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DESIGN ANALYSIS OF MATERIAL LAYOUT IN WH02 PT. XYZ TO MINIMIZE WASTE USING CLASS BASED STORAGE POLICY

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ABSTRACT

The business process at PT. XYZ is supported by various divisions with its own functions. One of the mentioned divisions is the Logistic division. This division manages the procurement of goods and services for the mining process. One of the subdivisions in Logistics is the warehouse. Warehouse handles incoming items and items that will be distributed to users. To meet user needs, warehouse operations must be optimized by reducing inefficient activitie. However, in reality, several problems are still found from various indications of waste that cause delays in warehouse operational processes. In this study, a waste analysis is conducted using the Waste Assessment Model to determine the percentage of each waste that occurs in warehouse activities and to identify the type of waste with the greatest impact for potential improvement. The identification results show the percentage for each type of waste, including waste overproduction 14,21%, waste inventory 15,25%, waste defect 12,41%, waste motion 13,48%, waste transportation 12,92%, waste process 17,79% and waste waiting 13,59%. Based on the results of waste identification, it was found that the waste process had the highest percentage, which is 17,79%. The root cause of the waste process occurs in the storage and retrieval processes of materials so that recommendations for improvement are given by relayout of material using the class-based storage policy. The implementation of the class-based storage method can optimize distance by 18,07%. The storage space is reduced by 10% with a reduction of rack usage by 13. Additionally, there is an 11%

Keywords: Warehouse, Seven Waste, Waste Assessment Model, Material Layout, Class Based Storage.

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1. INTRODUCTION

Waste is waste of any human activity that uses resources but does not create added value, such as errors that require correction, unnecessary processes, useless movement of labor and waiting for the final results of previous activities. Eliminating or reducing waste is considered to increase process efficiency and productivity. Systematic and sustainable identification and elimination of waste in the entire production process flow will lead to increased efficiency, improved process productivity and strengthened the company's overall competitiveness (Rawabdeh, 2005). One effort that can be made to identify and overcome waste is using a Lean approach.

According to Gaspersz (2007), Lean is an effort to continuously eliminate waste and increase added value. Meanwhile, according to Hines & Taylor (2000), waste is defined as all activities that occur within a company or wider supply chain that do not add value to the product or service provided to the final consumer.One method of implementing Lean that can be used to analyze waste is Value stream mapping (VSM). Value stream mapping pays attention to and identifies problems starting from the arrival of items/goods to the delivery of items/goods to end users. Then proceed with an analysis of the largest types of waste that occur in the warehouse using the Waste Assessment Model (WAM) method. The Waste Assessment Model is a model used to simplify the search for waste problems and identify them to minimize waste (Rawabdeh, 2005). Waste Assessment This model describes the relationship between seven wastes and produces the final result in the form of a numerical percentage. From the results of waste identification and analysis using the VSM and WAM methods, improvement efforts were made to reduce and eliminate the biggest causes of waste in the warehouse by re-laying the material layout.

Layout design is an activity of arranging the location of factory facilities that supports the running of a production process. Production activities that will be affected if the layout design is not carried out properly include the movement of raw materials, work equipment and workers. The type of facility layout arrangement can be divided into 2 types, namely relayout (changing the existing facility layout to be better) and construct (designing the facility layout from scratch) (Nugraha et al, 2022). At 3

This research carried out the layout design of the relayout type. A good layout can help a company achieve a strategy that supports a fast response in completing work in the warehouse which aims to determine the effectiveness of distance in the goods flow process and optimize space capacity utilization and streamline material retrieval and storage times.

Material layout in PT warehouse. XYZ is still less organized, there is still a buildup of material on one shelf. Apart from that, the material layout in the PT warehouse. XYZ still applies share storage, which means one shelf can be used to store various kinds of materials, so it is necessary to update the location for materials that move from one shelf to another. Based on these problems, the author recommends and analyzes a more optimal material layout design using the class based storage method. The class based storage method is based on the principle that materials that have similar characteristics or similar movements should be placed together in nearby storage areas. materials with similar characteristics or movements will be placed in the same zone or close to each other. This approach allows for reduced travel time and simplifies the process of moving goods within the warehouse. So in this research, material layout design was carried out using the class based storage method to minimize waste and optimize operational warehousing activities..

