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Implementation of Lean Warehousing to Improve Warehouse Performance of Plastic Packaging Company

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Abstract. Warehouse activities affect the operations in the business process of a cosmetic plastic packaging company especially the production floor since the activities have connected each other. The company has problems in maximizing the storage space and eliminating the floor stock because of inaccuracy of warehouse stock data processing and inappropriate stock placement. So that, there are several types of waste in the warehouse activities from receiving, put away, storing, and order/material picking. The problem will be solved by using lean warehousing. The collected data of raw material storage, WIP storage and finished goods storage will be visualized using value stream mapping (VSM) and process activity mapping (PAM). Then, the warehouse performance is measured. From the VSM, PAM and performance measure, the waste can be identified. The wastes in the raw material storage are overproduction, inventory, defect, transportation, waiting, excess processing and motion. Wastes in WIP and finished goods storage are inventory, defect, transportation, waiting, excess processing, and motion waste. The improvement plans are to allocate the special stocks, subleveling the small quantity items, warehouse mapping based on FSN (Fast moving, Slow moving, and Non-moving) classification, creating warehouse regulation and improving transfer officer movement. The warehouse performance after improvement shows that the financial and cycle time indicators decrease while utilization, quality and productivity indicators increase. By using lean techniques, inventory accuracy can be increased, order picking errors can be reduced, processing time can be reduced, and warehouse space can be streamlined.

1. Introduction

The object of observation is one of the plastic packaging companies in Indonesia that integrates injection molding, blow molding, and assembly. The raw materials from suppliers, WIP (Work in Process) and finished goods are stored in the warehouse. The part of main warehouse to store raw material is called as 030. The other part that stores WIP and finished goods is called as 020. So that, warehouse activity will affect the operations in the business process especially the production floor since the activities have connected each other. The company has problems in maximizing the storage space and eliminating the floor stock so that it will cause several types of waste in the warehouse activities. The waste in these warehouses can affect the activities in the warehouse and production department. The first cause of the problem is the inaccuracy of company's information system with the warehouse physical stock. The second cause of the problem is in storing the stocks. The warehouse officer has to allocate the new raw materials to the front warehouse because the main warehouse looks full and insufficient for the incoming materials. Other solution is that the officer places the material on the aisle which is called as floor stock. This solution will complicate the order picking process in the future since the officer has to move the floor stock first before picking the needed product and then return the floor stock to the previous position. Furthermore, the stock placement is random storage as the officer will fill any empty pallet without concerning the location in the warehouse.

The wastes in the warehouse are including long searching time, transportation when carrying material to the warehouse or from warehouse to warehouse, time when making material arrangements to storage bin and other waste that has not been identified. These wastes can reduce the performance of the warehouse. For this reason, a lean warehouse approach is needed in improving the warehousing system



to create a work process that flows well and provides convenience for those who are directly related to the warehouse. The improvements can be in the form of reducing warehouse space, reducing non-value-added activities, processing and lead time also inventory and processing accuracy [4], [11], [13].

2. Research Methodology

2.1. Define and Measure Phase

This research will start by using value stream mapping to identify the overall activities in the company especially the warehouse operations. Then by using process activity mapping, the waste can be identified. The existing warehouse performance indicators can be measured. The warehouse performance indicators to be used is Frazelle Model.

2.2. Analyze and Improve Phase

The root cause of waste can be analyzed by using root cause analysis. Finally, the improvement plans can be formulated. These plans include the recommended warehouse layout by combining FSN inventory classification (Fast moving, Slow moving and Non-moving). By using the techniques, inventory accuracy (physical count and system stock can be improved), the order picking error can be reduced, and the warehouse space can be streamlined.

