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Storage Optimization at PT XY Using Class Based Storage and FSN Analysis Methods

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ABSTRACT

This research aims to make the process of picking goods according to their type easier, so that the distance of transporting materials is shorter than the previous distance. FSN Analysis classifies goods based on the frequency of demand, and Class Based Storage groups goods based on their category (FSN) and places them in strategic locations in the warehouse. In this research, changes to the warehouse layout were made manually based on the results of the FSN analysis and the application of the Class Based Storage method. The results of the FSN Analysis are 7 types of Fast moving category goods, 6 types of Slow moving category goods, and 2 types of Non-moving category goods. FSN analysis is made by sorting all frequencies of goods from the highest value, as well as cumulative calculations and frequency percentages. By comparing the initial layout with the proposed layout, data processing results in a total decrease from IDR 6.558.992,00/ month to IDR 3.825.480,00/ month, or 41,7% more efficient by using the proposed layout based on the Class Based Storage method and FSN Analysis reduce moment material handling 42%. Therefore, it can be concluded that the problem of storing goods in PT XY's warehouse will be solved if using a storage optimization policy that uses the Class Based Storage method and FSN Analysis as a review and reference material in arranging future storage layouts.

INTRODUCTION

Warehouses are an important part of a company's logistics and operations, the warehouse itself functions as for goods, both for production activities and production products (Kumar, Narkhede, & Jain, 2021). Warehouses must be treated differently in handling stored goods, depending on the type of goods stored (Mulyati, Numang, & Aditya Nurdiansyah, 2020). One of the important functions in a warehousing system is storage, which means storing goods in a warehouse before they are shipped to buyers. (Tien, Anh, & Thuc, 2019). Reorganizing the layout of materials in the warehouse is one way to improve the storage function because the main purpose of storage is to maximize the use of warehouse resources, such as space, to meet customer needs (Kemklyano, Harimurti, & Purnaya, 2021).

Many industrial companies today have many products produced, so they need a lot of storage space, resulting in several obstacles in the placement of goods in the warehouse, such as, goods stored sometimes do not match the designated place, the placement of goods on the empty side of the warehouse entrance creates a buildup that hinders the process of getting in and out of goods and the distance between items that are not the same makes the goods untidy (Aulia, Gusti, Novenica, & Juniardi, 2020). The wide variety of products a company has can lead to overstocking, which can increase storage costs, lack of space for other goods, or expired product costs that can lead to direct or indirect financial losses (Kumar & Shukla, 2022). This research focuses on the Finished Good Warehouse department, which in this division is a department that provides various types of goods or finished products of the company which will later be sold in the market. From the data on the total number of goods in the finished goods warehouse at PT XY, there are a total of approximately 6000 types of goods in the initial grouping data. There are findings of several items that do not have a clear place or area so that the items are stored randomly in the storage area. The process of retrieving goods in the warehouse takes a lot of time and is ineffective in the process of retrieving goods and the process of receiving incoming goods, and there is a higher possibility of errors in the placement and retrieval of goods. Warehouse space may not be used optimally because there is no careful planning and items that are often moved have the potential for excessive damage.

The class-based storage method involved grouping products into three classes (A, B, C) based on their Pareto-based activity levels, with the highest activity group (A) placed closest to the entrance/exit (Nursyanti, Marlina, & Widyasari, 2024). The proposed layout resulted in a significant reduction in the distance traveled by the products, from 3228.67 m to 2791.2 m for SKM products and from 432.8 m to 641 m for SKT products (Ulum, 2022). The FSN analysis led to a maximum of 4,482 units of goods needing repair before the warehouse layout was optimized, and after the repairs, 5,500 units were optimized, resulting in a 30% efficiency improvement in search time and mileage (Aulia, Gusti, Novenica, & Juniardi, 2020). The application of the FSN Analysis method was found to be very useful in guiding the purchasing and ordering of spare parts at Agung Toyota Tabanan, the method helped the company recategorize parts and maintain optimal inventory levels based on the actual movement of parts over time (Harthawan, Manuaba, & Pratama, 2024). The purpose of this study is to determine the initial layout conditions by identifying storage and retrieval costs in the current conditions. So that it can be used to calculate the proposed layout starting from storage costs, and goods movement moments.

