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IMPROVEMENT OF WAREHOUSE LAYOUT USING DEDICATED STORAGE METHOD TO OPTIMIZE STORAGE UTILIZATION OF AUTOMOTIVE COMPONENTS AT PT XYZ

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ABSTRACT

The warehouse has a very important role in the supply chain network to distribute products to consumers. PT XYZ warehouse uses a rack system to store products before they are distributed to the production process. The problem faced is that the placement of products is scattered and irregular depending on the conditions in the field, products that come are placed in empty places which can cause the storage space to become larger so that the warehouse capacity has not been fully utilized with a utilization rate of 105% and causes a decrease in the actual warehouse capacity. It's necessary to rearrange the placement of products in the storage location to optimize the utilization rate of storage space, with the dedicated storage method. This method is to solve the problems that occur in the warehouse layout which includes product placement in the warehouse by placing only one type of product in one storage room. In this method product storage is more organized, it will be stored in a fixed location. The total storage slot requirement for each product is 19 slots and the highest T/S value is 2.32 activities/slot, and these products are prioritized for storage placement near the warehouse entrance and exit to optimize storage space utilization. The results of the application of the dedicated storage method obtained a storage space utilization rate of 100%, while in the existing condition it was 105% with a percentage decrease of 5%.

***Keywords**: Warehouse Layout, Dedicated storage, Utilisasi, Storage space, Space requirement.*

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1. INTRODUCTION

Warehouse is a key component of the supply chain network, and improving warehouse operational efficiency and productivity is very important (Islam, Ali. Fard, & Kabir, 2021), (Mokarrari, Sowlati, English, & Starkey, 2024). As one of the many logistics processes, the warehouse process currently has an irreplaceable position in the logistics and supply chain system. Currently, warehouses play a more vital role in the success or failure of companies (Kembro, Eriksson, & Norman, 2022). Random product storage can be improved by grouping product layouts by type and arranging each product type on the shelves (Christina, Palit, 2020). Dispersed and disorganized product storage, depending on field conditions, where incoming products are placed in empty spaces can lead to larger storage areas and longer search times (Alfian, Pratama, 2022), (Kartika, Helvianto, 2017). Placing products haphazardly means that the warehouse capacity is not being utilized to its full potential, leading to a reduction in the actual warehouse capacity. This can be resolved by the dedicated storage method, where stack height is regulated and storage areas are used for only one type of product (Alfian, Pratama, 2022), (Kartika, Helvianto, 2017). The lack of proper utilization of actual warehouse capacity means that the use of storage for these products in the warehouse must be improved to optimize warehouse utility (Kemklyano, Harimurti, & Purnaya, , 2021). The level of warehouse utilization can be optimized by arranging the layout, which has proven to be able to increase warehouse capacity from the previous condition (Alhori, Machfud, & Hasbullah, 2011).

The warehouse layout issue currently being researched is the automotive components warehouse at PT XYZ. The warehouse layout is a design aimed at minimizing total costs by finding the best combination between space area and goods handling (Gunawan, Gede, & Widyadana, 2019). PT XYZ's warehouse uses a shelving system for its product storage process. The stored products are those that will be used for the subsequent production process. The shelves used at PT XYZ consist of 6 rows of shelves measuring 3.7 m x 0.8 m x 1.8 m, with each shelf having 6 slots, each slot measuring 0.6 m x 0.8 m x 0.5 m.

In the initial condition of the product storage process, the shelves used could not accommodate incoming products in the storage warehouse, so the products had to be stored outside the storage shelves, disrupting the warehouse operator's activities. The dedicated storage method is considered a solution to this issue, as it has the advantage of reducing the search time for goods by the operator.

It is faster because it is more organized. However, the drawback of this method is that only predetermined goods can be stored, which can lead to suboptimal utilization (Irman, Septiani, 2020).

Based on the problems occurring at PT XYZ, this research aims to improve the warehouse layout by rearranging product placement to optimize storage space utilization. Factors considered in optimizing storage space utilization include the average product receipt rate, the average product retrieval rate, and the storage slot capacity. The objective of this research is to propose improvements in product placement layout to optimize storage space utilization. The scope of this research includes certain limitations: observations are only conducted at the PT XYZ warehouse, each storage slot contains only one type of product, and cost calculations are not considered.