3. Results and Discussion

3.1. Value Stream Mapping

The value stream map will describe the existing process in the warehouse. Value stream mapping will give description of both information and material flow through the process. The upper values are non-value-added time and lower values are value-added time [10]. Using value stream mapping, it can be inferred that the lead time of the existing process is 504 minutes. The lead time consists of 82 minutes non-value-added and 422 minutes value added time

3.2. Process Activity Mapping

After the value stream mapping has been done, then the process activity mapping in each storage from raw material storage, WIP storage and finished goods storage will be constructed. The activities will be categorized as value-added, necessary but non-value-added, and non-value-added activities. From the Process Activity Mapping, transportation, waiting, excess process and motion can be identified.

Finished goods storage process with the highest non-value-added duration is put away activity followed by picking, shipping, and storing. The processes with necessary non-value-added activities sequentially are receiving, storing, picking, and put away. Motion waste consists of necessary but non-value-added activities including looking for items, counting the quantities and reading transfer form. Waiting waste consists of non-value-added activities such as waiting for MHE and waiting for storing materials. Excess process waste consists of NVA that mostly relates with floor stock. Transportation waste consists of necessary but non-value-added activities moving in the warehouse.

3.3. Performance Indicator

The Frazelle (2002) indicators consist of the warehouse main activities including receiving, put away, storing, picking and transfer or shipping consist of financial, productivity, utilization, quality and time indicator.

3.4. Waste Identification

The wastes in the raw material storage are overproduction, inventory, defect, transportation, waiting, excess processing and motion. The overproduced item is MRTU that is stored while waiting to be used and sold. Inventory waste in warehouse is in the form of dead stock or non-moving items and several slow-moving item that take spaces of productive bin so the picking cannot be done efficiently. Defect is potentially happened as several bins consist of more than one type of item. Besides, the floor stock can also confuse the officer. Other type of defect is warehouse discrepancy. Transportation waste is in

the form of walking while picking, storing etc. which needs to be minimized. Waiting is including waiting for MHE while storing the item and waiting to move the floor stock. Excess processing in raw material storage relates with floor stock. Motion wastes in warehouse are including looking for empty places, reading form, counting item, reporting to admin and looking for item.

Wastes occurred or produced in WIP and finished goods storage are inventory, defect, transportation, waiting, excess processing, and motion waste. Inventory in WIP and finished goods storage is in the form of non-moving and several slow-moving items. Defect in WIP and finished goods storage is caused by picking mistake and warehouse discrepancies. The errors can be caused by inappropriate labelling and floor stocks. Transportation waste including transferring WIP from production and walking with hand pallet while processing receipt or order. Excess processing in WIP and finished goods storage is in the form of moving or returning the floor stock before storing or picking items. Motion waste such as looking for bin, reading the form, counting item, reporting item to admin and looking for item.

3.5. Item Classification Based on FSN Analysis

Item classification will be done to improve item movement including the length of stay (average stay) and how often the item goes in or out of warehouse (consumption rate). Average Stay means that inventory is classified based on the length of storing time in the warehouse until it is used/shipped. Consumption rate means that highly demanded products are allocated in slots close to the I/O doors. It specifies the frequency of retrieval of goods.

1) FSN classification based on average stay

Based on the head of warehouse, the item is categorized as fast moving when the length of stay is shorter than 60 days. The item is categorized as slow moving when the length of stay is between 61 or 180 days. And the item is classified as non-moving item if the length of stay is longer than 181 days. Based on average stay classification of 512 items, there are 324 fast-moving items, 132 slow-moving items and 56 non-moving items.

2) FSN classification based on consumption rate

The consumption rate is measured by counting the frequency of issues per month. The item is classified as fast-moving item if the frequency of issues per month is more than 26 times. It means that the item is issued almost every day. Item classified as slow-moving item, if the number of issues in one month is between 1 to 26. It indicates that the number of issues in one month is smaller than 1 issue in a day. Non-moving item is items that the frequency of issues per month is smaller than 1. It means that the consumption rate of the item is smaller than 1 issue in a month. From 1,535 observed items, there are 61 fast-moving items, 583 slow moving items, and 891 non-moving items.

3) FSN final classification

FSN final classification obtained by comparing classification based on average stay and consumption rate. The analysis done to the items that have both average stay and consumption rate data. So, out of 512 analyzed items, there are 50 items classified as fast-moving, 358 slow-moving items and 104 non-moving items. The data will be used to re-layout the warehouse and support the decision making for the improvement plans.