2. METHODS

Identifying waste in warehousing activities using Value Stream Mapping (VSM) and Waste Assessment Model (WAM) then analyzes Cause and Effect Using Fishbone Diagrams. Next, classification of consignment items is carried out for relayout design and comparing distance efficiency by considering company policy and using the Class Based Storage Method which will later get Recommendations for Layout and Preparation of Future State Mapping.

Womack & Jones (2003) state that the value stream is all activities (value added or non-value added) required to produce a product from the main production stream. Value streams describe product design flows, product flows, and information flows that support other activities. Wahab et al. (2013) stated that the main goal of value stream mapping is to find various types of waste and try to eliminate them.Value stream mapping is used to find out all the activities that take place during the warehousing process to understand and determine which steps add value or not to the warehousing process. Value stream mapping (VSM) can also be used to find out how long it takes to complete processes/activities in warehousing.

Waste identification is carried out using the Waste Assessment Model (WAM) method. This method shows the critical waste level or which is a priority for improvement. This method is used because it has several advantages compared to other methods, including: being able to show the critical waste rating; able to show the relationship between waste; and the use of questionnaires that cover various things so as to achieve accurate results in identifying waste.

3. FINDINGS AND DISCUSSION

3.1. Value Stream Mapping

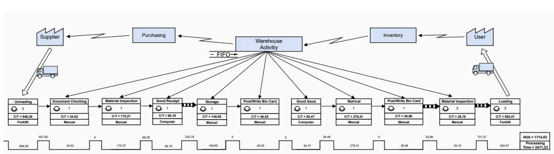


Figure 1. Current State Mapping

In this research, the process of identifying and calculating the time required for one time receiving and releasing spare parts was carried out using value stream mapping tools. This is to find out activities that do not create added value, resulting in a long time to complete them as in the figure 1.

Based on the depiction using value stream mapping, the unloading process is carried out with an average time of 948.28 seconds, checking material waybill with an average time of 34.52 seconds, physical checking of materials with an average time of 175.37 seconds, good receipt with average time 99.19 seconds, material storage (storage) with an average time of 148.85 seconds, bin card filling with an average time of 40.55 seconds, good issue with an average time of 92.47 seconds, collection material (retrieval) with an average time of 279.41 seconds, refilling the bin card with an average time of 30.96 seconds, material checking with an average time of 29.18 seconds, and the loading process with an average time of 592 seconds. .47 seconds. The total cycle time for warehousing activities is 2471.23 seconds and the total lead time is 1714.83 seconds for each user reservation.

3.2. Waste Identification

Waste identification is carried out using the Waste Assessment Model WAM method). This method shows the critical waste level or which is a priority for improvement. This method is used because it has several advantages compared to other methods, including: being able to show the critical waste rating; able to show the relationship between waste; and the use of questionnaires that cover various things so as to achieve accurate results in identifying waste.

3.2.1. Seven Waste Relationship

This stage is carried out to determine the relationship between waste. The calculation of the relationship between waste is carried out through discussions with company experts, namely warehouse supervisors. Weighting is carried out based on criteria developed by Rawabdeh (2005). The question aspects and weights for each question are as in table 1.

Table 1. Questions in seven waste relationships

No	Questions	Answer	Scor
1	Does i produce j	Always	4
		Sometimes	2
		Seldom	0
2	What is the type of relationship between i and j	If i goes up then j goes up	2
		If i increases then j remains the same	1
		Not necessarily depending on the circumstances	0
3	Impact on j because of i	It appears directly and clearly	4
		It takes time to appear	2
		Doesn't appear often	0
4	Eliminating the impact of i on j can be achieved by….	Engineering Methods	2
		Simple and direct	1
		Instructional solutions	0
5	The impact of i on j mainly affects…..	Product quality	1
		Resource productivity	1
		Lead Time	1
		Quality and Productivity	2
		Quality and Lead Time	2
		Productivity and Lead Time	2
		Quality, productivity and lead time	4
6	How much impact i has on j will increase the lead time	Very high	4
		Currently	2
		Low	0

After conducting an interview and filling out a questionnaire based on aspects of Rawabdeh's (2005) questions, a score result is obtained from the level of linkage between waste which will then be converted into a value according to table 2.

