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Raw Material Warehouse Layout Model To Improve Storage Effectiveness at PT. Papertech Indonesia Unit II Magelang

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Abstract – PT. Papertech Indonesia Unit II is a recycled paper factory that orders raw materials *Old Corrugated Container* (OCC) and *Mix Waste* (MW) is carried out every day, as a result the raw material storage warehouse often experiences excess capacity, so that its arrangement is often irregular. In order to optimize the utilization of the storage warehouse at PT. Papertech Indonesia Unit II Magelang, it is necessary to carry out a design model for the layout of the facility. One of the objectives of designing the layout of the facility is more effective use of space. The design in this study uses the method *Dedicated Storage*. The results of arranging paper raw materials in the warehouse using the method *Dedicated Storage* through addition *material handling* obtained a time effectiveness of 27%. Cost *material handling* The proposal obtained a 9% reduction in cost efficiency. Travel distance *material handling* on the proposed layout by 34%, with the warehouse storage capacity increasing by 10%. The proposed raw material storage warehouse layout is based on the method *Dedicated Storage* consists of 8 blocks, in one block consists of 6 areas, each area consists of 50 slots. The total number of slots that can be accommodated is 2,400 slots, resulting in a 25% increase in slot capacity. The floor area requirement for storing raw materials is 87.78 m x 62.24 m or 5,463 m^2thus increasing the utilization of the warehouse area by 7%. The remaining unused warehouse area is 1,662 m^2 with a percentage of remaining area of 23.32% and utilization of the remaining unused area of 20%.

Keywords: Facility Layout, Dedicated Storage, Material Handling

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1. Introduction

PT. Papertech Indonesia Unit II Magelang is a recycled paper factory which utilizes cardboard and used paper to be processed into semi-finished paper. Seeing paper production. The purpose of establishing PT. Papertech in Indonesia is to advance the recycled paper industry which is still rare in the market. To meet the needs and satisfaction of consumers, the company increases its production but there are still problems in the production process in the form of waste.

world is currently increasing rapidly so that companies are required to be able to survive and always increase their effectiveness and efficiency in running the production process. One of the factors that can affect the ineffectiveness and inefficiency of productivity is the existence of*waste*in the production process. Waste is any process or activity that does not provide added value.*Waste* is an activity that needs to be eliminated so that the production process runs smoothly (Majori, 2017).

Types of waste that do not add value include defects, waiting, unnecessary inventory, improper processes, unnecessary motion, transportation, and excess production (Besterfield, D., 2004). The production capacity of PT. Papertech Indonesia Unit II Magelang per month averages 1,825,389 kg, with an average amount of raw materials of 1,841,577 kg per month. From the data on the arrival of raw materials in December, there were 681,338 tons of Mix Waste (MW) and also 1,160,239 tons of Old Corrugated Container (OCC). However, the procurement of raw materials often does not pay attention to the needs of the production process. Ordering of OCC and MW raw materials is done every day, as a result the raw material storage warehouse often experiences excess capacity and is often not organized, some areas of raw materials are difficult to reach by Forklift. This can be said to be one type of waste that occurs because Unnecessary inventory or inventory exceeding the warehouse volume that has been determined.

PT. Papertech Unit II Magelang has a very large paper raw material storage warehouse with an overall dimension of 95 m x 75 m with the dimensions of the stored raw materials being 1.2m x 1m x 1m.

Another problem is the distance of moving goods that

is too far and the placement of raw materials that do not have arrangements in arranging goods based on their type, and the absence of forklift lanes/tracks, resulting in the accumulation of goods in one place which results in damage to raw materials which ultimately causes a decrease in the quality of raw materials or waste due to defects.

In order to optimize the utilization of storage warehouses at PT. Papertech Indonesia Unit II Magelang, it is necessary to design a model for the layout of the facility

2. Method

The method in this research begins with Warehouse Area Observation and the Dedicated Method. Storage.The research stages are as follows.

