Shelf Allocation Redesign and Warehouse Management System Improvement to Optimize Warehouse Material Flow in Oleo Chemical Industry Business

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Abstract. The increase in production results in an increase in the flow of material in the warehouse, while this increase does not consider the condition of the warehouse. The increase in production and the number of erratic shipments of goods is caused by external factors such as fluctuations in demand and availability of containers that cannot be controlled that will result in a bottleneck in the warehouse. The purpose of this study is to redesign the allocation of shelves and improve technology in the warehouse management system. The research method uses a material flow simulation model in the warehouse. The simulation validation and manual calculations results show that the rack simulation for dove and soap required 4,018 pallet positions and flaking drumming simulations required 1,815 pallet positions. Meanwhile, in actual conditions, the rack for dove and soap is allocated 2,834 pallet positions and 2,400 pallet positions for flaking and bagging. Class division using the ABC Classification method is carried out so that Class A, which is a group of Fast-Moving items, is brought closer to the receiving department, Class B, which is a group of Slow-Moving items, is placed after the placement of class A, then class C, which is also a group of Slow-Moving items, is placed after class B. Moreover, the results of slow-moving product optimization are seen from a reduction of 32,608 pcs from 581,096 pcs in July 2021 to 525,281 pcs in December 2021, and a reduction of $92,485 from $774,644 in July 2021 to $620,292 in December in the slow-moving value.

Keywords: Warehouse management · Shelf allocation · Product flow · Warehouse management system

1 Introduction

PT. UOI is a company engaged in the Oleo chemical business and has a warehouse with 6,889 pallet positions. PT. UOI is located in the Sei Mangkei Special Economic Zone, Bosar Maligas, Simalungun Regency, North Sumatra. PT. UOI has completed several projects that doubled the capacity from 102 tons to 204 tons per production day. An increase in production results in an increase in the material sent to and from the

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warehouse, where the increase does not consider the warehouse's condition. Thus, there is a buildup of material in the hallway area and an imbalance in material flow.

With the increase in production and the erratic number of shipments of goods caused by external factors such as fluctuations in demand and availability of containers that cannot be controlled, a bottleneck occurs in the warehouse. So far, the finished goods arrangement pattern used is still based on the previous production capacity, so product movement and material handling in the warehouse is not optimal [1, 2].

If reaching the point where the warehouse does not have an area to move (Table 1), there will be a build-up in the production area, which will result in production slowing down and even stopping. This will cause financial loss and low production capacity. This happened on 7–8 May 2021, which resulted in production stopping for one day. Stopping is a fatal failure for a manufacturing company. All profits in the manufacturing business come from producing quality products in large quantities.

Product build-up in the free area between the racks results in material handling, such as forklifts being unable to cross the aisle. Product build-up causes loss of location distinction between fast and slow-moving products, is dangerous to be hit by forklifts, and incorrect product inventory records. Product accumulation in the free area results in the product not having a clear position and causing the product not to have a precise location and cannot be found in the system. The fullness of the warehouse can be seen from the existence of port charges that arise because incoming material cannot enter the warehouse as there is no longer a place to put it. Data port charges are as follows on Table 2.

Irregularity causes many non-value-added activities to be carried out, such as searching for products and double handling the same material. Warehouse Management System (WMS) helps product management be efficient and fast in the organization [3]. Radio Frequency Identification (RFID) which is helpful for a barcode substitution to support the implementation of a fast and efficient WMS system, is needed. RFID is a technology that provides faster data transfer speeds and data on the number of items to achieve speed and efficiency of transaction processing on WMS [4]. Companies in the industrial sector, such as shoe factories, use RFID. Using WMS supported by RFID eases companies to find products and retrieve products using First In First Out (FIFO), helping speed up operations and analysis of production capacity in the warehouse.

