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Article

Evalution of Raw Material Management in the Warehouse Using the Shared Storage Method at PT X

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A B S T R A C T

PT X, located in Padang, is a company specializing in animal feed production, supported by a raw material warehouse that plays a critical role in its operational efficiency. This study was initiated due to inefficiencies in the current warehouse layout, particularly the improper placement of raw materials that are not grouped according to their types. The main objective of this research is to improve the efficiency of raw material retrieval and optimize the warehouse layout by organizing materials based on their classification and frequency of use. The shared storage method was employed to enable flexible storage allocation, allowing materials with different characteristics to be placed in the same area based on usage priority. Data were collected through interviews with warehouse personnel and direct observations of material flow and storage practices. The findings indicate that frequently used materials are stored too far from the production area, resulting in longer retrieval times and congestion. The proposed layout recommends repositioning these materials closer to the production entrance, with optimized distances ranging from 16.5 to 125.5 meters. This layout redesign aims to reduce material handling time and enhance overall warehouse efficiency through systematic organization based on type and usage frequency.

1. BACKGROUND

1.1. Introduction

Storage in the agro-industrial sector, particularly in animal feed production, requires an efficient warehouse system and effective storage management. A good warehouse does not necessarily need to be large; if supported by an effective storage system and inventory management, warehouse utilization can be maximized. The key aspect of a warehouse is that most raw materials must move continuously into production. Storing raw materials for extended periods can lead to quality degradation and increased storage costs. Proper warehouse layout and material placement are therefore essential.

A warehouse functions as a storage facility for various types of products, accommodating both large and small storage units during the period between production and when the products are required by customers or workstations in the production facility.

Warehouses are tasked with storing items until they are needed for production, according to the production schedule. An effective warehousing system indeed optimizes space utilization, which is crucial for preventing underutilization and minimizing overflow. a more Optimal warehouse layout can minimize material transfer distances, thereby increasing overall efficiency and effectiveness in managing warehouse space and operations (Muhamad et al, 2023).

A warehouse should be designed by considering the speed of material movement. Frequently used items should be placed closer to the retrieval point to minimize excessive movement. In warehouse storage, layout and building design significantly influence material handling efficiency (Tambunan et al, 2018). Layout planning is a common and unavoidable challenge in the industrial world, even on a smaller scale. Every industry requires proper layout planning to ensure smooth production processes and well-organized material storage.

Facility layout is defined as the arrangement of physical elements organized according to specific rules or logic. It is a subset of facility design that focuses on the organization of physical components such as machines, equipment, tables, and buildings. Facility layout planning involves designing the flow of components within a production system to create the most effective and efficient relationships among operators, equipment, and the transformation process from receiving to shipping (Apple, 1990).

PT X, located in Padang, operates in the animal feed industry. Currently, the company is experiencing issues related to the disorganized placement of raw materials within its warehouse. Many materials are scattered across the storage area, and some that should be placed near the production entrance are instead located farther away. This disorganization results in inefficiencies during material retrieval, increasing the time and effort required.

Therefore, this study aims to re-evaluate the layout and placement of raw materials in the warehouse, with a focus on optimizing material transfer distances to minimize overall warehouse and operational costs. A warehouse layout designed based on actual needs is expected to enhance company efficiency and provide a more comfortable working environment. Based on these considerations, the author was motivated to undertake this research, titled: "Evaluation of Raw Material Placement Management in the Warehouse of PT X, Padang Unit.

Given the broad scope of the issues faced by the company, and in order to ensure a more focused and structured discussion aligned with the study's objectives, this research is limited to evaluating the management of raw material placement at PT X Padang. Specifically, the study focuses on Raw Material Warehouse 3, which stores five types of raw materials: corn, CGM, SBM, PBM, and PBPM.

1.2. Research Purposes

Based on the above problems, the following problem formulation can be made:

1. How are the results of the management of the placement of raw materials in the warehouse at PT.X in Padang Unit?
2. How is the proposed layout of raw materials with *the shared storage method* in the warehouse of PT.X in Padang Unit?

2. METHODOLOGY

2.1. Research Location and Time

This research was conducted at PT. PT X is located in the Padang Kav Industrial Estate. NS. 10 Nagari Kasang, Batang Anai Padang Pariaman, West Sumatra. This research was carried out from January 13, 2020 – March 13, 2020.

2.2. Research Variabels

According to Sugiyono (2007), research variables are elements identified by researchers for investigation in order to obtain relevant information and draw conclusions. Similarly, Ridwan (2007) defines research variables as phenomena that researchers focus on and observe in a study. This study employs a single variable. As stated by Nawawi (2005), a single variable is a collection of symptoms encompassing various aspects or conditions that predominantly influence a particular situation or problem, without being associated with other variables. Accordingly, the single variable in this study is the arrangement of raw materials within the warehouse.

