Layout Design of Distributor Warehouse PT. X in Sidoarjo

Abdur Rohim Achmad, Indri Hapsari*, Dina Natalia Prayogo,
Industrial Engineering, University of Surabaya, Indonesia
indri@staff.ubaya.ac.id

Abstract

PT. X is a distributor of consumer goods products with a total of 34 warehouses and 121 branch offices. The process of storing goods was still random, then it resulted in the long process of searching and picking up goods. The objective of this research was to design a new layout for storing goods in the warehouse of PT. X in order to simplify the search process and minimize time for picking up goods. The proposed storage was the Class Based Storage method based on ABC Analysis. Each item was grouped based on each brand. Furthermore, each brand was classified into three classes by using ABC Analysis based on the frequency of picking up each item. We used it to determine the priority of the storage location of each brand. Class A would prioritize the storage slot area with the closest distance; class B would be in the storage slot area with a medium distance; and class C would be in the storage slot area with the furthest distance from the staging area. After obtaining the class of each brand, then the classification was carried out for each brand group in the same way to obtain priority storage locations for each product. The storage allocation process was carried out by using a simulation method with a spreadsheet. The results of the proposed layout design resulted in saving search time of 22% or 163 seconds and picking up time of 37% or 23.96 hours based on the 2 month purchase order list.

Keywords: ABC Analysis, Class Based Storage, Layout, Warehouse

1. Introduction

PT. X is a consumer goods distributor company in Indonesia. They distribute cleaners, fragrances, snacks, and beverages from several loyal principals. These products are distributed every day to their various consumers; including supermarkets, retail, shops and traditional markets. The coverage of distribution areas is wide, especially in eastern Indonesia, with a total of 34 warehouses and 121 branch offices. One of the warehouses which is located in Sidoarjo, East Java, is also their head office. This warehouse's storage capacity is large enough to store products with thousands of types and quantities.The products stored in this warehouse are supplied from several principals. However, in general, the stored products are divided into two types: food and non-food.

This 3,480 m² warehouse has a racking system where the product storage process is arranged on pallet shelves whichconsists of 6 levels. The warehouse has a total of 20 rows of shelves, with an average of 14 racks for each row. The existing storage area is divided into 3 cardboard areas which include food and non-food category products. There is a cooling area for easy-to-melt food and a specific area for products from Principal Z to serve orders in units. As a result, the warehouse implements the FEFO (First Expired First Out) system.

This research only focuses on the cardboard category products from Principal Z, because their products use 48.06% of warehouse space usage. The problem was the random storage process that made it mixed with other products. This results in a difficult searching process and long order picking time. At the end of the day, products were not placed in their right location and interfered with activities in the warehouse. The purpose of this research is to design a proposed layout for product storage in the warehouse of PT X with the objective to simplify the searching process and minimize order picking time. This research will provide recommendations for product storage strategy in the warehouse to increase warehouse productivity.

2. Method

Eldemir, Graves, Malmborg (2004) proposed a method for arranging the storage layout that depends on the characteristics of the products. This research will use the Class Based Storage method using ABC Analysis. Class Based Storage method is a combination between Random Storage method and Dedicated Storage method. This method divides the product into some classes based on the ratio of throughput and storage ratio. This method has a place arrangement that is designed to be more flexible by dividing the place into several classes. However, each place may contain goods randomly by several types of products that have been classified based on the type and characteristics of the goods.

For developing the class, this research used ABC Analysis for managing product inventory based on the Pareto

principle. Pareto principle states that 80 percent of the impact is caused by 20 causes. There is another criterion namely the frequency of movement, where the inventory in the warehouse is divided into 3 classes of specific criteria. First is class A that consists of items that account for a little less than 20 percent of the total number of goods but have a movement frequency of 80 percent. Second is class B for goods that have a total of 35 percent of the total number of goods in existence but have a movement frequency of 15 percent. The last is class C that has 45 percent of the total products with 5 percent of movement frequency (Manzini et al, 2015).

