Implementation of Lean Logistics in Apparel Manufacturing

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Abstract: Is Lean methodology able to reduce waste in textile industry? In fact apparel manufacturing is one of textile industries that has the most waste at all processes. This is due to have highest manpower at this industry rather than spinning, weaving, knitting...etc. Producing waste has negative effects on the output products as it affects the outcome quality, cost, and then profit of products. Therefore, the company role in the competitive market is badly affected. Thus, waste removal is an essential step in this industry. Lean thinking identifies waste types into eight classes as an acronym "TIMWOODS" which means; transportation, inventory, motion, waiting, over processing, over production, defect and Labor skills. So, this research work interested in reducing each type of these wastes to reduce the overall waste produced. This study applied lean principles at sewing and packing sections on T-shirt line production. Improvement evaluation was calculated by comparing the waste percentage before and after applying lean tools. In conclusion, overproduction waste was highly reduced and inventory waste was the least one reduced. Accordingly, the output quality level improved and then the expected profit increased.
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Key words: Lean tools- TIMWOODS- apparel production

1. Introduction

Apparel industry faces many challenges, for instance, producing cheap and high quality clothes fast. Most of the garment manufacturers have implemented different approaches to face this challenge to keep their role in the competitive market. Lean Manufacturing is one of these approaches which is originated in Japan. The objective of Lean is to eliminate waste followed by progress in productivity and quality of products reducing the total costs. Lean philosophy is defined as "A systematic approach to identify and eliminate waste through continuous improvement by achieving customer satisfaction" [1]. One of the major problems facing garment industry is depending on intensive manpower which leads to more waste. Therefore, there is a necessity to apply lean logistics in this industry. Silva *et al.* [2] implement suitable lean tools in Sri Lanka concluding that the most challenge for lean implantation was changing resistance of staff member as supervisors and middle management. On contrary, they gained many benefits as; reducing defects, better quality level, higher employee satisfaction, lower inventory space and lead time. Few researches applied lean at Egyptian mills. El-Geiheini *et al.* [3] studied the application of lean manufacturing to have optimum layout of machinery in garment mills. As a result the area of the studied line reduced by almost (30% - 40%) which minimized both of the consumed lighting power and overhead cost also decreased by eliminate non-value added activities to the product price.

2. Methodology

This study interested to reduce the non-value added (TIMWOODS) at V-Neck T-shirt production line in an Egyptian ready-made garment mill. The target of removal of these wastes is done by a continuous improvement to reduce each one till reach minimum possible level. This improvement is achieved using Lean tools as JIT[4], TAKT time [5,6], Pokayoke[6], VSM" Value Stream Mapping"[4,7], 5S[4,8], Kanban Concept "pull system"[8], spaghetti diagrams[9], and showing the analysis of NVA "Non-value added" activates "Muda"[8,9] which increase both time and cost causing money and people lose.

3. Results and Discussion

This section represents the outcome results of eight wastes studied before and after applying suggested lean tools.

(1) *Transportation*

Transportation refers to flow of the product along sewing and packing operations in this study. It is represented by unnecessary movements of the material between processes which analyzed by Spaghetti diagrams. The displacement of this flow is 76 meters and 26 meters through sewing and packing sections in successive, but after changing the layout using Spaghetti diagrams it decreased to be 50 meters and 11 meters through sewing and packing sections by replacing the inventory areas as shown in Figures (1&2). Material flow between both sections depends on handling by manual carriage which moves for 15 min double stroke (going and returning) for a distance 3 meters between sections. Because of moving the iron table, this distance is reduced to 1.6 meters which

reduced transportation time from 15 min and 8 min (go and back) before and after Lean between two sections. So, total transportation time between two sections per shift is 120 min /shift and 64 min/shift. Thus the product flow time is reduced by 46.6% between two sections as shown in figure (3).