RESEARCH METHODS

This research uses a research method that refers to the framework of the Class Based Storage method and FSN analysis, this method performs placement based on the frequency of movement, material handling cost, and FSN classification. This research uses 15 random samples of goods in the finished goods warehouse. The first step in evaluating the layout of warehouse facilities is to analyze the initial layout which is the object of research (Novira, Febrian, Saputra, & Prasetyo, 2023). The initial phase of the warehouse layout evaluation involved an in-depth analysis of the initial layout that adopted a block pattern with palletized storage using a random storage system. This layout, although simple, had a disadvantage in terms of efficiency due to the lack of consideration for the frequency of goods access. As a result, the time and distance traveled by workers in picking and putting away activities tend to be longer, thus increasing operational costs. In a random storage system, there are no specific rules in the placement of pallets, making it difficult to find specific items.

The following are the steps using FSN analysis to determining the class of warehousing that moves fast (F), slow (S) and non-moving (N) categories, It involves combining attributes, computing sell-through rates, and applying specific guidelines to determine each class. FSN analysis is used to group items based on inventory rotation (May, Atkinson, & Ferrer, 2019). The clustering results of the FSN analysis will be used as the basis for determining the number of classes in the CBS method which will get three classes as the final result. The division of classes by the FSN analysis method is very relevant to the CBS method where the FSN method helps identify slow-moving goods or overstocked goods so that corrective action can be taken, the combination of both increases the efficiency of warehouse space usage and reduces operational costs (Aulia, Gusti, Novenica, & Juniardi, 2020).

FSN analysis involves steps like listing materials, estimating frequency, calculating final frequency and average inventory, determining turnover ratio and period, sorting results, and grouping materials. Class Based Storage method includes calculating frequency of incoming and outgoing goods, determining material handling moment, and calculating material handling costs. Finally, the proposed layout is analyzed and visualized based on FSN classification and Class Based Storage results (Aulia, Gusti, Novenica, & Juniardi, 2020).

RESULTS AND DISCUSSION

Initial Layout Analysis

PT XY has several types of warehouses: finished goods, production, and receiving. The finished goods warehouse uses a pallet system and forklifts to move materials.The layout of the finished goods warehouse is as follows.