After the required data is collected, the first analysis is about initial conditions to determine the problems inside the warehouse. An improvement will be proposed to solve the existing problems. Kriehn et al (2018) in their research showed the result of layout improvement by grouping products based on each brand. After obtaining the brand group, ABC classification will proceed based on the order picking frequency to determine the priority of the storage area for each brand. This process will result in 3 classes. Class A will be prioritized to be placed in the storage area with the closest distance from the staging area, class B will be prioritized to be placed in the storage area with a medium distance, and class C will be prioritized to be placed in the storage area with the farthest distance. After each class is obtained, then the product classification will be developed for each brand group with the same steps. Then the calculation of the allocation amount of each product is based on the largest number of stocks based on company data (Thi & Nguyen, 2016).

The use of large amounts of stock is taken to anticipate a shortage of storage space if there is an increase in the number of incoming goods than usual (Berg& Gademann, 2010). After that, an allocation is made to each storage slot using a simulation method using the spreadsheet. The first allocation process is for level 1 storage slots, continued with calculating the capacity of each slot. The remaining amount of stock that has been allocated at level one is used to calculate space requirements at levels 2-6. After each product has been allocated to each slot, the searching time and order picking time are calculated for the initial layout and the proposed layout (Mirzaei, Zaerpour, Koster, 2021). The goal is to find out whether the proposed layout design is better or not.

3. Result and Discussion

Data of the timing of order picking activity for initial layout are obtained in Table 1. Picklist is for product ID that will be picked. Order picking time is the duration to pick the product from a specific location. Percentage of traveling time, picking time, and searching time are the proportion of order picking time. It can be seen in the initial layout; the searching time has a big percentage because the picker takes a long time to find the location of the items on the order picking list. The process of designing the proposal layout is continued using the Class-based Storage method (Ederl, 2020), where the products will be grouped based on their respective brands in order to facilitate the searching process. After grouping, then the ABC classification will be done for the brand group. Table 2 consists of example ABC classification for brand principal Group A. The process to arrange the class are:

1. Sorting the brand groups based on the order picking frequency from the largest to the smallest
2. Calculating the percentage of order picking frequency for each brand group
3. Calculating the cumulative percentage calculation by adding up the percentage of order picking frequency for each brand
4. The class is formed with class A as a group of brands with a cumulative frequency of 80%, class B is 81-95% (35%), and class C is 96-100% (5%).

After classifying the brand groups, the next step is classifying the products for each brand using the same steps. From each product, it will be allocated to the existing storage slot using the space needed for each product. Space requirements of each product is calculated based on historical data on the amount of inventory. Table 3 consists of space required for each product based on inventory in July until September in box. The maximum space will be used as the available space for a specific group.

Table 1
Time Analysis of Order Picking Activity

No	*Picklist*	*Order Picking* Time (second)	% traveling time	% picking time	% searching time
1	22	300	26%	23%	50%
2	25	900	25%	31%	44%
	28				
3	7	360	31%	25%	43%
	8				
4	10	540	12%	22%	65%
5	13	300	22%	17%	61%
6	71	240	32%	58%	10%
7	47	900	15%	10%	75%
8	51	300	52%	19%	30%
	53				
9	54	300	51%	6%	43%
	56				
	57				
10	58	600	45%	15%	40%
	63				
	55				

Table 2
ABC Classification in the Brand Principal Group A

No	Brand	Order Picking Frequency	% Order Picking Frequency	% Cumulative Percentage	Class
1	DWN	1904	45%	45%	A
2	PTN	1120	27%	72%	
3	H&S	370	9%	81%	B
4	PMPS	162	4%	85%	
5	REJ	154	4%	89%	
6	AP	128	3%	92%	
7	OLY	98	2%	94%	

