image, and product quality that offers prices below competitors to become business opportunities in the logistics sector in subsidiaries.

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Level of Preference Surabaya Students in Choosing Instant Noodle Using Linier Regression Method

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Abstract—The current rapid development of the times demands very high levels of activity, and of course to be able to carry out these various activities requires energy whose main source of energy is food. Currently, many students want to be more practical in consuming food, one of which is instant noodles. This research aims to determine the relationship between taste, ease of purchase, and price on the level of preference of Surabaya students for consuming instant noodles. The type of research is linear regression. The population in this study were students from the city of Surabaya and the sample was 38 people. The data collection technique is carried out by filling out a questionnaire. Next, the data was analyzed via linear regression. The results of the research concluded that taste, ease of purchase, and price both influence the level of student preference for consuming instant noodles. The factor that has the lowest influence on students' preference for consuming instant noodles is ease of purchase. Students' knowledge of taste and price is relatively good and the availability of instant noodles among students is quite good.

Keyword: Consuming; instant noodles; College Student

I. INTRODUCTION

An age of such rapid development today demands a very high level of activity, and of course, to be able to carry out such activities requires energy which is the primary source of energy from food. As a human being, it can`t be denied that food is something interesting. But nowadays, with increasing daily activity, eating factors are often overlooked, it can lead to a shortage of energy in the body that can hinder the performance of various activities. These adults are making it harder for people to enjoy a relaxed meal at lunchtime, because many feel too lazy to go out to eat, this is because of traffic jams.

Along with the changes in the business world, consumers also tend to be more selective about the product they are going to buy. Consumers are attracted to buy the product when they feel that the product has advantages and can satisfy their desires. One of them is my instant product.

Instant noodles are generally produced by the food processing industry with technology and provide a variety of additives to preserve and taste the product. The product is known as one of the fast food products that are increasingly popular because of the ease of food serving. Similarly, for college students, this product is a fast food that is commonly consumed because of its affordable price, ease of obtaining, practicality in processing, and durable properties.

Indonesia is a country with a high rate of instantaneous rice consumption. Mi instant seems inseparable from the Indonesians anymore. Proved, Indonesian instantaneous consumption by 2022 rose to 990 million packs. Indonesia is the second most instantaneously consumed country in the world. Defeated China/Hong Kong, followed by Vietnam in third place. According to the official website of the World Instant Noodles Association (WINA), Indonesian instantaneous milk consumption in 2022 reached 14.26 billion packs. Up from the recorded year 2021 of 13.27 billion packets. Meanwhile, China/Hong Kong's recorded instantaneous milk Consumption climbed to 45.07 billion packages from the year 2021 which was 43.99 billion Packs. (cnbcindonesia.com, 2023). The fierce competition in Indonesia has attracted the intention of foreign producers to join and reconcile the Indonesian instantaneous meat industry.

The current competitive conditions that occur in the instant product, that the variety of

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instant products that exists at the momentencourages consumers to make identification in decision making when determining a taste, price, and ease of purchase that they believe meets the criteria of an instant product.

As far as the food processing industry one of the largest food and beverage producers in Indonesia is concerned, it has launched instantaneous mie products that have several advantages, namely, Mie made of high-quality ingredients, a variety of tasty flavors, and easy-to-serve.

Success as an instantaneous mie producer is indeed not apart from the good quality of the product and also the price factor that is affordable to the general public. In addition to the efforts that have been made to influence the consumer's purchasing interest, then in this case must understand the characteristics and needs of its consumer segment and stimulate how the product will try to attract consumer interest to buy especially in the city of Surabaya.

Consumers who make purchases on instantaneous mie products are currently experiencing rapid development. Consumer behavior wants to get a practical product. Among the practical products is instantaneous mie. Therefore, this study aims to analyze the influence of taste, ease of purchase, and price on the rate of preference in choosing bread in the area of Surabaya City.

II. METHOD

The method used in this research is the associative method. An associative method is a type of method used in research that aims to find out the relationship between two or more variables. Thus, this study serves to determine the influence of taste (X1), ease of purchase (X2), and price (X3) on the level of preference (Y) of college students in Surabaya in choosing instant noodles.

Variable

The variables used in this study are as follows:

- Independent Variable

  An independent variable is the type of variable that explains or affects other variables. In this study, three independent variables are used: X1 (Taste), X2 (ease of Purchasing), and X3 (Price).

- Dependent Variable

  The dependent variable depends on the type of variable described or influenced by the independent variable. In this study, the role of the dependent variable is Y (level of preference).

Collecting Data

The technique used in collecting data by filling out a questionnaire. The questionnaire is made by entering questions that cover taste, convenience, purchase, and level of liking. The aim is to obtain information as to how much influence the rate of liking of the respondents, college students of Surabaya, has in choosing instant noodles. In the questionnaire on the level of liking, respondents are given some ratings that represent the degree of liking, such as 1 representing “very disliked," 2 representing “not liked," 3 representing "normal," 4 representing "liked,” and 5 representing “very liked.”.

Data Processing Method using Multiple Linear Regression

Data processing is done using the SPSS application with the multiple linear regression method. Multiple linear regression is a statistical analysis technique that uses two or more independent variables (taste, ease of purchase, and price) as the outcome of a dependent variable (level of preference). The dual linear regression model to be used is:

$$Y = \alpha + \beta1X1 + \beta2\ X2 + \beta3\ X3 + e$$

Description:

Y = Level of Preference
α = Constanta
β1, β2, β3 = Coefficient variable X1, X2, X3
X1 = Taste
X2 = Ease of Purchasing
X3 = Price
e = Error

F Test

The double linear regression F test is used to determine whether independent variables simultaneously or jointly have a significant influence on dependent variables. The result of the F test shows whether the overall regression model is significant or not. In this study, the hypothesis formulated is as follows:

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H0: taste, ease of purchase, and price do not simultaneously influence the level of preference.
Ha: flavor, convenience of purchase, and price influence simultaneously influence the level of preference.

To be able to say whether or not it has a significant influence on the F test is based on:
Based on counting values and tables when:

- The value of $F_{count}>F_{table}$, then H0 is rejected and Ha is accepted, which means that the independent variables (taste, ease of buying, and price) simultaneously influence the dependent variable (level of preference).

- The value of $F_{count}<F_{table}$, then Ha is rejected and H0 is accepted, which means that the independent variables (taste, ease of buying, and price) simultaneously do not affect the dependent variable (level of preference).

Based on significant value, if :

- The significant value < 0.05, then H0 is rejected and Ha is accepted, which means that all independent variables (taste, ease of buying, and price) have a significant effect on the dependent variable.

- The significant value > 0.05 then Ha is rejected and H0 is accepted, which means that all independent variables (taste, ease of buying, and price) have no significant effect on the dependent variable.

T Test

The double linear regression The T-test is used to determine whether the regression coefficient is partially significant or not. This test is performed by testing each independent variable separately against the dependent variable. The results of the T-test show whether the independent variables have a significant influence on the dependent variable or not. To be said to have a significant influence or not on the T-test is based on:
Based on the count and table values if :

- The value of count> table, then the independent variable affects the dependent variable.
- The value of count < table, then the independent variable does not affect the dependent variable.

Based on significant value, if:

- The significant value < 0.05, means the independent variable has a significant effect on the dependent variable.

- The significant value > 0.05 means the independent variable has no significant effect on the dependent variable.

III. RESULT AND DISCUSSION

Result

- **Result of the Determination Coefficient Test**

Based on the results of the determination coefficient test in Table 1, it is known that the R-Square value is 0.545, or 54.5%. The value of this determination factor shows that the influence of taste variables (X1), ease of purchase (X2), and price (X3) on the level of preference variable (Y) is 54.5%, while the remaining 45.5% is influenced by other variables.

Table 1. Result of the Determination Coefficient Test

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	,738[a]	,545	,535	,26425

a. Predictors: (Constant), Harga, Kemudahan Membeli, Rasa
b. Dependent Variable: TingkatKesukaan_Y2

- **Result of the F Test**

The F test is performed to determine whether independent variables simultaneously or jointly have a significant influence on dependent variables. In this study, the independent variables are taste (X1), ease of purchase (X2), and price (X3), and the dependent variable is level of preference (Y). If the sig value is less than α (0,05), then the hypothesis submitted by Ha is accepted, and if the sig value is greater than al (0,05), then the hypothesis submitted by Ha is rejected. The hypothesis put forward in this study is as follows:
H0: taste, ease of purchase, and price do not simultaneously influence the level of preference.
Ha: flavor, convenience of purchase, and price influence simultaneously influence the level of preference.

Based on the results of the F test in Table 2. it shows that the Sig value is 0,000 < 0.05, and

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the known F_{count} is 13,583 >F_{table} is 2,883. So it can be concluded that H0 is rejected and Ha is accepted, which means that taste variables, ease of purchase, and price simultaneously have a significant influence on the level of preference.

Table 2. Result of the F Test

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig
1	Regression	2,845	3	,948	13,583	,0[illegible]
	Residual	2,374	34	,070		
	Total	5,220	37			

a. Dependent Variable: Tingkat Kesukaan (Y)
b. Predictors: (Constant), Harga, Kemudahan Membeli, Rasa

- **Result of the T-Test**

The T-test is used to determine whether the regression coefficient is partially significant or not. In this study, the independent variables are taste (X1), ease of purchase (X2), and price (X3), and the dependent variable is level of preference (Y). If the Sig. value is less than α (0,05), then the hypothesis submitted by Ha is accepted. The hypothesis put forward in this study is as follows:

- $H0_1$: The taste variable is not influenced by the variable of the level of preference.
  Ha_1: The taste variable influences the variables of the level of preference.
- $H0_2$: The ease of purchasing variable is not influenced by the level of preference.
  Ha_2: The ease of purchasing variable influences the variables of the level of preference.
- $H0_3$: The price variable is not influenced by the variable of the level of preference.
  Ha_3: The price variable influences the variables of the level of preference.