Table 2. Seven waste relationship value conversion

Range	Type of Relationship	Symbol
17 – 20	*Absolutely Necessary*	A
13 – 16	*Especially Important*	E
9 – 12	*Important*	I
5 – 8	*Ordinanry Closeness*	O
1 – 4	*Unimportant*	U
0	*No Relation*	X

The score results and level of interrelationship between waste in warehousing activities based on filling out the questionnaire by company experts are shown in table 3.

Table 3. Results of the seven waste relationship questionnaire

Relationship	Questions						Total Scor	Symbol
	1	2	3	4	5	6		
O_I	4	2	4	1	2	4	17	A
O_T	4	2	2	0	2	4	14	E
O_W	4	2	4	2	2	4	18	A
O_M	2	1	4	1	2	4	14	E
O_P	4	2	4	0	2	4	16	E
O_D	0	0	2	0	2	2	6	O
I_O	4	2	4	2	4	4	20	A
I_T	4	2	4	2	2	4	18	A
I_W	4	1	4	2	4	4	19	A
I_M	4	2	4	2	4	4	20	A
I_P	4	2	4	2	4	4	20	A
I_D	2	0	0	2	4	4	12	I
T_O	4	2	0	0	2	4	12	I
T_I	0	0	2	1	2	4	9	I
T_W	2	0	4	1	1	4	12	I
T_M	4	2	4	1	2	4	17	A
T_P	2	0	4	1	2	4	13	E
T_D	0	0	4	1	2	4	11	I
W_O	4	0	4	0	2	4	14	E
W_I	0	1	4	0	2	4	11	I
W_T	0	1	0	1	2	4	8	O
W_M	0	1	4	1	2	4	12	I
W_P	2	2	4	0	2	4	14	E
W_D	0	0	2	1	2	0	5	O
M_O	0	1	2	1	2	0	6	O
M_I	0	1	2	0	4	0	7	O
M_T	0	1	4	1	1	2	9	I
M_W	4	2	4	0	2	4	16	E
M_P	4	2	4	1	4	4	19	A
M_D	2	0	2	1	1	2	8	O
P_O	0	1	4	2	2	4	13	E
P_I	0	1	2	1	2	4	10	I
P_T	4	2	4	1	2	4	17	A
P_W	4	2	4	0	2	4	16	E
P_M	4	2	4	0	2	4	16	E
P_D	2	0	2	1	4	4	13	E
D_O	0	2	4	2	4	4	16	E
D_I	4	2	4	2	1	4	17	A
D_T	0	2	4	1	1	4	12	I
D_W	4	2	4	1	4	4	19	A
D_M	4	2	4	1	4	4	19	A
D_P	4	2	4	2	2	4	18	A

3.2.2. Waste Relationship Matrix (WRM)

Based on the results of the Seven Waste Relationship weighting in the table above, a relationship matrix between waste is then created by inputting the Seven Waste Relationship data into the Waste Relationship Matrix table. Waste Relationship Matrix on warehousing activities, as shown in table 4.

Table 4. Waste relationship matrix results

F/T	O	I	D	M	T	P	W
O	A	A	O	E	E	E	A
I	A	A	I	A	A	A	A
D	E	A	A	A	I	A	A
M	O	O	O	A	I	A	E
T	I	I	I	A	A	E	I
P	E	I	E	E	A	A	E
W	E	I	O	I	O	E	A

From the table above, the score for the level of influence of each type of waste is then calculated using the conversion values A=10, E=8, I=6, O=4, U=2, and X=0. The results of the Waste Relationship Matrix conversion on warehousing activities are shown in table 5.

Table 5. Waste Matrix Value

F/T	O	I	D	M	T	P	W	Score	%
O	10	10	4	8	8	8	10	58	14,87
I	10	10	6	10	10	10	10	66	16,92
D	8	10	10	10	6	10	10	64	16,41
M	4	4	4	10	6	10	8	46	11,79
T	6	6	6	10	10	8	6	52	13,33
P	8	6	8	8	10	10	8	58	14,87
W	8	6	4	6	4	8	10	46	11,79
Score	54	52	42	62	54	64	62	390	100,00
%	13,85	13,33	10,77	15,90	13,85	16,41	15,90	100,00	

3.2.3. Waste Assesment Questionnaire (WAQ)

Based on the results of the waste assessment questionnaire, the percentage of each waste was obtained, including overproduction waste of 14.21%, inventory waste of 15.25%, defect waste of 12.41%, motion waste of 13.84%, transportation waste of 13.84%. 12.92%, process waste was 17.79% and waiting waste was 13.59%. The type of waste with the highest ranking is process waste with a percentage of 17.79%. so it is a priority for improvement