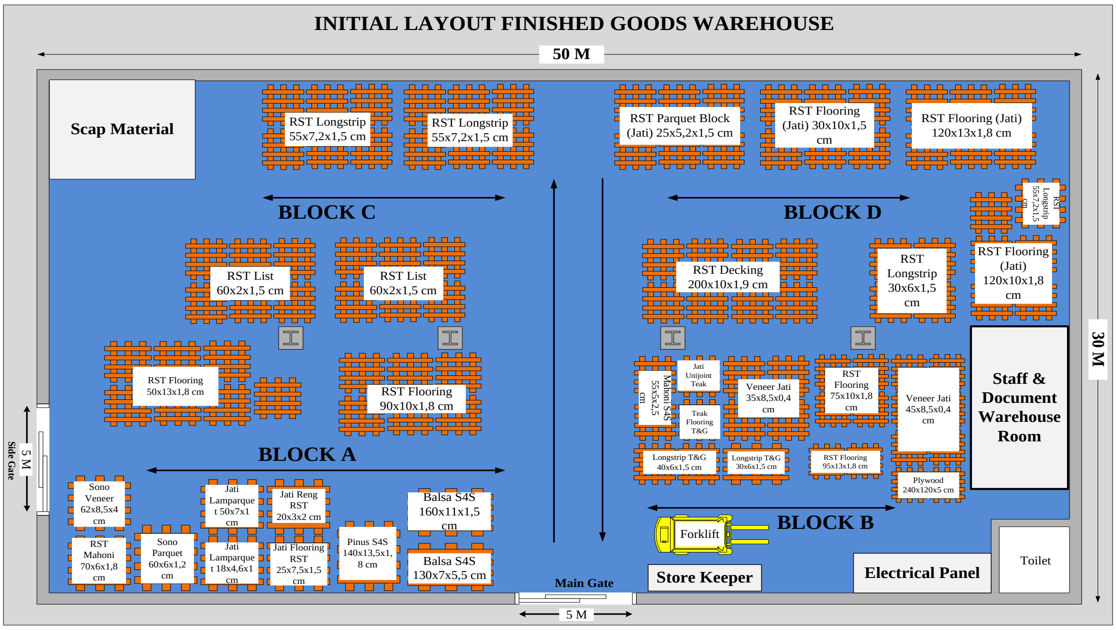

Figure 1. Initial Layout of Finished Goods Warehouse
Source : Initial Layout PT XY.

Description :

1. Block A: Build-up of RST Mahogany, Teak Lamparquet, and Teak Flooring RST in inaccessible locations.
2. Block B: Build-up of Unijoint Teak, Teak Flooring T&G, and Teak Veneer in inaccessible locations.
3. Block C: Contains RST Longstrip, RST List, and scrap materials.
4. Block D: Build-up of RST Longstrip in an incorrect location, causing delays in shipping..

Calculation of Displacement Frequency of the Initial Layout Finished Goods Warehouse

The frequency of finished product movement is calculated where the number of products shipped in and out is then converted into storage units based on the average item size and pallet capacity, which is explained as follows.

$$Item\ In\ or\ Item\ Out = \frac{Average\ In\ or\ Out\ Items}{Goods\ in\ area} \quad (1)$$

$$Frequency = Initial\ Inventory + Total\ Item\ In + Total\ Item\ Out \quad (2)$$

Table 1. Frequency of Goods Movement Count Results

Item Name	Average In (m³)	Average Out (m³)	Goods In 1 area per pallets (m³)	Initial Inventory	Frequency		Total Frequency
					Item In	Item Out	
Balsa S4S 160x11x1,5 cm	9,18	2,912	1,53	3	6	2	11
Pinus S4S 140x13,5x1,8 cm	6,12	2,25625	1,53	3	4	2	9
Jati Reng RST 20x3x2 cm	9,18	3,98475	1,53	3	6	3	12
Sono Veneer 62x8,5x4 cm	4,59	1,404	1,53	2	3	1	6
Longstrip T&G 40x6x1,5 cm	9,18	2,34	1,53	3	6	2	11
Veneer Jati 35x8,5x0,4 cm	0	1,6	1,53	30	0	2	32
RST Flooring 95x13x1,8 cm	6,12	2,5	1,53	2	4	2	8
Veneer Jati 45x8,5x0,4 cm	9,18	1,32	1,53	2	6	1	9
RST List 60x2x1,5 cm	38,25	34,155	1,53	4	25	23	52
RST Longstrip 55x7,2x1,5 cm	58,14	56,265	1,53	4	38	37	79
RST Parquet Block (Jati) 25x5,2x1,5 cm	12,24	9,438	1,53	2	8	7	17
RST Decking 200x10x1,9 cm	24,48	22,4	1,53	6	16	15	37
RST Flooring (Jati) 30x10x1,5 cm	64,26	58,08	1,53	6	42	38	86
RST Flooring (Jati) 120x13x1,8 cm	29,07	26,91	1,53	6	19	18	43
RST Flooring (Jati) 120x10x1,8 cm	33,66	28,08	1,53	5	22	19	46
Total							**458**

Source : Data of Goods In and Out of PT XY

FSN Analysis (Based on Inventory Demand)