2.3. Data Collection Techniques

The data collection techniques in this study are:

1. Interview q

According to Sugiono (2009), an interview is a meeting of two people to exchange information and ideas through questions and answers so that the meaning in a certain topic can be constructed and with the interview, the author will know more in-depth things about the participants in interpreting situations and phenomena that occur that are impossible to find through observation.

2. Observation

It is a method that is done by observing directly or face-to-face with field supervisors, warehouse heads, operators, and other employees carried out at PT. X Padang.

3. Literature Studies

Data collection through literature studies is carried out by tracing events that have been researched by previous authors as references and references and so on. Anggraini (2024) explained that the purpose of a literature study is to collect data and theoretical insights from various sources, evaluate methodologies, and analyze existing research. This process sharpens methodology, deepens technical understanding, and informs about similar research conducted by others.

2.4. Data Processing

The analysis was carried out by comparing the theories obtained from the results of the literature study with the data obtained from the results of surveys and field studies. The data that has been collected is then processed. The method used is Shared Storage. Here are the steps in data processing Ardiansyah (2012) and Zaenuri, (2015):

1. Determining the average number of product demands, data on the number of product requests in 2019 is processed to obtain average demand data for each product.
2. The average frequency of orders for each type of product per month.
3. Number of products per order per product type per month

$$M = \frac{\sum_{i=1}^{12} D}{12} \quad (1)$$

D = Product Demand
M = Monthly Product Demand

4. Determining the need for space
5. Determinion of the required storage area

$$S = \frac{T}{P} \quad (2)$$

S = Storage space requirement
T = Total Products
P = Products Per Area

6. Determining the allowance of space.

$$\text{Diagonal} = \sqrt{(Length)^2 + (Width)^2} \quad (3)$$

7. Placement of storage areas.
8. Calculate the distance traveled by each warehouse area to each exit.

$$Dij = |x - a| + |y - b| \quad (4)$$

9. Determining and coding the storage areas hierarchically based on the shortest distance between each storage area and the exit point.

3. RESULTS AND DISCUSSION

The warehouse area of PT. X has a raw material warehouse area of 9,870 m2 with the following details:

1. The area of warehouse 1 is a feed warehouse or finished goods 48m x 65m = 3,120 m
2. The area of warehouses 2,3 and 4 is 114m x 35m = 3,990 m
3. The area of the 5.6 warehouse is, 46m x 60m = 2760 m.

However, this study only focuses on warehouse 3 which contains 5 types of raw materials, namely Corn, CGM, SBM, MBM, PBPM. A picture of the current layout condition of the Warehouse can be seen in appendix A figure 1.

3.1. Determine the average number of products per month

The number of product requests per month can be seen in the following table:

Table 1. Raw Material Demand Number

Products	1	2	3	4	5	6	7	8	9	10	11	12	Total	Average
Corn	1112	550	1095	2398	4667	2234	3027	3276	3713	582	3739	1848	28241	2.353,42
CGM	183	181	60	534	1024	415	459	444	371	452	447	461	5031	419,25
SBM	1750	1919	1807	1276	7189	4071	5449	534	4216	5276	4950	5411	43848	3.654,00
MBM	379	254	279	347	626	153	325	338	324	351	327	331	4034	336,17
PBPM	283	121	123	190	189	35	43	175	26	26	72	414	1697	141,42

$$M = \frac{\sum_{i=1}^{12} D}{12}$$

a) Corn $= \frac{28.241\ Ton}{12}$
$= 2.353,4$ ton/month

b) CGM $= \frac{\mathbf{5031\ Ton}}{\mathbf{12}}$
$= 419,25$ ton/month
≈ 419 ton/month

c) SBM $= \frac{43.848\ Ton}{12}$
$= 3.654$ ton/month

d) MBM $= \frac{4034\ Ton}{12}$
$= 336,16$ ton/month
≈ 336 ton/month

e) PBPM $= \frac{1697\ Ton}{12}$
$= 141,416$ ton/month
≈ 141 ton/month

3.2. Average Order Frequency of Each Product Type Per Month

The following is a recapitulation of the frequency of the number of demand for raw materials for making animal feed every month.

Table 2. Frequency of Demand for Raw Materials for Animal Feed Manufacturing Per Month.