Table 1. Actual vs. Usage Racking Allocation

Type	Description	Cap. Rack	Usage	% Usage
302	Dove Rack	1.160	703	61%
303	Soap Rack	1.380	915	66%
304	C12C14 Rack	2.214	1.322	62%
306	Glycerin Rack	276	235	85%
502	Area Soap Maturation	294	988	588%
502	Area Dove Maturation		742	
Occupancy warehouse		5.234	4.905	94%

Table 2. Demurrage and Port Charges

Month	Container 20 ft	Container 40 ft	Total Container	Average Clearance Days	Port Charges	Demurrage Cost
Jan	43	12	55	2.89	IDR 33,489,150	IDR 6,000,000
Feb	112	10	122	2.81	IDR 49,751,985	IDR 12,324,320
Mar	87	14	101	5	IDR 70,992,399	IDR 22,754,700
Apr	130	19	149	3.45	IDR 93,652760	IDR 24,340,000
May	71	13	84	4.52	IDR 77,245,810	IDR 6,178,350
June	142	20	162	5.32	IDR 146,597,030	IDR 132,051,972
July	148	13	161	6.97	IDR 225,272,990	IDR 37,530,770
Grand Total	733	101	834		IDR 697,002,124	IDR 241,180,112

This paper aims to implement improvements to the PT. UOI warehouse so that there is no product buildup in the free area. The specific objective of this research is to optimize the flow of product material.

2 Research Methods

This study is simulation research. Simulation research aims to create a picture through a small or simple system, then manipulation or control in the model will be carried out to see its effect. The object of this research was the need for shelves and layouts in the PT. UOI. The research focused on the layout design and analysis of shelf requirements, implementation, and use of WMS at PT. UOI.

The variables used in this study were as follows: Storage Type, this variable is used to divide the placement of stored items by type of place. Item Transfer Frequency, this variable is used to determine the layout of each item in the warehouse based on the number of moves. The dimensions of each item are used to calculate the area required for each item in the warehouse. The warehouse area size variable is used to calculate the warehouse area. Shelf Size, this variable is used to determine the location of each item in the warehouse based on the item size on the rack. The framework for thinking from research can be seen on Fig. 1.

The flowchart for this research is as follows Fig. 2.

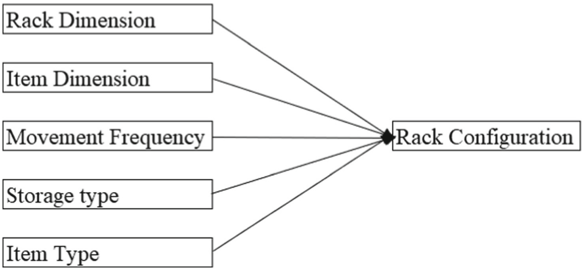


Fig. 1. Framework Research

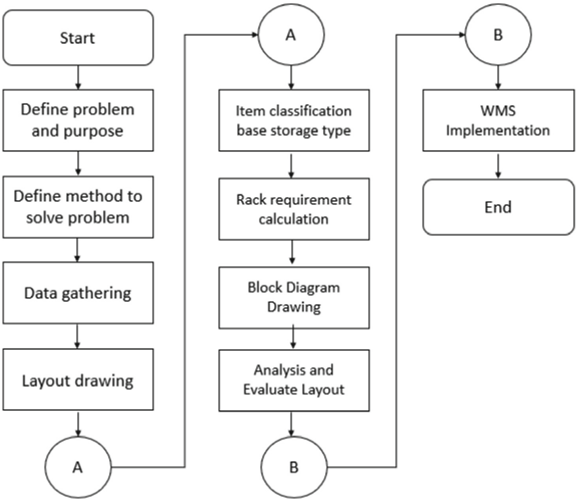


Fig. 2. Flowchart Research

3 Results and Discussion

The actual layout of PT. UOI with a length x width of 81.51 m × 52.95 m totalling 4,315 m^2 can be seen in the following Fig. 3.

The size of each warehouse room can be seen in Table 3.

The size of each shelf can be seen in Table 4.

The types of items in the warehouse can be seen in Table 5.

In the initial conditions, the laying of goods does not follow the rules in accordance with the racks used in the warehouse. Classification of items based on shelves is divided into 3 categories by considering the size of the items stored. The Dove and Soap Shelf section has 40 types of items, and the Flaking Drumming Rack section has 33 types of items. The division of goods classification is used to identify and divide items into certain shelves so that these items can be entered and stored properly without affecting the quality and safety issues of the product.

