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Implementation of Six Sigma Philosophy and 6s Principles on Bag Making Warehouse at PT. X

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Abstract

PT. X is a company specializing in rotogravure printing, laminating, and flexible packaging. One of the divisions in PT. X is the bag making division. The division is in charge of processing the print roll using machine to become shape of a bag. After the process, all of the excess bags that are not sent to the customer are kept in a box and then put in an area designated for storage. Even though the company has already set a designated place for the excess products, there is no warehouse monitoring system implemented in that area. Consequently, the items inside are stacking up day by day, causing the area to be overloaded making it hard to organize the boxes and makes it hard to go into the area. This research will try to solve the problem stated above using DMAIC (Define, Measure, Analyze, Improve, Control) methodology. The improvements in this research will be based on the 6S (Sort, Set in order, Shine, Standardize, Sustain, Safety) principles of lean manufacturing. The results are improved search time and accuracy, also conformity to the 6S of lean manufacturing principles.

Keywords: *SIX SIGMA, DMAIC, 6S, Lean Manufacuring*

INTRODUCTION

PT. X is a company specializing in rotogravure printing, laminating, and flexible packaging. The company provides packaging for various industries such as: food and beverages, cooking oil, seasoning, personal care, and home care. The customer of the company varies from small medium enterprises to larg e established companies. One of the divisions in PT. X is the bag making division. The division is in charge of processing the print roll using machine to the form of a bag. The process involves folding the sheet, sealing the joints and cutting the sheet in order to create a bag. The process goes on until the end of the production schedule or until the print roll sheets are out. After the bags are made, then the bags are put inside boxes to later shipped to the customer.

After the production schedule or after all of the materials are out, all of the excess bags that are not sent to the customer are kept in a box and then put in an area designated for storage. Even though the company has already set a designated place for the excess products. There is no warehouse monitoring system implemented in that area. The lack of a monitoring system in the area causes the products inside are not traceable. Meaning that neither the operator, production admin, or staff knows what is inside the area or how many is inside the area. Consequently, the items inside are stacking up day by day, causing the area to be overloaded making it hard to organize the boxes and makes it hard to go into the area. The products left in the area are also prone to contaminants such as dust and rodents. All of those leads to the excess bags becoming waste whereas those products can be sent to customers on the next order.

This research was carried out based on the problem stated above. This research will try to find out the root cause of the problem, designing a solution, implementing the solution, and lastly evaluating the implementation. Through this research, the company hopes that the area would become

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arranged, and also there can be a system that can help the bag making division to slowly release the bags currently piling up in the area.

LITERATURE REVIEW

Linderman et al. (2003) defined Six Sigma as an organized and systematic method for strategic process improvement and new product and service development that relies on statistical methods and the scientific method to make dramatic reductions in customer defined defect rates. Six Sigma's structured improvement procedure is seen as a novel and effective contribution to quality management. This improvement procedure is generally known under the acronym DMAIC, standing for Define, Measure, Analyze, Improve and Control (De Mast & Lokkerbol, 2012).

Lean manufacturing is designing a system that is responsive, flexible, predictable, and consistent. Through lean manufacturing, an organization can create a manufacturing operation that is focused on continuous improvement (Feld, 2000). One of the commonly used methods of applying lean manufacturing is the 6S principle. 6S is the method of creating and maintaining a well-organized, neat and clean environment in the workplace (Dhounchak & Khatak, 2017). Through 6s, an organization is able to minimize waste and to enhance productivity (Sukdeo, 2017). The 6S method steps are: Sort, Set in order, Shine, Standardize, Sustain, Safety.

METHODOLOGY

This research is done using a systematic approach in order to achieve the desired goal. This thesis will use DMAIC methodology as it is proven to be able to improve the quality of a process (Smętkowska & Mrugalska, 2018). The DMAIC method are then put onto a process flowchart which can be seen in Figure 1.