Table 6. Waste ranking calculation results

	O	I	D	M	T	P	W
Score (Yj)	7,67	7,51	7,81	8,21	7,78	8,11	8,06
Pj Factor	205,92	225,64	176,73	187,51	184,62	244,05	187,51
Final Result (Yj Final)	1579,8	1695,4	1380	1538,7	1436,6	1978,2	1510,8
Final Result (%)	14,21	15,25	12,41	13,84	12,92	17,79	13,59
Rank	3	2	7	4	6	1	5

3.2. Fishbone Diagram

The results of waste analysis using the waste assessment model, it was found that the waste that has the greatest impact on warehousing activities is process waste. So an analysis is carried out to determine the causes and effects of the waste process using a fishbone diagram. The root problem of the waste process is that the storage and retrieval of materials sometimes takes a long time. because there is a difference between the location recorded in the system and the actual location, so it requires more effort to find the required materials. Apart from differences in material location, often the actual quantity of material recorded in the system is also different so that when a user needs material that is actually out of stock, but is recorded in the system as available, a process is needed to order material outside of the specified period, thus increasing service time. user. This addition of time or process is an example of an activity that is inefficient and does non add value. The cause and effect analysis of the waste process is shown in Figure 2.

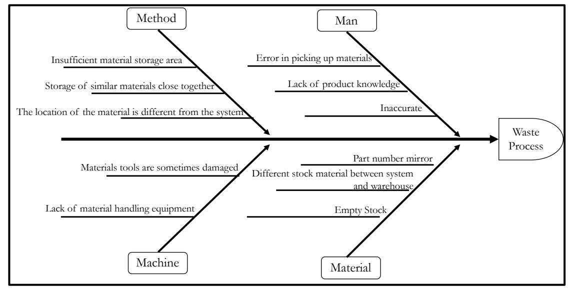


Figure 2. Fishbone Diagram

3.3 Warehouse Layout Improvements Using Class Based Storage

According to Tompkins et al (2003:435), class based storage is a material placement policy based on the similarity of a type of material into one group. This group will then be placed in a certain position in the warehouse. This material similarity can be in the form of material similarity or frequency of orders from consumers. In this research, the formation of material classes was carried out based on the total frequency of use in one period (12 months), there were 533 types of spare parts with a total use of 20,748. Data on the total frequency of expenditure of spare part materials was calculated starting from May 2022 to May 2023. Initial layout shown in figure 3. Figure 4 shown warehouse shelf design display.

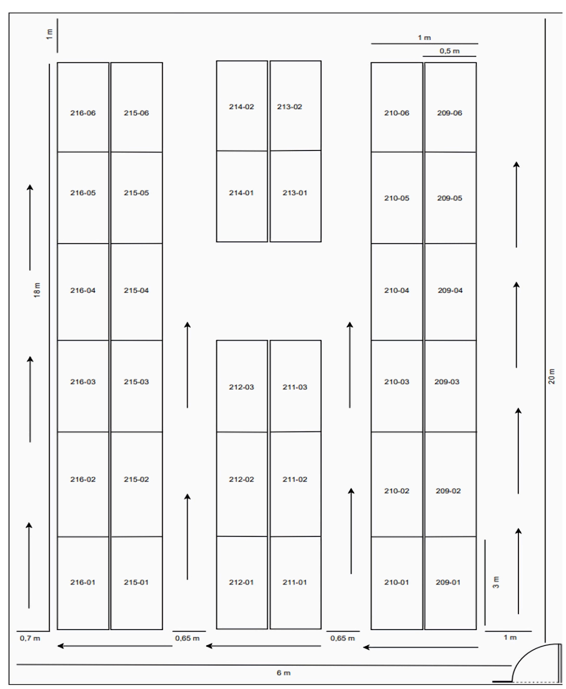
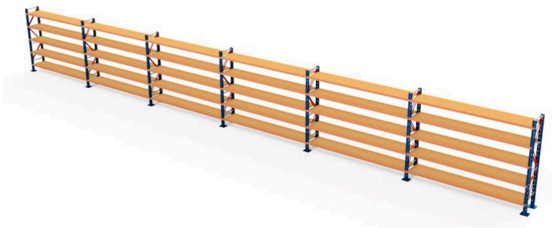


