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ANALYSIS OF PROCESS RE-ENGINEERING TO REDUCE LEAD TIME IN APPAREL INDUSTRY BY LEAN MANUFACTURING THROUGH VALUE STREAM MAPPING

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Abstract - *This research has been performed to implement the Lean manufacturing in manufacturing unit with the help of value stream mapping i.e. tool of Lean Manufacturing. Value Stream mapping being an efficient Lean tool has appeared as the ideal way to spot and remove waste, through continuous improvement in almost every type of production industry. This research aims at analyzing on how value stream mapping can be applied to a manufacturing business, in specification to the company manufacturing shirts. This research kicks off with the notion of incorporation of lean techniques with manufacturing and results in encouraging response with noteworthy reduction in lead times. The process is first designed to reflect current state of the cutting section then analyzed for improvements. Thereby the value stream is redesigned to obtain an optimized flow of process i.e. future state. The research concludes with a result that the implementation of future state value stream map can give a considerable reduction in the current lead time in a day in cutting section with up to 60%*

Key Words**: Lean manufacturing, value stream**

1. INTRODUCTION

This research study has been carried out on one of the up-and-coming issues of every industry in current scenario i.e. "Lean philosophy". The key to contending in the international market place is to concurrently improve both quality and productivity on frequent bases. The major purposes of the lean production are to amplify productivity, improve product quality and manufacturing cycle time, reduce inventory, decrease lead time and reduce manufacturing waste.

This Paper is a case study explaining about the successful implementation of lean manufacturing tools and techniques in the progress and implementation of pinning table in the cutting section of a shirt manufacturing unit. The case company in this study is "Arvind Limited" having the manufacturing facility in Bangalore, India. The Target Product is "Check Shirts" and the research is completed with the help of one of the Lean tools i.e. Value Stream Mapping (VSM).

Eiji Toyota and Taichi Ohno at the Toyota Motor company in Japan pioneered the design of the 'Toyota Production System', or what is branded today in the US as 'Lean Manufacturing'. Lean is a continuous improvement process intended for long term maximization of company resources. It utilizes techniques and principles that develop efficiencies of Value added activities. The basic idea behind the system is eliminating waste [1]. Waste is everything that does not add value to the end product from the customer's view. The main objective of lean manufacturing is to aid manufacturers who have a desire to improve their company's operations and become more spirited through the implementation of different lean manufacturing tools and techniques.

1.1 Value Stream Mapping (VSM)

Value Stream Mapping is important that it is the method of mapping the material and information flows necessary to synchronize the activities perform by the manufacturers, suppliers and distributers to distribute products to customers. Value Stream Mapping is used to exemplify the flow and relationship between work processes. A key constituent of VSM is differentiating value adding activities from non-value adding activities. Plummeting or eliminating non-value adding activities is of dominant importance and a principal goal of lean manufacturing. VSM is a paper and pencil tool that helps you to see and comprehend the flow of material and information as a manufactured goods or service makes its way through the value stream. A current state map (CSM) is drawn to record how things actually operate.

Then a Future State Map (FSM) is prepared to implement a lean process flow through the elimination of the root culprits of wastes & non-value added activities and during process improvement all aiming to and implementation plan that information that the actions steps needed to carry the objectives. During the 1990's the dynamic force behind the use of value stream mapping emerged as lean manufacturing which was pioneered by Dr. James Womack, author of The

Machine that changed the world [2] and lean thinking [3]. Just as function investigation part of value management, value stream mapping is part of lean manufacturing.

2. LITERATURE REVIEW

Jafri Mohd Rohani et al [4] had put into effect of one of the most significant lean manufacturing techniques called Value Stream Mapping (VSM) to enhance the productivity of the production line of a color industry. To accomplish this goal, lean fundamental principles was implemented. To construct map for identification and removal of wastes team structure, product choice, conceptual design, and time-frame formulation through Takt time computation as done. Based on the future state map, outcome showed that by using some lean techniques, Production Lead-time and the value added time decreased from 8.5 days to 6 days and 68 minutes to 37 minutes respectively.

Jitendra Chouhan et al [5], applied a study in a multinational company "MAN Trucks Private Limited The targeted product was 'Cylinder Block' and the research was concluded in context of machining with the help of one of the Lean Tools i.e. Value Stream Mapping (VSM). The pleasing results of implementation of VSM in manufacturing proved that it is practicable to reduce the current lead time up to 23.41% for semi finish line and 26.17% for finish line and an average reduction in lead time for overall machining line is about 24.75%.

