Application of Lean Manufacturing Tools in a Garment Industry as a Strategy for Productivity Improvement

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Abstract - *This study aimed to use and apply lean tools as ways of improving manufacturing systems that lead to reduction of wastes and standardization of cycle time. Model A in Line 1 at sewing section was the focus of the study. The researcher used questionnaires, 5S Audit checklists, and Time Study forms in information-gathering and cycle time-computation. Based on the observation done, the company does not have a standard operation time. Similarly, the researcher observed non-value activities such as unnecessary transportation and manual counting, and there were also product defects due to poor 5S and WIP inventories. After considering lean tools, using process flow and cycle time analysis, the standard time was determined. Likewise, the non-value added activities were reduced, thus productivity was improved. After lean implementation, 100% efficiency was achieved, the rejection rate was reduced to 0.08% and zero WIP inventories in Line 1 became a practice. Lean tools brought significant changes in providing smooth process flow and productive operations, which in turn, give a remarkable contribution in achieving company's goals, focus on the customers, giving quality products at the right time and at the right place. Therefore, the full implementation of BY Garments would contribute in gaining more profits*.

Keyword: *Lean Manufacturing, Just in Time, Productivity, Time Study*

INTRODUCTION

In today's competitive manufacturing environment, companies are constantly looking for ways on how to improve. Because of this, many companies are striving to practice lean manufacturing, which is a difficult process. Productivity improvement is not a job for specialist only, it should be a part of every job in the organization. It requires the optimal use of all resources like manpower, machinery, money and methods [1]. The use of lean production is now being practiced by organizations which aim to increase productivity, improve product quality and manufacturing cycle time, reduce inventory, reduce lead time and eliminate manufacturing waste. To achieve these, the lean production philosophy uses several concepts like Kaizen, Kanban, 5'S, Just in Time (JIT), Value Stream Mapping (VSM), etc. Kaizen is a Japanese term for continuous improvement, the philosophy that seeks to improve all factors related to the process of converting inputs into outputs on an ongoing basis [2]. Another japanese term used in production system is the Kanban which means signal or visible record. It is the kanban card or other devise that communicates demand for work or materials from the preceding station. 5S which also developed by Japanese who pursued housekeeping for a neat, orderly, and efficient workplace and as a means of reducing waste. 5'S stands for Sort(Seiri), Simplify(Seiton), Shine(Seiso), Standardize(Seiketsu) and Sustain (Shitsuke)[3]. Just in time (JIT) is an approach of continuous and forced problem solving via a focus on throughput and reduced inventory. With JIT, materials arrive where they are needed only when they are needed. When good units do not arrive just as needed, a problem has been identified [3].

Another lean tools is the Value Stream Mapping (VSM) which is the process that helps managers understand how to add value in the flow of material and information through the entire production process[3]. Time study is a work measurement technique for recording the times and rates of working for the elements of a specified job carried out under specified conditions, and for analyzing the data so as to obtain the time necessary for carrying out the job at a defined level of performance. A time study has been carried out for all operations on the bearing cap in the layout by direct observation method and the observed data [4]. These studies clearly explain the lean concepts, its principle, importance and benefits. It also addresses the approaches to implement lean practices in apparel and garments manufacturing company specifically the BY Garments Industries located at Balayan, Batangas.

Lean manufacturing strives to improve as much as possible the value-added component of lead time, but focus first on reducing the non-value-added component of lead time. These principles on lean management has been integrated by the study made by Tinoco [5] with the title Implementation of Lean Manufacturing, the author focused his study in developing a stream value map for XYZ Company in Minnesota. He used lean manufacturing principles like JIT, Kanba, Kaizen, 5'S and Value Stream Mapping. Creating a value stream map will allow the company to document current production lead time, inventory levels, and cycle times in order to determine the ratio of value-added to total lead time of the product family being analyzed, creating a vision of an ideal value flow. The goal is to identify and eliminate the wastes in the production process. The company will use these results in order to map the future state and implement lean manufacturing.

BY Garments Industries was organized in 1978 as a small cottage business. The proprietor, Mr.Estelito C. Bagunas, and manager, Mrs. Ester R. Bagunas, are responsible for the production, operations and marketing of the products. The company started as a sub-contractor supplying exporters with crochet garments requirements.