2. METHODS

The research stages begin with identifying the problems that occur, namely the random arrangement that causes a large warehouse space requirement. The approach used is the arrangement of goods storage based on the dedicated storage method, where goods are arranged according to the comparison of throughput with the largest space requirement, then placed on racks near the entrance and exit. The average receipt and issuance of products, space requirement, and material handling capacity are determining factors in the dedicated storage method (Audrey, Sukania, & Nasution, 2021) (Alfian, Pratama, 2022). The research stages in solving the problem consist of several calculation stages, namely Space requirement, Throughput, and the comparison of Space requirement with Throughput.

A. **Space requirement** involves calculating the space needed to determine the number of slots for storing each type of product (Bocelli, Michele, Bottani, Volpi, et al., 2024). The calculation is based on the average product receipt divided by the storage capacity. Space requirement is important to ensure that each type of product stored in the warehouse has a storage space that matches the production volume of the product (Asti, 2024).

B. **Throughput** refers to the activity of receiving or shipping products handled with material handling. The calculation is based on the average receipt or issuance of products divided by the material handling capacity. The number of activities required to deliver products to the warehouse must be calculated to estimate the throughput value (Asti, 2024).

C. **The comparison of throughput with space requirement** involves ranking products based on the results of the comparison between throughput and space requirement.

The solution to the product placement layout problem using the dedicated storage method can be seen in Figure 1.

Figure 1. Steps for Solving the Product Placement Layout Problem

2. FINDINGS AND DISCUSSION

The layout problem at PT XYZ, as previously explained, has a utilization rate above 100% because the storage racks cannot accommodate the products, which are placed on wooden pallets and consist of various types of products, as seen in Figure 2.

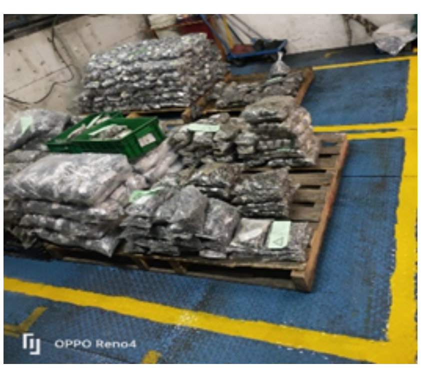


Figure 2. Product Placement on Pallets

The object of this research development focuses on propose improvements to the product storage layout to enhance the utilization of the product placement area. To eliminate pallet and mixed storage, the dedicated storage method can be used. In this method, product placement is fixed in a specific area, making it easier for operators to retrieve products. The drawback of this method is that once an area is designated for product placement, it is used only for that purpose, thus increasing the utilization of the product placement area. The limitation of this method is that the storage space cannot be replaced with other products.

Space Requirement Calculation

The space requirement determination stage aims to determine the storage slot capacity for accommodating products (Rossenberg, 2018). At PT XYZ, similar products that will be stored are arranged in slots on the storage racks. The storage slots have varying capacities depending on the type of product. The space requirement for each product type can be seen in Table 1.

Table 1. Space Requirement for Each Product Type

Product	Average Receipt *(Pieces)*	Maximum Slot Capacity *(Pieces)*	SR
Guide Stay Eng Harness K1Z	5.000	45.000	1
Bar Wahser Comp Handle Holder	7.000	39.000	1
Baud Oval Component Assy Ga 0E04700	6.000	27.000	1
Bolt, 6 X 1	4.000	12.000	1
Bolt, Weld 12 X 27	2.000	5.000	1
Bolt, Weld 6 X 18	5.000	10.000	1
Bolt, Welding 6 X 12	5.000	10.000	1
Clamp Wire 8mm	700	4.000	1
Clamp/Hollow	7.500	20.000	1

Product	Average Receipt (*Pieces*)	Maximum Slot Capacity (*Pieces*)	SR
Clip Component Assy	1.700	3.000	1
Collar 8.2 X 6.1 X 4.0 Main Stand Shaft	5.000	20.000	1
Collar 8.4 X 6.1 X 4.8 Horn Set	5.000	20.000	1
Collar Front Cowl	6.000	10.000	1
Collar Kyt	40.500	10.000	5
Collar Muff Mount	5.000	15.000	1