3.6. Root Cause Analysis

Table 2 shows the recapitulation of warehouse waste root causes in storage 020 and 030. The root cause of overproduction is that the items are produced in large number while the need is smaller. Inventory waste is caused by the smaller production requirement than the stocks. Defect in the form of warehouse discrepancies is caused by the special stocks, wrong picked material, new product that has not recorded in the master data, and other items that are not stored in the correct location. Defect waste in the form of picking mistake is caused by the inappropriate labelling. Transportation waste occurred as the items are placed randomly and many floor stocks in the warehouse so that the picking process takes time. Waiting waste is caused by the inappropriate method of the officers or the location of the items. Root causes of motion waste are the dashboard information, officer activities and floor stocks.

3.7. Improvement Plans

The plans will be formulated in order to reduce and remove the warehouse wastes. Each improvement plan will explain what wastes that are going to be addressed along with the detail of plan implementation.

3.7.1. Stock Allocation.

Stock allocation, in this case, means to move or allocate the items or stocks in the warehouse to new dedicated area that is more suitable to the item characteristics. Stock allocation in warehouse will be able to solve C01, C03, and C22. There are two alternatives for this improvement.

- The item is stored outside the warehouse. MRTU and RGND stocks should be stored outside the warehouse so that the bin can be used for other stocks. The advantages of storing the stocks outside the warehouse are more empty spaces in warehouse, and easy handling when the item is needed by the production department or ready for sell. The disadvantages of this alternative are risk of material and pallet damage, need a lot of spaces and there is a possibility that item is still needed.
- The item should be stored in level 5. MRTU and RGND stocks can also be stored in level 5 so that the level 5 bins can be utilized, and the bins can be used for other stocks. This alternative also overcome the wastes that are related with floor stock which are waiting, excess process, motion due to not maximized warehouse space. The advantages of this alternative are more empty bins in the warehouse and no risks of damaging materials. The disadvantages of the alternative are that it needs more pallets since the level 5 space is smaller. Then the quantity per pallet in level 5 bin is smaller than the quantity per pallet in level 1, 2, or 3 bins.

To see the significance of the improvement to the warehouse condition, the improvement plans are implemented to warehouse data of 8 May 2019. The improvement plans that will be implemented to the stock data are stock allocation, subleveling, warehouse mapping and reducing ineffective bins. After that, the warehouse activities will be compared after the implementation of improvement plans and then see the improved warehouse performance. As the comparison, the existing condition, there are 284 used bins and 29 floor stocks in 8 May 2019 in storage 030. The storage utilization is 53.8%. There are 388 pallets in storage 020 and the utilization is 50.4%.

Stock allocation plans will be done by removing the RGND and MRTU stocks data in the warehouse dashboards as the simulation of moving items outside the warehouse. The utilization decreases to 51.5% as there are 12 pallets moved out. There are 3 pallets are available for use as the stocks need only 9 pallets. The second alternative of stock allocation is done by assigning the stocks to empty bins in level 5 of storage 030. There are 12 available bins for floor stock. The utilization increases to 54.70% as the stocks is entering the storage bins.

3.7.2. Subleveling.

Small consumed items fill the storage bins. However, the utilization is very small (average: 0.12). The bin is not maximally utilized. Subleveling is to divide the space of storage bin into two smaller part. By doing so, small sized items can be stored in the lower and upper space. Subleveling in warehouse will be able to solve C21, C23, and C24. The advantages are there will be more empty spaces in warehouse, more unutilized pallets, and bin utilization can be increased. The disadvantages are that there's risk of picking wrong item and need to create sub-levels. It is recommended to use simple board that can divide the bin into 2 sub levels such as wooden table or wooden rack. The item can be placed on the floor and on the top of the table so the bin space can be utilized efficiently.