At present, the company's capacity is based on the produce of the factory in Balayan, Batangas, Philippines. The company's working force is approximately 290 employees. Its clientele include importers and wholesalers in Asia, Europe, Canada and in the United States. BY Garments Industries' main line of production, concerns customarily on children's wear and ladies clothes such as dresses and blouses.

However, the company could not determine the profit and losses incurred because activities in manufacturing are not monitored. This is because no operations system was established. There is no standard output requirement for each product line. Ever since establishment, the owner did not make production reports to monitor productivity and efficiency of employees.

Based on the initial observation done, there were unbalanced workloads of each sewer, thereby daily output of workers were not established. Due to this situation, the different operations per model are done in different lines. There were no specific lines assigned for each model so that some of the sewers who already completed their tasks have to continue working on different models or styles. Common problems encountered by the researcher included the mixing of trims like threads, labels, and tickets. Rejects caused by dirt or stain on fabrics were mainly attributable to poor practice in housekeeping. The absence of an engineer, particularly an Industrial Engineer, was considered one of the reasons for this kind of mismanagement for which the owner, Ms.Bagunas sought solutions by extending these problems to the researcher.

Through previous researches and literature reviews, this study has been given justification, clear understanding on the research concepts specifically lean management principles, and the theories that are related to the pursuance of this study.

OBJECTIVES OF THE STUDY

This research focused on the application of Lean Manufacturing in baby dress sewing section in BY Garments Industries, Inc., as a strategy for productivity improvement. Specifically, it sought to answer the following objectives: to determine the status of BY Garments Industries, Inc. in terms of the following parameters: operation process flow; value stream mapping in terms of value activities, and non value activities; takt time / cycle time, work in process (WIP) inventories, and 5'S practices; to identify the specific lean manufacturing tools that were applied to the aforementioned parameters; to determine the extent of the productivity after the application of lean manufacturing tools in terms of productivity, manpower requirements, work in process (WIP) inventories, efficiency, rejection rate, and 5'S practice; and to develop a time study system to achieve productivity.

MATERIALS AND METHODS

The descriptive research design was used by the researcher to gather information about present existing conditions needed in the chosen field of study. In this method of research, a combination of Qualitative and

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Quantitative Research were used to gather relevant data on current status BY Garments Industries considering different parameters [6].

Study Population

The workers and operators of BY Garments Industries, Inc., which is located at Balayan, Batangas, compose the study population. The operation manager, the 13 sewers, 1 line inspector, and 2 supervisors in Line 1 – Model A were the subjects of the study because they are the sources of relevant data through survey and interviews.

Description of Respondents

The supervisor in Line 1 was the main respondent of the study since she is in charge in the monitoring activities in sewing section. As they are directly involved in the production and operation system, the sewers in each process were interviewed and observed to gather important information. All pertinent data and information related to process flow and operations will be gathered from them like time study and 5'S practice audit.

Research Instrument

Based on the outlined objectives, self constructed interview guide, standardized forms such as Cycle Time Observation Form, Process Flow Chart, and 5'S Audit Checklist were the main instrument for data collection. These data and information were used in the development of the study. The researcher also used the company's floor plan layout and business profile as part of document analysis and interviewed some sewers and line supervisors.

RESULTS AND DISCUSSION

Current Status of BY Garments Industries, Inc

From the time BY Garments Industries, Inc., has been established, it had no systematic flow of operations, monitoring records of production output, waste reduction policies, and non-value added activity elimination measures. It was shown in Table 1 the total time consumed in non value added activities such as transportation and manual counting

1.1. Operation Process Flow

The stitching operations in sewing process can be done simultaneously; that is, the stitching for armhole, neckline, delio on bottom skirt, cover stitch while edging and finishing inspection are done after all the stitching operations. At present, the operators were not given a target output requirement on daily basis. With that, there are operations that completed already while the others are still on process. This is the reason why some operations are done in separate line as seen in the figure 1.

1.2. Value Stream Mapping

1.2.1. Value Added Activities

In garments industry, the activities that are considered as with value are the operations that have importance in producing the products. These are piping, delio, attach button or accessories, edging parts, or the stitching operations needed in the production of baby dresses.