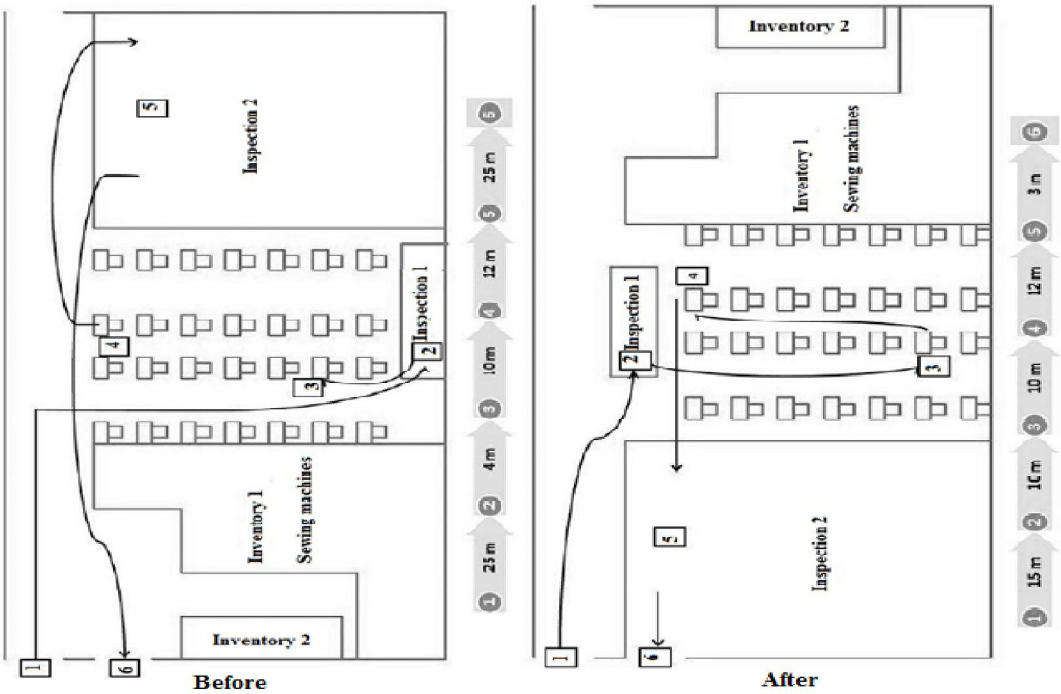
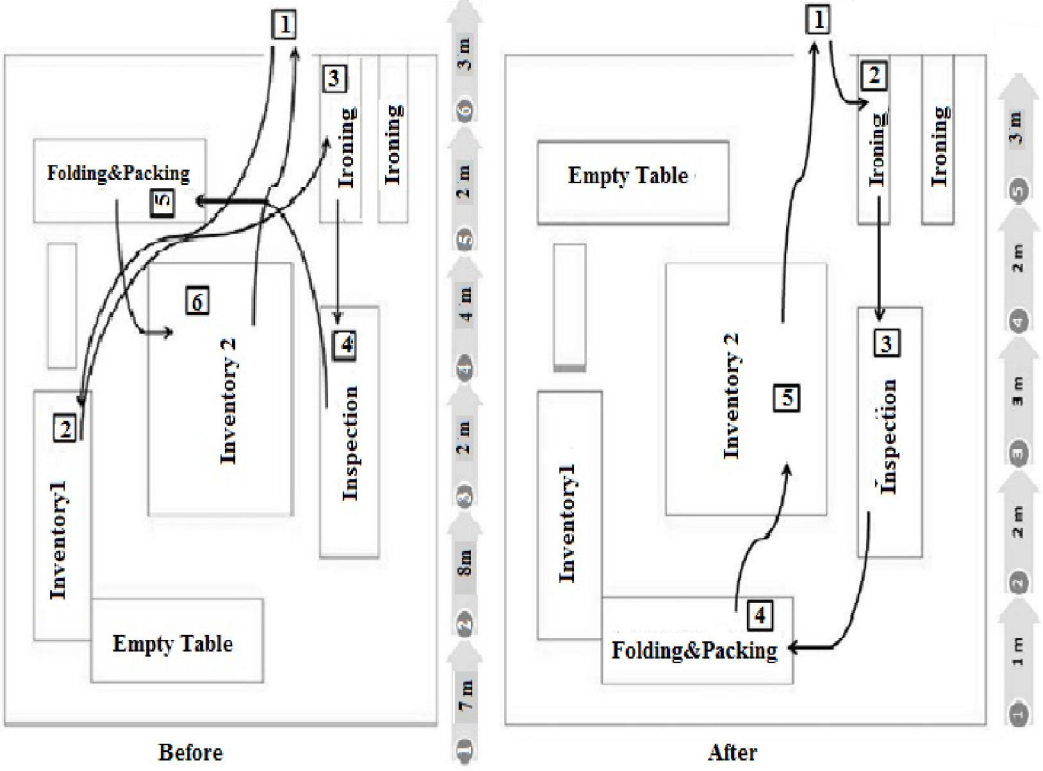


Figure (1): Spaghetti diagram for sewing section before and after applying lean principles



Figure(2): Spaghetti diagram for packing section before and after applying lean principles.

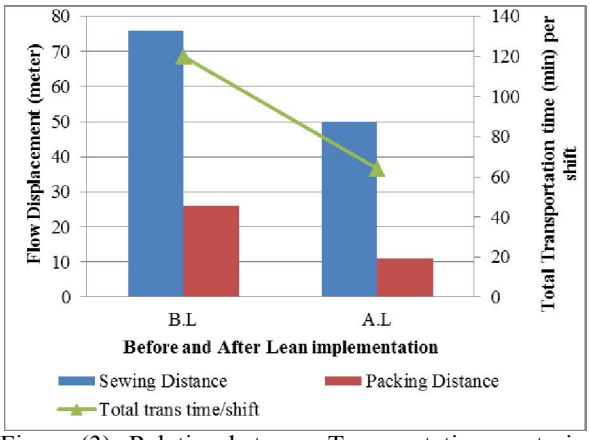


Figure (3): Relation between Transportation waste in distance and time before and after Lean