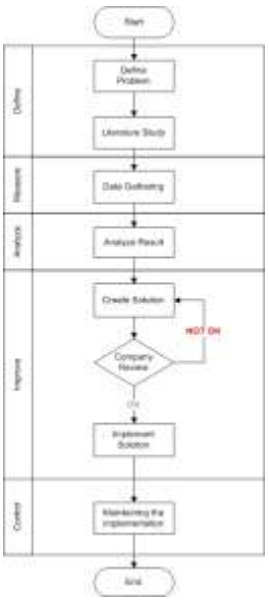

Figure 1. Research Methodology

FINDINGS AND DISCUSSION

Dmaic Improvements

1. Define

In DMAIC methodology, the research starts with the define phase. The lack of warehouse management causes neither the operator or the admin knows whether the item mentioned is in the warehouse or not. This makes the operator have to search the whole warehouse thoroughly in order to find the items until later then the operator deemed that the warehouse doesn't have the item mentioned, meanwhile there could be possibility that the item mentioned is in the warehouse, it is just not seen by the operator. Missed items will remain until it is found, thus leading to become waste in the warehouse. The overloaded items that are not sorted well makes it hard to move inside the area, resulting in even longer search times. Based on that, the defined parameters that needed to be observed is the search time of a specified item, and the accuracy of the search. Measure after identifying the problem and deciding which data to gather. The researcher then moves on to gather data in order to see the improvement and to support the research. The data are gathered by first looking at the item list currently in the storage, then the researcher will point out one item from the item list, asking the operator to find the specified item in the storage and then point it out to the researcher. The time starts when the researcher informs the item name and number, and the timer stops when the operator can point out the location of the specified item in the storage. The process then repeats until the data requirements are met. The data gathered are the time and the accuracy of items found on the product list. The observed time is the time the subject requires in order to point out the product mentioned in the list meanwhile accuracy is whether the product is found or not. The product is "not found" if the timer goes past five minutes or the subject decides that the product is not found after the timer goes above 3 minutes. The observation is conducted 30 times. The data are put into Minitab software and then the researcher uses the descriptive statistical analysis. In order to give better comparison of the time study, the observations used in the descriptive statistic calculation are observations where the operator is able to find the items. The result of the data processing can be found in figure 2 below.

Descriptive Statistics: Observed Time Before_1

Variable	N	N*	Mean	SE Mean	StDev	Minimum	Q1	Median
Observed Time Before_1	18	9	115.3	11.6	49.3	72.0	77.0	99.0

Variable	Q3	Maximum
Observed Time Before_1	130.0	235.0

Figure 2. Descriptive Statistical Analysis of Observed Time from Minitab Before Improvement

From the figure 2 above, the mean observed time is 115.3seconds. the researcher then goes on to find the accuracy percentage of the subject. the table containing the summary of the accuracy during the observations can be seen in the table below

Item Found (Yes/No)	No. Of Occurrences	% Occurrences
Yes	18	60%
No	12	40%
Total	30	100%

Figure 3. Subject Accuracy From 30 Observations (Before Improvement)

From the summary table on Figure 3 the researcher finds that the accuracy of finding the product from the list in the bag making storage area is 60%.

2. Analyze

In the analyze phase, the researcher did interviews and observations in the storage area of the bag making division, the researcher created a list of possible factors that contribute to the main problem which is no items going out from the storage. The researcher then uses the list to create a cause-and-effect diagram. Originally the cause-and- effect diagram has 6 categories (Measurements, Materials, Personnel, Environment, Methods, Machines). But in this research, the causes contributing to the problem only come from four categories (Measurement, Personnel, Methods, Environment). The cause-and-effect diagram of the research can be seen in figure 4 below.