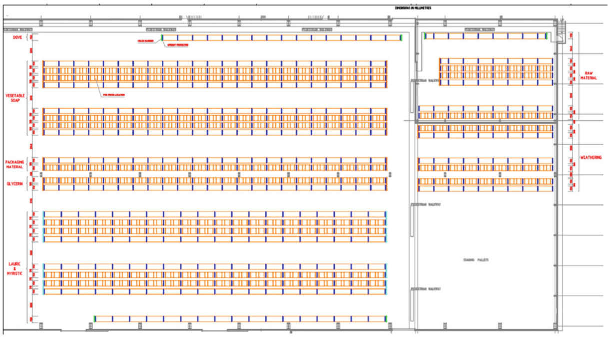


Fig. 3. Actual warehouse layout

Table 3. Warehouse Room Size

No	Area Rack	Length	Width	Pallet Position	Height
1	Maturation Dove & Soap	95 cm	120 cm	294	200 cm
2	Dove & Soap	95 cm	120 cm	2540	165 cm
3	Flaking and Drumming	95 cm	120 cm	2400	160 cm
4	Raw & Packing Material	95 cm	120 cm	1652	170 cm

Table 4. Size of each shelf

No	Rack Type	Length	Width	Height	Level
1	Rack Double Deep Dove and Soap	2.600 cm	120 cm	8.725 cm	6
2	Rack Single Deep Dove and Soap	2.600 cm	120 cm	8.725 cm	6
3	Rack Double Deep Flaker & Gly	3.000 cm	120 cm	9.125 cm	7
4	Rack Single Deep Flaker	3.000 cm	120 cm	9.125 cm	7
5	Rack Raw Material	2.600 cm	120 cm	8.675 cm	6
6	Rack Packing Material	2.600 cm	120 cm	9.125 cm	7

Calculating the total shelf requirement for each item can be done by multiplying the production per day, the length of time the product has been idle for maturation, and the length of time waiting for the container to arrive and adding safety stock (if any) (Table 6).

Classification of items based on the type of shelf using the Decision Tree Algorithm Method as follows (Figs. 4 and 5).

1. If the product height is <110 cm, it is a Raw Material rack group.
2. If 110 cm product height <135 cm, then the goods enter the Packing Material rack.

Table 5. Item Types

No	Item Type
1	Dove & Soap
2	Flaking and Drumming
3	Raw Material
4	Packing Material

Table 6. Racking Calculation

Product	Type	Production Rate (MT/day)	Maturasi (Days)	Average time in WH	Safety Stock (MT)	Weight (MT)	Total Rack
Dove		204	2	6.8	110	1.1	1,732
Soap		240	2	5.6	85	0.85	2,246
Flakes	C12	120	2	4.8	120	0.7	1,337
	C14	50	1	3	50	0.7	357
Drum	Gly	50	1	1	0	0.72	139
Total							5,81

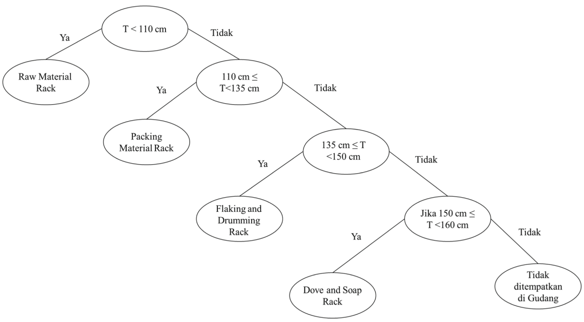


Fig. 4. ABC Classification Logic

3. If 135 cm product height <150 cm, then the goods enter Flaking and drumming rack.
4. If 150 cm product height is 160 cm, then the goods enter the Dove and Soap rack.
5. If the four algorithms above are not met, then the product cannot be placed in the warehouse.