FSN analysis is a method to categorize inventory items into Fast, Slow, and Non-Moving categories based on factors like sell-through rates and specific guidelines (Inventory Categorization Using Multiple Criteria Classification) (Wasnik & Gidwani, 2020). In FSN analysis products are classified by stock rotation or demand, divided into three groups: fast, slow, and stationary (Elquthb, Nugroho, & Khasanah, 2024). Class classification is determined based on TOR (Turn Over Ratio), which is the ratio of annual raw material usage to average warehouse inventory (Elquthb, Nugroho, & Khasanah, 2024). In this FSN analysis method, TOR value is calculated by dividing warehouse stock by average inventory (Elquthb, Nugroho, & Khasanah, 2024). The following is the formula for calculating the FSN Analysis.

$$Ending\ Inventory = Initial\ Inventory + Input - Output \quad (3)$$

$$Average\ Inventory = \frac{Initial\ Inventory + Ending\ Inventory}{2} \quad (4)$$

$$Turn\ Over\ Ratio\ Obs.Period = \frac{Amount\ of\ Item\ Used}{Average\ Inventory} \quad (5)$$

$$Inventory\ Period = \frac{Number\ Days\ of\ Observation\ Period}{TORp} \quad (6)$$

$$Turn\ Over\ Ratio = \frac{Number\ Days\ of\ per\ Year}{Inventory\ Period} \quad (7)$$

Table 2. Classification Result of FSN Analysis

Item Name	Ending Inventory (EI)	Average Inventory (AI)	Turnover Ratio Obs Period (TORp)	Inventory Period	Turnover Ratio (TOR)	Class
RST Longstrip 55x7,2x1,5 cm	5	4,5	8,2	10,95	33,346	F
RST Flooring (Jati) 30x10x1,5 cm	10	8,0	4,8	18,95	19,264	F
RST List 60x2x1,5 cm	6	5,0	4,6	19,57	18,656	F
RST Flooring (Jati) 120x10x1,8 cm	8	6,5	2,9	30,79	11,855	F
RST Parquet Block (Jati) 25x5,2x1,5 cm	3	2,500	2,8	32,14	11,356	F
RST Flooring (Jati) 120x13x1,8 cm	7	6,500	2,8	32,5	11,231	F
RST Decking 200x10x1,9 cm	7	6,5	2,3	39	9,359	F
Jati Reng RST 20x3x2 cm	6	4,5	0,7	135	2,704	S
RST Flooring 95x13x1,8 cm	4	3	0,667	135	2,704	S
Pinus S4S 140x13,5x1,8 cm	5	4	0,5	180	2,028	S
Balsa S4S 160x11x1,5 cm	7	5	0,4	225	1,622	S
Longstrip T&G 40x6x1,5 cm	7	5	0,4	225	1,622	S
Sono Veneer 62x8,5x4 cm	4	3	0,3	270	1,352	S
Veneer Jati 45x8,5x0,4 cm	7	4,5	0,2	405	0,901	N
Veneer Jati 35x8,5x0,4 cm	28	29	0,1	1305	0,280	N

Based on TOR values, items in the Fast class (TOR >3, 7 items) should be prioritized for placement near entrances/exits. Slow class items (TOR 1-3, 6 items) and Immobile class items (TOR <1, 2 items) can be placed less accessibly.

Calculation of Moment Material Handling for the Initial Layout

The distance of material handling is calculated from the main door to the storage location, starting from the moment of unloading incoming goods (Rahmandhani & Ekoanindiyo, 2023). The following is the data obtained from direct measurements at PT XY with the object of measuring the finished goods warehouse to the loading and unloading place. The formula is as follows.