Rajendra et al. [6] stated that Lean manufacturing is an applied scientific method of techniques where processes of minimum non value adding activities are attained. This study described an application of VSM, where present and future states of value stream maps are structured to enhance the efficiency. As a result of implementation, reduction in manufacturing cycle time and increase in cycle efficiency is achieved. The flow of production process was stream lined thus reducing non value added activities like waiting time bottlenecking time and material handling time etc

Haque et al. [7] concentrated on the implementation of lean principles in one sewing line of selected large integrated readymade garments manufacturing section was examined. 41 sewing related operations were evaluated in the assembly line for variety design of polo T-shirts. Value Stream mapping tool was used to find the NVA activities in sewing section. The aim of research was not only to determine the NVA activities and also to analyze the root causes, increase VA time by designing new assembly line and reduce the total manpower involvement without hampering the Production efficiency and Productivity of selected firm. After implementation of future state VSM layout, some NVA activities were eliminated using the JIT, total productive maintenance, 5S and Poka Yoka concepts. It was improved the Productivity of garment manufacturing by 62% and also reduced the number of operators and Production lead-time and lowered the inventory level effectively.

Ramdass & Pretorius [8] recommended a case history and experiences of a South African garment manufacturer with qualitative outcome of the execution of modular manufacturing systems. Modular manufacturing backed by top level management and dedicated employees; selected garment benefited 10% of overall Productivity of the line enhanced by whereas operator efficiency of 15% increased by morale of the employees improved with education, open communication, training being treating them with dignity after the lean manufacturing implementation.

Naik et al. [9] performed a reasearch in Bangalore in the cutting section of garments to determine the non-value added activities so as to decrease them for saving time, increase the internal throughput time and lessen the Product cost. The performance level of supplier was also analyzed for cutback of the cost. Stop watch method was used to calculate the total time taken for each garment to finish the process of operation from fabric received in cutting till the cut audit section. Segregations of value added and non-value added activities were made. Time wastes were noticed due to carelessness of operators, without proper recognition, waiting, zigzag motion between the processes due to improper lay out, excess processes and no standard process being followed by the operator.

Patel et al. [10] gave description of VSM and Kaizen principles which were highlighted with the textile case study, here the work method across the Value stream was studied for finding VA and NVA activities and kaizen application is implemented through the revision of process layout to attain the desired productivity is the main intention of this work. In previous years, there were many such illustrations on use of VSM and kaizen to other SME, s except textile industries but hardly ever addressed the function of VSM and Kaizen in textile industries to lessen the waste in their process.

3. RESEARCH OF OBJECTIVE

- To reduce lead time in the shop floor
- To improve productivity in the shop floor by implementing lean manufacturing tool.
- To put into practice value stream mapping by implementation of pinning table.
- Re- engineering of the processes to streamline the flow of materials from one end to another.
- Saving of manpower in the cutting section

4. RESEARCH METHODOLOGY

This research focuses on increment of productivity and optimizing the process flow by identifying various waste involved and then eliminating them with the implementation of lean principles in the "Cutting Assembly Line section".

VSM has four major step explained by Rother and Shook [10]:

- Product Selection
- Drawing current state
- Drawing future State
- Develop process improvement for implementation of future state

4.1 Data Collection

A long time study was conducted at every work station to document the list of operations for each process. The beginning and ending times of each process were also recorded with digital watch. Layout of the section is noticed and a range of activities at each work station are disintegrated into sub activities. Questionnaires were also conducted with the employees to understand the importance of each task they carried out and problems they faced. A scaffold is decided to note down the details at each work station. 'Cycle Time' gives the average total time a product is taking on respective station. The average cycle time inform us how well the current process doing in relation to Takt time. Further, Total Lead Time or Production Lead Time is the total time in which specific product is taking out of entire section. This gives the very important information like the "waiting time" and unnecessary activities and inventory on shop floor.