2.1. Warehouse Are Observation

The type of data used in the warehouse area observation is secondary data consisting of warehouse area data, raw material stock data, raw material demand data, production capacity data and raw material usage data, and daily raw material storage data. The data used as research material is one month's data. The data collection technique used in this study was carried out by observation and documentation. The observation method is used to collect data in the paper raw material warehouse. The observations made include the raw material arrangement policy and the raw material retrieval process, as well as the production process. The data collection steps begin with measuring the warehouse area, calculating raw material stock, calculating raw material demand, calculating production capacity, calculating raw material usage, and calculating daily raw material storage

2.2. Metode Dedicated Storage

This method is called fixed and fixed storage because the location for each item has been determined. The number of storage locations for a raw material must be able to meet the maximum storage space requirements of a particular raw material. The storage space required is the total of the maximum storage requirements of each type, if the raw material stored is more than one type. The stages are as follows.

a. Calculation of average production data
b. Calculating the average production data is done on raw materials of OCC type paper consisting of paper types such as large cardboard and cardboard and MW consisting of thin paper types such as HVS paper and the like. Activities that occur in the warehouse include the process of storing and sending raw materials to the production process. The average production data is obtained from the total amount of production divided by the number of months of production.
c. Calculation of average storage data for each type of raw material.
   The data to be stored is data on the amount of raw materials entering the raw materials warehouse in the form of bundles, while the data sent is daily raw material data leaving the storage warehouse for the production process.
d. Calculation of warehouse slot and floor area requirements.
   The average storage for each type off raw material is around 1.2 meters based oon the average area of existing waste paper. While the capacity size of each slot is around 3 meters to create space for the raw material so that the quality of the raw material is maintained.
e. Throughput Measurement Material flow Handling Activities are carried out based on measurements of storage and shipping activities in the raw material warehouse on average per day.
f. Placement of raw materials/Assignment
   There are two processes in raw material placement, the first compares and ranks Throughput with Space Requirement (T/S), placing raw materials and calculating the total distance traveled. The placement of raw materials is done based on Throughput with Storage (T/S) with the greatest distance traveled, then placed at the beginning at the I/O point.
   The second process is determining the allowance aisle space for moving materials handling. Calculating T/S is needed as an initial benchmark for placing raw materials
g. Warehouse layout creation This layout design model will create an effective and efficient warehouse system for PT Papertech Indonesia Unit II Magelang.
h. Distance comparison calculation
   The comparison is made by calculating the total travel distance and total travel time for the proposed warehouse layout
i. Material Cost Calculation Handling
   Steps to calculate material costs handling, namely calculating equipment costs, fuel costs, depreciation calculations, machine costs, forklift operator costs, material cost calculation handling initial, and material cost calculations handling proposal.

3. Result and Discussion

3.1 Warehouse Area Observation

a. Warehouse Area Size

PT. Papertech Indonesia Unit II Magelang has a warehouse area for storing raw materials with an overall dimension of 95 x 75 m or equivalent to 7,125 m². The following is a picture of

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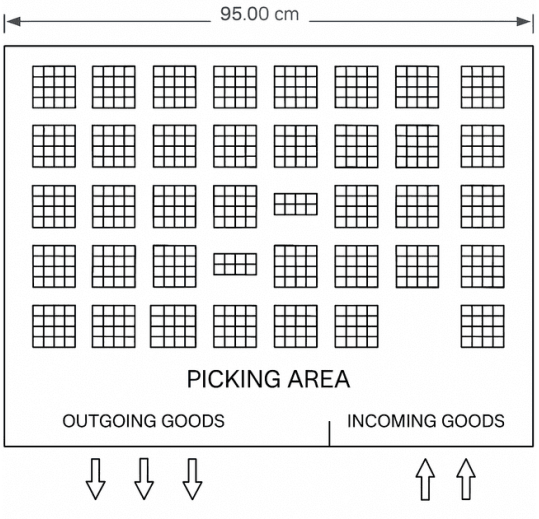

Figure 1. Current Warehouse Layout (PT. Papertech Indonesia).