Products	Frequency Number of Demand Per Month												Average
	1	2	3	4	5	6	7	8	9	10	11	12	
Corn	12	12	11	10	12	10	12	10	12	12	10	12	11
CGM	10	8	7	8	7	8	7	7	8	10	7	8	8
MBM	7	8	6	6	6	8	7	8	6	6	6	6	7
SBM	6	6	8	8	5	8	8	7	7	7	6	6	7
PBPM	7	7	7	8	6	5	5	6	6	8	8	6	7

3.3. Number of Product Per Order for Each Product Type Per Month

By knowing the average frequency of demand per month, it can be determined the number of products per order for each product. It can be seen in the following table:

Table 3. Number of Demand for Animal Feed Raw Materials Per Order

No	Products	Monthly Demand (Ton) (1)	Frequency Per Month (1)	Number of Demand Per Order (1:2)
1	Corn	2354	11	214
2	CGM	419	8	52
3	MBM	3654	7	522
4	SBM	336	7	48
5	PBPM	141	7	20
Total		6904		

3.4. Determining the need for space

The length of time between production and delivery date can be determined as the length of time a product has been in the warehouse.In determining the space needed for a warehouse, it is to know how long it takes between each shipment of each product. The length of time between production and delivery date can be determined as the length of time a product has been in the warehouse (lead time) the average production time to shipment can be seen in the following table:

Table 4. Average Shipments of Animal Feed Raw Material Suppliers (days)

No	Products	Average of delivery (days)
1	Corn	16
2	CGM	12
3	MBM	10
4	SBM	11
5	PBPM	10

The largest lead time is 16 days and the production capacity per day is 7500 tons, therefore the space requirement is 16 days, namely lead time x production capacity per day = 16 x 7500 = 120,000 tons or 120,000,000 kg in the warehouse. For the number of products in its capacity, namely with 1 sack weighing 58 kg, the total number of all products is 120,000,000 kg / 58 kg = 2,068,965 raw material products.

3.5. Determination of the Required Storage Area

The storage system utilizes pallets arranged in a plot system to optimize space usage. Products are stacked in 3 to 4 layers, with an accumulation of up to 10 to 12 pallet levels. Each plot follows a 3 x 4 configuration, resulting in 36 products per storage plot. This arrangement facilitates efficient product organization within the storage area and maximizes space utilization. Accordingly, the area required for a single storage plot is calculated as follows :

Storage area = product length x product width
Storage area = 1.01 m x 0.66 m = 0.67 m2

The amount of storage area needed is:

Storage space requirement = $\frac{2.068.965}{36}$ = 68,965 area

Space requirements for 68,965 areas are 68,965 x 0.67 = 46,206 m2

3.6. Determination of space allowance

Allowance is used as a movement path for material handling, while the material handling used in storage is human labor. The manual material handling of human power has a size p x l = 3.63m x 1.15m.

Diagonal = $\sqrt{(Length)^2 + (Width)^2}$
Diagonal = $\sqrt{(3{,}63)^2 + (1{,}15)^2}$
= 3,8 m

With this formula, an effective space allowance area is obtained as a path of movement of material handling.

3.7. Storage Area Placement

After determining the required storage space, the number of storage areas that can be accommodated within the warehouse can be calculated. The total warehouse area is 160 meters by 95 meters, amounting to 15,200 m². The layout of the storage areas within the warehouse is then arranged based on the spatial requirements, considering both the width of the warehouse and the area occupied by each storage plot.

3.8. Distance from the storage area to the door

The distance traveled between material handling is from the door (I/O) to the storage area. Distance calculation was carried out using the rectilinear distance method. The distance is measured along the track using a perpendicular (orthogonal) line to each other against the midpoint of each storage area with the formula:

$$D_{ij} = |x - a|+|y - b| \quad (5)$$

Legend:

Dij = the distance of the ij slot to the I/O point

X = the starting point of the I/O calculation on the x-axis (horizontal) (Starting from the starting point 0 i.e. the door goes into the warehouse :)

a = distance of the destination midpoint to the x-axis (Distance of the starting point to the first rack)

y = the starting point of the I/O calculation on the y-axis (vertical) (Starting from 0 y-axis calculation)

b = distance of the destination midpoint to the y-axis (height of the rack used)

Example calculation:

$D1 = |x - a|+|y - b|$

$D1 = |0 - 1.4|+|0- 1.98| = 3.38\ m$

$D2 = |x - a|+|y - b|$

$D2 = |0 - 2.1|+|0- 1.98| = 4.08\ m$

The calculation of the mileage of each storage area to the I/O point can be seen in the following table.

3.9. Area Designation Based on Closest Distance to I/O Door

In the shared storage method, the filling of storage areas is carried out based on the order of empty areas closest to the door of the production area. To make placement easier, coding is carried out. The determination of the area from closest to farthest can be seen in the following table.