8	VKS	92	2%	96%	C
9	GIL	66	2%	98%	
10	OB	56	1%	99%	
11	WHIS	40	1%	100%	
12	HE	0	0%	100%	
Total		4190			

Tabel 3
Space Requirements Of Each Product

GBS Code	July (box)	August (box)	September (box)	Max (box)
01/326127402R	2730	1374	1380	2730
01/326127403U	1584	295	1185	1584
01/326127403W	1741	349	903	1741
01/326127402T	637	163	336	637
01/326127403S	325	143	281	325
...				
01/274923801A	24	12	7	24
01/274921601C	2	2	3	3
01/244621005B	5	11	2	11
01/07060502A	34	20	12	34
01/265525501F	1	8	1	8

Level 1 storage slots are for products that are commonly used for daily order picking processes. The allocation process is arranged by simulation using spreadsheets in accordance with the classification results that have been done. At level 1 slot there are 3 types of storage slots, which are without pallets, pallets (not full), and full pallets. This type of storage slot is also a concern during the allocation process. The storage slot without pallet is prioritized for small and medium category products, while pallet and full pallet storage types are prioritized for large and medium categories. After all products have occupied one slot at level 1, the next step is to calculate the capacity of each product based on the storage slot type. Table 4 consists of product allocation examples for level 1. GBS Code is identification for the product, category for the size, storage type is determination to use material handling. Distance comes from the location in the warehouse.

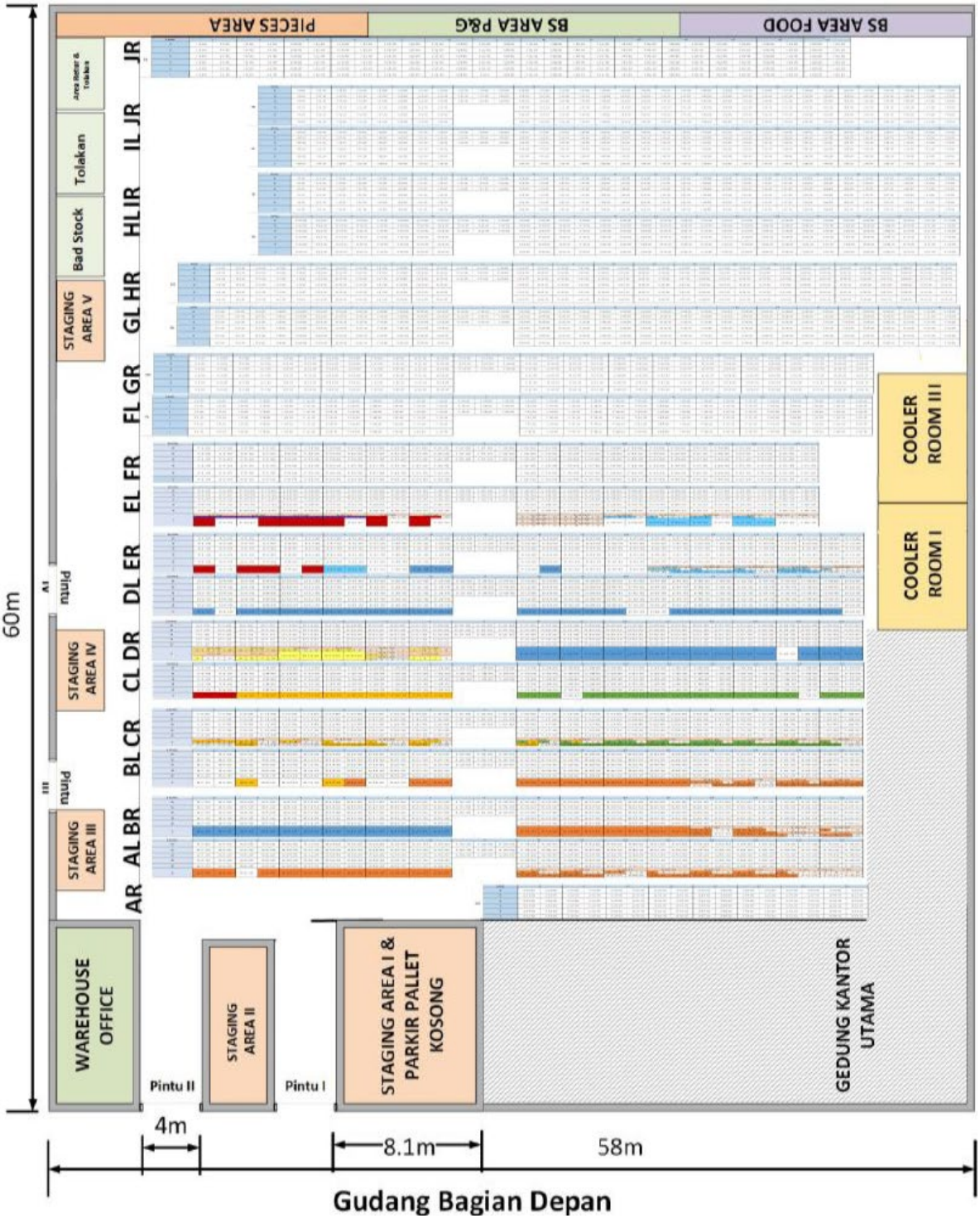
Table 4
Product Allocation to Level 1 Storage Slots