Thwarehouse layout at PT. Papertech Indoneisa Unit II Magelang regarding the area to be analyzed.

b. Raw Material Dimensions
The raw materials of paper used for the recycling process at PT. Papertech Indonesia Unit II Magelang, namely OCC in the form of cardboard and MW in the form of a mixture of various types of used paper. Both have the same size, namely 1m x 1.2 m x 1m with a weight of 300 kg for each bundle.

c. Stock of Raw Material
Raw Material Stock Data at the warehouse of PT. Papertech Indonesia Unit II Magelang in December is shown in Figure 2

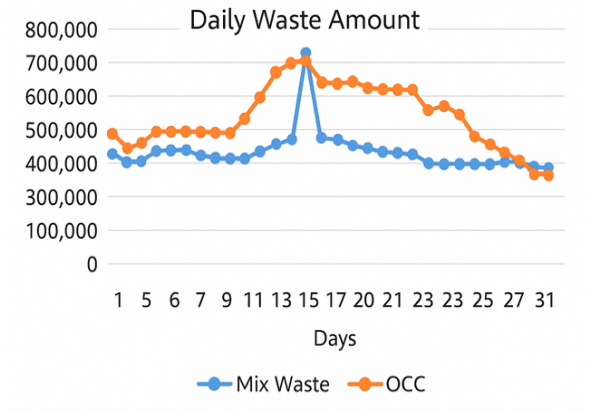

Figure 2. Raw Material Stock (PT. Papertech Indonesia)

The calculation of raw material stock is a follows

.

$$Average\ stock = \frac{Stock\ Amount\ (kg)}{number\ of\ days\ in\ 1\ month}$$

$$= \frac{27.745.949}{31} = 895.031\ kg/day$$

d. Raw Material Demand Data
Total demand for raw material paper in December 1,231,261 kg, raw material MW most frequently ordered is 952,839 kg of paper. The average demand for OCC raw material paper is 8,982 kg and MW 30,373 kg. One piece of raw material weighs 300 kg. So the average demand for OOC paper is 30 pieces and MW is 103 pieces per day.

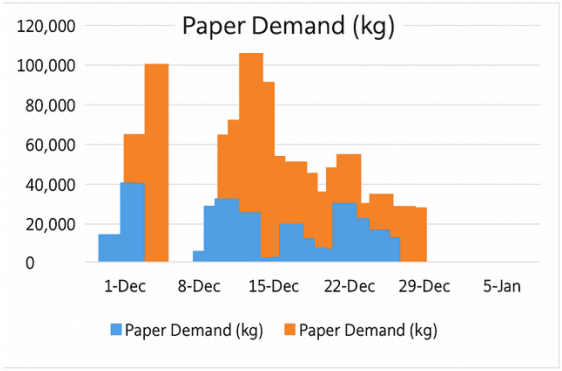

Figure 3. Paper Demand (PT. Papertech Indonesia)

The calculation of raw material paper demand is as follows

$$Average\ demand = \frac{Total\ paper\ requests\ in\ 1\ month}{number\ of\ days\ in\ 1\ month}$$

$$= \frac{1.231.261}{31} = 39{,}719\ kg/day$$

e. Production Capacity
PT. Papertech Indonesia Unit II Magelang produced 1,917,982 kg, with a downgrade rate of of 71,885 kg, downgrade is a decrease in paper quality. So, the net production produced in December was 1,841,557 kg. total production was 1,841,577 kg in December, the use of raw materials consisted of OCC of 1,160,239 kg and MW of 681,338 kg. The average use of raw materials OCC and MW per day is 125 pieces and 74 pieces. The use of raw materials per day is calculated as follows.