Based on the processing of the T-test in Table 3. it is obtained that:

- The T-test result on the taste variable (X1) obtains a count is -3,404 and a tableis -1,688 with a significant value is 0.02, so that the count>t_{table} (-3,404 < 2,028), and a significant value is smaller than 0.05 (0,002 < 0.05), then $H0_1$ rejects and Ha_1 accepts, which means that the sense variable has a significant influence on the preference level variable.
- The T-test result on the purchasing ease variable (X2) obtained a count value is 1,898 and a table is -1,688 with a significant value is 0,066 so that the count>t_{table} (1,898 < 2,028) and a significant value greater than 0.05 (0,066 > 0.05), then Ha_2 rejects and $H0_2$ can be concluded that the purchase ease variable has no significant influence on the preference rate variable.
- The T-test result on the price variable (X3) obtained a count value is -4,170 and a stable value is -1,688 with a significant value is 0,000, so that the count> table (-4,170 < 2,028) and the significant value is smaller than 0.05 (0,000 < 0.05), then $H0_3$ rejects and Ha_3 can be concluded that price variables have a significant influence on the preference level variable.

Table 3. Result of the T-Test

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	[illegible]	,3[illegible]		[illegible]	,000		
	Rasa	[illegible]	,034	,412	3,404	,002	,919	1,088
	Kemudahan Membeli	[illegible]	,075	,223	1,898	,066	,926	1,080
	Harga	[illegible]	,077	[illegible]	-4,170	,000	,973	1,028

a. Dependent Variable: Tingkat Kesukaan (Y)

Discussion

- Impact of Taste on the Level of Preference in Choosing Instant Noodles.
  Based on the test carried out based on the questionnaire filled out by the students in Surabaya who stated the effect of taste in choosing instant noodles, the count value is -3,404 and the significant value is 0,002 showing that the taste has a significant influence on the level of preference in choosing instant noodles.

- Impact of Ease of Purchasing on the Level of Preference in Choosing Instant Noodles.
  Based on the test carried out based on the questionnaire filled out by the students in Surabaya who stated the influence of taste in choosing instant noodles, the count value is 1,898 and the significant value is 0.066. The ease of purchasing had no significant influence on the level of preference in choosing instant noodles.

- Impact of Price on the Level of Preference in Choosing Instant Noodles.
  Based on the test carried out based on the questionnaire filled out by the students in Surabaya who stated the influence on taste in choosing instant

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noodles, the count value is -4,170 and the significant value is 0.000 showing that the price has a significant influence on the level of preference in choosing ainstant noodles.

- Impact of Taste, Ease of Purchasing, and Price on the Level of Preference in Choosing Instant Noodles.

  Based on the hypothesis testing of the test F all variables of taste, ease of purchase, and price jointly affect the degree of satisfaction of students in Surabaya in choosing instant noodles. This can be known by the test result F, which has a counted value is 13,583 and a significant value is 0.000. This means the taste variables, ease of purchasing, and price simultaneously have a significant influence on the level of preference.

IV. CONCLUSION

Based on the results of research and discussions about the level of favor of students or students of Surabaya in choosing instant noodles, the conclusion is as follows:

1) Based on the results of the F test, it is known that taste variables, ease of purchase, and price have a significant effect simultaneously or jointly on preference level variables.
2) Based on the results of the T-test, it is known that taste variables and price variables have a significant influence on the level of pleasure.

So it can be concluded that the level of preference of Surabaya College students in choosing instant noodles is significantly influenced by taste variables and price variables

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Layout of Conveyor Production Facilities With Craft Method

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Abstract - ***CV. Frontec Agritama Engineering is a company engaged in manufacturing, the increasing demand for products makes the company lack a place for production activities and a place to store raw materials and finished materials, thus the company plans to move to a wider area so that the production process runs effectively. This research will use the CRAFT method. The purpose of the CRAFT method is to evaluate the factory layout to get the most optimal results that are harmonized with the ARC method. Data collection in this study is through measuring the distance between stations and the number of stations in the company. The results of research using the CRAFT method resulted in a layout of proposed production areas with a total FTC distance of 807.88 meters.***

Keywords: Facility Layout, From to Chart, Craft Method, Activity Relation Chart

I. INTRODUCTION

A conveyor is a machine that has a mechanical system that can move bulk materials from one place to another with a predetermined small to large capacity [1]. *Conveyorsare* chosen as a fast and effective means of transportation. There are several types of *Conveyors* Including *belt conveyors*, *Chain conveyors*, *screw conveyors*, *gravity conveyors*, and *bucket conveyors*[2]. In an industry sometimes some materials are vulnerable, and people cannot move them. Therefore, a means of transportation that can overcome human limitations is needed to protect the safety and security of workers. Because of this *Conveyor* Often chosen as a means of transporting large-sized production materials.

CV. Frontec Agritama Engineering is a company engaged in manufacturing. As an economic activity, manufacturing accounts for 20-30% of the value of domestically produced goods and services. The company produces machine*feed mills* like *Chain Conveyor*, *bucket conveyors*, *Pneumatic Slidegate*, and others. In the last 2 years, the demand for machines has increased by an average of around 60%, with this increasing demand making the company lack a place for production activities and storage of raw materials and finished materials, thus the company plans to move to a wider area so that the production process continues. With the movement of production sites, it requires companies to design the layout of production machines optimally so that the production process can run efficiently [3].

Based on the description, Preparation *Layout* Production is very important for companies which includes optimizing time, with a layout that has been arranged can save time in doing work and then can also expedite the process of work and material transportation so that no goods or work goes back and forth, intersects and cuts the flow of work. So the design and layout of machines, equipment, or rooms are very influential for the continuity of the production process in a company because the factors that affect the efficiency of the production process are the layout design and warehouse design [4]. The layout design of this production facility can be done by the CRAFT method. The choice of the CRAFT method is because the method has advantages in determining locations with simple and short computational time [5].

II. LITERATURE REVIEW

a. Conveyor

The conveyor is a mechanical system with the function of moving material from one process to another [6]. Conveyors are often used in industry to move heavy loads of goods, many

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continuously [7]. In certain situations, conveyors are widely used because they offer greater economic advantages than other modes of transportation such as trucks and motor vehicles. The conveyor can move objects quickly and continuously from one location to another. In an industry, sometimes the raw materials produced are materials that are harmful to humans or have abundant quantities. For that reason, a means of transportation is needed to move materials, considering the maximum capacity of human labor both in terms of the ability of objects to be transported and the safety of workers.

b. Feature Layout

Facility layout is an integrated planning of the flow of components of a product (goods or services) in an operating system (manufacturing and/or non-manufacturing) to obtain efficient linkages between workers, materials, machinery, and equipment as well as the transfer and handling of materials, semi-finished goods, from one department to another [8]. Facility layout is one of the important points in the design of production systems and the key to increasing factory productivity. The purpose of processing facilities is to increase the efficiency of several facilities or machines in one production line or production area, thereby reducing material costs and increasing the productivity of an industry [9]. There are four basic types of production floor layouts, namely:

1. Product Layout

A product-based layout is often referred to as a production line layout. This layout uses a method in which the arrangement and placement of all facilities are placed according to the order of the production process. The main purpose of this layout is to minimize the movement of materials and facilitate the monitoring of the production process.

2. Process Layout

Process-based layout, often referred to as process or function layout, is a method of organizing all similar production machinery and equipment within a department.

3. Fixed Position Layout

Fixed position layout, often referredto as *fixed position layout*, is a method of arrangement in which the main materials or components remain in their location or position, while production facilities such as tools, machinery, workers, and other components move toward the position of the main components.

4. Group Technology Layout

This type of layout is based on grouping the components or products to be manufactured. Identical products are collected based on classification, type, machinery, or equipment. This type of layout also groups all production systems into "*manufacturing cells*". By grouping and organizing production equipment, it will be able to achieve smooth workflow and achieve high efficiency.

c. Activity Relation Chart

Activity Relation Chart (ARC) is a way to plan the relationship between workstations based on the degree of activity relationship. This method can provide new configurations when laying out production facilities so that it can be used to increase productivity and efficiency [10]. In ARC, there are variables in the form of alphabetical symbols that indicate the degree of closeness between one department and another department, and numerical symbols that indicate the reason for closeness [11], which can be seen in Tables 1 and 2.

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Table 1 Relationship Degree Symbol

Symbol	Description
A	Close
E	It is very important to bring it closer
I	Important to be close
O	Usual
U	It is not important to bring it closer
X	It is not desirable to be brought close

Table 2 Symbol of Proximity Reasons

Symbol	Description
1	Material flow
2	Administration
3	Visual checking
4	Necessity
5	Dangerous

d. From to Chart

From to chart (FTC) is a traditional method used to plan plant layout and material transfer in the production process. From to chart is an adaptation of a distance chart that is usually applied to a certain route (road map), resulting in a total load weight. FTC is also known as a trip frequency chart or Travel Chart. FTC is a graph used to show the flow of material from one department to another [12]. This technique is quite useful in situations where many goods move through a certain space, such as job shops, machinery workshops, offices, and so on. The calculation of FTC distance in this study uses the euclidian method with the formula [8].

$$d_{ij} = \sqrt{(x^i - x^j)^2 + (y^i - y^j)^2} \quad (1)$$

Where:
d_{ij} = distance between
(x^i, y^i) = coordinates of one point
(x^j, y^j) = coordinates of the other point

e. Craft Methode

Computerized Relative Allocation of Facilities Techniques (CRAFT) was developed in 1983 aiming to reduce material moving costs, where material moving costs are defined as product flow, distance, and unit transport costs [13]. The CRAFT method is an improvement program, this program aims to find the optimum design by interchanging each department. Optimum or optimal means best or highest [14]. So the word optimal here means the closer or the less the distance of movement between departments, it can be said *Layout* has reached the optimal. The principle of departmental exchange according to the CRAFT method must meet one of the following three conditions, namely, departments must have the same borders, departments must have the same size and departments must have both boundaries in the same three departments [15].