GBS code	Category	Slot	Distance	Storage Type
01/326127402R	Small	A-24-10	8,12	Full Pallet
01/245124609D	Medium	A-22-10	14	Without Pallet
01/326127402V	Medium	A-20-10	15,09	Pallet
...				
01/274921601C	Small	E-8-10-C	46,43	Without Pallet
01/244621005B	Small	E-8-10-D	46,43	Without Pallet
01/07060502A	Big	E-82-10	50,56	Pallet
01/265525501F	Big	E-84-10	51,86	Pallet

Calculation of the capacity of each storage slot
• Without Pallet (comparing slot dimensions with product dimensions)
Example for product 01 / 245124609D
Capacity = (Ps/Pp)x(Ls/Lp)x(Ts/Tp) (s = slot, p = product)
= (57.5/29.3) x (105/21.6) x (76/25.7) = 1 x 4 x 2 = 8 cartons
• Pallet: (Compares slot height to product height x product per layer)
Example for product 01 / 326127402V
Capacity = B x (Ts/Tp) (s = slots, p = pallet, B = number of products per layer)
= 11 x (106/34) = 11 x 3 = 33 cartons
Full Pallet: (Based on data on the number of products per pallet)

After the capacity of each product at level 1 is known, the next allocation process is for storage slots level 2 until 6. The number of products allocated is based on the amount of remaining stock that has been allocated to the level 1 storage slot that has been converted in the form of pallets. The layout arrangement between initial layout and proposed layout shows in Figure 1. In the initial layout, because it did not consider the ABC Analysis, the location of products was scattered and it was difficult to search. The location also gave effect to longer distance and time. After the proposed layout was arranged, the product will be collected in one location based on ABC analysis. It will help the operator to find the product, making it less effort to access the location. It will give effect to picking time and distance.

From the results of the proposed layout design that has been made, we calculate the searching time and the order picking time for initial layout and the proposed layout. The searching time is measured using a simulation based on the existing picklist data, while the picking time is calculated based on the length of travel time and the extracting time. Table 5 shows the comparison between the searching time and Table 6 shows the picking time for initial and proposed layout.