To see the significance of subleveling, the low-utilized bins will be assigned to the smaller bin. From 29 low-utilized bins, after subleveling, the warehouse only needs 7 bins. Then there will be 22 available bins for floor stock or incoming items. The utilization decreases to 50.60%. There are 29 empty pallets as bin with sublevels do not need pallet.

3.7.3. Improve Labelling.

From the root cause analysis, one of the root cause of defect waste in storage 020 and 030 is that the item label is not clear enough to differentiate the items. Even the number of errors in warehouse activities is very small, the label needs to be improved to prevent any error in the future. Moreover, with the implementation of subleveling and stock allocation, many items may be stored together in one bin. From the interview and observation, it can be concluded the error can be happen because the officer has to look for item in a mixed bin.

The label is in the form of laminated A4 paper with the bin name, then the officer can update the quantity in the paper with broad marker. This labelling is cheaper and easy to be used as an alternative of white board. The stickers in the stocks will ease the officer to find the item rather than relying on the officer memory. This method will ease and efficient the picking process. Besides, the officer does not have to wait for the admin to print the label and change the label when it is full of scribbles or tear out. The items in the mixed bin are given stickers with the ID number to ease the officer while picking. With the improved labelling, the officer can label the stocks quickly with the sticker and the bin label. By doing so, the time to print the label will be lower.

3.7.4. Warehouse Mapping and Reducing Ineffective Bins. Inventory waste in warehouse is in the form of dead stock or non-moving items and several slow-moving item. These items are supposed to be eliminated or stored in location for low consumption items. These items take spaces of productive bin so the picking cannot be done efficiently. By creating warehouse mapping and reducing the ineffective bin, C02, C10, C11, C14, C15, and C20 waste can be reduced. From the process activity mapping, the floor stock causes many non-value-added activities. So that the floor stock should be removed by allocating the floor stocks to the storage bin. To do so, the first thing to do is to reduce ineffective bins in the warehouse and allocate items by the characteristics so that there will be empty storage bin for the floor stock. After that, the mapping of ideal warehouse will be created. Slow moving and non-moving items will be stored in less productive area while the fast-moving items should be stored in productive area which close to the aisle and in the lower racks.

After the implementation of stock allocation and subleveling, there will be more empty pallets so that the officer does not have to look for empty pallet while receiving. The empty bins in the warehouse will be able to store the floor stocks, so that the non-value-added activities due to floor stock such as moving and returning floor stocks and waiting for moving floor stocks can be removed. If the storage bins have been maximized, the storing process can be faster as there is no other item placed in the bin. By the item placement based on the classification, the storing and order picking process can be more efficient because the more frequently issued items are placed in productive area.

3.7.5. Warehouse Regulation.

Warehouse regulations regarding the warehouse activities can solve C04, C05, C06, and C07. These causes cause warehouse discrepancies in the warehouse system. As the solution for this waste, the warehouse department need to have a new rule that:

- The wrongly picked item has to be returned at the moment
- No other items can be placed in pallet stack area
- Warehouse admins have to update every new material or product data to master data
- No other items can be placed in any storage bin

4. Conclusion

The waste in the storage 030 of main warehouse are overproduction, inventory, defect, transportation, waiting, excess processing and motion. Wastes occurred or produced in storage 020 are inventory, defect, transportation, waiting, excess processing, and motion waste. The root cause of overproduction is that the items are produced in large number while the need is smaller. Inventory waste is caused by the smaller production requirement than the stocks. Defect in the form of warehouse discrepancies is caused by the special stocks, wrong picked material, new product that has not recorded in the master data, and other items that are not stored in the correct location. Defect waste in the form of picking mistake is caused by the inappropriate labelling. Transportation waste occurred as the items are placed randomly and many floor stocks in the warehouse so that the picking process takes time. Waiting waste is caused by the inappropriate method of the officers or the location of the items. Root causes of motion waste are the dashboard information, officer activities and floor stocks. The improvement plans are to

allocate the special stocks, subleveling the small quantity items, warehouse mapping based on FSN classification, creating warehouse regulation and improving transfer officer movement.

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