III. RESEARCH METHOD

This research was carried out in CV. Frontec Agritama Engineering with a research time of 6 months, namely from November 2022 to April 2023. Data was obtained using observation and interview

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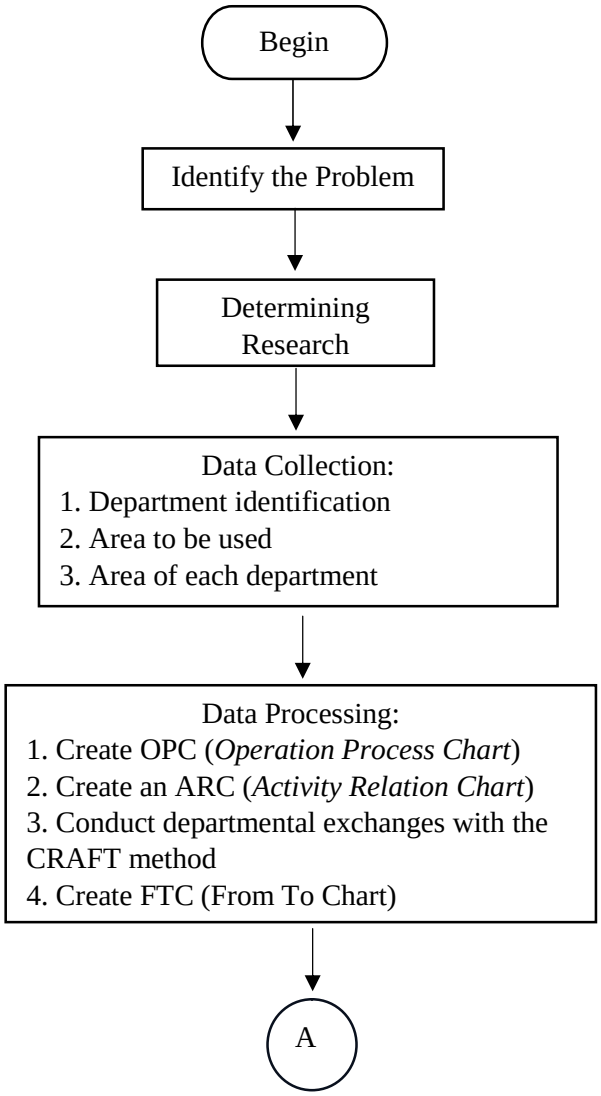
techniques. The observations made in this study are unstructured observations, where the process makes observational observations freely without using observation guidelines. Interviews are conducted directly with production managers, production supervisors, and production employees. This interview aims to find out the data on the area of the machine area as well as the data on the area that will be used as a new area. The research flow can be seen in Figure 1.



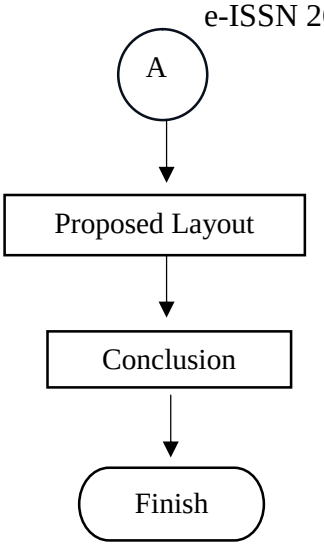


Figure 1. Flow Diagram

The steps taken in the data processing process include:

1. Identify departments in the production area

   This identification aims to find out what departments are in the production area.
2. Calculating the area of each department in the production area

   Area calculation aims to find out the area of each department so that when exchanging blocks, the area of the department remains the same as the initial data.
3. Create an ARC

   The relationship between departments is measured qualitatively using a benchmark of the degree of proximity between one facility and another. Also included are the reasons underlying the relationship between these departments.
4. Design layouts based on ARC

   Describe the position of each department by taking into account the relationship between departments.
5. Create FTC distance per department

   Calculate the distance between one department and another. The calculation of this distance uses the Euclidian method.
6. Exchange individual departments

   Perform trial and error to find the optimal layout.

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IV. ANALYSIS AND DISCUSSION

4.1 Data Collection

From the results of observations and interviews, results were obtained in the form of the production process seen in Figure 2 and there are 8 departments in the production area shown in Table 3. These departments are planned to occupy a production area of 600m^2.

Table 3 Production Area Department

Code	Department	Function
A	Office	Office space for information collection such as planning, and decision-making.
B	Raw Material Warehouse	Raw material warehouse for storing raw materials.
C	*Cutting*	Cutting area for cutting raw materials or parts to be produced.
D	*Bending*	Bending area *for bending raw materials or parts to be produced.*
E	*Rolling*	Bending area to roll raw materials or parts to be produced.
F	*Fabrication*	Fabrication area to combine several parts into subassembly.
G	*Finishing*	Finishing areafor part painting or subassembly.
H	Finished Goods Area	Finished material area to store parts or *subassemblies* that have been completed.

As an illustration of conveyor production in CV. Frontec Agritama Engineering, the manufacturing process flow is depicted in the form of an operation process diagram which can be seen in Figure 2.

Figure 2. Operation Process Chart Drive Chain Conveyor

Based on the data in Table 3, the company wants the area of each department to be adjusted so that the production area can run optimally in an area of 600m2. From the results of interviews with production managers and production heads, data were obtained in Table 4.

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Table 4 Department Area Production Area

Department Code	Department	P (m)	×	L(m)	Area (m2)
A	Office	7	×	6	42
B	Raw Material Warehouse	6	×	13	78
C	*Cutting*	16	×	7	112
D	*Bending*	7	×	8	56
E	*Rolling*	7	×	5	35
F	*Fabrication*	7	×	19	133
G	*Finishing*	6	×	5	30
H	Finished Goods Area	19	×	6	114

4.2 Data Processing

1. Activity Relation Chart (ARC)

The ARC diagram is arranged based on the degree of proximity, the value of the degree of proximity is shown in Table 1. While the reasons for closeness between departments and the reasons for closeness are obtained from interviews and observations with the head of production, the ARC diagram is shown in Figure 3.

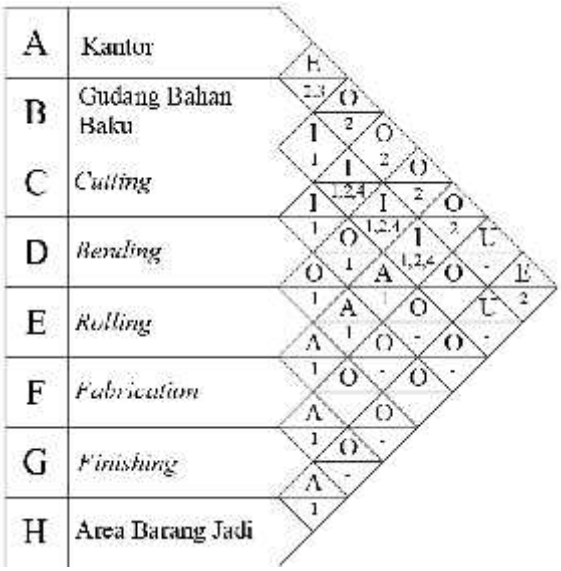

Figure 3. Activity relation Chart

2. Data processing using Autocad software.

a. Layout proposal 1

Based on the ARC diagram, several departments are absolutely closer to the fabrication department, namely the cutting, bending, rolling and finishing departments because they are related to material flow. Then the office department is very important to be close to the raw material warehouse department and finished goods area because it is related to administration and visual checking.

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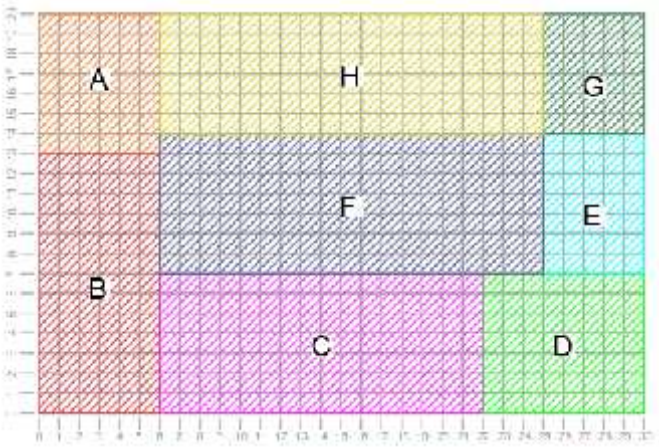

Figure 4. Layout Proposal 1

Furthermore, from the layout of Figure 4 a calculation is made for From To Chart (FTC) distance. As for the FTC layout, proposal 1 is prepared in Table 5.

Table 5 From to Chart Distance in Proposal Layout 1 (in m)

	To A	To B	To C	To D	To E	To F	To G	To H	Sub Total
From A	0	10,00	17,03	26,42	25,22	13,87	24,51	12,51	129,56
From B	10,00	0	11,40	23,19	24,82	13,12	26,66	16,32	125,51
From C	17,03	11,40	0	12,00	15,21	7,16	19,09	13,58	95,47
From D	26,42	23,19	12,00	0	7,16	12,62	13,58	17,10	112,07
From E	25,22	24,82	15,21	7,16	0	12,00	6,50	13,65	104,56
By F	13,87	13,12	7,16	12,62	12,00	0	13,65	6,50	78,92
From G	24,51	26,66	19,09	13,58	6,50	13,65	0	12,00	115,99
From H	12,51	16,32	13,58	17,10	13,65	6,50	12,00	0	91,66
Sub Total	129,56	125,51	95,47	112,07	104,56	78,92	115,99	91,66	853,74

b. Layout Proposal 2

In the proposed layout 2 cutting departments (C) shifted closer to the fabrication (F) and finishing (G) departments, while the bending (D) and rolling (E) departments shifted closer to the raw material warehouse department (B).

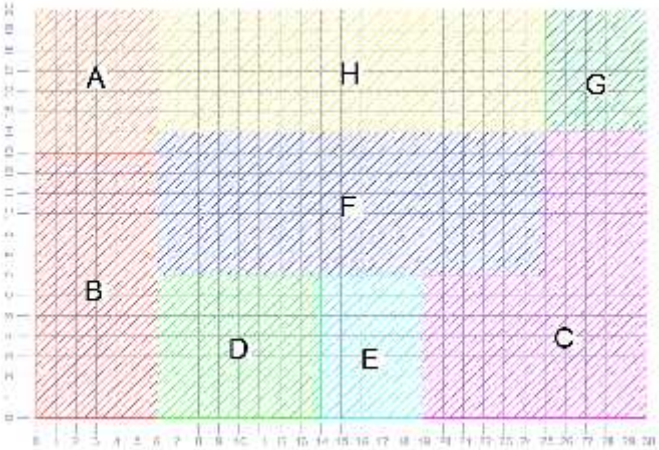

Figure 5. Layout Proposal 2

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Furthermore, from the layout of Figure 5 a calculation is made for From To Chart (FTC) distance. Table 6 is FTC layout proposal 2.