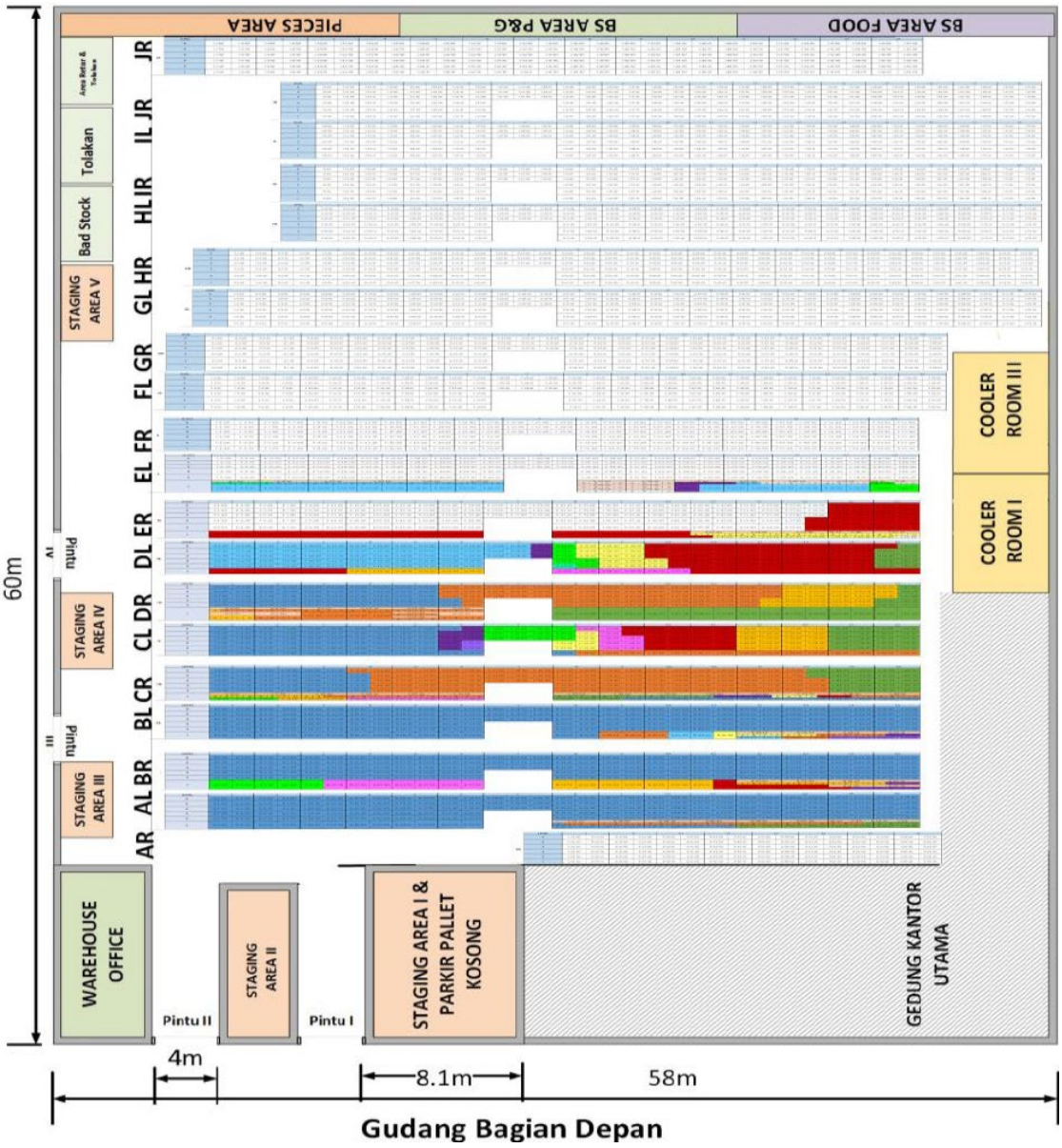


Figure 1: The layout arrangement between initial layout (top) and proposed layout (bottom)

Table 5
Comparison of Initial and Proposed Layout Searching Time

No Picklist	Initial Layout	Proposed Layout	Saving
22	204	202	-1%
25	201	141	-30%
47	116	74	-37%
51	176	137	-22%
71	47	26	-44%
Total Time (second)	744	580	-22%

Table 6
Comparison of Initial and Proposed Layout Picking Time

GBS Code	Picking Frequency	*Picking* Time (second)	Total *Picking* Time (second)	Saving (%)	GBS Code	Picking Frequency
		Initial	Proposed	Initial	Proposed	
01/326127402R	182	55,60	20,61	10118,54	3750,46	-63%
01/326127402V	180	53,30	20,61	9594,30	3709,25	-61%
01/245124609D	146	55,41	14,62	8089,41	2135,07	-74%
...						
01/245321106B	2	64,68	66,44	129,35	132,89	3%
01/245321105D	2	48,82	73,98	97,65	147,96	52%
Total	3654	25499,31	23842,49	234915,23	148628,1	-37%

From the comparisons above, the proposed layout results in searching time and picking time saving. Saving searching time was 22% and picking time was 37%.