Example calculation of space requirement for the product guide Stay Eng Harness K1Z: Average receipt of 5,000 pieces. In one storage slot, the maximum storage capacity is 45,000 pieces, so the space requirement for the product guide Stay Eng Harness K1Z is:

Space requirement = 5000/45000 = 0.111 = 1

Throughput Calculation

Throughput calculation is used as a measure of the number of storage and issuance activities that occur. The material handling capacity used for each type of product is different. Throughput shelf arrangement is carried out to determine the types of products that have the fastest to the slowest movement activities (Audrey, Sukania, & Nasution, 2021). The throughput calculation for each product type can be seen in Table 2.

Table 2. Throughput for Each Product Type

Prod.	Av. Receipt (*Pieces*)	Av. expense (*Pieces*)	Trolley Cap. (*Pieces*)	T Accept	T Sent	T Total
Guide Stay Eng Harness K1Z	5.000	4.500	4.800	1,04	0,94	1,98
Bar Wahser Comp Handle Holder	7.000	6.000	5.600	1,25	1,07	2,32
Baud Oval Component Assy Ga 0E04700	6.000	5.500	10.000	0,60	0,55	1,15
Bolt. 6 X 1	4.000	3.500	15.000	0,27	0,23	0,50
Bolt. Weld 12 X 27	2.000	1.800	8.000	0,25	0,23	0,48
Bolt. Weld 6 X 18	5.000	1.500	12.000	0,42	0,13	0,54
Bolt. Welding 6 X 12	5.000	1.500	12.000	0,42	0,13	0,54
Clamp Wire 8mm	700	100	2.000	0,35	0,05	0,40
Clamp/ Hollow	7.500	5.500	10.000	0,75	0,55	1,30

Prod.	Av. Receipt (Pieces)	Av. expense (Pieces)	Trolley Cap. (Pieces)	T Accept	T Sent	T Total
Clip Component Assy	1.700	1.500	5.000	0,34	0,30	0,64
Collar 8.2 X 6.1 X 4.0 Main Stand Shaft	5.000	1.000	13.000	0,38	0,08	0,46
Collar 8.4 X 6.1 X	5.000	1.000	13.000	0,38	0,08	0,46

Prod.	Av. Receipt (Pieces)	Av. expense (Pieces)	Trolley Cap. (Pieces)	T Accept	T Sent	T Total
4.8 Horn Set						
Collar Front Cowl	6.000	1.000	10.000	0,60	0,10	0,70
Collar Kyt	40.500	8.000	35.000	1,16	0,23	1,39
Collar Muff Mount	5.000	1.200	7.500	0,67	0,16	0,83

Example of throughput calculation for the Stay Eng Harness K1Z product:

- Average product receipt: 5,000 pieces
- In one material handling trip, the capacity is 4,800 pieces

Therefore, the throughput for the receipt activity is:

$$Tj = \left(\frac{5.000}{4.800}\right) + \left(\frac{4.500}{4.800}\right)$$

$$= 1.04 + 0.94 = 1.98$$

Comparison of Throughput with Space Requirements

In Table 1, the storage slots required for each product type are obtained, and in Table 2, the number of activities for each product type is obtained. The T/S calculation results are needed as a benchmark for product placement. The T/S results for each product type can be seen in Table 3.

Table 3. Comparison of T/S for Each Product Type

Nama Material	SR	T terima	T kirim	T Total	T/S terima	T/S kirim	T/S total
Guide Stay Eng Harness K1Z	1	1.04	0.94	1.98	1.04	0.94	1.98

Table 3. Comparison of T/S for Each Product Type

Based on the Peformance of the milling machine, the average Performance value for one year is 0.536 (53,6%). The ability of the cassava milling machine to produce quality products is one of the variables used in the OEE calculation. Analysis related to the machine's performance in delivering quality products using the Quality Rate value by comparing the ground cassava production with the resulting cassava milled pulp. The results of the Quality Rate of the cassava milling machine can be seen in Table 3.

