e-ISSN: 2686-522X, p-ISSN: 2686-5211
Received: 20 Agust 2022, Revised: 14 September 2022, Publish: 22 September 2022
DOI: https://doi.org/10.31933/dijms.v4i1

Redesigning of Industrial Warehouse Layout Using CADD

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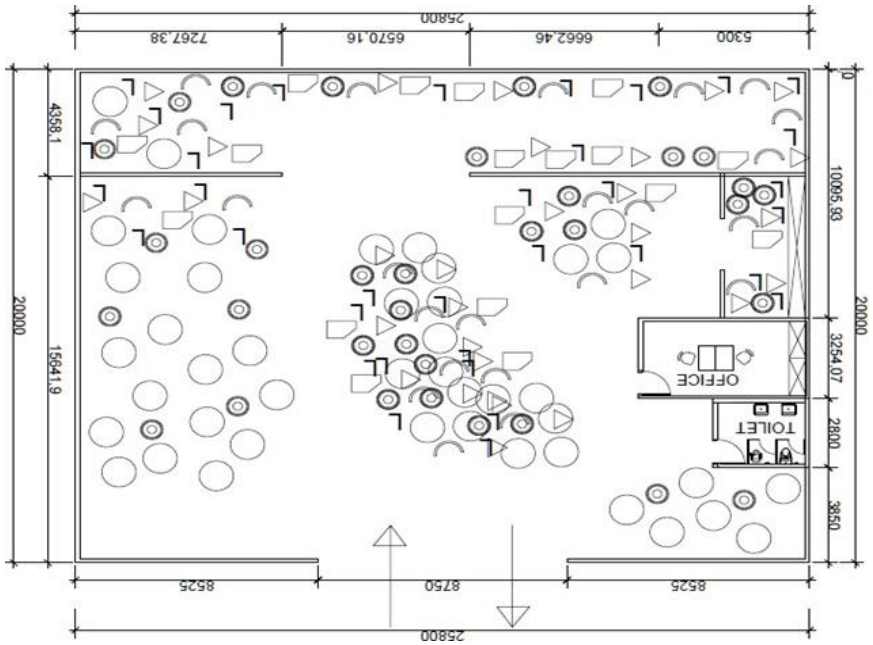
Abstract: They take a look at changes in seeking out the most appropriate application of warehouse layout patterns using an extended AutoCAD simulation model. preliminary data changed into won based totally on the financial and overall performance of foremost heavy components providers. both primary and secondary data assets have been processed and analyzed at some point which calculated the ratio of the proportion of location for each type of product class based on sales productiveness and the percentage effects can be applied with CADD simulation (pc Aided layout and Drafting) by using the use of software program software AutoCAD and SketchUp to make clear in viewing pix in three-dimensional form. After the reapply layout is implemented in the utility, the organization can use shade codes and numeric / letter codes to make it smooth in grouping classes of goods. The outcomes indicate that properly-prepared and technology-based warehouse operations brought full-size and giant growth to both efficiency and sales in a selected post-pandemic.

Keywords: Industrial Warehouse, Layout Simulation, CADD Simulation.

INTRODUCTION

The research objects were companies that engaged in heavy industrial spare parts such as excavators, frontons, and frontons trucks. These companies also accommodate, develop products, market, and distribute partner products from within and outside the country. These companies have nine warehouses and distribution centers to support their business. However, in running a business it is not easy every company must have obstacles that must be overcome both from the operational and other sides, for this the company must also make continuous improvements for the sustainability of its business. The companies have several obstacles, one of which is the unstructured arrangement of the layout of the goods. The photos below were the current warehouse layout, which can be seen as an unstructured layout. The companies realize that this can be an obstacle for the company, which can cause a lack of security in the environment and work safety, low flow of inventory turnover in the

warehouse because it is difficult to find items that take longer .