Table 6 From to Chart Distance in Proposal Layout 2 (in m)

	To A	To B	To C	To D	To E	To F	To G	To H	Sub Total
From A	0	10,00	24,91	14,76	18,74	13,87	24,51	12,51	119,30
From B	10,00	0	22,45	7,62	13,83	13,12	26,66	16,32	110,00
From C	24,91	22,45	0	15,59	9,20	11,04	11,50	15,06	109,75
From D	14,76	7,62	15,59	0	6,50	8,90	22,10	14,58	90,05
From E	18,74	13,83	9,20	6,50	0	7,07	17,41	13,54	86,29
By F	13,87	13,12	11,04	8,90	7,07	0	13,65	6,50	74,15
From G	24,51	26,66	11,50	22,10	17,41	13,65	0	12,00	127,83
From H	12,51	16,32	15,06	14,58	13,54	6,50	12,00	0	90,51
Sub Total	119,30	110,00	109,75	90,05	86,29	74,15	127,83	90,51	807,88

c. Layout Proposal 3

In the proposed layout, 3 bending departments (D) were exchanged for rolling departments (E).

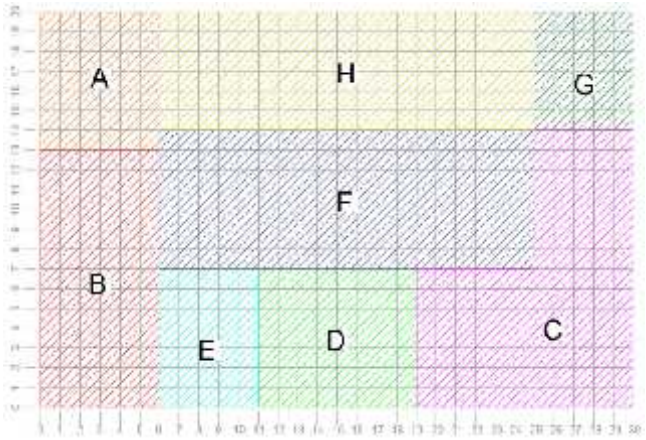

Figure 6. Layout Proposal 3

Furthermore, from the layout of Figure 6 a calculation is made for From To Chart (FTC) distance. As for the FTC layout proposal 3 is seen in table 7.

Table 7 From to Chart Distance in Proposal Layout 3 (in m)

	To A	To B	To C	To D	To E	To F	To G	To H	Sub Total
From A	0	10,00	24,91	17,69	14,12	13,87	24,51	12,51	117,61
From B	10,00	0	22,45	12,37	6,27	13,12	26,66	16,32	107,19
From C	24,91	22,45	0	10,66	17,08	11,04	11,50	15,06	112,70
From D	17,69	12,37	10,66	0	6,50	7,02	18,40	13,51	86,15
From E	14,12	6,27	17,08	6,50	0	9,90	23,31	15,21	92,39
By F	13,87	13,12	11,04	7,02	9,90	0	13,65	6,50	75,10
From G	24,51	26,66	11,50	18,40	23,31	13,65	0	12,00	130,03
From H	12,51	16,32	15,06	13,51	15,21	6,50	12,00	0	91,11
Sub Total	117,61	107,19	112,70	86,15	92,39	75,10	130,03	91,11	812,28

4.3 Discussion

In the layout proposal 1 is the output based on ARC, where A is the office department, B is the raw materials department, C is the cutting department, D is the bending department, E is the rolling department, F is

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the fabrication department, G is the finishing department and H is the finished goods department, then from the layout is calculated FTC distance of each department. The calculation of FTC distance uses the Euclidean distance technique where the measurement measures the line from the midpoint of the department to the midpoint of another department. The FTC distance results in the proposed layout 1 get a total of 853.74m.

Then in the layout of proposal 2 the FTC results changed because the cutting department moved its position under the finishing department while the bending and rolling department shifted closer to the raw material warehouse, the FTC results in the distance in the layout of proposal 2 got a total of 807.88m. From the proposed layouts 1 and 2, there is a significant distance difference of 45.86m.

In the proposed layout 3 bending department positions were exchanged for rolling departments, from these exchanges resulted in a total FTC distance of 812.28m. Compared to the proposed layout 2, the proposed layout 3 has a larger distance with a distance difference of 4.4m.

V. CONCLUSION

From research using the CRAFT method that utilizes AutoCAD software, several proposed layouts were produced, namely proposal layout 1 got a total FTC distance of 853.74 m, proposal layout 2 got a total FTC distance of 807.88 m and proposal layout 3 got a total FTC distance of 812.28 m. of the three proposals, proposal layout 2 is the optimal layout because the FTC subtotal results the distance is the smallest at 807.88 meters. It can be seen in Figure 7.

With the absence of material handling costs making this study less complete, it is hoped that in future studies material handling costs can be added to see the level of cost savings in the production area.

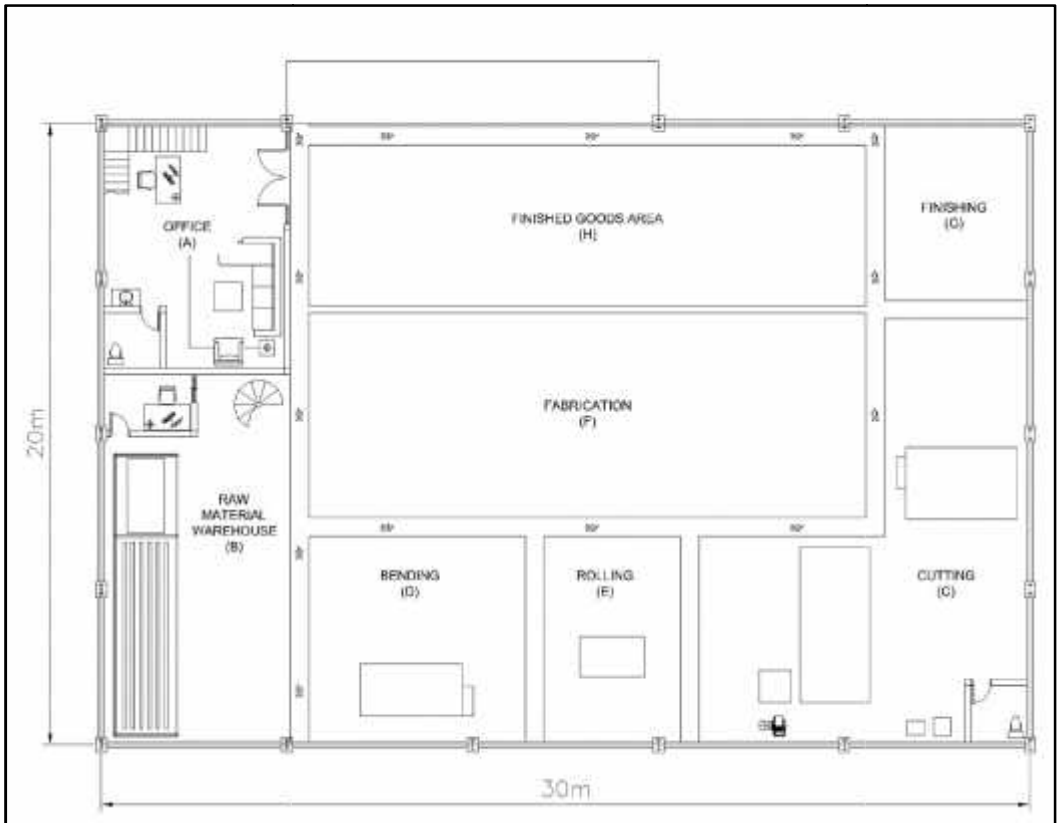

Figure 7. Proposed Production Area Layout

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Model Lean Manufacturing With The VSM Method to Reduce Waste In The Production Process Box Electrical Panel at PT.DMI

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Abstract - PT. DMI is a medium-sized company that produces electrical panel boxes. Make-to-order (MTO) is a reference at the start of the production process. The production process includes plate cutting, bending, welding, grinding, powder coating, and part-by-part assembly. Lean Manufacturing started in Japanese manufacturing, to eliminate all waste from the process while pursuing quality improvement in producing finished products. Value stream mapping is an important step in the lean transformation process before entering the waste elimination stage. which can lead to a decrease in the productivity of the company. One of the biggest problems was the lack of bending machines and not having our powder coating machine.

Keywords: Value Stream Mapping, Fishbone diagrams, Flow Process Charts.

1. Introduction

The manufacturing industry is the process of converting raw materials into finished products. This process involves several stages, such as product design, material selection, and production stages or processes. Today, manufacturing involves making products from raw materials through various processes, machines, and operations, all of which are managed in an organized manner through good planning for each activity required.(Supriyanto, 2013).

The electric panel is a container in the form of a rectangular cube box where inside the box, there is a cable connection or electrical panel. The box's existence is very important to protect against leakage of electric current which is dangerous for workers or humans.

One of the problems that will be analyzed is the problem of delays in the production process at PT. DMI. The delay in question is a delay in the production process caused by waste such as downtime, waiting time, or other waste contained in the electric box production line.

2. Literature Review

A. Lean manufacturing

Lean is an approach that aims to improve processes by eliminating activities that do not add value and increase work effectiveness and efficiency. Thus, this method creates faster and optimal performance (Wijaya, 2023).

The main focus of Lean is to identify and eliminate non-value-adding activities in production design (for the manufacturing sector) or operations (for the service sector) as well as supply chain management, which are directly related to customer needs (Gaspersz in Sustainable, 2019).

One method that has been proven effective in quality control and is widely used by large companies around the world is the lean manufacturing method. This lean approach aims to eliminate waste (waste elimination), improve the flow of materials, products, and information, and prioritize process speed to create a smooth flow of products throughout the value stream process (value stream process).

B. Value stream mapping

Value Stream Mapping (VSM) is a method used to describe the physical value stream of a product and identify the root causes of waste.