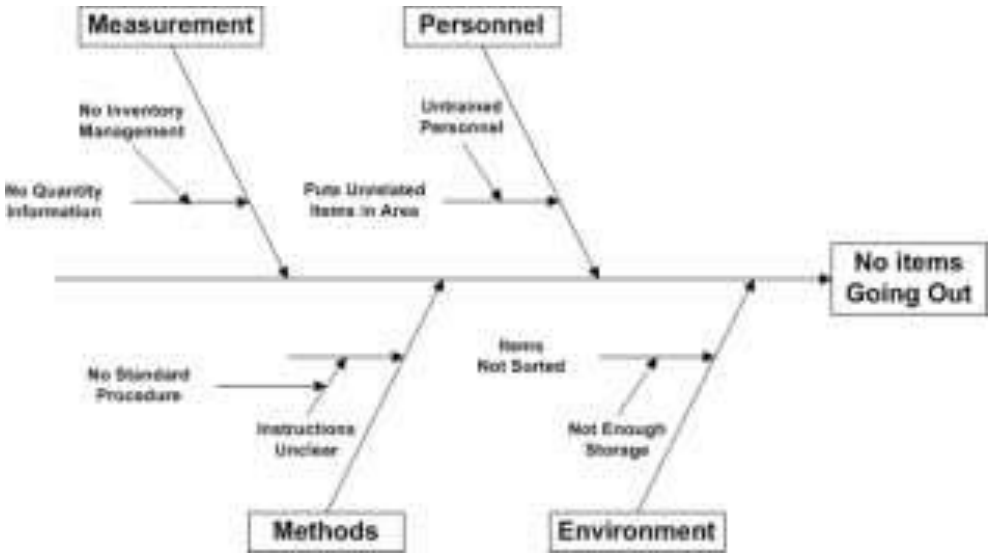

Figure 4. Cause and Effect Diagram

3. Improve

After analyzing the problem, the researcher then moves on to the improve phase. the improve phase starts by designing a solution. The researcher uses the cause-and-effect diagram and then uses 6S as the basis for the solution design.

4. Sort

The improvement starts from removing unused items from the bag making storage. Some of the unused items include old designs that have not been used anymore. According to Mertens (2016) one of the wastes in the warehouse is unused / expired items. The decision of the old design has come from the customer from a long time ago but the items mentioned are not thrown away. In order to follow the first s which is sort, the unused items need to be thrown away because unused items in the area will increase numbers of items in the area which causes the search time to increase.

5. Set in Order

After the unused items have been removed from the bag making area, the project moves on to setting everything in order. According to the cause-and-effect diagram in Figure 4, one of the root causes of the problem is because the storage is not able to accommodate the items inside the bag making storage. The researcher then suggests adding 2 more shelves. The decision was based on the number of items that are currently not on a shelf. And compare them to the capacity of the current shelf.

After adding the shelf, a new layout is also designed. The new layout should have access into and out of the bag making storage area. Walking space is also considered as one of the factors. Daamen (2003) in his research shows that walking space has correlation with the walking speed of a person. The walking speed of a person can improve the time for the operator to go through each area and shelf so the operator can find the items faster. The new layout gives operators space to access all of the shelves, while also maximizing the space available in order to be able to store as many items as possible. With the new layout, the researcher also suggests grouping the placement of items by its customer/ usage. According to the second S (set in order) principle, grouping items by its usage can improve the time required to search for the item later. The suggested plots can be seen in the figure 5.

Location	Usage
Old Shelf	Excess items from production (Customer Y)
New Shelf A	Items that require treatment (Other Customers)
New Shelf B	Excess items from production (Other Customers)
Item Area 1	Items that require treatment (Customer Y)
Item Area 2	Excess items from production (Customer Y)

Figure 5. Location And Usage Table

The grouping was determined from the number of boxes that are in the storage. PT X has one main customer which takes most of the order. The researcher suggests grouping the customer y items into one group so that the operators can find the items faster. For example, if the operator needs to find excess production items from Customer Y, then the operator will only need to search from either the old shelf or in the item area 2. The improvement after all of the items are set in order can be seen in figure 5 below.

Figure 5. Improvement After Sort and Set in Order

6. Shine

The next component of the 6s is Shine the researcher suggests to replace the old boxes that are contaminated heavily with dust. The reason to replace the boxes are so that the items inside are not contaminated with dust. If the items inside are contaminated with dust, the items are going to be rejected by the customer.

7. Standardize

The next step is to standardize the process. Standardization is important in order to maintain the improvements that have already been implemented (Gapp et al., 2008). The standardization of bag making storage comes in the form of giving labels for each box, and implementation of warehouse management system. The explanation of each improvement can be seen in the paragraph below.