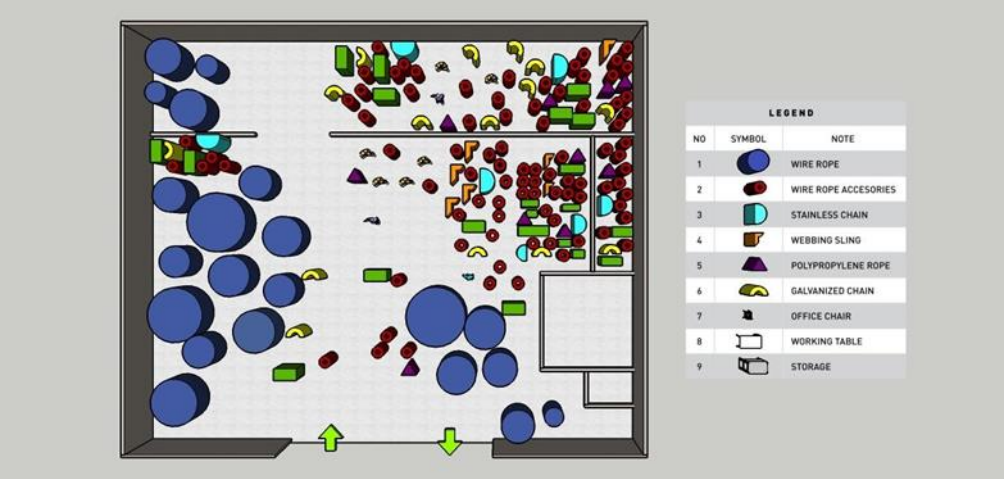


Source: research data (2021)

Figure 1. The existing warehouses' arrangement (analyzed by CADD)

time to find goods when there is an order and also a difficulty for companies to predict / stock items. In addition, if the company does not do a good layout it can make it difficult to do stock taking which will have an impact on recording incoming goods, outgoing goods, and inappropriate stock of goods. The companies also realize that the arrangement of the layout of goods is important for the continuity of warehousing activities and the smooth flow of activities, for that companies were trying to expand by buying more storage places (warehouses) to make it more neatly organized, but still in the construction completion stage. The company has also tried a strategy for re-layout and did a good layout plan, but it has not been implemented optimally. The similarity of the arrangement is shown in Figures 1 and 2 below (scale 1:15):

The importance of the layout function in the warehouses was also useful for preventing double purchases of goods, meaning that goods that should still have stock in the warehouses are bought again because the arrangement of goods is still unstructured which can cause greater costs. In addition, the organizational structure and operational systems of the company have not been properly socialized which has an impact on the lack of effectiveness in the performance of employees and companies. Lack of awareness and training for employees can also hinder the running of the company's activities, not only do the authors see a lack of knowledge about products and the use of technology in a company environment that is still minimal. Therefore, to maintain good quality and operational performance in the warehouse environment, companies must realize the importance of implementing a good layout to optimize the process of warehousing activities to get maximum results. From the above background, the researcher formulates the problems raised in this study, as follows: How's the implementation of the company's warehouse layout pattern? What is the appropriate method for positioning the optimal layout? How do place the various types and types of goods effectively?



Source: research data (2021)

Figure 2. Existing Warehouses Arrangement (analyzed by SketchUp)

LITERATURE REVIEW

Warehousing activities be aware of the physical garage, material retrieval, and control of modern-day information wished about stored items (Aghazadeh et al., 2011). The warehousing is approval-oriented and calls for green use of modern-day media to keep and manage records approximately information actions (Al-Hyari et al., 2019). Simulation has ended up diagnosed as a tool for designing and evaluating complicated, production facilities including pretty automatic and bendy production strains. The simulation can decide the performance of ultra-modern numerous viable machine layouts and scheduling regulations to fianthe excellent performance system (Buddas, 2014). This system may be tested against an expected production agenda to determine whether the planned production capacity is carried out, and the right aid utilization (Mitra Debnath, 2019). The format is one of the key selections that decide the long-run efficiency of trendy operations (Lee & Ebrahimpour, 1984). The layout has a strategic implication because it establishes an organization's competitive priorities regarding the process, flexibility, and value, in addition to nice or life, client touch, and photograph (Altinisik & Yildirim, 2020). Format planning is choosing the high-quality physical preparations today's all sources that eat space inside a facility (Bhat et al., 2021). office format: Retail layout: Warehouse layout: fixed-function format: procedure-orientated format: work-cellular layout: Product-oriented format (Bhatnagar et al., 2019). Sanders (2007) the format kind is divided into 4 parts, specifically: process format, Product layout. There are 6 traits in the product layout, namely: resources are speciaspecializeders are capital intensive, Processing charges are faster, fabric handling fees are lower, space necessities for stock storage are lower, and versatility is low relative to the marketplace (Bhat et al., 2021). There are differences in characteristics between the procedure and product format which may be visible in the table beneath (Kauppi & Luzzini, 2022). A framework for designing warehousing layouts to arrange the layout method, which are specifying the kind and motive of modern-day warehouses (Hemalattha & Vidjeapriya, 2021). keep away from the placement of modern materials or components in storage by processing them as they're acquired for shipment (Jansson, 2022). Cross-docking can be described to avoid putting materials or inventory gadgets the in garage inside the warehouse by being processed straight away while the goods are acquired and blended for the equal shipping motive so that they do now not require a large storage place (Kauppi & Luzzini, 2022).