4.2 Symbols used in value stream map

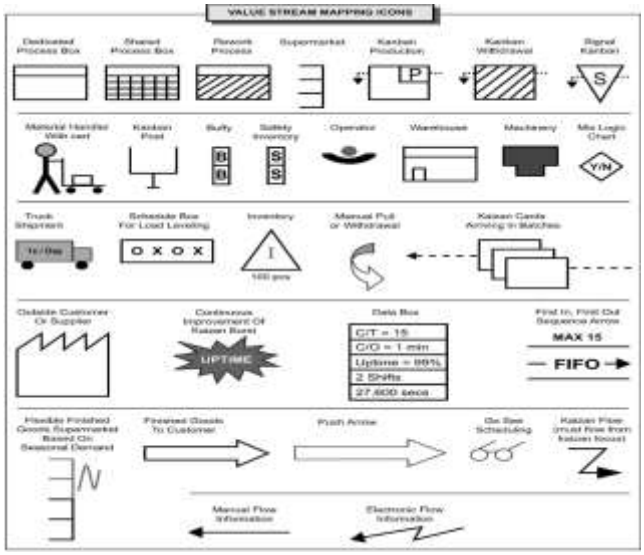

Figure 1: Value stream mapping icons

4.3 Current State Map

The lean matrics findings from current state of cutting section are:

Table 1: Current Lean matrics findings

Activity Category	Cutting process details	Time Taken (Minutes)
Value Added	Spreading	30
	Cutting	10
	Relay	180
	Relay Cut	10
	Edge Cut	60
Unavoidable non value added activity	Panel Checking	18
	Numbering	32
	Final Audit	10
Non Value Added Activity	Waiting for next operation	2314
	Waiting for next process	

Processing Time (Value Added and Unavoidable non value Activities) = 350 minutes

Retention Time (Non Value Added Activities) = 2314 minutes

Lead time = Processing time + retention time = 350+2314 = 2664 minutes

Percentage of value added time= 10.88%

Percentage of non-value added time= 86.86%

Percentage of unavoidable non value added time= 2.59%

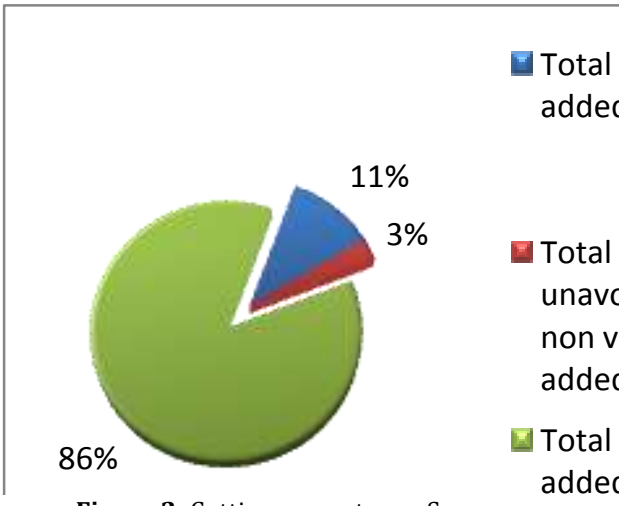

Figure 2: Cutting current map Summary

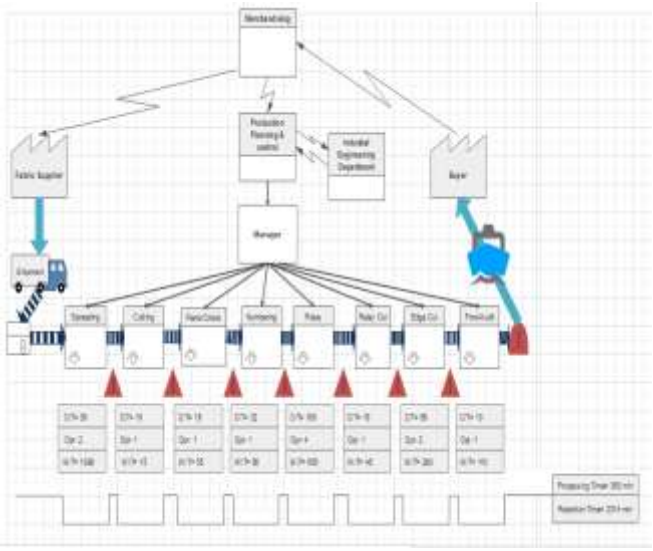

Figure 3: Current design of value stream map

4.4 Process Re-Engineering and Improvement

Since, we need to minimize the non value added activities and simultaneously maximize or sustain the value added activities; we need to implement the pinning table which will be used for matching checks fabrics in garment manufacturing.

