Abstract

Lean manufacturing is one of the most effective techniques, which is a systematic approach to identifying and eliminating waste through continuous improvement by flowing the product. Most of the Indian textile Industry follows mass production system are so called Progressive Bundling System (PBS). This typical system creates high amount of non-value added activity, longer production lead time due to higher Work in progress (WIP). Which in turn affects smooth production flow. A value stream is comprised of all the actions, both value added and non-value added. The main strategy of lean manufacturing is increasing the operating speed, reducing the duration of flow quality, and improving the cost and delivery performance. This study was carried out at a men’s shirt producer i.e. a ready wear company. First of all, the current state of the production lines was analyzed within the scope of the study. Then shirt production lines were organized with the lean manufacturing techniques. As a result, some improvements were made in productivity, quality and lead time.

I. INTRODUCTION

Taiichi Ohno of the Toyota Motor Company developed the lean strategy in the 1950s [1]. Lean manufacturing is a conceptual framework popularized in many Western industrial companies since the early 1990s. Initially the publication of the book ‘The Machine that Changed the World’ [2] started the diffusion of some lean manufacturing practices developed by the most competitive auto manufacturers in the world. Thereinafter lean manufacturing was studied in other industries [3, 4]. The main purpose of a lean strategy is to eliminate wastes (muda) or non-value added activities from a process [5]. Lean means “manufacturing without waste.” Waste is anything other than the minimum amount of equipment, materials, parts, and working time that are essential to production. Waste (“muda” in Japanese) has seven types: waste from overproduction, waste of waiting time,
transportation waste, inventory waste, processing waste, waste of motion, and waste from product defects [6].

Many sample studies were performed in different industries regarding lean manufacturing practice. For example, Gurumuthy [7] performed lean manufacturing practice by simulation and value stream mapping in an enterprise producing cars and windows. Moreover Gurumurty and Kodali determined in their study that lean manufacturing practices are performed mostly in production sectors [7]. Studies on lean manufacturing are mostly based on experimental studies about the efficiency of enterprises. The primary goal of introducing any lean manufacturing program in a shop, factory or company is to increase productivity, reduce lead times and costs, improve quality, etc. [4].

A study by Zayko et al. [8] points out that lean manufacturing can result in a 50 percent reduction in human effort, manufacturing space, tool investment and product development time, and a 200-500 percent improvement in quality [9].

II. LITERATURE REVIEW

- Lean Production (LP) has its origins in the Toyota Company at the end of World War II with the implementation of the Toyota Production System (TPS) (Monden, 1983). The designation Lean Production appears lately in the famous book “The Machine That Changed the World” (Womack et al., 1990).

- According National Institute of Standards and Technology (2010) Lean Production was defined as “... a series of tools and techniques for managing your organization’s processes. Specifically, Lean focuses on eliminating all non-value-added activities and waste from processes. Although Lean tools differ from application to application, the goal is always incremental and breakthrough improvement. Lean projects might focus on eliminating or reducing anything a final customer would not want to pay for: scrap, rework, inspection, inventory, queuing or wait time, transportation of materials or products, redundant motion and other non-value-added process steps.”

- Lean Production key idea is “Doing more with less” where less means less space, less inventory, less human effort, less transports, less movements, etc. LP is concerned with people and environment hence it promote the regularity to avoid the overburden, the stressful conditions, the consuming processes that are waste symptoms. For this, a careful attention is costs by eliminating wastes. This implementation is happen in companies of all kind of goods and services (Melton, 2005; Alvet al., 2011; 2014)

- Lean implementation is not an easy or simple task because it involves changing the mindset, the culture of a company. It demands a new paradigm and a congruency between the thinking and the doing that in most organizations is failing (Flumerfelt et al., 2014).

- To achieve this, it is important to follow a methodology to guide this implementation. Each industry or organization has its own work pattern and requisites and, sometimes, a dedicated or focused methodology is better than a general one. This is the reason why it is possible to find in the literature many methodologies (Maia et al., 2011).
The Textile and Clothing industry is a peculiar industry with many contextual differences that is always knowing a lot of changes caused by the context and market and some methodologies had been proposed for Lean implementation (Hodge et al., 2011; Maia et al., 2012a; 2013b). Before implementing Lean in this industry, it is important to infer about work conditions and environment (Maia et al., 2012b; 2014a; Eira et al., 2015a) because traditionally is an industry with low wages, family based structure, poor ergonomic conditions with many employees unsatisfied. Additionally, the need to change must be felt to overcome the resistance to introduce a different paradigm (Maia et al., 2014b; Eira et al., 2015b).

According to Alukal and Manons (2002), a planned implementation of lean production system leads to improved quality, better cash flow, increased sales, better productivity, improved morale and higher profits. They further reported that companies earned greater benefits by implementing lean techniques in the office functions in non-manufacturing organizations too, such as banks, hospitals, restaurants etc. A study on a Novartis International AG – A Switzerland-based company (Society of Manufacturing Engineers, 2002) reviewed their production process and realized the need for some improvement. They introduced lean picking system for the movement of the goods from the warehouse to the packing lines. This redesigned material supply is a kind of Kanban system. Through this picking system the company reduced its waste to a good extent. By using this system they were benefited in terms of waste elimination from the redesigned material supply process. The study was anticipated that this lean picking system would facilitate faster picking lines as well as would shorter the run times.

