

Lean Tool Implementation in the Garment Industry

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Abstract

Garment Manufacturing is one of the oldest in the world, comprising a high number of critical operations. The main issues in the garment industry are the lead time, production rate, very poor line balancing and fabric wastes. Productivity improvement is carried out by implementing the various lean tools in the industry, such as 5S, Value Stream Mapping (VSM) and line balancing in the sewing section. After the implementation of lean tools in the garment industry, the outcomes observed are a reduction in work-in-progress inventory, increases in the production process and increased line efficiency. Similarly the before and after implementation of 5S, which shows space utilisation in the sewing section, is increased. In this research, an implementation study was conducted in only one organisation. Hence the results extracted by the conduct of this implementation study are achievable and adaptable in similar organisations.

Key words: lean tools, value stream mapping, 5S, line balancing.

Introduction

Global competition in the garment sectors makes garment manufacturing a most sensitive issue [1]. The trend which makes the garment industries look for change in the manufacturing paradigm is the fluctuating demand in market conditions. Thus lean manufacturing emerged as a paradigm to make the industry more competitive by eliminating wastes [2]. In lean manufacturing, which encompasses various tools and techniques to enhance performances, some of the tools are 5S, Value stream mapping (VSM) and line balancing [3]. The production process in the garment industry involves four main processes, namely designing/pattern generation, cutting, sewing and packing. The most important and critical factor in the garment industry is the sewing section, which involves a greater number of operations [4]. This case study highlights the various wastes in the garment industry, such as inventory, lead time and quality defects, which are reduced to improve productivity. Thus lean tools such as VSM, 5S and line balancing help in visualising the wastes occurring in an organisation and possibilities for eliminating/reducing them. The application of VSM initially attempts to reduce waste and non-value activities, and find possible improvements in the lead time, production time and inventory level [5]. Based on the existing study in the organisation, a current state map is generated. Upon analysis of the current state map with TAKT time calculation, a future state map is proposed with the possible improvements, and an attempt is made on the production line to balance the work at each station. The understanding of this

implementation is essential to adapt it in similar garment industries to identify improvements in small and middle scale industries.

The garment sector production process is always a short life cycle with a number of sub-processes [6]. The fast change in the fashion and customer-focused market creates the values in apparel manufacturing [7]. The garment industry is exposed to an inconsistent supply of raw materials in the production process. Resource allocation is a major process in any organisation, which requires continuous analysis of internal and external factors due to the inherent complexity [8]. Lean manufacturing focuses on waste reduction and productivity improvement through various lean tools, value stream mapping, line balancing and work standardisation [9]. The combination of various lean tools, such as 5S, line balancing, standardised work and value stream mapping, results in productivity improvement in both labour intensity and equipment flexibility [10]. Successful implementation of the lean manufacturing tool in small and medium scale industries leads to increases in the workforce, machines and methods of the manufacturing process [11]. Value stream mapping is a key performance indicator that measures the performance of a manufacturing process [12]. Lean manufacturing, which reduces the flow quality duration, increases the operating speed and improves delivery performances [13]. Line balancing is a tool which enhances productivity and improves the efficiency of the production process, while Poka-Yoke is one of the lean manufacturing tools which can eliminate waste by pool proofing [14].

An ideal workstation can be effectively utilised by using line balancing without an uninterrupted flow in the process [15]. An empirical study in the garment industry gave a more in-depth validation of the ideas proposed [16]. Lean manufacturing tools can enhance productivity by a reduction in the lead time of the process through eliminating non-value added activities [17]. Productivity is an important parameter for any manufacturing industry, comprising value added activities and non-value added activities [18]. 5S is a basic lean manufacturing tool which provides a pathway for other lean tools to implement in any organisation [19].