Nama Material	SR	T terima	T kirim	T Total	T/S terima	T/S kirim	T/S total
Bar Wahser Comp Hbdl	1	1.25	1.07	2.32	1.25	1.07	2.32

Nama Material	SR	T terima	T kirim	T Total	T/S terima	T/S kirim	T/S total
Holder K1zk							
Baud Oval Component Assy Ga 0e04700	1	0.60	0.55	1.15	0.60	0.55	1.15
Bolt, 6 X 14	1	0.27	0.23	0.50	0.27	0.23	0.50
Bolt, Weld 12 X 27	1	0.25	0.23	0.48	0.25	0.23	0.48
Bolt, Weld 6 X 18	1	0.42	0.13	0.54	0.42	0.13	0.54
Bolt, Welding 6 X 12	1	0.42	0.13	0.54	0.42	0.13	0.54
Clamp Wire 8mm	1	0.35	0.05	0.40	0.35	0.05	0.40
Clamp/ Hollow	1	0.75	0.55	1.30	0.75	0.55	1.30
Clip Component Assy	1	0.34	0.30	0.64	0.34	0.30	0.64
Collar 8.2 X 6.1 X 4.0	1	0.38	0.08	0.46	0.38	0.08	0.46

Example of T/S calculation for the Stay Eng Harness K1Z product:

T/S accept = $\frac{1,04}{1} = 1,04$

T/S sent = $\frac{0,94}{1} = 0,94$

T/S total = 1,04 + 0,94 = 1,98 Activity/Slot

Product placement is done based on the comparison of throughput with space requirements. The highest T/S results are prioritized for storage near the warehouse entrance and exit. The ranking of products based on the highest and lowest T/S values can be seen in Table 4.

Table 4. Ranking of Products Based on T/S Values

Nama Material	SR	T terima	T kirim	T Total	T/S terima	T/S kirim	T/S total
Main Stand Shaft							
Collar 8.4 X 6.1 X 4.8 Horn Set	1	0.38	0.08	0.46	0.38	0.08	0.46
Collar Front Cowl	1	0.60	0.10	0.70	0.60	0.10	0.70
Collar Kyt	5	1.16	0.23	1.39	0.23	0.05	0.28
Collar Muff Mount Kaf	1	0.67	0.16	0.83	0.67	0.16	0.83

Based on the Quality Rate of the milling machine, the average Quality Rate value for one year is 0.896 (89,6%). The results of the calculation of Availability, Performance, and Quality Rate, it is possible to analyze the effectiveness of the cassava milling machine using Overall Equipment Effectiveness (OEE). This OEE analysis is used to see the ability of the milling machine for one year to take advantage of the production time to produce tapioca flour. The results of the OEE milling machine can be seen in Table 4.

Nama Material	SR	T terima	T kirim	T Total	T/S terima	T/S kirim	T/S total
Bar Wahser Comp Hbdl Holder K1Z	1	1.25	1.07	2.32	1.25	1.07	2.32
Guide Stay Eng Harness K1Z	1	1.04	0.94	1.98	1.04	0.94	1.98
Clamp/ Hollow	1	0.75	0.55	1.30	0.75	0.55	1.30
Baud Oval Component Assy	1	0.60	0.55	1.15	0.60	0.55	1.15

Nama Material	SR	T terima	T kirim	T Total	T/S terima	T/S kirim	T/S total
Ga 0e04700							
Collar Muff Mount Kaf	1	0.67	0.16	0.83	0.67	0.16	0.83
Collar Front Cowl	1	0.60	0.10	0.70	0.60	0.10	0.70
Clip Component Assy	1	0.34	0.30	0.64	0.34	0.30	0.64
Bolt, Weld 6 X 18	1	0.42	0.13	0.54	0.42	0.13	0.54
Bolt, Welding 6 X 12	1	0.42	0.13	0.54	0.42	0.13	0.54
Bolt, 6 X 14	1	0.27	0.23	0.50	0.27	0.23	0.50
Bolt, Weld 12 X 27	1	0.25	0.23	0.48	0.25	0.23	0.48
Collar 8.2 X 6.1 X 4.0 Main Stand Shaft	1	0.38	0.08	0.46	0.38	0.08	0.46
Collar 8.4 X 6.1 X 4.8 Horn Set	1	0.38	0.08	0.46	0.38	0.08	0.46
Clamp Wire 8mm	1	0.35	0.05	0.40	0.35	0.05	0.40
Collar Kyt	5	1.16	0.23	1.39	0.23	0.05	0.28