If the products are processed without delay, it's going to avoid the formal sports of receiving items, counting inventory /storage, and choosing orders, this doesn't add price to the product so if it's miles removed the organization will shop costs (Muganyi et al., 2019)

So, doing cross-docking requires strict scheduling; and accurate identification of incoming merchandise. used in warehousing to find inventory anywhere there's an open vicinity (Bhatnagar et al., 2019). Random stocking can be described as the placement of an open warehouse, which does not require a unique room to store certain objects (Patel & Patel, 2021). Random stocking is likewise used in the warehousing procedure to determine the region of products and if there are locations to be had (Heizer, 2014). The use of warehousing to feature fees to a product via component modification, repainting, labeling, and packaging (Vamsi Krishna Jasti & Kodali, 2014). Making layout facilities and a constructing method is very necessary; because in case you just maximize one factor you will enjoy shortcomings. coping with fabric and warehousing costs want to be identified based totally on need (Mitra Debnath, 2019). There's a format class primarily based on the receipt of goods to the area of the goods for delivery in the warehouse, namely U-form and go-docking (Mitra Debnath, 2019).

Application of Decision Support System for Warehousing Strategy

The application of a choice aid gadget for the method (Warehousing selection guide device / WDSS) has three fashions: (1). laptop-Aided layout (CAD) is a simulation model based on computer design that maps warehousing capabilities together with receiving, storing, and dividing based on one-of-a-kind format options and helps to visualize the flow of materials or components in the warehouse (Durmusoglu, 2018). The laptop-Aided layout or generally referred to as computer-Aided Design and Drafting (CADD) is a pc gadget that offers comfort inside the drawing procedure and making plans and layout processes thru current automation, CADD also replaces tedious and time-consuming obligations (Chugani et al., 2017). CAD commenced being acknowledged on the pc with one of the AutoCAD software (Naeemah & Wong, 2021). AutoCAD is not the most effective used for special applications consisting of architecture however can draw anything. (2) Forecasting model features to predict destiny orders and can be related to the simulation model. (three) Analytic Hierarchy Process (AHP) can be used to assess the pros and cons of warehouse locations/layouts that may be made with simulation experiments and then pick out the preferred alternative. AHP can also assist pick out the proper format alternatives; but can check the professionals and cons of each alternative iaboutaboutng deaboutmaking criteria, particularly: material handling Time, Warehousing value, Throughputs, and Command compatibility with the existing warehouse setting (Jacobs, 2013). The implementation of WDSS may be completed in three steps, namely (1) Warehousing capacity enlargement/growth of warehouse potential. (2) Warehouse layout/warehouse format. (3) Re-warehousing / Rearranging the format (Narula et al., 2022).