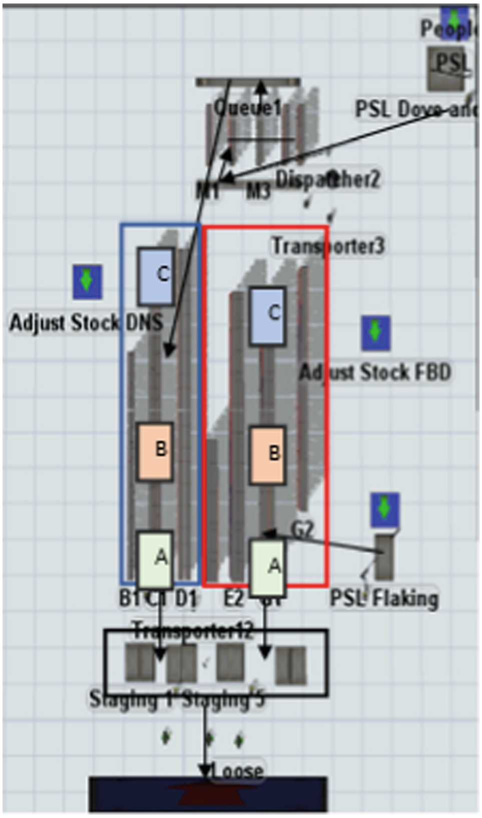


Fig. 5. ABC Calculation-based Layout

The classification results show that the Dove and Soap section has 40 item types, Flaking Drumming has 31 item types, the Packing Material section has 31 item types, and the Raw Material rack has 10 item types.

Block diagrams are made based on the class division that has been done on the ABC Classification method. Class A is a group of Fast-Moving items and is brought closer to the goods receiving section, Class B, which is a group of Slow-Moving items, is placed after the placement of Class A, then Class C, which is also a group of Slow-Moving items is placed after Class B. This block diagram is made as a simulation preparation and optimization of the used rack allocation.

In this section, the process of creating a warehouse simulation model using Flexsim software was carried out (Fig. 6). In this simulation, primary and secondary data were entered from data collection.

Based on rack calculations using mathematical and simulation, the results can be seen as follows on Table 7.

Based on the Simulation and Calculation validation, the rack simulation for dove and soap required 4,018 pallet positions, while the manual calculation required 3,978

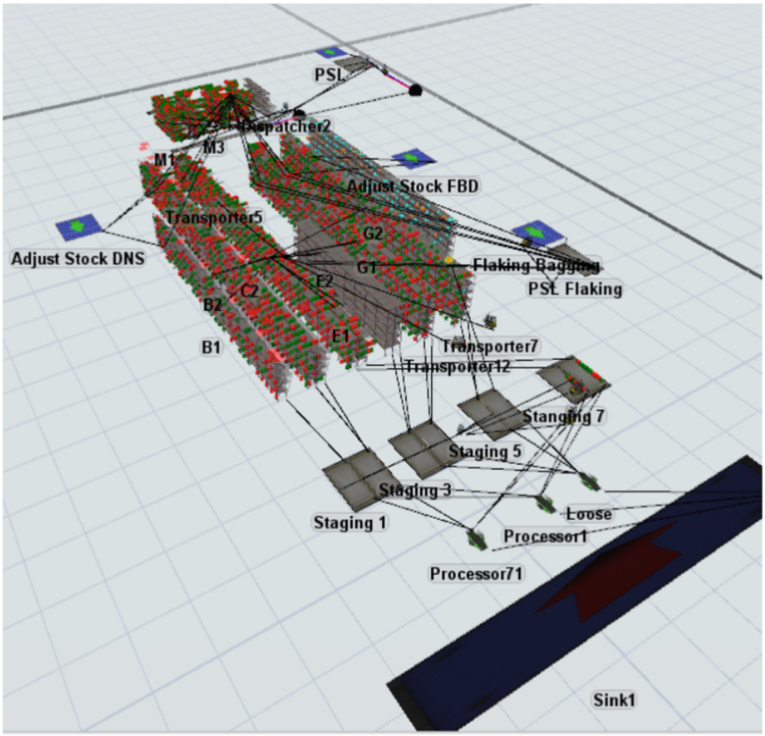


Fig. 6. Final Simulation Results

Table 7. Racking Calculation Validation

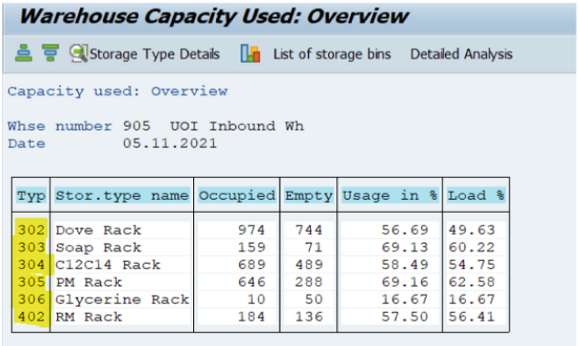
Product	Actual	Manual	Simulation
Dove and Soap	2,834	3,978	4,018
Flaking Drumming	2,400	1,833	1,815
Total	5,234	5,811	5,833

pallet positions, the flaking and drumming simulation required 1,815 pallet positions, and the calculation required 1,833 pallets.