Average raw material usage/day

$$= \frac{total\ raw\ materials}{number\ of\ days\ in\ a\ month}$$

$$= \frac{1.841.577}{31}$$

= 59,406 kg

The average raw material used is 59,406 kg/day.

f. Daily Storage of Raw Materials
The maximum initial stock value for the OCC raw material type is 740,150 kg and the maximum initial stock value for the MW raw material type is 751,183 kg. It is known that the weight of each 1 piece of raw material is 300 kg. So the maximum

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initial stock value of OCC is 2,368 pieces and the maximum initial stock value of MW is 2,504 piece

3.2 Dedicateed Storage

a. Space Requirements

The formula used in calculating space requirements

$$Space\ Requirement = \frac{Maximum\ storage\ requirement\ per\ product\ per\ day}{Raw\ material\ storage\ capacity/slot}$$

$$Floor\ area\ requirement = space\ requirement\ x\ product\ dimensions$$

The space requirements for each type of raw material can be seen in Table 1

Table 1. Space Requirements Raw material

No.	Types of Raw Materials	Maximum Storage (Fruits)	*Space Requirement (slot)*	Floor Area Requirement (m^2)
1	OCC	2.368	790	948
2	*Mix Waste*	2.504	835	1.002
	Total		1.625	1.950

Source: Processed data

b. Througput

Throughput Calculation which is used with the following formula.

$$T = \frac{Average\ login\ activity/day}{Number\ of\ transfers\ per\ shipment} + \frac{Average\ Outgoing\ Activity/day}{Number\ of\ transfers\ per\ shipment}$$

Throughput Calculation for raw materials can be seen in Table 2.

No	Types of Raw Materials	Average entry		Average exit		Throughput (Activity)
		(fruit)	(slot)	(fruit)	(slot)	
1	OCC	30	10	125	42	52
2	*Mix Waste*	103	35	74	25	60

Source: Processed data

c.Assigment

The steps taken in placing raw materials are ranking raw materials based on the comparison of Throughput (Tj) and Storage atau Space Requirement (Sj) and determination of space allowance. Comparison of Tj and Sj raw materials in the warehouse can be seen in Table 3.

Table 3. Comparison of Throughput and Space Requirements

No	Types of Raw Materials	*Throughput* (Activity)	T/S (activity/slot)
1	*Mix Waste*	60	0,071
2	OCC	52	0,065

Source: Processed data

Setting the space allowance is needed in arranging raw materials in the warehouse. Allowance space between areas of 2.86 m and aisle width between blocks of 3.6 m which allows forklifts to move freely forward, backward or make U-turns.

d. Proposed layout

In the proposed layout, a good product placement system is implemented using the First In First Out (FIFO) technique to increase the effectiveness of distance in product movement

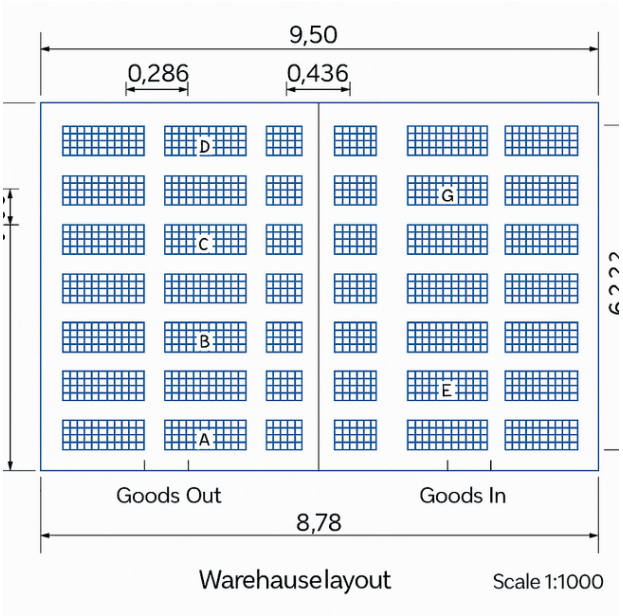

Figure 4. Proposed Warehouse Layout Design(Processed data)