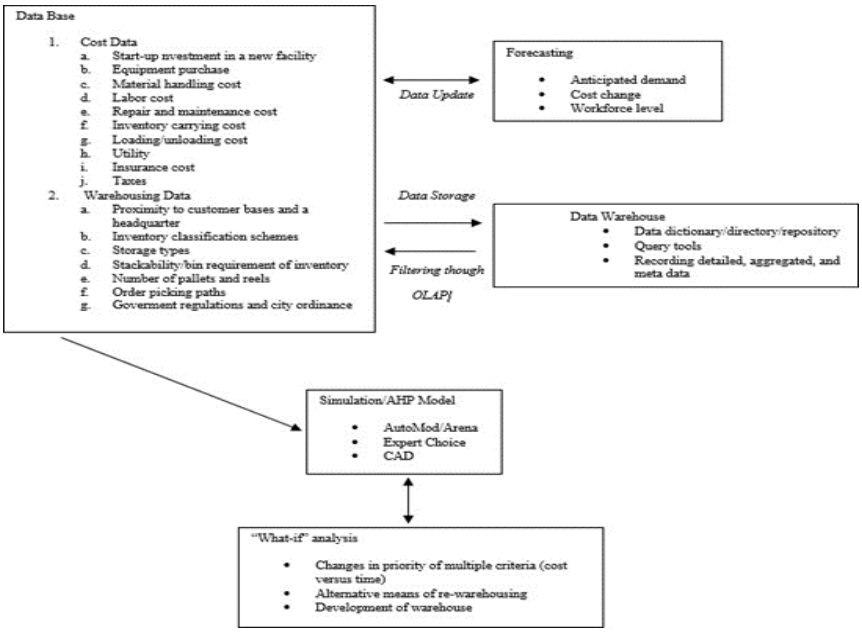
Warehouse Management Technology

For efficient warehouse management, people need to know the warehouse data itself, what its contents are, and where exactly each item is stored. Knowing where the goods are stored is very important for efficient order taking (Raval et al., 2018). Simple physical labels can help search for goods, where simple physical labels can provide different addresses for each type of item to each shelf or room in the storage area, and the database records the address on each item (Patel & Patel, 2021). The purpose of this labeling itself is to facilitate the search for goods using technology and to facilitate accurate stock control. This labeling also serves to find out how much of the item enters and leaves the storage area. Examples of labeling: barcode, radio frequency identification (RFID), and universal product code. Usually, company decision-making is determined by warehouse data; and the importance of analyzing warehouse management and maintenance for its future (Purushothaman et al., 2022). To communicate visually and emotionally with your work, you need to be acquainted

with the characteristics of color and its many variations. Color is a tool to help an artist in helping to express his personality that can show feelings (mood) and character both in communicating visually and emotionally through the colors used/chosen (Forslund et al., 2022). To use color effectively, we need to understand what it is and how it works. In using color effectively, we must understand what color is and what benefits or how it works (Fern & Almeria, 2022).

RESEARCH METHODS

The data collection technique used and the research map was shown in Figure 3 below:



Source: Min (2009)

Figure 3. Research Map

In this study, the authors of the replication of the research framework stated by Min (2009). The author obtained data for the period January to September 2020. The author processes sales and product data from a total of 110 types of product categories in large-heavy categories into 6 types of large category products that have the highest sales during the last 9 months. These products are Wire Products which are further divided into 6 major categories, namely: Wire Rope, Polypropylene Rope, Wire Rope Accessories, Shackle, Wire Clip, Turnbuckle, Thimble, Masterlink, Eyehook, Socket, Load Binder, Eyebolt, Galvanized Chain, Stainless Chain, Webbing Sling. However, there are differences in database collection.

Data analysis techniques, in the new warehouse layout, the author will place goods based on 6 types of item categories with their types and sizes. The author uses the Extended AutoCAD software application to support the creation of warehousing layouts to make it tidier, more specific, and accurate; and can predict the number of items that can be in stock. Creating a new layout using this software application requires calculations to determine the percentage of space required for the six products.

1) Warehouse Allocation Ratio.To calculate how much warehouse allocation is needed in each product category based on sales. The warehouse allocation ratio is equal to sales divided by the total sales, and it would be a percentage of the result.
2) Storage Allocation Ratio; To calculate how much storage allocation is needed in each product category. Storage Allocation Ratio would be coming from the total usage of the

building divided by the total building area, and it would be a percentage of the result.

FINDINGS AND DISCUSSION

Data had been collected data during January to September 2020, from the results of the total sales reports each month showed a significant increase. It can be seen from the following table. From the results of the sales report, the author observes the categories of types of goods with the most sales, there are 6 types of sales categories, namely: wire rope, polypropylene rope, wire rope accessories, galvanized chain, webbing sling, and stainless chain. From the sales report data provided by the company, the authors process the data into sales reports as follows: Of the six product sales data for January to September 2020 shows that wire rope has the highest sales, which can be said an Excellent product or products that are sought after by customers so that larger storage space is needed than other products. After wire rope, the second product that had the most sales was polypropylene, followed by wire rope accessories, galvanized chains, stainless chains, and webbing slings. From the sales report above, the company can calculate the ratio of warehousing allocation based on sales productivity to calculate how much the percentage (%) of the layout of each product is applied to the new warehousing layout. Six items are the most saleable to consumers, so the company itself focuses on supplying these six items.

From the warehouse allocation ratio data based on productivity above, it can be seen that based on sales, wire rope has the largest storage capacity, namely 47.99% because wire rope has the largest sales. Furthermore, polypropylene rope has the second largest storage area, which is.

