GARMENT PRODUCTIVITY IMPROVEMENT: IMPLEMENTING LEAN MANUFACTURING TOOL AS A STRATEGY FOR IMPROVEMENT

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Abstract– This study is focused on apply lean tools for improving manufacturing process with standardization of process cycle time and waste reduction. Self-customized questionnaires, time study forms and 5S checklists are used in information gathering and computation. Unnecessary transportation and movement were observed as non-value added activities and defects also found due to poor 5S practice. Lack of standard operation time or any other lean tools are found. After implementation of lean tools like cycle time analysis and operation bulletin, the standard time for every process was determined and the non-value added activities were also reduced thus, the productivity improved. The lean implementation results in efficiency increase and reduce rejection rate. Applying lean tools brought remarkable changes in process flow and productive and efficient operations, which allows focusing on the customers demand, delivering quality products at the right time.

Keyword- Lean Manufacturing, 5S, Productivity, Time Study

I. INTRODUCTION

Now a days it's a very competitive market and all manufacturing company are finding their way out for better establishment. And to sustain in the business they are practicing lean which is difficult process. The designated person is not only responsible for the productivity improvement rather the organization in a whole should participate on improving. The optimal use of all resources like manpower, machinery, money and methods are necessary [1]. To increase productivity, product quality, reduce lead time and eliminate waste the organizations are using lean tools. To achieve the goals, they are using 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 main theme is 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 a scheduling system for lean manufacturing. Kanban is an inventory-control system to control the supply chain. 5S is the name of a workplace organization method that uses a list of five Japanese words: seiri, seiton, seiso, seiketsu, and shitsuke. Transliterated into Roman Script, they all start with the letter "S"[3]. Just-in-time (JIT) is an inventory strategy companies employ to increase efficiency and decrease waste by receiving goods only as they are needed in the production process, thereby reducing inventory costs[3].

Value stream mapping is another lean manufacturing technique used to document, analyze and improve the flow of information or materials required to produce a product or service for a customer [3]. Time study is a systematic observation, analysis, and measurement of the separate steps in the performance of a specific job for the purpose of establishing a standard time for each performance, improving procedures, and increasing productivity. 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. These studies explain the lean concepts, principle, importance, benefits and also discourses the methods to implement lean in apparel and garments manufacturing company.

Lean endeavors to improve as much as possible the value-added component, but focus on reducing the non-value-added component first. These lean management has principals have been integrated by the study made by Tinoco [4] naming Implementation of Lean Manufacturing, the author focused his study in developing a stream value map for XYZ Company in Minnesota. He used lean tools like JIT, Kanba, Kaizen, 5"S and Value Stream Mapping.

To visualize current production lead time, inventory levels, and cycle times in order to determine the ratio of value-added and non-value-added time of the product family can be easily done by generating a value stream map. The goal is to categorize and eliminate the wastes in the process. The company will use these results mapping the future state and implement lean tools.

The examined Industry was established in 1998 as a small business. The owner himself was responsible for the production, operations and marketing of the products. The company started as a sub-contractor supplying exporters.

At present, the company's capacity is based on the produce of the factory in Bangladesh. The work force is approximately 1800. Its clients include importers in Asia, Europe and in the United States. Main product is gent's clothes and ladies clothes.

However, the company could not govern the actual profit and losses sustained because activities in

manufacturing are not scrutinized. This is because no operations structure was established. There is no standard target for each production line. From the beginning to till now there is no production report to observe the efficiency and productivity of the product lines. The baseline study reveals discrimination in workload of the workers. For this reason all the operations per model are done in different lines and different machines. Common problems encountered by the researcher included the mixing of trims, threads, and labels. Defects caused by dirt or stain on fabrics were mainly attributable to poor practice in housekeeping. The absence of an industrial engineer was one of the main reasons for this kind of maladministration. 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 fulfilment of this study.

II. OBJECTIVES OF THE STUDY

This research focused on the application of Lean tools in dress sewing section as a strategy for improving productivity. Precisely, it required to answer the following goals: to determine the status of the selected Garments Industry in terms of the following parameters: process flow; value stream mapping in terms of value activities, and non-value added activities; takt time / cycle time, work in process (WIP) 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.

Methodology

The descriptive research design was used by the researcher to gather information about present conditions needed in the chosen field of study. In this method of research, a combination of Qualitative and Quantitative Research were used to gather relevant data on current status considering different parameters [5].