Simulation and manual calculations have similar results for rack allocation while there is a significant difference in the actual; this is due to the very high flaking rack allocation and is no longer relevant. This significant difference is caused by market movements and business strategies that produce dove and soap compared to flaking.

Based on the simulation and calculation results, the data is entered into SAP to change the rack allocation in SAP as follows (Fig. 7).

Optimization of product flow can be seen from the reduction in slow-moving which can be seen in Table 8.



Warehouse Capacity Used: Overview

Storage Type Details List of storage bins Detailed Analysis

Capacity used: Overview

Whse number 905 UOI Inbound Wh
Date 05.11.2021

Typ	Stor.type name	Occupied	Empty	Usage in %	Load %
302	Dove Rack	974	744	56.69	49.63
303	Soap Rack	159	71	69.13	60.22
304	C12C14 Rack	689	489	58.49	54.75
305	PM Rack	646	288	69.16	62.58
306	Glycerine Rack	10	50	16.67	16.67
402	RM Rack	184	136	57.50	56.41

Fig. 7. SAP Rack Capacity

Table 8. Twelve-Month Slow-Moving Material

Month	Quantity	Value ($)
January	387,394	556,722
February	422,375	607,670
March	515,888	689,154
April	485,451	663,092
May	487,451	664,856
June	537,795	716,962
July	581,096	774,644
August	557,889	712,778
September	515,203	634,995
October	553,617	708,990
November	519,274	636,902
December	525,281	620,293

Table 8 exhibits a reduction of 32,608 pcs from 581,096 pcs in July 2021 to 525,281 pcs in December 2021 and a reduction of $92,485 from $774,644 in July 2021 to $620,292 in December in the slow-moving value. This decrease was caused by improved product flow, product classification, and improved WMS, making it possible to search for products quickly and apply FIFO to real situations.

Improvements in the allocation of shelves in business can be made by rearranging the entire shelf area during the annual shutdown, which was carried out in December. At the time of the annual shutdown, the stock in the warehouse will be low and not moving, so it can be reset according to the recommended settings. In the SAP system, additional racks can be added via Tcode LS01N.

This simulation can be used and edited according to the strategy of the warehouse management team [5]. The warehouse team can train workers to understand and use this system to simulate the best strategy. In its implementation, the use of simulation must be updated according to actual conditions in a certain period. The data that need to be updated are production capacity, speed of distribution of goods, allocation of storage space, speed of delivery, number of products per certain period, and number of workers.

4 Conclusion

This study's results show that the simulation validation and manual calculations results show that the rack simulation for dove and soap required 4,018 pallet positions, and flaking drumming simulations required 1,815 pallet positions. Meanwhile, in actual conditions, the rack for dove and soap is allocated 2,834 pallet positions and 2,400 pallet positions for flaking and bagging. Class division using the ABC Classification method is carried out so that Class A, which is the Fast-Moving product group, is brought closer to the goods entry section, Class B, which is the Slow-Moving product group, is placed after the A class area, then Class C, which is also the Slow-Moving item group, is placed after class B. Moreover, the results of Slow-Moving product optimization are seen from a reduction of 32,608 pcs from 581,096 pcs in July 2021 to 525,281 pcs in December 2021 and a reduction of $92,485 from $774,644 in July 2021 to $620,292 in December in the slow-moving value.

It is suggested that simulation should be carried out every week to ensure that the rack allocation remains accurate by entering the actual storage period, production schedule, and product delivery schedule to view the simulation and estimate the condition of the warehouse in the future to maintain smooth activities in the warehouse.

The authors also recommend that every time there is an addition of new products, ABC Classification must be carried out to ensure where the product will be placed to avoid safety hazards because the product does not fit on the shelf, maintain order and distribution of types of each item placed in the warehouse. Besides, the authors recommend that every time there is a change in rack allocation, the SAP WMS must be changed immediately to resemble the actual situation in the warehouse to maintain product accuracy and the accuracy and correctness of the data that will be used to make strategic decisions in the warehouse.

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