Current Warehouse Layout

The warehouse layout serves a strategic function as it will determine an operation in the long term (Mohamud, Kafi, Shahron, et al., 2023). The storage warehouse at PT XYZ consists of 6 rows of storage racks, each comprising 6 storage slots, resulting in a total of 36 storage slots. Each storage slot is 0.8 meters wide. The product arrangement in the current warehouse condition is disorganized due to the lack of specific places for product storage. Incoming products are stored in the available empty slots and get mixed with other types of products in those storage slots. The product storage layout in the warehouse at PT XYZ can be seen in Figure 3.

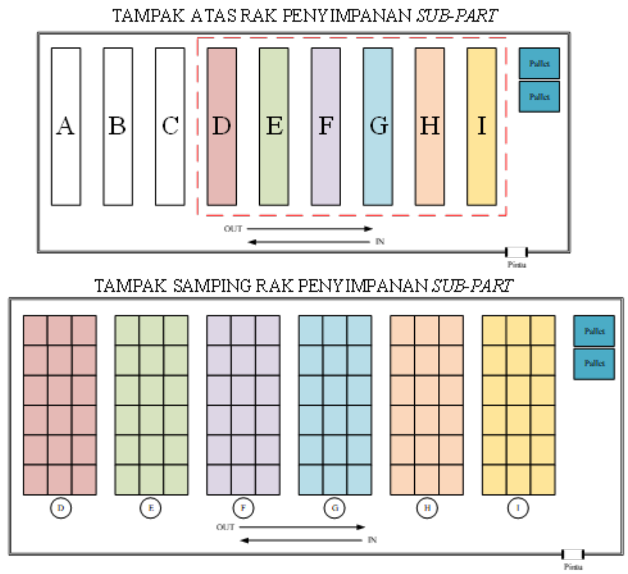


Figure 3. Current Warehouse Layout

Initial Condition Calculation

In the initial condition, product placement has no rules, allowing products to be placed anywhere. This situation leads to storage exceeding the capacity of the racks due to suboptimal utilization of storage space. The utilization calculation in the initial condition:

$$\text{Storage Warehouse Utilization} = \frac{\textit{Storage exceeding area}}{\textit{AStorage space area}} \times 100\%$$

$$= \frac{25{,}92 + 0{,}61}{25{,}92} \times 100\%$$

$$= 105\%$$

Based on the initial product placement, the storage space utilization calculation is 105%. The product placement layout can be seen in Figure 1.

Proposed Improvement Calculation

Product placement based on the highest T/S results is prioritized on racks close to the warehouse entrance and exit. Therefore, the T/S results for each product type are ranked from highest to lowest. The T/S ranking can be seen in Table 4. Based on the space requirement calculation, the storage slots needed for each product type are sufficient, resulting in the utilization calculation after the improvement:

$$\text{Storage Warehouse Utilization} = \frac{Storage\ exceeding\ area}{AStorage\ space\ area} \times 100\%$$

$$= \frac{25{,}92}{25{,}92} \times 100\%$$

$$= 100\%$$

Comparison of Storage Space Utilization: Initial Condition vs. Proposed Improvement

Based on the storage space utilization calculation, a comparison is made to determine the percentage decrease in storage space utilization. The comparison of storage space utilization can be seen in Table 5.