Explanation for table 3:

a. A is the place where goods enter (main door) or the place of loading and unloading.

b. Z is the area where items are placed in the warehouse.

$$Moment\ Material\ Handling = Frequency \times Distance \quad (8)$$

Table 3. Calculation of Moment Material Handling Initial Layout

No	Item Name	From	To	Frequency		Distance (m)	Momment Materials Handling	
				In	Out		In	Out
1	Balsa S4S 160x11x1,5 cm	A	Z	6	2	12,5	75	25
2	Pinus S4S 140x13,5x1,8 cm	A	Z	4	2	15	60	30
3	Jati Reng RST 20x3x2 cm	A	Z	6	3	17,5	105	52,5
4	Sono Veneer 62x8,5x4 cm	A	Z	3	1	26,5	79,5	26,5
5	Longstrip T&G 40x6x1,5 cm	A	Z	6	2	11,5	69	23
6	Veneer Jati 35x8,5x0,4 cm	A	Z	0	2	15	0	30
7	RST Flooring 95x13x1,8 cm	A	Z	4	2	17,5	70	35
8	Veneer Jati 45x8,5x0,4 cm	A	Z	6	1	21	126	21
9	RST List 60x2x1,5 cm	A	Z	25	23	38,5	962,5	885,5
10	RST Longstrip 55x7,2x1,5 cm	A	Z	38	37	59,5	2261	2201,5
11	RST Parquet Block (Jati) 25x5,2x1,5 cm	A	Z	8	7	29,5	236	206,5
12	RST Decking 200x10x1,9 cm	A	Z	16	15	30	480	450
13	RST Flooring (Jati) 30x10x1,5 cm	A	Z	42	38	35,5	1491	1349
14	RST Flooring (Jati) 120x13x1,8 cm	A	Z	19	18	41,5	788,5	747
15	RST Flooring (Jati) 120x10x1,8 cm	A	Z	22	19	42	924	798
Amount							**7727,5**	**6880,5**
Total							**14608**	

From the results of the calculation on the moment material handling layout proposed, the following calculations are obtained:

$$\sum \textit{Moment Haterial Handling} = \sum \textit{MMH in} + \sum \textit{MMH out} \quad (9)$$

$\sum$ *Moment Material Handling* = 7727,5+ 6880,5 = 14.608 m/month.

Calculation of Material Handling Costs for the Initial Layout

Expenses for material management in the finished goods warehouse division of PT XY are costs associated with handling materials in the warehouse. The processes of receiving, storing, and handling materials within a warehouse all involve costs (Choernelia & Yohanes, 2022). If the material handling movement is done semi-manually using human labor and forklift vehicles, the following calculation of material handling costs uses the worker salary and vehicle component:

1. The number of employees working in the warehouse at PT XY has 4 employees.
2. For warehouse employee salary per month IDR 3,800,000.00.
3. A total of 25 working days are considered effective days per month.
4. The average usage time of a forklift vehicle is 6 hours.
5. The price of diesel fuel is IDR 6,800/liters and fuel consumption hourly 2.7 liters.
6. Salary for 4 workers.

$$\frac{\textit{Employee Salary/Month x Number of Employee}}{\textit{Number of Working Days}} \quad (10)$$

$$= \frac{\text{IDR 3.800.000 x 4}}{25} = \frac{\text{IDR 15.200.000}}{25} = \text{IDR 608.000/Day.}$$

7. Worker salary for 1 worker.

$$\frac{Salary\ for\ All\ Workers/day}{Number\ of\ Workers} \quad (11)$$

$$= \frac{\text{IDR } 608.000}{4} = \text{IDR } 152.000/\text{Day.}$$

8. Moving distance/day.

$$\frac{\Sigma\ Moment\ Material\ Handling}{25\ Day} \quad (12)$$

$$= \frac{14.608}{25} = 584{,}32\ \text{m/Day.}$$

9. Human Cost/m.

$$\frac{\sum Salary/Day}{Moving\ Distance/Day} \quad (13)$$

$$= \frac{\text{IDR } 152.000}{584{,}32} = \text{IDR } 260{,}1314/\text{m}$$

10. Total Fuel Consumption Cost of the Transport Vehicle.

$$Average\ usage\ time\ x\ Fuel\ price\ x\ Total\ fuel\ consumption\ per\ Hours \quad (14)$$

$$= 6\ \text{Hour x IDR } 6.800{,}00 \text{ x } 2{,}7\ \text{Liters} = \text{IDR } 110.160$$