Table 1. Ratio Slot based on Productivity Sales

Product Category	SALES (in Mio)		Percentage (%)
Wire Rope	Rp	759.113	47,99
Polypropylene Rope	Rp	465.232	29,41
Wire Rope Accessories	Rp	112.989	7,14
Galvanized Chain	Rp	90.223	5,70
Stainless Chain	Rp	88.376	5,58
Webbing Sling	Rp	65.750	4,15
Total Sales	**Rp**	**1.581.683**	**100**

Source: Research Data (2021)

followed by wire rope accessories at 7.14%, galvanized chain at 5.70%, webbing sling at 4.15%, and the order of the smallest storage place stainless chain at 5.58 %. However, from the warehouse allocation ratio above the company also needs other rooms such as offices, machines, places for employees to work, and toilets. This requires a reduction in the warehouse allocation for storage space. Here's the storage allocation ratio:

Table 2. Ratio Slot of Inventory

Product Category	Storage Space (P x L) m^2	Percentage (%)
Wire Rope	16,897	37.54
Polypropylene Rope	4,886	10.85
Wire Rope Accessories	3,250	7.22
Galvanized Chain	2,908	6.46
Stainless Chain	1,907	4.23
Webbing Sling	2,120	4.71

Other companies	13,082	29.26
	45,050 m^2	**100**

Source: Research Data (2021)

From the table above, it can be concluded that as much as 70.74% of the total building area is used for storage. Meanwhile, the remaining building area is 29.26% of the building area used for the needs of other companies.

There was an alternative layout to maximize efficiency based on a product-oriented and work cell strategy (Aghazadeh et al., 2011).

Optimal Layout

Inventory	Shipping/Receiving	Offices	Fo
1	Assembly Line	10	
2		9	
3		8	
4	5	6	7

Source: Aghazadeh (2018)

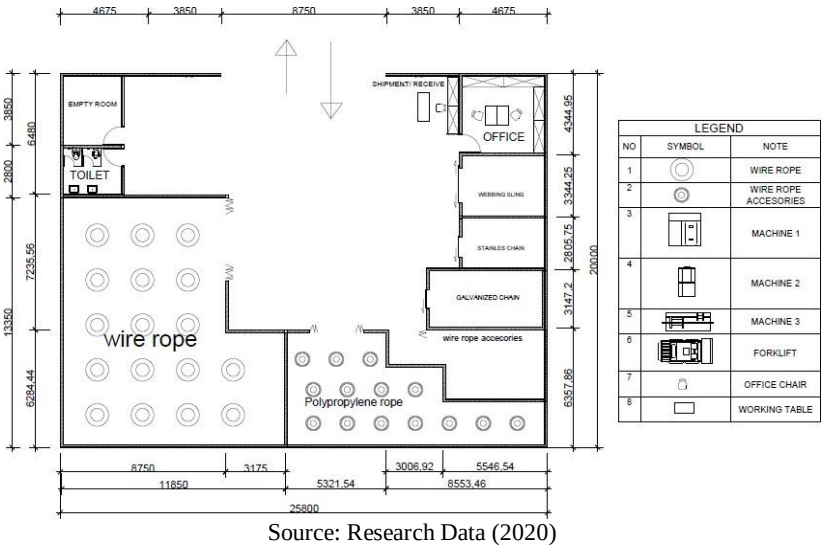
Figure 5. Alternative Layout

The layout form in the image above shows that there are 10 places for arranging items that are numbered 1-10. In the figure, items with more stock are occupied in numbers 5 and 6. In the middle, there is an assembly line where the movement of workers is minimized as little as possible to produce a faster product. At the front, there is a place for the receiving part of the goods whose job is to check goods both in terms of quantity and quality. This layout features office space on the right front. The layout image above can be used by companies because the products that can be said fall into the big category. However, from observations and direct interviews by the author, the picture above is still inaccurate because from the results of its sales report data processing, workers need more space to do their work, not only that the company also has three machines, namely machines for rolling, cutting, and connect.

For this reason, the authors make additions to the layout which are reflected in the alternative layouts 1, 2 & 3. From several references based on books and journals, the author suggests several new warehouse layout alternatives.