The number of blocks required is 8 blocks with the number of slots being 1,625 slots. Each block will be calculated its distance from the I/O point using a straight line with the formula.

$$Dij \sqrt{[(x-a)^2 + (y-b)^2]}$$

Where:

dij = distance from facility i to facility j

x = distance of the midpoint of facility I to the x-axis (horizontal)

a = distance of the midpoint of facility j to the x-axis

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x y = distance of the midpoint of facility I to the y-axis (vertical)
b = distance of the midpoint of facility j to the y-axis

Calculation

$$Dij = \sqrt{[(x-a)^2 + (y-b)^2]}$$
$$= \sqrt{[(0-24{,}47)^2 + (0-12{,}81)^2]}$$
$$= \sqrt{598{,}7 + 164{,}1}$$
$$= \sqrt{762{,}8} = 27.61 \text{ m}$$

The calculation of the distance for placing raw materials in each block can be seen in table 4.

Table 4. Distance of Material Handling to I/O Door

No	Code Block	Activity	Distance x Activity
1	A	52	1.436
2	B	52	2.011
3	C	52	2.697
4	D	52	3.475
5	AND	60	4.302
6	F	60	4.599
7	G	60	5.044
8	H	60	5.642
	Total		29.206

Source: Processed data

e. Total Mileage

Measuring the total distance traveled on the flow of raw materials in the warehouse. The calculation of the total distance traveled is as follows.

$$Total\ Distance = Space\ Requirement \times \frac{T}{S} \times (Distance\ per\ block \div Space\ Requirement)$$

1)Preliminary Warehouse Planing Mileage
Total Distance = 2.160 x 0.094 (32.377 : 2.160+
= 3.043 m

2)Proposed Warehouse Design Mileage
Total Distance = 1.625 x 0.068 x (29.206 : 1.652)
= 1.986 m

f. Cost Material Handing

1) Equipment Cost (Fixed Cost) Forklift Specifications

Table 5. Forklift Specifications

Brand	TCM-FG 20
Purchase Price (P)	Rp. 200,000,000,-
Economic Life (N)	10 years
Residual Value (S)	Rp. 20,000,000,-
Cost *Maintenance*	Rp. 5,000,000,- / year
Fuel Type	Solar
Fuel Consumption	5 km / liter

Source: PT. Papertech Indonesia

2) Fuel Cost (Variable Cost)
Fuel cost = diesel requirement (l) per meter x current diesel price
a)Initial warehouse design fuel costs
= 32,377 x Rp 9,400 x 1/5
= Rp. 60,868,760
b)Initial warehouse design fuel costs
= 29,206 x Rp 9400 x 1/5
= Rp. 54,907,280

3)Depreciation Calculation (Fixed Cost)

$$Depreciation = \frac{forklift\ price(P) - residual\ value(S)}{N}$$
$$= \frac{200.000.000 - 20.000.000}{10}$$
$$= 18.000.000$$

4)Machine Cost
Machine Cost = Fixed Cost (Depreciation + Maintenance Cost) + Variable Cost (Fuel Cost)
a) Intial Ware House Design Machine Cost
= Rp. 18.000.000 + Rp. 5.000.000 + (32.377 x 12 x 9400 x 1/5)
= Rp. 23.000.000 + Rp. 730.425.120
= Rp. 753.425.120 per year
b) Proposed Warehouse Design Machine Cost
= Rp. 18.000.000 + Rp. 5.000.000 + (32.377 x 12 x 9400 x 1/5)
= Rp. 23.000.000 + Rp. 658.887.360
= Rp. 681.887.360 per year

5)Forklift Operator Cost
a) Initial Warehouse Design Operator Cost

$$Forklift\ Speed\ (V) = \frac{Displacement\ distance\ (m)}{time\ (t)}$$
$$= \frac{32.377\ m}{7.2\ hours}$$
= 4,497 m/h
= 4,497 km/jam