Figure 3. Initial layout of warehouse PT XYZ



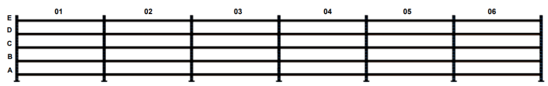


Figure 4. Warehouse shelf design display

After processing the data and classifying each spare part into its respective class, it can be seen that, class A has a value of 79.89% of the total 21.20% of the total spare parts, class B has a value of 15.05% of the total 27.48% of the total spare parts, and class C has a value of 5.06% of the total 50.10% of spare parts. The following is a Pareto diagram that shows the cumulative percentage of the total spare parts categories in the Figure 5.

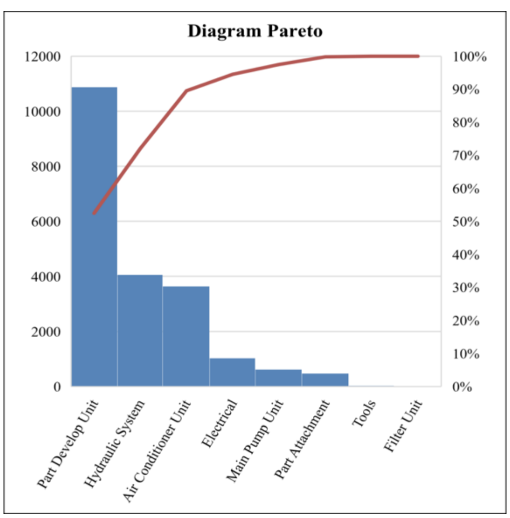


Figure 5. Warehouse shelf design display

Based on the Pareto diagram, it is found that the spare parts in the Part Develop Unit category are the materials that have the highest movement frequency. The classification of spare parts categories can be seen in table 7.

Table 7. Classification of spare parts categories

Class	Category of *Sparepart*	Code	Value	Total
A (*Fast Moving*)	*Air Conditioner Unit*	ACU-A	25	113
	Electrical	E-A	6	
	Hydraulic System	HS-A	8	
	Main Pump Unit	MPU-A	3	
	Part Attachment	PA-A	3	
	Part Develop Unit	PDU-A	68	
B (*Medium Moving*)	*Air Conditioner Unit*	ACU-B	24	144
	Hydraulic System	HS-B	20	
	Main Pump Unit	MPU-B	7	
	Part Develop Unit	PDU-B	92	
	Tools	T-B	1	
C (*Slow Moving*)	*Air Conditioner Unit*	ACU-C	91	276
	Electrical	E-C	8	
	Filter Unit	FU-C	8	
	Hydraulic System	HS-C	26	
	Main Pump Unit	MPU-C	37	
	Part Develop Unit	PDU-C	106	

3.4 Material Layout in PT XYZ

3.4.1 Initial Layout

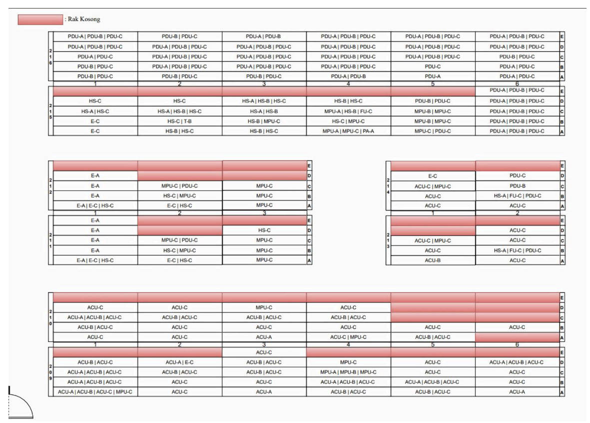


Figure 6. Initial Layout

PT. XYZ material layout still uses a random system, where material can move from one shelf to another shown in Figure 6. The results of calculating the distance traveled for the initial layout of the PT warehouse. XYZ is shown in the table 8