The class division was based on the frequency of taking each product. Each class determines the priority of the storage location placement for each product. With this method, not all products in the brand will be placed in a location but based on class groups. Thus the product class that has the highest frequency of collection from each brand will occupy the closest location. This will reduce the travel time between products and order picking process will be faster.

In the initial layout, the storage process is carried out based on the most sold products. The storage location near the staging area is occupied by the product group that has the highest sales figure regardless of the picking frequency for each product. Most sold products are not similar to the highest picking frequency product, because some of those products are demanded by a single customer. It makes many products that have more picking frequency are placed in remote locations and the order picking process takes longer time. In the proposed layout, the storage process will consider the picking frequency for each item. Grouping is developed based on the same brand, but not all product members are placed in one location, but based on the priority classes that have been made. The high frequency inter-brand products located close to each other, thus traveling time is getting faster. Table 7 shows comparison of distance between initial and proposed layout.

These achievements are evidence of the success of the layout arrangement that has been carried out. By arranging product layouts based on ABC Analysis, it supports the activities of storing and retrieving goods in the warehouse. ABC Analysis considers the specifications of each group so that the placement of the item will be in accordance with the effort to reach the location of the item. By using simulations that use spreadsheets, it is proven that there is less storage and retrieval time and distance. The savings obtained can be used to carry out other more value-added activities, increase warehouse capacity, and reduce resource use.

Table 7. Distance comparison between Initial and Proposed Layout

Brand	GBS Code	Initial		Proposed	
		Location	Distance	Location	Distance
DOWNY	01/326127402R	B-7-10	24.74	A-24-10	8.12
DOWNY	01/326127402V	B-9-10	23.65	A-34-10	8.12
PANTENE	01/245124609D	A-4-10	24.65	A-32-10-B	5.28
DOWNY	01/326127403U	B-3-10	27.13	A-22-10	14.00
PANTENE	01/245124609A	A-2-10	25.95	A-32-10-C	5.28
DOWNY	01/326127402S	B-13-10	21.26	A-36-10	14.00
DOWNY	01/326127403W	B-1-10	28.43	A-20-10	15.09
PANTENE	01/245124609B	A-24-10	8.12	A-32-10-D	5.28
DOWNY	01/326127403X	B-5-10	26.04	A-40-10	15.09
HEAD & SHOULDERS	01/244524603L	C-42-10	30.54	A-68-10-D	17.58
...					
PANTENE	01/245124609K	B-16-10	23.36	D-1-10-C	39.54
REJOICE	01/245321001N	C-45-10	21.06	D-24-10	30.34
GILLETTE	01/33109101A	E-28-10	39.91	D-10-10	38.81
ORAL-B	01/341313502A	E-74-10-A	48.82	E-14-10-B	44.04
AMBIPUR	01/316027112F	E-2-10-D	48.82	B-63-10-D	30.08
OLAY	01/294825206Q	D-5-10-D	37.15	E-55-10-C	45.42
PAMPERS	01/225026510B	F-11-10	45.87	B-23-10	15.18
WHISPER	01/235725801A	F-45-10	47.17	B-70-10	36.61
VICKS	01/07060401A	F-57-10	54.34	C-3-10	34.31

4. Conclusion

The development of the proposed layout design that uses the Class Based Storage method based on ABC Analysis can simplify the product search process, based on time saving 22% or 163 seconds. In the picking time, a savings of 37% or 23.96 hours (23 hours 57 minutes) was also obtained based on the order picking list for 2 months. The distance saving is 30.45% or 184.84 m. These savings were a result from locating the products with high picking frequencies in the nearest location to the shipping dock. Grouping products by brand makes it easier for pickers to remember

where the product is located, because each brand is divided into specific locations. This target will give effect to increasing company productivity because of the logistics smoothness. The proposed layout design can be a consideration for companies in determining the allocation of storage for goods in the warehouse.

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