Alternative Layout 1,

This layout is suitable for warehouses; because based on the categories of goods supplied by companies, it can be said that they vary both in shape and size. The application of warehouse layout is arranged based on 6 types of goods categories according to their sales sequentially. This alternative has one door for exit and entry, has a storage area by the size of its sales, has free space that can be used to store goods other than the six superior products / used for other purposes, and an additional area for machines and workers. From the building area owned by companies, which averages 2056 m^2, the company must make the best use of the space, for the area of each storage room the percentage ratio is calculated based on the sales of these items for the last four months; because from the sales report, it can be concluded that of the 20 types of goods in large categories there are 6 types of categories of goods that are sold the most each month. The following is an image that has been visualized. using AutoCAD software by changing the position of the item with the addition of an area/room:

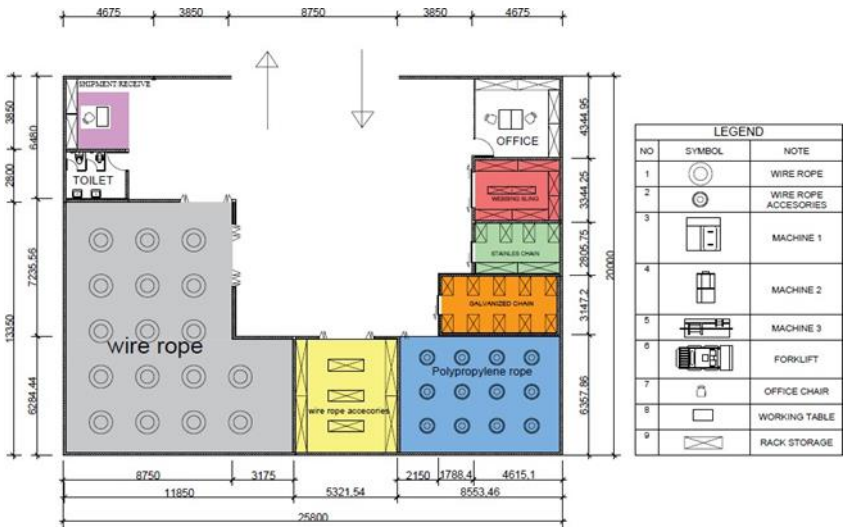


Source: Research Data (2020)

Figure 6. Alternative Layout 1 (analyzed by AutoCAD)

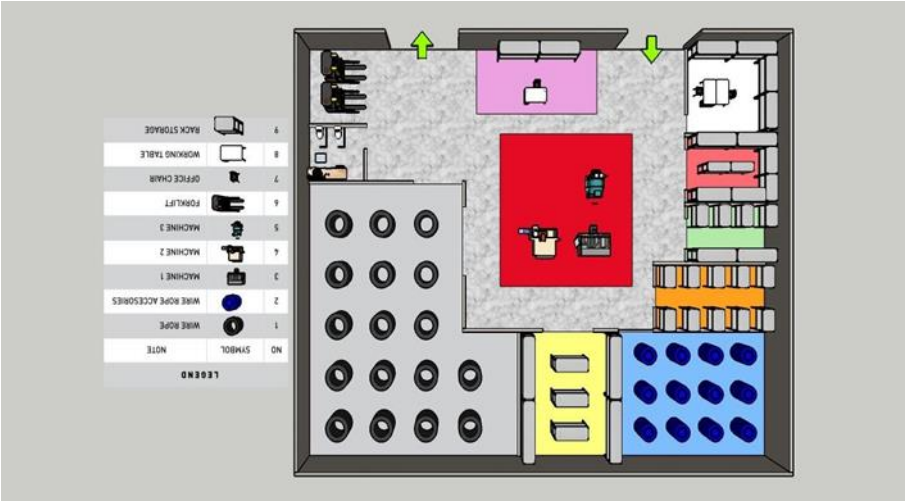
Alternative Layout 2

In alternative layout 2, there is a difference in the warehouse layout, the space is replaced by a parking area for the forklift so that the forklift does not interfere with the movement of warehouse activities. The warehouse layout was added with color to the storage areas and places in the warehouse. After conducting interviews and direct observation on the alternative layout 3, the writer made 6 rooms as storage places for goods based on product categories by providing shelves in several storage areas to make more storage; and to reduce errors, the company also needs to add a reception area and delivery of goods. The author also makes it easy for workers who are still lacking in product knowledge by providing color codes in the form of color codes (zoning coloring) in parts/areas of the storage room based on their categories, not only company colors can code numbers/letters to make it easier and faster when searching goods for employees and employees who do not understand the product. The following is the implementation of alternative layout 2 (scale 1:15):