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Operator Cost = cost/hour x forklift movement operating time

$$= \text{Rp. } 10{,}812\left(\frac{X}{V}\right)$$
$$= \text{Rp. } 10{,}812\left(\frac{777.048x\ 12}{4.497}\right)$$
$$= \text{Rp } 22{,}418{,}793 \text{ per year}$$

Where
X = Fuel Cost (Variabel Cost)
V = Forklift Speed

b) Proposed Warehouse Design Operator Cost

$$\text{Speed} = \frac{29.206\ m}{7.2\ hours}$$
$$= 4{,}056 \text{ m/h}$$
$$= 4{,}056 \text{ km/jam}$$
$$\text{Operator Fees} = \text{Rp. } 10{,}812\left(\frac{X}{V}\right)$$
$$= \text{Rp. } 10{,}812\left(\frac{700.944x\ 12}{4.056}\right)$$
$$= \text{Rp. } 22{,}421{,}912 \text{ per year}$$

6) Material Cost Calculation Handling (OMH)

a) Cost Calculation on layout early
OMH = Machine Cost + Operator Cost
= Rp. 753,425,120 + Rp. 22,418,793
= Rp 775,843,913 per year

b) Cost calculation on layout proposal
OMH = Rp 681,887,360 + Rp 22,421,912
= Rp 704,309,272 per year

7) Total Time

a) Initial Total Time
Total Time = Total Distance ÷ Speed
= 3.043 m ÷ 4.497 m/jam
= 0.67 hours = 40.20 minutes

b) Total Proposed Time
Total Time = Total Distance ÷ Speed
= 1.986 m ÷ 4.056 m/jam
= 0.48 hours = 29.20 minutes

8) Remaining Area = Available area – Used area
= (95 x 75) m – (87,78 x 62,24)
= 7.125 m2 – 5.463 m2
= 1.662 m2

So the percentage of unused area for storing raw materials in the warehouse
% remaining area = (Remaining area)/(Available area) x 100%
= 1.662/7.125 x 100%
= 23,32 %

The following is a table of results showing the effectiveness and efficiency of the design results for each indicator observed

Table 6. Table of Effectiveness of Design Model Results

No	Indicator	Early plans	Draft proposal	Effectiveness	Effectiveness %
1	Floor area requirements	5.041 m^2	5.463 m^2	422 m^2	7%
2	Storage capacity	1.944 ton	2.160 ton	216 ton	10%
3	Slot capacity	1800 slot	2400 slot	600 slot	25%
4	Mileage	3.043 m	1.986 m	1.057 m	34%
5	Cost	Rp. 775,843,120	Rp. 704,309,272	Rp. 71,533,848	9%
6	Time	40.20 minutes	29.2 minutes	11 minutes	27%
7	Remaining unused area %	2.084 m^2	1.662 m^2	422 m^2	20%
8	Remaining unused area	29,24%	23,32%	5,92%	20%

4. Conclusion

1. The arrangement of paper raw materials in the warehouse of PT. Papertech Indonesia Unit II Magelang is carried out based on the Dedicated Storage method with the addition of Material handling, which obtained a time effectiveness of 27%. The proposed material handling costs obtained a decrease in cost efficiency of 9%. The travel distance of material handling in the proposed layout is 34%, with the warehouse storage capacity increasing by 10%.

2. The proposed raw material storage warehouse layout based on the Dedicated Storage method consists of 8 blocks, in one block consisting of 6 areas, each area consisting of 50 slots. The total number of slots that can be accommodated is 2,400 slots, resulting in a 25% increase in slot capacity. The floor area requirement for raw material storage is 87.78 m x 62.24 m or 5,463 m2, thus increasing the utilization of the warehouse area by 7%.
The remaining unused warehouse area is 1,662 m2 with a percentage of the remaining area of 23.32%. The utilization of the remaining unused area is 20

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