Value Stream Consists of 2 types according to (Anugrah, 2016) as follows:

a. Mapping the Current Situation Map, aims to find out the flow of the production process and process information from ordering to delivery to consumers.
b. The design of the Future State and Value Stream Map serves as an illustration of the comparison between the current state of the company and the future state of which improvement proposals have been designed to minimize waste and optimize value-added activities.

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C. Waste

Waste (waste) or in Japanese called "muda," is an activity that is highly undesirable in the production system. Youth is an activity that absorbs labor but does not add value to the product(Womack & Jones, 2003).

Table 1. Flow Process

No	Langkah Proses	Waktu (menit)
1	*Cutting, Suplier* melakukan pemotongan lembar plat menjadi beberapa bagian sesuai ukuran dan pola desain	30
2	Menunggu lembar plat yang sudah dipotong untuk masuk *inventory*	1440
3	*Loading* lembaran plat ke mesin *cutting plasma*	5
4	Proses *cutting plasma* memotong bagian-bagian kecil yang terdapat didesain *Box*	20
5	Proses *loading* plat ke mesin *bending*	5
6	Plat di *bending* sesuai pola tekukan	10
7	Koordinasi desain tekukan pada plat	6
8	Proses *loading* plat yang sudah ditekuk ke devisi *welding*	2
9	Proses pengelompokan plat yang sudah dibengkokan	1
10	Proses *welding*	15
11	Proses pengecekan hasil *welding*	5
12	*Loading Box* ke mesin *Grinding*	1
13	Grinding dilakukan ditiap sisi yang terdapat hasil las	10
14	Proses *loading* ke truck	10
15	Proses *powder coatting* dilakukan pada subkon	20
16	Menunggu *Box* selesai di *coating*	1440
17	Proses loading penurunan box dari truk	10
18	Pengambilan aksesoris	5
19	Proses assembly part by part Box	12
	Total waktu	3047

Waste consists of activities that do not add value, but add production costs that are not wanted by consumers (Gopinath & Freiheit, 2012).

3. Methodology

This study uses the VSM method as a performance measurement tool for the lean manufacturing approach. VSM can identify activities that have added value or not. The first stage begins with data collection during the production process of the Electrical Panel Box using a stopwatch as a measuring tool.

The following are the steps taken in making VSM (Value Stream Mapping):

a. Identification of Family Products

This identification is intended to focus the mapping process on products that have less efficient processes and simplify it so that data collection can be done more easily and quickly.

b. Creation of Current State Map

Making a map of the current state (current state map) is done by using Value Stream Mapping (VSM) of the company's actual situation which includes consumer orders, the company's operational processes, and the product journey from start to arrival in the hands of consumers.

c. Problems in VSM flow

At this stage, an analysis of existing activities is carried out, which can be classified into three categories, namely activities that provide added value (value-added activities), activities that are necessary but do not provide added value (necessary but non-value-added activities), and activities that do not provide added value (non-value-added activity).

d. Creating a Future State Map

A future state map is a visual picture of the conditions desired by the company in the future, based on improvement proposals taken from the existing current state map.

4. Results and Discussion

A. Flow Process

Flow Processes data that shows the sequence of operations, inspections, transportation, delays, and storage that occur during a process or procedure.

B. Current state map

After making observations, the flow of the production process is obtained in the table**1**, and then a current state map in image 1 from the

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beginning of the manufacturing process to the end of the manufacture of electrical panel boxes.

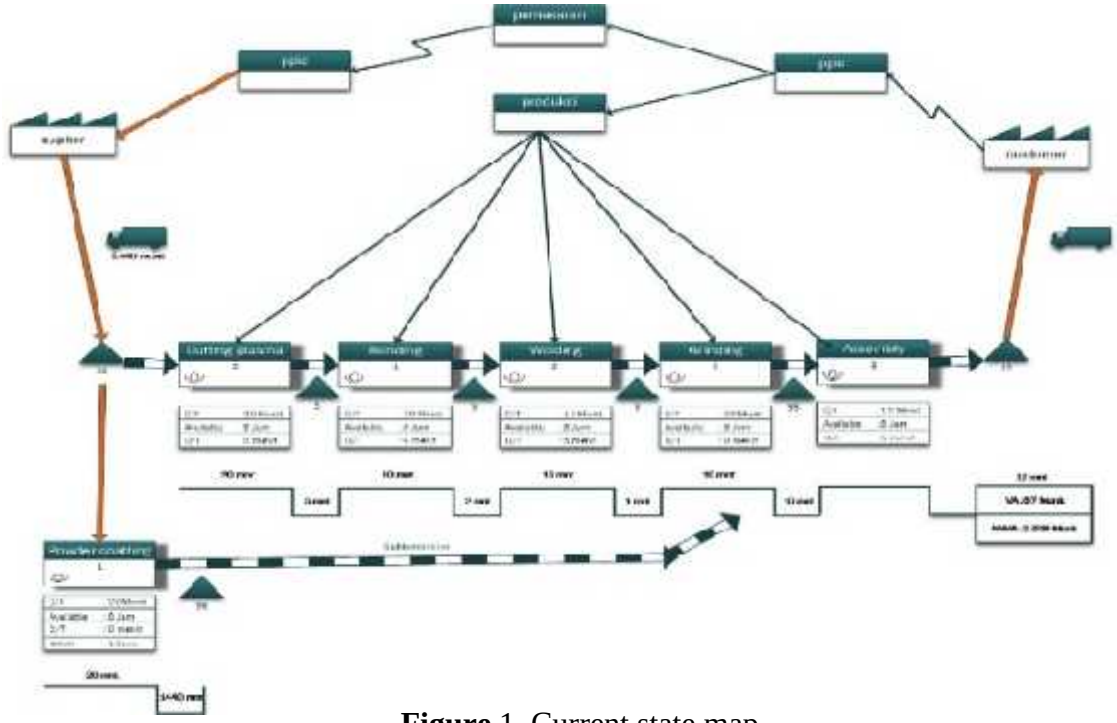

Figure 1. Current state map

C. Fishbone diagrams

Once it is known that the waste that occurs at PT. DMI is waste waiting and processing, then identification of the causal factors for the occurrence of waste is carried out to find out what factors influence the occurrence of waste in companies using the 5 Why, namely humans, methods, machines, and environment.

a. waiting(Powder Coating)

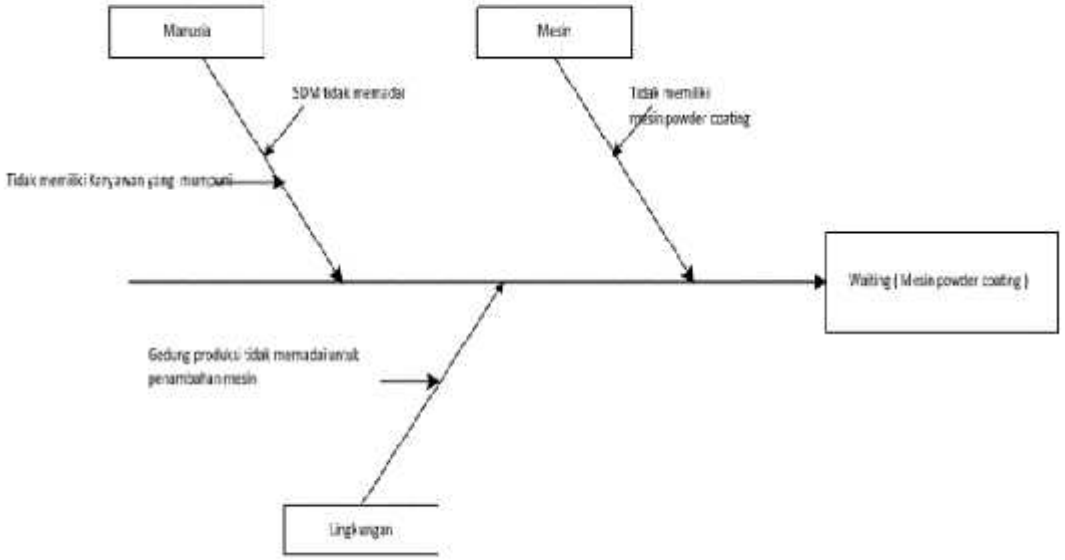

Figure 2. Waiting fishbone diagram

In the picture above are the factors causing the occurrence of wastewater (powder coating), there are 3 factors for the occurrence of waiting which will be described as follows:

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1) Man

Humans are a factor causing waste because the company does not yet have workers who meet the operating standards of powder coating machines.

2) Machine

The machine is a factor causing waste because the company does not have its powder coating machine so it cannot run the process, this requires PT. DMI Indonesia uses the services of a subcontractor for the continuity of the electrical panel box production process.

3) Environment

The environment is a factor that causes waste because the conditions in the production building are inadequate for installing powder coating machines.

b. processing(Bending Process)

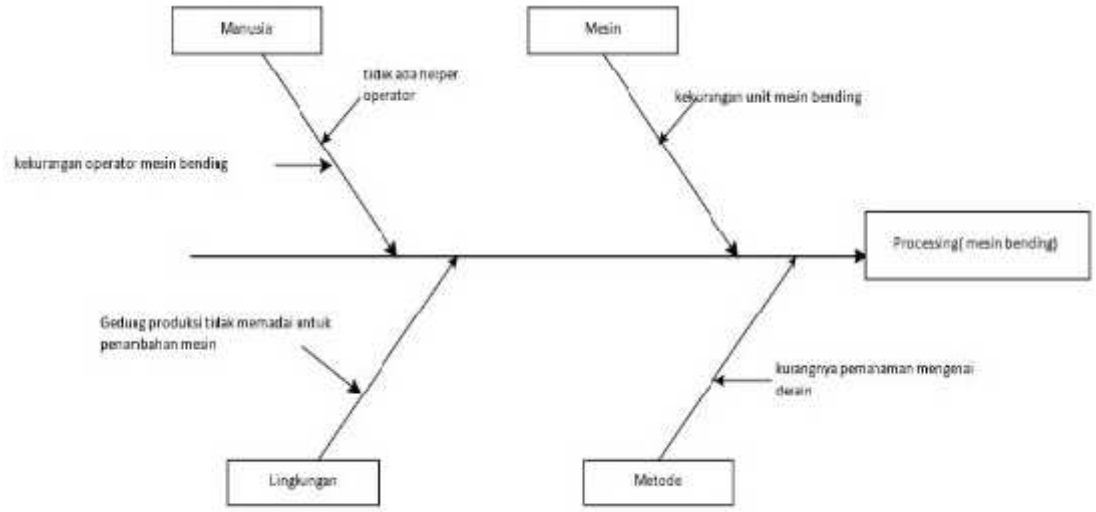

Figure 3. Fishbone diagram processing

Picture 3 shows the factors that cause waste processing (bending machines), 4 factors cause waste processing which will be described as follows:

1) Man

Human or humans become a factor causing waste processing due to the lack of operators in the bending process and the lack of additional workers as operator assistants.