Table 8. Distance of Initial Layout

Shelf		*Sparepart*	Distance (m)
209	01	*Air Conditioner & Main Pump Unit*	50286
	02	*Air Conditioner Unit & Electrical*	9600
	03	*Air Conditioner Unit*	4760
	04	*Air Conditioner & Main Pum Unit*	18544
	05	*Air Conditioner Unit*	21607
	06	*Air Conditioner Unit*	17292
210	01	*Air Conditioner Unit*	8569,35
	02	*Air Conditioner Unit*	33,825
	03	*Air Conditioner & Main Pum Unit*	4566,3
	04	*Air Conditioner & Main Pum Unit*	1871,775
	05	*Air Conditioner Unit*	299,775
	06	*Air Conditioner Unit*	91,65
211	01	*Electrical & Hydraulic System*	29992,725
	02	*Electrical, Hydraulic System, Main Pump& Part*	845,625
	03	*Main Pump Unit & Hydraulic System*	994,275
212	01	*Electrical & Hydraulic System*	0
	02	*Electrical, Hydraulic System, Main Pump& Part*	1277,1
	03	*Main Pump Unit*	1615,95
213	01	*Air Conditioner & Main Pum Unit*	1498,875
	02	*Hydraulic System, Filter, Air Conditioner & Part*	504,075
214	01	*Electrical, Air Conditioner & Main Pum Unit*	1467,675
	02	*Hydraulic System, Filter, Air Conditioner & Part*	95424,75
215	01	*Electrical & Hydraulic System*	20556,675
	02	*Hydraulic System & Tools*	27528,6
	03	*Main Pump Unit & Hydraulic System*	24739,425
	04	*Hydraulic System, Part Attachment, Filter & Main*	29115,45
	05	*Main Pump & Part Develop Unit*	6226,5
	06	*Part Develop Unit*	63236,7
216	01	*Part Develop Unit*	70895,4
	02	*Part Develop Unit*	45397,3
	03	*Part Develop Unit*	29992,05
	04	*Part Develop Unit*	95879,3
	05	*Part Develop Unit*	65625,3
	06	*Part Develop Unit*	78836,6
		Total Mileage (m)	**829172,03**
		Total Mileage (km)	**829,17**

3.4.2 First Proposed Layout

Alternative 1 layout design is carried out by placing class A material on the outer shelf which is the closest distance to the main warehouse door, while class C material is placed on the inner shelf which is the shelf furthest from the main warehouse door. Class B material is placed between class A and C materials. The layout design display using the alternative 1 class based storage method can be seen in figure 7.

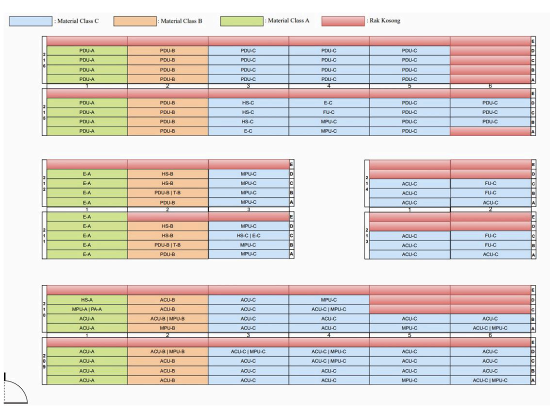


Figure 7. First Proposed Layout

When calculating the layout distance using the class based storage method, the position of the existing shelves in the initial layout is not changed. So the calculation of the distance between each shelf remains the same as the initial layout. Distance calculations are carried out by measuring the distance between the entry and exit points and the center point of the storage rack. The distance of first proposed layout shown in Table 9.