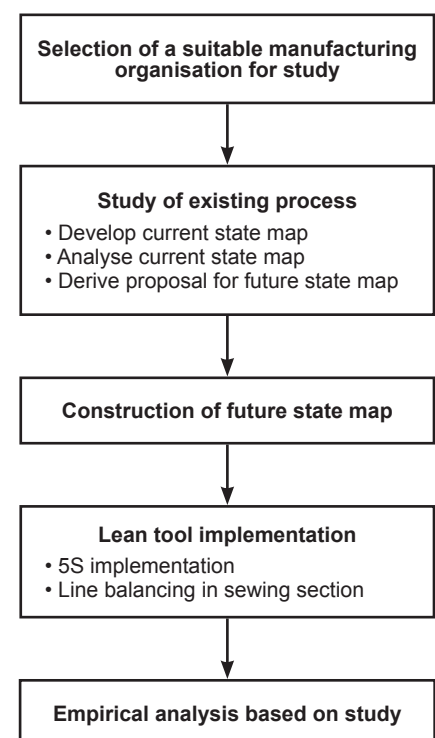


Figure 1. Research methodology.

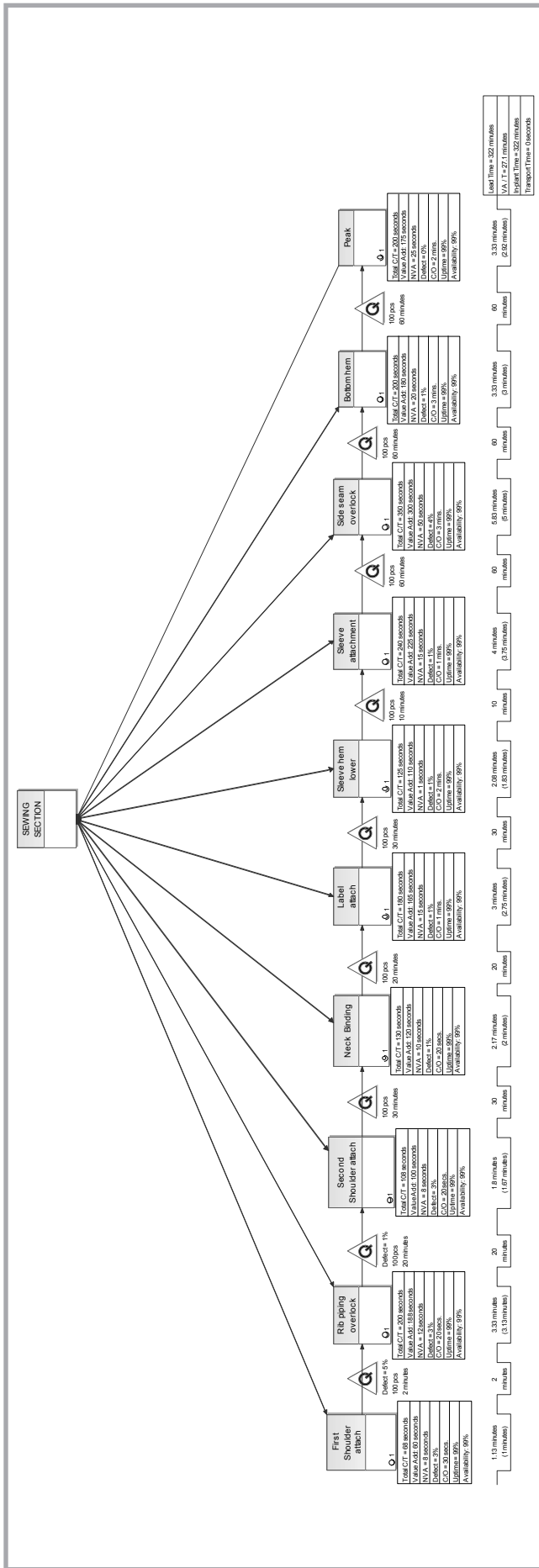


Figure 2. Current state map.