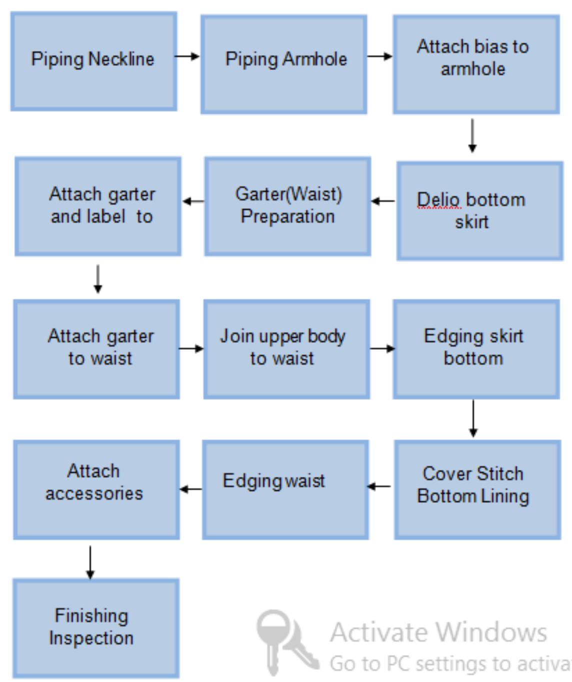

Figure 1. Sewing Process in Line 1

Figure 1 shows the current process flow under sewing for baby dress. The raw parts issued by cutting department are to be processed in sewing section.

1.2.2. Non-Value Added Activities

The non-value activities are insignificant activities in producing the product. In BY Garments Industries, non-value added activity(NVAA) found is transportation from one operation to another. The sewer, after finishing his/her operation, has to travel to get the parts to be processed in other lines. Another NVAA is the manual counting, which is done by all sewers after completing the batch of parts before loading to the next process. Other NVAs, such as transferring of products to the next process, confusion of work sequence, and waiting times due to delay of the foregoing process, were found in sewing section. The average NVAA is 65 minutes per day.

Table 1. Time Consumed by Non Value Added Activities at Sewing Section

Non Value Activities	Time consumed (minutes/day) February 16-20 2015				
Transportation	25.75	25.20	21.45	26.05	25.50
Manual Counting	23.40	22.70	18.50	20.25	24.00
Waiting Time	12.30	10.25	12.10	11.75	14.50
Others (Verification, etc)	7.5	6.10	5.10	8.50	7.75
TOTAL	68.95	64.25	57.15	66.55	71.75
Average			**65.72**		

The table shows the time consumed by non-value added activities present in the sewing section from Line 1 to Line 4 from February 16 to 20, 2015. The total time consumed was based on the transportation of each operator from one process to another

1.3. Takt Time and Cycle Time

In BY Garments, operations are not standardized. The operator or sewer does not have an output requirement per day, because each operation in sewing process is paid at a per piece rate. That is why inconsistencies in daily output cannot be avoided because there are sewers who work faster than others. Because of which, the company suffers from meeting the deadlines of customer. Most of the time, especially when there are urgent orders, the late operations are required to extend, operators to render overtime.

1.4. Work in Process (WIP) Inventories

In the existing system, operators start producing parts continuously at their full efficiency irrespective of the requirement of succeeding operation. Due to this, there is a huge amount of WIP in between processes, creating problems. As the WIP increases, the possibility of mistakes also increases. The average WIP inventories per week is 5.4%

The table 2 shows the time consumed by non-value added activities present in the sewing section from Line 1 to Line 4 from February 16 to 20, 2015. The total time consumed was based on the transportation of each operator from one process to another.

Table 2. WIP Rejection Rate as of February 21, 2015 (N = 1200 pieces)

Defects	**Number of Rejected WIP (X_i)**	**Rejection Rate**
Damaged	27	(27/1200) 2.75%
Wrong Buttons/accessories	42	(42/1200) 3.5%
Wrong trims	28	(28/1200) 2.3%
Wrong labels	15	(15/1200) 1.25%

It can be seen in Figure 2 that the NVAs identified in Model A are caused by unbalanced workload and the arrangement where no single line is used in each process. The transportation from one process to another has the highest percentage of NVA in Model A. This is because the operations' processes 1 to 13 are not done in a single line.