The pressure placed on firms in the garment industry from international competition and dynamic changes in the retail sector have been enormous. “The increase in competition has led to an increased focus on customer satisfaction as a survival of the company in the long run” (Kapuge and Smith, 2007, p.304). In today’s competitive business world, firms are fighting against each other just to ensure their survival. In this highly competitive business market, the garment industry is also searching for ways and techniques to cut cost and improve performance. When other industries are facing high pressure from competitors, the garment industry is also facing challenges such as price, delivery time and service offered etc. This industry has opportunities to improve, but requires some changes. Under the highly competitive environment, the garment industry has numerous opportunities for improvement using lean principles (Mercado, 2007).

### III. METHODOLOGY

A very brief description of the most common lean tools is given below [10 - 14];

3.1 **Cellular manufacturing**: organizes the entire process for a particular product or similar products into a group, including all the necessary machines, equipment and operators. Resources within cells are arranged to easily facilitate all operations.
3.2 **Just-in-time (JIT):** a system where a customer initiates demand, which is then transmitted backward from the final assembly all the way to the raw material, thus "pulling" all requirements just when they are required.

3.3 **Kanbans:** a signaling system for implementing JIT production.

3.4 **Total preventive maintenance:** workers carry out regular equipment maintenance to detect any anomalies. The focus is changed from fixing breakdowns to preventing them. Operators are included in maintenance and monitoring activities in order to prevent and provide warning of malfunctions.

3.5 **Setup time reduction:** continuously try to reduce the setup time on a machine.

Total quality management: a system of continuous improvement employing participative management that is centered on the needs of customers. Key components are employee involvement and training, problemsolving teams, statistical methods, long-term goals, and recognition that in efficiencies are produced by the system, not people.

3.6 **One piece flow:** to minimize work-in-process, operators should focus on completing one part through the process before starting on the next.

3.7 **Value stream mapping (VSM)**

A value stream is all the actions (both value added and non-value added) currently required to bring a product through the main flows, starting from raw material and ending with the customer. VSM is a pencil and paper tool that helps you to see and understand the flow of material and information as a product makes its way through the value stream. These actions consider the flow of both information and materials within the overall supply chain. The ultimate goal of VSM is to identify all types of waste in the value stream and to try and eliminate these.

Senthil Kumar and Sampath (2012) focused investigation of VSM in existing product line and to alter the same with new cellular based layout which reduces the product lead time significantly. Value stream mapping is a pencil and paper tool, which is created using a predefined set of icons (shown in Figure 3.7.1 below). There are a lot of benefits to drawing value stream maps by hand with paper and pencil. Manual mapping lets us see what is actually happening in a shop floor value stream, rather than being restrained.
to a computer. Also, the process of quickly drawing and redrawing a map acts as a plan-
docheck-act cycle that deepens our understanding of the overall flow of value or lack thereof. The first step is to choose a particular product or product family as the target for improvement. The next step is to draw a current state map that is essentially a snapshot capturing how things are currently being done. This is accomplished while walking along the actual process, and provides one with a basis for analyzing the system and identifying its weaknesses. The third step in VSM is to create a future state map, which is a picture of how the system should look after the inefficiencies in it have been removed. Creating a future state map is done by answering a set of questions on issues related to efficiency, and on technical implementation related to the use of lean tools. This map then becomes the basis for making the necessary changes to the system [12].

IV. PROBLEM STATEMENTS
Increasing the number of models and decreasing the number of orders in parallel with the changing sense of fashion pose the biggest problem for the firm. The current production structure of the firm is set up according to mass production in parallel with these problems, and it works with high internal stock. And this brings along with it both quality and efficiency problems. In addition, setting the ironing and packaging departments in one line and high stock between the sewing lines result in extending the lead time and also realizing quality problems late.

V. OBJECTIVE
To examine the present level of applying lean manufacturing in textile manufacturing organization. Besides, to identify and propose potential avenues for improving present level of lean manufacturing. Also to eliminating waste in the processes and helping the companies to achieve a shorter lead time, lower cost, highest quality and to achieve a competitive advantage.

VI. METHOD AND MATERIAL
Lean manufacturing techniques and especially that of value flow analysis are used to acquire data in this study. Moreover REFA work and time study techniques were used in determining process times of shirt models. The material of this study consists of data obtained from the enterprise producing shirts for customers.

VII. ANALYSIS STUDIES
First of all, the current state of production lines is analyzed in this study. The main topics and practice studies of the study performed are as follows:
Step 1: Revealing current value flow chart and analysis short cycle time
Step 2: Future state value flow chart

VIII. VALUE STREAM MAPPING
Firstly value stream mapping is formed in order to reveal the current situation. As is seen in Figure 2, VA (Value Added) the time is 1333 seconds and the production lead time 11.85
days. It is determined that a very long lead time is mostly caused by buffer stock and non-value added operations.