Table 5. Comparison of Storage Space Utilization

Layout	Utilization	Difference from the Initial Condition
Initial	105%	
Proposed	100%	5%

The dedicated storage method is used in this research in accordance with the occurring issues. Product storage at PT XYZ is conducted on a dedicated basis according to the type of product, where only one type of product is stored in each storage slot. Because one place for storing products can only be used by that product and cannot be mixed with other goods, this method is often referred to as the fixed lot storage method (Asti, 2024). The resolution of the occurring issues using the dedicated method consists of several stages. The first stage is the calculation of space requirements. Space requirements are obtained from calculating the average product receipt divided by the capacity of the product storage slot (Islam, Ali. Fard, & Kabir, 2021). Based on the calculation of space requirements, the space needed for each type of product is obtained. The second stage is the calculation of throughput which is obtained from the average receipt or shipment of products divided with the capacity of material handling. The third stage is the comparison of throughput with space requirements. The results of the T/S comparison are used as a proposal for improving storage layout in this research. Product placement is based on ranking from the highest to the lowest T/S results, which results in product placement that matches the existing rack conditions in the warehouse, thereby optimizing storage space utilization.

Space Requirement Analysis

Space requirement analysis is conducted to determine the number of storage slots needed for each type of product to be stored in the warehouse (Rossenberg, 2018). At PT XYZ's warehouse, the calculation of space requirements is used to determine the capacity of storage slots and to know whether the existing storage slots are sufficient to place incoming products. The number of storage slots is influenced by the area size and the average product receipts.

Throughput Analysis

Throughput calculation is used as a measure of the number of storage and product retrieval activities that occur. Throughput measurement is one of the processes conducted to determine product placement, where products with the highest throughput value are placed in storage slots near the entry/exit doors (Tambunan, 2020) to minimize material handling activities. In the storage warehouse, material handling activities use trolleys with a capacity of 4,800 for the Guide Stay Eng Harness K1Z product, with an average product receipt of 5,000 pieces and an average product dispatch of 4,500 pieces, resulting in a total throughput value of 1.98 activities.

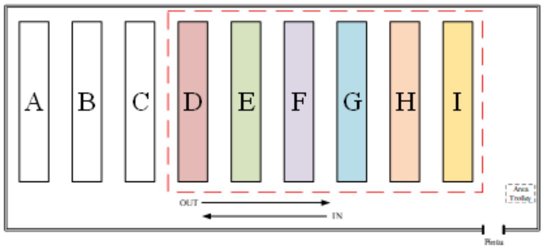
T/S Comparison Ranking Analysis

Throughput and space requirements are calculated to determine how many activities originate from each storage slot. The more activities needed, the higher the T/S value (Asti, 2024). The application of the dedicated storage method by comparing throughput value with space requirements makes the storage process better because the process is organized and placed according to the number of activities and space needs (Kartika, Helvianto, 2017). Based on the T/S comparison results, the highest order is 2.32 activities/slot for the Bar Wahser Comp Hndl Holder K1Z product and the lowest is 0.28 activities/slot for the Collar Kyt product.

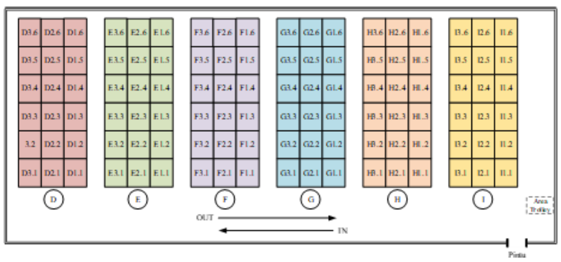
Proposed Warehouse Layout

Product placement in the proposed warehouse layout is based on the highest T/S comparison value, placed near the entry/exit doors or with the shortest travel distance. The proposed warehouse layout can be seen in Figure 4.

Top View of Sub Part Storage Rack



Side View of Sub Part Storage Rack



LEGENDA

CARA PEMBACAAN KODE
(Contoh: F1.1)

A = Huruf pertama menandakan rak
1 = Angka kedua menandakan kolom pada rak
1 = Angka ketiga menandakan baris pada rak