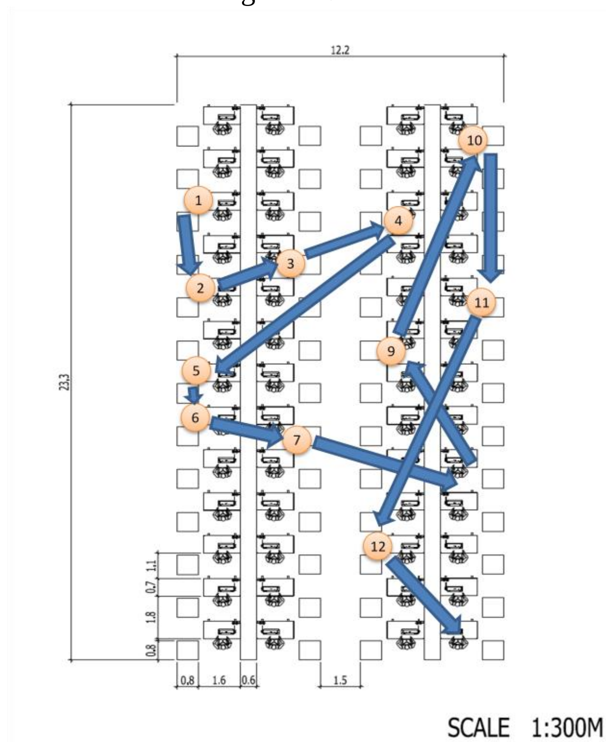

Figure 2. Current Sewing Section Operation Process and Transportation

1.1. 5'S Practices

The problems met at present due to poor 5'S practice are mixing of trims (threads, buttons, labels, tickets, etc.), confusion of which model is being processed because labels, non-provision of work samples, and defects on products(like dirt and stains, due to dirty machines and floors). The average rejections were estimated to 3% of the total output produced per week. With this, there are entailed expenses incurred for rework of rejected parts and products.

The table 3 shows the estimated rejection rate brought by the poor 5'S practice in sewing section. The most defects are from dirt and stains on fabric due to poor housekeeping.

Table 3. Rejection Rate Due to Poor 5'S Practice of Model A (N = 1200 pieces)

Rejections	(X_i)	Percentage
Dirt and Stain at fabrics	35	(35/1200) 2.9%
Mixing of trims (threads)	29	(29/1200) 2.4%
Damaged buttons/accessories	22	(22/1200) 1.8%
Damaged labels/tickets	18	(18/1200) 1.5%

(X_i)- No. of Rejects

2. Application of Lean Manufacturing Tools

2.1. Process Flow

In BY Garments based from current process flow, there were some operations in sewing area that needs to be reorganized. To eliminate the non-value activities and unnecessary movements of sewers, the flow of operations must be based on the length of each work available for each sewer. This is to balance the operations for each model and avoid the late process of other operations. To achieve this, each operation in each model will be done in a single line, the computed standard time was used as a basis in determining the capacity of each operator, the required output per day per operator and the number of machines required to accomplish the target output were determined. In this way, proper planning and scheduling could be easily done for each model. The mixing of parts of every model was eliminated and non-value activities have been reduced such as transportations and waiting time. Other NVAA will be eliminated such as manual counting.

2.2. Elimination of Non Value Added Activities

The time study was conducted at BY Garments and the standard time was determined. For Process 1 (piping neckline), the operator was selected. The researcher used 10 cycles, using a stopwatch. The elements were broken down in such a way that the operation will be simplified. For process 1, there were 2 elements used, "getting the parts from the box" and "sewing of parts". The average observed cycle time is the arithmetic mean of the times for each element measured, adjusted for unusual influence for each element. Likewise, average NT was computed as basis in solving the Standard Time (ST). The allowance factor use was the standard PDF of 15%. The same procedure was done in Process 2 to 13. Based on the computation, Model A under Line 1 has total Cycle Time of 926 seconds.

2.3. Work in Process (WIP) Inventories

To eliminate WIP in production, lean tools such as Line Balancing which is levelling the workload across all processes in a cell or value stream to remove bottlenecks and excess capacity was used. Line Balancing is standardization of cycle time which calculated and applied in sewing section. With this, at the end of each shift, there were no more WIP inventories existing from each operation. The standard time was computed based on the time study conducted. Another tools which helped BY Garments is the Just in Time (JIT). The principle that underpins JIT is that production should be 'pulled through' rather than 'pushed through'. This means that production should be for specific customer orders, so that the production cycle starts only once a customer has placed an order with the producer.