After laying the area, measuring the distance and coding based on the closest distance to the door, the layout of the proposed warehouse has been completed, can be seen in the image of Appendix A.

Table 5. Distance Traveled Between Doors to Raw Material Storage Areas of Each Plot

No	Raw Material	KAV Number	Distance (m)
1	Corn 1	KAV 1	111.5
2	Corn 2	KAV 2	102
3	Corn 3	KAV 3	92.5
4	A	KAV 4	82.5
5	B	KAV 5	73
6	CGM 1	KAV 6	45
7	CGM 2	KAV 7	25.5
8	CGM 3	KAV 8	26
9	MBM 1	KAV 9	26
10	MBM 2	KAV 10	16.5
11	SBM 1	KAV 11	125.5
12	SBM 2	KAV 12	116
13	SBM 3	KAV 13	106
14	PBPM 1	KAV 14	49.5
15	PBPM 2	KAV 15	40
16	MBM 3	KAV 16	15.5
17	C	KAV 17	96.5
18	D	KAV 18	87
19	E	KAV 19	40
20	F	KAV 20	30.5

Based on the calculation results, it was found that the current raw material storage layout at PT X, is suboptimal. Many raw materials are not placed according to their designated storage plots, and materials that should be located near the production entrance are instead stored further away. The existing layout appears to be random, without consideration for the flow of materials in and out of the production area. As a result, significant time is required for raw material retrieval, leading to inefficiencies.

Moreover, forklifts must travel longer distances, increasing fuel consumption and operating labor costs, which ultimately raises operational expenses. If this issue persists, it may result in financial losses due to ineffective warehouse operations. To address these challenges, this study proposes an improvement in raw material placement by prioritizing frequently used materials to be stored closer to the production entrance, thereby facilitating quicker access when needed.

Table 6. Coding and Distance Traveled Between Doors to Raw Material Storage Areas of Each Plot

No	Raw Material	KAV Number	Distance (m)
1	MBM 2	KAV 10	16,5
2	CGM 3	KAV 8	35,5
3	MBM 1	KAV 9	26
4	F	KAV 20	30,5
5	E	KAV 19	40
6	CGM 2	KAV 7	45
7	PBPM 2	KAV 15	49,5
8	CGM 1	KAV 6	54,5
9	PBPM 1	KAV 14	59
10	MBM 3	KAV 16	68,5
11	B	KAV 5	73
12	A	KAV 4	82,5
13	D	KAV 18	87
14	Corn 3	KAV 3	92,5
15	C	KAV 17	96,5
16	Corn 2	KAV 2	102
17	SBM 3	KAV 13	106
18	Corn 1	KAV 1	111,5
19	SBM 2	KAV 12	116
20	SBM 1	KAV 11	125,5

The implementation utilizes the shared storage method and follows the FIFO (First-In, First-Out) principle. Specifically:

7. Raw materials with high usage frequency should be placed near the production entrance to streamline retrieval processes.
8. To ensure ease of identification, each storage plot should ideally contain only one type of raw material. However, if demand increases, overflow may be allocated to adjacent plots.

4. CONSCLUCSION

Based on the research that has been conducted, the following conclusions can be drawn:

1. The management of the placement of raw materials in the warehouse of PT X with the shared storage method obtained the results of the demand for raw materials with the following details: Corn = 2354, CGM = 419, SBM = 3654, MBM = 336, PBPM = 141. The average frequency of ordering raw materials every month is Corn = 11, CGM = 8, MBM = 7, SBM = 7, PBPM = 7. The number of raw material demand per month order is Corn = 214, CGM = 52, MBM = 522, SBM = 48, PBPM = 20. The storage area required by the storage area is 46,206 m2. Space allowance is 3.8m. And the placement of storage areas using the rectilinear distance method.
2. The layout of raw materials using the shared storage method in the warehouse of PT. X is the need for raw materials such as SBM and Corn are raw materials that are very often used. Therefore, it is placed near the production door based on the calculation of the distance from the rectilinear distance result. Furthermore, for CGM, MBM and PBPM raw materials, they are placed a little or somewhat far from the production warehouse door. And other raw materials such as A, B, C, D, E and F are placed far from the production door because they are rarely or not often used. SBM is placed on plots 9,10 and 20. Corn is placed on plots 7, 8 and 19. CGM is placed on plots 6, 17 and 18, MBM is placed on plots 4, 5, and 16. PBPM is placed on lots 14 and 15. Raw materials A, B, C, D, E, F are laid on lots 1, 2, 3, 11, 12, and 13.

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