KODE	NAMA MATERIAL	KODE	NAMA MATERIAL
D1.1	Wire B Clamper Cable K1zk	H1.1	Wire Clamper Brake Hose
D1.2	Wire B Clamper Cable K1zk	H1.2	Nipple End
D1.3	Wire B Clamper Cable K1zk	H1.3	Nut Square Weld 8 mm
D1.4	Wire B Clamper Cable K1zk	H1.4	Nut Square Weld 8 mm
D1.5	Support, Reserve Tank	H1.5	Nut Square Weld 8 mm
D1.6	Support, Reserve Tank	H1.6	O-Ring 3.8 x 1.4
D2.1	Support, Reserve Tank	H2.1	Rubber Battery K84
D2.2	Support, Reserve Tank	H2.2	Rubber Component Assy GA 0E04700
D2.3	Support, Reserve Tank	H2.3	Nut Special 6mm KGH
D2.4	Non Woven Fabric Reg 132x3x2 5mm	H2.4	Collar Muff Mount KAF
D2.5	Non Woven Fabric Reg 132x3x2 5mm	H2.5	Non Woven Fabric 15x15x1mm
D2.6	Non Woven Fabric Reg 132x3x2 5mm	H2.6	Cup, Separator
D3.1	Non Woven Fabric Reg 132x3x2 5mm	H3.1	Non Woven Sup 100x15 X T.2mm
D3.2	Non Woven Fabric Reg 132x3x2 5mm	H3.2	Nut Hexagonal M8
D3.3	Nut Hex Cap 6mm	H3.3	Wire Guide Brake Hose K1Z
D3.4	Nut Weld 5m (Special)	H3.4	Wire Guide Brake Hose K1Z
D3.5	Hollow Clevis Au010230c	H3.5	Wire Guide Brake Hose K1Z
D3.6	Guide, Fuel Feed Hose	H3.6	Wire Guide Brake Hose K1Z
E1.1	Nut Projection 6 Mm Kvg	I1.1	Bar Washer Comp Hndl Holder K1Z
E1.2	Nut Projection 6 Mm Kvg	I1.2	Guide Hose
E1.3	Nut Projection 6 Mm Kvg	I1.3	Guide Stay Eng Harness K1Z
E1.4	Wire Brkt Ctr Under Cowl	I1.4	Cover ABS Mod
E1.5	Clamp Wire 8mm	I1.5	Grommet (Grommet Baru)
E1.6	Wire A, Stay Comp Hose Clamper	I1.6	Pin Clevis AUO100300
E2.1	Wire Bracket Extinguisher	I2.1	Wire Clamper Stay C Ign C K1N
E2.2	Collar Kyt	I2.2	Hollow Clevis AUO100300
E2.3	Collar Kyt	I2.3	Clamp/Hollow
E2.4	Collar Kyt	I2.4	Guide Stay Sub Harness Eng
E2.5	Collar Kyt	I2.5	Non Woven Fab Sup 120x51x2 mm
E2.6	Collar Kyt	I2.6	Spring Fuel Filler Cup
E3.1	Wire A Clamper Cable K1zk	I3.1	Guide Tube
E3.2	Wire A Clamper Cable K1zk	I3.2	Baud Oval Component Assy
E3.3	Wire A Clamper Cable K1zk	I3.3	Wire Clamper Comp K41
E3.4	Wire A Clamper Cable K1zk	I3.4	Guide Brake Cable A
E3.5	Wire A Clamper Cable K1zk	I3.5	Separator
E3.6	Wire B Clamper Cable K1zk	I3.6	Sokket
F1.1	Pin Clevis AA 0051400		
F1.2	Pin Lever Sub Assy New		
F1.3	Rivet, Push 7mm		
F1.4	Nut Hexagonal M6		
F1.5	Bolt, Weld 6 X 18		
F1.6	Bolt, Welding 6 X 12		
F2.1	Packing Fuel Filler Cap		
F2.2	Bolt, 6 X 14		
F2.3	Bolt, Weld 12 X 27		
F2.4	Nut Square Weld 5 Mm		
F2.5	Collar 8.2 X 6.1 X 4.0 Main Stand Shaft		
F2.6	Collar 8.4 X 6.1 X 4.8 Horn Set		
F3.1	Hollow Clevis Auog00300		
F3.2	Nut Special 6 Mm Pj 5.5 (Kph)		
F3.3	Nut Special 6 Mm Pj 5.5 (Kph)		
F3.4	Nut Special 6 Mm Pj 5.5 (Kph)		
F3.5	Nut Special 6 Mm Pj 5.5 (Kph)		
F3.6	Nut Projection 6 Mm Kvg		
G1.1	Wire (Wire Hook)		
G1.2	Collar Front Cowl		
G1.3	Pin Clevis Galvanis		
G1.4	Packing Separator		
G1.5	Wire 4 (D4)		
G1.6	Nut Welding 6mm		
G2.1	Nut Welding 6mm		
G2.2	Nut Welding 6mm		
G2.3	Nut Welding 6mm		
G2.4	Nut Welding 6mm		
G2.5	Nut Welding 6mm		
G2.6	Nut Welding 6mm		
G3.1	Nut Welding 6mm		
G3.2	Nut Welding 6mm		
G3.3	Nut Welding 6mm		
G3.4	Rubber B Seat Mount		
G3.5	Clip Component Assy		
G3.6	Sponge Set Plate		