Lastly, the Push and Pull System, another tool, is very applicable in eliminating WIP. The kanban bin which is part of Push and Pull System was used in Line 1. The operator after each process will push the bin to the next process until the last operation. After end of the shift, the kanban bin will be empty and no more WIP inventories.

2.4. 5'S Practices

To start the implementation, the management of BY Garments started the implementation by conducting 5'S training in production, especially in the sewing section. All workers in production from cutting to packing section were trained in 5'S principles. All staff will be trained on how the 5'S (Sort, Set in order, Shine, Standardize and Sustain) are applied in daily operation.

3. Effectiveness of Lean Manufacturing Principles at BY Garments Inc

3.1. Productivity

With the computed cycle time in Model A, the total output of 1,200 was finished within 3.7 days only or an output of 326 pieces in daily operation with the basis of 7 hours available time and only 12 operators were required for its completion. The operations process was also arranged in a way that transportation and waiting time are minimized.

Table 4. Computed Cycle Time for Model A

Operations	CT (sec)	Operator
1. Piping Armhole	35.631	OP 1
2. Attach bias to armhole	45.243	OP 1
3. Attach Garter and label	231.139	OP 2,3,4
4. Join upper body to waist	77.739	OP 5
5. Garter (waist) preparation	16.675	OP 6
6. Attach garter to waist	60.026	OP 6
7. Delio bottom skirt	76.980	OP 7
8. Cover stitch bottom lining	76.213	OP 8
9. Piping neckline	24.0805	OP 9
10. Edging skirt bottom	25.415	OP 9
11. Edging waist	25.258	OP 9
12. Attach accessories	153.41	OP 10 OP11
13. Finishing Inspection	75.648	OP 12
Total	**928.20**	

In Table 4, the balanced workload and the required manpower to do tasks after the implementation of standard cycle time per operation are shown. Completion of 326 pieces per day shows 100% efficiency was attained

3.2. Manpower Requirement

After the computation of takt time, the 13 operators required to finish the 1200 pieces demand has been reduced to 12 operators. Based on the recorded capacity completed by sewers in Line 1,after the implementation dated February 23-27,2015, the target output of 326 per day was achieved by the 12 operators.

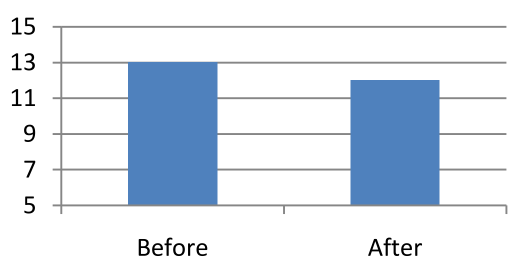

Figure 3. Comparison of manpower requirement

The figure above shows the reduction of manpower to do the volume demanded for Line 1. The excess manpower was transferred to other lines. Only 12 operators were required for the new workload assigned, based on the takt time computed.

3.3. Work in Process Inventories

With the implementation balanced of workload, the rework level has been decreased over existing trends. In existing production, the rework level is approximately 2.45% but after implementation of recommended process flow and required manpower, the rework level falls to 0.0825%. The main reason for rework reduction is due to reduction in WIP and balanced work cells.

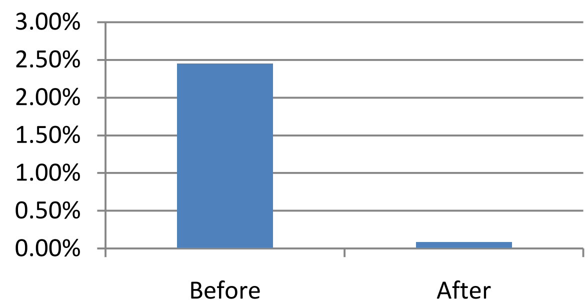

Figure 4. Comparison of WIP Rejection Rate

The figure shows comparison of the rejection rate from the WIP inventories recorded from February 16-20, 2015 and the rate after the implementation of zero WIP inventories. From 2.45%, it was reduced to 0.085%.

3.4. Efficiency

The efficiency of Line 1 before the implementation of line balancing was 74% compared to the 100% rate after the workload was balanced. It was computed by dividing the total work content in seconds by the number of operators multiplied by the takt time.