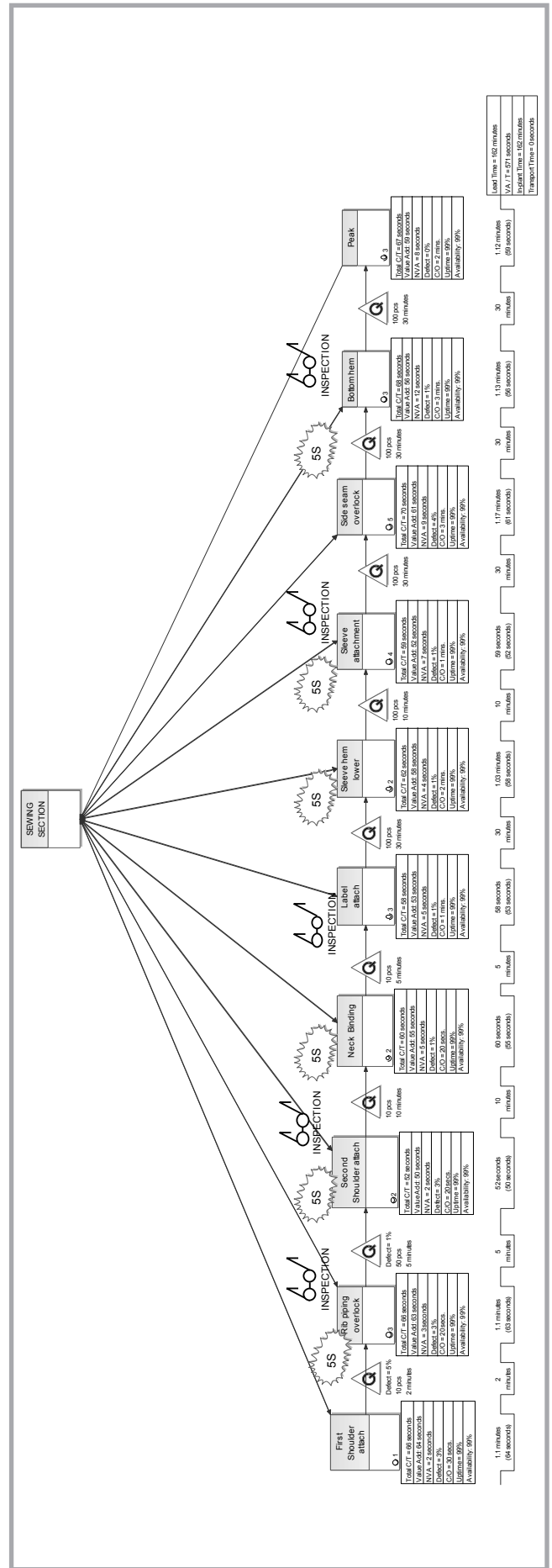


Figure 3. Future state map.

Research methodology

The methodology followed during this research project is shown in *Figure 1*. Summarising a review of suitable organisations for implementing the various lean tools was undertaken to carry out the study. After identifying the organisation, the existing products and processes preformed in the organisation for manufacturing the products were classified. A current state map was developed for formulated and further improvements in lean tool implementation, discussed with the executives of the organisation to develop a future state map. After the development of the future state map, lean tools such as 5S and line balancing were implemented in the organisation. Finally empirical analysis was carried out with the executives of the company on lean tool implementation.

About the organisation

A study on lean implementation using VSM was carried out at the ABC garment factory located in Tiruppur, India. It is an ISO certified organisation manufacturing products for men, ladies and children. The company manufactures normal styles, trendy styles, night-wears and value-added styles, with accessories made even at their customers' choice. The ABC garment factory was started in the year 1999 with 10 employees. Presently it employs 300 personnel, including management, with an annual turnover of about four crores Indian national rupees (INR). Some of the potential export countries include European ones: Italy, Germany, Switzerland, Hungary and Portugal.

Selection of the product

All the dates concerning the product were studied in terms of production volume, demand, inventory and operations performed. A baby girl's tee was selected as the product for study. Raw materials were supplied by an external vendor and a manufacturing process for pattern making, sewing, thread trimming and pressing, quality checks and packing was made to complete this product cycle.

Current state map

A current state map is developed for the kid's tee as shown in *Figure 2*. Orders are received from the customer regularly on a monthly basis of around 8500 pieces. This information is shared with the supervisor for the allocation of personnel

Table 1. Reduction in each category.