2) Machine

Machines are the cause of waste because the number of bending machine units owned is only 1 unit. This triggers waste in the cycle time of the electrical panel box production process.

3) Environment

The environment is the cause of waste because the bending machine area does not have sufficient space to place the raw materials to be worked on.

4) Method

The working method is also the cause of waste in the production line, especially in the bending process section because during work the workers spend several times consulting regarding the design of the plate to be bent.

D. Improvement recommendations

Based on the current state map of the VSM that was made previously, to reduce waste in the electrical panel box production line at PT. DMI.

1. The first recommendation is to increase the number of operators and helpers in each machine to speed up the process of loading and unloading material to the next process.

   The addition of employees to the bending machine section, which originally numbered 1 person, was added with 1 more person as assistant operator 1 in operating the machine.
2. The second recommendation is that the company adds a bending machine, there is already 1 unit of bending machine operating, and 1 more unit is needed to speed up the

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plate bending process, this can be seen from the downtime in the bending process which gets the highest value of 6 minutes per process, where this is used by the operator to set up the machine and read the design which results in delays and waste. The company added a bending machine which previously only had 1 unit of bending machine plus 1 more unit so that it has 2 units of bending machine.

3. The third recommendation is that the company adds space to the production line which will later be used for placing powder coating machines, this is necessary because one of the obstacles is in the powder coating process where the company still uses sub-contractor services to carry out the process of painting electrical panel boxes with a period of 1,440 minutes. Which should be trimmed to 20 minutes per 50 pcs boxes to be painted using a powder coating machine with a capacity of 50 pcs per 1 round.

E. Future state map

Based on the recommendations for improvements above that have been discussed with the company's experts, improvements to the production process are made using the VSM Future state map in the image as follows:

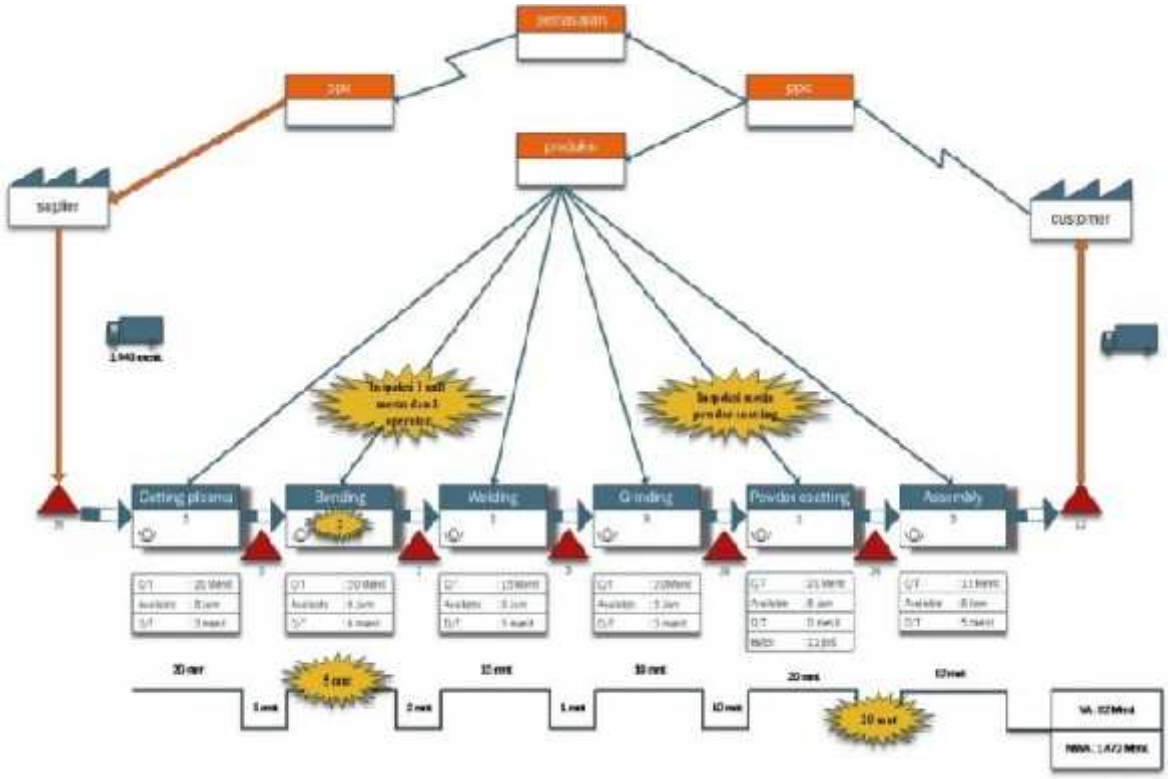

Figure 4. Future State Map

Based on the results of improvements using the future state map, it can be seen that it is effective and by the research objectives, namely lean manufacturing analysis with the vsm method to reduce waste in the electrical panel box production process at PT. DMI.

The first improvement is due to the waste of waiting (powder coatingting) with the addition of a powder coating machine that can minimize waste in the production process, especially eliminating the waiting time for the painting process and reducing company waste. The second improvement is by adding operators to the bending section, which was originally 1 operator to 2 operators. As an assistant to the main operator, this is done because the bending process takes a long time and creates waste if it is only done with 1 operator. It can be seen from

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the current state map that the VA value is 10 minutes. 5 minutes.

The coating process no longer uses subcontractor services to reduce waiting time after the coating process enters the assembly process. This was done because looking at the processing results which showed the high waiting time from the coating process to the assembly process which was previously 1,440 minutes after the addition of a powder coating machine at the company could cut the time by 1,410 minutes so that the waiting time became longer. process to only 30 minutes.

Furthermore, in the bending process, 1 additional operator was added, which previously only had 1 operator, now it has 2 operators, this is done to speed up the bending process itself which previously took 10 minutes to 5 minutes. This is beneficial because it can reduce waste in the bending process.

The time needed for the production process of the electric panel box is 1.488 minutes if converted into days is 1.3 days. This procurement process has increased by 1 day from the previous total production time.

F. Process flow analysis

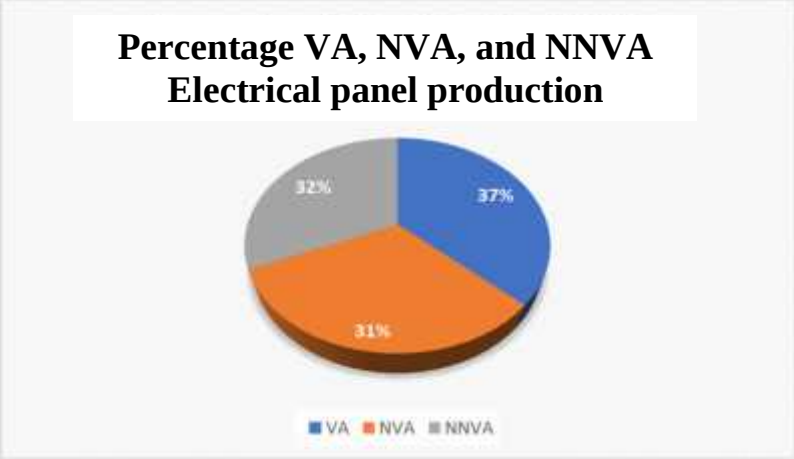

Figure 5. FPC analysis pie chart before repair

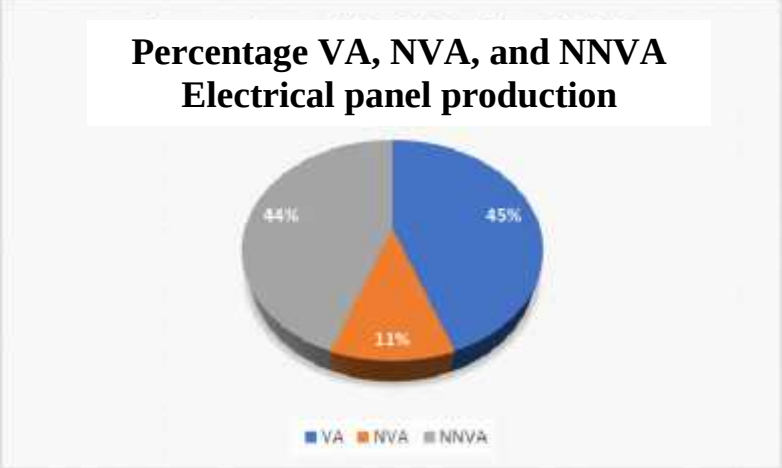

Figure 6. FPC analysis pie chart after repair

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After making improvements, it can be seen that in the previous FPC, the value for VA classification or production, operation, and storage processes was 37%. After the repair was done, the VA value increased to 45%. This was due to the addition of a powder coating machine, the addition of 1 bending machine unit, and 1 operator which made the production process time faster. In addition, the weighing process has also been changed to an operational process.

Furthermore, for the NNVA classification or production, transportation, and inspection processes, the value at the previous FPC was 32%. After the repairs were made, the NNVA value increased to 44%. This is due to the elimination of the long time-consuming transportation process from subcontractors so that transportation time can be reduced.

Finally, the NVA classification or waiting production process on the previous FPC has a value of 31%. After the repairs were made, the NVA value became 11%. This happens because delays only occur in the process of procuring raw materials from suppliers.