Table 9. First Proposed Layout

Shelf		Sparepart	Distance (m)
	01	*Air Conditioner Unit*	87696
	02	*Air Conditioner & Main Pump Unit*	13088
	03	*Air Conditioner & Main Pump Unit*	3570
	04	*Air Conditioner & Main Pump Unit*	2698
	05	*Air Conditioner & Main Pump Unit*	3239
209	06	*Air Conditioner & Main Pump Unit*	2741
	01	*Hydraulic System, Part Attachment, Air Conditioner & Main P.*	129619,125
	02	*Air Conditioner & Main Pump Unit*	8828,325
	03	*Air Conditioner & Main Pump Unit*	994,275
	04	*Air Conditioner & Main Pump Unit*	477,9
	05	*Air Conditioner Unit*	0
210	06	*Air Conditioner Unit*	0
	01	*Electrical & Hydraulic System*	29869,425
	02	*Electrical, Hydraulic System, Main Pump& Part Develop Unit*	22053,9
211	03	*Main Pump Unit & Hydraulic System*	1288,875
	01	*Electrical*	0
	02	*Tools, Hydraulic System & Part Develop Unit*	461,175
212	03	*Main Pump Unit*	1731,375
	01	*Air Conditioner Unit*	339,075
213	02	*Filter & Air Conditioner Unit*	405,9
	01	*Electrical, Air Conditioner & Main Pum Unit*	389,7
214	02	*Unit*	354,75
	01	*Part Develop Unit*	106355,625
	02	*Part Develop Unit*	28557,375
	03	*Electrical & Hydraulic System*	4155,3
	04	*Electrical, Filter, & Main Pump Unit*	1534,575
	05	*Part Develop Unit*	1022,925
215	06	*Part Develop Unit*	2373,75
	01	*Part Develop Unit*	177614,15
	02	*Part Develop Unit*	33992,25
	03	*Part Develop Unit*	3814,25
	04	*Part Develop Unit*	5480,05
	05	*Part Develop Unit*	4568,85
216	06	*Part Develop Unit*	0
		Total Mileage (m)	**679314,90**
		Total Mileage (km)	**679,31**

3.4.3 Proposed Second Layout

Alternative layout design 2 is carried out by placing class A material on shelf 209, namely the outermost shelf which is the closest to the main door of the warehouse, while class C material is placed on shelf 216, namely the innermost shelf which has the furthest distance from the main door of the warehouse. Class B material is placed between class A and C materials. The appearance of the layout design using the alternative 2 class based storage method can be seen in the Figure 8.

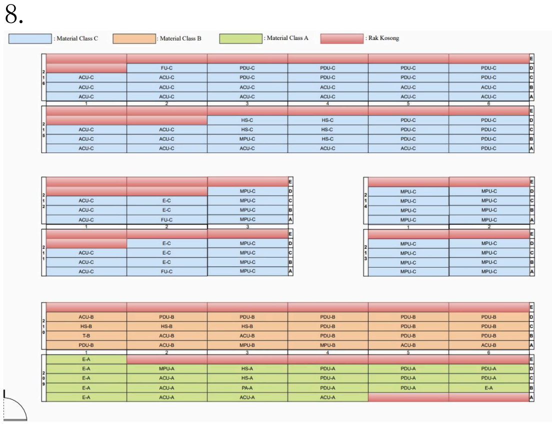


Figure 7. Proposed Second Layout

Calculating the layout distance using the class based storage method does not change the position of the shelves in the initial layout. So the calculation of the distance between each shelf remains the same as the initial layout. Distance calculations are carried out by measuring the distance between the entry and exit points and the center point of the storage rack for each spare part. The distance of first proposed layout shown in Table 10.

Table 10. Proposed Second Layout.

Shelf		Sparepart	Distance (m)
209	01	Electrical	28101
	02	*Air Conditioner & Main Pump Unit*	83136
	03	*Hydraulic System, Part Attachment, & Air Conditioner Unit*	145390
	04	*Part Develop Unit*	200830
	05	*Part Develop Unit*	115374
	06	*Electrical & Part Develop Unit*	35420
210	01	*Tools, Hydraulic System, Air Conditioner & Part Develop Unit*	5271,075
	02	*Hydraulic System, Air Conditioner & Part Develop Unit*	18333,15
	03	*Hydraulic System, Air Conditioner, Main Pump & Part Develop Unit*	24341,325
	04	*Main Pump & Part Develop Unit*	20376,225
	05	*Air Conditioner & Part Develop unit*	29463,6
	06	*Air Conditioner & Part Develop unit*	24470,55
211	01	*Air Conditioner Unit*	893,925
	02	*Electrical & Filter Unit*	744,15
	03	*Main Pump Unit*	1878,075
212	01	*Air Conditioner Unit*	0
	02	*Electrical & Filter Unit*	0
	03	*Main Pump Unit*	0
213	01	*Main Pump Unit*	1927,125
	02	*Main Pump Unit*	2629,5
214	01	*Main Pump Unit*	0
	02	*Main Pump Unit*	0
215	01	*Air Conditioner Unit*	1363,95
	02	*Air Conditioner Unit*	709,5
	03	*Hydraulic System, Air Conditioner & Main Pump Unit*	3385,8
	04	*Hydraulic System, Air Conditioner Unit*	3193,575
	05	*Air Conditioner & Part Develop Unit*	2979,825
	06	*Part Develop Unit*	3845,475
216	01	*Air Conditioner Unit*	1946,55
	02	*Air Conditioner & Filter unit*	1114,5
	03	*Air Conditioner & Part Develop unit*	3292,3
	04	*Air Conditioner & Part Develop unit*	1941,75
	05	*Air Conditioner & Part Develop unit*	6091,8
	06	*Air Conditioner & Part Develop unit*	5898
		Total Mileage (m)	**774342,73**
		Total Mileage (km)	**774,34**