Time for operations	Production cycle time, sec		Non-value added time, sec		Inventory, min	
	Current state	Future state	Current state	Future state	Current state	Future state
One side shoulder attach	68	66	8	2	2	2
Rib piping overlock	200	66	12	3	20	5
Second shoulder attach	108	52	8	2	30	10
Neck binding	130	60	10	5	20	5
Neck binding finish (label)	180	58	15	5	30	30
Sleeve hem lower	125	62	15	4	10	10
Sleeve attachment	240	59	15	7	60	60
Side seem overlock	350	70	50	9	60	60
Bottom hem (full length)	200	68	20	12	60	60
Peak (in sleeve and rib)	200	67	25	8	60	60
Total time	1801	628	178	57	352	302
Percentage reduction, %	34.86		32.07		14.02	

and resources. An average of sixteen processes are carried out in completing the kid's tees. The main processes include marking and cutting, sewing, inspection, finishing and packing. The sewing section is taken for analysis, in which more critical processes are carried out. The change over time between the process is 10 minutes. The organisation works on three shifts every day (each shift of an eight-hour duration with a thirty minute lunch break). The bundle system of manufacturing currently I progress is followed in the garment factory with a batch size of two hundred pieces.

The available production time is calculated as follows:

$$\text{Available time} = \text{Total production time} - \text{Planned down time}$$

$$\text{Available time} = (60 \times 8 \times 3) - (30 \times 3) = 1350 \text{ Minutes}$$

$$\text{Uptime} = \frac{\text{Actual operating time}}{\text{Available time}}$$

$$= \frac{(\text{Available time} - \text{Changeover time}) \times 100\%}{\text{Available time}} = \frac{(1350 - 10) \times 100}{1350} = 99.2\%$$

$$\text{Takt time} = \frac{\text{Available working time per day}}{\text{Custome demand rate per day}}$$

$$= \frac{1350}{340} = 238 \text{ sec}$$

The value added time for the current process is 27 minutes for all the process in the sewing section. The process duration of the product of the daily demand is 322 minutes, and the idle time for the process is 1000 minutes.

Future state map

The future state map preparation is initiated with the aid of the current state map. The gaps and possible improvements are identified from the current state map to propose a future state map. The difference made in the existing production cycle time is 30 minutes, which is reduced to 10 minutes, which is proposed in the future state map, as shown in *Figure 3*. The existing inventory is reduced to 302 minutes in the future state from the current state of 352 minutes. The lead time for completing the process is reduced to 252 minutes from the current state of 322 minutes in the future state proposed. 5S introduced is at every stage of the operations in the organisation. Stage inspection is introduced, which eliminates the final inspection, and consequently the rejection of the product at the final stage is reduced.

Results and discussion

Value stream mapping

Several improvements are identified based on the current state map for the future state map for implementation. Significant changes are developed in the future state, such as a reduction in the production time, non-value added time and inventory time, as shown in *Table 1*. The change-over-time benefits the organisation in shifting to a new product family and helps in the delivery schedule. The value added time gives an excess of 18 hrs to the process.

A comparison of cycle time modifications is shown in *Figure 4*. Based on the possible potentials identified during the analysis of the current state map, few ma-



Figure 4. 5S Implementation.

Table 2. Line balancing outcomes.

Productivity variable	Before line balancing	After line balancing
Labours per production line	8 Labours/line	7 Labours/line
Production target	44 tees/day/labour	41 tees/day/labour
Production capacity	350/day	352/day
Balancing loss	18%	12.48%

major changes are proposed and implemented to observe the changes made during the lean implementation. As a result, the production process at the inventory level is reduced by 14.02%, which is achieved by regularising proper communications among the employees and the pull system and implementing 5S in the cutting and sewing sections. The production process is modified from a progressive bundle system to a unit production system.

5S tool

The 5S tool helps everyone by making the opportunity to learn a culture of developing and maintaining a clean and organised working environment. 5S is implemented in the sewing section and cutting section in the garment factory as a model, since it is one of the most critical work areas. The complications in the cutting and sewing section are space utilisation, semi-finished fabric around the sewing machine, unneeded stock between workers, excess inventory on the floor, improper flow of needed equipment and no floor layout. This is refined by removing excess inventory and introducing a floor layout, as shown in Figure 4.