Source: Research Data (2020)

Figure 7. Alternative layout 2 (analyzed by AutoCAD)



Source: Research Data (2020)

Figure 8. Alternative layout 2 (analyzed by SketchUp

Alternative Layout 3,

In alternative 2 it has been developed again into alternative 3, namely making changes to the entrance and exit which initially only has one door, alternative layout 2 has 2 doors on the right and left sides. This separation at the entrance and exit is useful for accelerating warehouse activity when goods enter and leave simultaneously. Initially, with just one door it took approximately 60-120 minutes when the goods to enter and left, which resulted in a long queue time, while the company's target was to be up to 50% faster, so there needed to change. Companies need space/space to occupy machines, open space for workers so that there is an empty middle that is used for the machine area, and an area for workers so that the movement of picking up goods to sending goods is minimized to as little as possible. From the calculation of the time for picking up goods that the author did with the layout before it was repaired, it took an average of 60-90 minutes to collect the goods, while the target the company wanted to collect the goods was 30 minutes or 50% faster. Here are the areas proposed by the authors and the areas that are colored in the alternative planning layout 3:

1) Ty

pes of Products Supplied; The location of the company's product warehousing is the most important in the warehouse area, the company needs to set a good layout to organize and

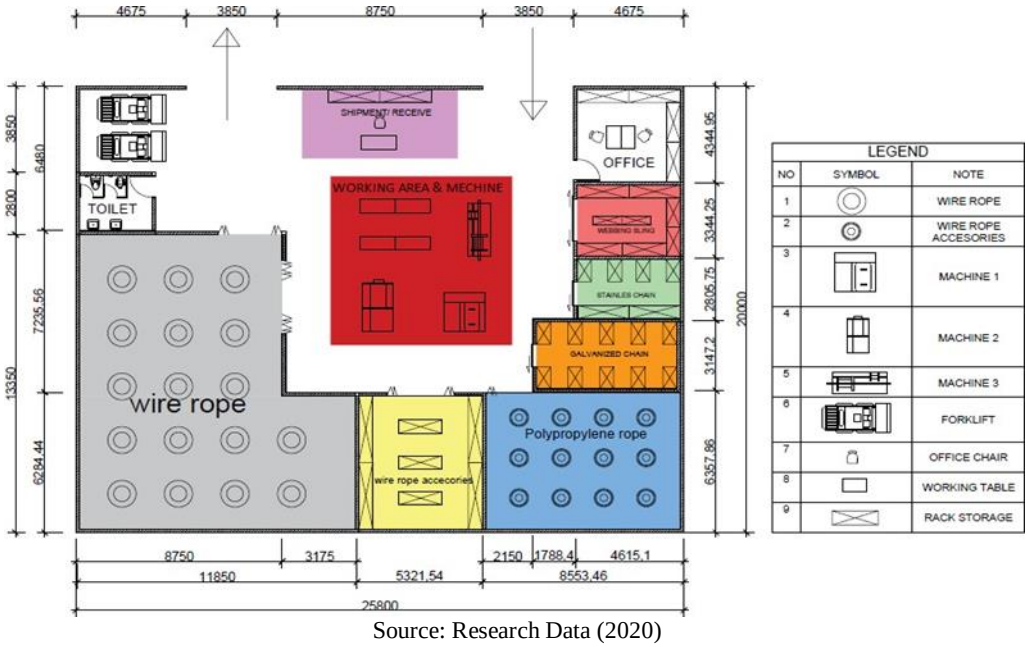
maintain its products. In implementing these 3 alternative layouts, the product area is colored, which serves to make it easier for employees to find items. Apart from the color code of each storage area, companies can add a code in the form of numbers/letters according to a more specific type. The function of the color code and letters/numbers is very helpful for employees to find products and reduce errors in the work and delivery of goods. Number/letter codes that can be used on each row or shelf in the room.

2) Working Area and Machine; The working area and machines are color coded which functions to reduce accidents in the warehouse area by giving this area color, and showing that the area is not free to pass and only for certain employees, because it will be dangerous when working with machines or by using other tools contain people who do not have an interest / do not understand the area.

Receive dan Shipment

Strongly suggested that these companies should consider the additional layout for receiving and shipment yards. As these companies also accommodate, market, develop products and distribute products, it requires this section to check both when receiving goods and distributing goods. In the receive and shipment sections, colors are also given to show that the area is still a work area, and not just anyone can occupy this area. The following figure has been applied by the author from the sales report along with the calculation and addition of the area required by the company through the AutoCAD software system application.