5. Conclusion

Based on the results of observing and processing data on the production process of the electric panel box, the following conclusions can be drawn:

1. There are 2 types of waste identified, namely waiting time and shortage of powder coating machines.
2. The factors that influence the existence of the two identified types of waste are waiting for time and powder coating machines because both are closely related and are caused by powder coating machine units that are not owned by the company so PT. DMI uses subcontractor services as service providers for powder coating products. The lack of powder coating machines causes product buildup which results in waste.
3. Recommendations for improvement that can be given include:

G. The addition of a powder coating machine so that it does not take long and avoids the accumulation of boxes which can result in waste.

H. The addition of 1 bending machine unit to speed up the bending process on the plate to minimize downtime in the process and minimize waste.

I. The addition of employees to speed up the loading and unloading process in each existing machining process, is done to reduce the amount of waste in each box that is transferred to the next process.

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Solutions for Young Entrepreneurs in the Socially-Based Fourth Industrial Revolution Era

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***Abstract*—A startup is a venture or business within a social organization that leverages information technology to conduct its business, targeting a wide market audience and establishing numerous relationships to support its operations. A digital startup is a business within an organization that primarily operates its business through computers and is managed by various partners handling aspects of marketing, sales, and payments. Essentially, this digital startup serves as an intermediary for marketing or ongoing business activities. The strategy of a digital startup revolves around maximizing marketing efforts through technology, staying updated with current trends, and maintaining courteous and measured communication to provide comprehensive and inseparable customer service, using this approach to fulfill their needs. Social entrepreneurship during the era of the Fourth Industrial Revolution involves combining creativity with rapidly advancing technology for sociallybased entrepreneurial activities.**

Keywords; Digital Business Startup, Young Entrepreneurs, Fourth Industrial Revolution Era, Social-based Entrepreneurship.

I. INTRODUCTION

In the era of the industrial revolution, rapid technological and informational advancements have taken place. The term "Industry 4.0" emerged from the idea of the fourth industrial revolution. According to [1], the industrial revolution has occurred four times. The first industrial revolution happened in England in 1784, when the invention of steam engines and mechanization began replacing human labor [1]–[5]. The second revolution occurred in the late 19th century when electric-powered production machines were used for mass production. The third industrial revolution saw the use of computer technology for manufacturing automation, starting around 1970. Currently, the rapid development of sensor technology, interconnectivity, and data analysis has given rise to the idea of integrating these technologies across various industries. [6] argue that this idea is what is predicted to be the next industrial revolution, referred to as Industry 4.0.

The term "4.0" signifies the fourth revolution. Industry 4.0 is a unique phenomenon compared to its predecessors since it was announced apriori, meaning it is still in the conceptual stage and has not yet fully materialized [6]–[9].

Consequently, the current period is characterized by technological and digital development, providing significant opportunities for entrepreneurs, especially in Indonesia. As technology progresses, internet usage has inevitably become prevalent. Data indicates that internet usage in Indonesia has increased by approximately 8 percent, reaching 143.26 million users, which is equivalent to 54.68 percent of the population of 262 million people [10]. This significant increase in internet users represents a promising target market for online business owners. Considering that the majority of internet users are active on social media and also engage in online trading (E-commerce), the rapid development of technology, facilitated by comprehensive and fast internet access, has led to the emergence of new businesses known as "Startup Businesses."

According to [11]–[13], a startup is a company with less than 20 employees that operates digitally and has rapid growth. Renowned companies such as Lazada, Urbanesia, Gojek, Uber, and Kaskus are examples of successful startups in the real world. Through innovative

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products, they have made a significant impact and provided solutions to various problems. [14]–[17] explains that startups are organizations or businesses that are newly established and attempt to address existing problems by employing solutions that have not yet been accurately proven for success. They either utilize unconventional approaches (early stage) or implement existing ones but have not achieved sustainable impacts for the future (growth stage).

All these businesses operate in the realm of trade and services, catering to consumers' daily needs, with the majority of them being online-based. Most of the business owners are young and may lack experience, but their proficiency in leveraging and utilizing their skills in the field of information technology, which is continuously evolving, demands them to create innovations. These young individuals are the driving force behind the innovations in their businesses. In the startup world, creative and innovative ideas are crucial for developing and expanding businesses. Thus, in the era of Industry 4.0, startups that harness digital technology to develop their businesses and create new entrepreneurial opportunities across various digital technology sectors to meet consumers' daily needs are suitable business ventures for young individuals.

II. METHOD

In this article, the methodology used in its creation involves collecting literature from journals and books discussing digital startups, entrepreneurial intentions, digital startup strategies, and social entrepreneurship in the era of the Fourth Industrial Revolution.

a. Digital Startup

According to [18]–[20], a startup originates from the English language, meaning "the act or process of starting a new organization or business venture." It refers to the actions or processes involved in initiating a new organization or business venture. The term startup gained popularity in Silicon Valley, which is synonymous with technology, especially ICT. Hence, the term startup is commonly associated with the ICT sector.

A startup is fundamentally not a business that merely writes code or programs for other companies, whether as an IT consultant or customizes applications specifically for each client. It is also not a department or division of a company assigned to act like a startup in building something different. According to [17], [21], [22], digitalization tends to focus on automated operating systems with computer-readable formats. A startup is a business or venture in a social organization that utilizes information technology to conduct its operations, targeting a wide market and establishing numerous relationships to support its business. A digital startup is a business or venture that sets up a platform to operate the business through computers and is operated by other partners who manage aspects such as marketing, sales, and payments. This digital startup merely serves as an intermediary for ongoing marketing or business endeavors.

b. Digital Startup Strategy

Startup businesses fall under a challenging business model as information often rushes, and consumers have various ways to obtain goods and services quickly without physical encounters or direct inspections at the location, with payments made electronically through transfers [23], [24]. Therefore, success in the digital business realm requires continuously seeking information about trends, i.e., staying up-to-date with fashion, products, and services. Developing a digital business is similar to any other business, but it utilizes technology in its marketing aspect and delivers products directly to customers after payment.

According to [18], [25]–[27], digital marketing strategies must be well-understood by digital startup owners. Digital marketing, in general, can be defined as the use of integrated technology. Thus, the strategy for a digital startup involves maximizing marketing efforts using technology, ensuring constant updates on current trends, and providing courteous and measured customer service to establish lasting relationships and meet their needs.

c. Social Entrepreneurship (Muda) in the Fourth Industrial Revolution Era

According to [19], [20], [28], entrepreneurship plays a crucial role in a country's development. In the context of social entrepreneurship, economic problems, which are financial issues, are prevalent and affect everyone. Social entrepreneurship, according to [29]–[31], involves activities with its logic. To address these economic problems, social entrepreneurship is needed. According to [32]–[34], social entrepreneurship is a process that uses entrepreneurial activities to bring about social, welfare, educational, and health changes. In summary, social entrepreneurship is a beneficial

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and creative activity aimed at meeting social needs and achieving social well-being in various aspects of life.

According to [35], [36], social entrepreneurship comprises four key elements:

a. Social Value

Social value is the most crucial aspect in providing benefits to society in various aspects of life.

b. Civil Society

Social entrepreneurship activities stem from the creativity of the community to address ongoing social issues.

c. Innovation

Social entrepreneurship is based on creative ideas and innovations from the community.

d. Economic Activity

The success of social entrepreneurship also depends on economic activity, where economic activities must be balanced with social activities to achieve social missions.

The Fourth Industrial Revolution era is characterized by the rapid development and utilization of information technology. In social entrepreneurship during this era, creativity must be combined with fast-paced technology to be effectively applied in social entrepreneurship endeavors.

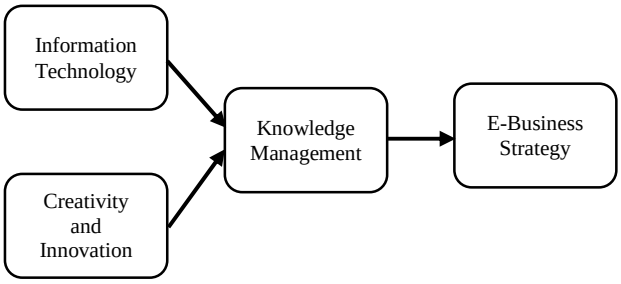
III. RESULT AND DISCUSSION

Starting a business startup requires the prospective entrepreneur to possess knowledge about startups, as the emergence of this knowledge will have an impact on internet-based business operators, which is significantly different from traditional physical entrepreneurship. The key differences lie in the aspects of capital, location, products, and marketing.In terms of capital, traditional physical businesses often require substantial initial investments to establish a new venture. On the other hand, internet-based startups can rely on the flexibility of capital, depending on the owner's abilities and resources. Young individuals who lack extensive business experience and access to substantial capital find startups a suitable choice given their lower financial barriers.Location is a crucial aspect in traditional businesses, as selecting a strategic location plays a vital role in their success. However, digital startups minimize the importance of physical location since they can operate online, eliminating the need for a specific physical presence. This lowers the risks associated with startup operations for young and less experienced entrepreneurs.

The product variety is another difference between traditional and digital startups. Physical businesses often focus on specific products or services due to limited resources, whereas digital startups have the advantage of offering a wide range of products or services with minimal production space requirements.Marketing is also affected by the digital nature of startups. Internet-based businesses can reach a larger audience through extensive broadcasting, allowing potential customers to become aware of their offerings.

In the realm of knowledge management for digital startups, utilizing existing knowledge and continuously creating new knowledge is essential. Entrepreneurs must be adept at identifying business opportunities, as this skill will position their startup in the target market. While technology provides ample resources to strengthen and support business operations, digital entrepreneurs are constantly exploring effective methods to share knowledge and ensure that users reciprocate knowledge dissemination.Innovation and creativity are critical for generating and implementing ideas in digital startup ventures. Young entrepreneurs tend to excel in this area due to their up-to-date knowledge of technology compared to more experienced individuals who may lack the same level of familiarity with digital platforms.

The process of entrepreneurship in digital startups involves several stages, such as pre-seed, seed, startup, and expansion/exit. At the pre-seed stage, entrepreneurs explore various digital business concepts and gather information to develop their ideas. The seed stage marks the start of implementation, where decisions play a crucial role in the success of the startup. The startup phase involves creating and implementing products or services online for potential customers, while the expansion/exit phase focuses on scaling and evaluating the business.