Figure 4. Proposed Warehouse Layout

Based on the results of the layout improvement design, several limitations of this method should be noted:

1. **Inefficiency of space,** as each product has a fixed location, which means there is a possibility that space is not used optimally (Audrey, Sukania, & Nasution, 2021)(Irman, Septiani, 2020)(Patel, 2024).
2. **Lack of flexibility** to accommodate changes in the types of products stored, making it less efficient (Irman, Septiani, 2020).
3. **Capacity limitations,** if there is a sudden increase in the number of stored products, it may not accommodate all the items (Audrey, Sukania, & Nasution, 2021).
4. **Higher investment costs** for managing and maintaining fixed storage locations (Irman, Septiani, 2020).

Analysis of Product Placement in Current and Proposed Conditions

The current product placement in PT XYZ's warehouse does not follow a specific storage placement rule. Incoming products are placed in empty slots, causing the racks used to be unable to accommodate the incoming products in the storage warehouse. This situation causes products to be stored outside the storage racks, disrupting warehouse operator activities as shown in Figure 5.

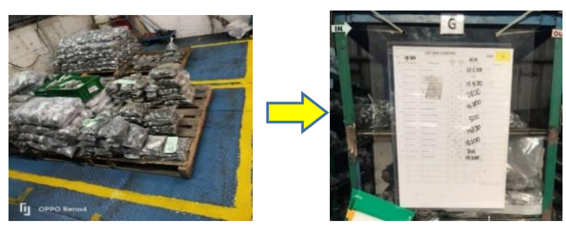


Figure 5. Product Storage placed in storage racks

The proposed product placement based on the identified issues applies the dedicated storage method by changing the product placement. Product placement using the dedicated storage method is based on ranking the T/S value comparison results, with the highest T/S value placed in storage slots near the warehouse entry/exit doors to facilitate material handling during storage and product dispatch processes. Product placement in storage slots contains only one type of product per slot, thereby minimizing product search time and optimizing product storage space utilization. By applying the dedicated storage method, the utilization of storage racks can be maximized so that products entering the storage warehouse can be immediately placed in the designated storage slots.

Analysis of Storage Space Utilization Comparison for Initial and Proposed Conditions
The current storage space utilization in PT XYZ's warehouse is still not optimal, as the racks used for product storage cannot accommodate all the incoming products, disrupting operator activities. Storage space utilization can be measured by comparing the utilized area to the total area. In the current condition, the storage racks in PT XYZ's warehouse have a utilization rate of 105% due to products stored outside the storage racks. Based on the calculation of storage slot capacity using the dedicated storage method, the storage slot capacity meets the requirements for each type of product, resulting in a proposed condition utilization rate of 100%, as each type of product entering the storage warehouse has a designated storage slot.

4. CONCLUSION AND SUGGESTION

Based on the research that has been conducted, it can be concluded that: a. The storage warehouse at PT XYZ consists of 36 storage slots (existing). Based on the space requirement calculation (proposed), the total storage slot requirement for each product is 19 slots. b. The highest T/S value is 2.32 activities/slot, and these products are prioritized for storage placement near the warehouse entrance and exit to optimize storage space utilization. c. Based on the utilization rate calculation, there is a decrease in utilization from 105% (overload) before improvement to 100% (full capacity) after applying dedicated storage. d. By applying dedicated storage, storage space utilization can be maximized so that products entering the storage warehouse can be immediately placed in the designated storage racks.

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