11. Transport Vehicle Cost/m.

$$\frac{\sum Total\ Fuel\ Consumption}{Moving\ Distance/Day} \quad (15)$$

$$= \frac{\text{IDR } 110.160}{584{,}32} = \text{IDR } 188{,}5268/\text{m}$$

12. Material Handling Cost.

$$Human\ Cost/m + Transport\ Vehicle\ Cost/m \quad (16)$$

$$= \text{IDR } 260{,}1314 + \text{IDR } 188{,}5268 = \text{IDR } 448{,}6582694 = \text{IDR } 449/\text{m}$$

The following formulas and tables show the material transportation costs for the initial layout.

$$Total\ Material\ Handling\ Cost = Frequency\ x\ Distance\ x\ Material\ Handling\ Cost \quad (17)$$

Table 4. Calculation of Material Handling Costs for the Initial Layout

Item Name	From	To	Frequency		Distance (m)	MHC (IDR/m)	Total MHC (IDR/Month)	
			In	Out			In	Out
Balsa S4S 160x11x1,5 cm	A	Z	6	2	12,5	449	33.675	11.225
Pinus S4S 140x13,5x1,8 cm	A	Z	4	2	15	449	26.940	13.470
Jati Reng RST 20x3x2 cm	A	Z	6	3	17,5	449	47.145	23.573
Sono Veneer 62x8,5x4 cm	A	Z	3	1	26,5	449	35.696	11.899
Longstrip T&G 40x6x1,5 cm	A	Z	6	2	11,5	449	30.981	10.327
Veneer Jati 35x8,5x0,4 cm	A	Z	0	2	15	449	0	13.470
RST Flooring 95x13x1,8 cm	A	Z	4	2	17,5	449	31.430	15.715
Veneer Jati 45x8,5x0,4 cm	A	Z	6	1	21	449	56.574	9.429

RST List 60x2x1,5 cm	A	Z	25	23	38,5	449	432.163	397.590
RST Longstrip 55x7,2x1,5 cm	A	Z	38	37	59,5	449	1.015.189	988.474
RST Parquet Block (Jati) 25x5,2x1,5 cm	A	Z	8	7	29,5	449	105.964	92.719
RST Decking 200x10x1,9 cm	A	Z	16	15	30	449	215.520	202.050
RST Flooring (Jati) 30x10x1,5 cm	A	Z	42	38	35,5	449	669.459	605.701
RST Flooring (Jati) 120x13x1,8 cm	A	Z	19	18	41,5	449	354.037	335.403
RST Flooring (Jati) 120x10x1,8 cm	A	Z	22	19	42	449	414.876	358.302
Amount							**3.469.648**	**3.089.345**
Total							**6.558.992**	

In the calculation of material handling costs for the initial layout, it was found that the amount of costs borne was IDR 6.558.992,00 by PT XY in the implementation of warehouse operations.

Proposed Layout Analysis

To optimize picking efficiency, fast-moving goods are placed near the door, slow-moving goods in the middle, and non-moving goods at the back. This arrangement is based on frequency data (Table 3) and FSN analysis (Table 2).