This pinning table offers a unique solution mainly designed in order to support and to allow the spreading and matching of checks fabrics in multiple plies. Why aligning of stripes and plaids are required is the question? This is because when the fabric is spread one over the other multiple layers of fabric form ply of fabric so that when cutting bulk layer location of stripe and plaids is at same place of all pattern components in the cut stack. This is needed for different matching and balancing parameters requirement of the shirt (e.g. matching pocket with front stripe, matching of front to front, sleeve placket horizontal and vertical matching) during sewing process.

In garmenting the utilization of pins or pining tables for aligning stripes and checks while spreading of fabric is not common. This table will help in process re engineering of cutting section and will replace the traditional follow up of activities which will change the value added activities and non value added activities.

The process that will be re-engineered will in two forms i.e.-

- The spreading process and relay process will be made one into spreading and pinning on pinning table itself.
- The block cutting, relay cutting and edge cutting will be made into one ready cutting

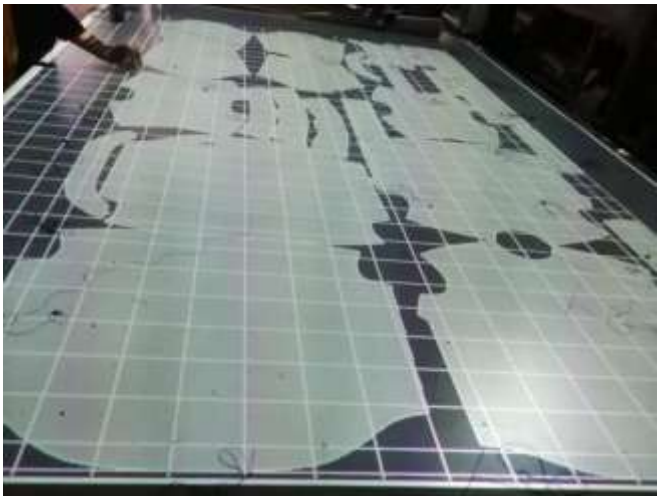

Figure 4: Pattern displayed on table from projector on pinning table

Pins have to be inserted in pinning table according to the required matching and balancing parameters of the checks shirt as mentioned below-

Figure 5: Marker

The proposed flow of activities after the implementation of pinning table is-

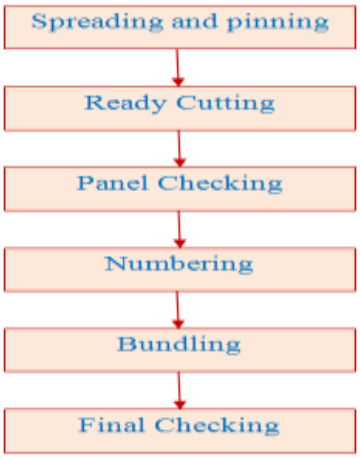

Figure6: Proposed flow

4.5 Future State Map

The lean matrics findings from future state of cutting section after process re-engineering and implementation of pinning table are:

Table 2: Future Lean matrics findings

Activity Category	Cutting process details	Time Taken (Minutes)
Value Added	Spreading	180
	Cutting	60
Unavoidable value added activity	Panel Checking	14
	Numbering	30
	Final Audit	10
Non Value Added Activity	Waiting for next operation	1362
	Waiting for next process	