Study Resources

The workers and operators compose the study resources. The operation manager, the 13 sewers, 1 quality inspector, and supervisor 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 he 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 Tool

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 layout and business profile as part of document analysis and interviewed some sewers and line supervisor.

III. RESULTS AND DISCUSSION

Current Status

From the time the industry 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 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 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

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.

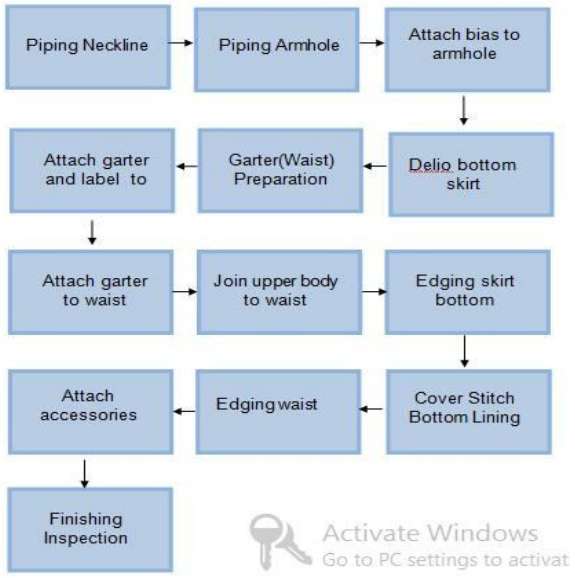

Figure 1. Sewing Process in Line 1

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

Non Value Activities		Time consumed (minutes/day) June 17-21 2017			
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 June 17 to 21, 2017. 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 this garment, operations are not standardized. The operator or sewer does not have an output requirement per day. 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 encompass, operators to condense overtime.

1.4 Work in Process (WIP)

In the existing system, operators start producing parts continuously at their full efficiency regardless of the requirement of successive operation. Due to this, there is a huge amount of WIP in between processes, creating problems. As the WIP increases, the possibility of defective item 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 June 17 to 21, 2017.

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.

1.5 5'S Practices

The problems met at present due to poor 5'S practice are mixing of trims (threads, buttons, labels 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.

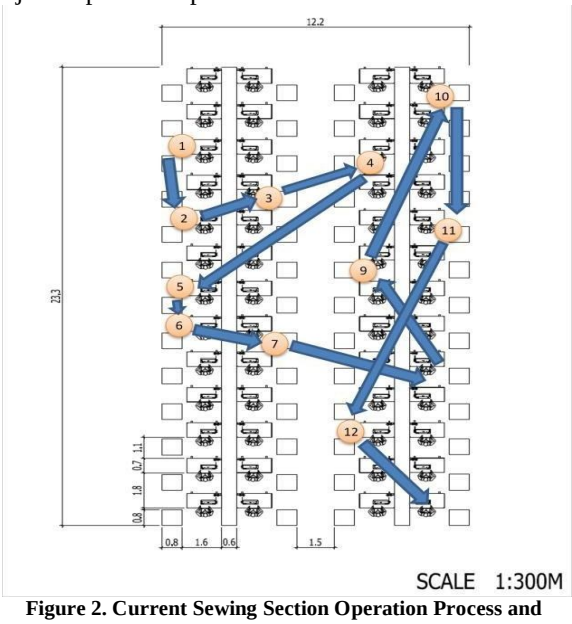

Figure 2. Current Sewing Section Operation Process and Transportation

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 the selected factory based from current process flow, there were some operations in sewing area that needs to be restructured. To remove the non-value activities and unnecessary activities 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 the selected factory and the standard time was determined. For Process 1 (piping neckline), the operator was selected. The researcher used 15 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 Normal Time (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)

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 existing from each operation. The standard time was computed based on the time study conducted. Another tools which helped the factory 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.

2.4 5'S Practices

To start the implementation, the management of the 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

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 June 24-28, 2017, the target output of 326 per day was achieved by the 12 operators.