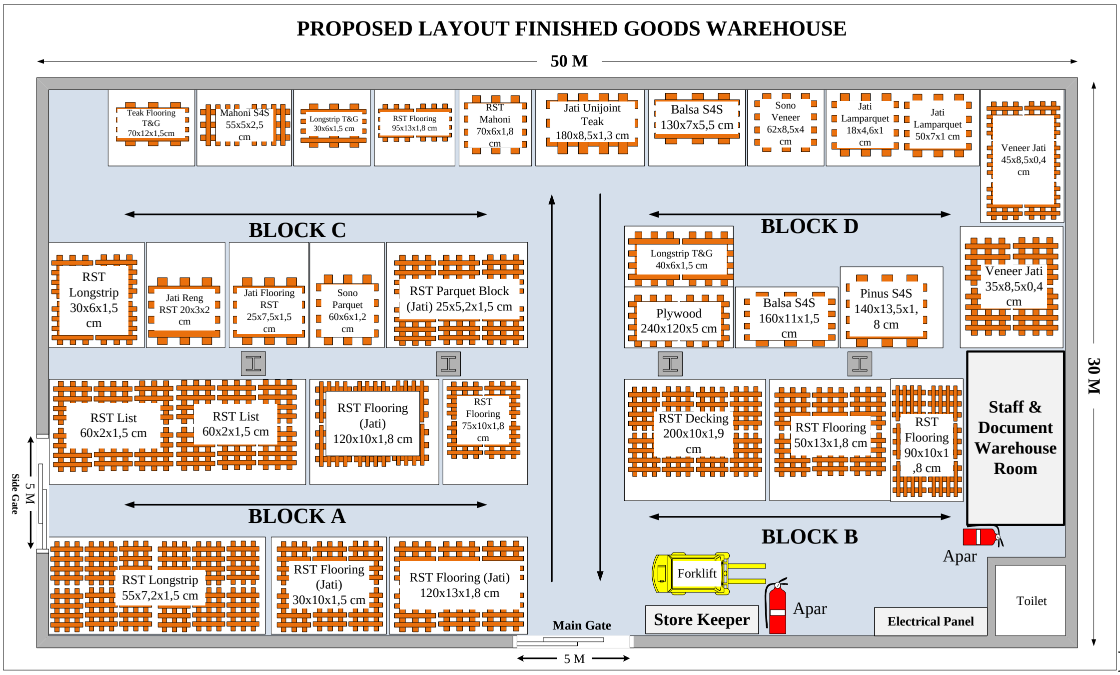

Figure 2. Proposed Layout of Finished Goods Warehouse.

Description :

1. Fast-moving goods will be prioritized in Blocks A and B.
2. Medium and slow-moving goods will be stored in Blocks C and D.
3. Unused space for scrap materials will be repurposed for storage.
4. Clear labeling will be implemented to improve item identification.

Calculation of Moment Material Handling for the Proposed Layout

Table 5. Calculation of Moment Material Handling for the Proposed Layout

Item Name	From	To	Frequency		Distance (m)	Momment Materials Handling	
			In	Out		In	Out
RST Longstrip 55x7,2x1,5 cm	A	Z	38	37	26,5	1007	980,5
RST Flooring (Jati) 30x10x1,5 cm	A	Z	42	38	17,5	735	665
RST List 60x2x1,5 cm	A	Z	25	23	26,5	662,5	609,5
RST Flooring (Jati) 120x10x1,8 cm	A	Z	22	19	17,5	385	332,5
RST Parquet Block (Jati) 25x5,2x1,5 cm	A	Z	8	7	29,5	236	206,5
RST Flooring (Jati) 120x13x1,8 cm	A	Z	19	18	14,5	275,5	261
RST Decking 200x10x1,9 cm	A	Z	16	15	14,5	232	217,5
Jati Reng RST 20x3x2 cm	A	Z	6	3	38,5	231	115,5
RST Flooring 95x13x1,8 cm	A	Z	4	2	29,5	118	59
Pinus S4S 140x13,5x1,8 cm	A	Z	4	2	35,5	142	71
Balsa S4S 160x11x1,5 cm	A	Z	6	2	32,5	195	65
Longstrip T&G 40x6x1,5 cm	A	Z	4	2	35,5	142	71
Sono Veneer 62x8,5x4 cm	A	Z	3	1	29,5	88,5	29,5
Veneer Jati 45x8,5x0,4 cm	A	Z	6	1	43	258	43
Veneer Jati 35x8,5x0,4 cm	A	Z	0	2	43	0	86
Amount						**4707,5**	**3812,5**
Total						**8520**	

From the results of the calculation on the moment material handling layout proposed, the following calculations are obtained:

$$\sum Moment\ Haterial\ Handling = \sum MMH\ in + \sum MMH\ out \quad (18)$$

$\sum$ Moment Material Handling = 4707,5 + 3812,5 = 8520 m/month

Based on the calculation, The proposed layout requires 6088 m less distance for material handling per month compared to the initial layout.By using the proposed item placement can reduce moment material handling by:

$$Decreased\ Moment\ Material\ Handling\ (\%) = \frac{Initial\ MMH - Proposed\ MMH}{Initial\ MMH}\ x\ 100\% \quad (19)$$

Decreased Moment Material Handling (%) = $\frac{14.608-8.520}{14.608}$ x 100% = 42%

The improved layout reduces material handling moment by 42%, making it more efficient.