3.4.4 Differences in Initial Layout with the Class Based Storage Method

A comparison of the initial layout with the design results using the class based storage method can be seen in the table 11 judging from three indicators, namely travel distance, use of shelves/slots, and overall storage space, the class based storage method has decreased.

Indicator	Initial Layout	Proposed Layout	
		1st Proposed	2nd Propsed
Mileage (m)	829172,03	679314,90	774342,73
Use of Shelves/Slots (shelves)	136	123	129
Storage Space Area (m2)	204	184,5	193,5

3.5 Future State Mapping

Proposed waste control improvements were then carried out in an experiment to compare the time difference between before and after redesigning the material layout. In this experiment, processing time was calculated for each warehousing activity. The following is a proposed value stream mapping (future state mapping) for warehousing activities shown in the Figure 8.

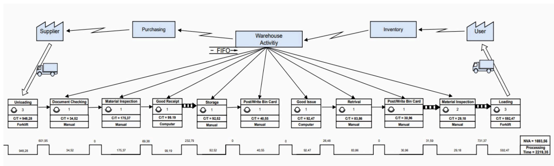


Figure 8. Future State Mapping

3.5. Discussion

Comparison of processing time before and after improvements to PT warehouse layout. XYZ can be seen in table 11.

Table 10. Comparison of actual and proposed processing times.

Warehousing Activity	Initial (second)	Proposed (second)
Unloading material	948,2755	948,2755
Checking material documents	34,524	34,524
Physical checking and inspection of materials	175,37	175,37
Material receiving process	99,185	99,185
Material storage (storage)	148,847	92,52
Bin card filling	40,545	40,545
Material dispensing process	92,47	92,47
Material retrieval	279,41	83,86
Bin card filling	30,955	30,955
Inspection	29,175	29,175
Loading/distribution of materials	592,47	592,47
Total Processing Time	**2471,2265**	**2219,3495**

After improving the material layout using the class based storage method, a reduction in processing time for warehousing activities in the storage and retrieval of spare parts was obtained. In storage activities it decreased by 56.32 seconds and in retrieval activities it decreased by 195.55 seconds. Overall, the warehousing activity processing time for one reservation was reduced by 11%, where before improvements were made the processing time was 2471.23 seconds and after improvements the processing time was

4.CONCLUSION AND SUGGESTION

4.1 Conclusion

Identification of waste in warehousing activities is carried out using the waste assessment model (WAM) method. Data collection was carried out using the seven waste relationship questionnaire and waste assessment questionnaire. The waste identification results show the percentage for each type of waste, for overproduction waste it is 14.21%, inventory waste is 15.25%, defect waste is 12.41%, motion waste is 13.48%, transportation waste is 12.92% , process waste was 17.79% and waiting waste was 13.59%. Based on the waste identification results, it was found that process waste had the largest percentage, namely 17.79%, so it was a priority for improvement.

The right material layout design to minimize waste in the warehouse is by applying the class based storage method as in Figure 22 alternative layout 1. The research results show that by applying this layout, an optimization of mileage of 18.07% is obtained, where the total mileage of the initial layout is 829172.03 m (829 km) and the total distance traveled using the class based storage method is 679314.90 m (679 km). The area used for storage space was also reduced by 10%, where the initial layout storage space area was 204 m2 and the storage space area using the class based storage method was 184.5 m2. And there was a reduction in shelf use by 13. In addition, there was a reduction in processing time for warehousing activities in the storage process by 56.32 seconds and retrieval by 195.55 seconds. Overall, the warehousing activity processing time for one reservation was reduced by 11%, where before improvements were made the processing time was 2471.23 seconds and after improvements the processing time was 2219.35.

4.2 Suggestion

It is recommended for companies to implement material layout design in the warehouse using the class based storage method to reduce the impact of waste processes. By using the class based storage method, companies can minimize travel distance, storage space and shelf use in the warehouse.

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