Processing Time (Value Added and Unavoidable non value Activities) = 294 minutes

Retention Time (Non Value Added Activities) = 1362 minutes

Lead time = Processing time + retention time = 294+1362 = 1656 minutes

Percentage of value added time= 14.49%

Percentage of non-value added time= 82.20%

Percentage of unavoidable non value added time= 3.26%

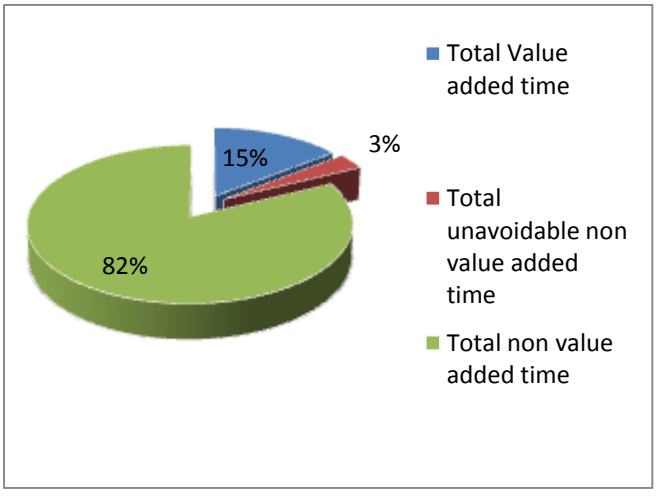

Figure 7: Cutting future map Summary

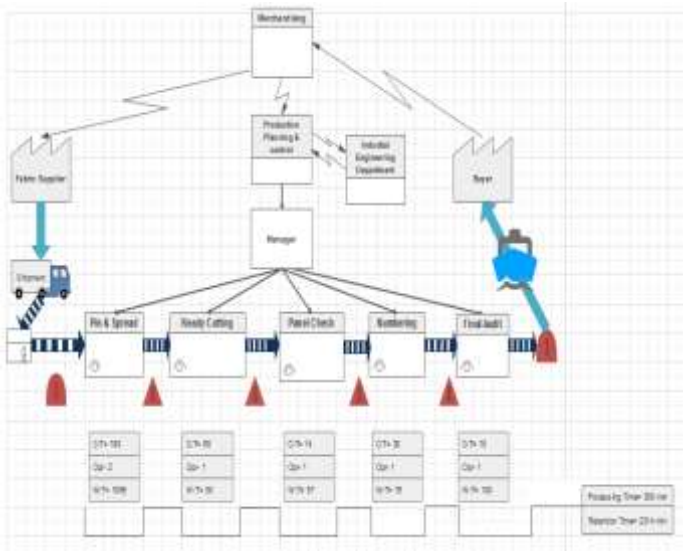

Figure 8: Future design of value stream map

5 RESULTS AND DISCUSSIONS

This paper work has been carried out to implement Value Stream Mapping (VSM) tool, which is converting into a basic tool for acknowledging lean assembling in real production settings and also implement pinning table in the cutting section. Basic ideas have been discussed about, as have standard symbol and terminology, process, and educational modules mixture methods. The outcomes are appeared as current and future state Mapping and change is appeared in the decrease in lead time, cycle time and manpower consumption. Analysis of comparison between current & future value adding, non-value adding and unavoidable non value percentage can be done by below figure.

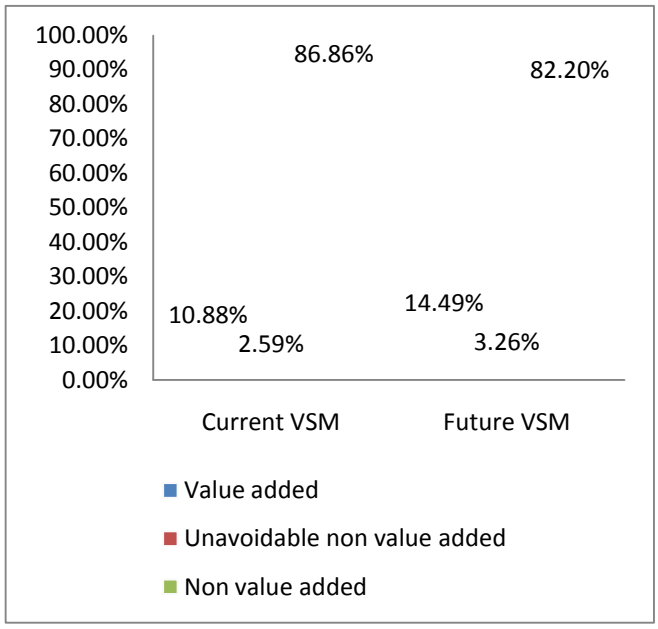

Figure 9- Comparison between current & future value stream map

Also when future state is compared with the current state of cutting section it was found that there is reduction of manpower from 13 to 6 after the process re-engineering and implementation of lean manufacturing which will lead to cost saving in the organization.

6. CONCLUSIONS

- The lead time is reduced from 2664 minutes or 1.85 days before value stream mapping to 1656 minutes or 1.15 days after implementation of pining table which accounts for an overall improvement of 60.8%.
- The cycle time decreased from 290 minutes to 240 minutes after the process improvement was done which resulted in an overall development of 20.8%.
- There is reduction of time of non value added activities from 2314 minutes to 1362 minutes which is an improvement of 69.89%.
- There is change of number of operators used before and after the re-engineering of processes is from 13 to 6 respectively in re-engineered processes, which is a saving of 116.67%

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