Those three alternatives have advantages and disadvantages to implementing the three layouts. The advantages of alternative Layout 1 were having extra spaces for keeping other parts, thus low operating cost. The advantages of alternative Layout 2 were clear classification as area been color-coded and more capacity for inventory as using the racking system. The advantages of alternative Layout 3 were clear and specific parts classifications, more spaces for storage, certain areas for employees, machinery close to products area, minimizing movement, and giving 2 access doors for incoming and departing goods. The disadvantages of alternative Layout 1 were less storage area and time-consuming goods access. The disadvantages of alternative Layout 2 were the high cost with a racking system and the long waiting time for goods traffic. The disadvantages of alternative Layout 3 were the high cost due to the racking system and no extra space to keep other parts.



Source: Research Data (2020)

Figure 9. Alternative layout 3 (analyzed by AutoCAD)

The placement of goods / the layout of the goods from the three alternatives has differences, among others: Alternative Layout 1: the application of this layout shows where to store goods according to product categories sequentially, but has not made the most of the space. Alternative Layout 2: the application of this layout shows the storage area of goods based on the classification of products according to the percentage of sales, with the use of shelves. Alternative Layout 3: the application of this layout shows the placement of goods by classifying products based on the type and type of goods. The middle, which has free space, is used for the machine area and the work area according to the company's needs. The use of shelves in goods storage rooms that have smaller item sizes, use of these racks saves more space and more storage capacity, and use color/letter codes to speed up the search for items. Minimizing the movement of the search for goods, before using color/letter codes in the search for goods it takes 60-90 minutes, it is targeted to take 50% faster. In this alternative, the space is removed for the forklift area so as not to interfere with warehouse activities, and the area is used for other areas.

When companies repair / re-layout, it is important to consider the factors or impacts that will occur. Likewise in the selection of the layout, there must be sacrifices. In this study there are 3 alternative warehouse layouts, the authors chose to use alternative layout 3 because it has many advantages over other alternatives. In implementing a warehouse layout, it is not only necessary to have a good layout but also to consider the needs of the company. In addition, of the six types of goods the company chooses not to have special storage space because these goods do not have a large size such as wire rope and polypropylene rope (dia. 80-120cm) which can interfere with the warehousing work process; when there are orders other than For these six items, the company sends directly from the supplier to the customer or the goods arrive at the warehouse directly sent back so that they do not need to be stored in the warehouse which takes a long time, and does not require special storage so that it is used for the forklift area.

CONCLUSION AND RECOMMENDATION

The following conclusions would be: (1) The application of the layout pattern to the warehouses of these companies currently still has many obstacles due to a lack of unstructured layout arrangements and the company is aware of that. To overcome the constraints and losses caused by this layout, the company has tried to expand by buying a

new warehouse for additional storage, but it has not been effective and efficient. (2) The appropriate method for positioning the optimal layout can be assisted by sales data over the last few months to determine which products have the most sales and are in demand by consumers. (3). An effective way to place various types and types of goods based on the calculation of warehouse allocation ratios and storage allocation ratios with the help of being applied by the AutoCAD software application for the calculation of storage area and the SketchUp application for viewing results in 3 dimensions (3D).

Based on the above conclusions, the authors would like to propose several suggestions in the hope that they can be useful for the company, as follows: (1). Create a new warehouses layout to make it more structured, based on the type, type, category and size of products in each area. See the products that are most in-demand by consumers, and have the most sales. There are 6 types of product categories supplied by companies that are the most in-demand during the last few months. To get the optimal position from the sales data, the percentage of warehouse allocation ratio is calculated based on sales productivity. After that, it can be seen that the sales of most types of products have the largest storage capacity, as well as the percentage of capacity for other products. In implementing the new layout with the help of using the AutoCAD and SketchUp software applications, you can add the use color codes such as storage areas, working areas, receive / shipment, and others. Not only color coding in the warehouse area, but you can also use numeric / letter codes on the type and size of goods. The use of this code is useful for making it easier to find goods, take stock-taking, and be more organized in carrying out the warehousing process. Recommendation for further research could implement other simulation software to enrich the alternatives of the layout proposals, including expansion process of simultaneous similar heavy-part industries to ensure the result could encourage companies to give more attention and invest in high technology infrastructures.

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