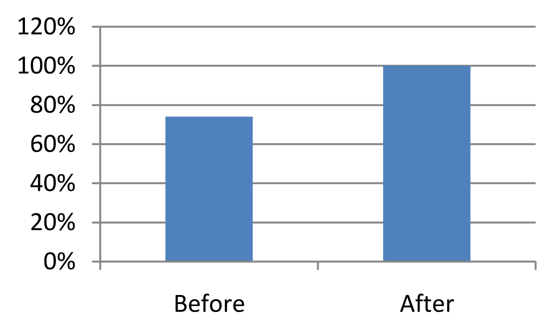

Figure 5. Comparison of Efficiency in Line 1

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The figure above shows the efficiency rate after implementation of line balancing in Line 1. The efficiency achieved was 100% with reduction in manpower from 13 to 12 operators doing the 13 operations.

3.5. Rejection Rate

The improvement in terms of reduction in number of defects was considered in measuring the effectiveness of lean tools application. The defects due to poor 5'S practice were reduced to 0.25% which most of the defects were from mixing of buttons. This problem still exists because 5'S practice has not been fully implemented. Likewise, the WIP has reduced the defects to 0.085%.

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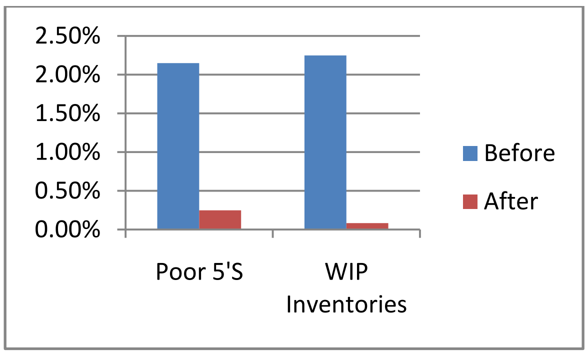


Figure 6. Comparison of Rejection Rate from Poor 5'S and WIP Inventories

Figure 6 shows the comparison of rejection rate before and after implementation of 5'S practice and balanced workload of workers. It is remarkably decreased the rate of rejections which means effectiveness of lean

3.6. 5'S Practice

After the application of 5'S principles, based on the checklist used for 5'S audit, there were 50%-90% ratings of implementation. Some areas that need budget allocation to fully applied 5'S have not yet been provided for by the management. Some requirements were not yet accomplished, such as 5'S checksheets and labels or posters. In addition, it was recorded that the number of rejections was reduced from 2.45% to0.25%.

Figure 7 shows the comparison of defects found due to poor 5'S and the rate after implementing 5'S practice. Mixing of trims such as threads were reduced to 0%, while there were still dirt and stains that may be because the 5'S is not 100% implemented. The rate of defect is expected to further decrease until total elimination by the end of first quarter.

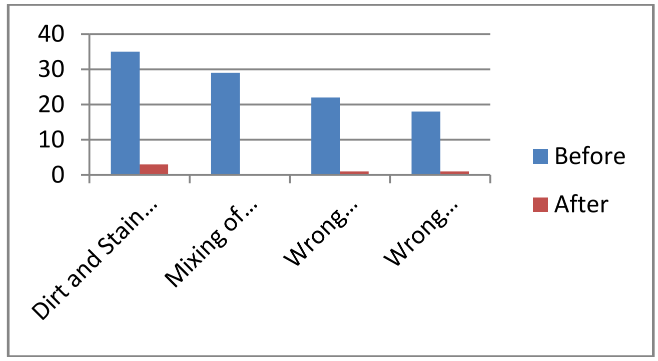
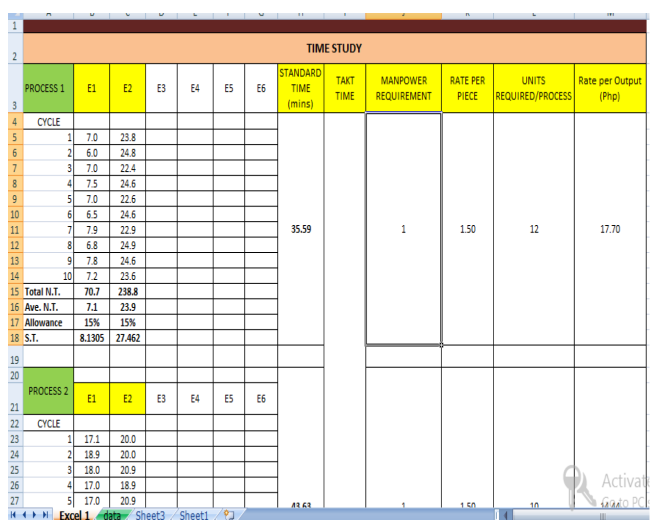