[37]**Figure** 1 Knowledge Management Models

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For a successful digital entrepreneur, having a clear strategy is essential. A lack of vision and long-term planning can lead to missed opportunities and limited business growth. Integration of information within different systems is critical for seamless operations and adaptability to technological changes.

In summary, the rise of digital startups presents new opportunities for young entrepreneurs who possess technology-related skills. By capitalizing on their creative ideas and effectively managing knowledge, these entrepreneurs can thrive in the dynamic digital business landscape, paving the way for successful ventures in the ever-changing world of technology and entrepreneurship.

IV. CONCLUSION

The rapidly advancing technology has both positive and negative impacts. On the positive side, individuals who can recognize and seize opportunities can utilize them effectively for business purposes. However, on the negative side, passivity and failure to perceive opportunities can lead to the technology being used solely for entertainment, resulting in disadvantages.

Empowered by enthusiasm and knowledge, the young generation is encouraged to make substantial contributions to the competitive landscape of startup businesses. By introducing various types of innovations and other forms of creativity, they can enhance the development of digital startup ventures.

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Applied OHS With Empirical Ergonomics and Hazard Methods to Minimize Fatigue at KPPS Cerme Gresik

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Abstract-To support fair, honest, and Luber Jurdil elections, public awareness about the importance of healthy politics needs to be increased. Voters who have registered for the permanent election (DPT) must cast five ballots in the 2019 simultaneous elections. Voter participation in the 2019 elections, which reached 81.97%, and legislative participation (Pileg) in 2019, which reached 81.69%, showed a fairly good election organization in 2019. However, this is at odds with the health and safety of KPPS officers. According to the KPU RI, the number of election organizers who died in the 2019 elections was 11,239, with 527 victims dying, based on the results of the Ministry of Health's investigation in 28 provinces. Based on the investigation and analysis of the Indonesian Ministry of Health, the fatigue factor triggered the disease suffered by polling station officers. It is necessary to conduct ergonomic research on KPPS officers in the 2024 elections, which is useful for developing an election polling station model that is comfortable, safe, healthy, effective, and efficient so as to reduce factors that cause fatigue while working. The components studied include workload components, rest time, or the physical work environment at election polling stations. The data collection methods used in this research are observation, interview, direct data, and literature study.The analysis used in this study produces a list of events and classifies the incidence of fatigue of KPPS officers, the most problematic workplace. fatigue classification, Identifying Ergonomic Risk Factor (ERF), Data processing, Analysis and discussion as well as conclusions and suggestions.

Keywords: Ergonomics, KPPS, Fatigue.

I. INTRODUCTION

The people are responsible for the primacy of Indonesia, which is a state of law and democracy. Indonesia is a democratic country with general elections held every five years (Alra, 2023). The voter participation rate in the 2019 Presidential Election was 81.97%, and the voter participation rate in the 2019 Legislative Election was 81.69%, according to data released by the General Election Commission (KPU).

However, this is contrary to the health and safety of KPPS officers. According to KPU RI data, in the evaluation of the 2019 simultaneous elections, there were 11,239 election officers who died and 527 victims died. There are 13 diseases that cause death. Heart disease is the most common, followed by myocardial infarction, hepatic coma, stroke, and hypertension.

KPPS officers perform ordinary tasks that do not pose health risks. Workers who work for long durations of time, with unhealthy postures, and without the right work environment are particularly vulnerable. (Pramono et al., 2022).

It is necessary to conduct ergonomic research on KPPS officers in the 2024 elections which is useful for developing an election polling station model that is comfortable, safe, healthy, effective, and efficient so as to reduce factors that cause fatigue while working. The components studied include workload components, rest

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time, or the physical work environment at election polling stations.

Problem Statment:

1. How to overcome fatigue at KPPS 07 Cerme Gresik by using the Empirical Ergonomics and Hazard Ergonomics methods?
2. How to improve and reduce the risk of fatigue that occurs at KPPS 07 Cerme Gresik by comparing the KPU regulations in 2019 with the 2024 regulations whether it has reduced the level of risk that occurs?
3. How to solve these problems efficiently and practically independently and can be useful for the public in every election in order to reduce the level of fatigue for KPPS members?

Purpose

1. Reduce the fatigue risk level of KPPS 07 Cerme Kidul officers.
2. Aim to improve the level of risk that occurs by using Empirical Ergonomics and Hazard Ergonomics methods.
3. Creating a cheerful polling station synergized for its KPPS members by applying the methods given.

II. LITERATURE REVIEW

2.1 Occupational Health and Safety

According to OHSAS 18001:2007, Occupational Health and Safety (OHS) is all matters and factors that can affect the occupational safety and health of the workforce and other people (contractors, suppliers, visitors and guests) in the workplace. An occupational health program, according to Mangkunegara (2000), means a condition free from physical, mental, emotional, or pain disorders caused by the work environment. In a workplace environment where people work more than the specified time, there are health risks.

2.2 Ergonomic

"Ergonomics" comes from the Greek words "ergon", meaning "work", and "nomos", meaning "rule or law." That is, ergonomics is the rules or norms that exist in work systems. In the United States, "Human Engineering" or "Human Factors Engineering" is used, and in Indonesia, "ergonomics" and in other countries, such as Scandinavia, "bioengineering" are used (Tanjung et al., 2023).

2.3 Hazard

Hazard analysis is a systematic, thorough, and structured method of hazard identification. Standard hazard analysis techniques are used when preparing the safety determination of new systems or changes for the presence of potential hazards or operating problems. Risks are identified to indicate various problems that interfere with the process and risks that exist in a piece of equipment. This can pose a risk or harm to individuals or facilities in the system (Qibti et al., 2022)

2.4 KPPS

Based on Law Number 8 of 2022, KPPS is domiciled at polling stations and was formed to organize voting and counting of votes in elections and elections at polling stations. KPPS members consist of 7 (seven) people who come from members of the community around the TPS who are eligible to become members and 6 (six) members. (KPU, 2022.)

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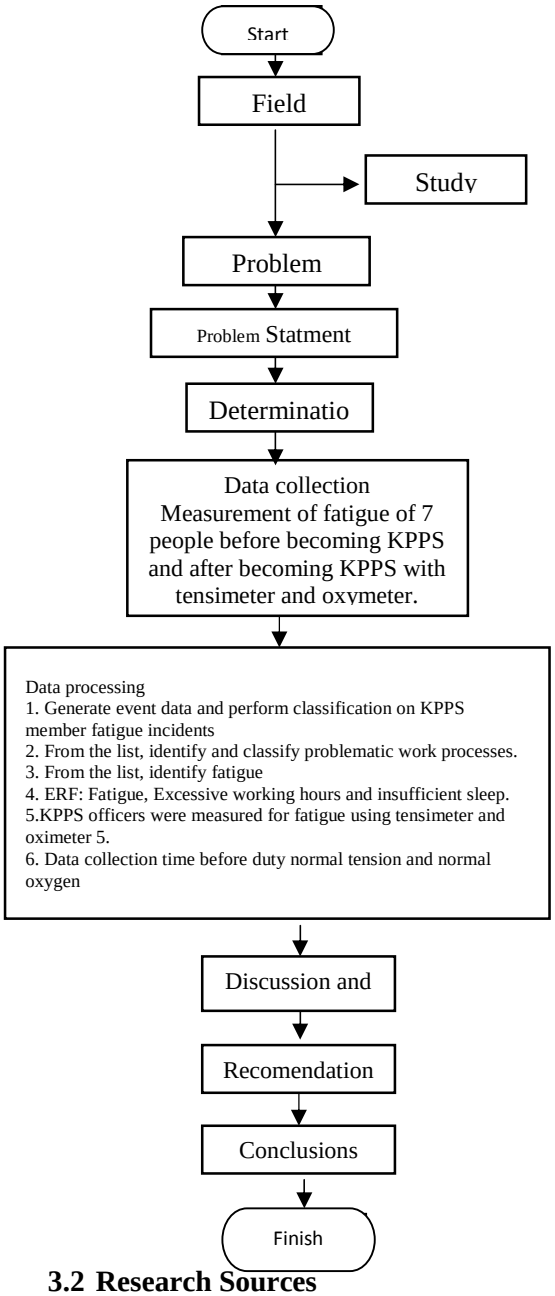
III. Research Methods

3.1 Flow Chart



3.2 Research Sources

Basically, research subjects are respondents or people who respond to a treatment given to them. The term respondent is then called an informant or person who provides information about the data the researcher wants related to the research being carried out. Then there were 7 people who became research subjects: 1 KPPS Chairman, and 6 KPPS members.

3.3 Data Processing

The data collection methods used in this study are:

1. Observation, which is a method for obtaining data, by direct observation of the actual situation of KPPS officers at TPS 07 located in the Cerme Region, Gresik Regency.
2. Interview is a data collection technique that involves direct questions to KPPS officers while they are working on tasks that can help explain the problem being studied.
3. Primary Data, Is data taken directly from the results of the tensimeter and oximeter.
4. Literature study is a research stage in which people search, collect, read, and study information from various sources related to the research topic. Literature studies are conducted to obtain research findings that are relevant to the research topic. Thus, this literature study produces a theory about the problem to be discussed.

3.4 Data Analysis

In the data processing process there are stages in this research, namely:

1. List and categorize the incidence of fatigue of KPPS officers,
2. The most problematic workplaces are identified and classified from the list of events.
3. From the list of events, the identification and classification of KPPS members' fatigue is carried out
4. Determine ergonomic risk factors (ERFs) on the most challenging workload through research on fatigue, excessive working hours, and sleep deprivation.
5. Analysis and Discussion: The results from the previous subsections are analyzed and discussed to determine whether the

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research findings meet the objectives.

6. After knowing the results of the analysis at the data processing stage, the data becomes the basis for improving the current conditions as KPPS officers. This research will improve the current scheme by creating a larger layout drawing and identifying the associated ergonomic risk factors (ERFs) at the work site.
7. The conclusion of this research can be made based on the results of data processing, analysis, and discussion.

3.5 Research Time

This research was conducted in the TPS 07 area located in the Cerme Region, Gresik Regency. The research was conducted on January 25 - February 15, 2024.

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