The takt time is calculated by proportioning with the daily demand. The daily demand is 300 pieces/day, and the firm works 10 hours a day. Therefore the available working time is found to be $10 \times 60 \times 60 = 36000$ seconds. As a result the takt time is found 120 seconds.

$$Takt\ Time = \frac{available\ working\ time}{daily\ demand} = \frac{36000}{300}$$

$$Takt\ Time = 120\ seconds/pcs$$

**IX. FUTURE STATE VALUE STREAM MAPPING (VSM) FOR THE PRODUCT LINE**

Describing and defining the future state map actually starts while developing the current state map, where target areas for improvement start to show up. Looking at the current state map several things standout:

(a) the huge difference between the production lead-time and the value added time
(b) the process that happens on its own schedule
(c) very low process ratio.

The goal of lean manufacturing is to aid in improving the satisfaction of customer requirements through the whole value stream. In our current state map to view inventory and lead-time as two equivalent thing sand try to identify lean manufacturing tools to drive them down and create the ideal state map. The basic philosophy is that more the inventory longer the lead time, therefore the reduction of lead-time and inventory will expose and force other kinds of wastes to surface, creating the opportunity for their removal.
Main objective of this work was to study and implement Lean Manufacturing tools and techniques. To perform it, Textiles Factory was chosen for focusing all activities of the garments production line. When the study started the floor was in haphazard situations. No systematic ways were present. Operations were done here and there and there was a very little degree of integration. Lots of In-process inventories were present. From this study several areas were found where significant improvements can be made. But it was really hard to apply the lean manufacturing tools and techniques, it was time consuming as well. Some tools and techniques applied in the production line are Value Stream Mapping (VSM) some comparison was shown between the current situations and the proposed situations which are shown in the table (11.1).

<table>
<thead>
<tr>
<th>Value Added Time (sec)</th>
<th>Non Value Added Time (sec)</th>
<th>Total Time (sec)</th>
<th>Value Added Time (sec)</th>
<th>Non Value Added Time (sec)</th>
<th>Total Time (sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1333</td>
<td>42660</td>
<td>43993</td>
<td>1303</td>
<td>25560</td>
<td>26863</td>
</tr>
</tbody>
</table>

**Table 10.1: Comparison of Total Operation Times between Existing & Proposed Layout**
Table 10.2: Comparison of Operation Times between Existing & Proposed VSM

<table>
<thead>
<tr>
<th>Existing Layout</th>
<th>Proposed Layout</th>
<th>Improvement (% value added)</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Non-value added time</td>
<td>% Value added Time</td>
<td>% Non-value added time</td>
</tr>
<tr>
<td>96.96%</td>
<td>3.03%</td>
<td>95.14%</td>
</tr>
</tbody>
</table>

From the value stream mapping of current situation the value added time and non-value added time was calculated. Where the value added time for existing layout was found 3.03%. As focus was to reduce nonvalue added time as much as possible and to do so the tools and techniques of lean manufacturing was used. All the processes required were made grouped and made cells to reduce the In-process inventory, smooth production flow and pull system so that the much of the idle time can be saved. By doing so it eventually reduced the non-value added time significantly. For instance, existing value-added time is 3.03% and improved value added time is 1.809%. Therefore Value added time is increased about 4.839% (Table 11.2).

Table 10.3: Comparison of productivity

<table>
<thead>
<tr>
<th>Existing productivity (Units per day 10 hour)</th>
<th>Proposed productivity (Units per day 10 hour)</th>
<th>Improvement</th>
<th>% of Improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>300</td>
<td>400</td>
<td>100</td>
<td>25%</td>
</tr>
</tbody>
</table>

Here also the target was to eliminate this inventory which of course is a waste, and to make the flow continuous and streamlined throughout everywhere. If a comparison is made, it can shows that the existing output is 300pcs daily and the output from our proposed layout is 400pcs. So there is an increment of 100pcs daily which is about 25% (Table 11.3).

Another important improvement is associating workers. By incorporating multi skilled workers and with the help of cellular layout designing number of worker needed was reduced. The benefit of multi skilled workers is that they are able to perform two or more different types of work that can results minimum material handling with a minimum or no In-process inventory. Here it was found that existing workers is 17 where in the proposal it is 13. Therefore it saves an extra 4 persons here (Table 11.4).

Table 10.4: Comparison of Required Worker

<table>
<thead>
<tr>
<th>Existing No. of Worker</th>
<th>Worker in Proposed Layout</th>
<th>Improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
<td>13</td>
<td>4</td>
</tr>
</tbody>
</table>
XI. CONCLUSIONS

Techniques where found some problems. Eventually some layouts and process flows are proposed. Those processes were studied as well as analyzed using some lean manufacturing tools and in this case work which certainly maximizes the productivity and minimizes cost. It was also ensured that the better utilization of manpower and factory floor space is still possible. At the same time these proposals will help to develop a good relationship among the workers and will provide an easier way for the management to coordinate and integrate the factory production with the current level of resources. It is hoped and believed that, if the management accepts these proposals and implement these techniques, it will certainly help them to increase the productivity with this existing level of resources.

XII. REFERENCES


TO CITE THIS PAPER