- Label for Each Box

One of the tools to identify an item is using a label. Using labels to identify items can help operators to find an item faster (Bzostek & Wogalter, 1991). The bag making division already has a label for the items in the bag making storage. The problem with the labels is that the labels are not utilized well. So, the researcher suggests to re-implement the use of the labels. Use of signage can remind a person of things to do and things to avoid (wang et al., 2017). Based on the statement before, the researcher decides to use signage to remind the operator to use the label.

- Warehouse Management System

One of the root causes of the problem based on the cause-and-effect diagram is that there is no warehouse management system. So, a warehouse management system is made as an improvement to the bag making division. The warehouse management system uses excel for the software and visual basic for application as the programming language.

RESULTS AFTER IMPROVEMENT

After the implementation of the improve step, the researcher then does another observation in order to see the improvement after the implementation. The method of the observation remains the same, and done with the same subject in order to give an accurate interpretation of the improvement. The researcher then uses Minitab in order to get a summary of the data. The data are put into Minitab and then the researcher uses the descriptive statistical analysis in order to display the overall summary of the 30 observations. The result of the data processing can be found in figure 6 below.

Descriptive Statistics: Observed Time After Improvement

Variable	N	N*	Mean	SE Mean	StDev	Minimum	Q1	Median
Observed Time After Impr	30	0	31.17	4.28	23.43	10.00	18.75	24.00

Variable	Q3	Maximum
Observed Time After Impr	35.00	100.00

Figure 6. Descriptive Statistical Analysis of Observed Time from Minitab After Improvement

From the figure 6 above, the mean observed time is 31.17 seconds. The researcher then goes on to find the accuracy percentage of the subject. The table containing the summary of the accuracy during the observations can be seen in the figure 7 below.

Item Found (Yes/No)	No. Of Occurrences	% Occurrences
Yes	30	100%
No	0	0%
Total	30	100%

Figure 7. Subject Accuracy From 30 Observations (After Improvement)

From the summary table the researcher finds that the accuracy of finding the product from the list in the bag making storage area is 100%. After the data have been processed, then the researcher compares the data from before improvement and after the improvement has been implemented. Figure 8 shows the comparison between before and after improvement.

Parameter	Before Improvement	After Improvement
Mean Observed Time	115.2 Seconds	31.17 Seconds
Accuracy	60%	100%

Figure 8. Comparison Between Before and After Improvement

By looking at figure 8 the researcher can see significant reduction in the mean observed time. Due to observations when items are not found are not accounted in the statistic calculation, the researcher is sure that the reduction of search time is significant. On the other hand, the search accuracy gains a significant improvement from 60% to 100%. The improvements have effectively improved the overall search time of the products, and solved the problem of this research.

CONCLUSION AND FURTHER RESEARCH

The root cause analysis is done using a cause-and-effect diagram. The diagram includes four categories (measurement, personnel, methods, environment). After the cause-and-effect diagram, an improvement design was created according to the 6S principles of lean manufacturing (Sort, Set in order, Shine, Standardize, Sustain, Safety). And then the design was implemented. The design includes removing unnecessary objects, addition of a new shelf in order to accommodate all the items, application of warehouse management system, standardization of procedures related to the activity, and assessment of the safety aspect. The changes resulted in improvement of the 6S principal implementations, improved search time, and improved item search accuracy. Also, with the new warehouse management system, the division is able to track the number of items inside the storage and create optimization strategies for other departments related to the warehouse such as production planning, and inventory control.

After the improvements done to the bag making storage, the next step for the company is to sustain the improvements, and utilize the tools in order to reduce the number of items in the storage, and to prevent the items piling up again in the future. The other division such as production planning and inventory control division can also utilize the warehouse management system by accessing the file in the company file server, searches the items in the second sheet of the excel to know the stock, and then reduce the production plan with the number of stocks in the bag making storage. By doing so, the other division can help the bag making division to reduce the number of items in the bag making storage, and eliminate the chance of items piling up again in the future.

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