Figure 7. Comparison of Defect Rates after 5'S Implementation

4. Time Study Template System Developed

The full implementation of lean manufacturing principles are integrated in other lines is made possible by the researcher by providing the company the Time Study Template or system which she developed to automatically compute takt time once the standard time for each operation is keyed in. This template can also be used in all modes.

Proper way of using the Template was discussed and trained to all production supervisors and operations manager. Only the operations manager and supervisors are permitted to use the system. The password is provided for the protection from unauthorized use.



TIME STUDY

PROCESS 1	E1	E2	E3	E4	E5	E6	STANDARD TIME (mins)	TAKT TIME	MANPOWER REQUIREMENT	RATE PER PIECE	UNITS REQUIRED/PROCESS	Rate per Output (Php)
CYCLE							35.59		1	1.50	12	17.70
1	7.0	23.8										
2	6.0	24.8										
3	7.0	22.4										
4	7.5	24.6										
5	7.0	22.6										
6	6.5	24.6										
7	7.9	22.9										
8	6.8	24.9										
9	7.8	24.6										
10	7.2	23.6										
Total N.T.	70.7	238.8										
Ave. N.T.	7.1	23.9										
Allowance	15%	15%										
S.T.	8.1305	27.462										
PROCESS 2	E1	E2	E3	E4	E5	E6	43.63		1	1.50	10	
CYCLE												
1	17.1	20.0										
2	18.9	20.0										
3	18.0	20.9										
4	17.0	18.9										
5	17.0	20.9										

Figure 8. Time Study Template

Figure 8 shows the Time Study template for easy calculations of takt time and standard time. In the system, the supervisors will key in the cycle time recorded during time study

CONCLUSION AND RECOMMENDATION

Lack of knowledge, specifically in production systems and resources management of the operations manager of BY Garments, resulted to the low productivity and efficiency of manpower. The lean manufacturing system is a continuous improvement method; thereby, its implementation helps the company minimize waste, enhance quality of products and definitely create its sustainability. Lean manufacturing tools contribute to the productivity of both workers and the company. The Time Study monitoring system, an output of the study, is an effective and efficient tool to enhance productivity in the entire sewing section, whose benefits extend to the whole organization.

In this research, only the operations in Line 1 at sewing section were standardized due to time limitation of research. But this work can be extended for any new style or model. Time study and standard time for each operation must be established for other styles to fully implement lean environment at BY Garments Industries, Inc.

The company may recall the previous 5'S Team for the continuance of their function to further implementation of 5'S. They can be motivated in this endeavor by using the system of group of incentive and rewards to employees such as "Employee of the Month", "Best in 5'S Group", etc. By encouraging 5S practice in groups, all workers will also be motivated to practice the 5'S daily until it develops into regular routine while inside the company.

BY Garments may consider hiring an Industrial Engineer who can facilitate the overall production system, including manpower allocation, general supervision and management initiatives and resources optimization.

REFERENCES

[1] Wilson, L (2010), *How to Implement Lean Manufacturing*, 1st Edition McGraw Hill, New York

[2] Stevenson, W.L. (2001) *Production Operations Management 6th Edition*, Mc-Graw Hill, Copyright 2001

[3] Heizer,and Reinder (2011) *Operations Management 10th Edition*, Prentice Hall

[4] Niebel, B. (2009) *Method Standard and Work Design* 12th Edition, McGraw Hill

[5] Tinoco, J. (2004) Implementation of Lean Manufacturing, the author focused his study in developing a stream value map for XYZ Company in Minnesota. Retrieved December 18, 2014, URL: http://goo.gl/hMhx75

[6] Calderon, J. F., & Gonzales, E. C. (2011), *Methods of Research and Thesis Writing*, Philippine Copyright, National Book Store