Sort: All useless items are sorted and eliminated from the sewing section for

smooth flow. In addition to that, the semi-finished fabric is sorted and an order number is given in the cutting section to ensure proper fabric identification in the temporary storage, created based on the processing time and sequences of the operations performed in the factory, which results in more space availability.

Shine: Dust, dirt, waste fabrics and other wastes are removed. Temporary storage tables and floors have been cleaned according to the time schedule. All machines, tools and work areas are cleaned by the employee at the end of the shift time.

Order: All items are placed and arranged in an appropriate place after sorting and cleaning. The items are arranged in such a way that they are based on the degree of usage in the production process. Semi-finished fabric is arranged in an 'L' shaped layout, which enables the smooth flow of materials. To ensure safety in the factory, work surface borders, floor borders for walkways, workways and storage location have been introduced in the section.

Line balancing

Line balancing is the one of the important factors to make production flow smoother as compared to the normal flow. Rank

Positional Weight (RPA) techniques are used for balancing the line in the sewing section. The preference relationship between each task and the specific order in which the tasks are performed is calculated. After the cycle time (C) is calculated, the theoretical minimum number of workstations is determined in order to satisfy the workstation cycle time:

$$\begin{aligned} \text{Cycle time } C &= \frac{\text{Total available period}}{\text{Total output required}} \\ &= \frac{1350}{350} \\ &= 3.85 \text{ min/tees} \end{aligned}$$

$$\begin{aligned} \text{Number of workstations required, } N &= \frac{\text{Sum of task time}}{\text{Cycle time}} \\ &= \frac{26.9}{3.85} \\ &= 6.97 \approx 7 \text{ Stations} \end{aligned}$$

$$\begin{aligned} \text{Theoretical efficiency of the line } T_E &= \frac{\text{Sum of task time}}{(\text{Number of stations} \times \text{cycle time})} \\ &= \frac{26.9}{(7 \times 3.85)} \\ &= 99.81\% \end{aligned}$$

$$\begin{aligned} \text{Actual efficiency of the line } T_A &= \frac{\text{Sum of task time}}{(\text{Number of stations} \times \text{cycle time})} \\ &= \frac{26.9}{(8 \times 3.85)} \\ &= 87.33\% \end{aligned}$$

$$\begin{aligned} \text{Balancing loss } B_L &= 99.81 - 87.33 \\ &= 12.48\% \end{aligned}$$

$$\begin{aligned} \text{Production target } P_T \text{ at } 65\% \text{ efficiency} &= \frac{(7 \text{ labours} \times 1350 \text{ min/day})}{26.9} \\ &= 352 \text{ tees/day.} \end{aligned}$$

$$\text{Total labour productivity in sewing section} = \frac{352}{21} = 17 \text{ tees/labour/day}$$

Balancing in the line is made by changing the traditional layout to a balanced

layout model, which demonstrates the amount of improvement considered in the process, as shown in **Table 2**.

Conclusions

The lean tool is a potential means of eliminating wastes in an organisation, and recommended for identifying possible improvements in an organisation. During the implementation of lean tools in the garment industry, many potentials have been identified with the analysis of the current state map. These possible improvements are mapped with the future state map proposed. 5S and line balancing in a garment factory are implemented in the sewing and cutting section as a pilot run, which shows a considerable improvement in the factory. Based on the outcomes achieved in this implementation, the following results are obtained:

- A significant achievement is a 34% reduction in the production cycle time, a 14% reduction in the inventory time, and a 32% decrease in the non-value time.
- 5S implementation in cutting and sewing enables better utilisation of resources in an effective manner.
- The efficiency of the line is increased by 12.5%, so that human resources can be well utilised.
- The production system has been modified from a progressive bundle system to a unit production system.

Lean tools have been employed to identify waste, but it is well-known that tool implementation is limited to a single product family. Further research can be extended to implementing lean tools to the rest of the product families in an organisation. Other lean tools can be im-

plemented which will provide even better improvements for an organisation.



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