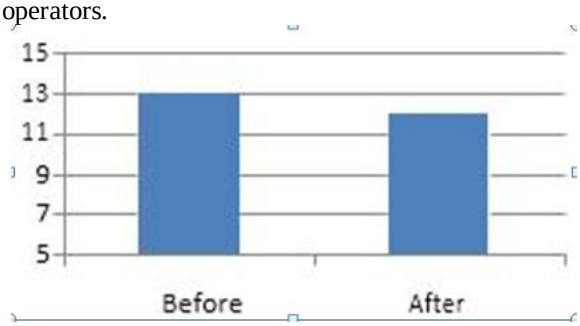

Figure 3. Comparison of manpower requirement

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

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.

The figure shows comparison of the rejection rate from the WIP inventories recorded from June 17-21, 2017 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.

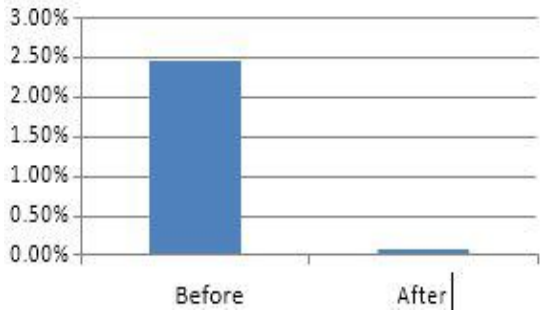

Figure 4. Comparison of WIP Rejection Rate

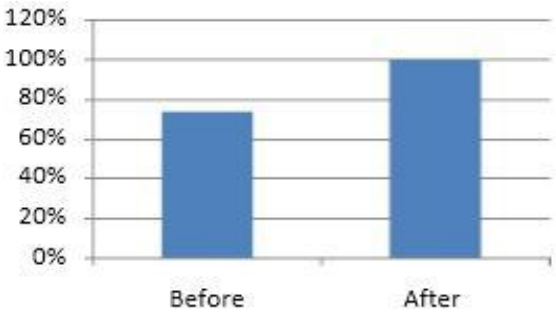

Figure 5. Comparison of Efficiency in Line 1

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%.

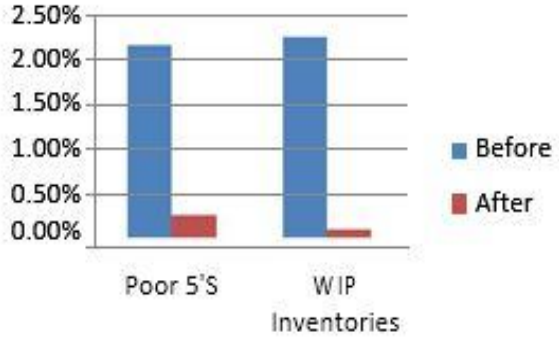

Figure 6. Comparison of Rejection Rate from Poor 5'S and WIP Inventories

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 check sheets 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.

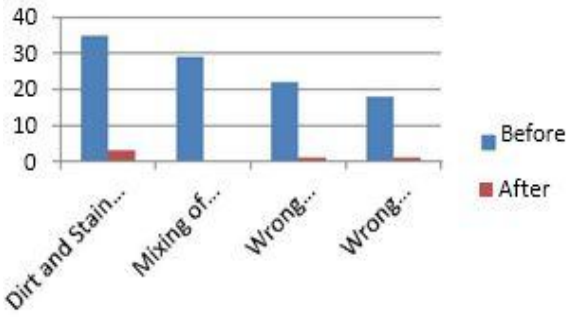

Figure 7. Comparison of Defect Rates after 5'S Implementation

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.

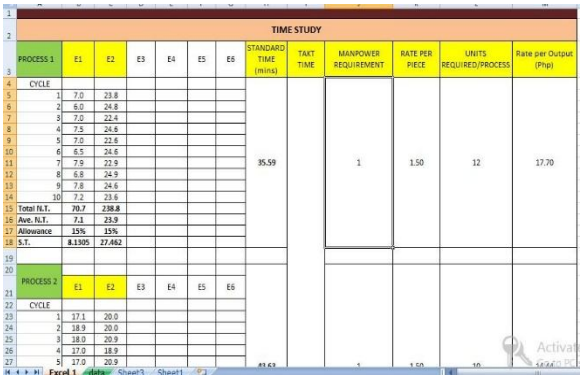

Figure 8. Time Study Template

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, precisely in production systems and resources management of the operations manager of the factory, 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.

The company may recall the previous 5'S Team for the continuation of their function to further implementation of 5'S. They can be motivated in this effort 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 5'S 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.

The company 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] 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

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

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