Calculation of Material Handling Costs for the Proposed Layout

Table 6. Calculation of Material Handling Costs for the Proposed Layout

Item Name	From	To	Frequency		Distance (m)	MHC (IDR/m)	Total MHC (IDR/Month)	
			In	Out			In	Out
RST Longstrip 55x7,2x1,5 cm	A	Z	38	37	26,5	449	452.143	440.245
RST Flooring (Jati) 30x10x1,5 cm	A	Z	42	38	17,5	449	330.015	298.585
RST List 60x2x1,5 cm	A	Z	25	23	26,5	449	297.463	273.666
RST Flooring (Jati) 120x10x1,8 cm	A	Z	22	19	17,5	449	172.865	149.293
RST Parquet Block (Jati) 25x5,2x1,5 cm	A	Z	8	7	29,5	449	105.964	92.719
RST Flooring (Jati) 120x13x1,8 cm	A	Z	19	18	14,5	449	123.700	117.189
RST Decking 200x10x1,9 cm	A	Z	16	15	14,5	449	104.168	97.658
Jati Reng RST 20x3x2 cm	A	Z	6	3	38,5	449	103.719	51.860
RST Flooring 95x13x1,8 cm	A	Z	4	2	29,5	449	52.982	26.491
Pinus S4S 140x13,5x1,8 cm	A	Z	4	2	35,5	449	63.758	31.879
Balsa S4S 160x11x1,5 cm	A	Z	6	2	32,5	449	87.555	29.185
Longstrip T&G 40x6x1,5 cm	A	Z	4	2	35,5	449	63.758	31.879
Sono Veneer 62x8,5x4 cm	A	Z	3	1	29,5	449	39.737	13.246
Veneer Jati 45x8,5x0,4 cm	A	Z	6	1	43	449	115.842	19.307
Veneer Jati 35x8,5x0,4 cm	A	Z	0	2	43	449	0	38.614
Amount							**2.113.668**	**1.711.813**
Total							**3.825.480**	

To calculate material handling costs for the proposed layout, we use the previous result of IDR 449/m. The cost of material handling for PT XY while putting the proposed warehouse layout in operation is IDR 3.825.480,00.

Based on the calculation, the proposed layout plan saves IDR 2.733.512,00 in material handling costs per month. By using the proposed item placement can reduce material handling costs by:

$$Decreased\ Material\ Handling\ Costs\ (\%) = \frac{Initial\ MHC - Proposed\ MHC}{Initial\ MHC}\ x\ 100\% \qquad (20)$$

$$\text{Decreased Material Handling Costs (\%)} = \frac{6.558.992 - 3.825.480}{6.558.992} \text{ x } 100\% = 41{,}7\%$$

After the calculation can be concluded that the proposed layout is more efficient, reducing material handling costs by 41,7%.

CONCLUSION

Based on the analysis and discussions carried out, that 7 items are Fast Moving, 6 are Slow Moving, and 2 are Non-Moving, based on FSN analysis. Improper storage and grouping of goods in the finished goods warehouse hinder smooth warehouse operations, causing inefficiencies in receiving and dispatching processes. Based on the calculations to identify the layout of PT XY facilities, the first plan results in total material handling costs of IDR 6.558.992,00 per month. From loading and unloading (main door) to item placement, the proposed plan costs IDR 3.825.480,00 per month. This proposed layout is more efficient to use because it can reduce material handling costs 41,7% and reduces material handling moment by 42%, making it more efficient than initial layout.

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