(2) *Inventory*

In spite of importance of having inventory to hold a stock of inputs and outputs, companies should realize the total cost of holding inventories. This cost is associated by elements of inventory carrying cost as capital cost, inventory service cost, inventory risk cost, and storage space cost. This study interested in studying benefits of getting rid of inventory space as possible. Lean principles as *JIT" Just In Time", Kanban* are applied to manage inventories levels at sewing and packing sections. The measured areas of sewing and packing sections are 450 $m^2$and 64 m^2 in series and the inventory areas are 100 m^2 and 11 m^2 in sequence. Figure (4) shows the relation between inventories waste ratios and whole space at sewing and packing. In details, sewing section uses lager inventory space to keep the product till carrying out the whole order, which decreased by manufacturing small patch.

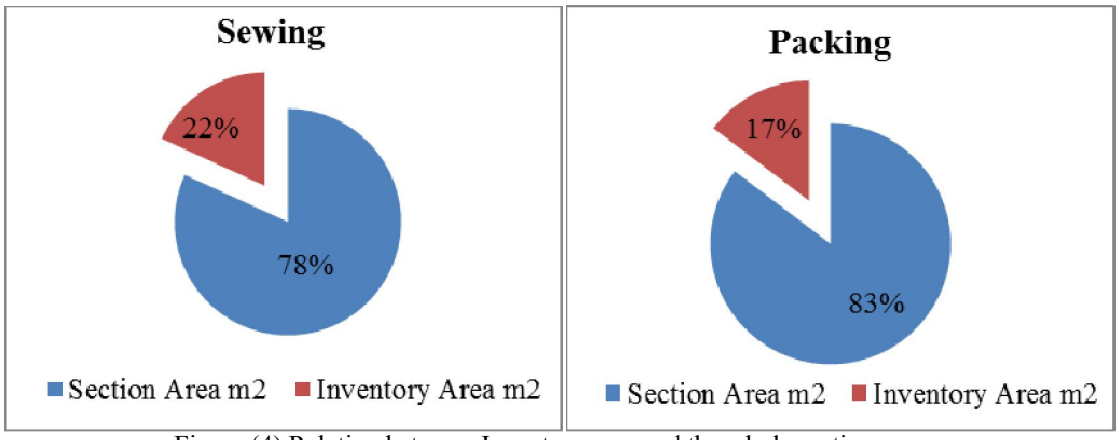


Figure (4) Relation between Inventory area and the whole section space

(3) *Motion*

Motion refers to unnecessary labor movement in the workspace to accomplish his job. Unorganized workspace leads to excessive motion waste. "5S" is an efficient Lean tool used to eliminate this waste by organized the workspace making it planned, shy, clean and safe. Processing time is measured for all sewing and packing process for five times. Motion waste is calculated as the difference between processing time and standard time for sewing and packing before and after applying 5S principles and labor training. Figure (5) compares between the average time of actual and standard total time in both cases. Hence, work became comfortable and easier as well as growing processes efficiency. Consequently, motion time reduced from 30% to 14% at sewing section and from 40% to 20% at packing section.

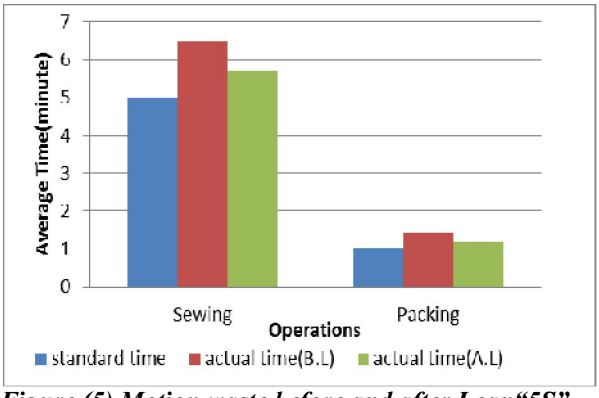


Figure (5) Motion waste before and after Lean"5S"

(4) *Waiting*

A qualified process time management is capable of reducing Waiting time waste that comes from uncontrolled preceding process. VSM" Value Stream

Mapping" shown in figure (6) is a lean-management technique used to analyze sequence of all operations from product beginning at fabric delivery then spreading process involved in cutting section passing by sewing section involved all sewing processes followed by finishing and packing section and finally product arrival to the customer. The output results of time analysis by this map refer to packing section had to wait about (3 hours) as a delay without working until the sewing section completes its processes. A clear illustration of lead time, cycle time and delay or waiting time as well as Takt time which is a balancing of any process is introduced by this map. Because of being a deeper visual analysis for any process cycle times, VSM helps reducing both of overproduction and inventory wastes by minimizing material flow and labor motion between and within work places by removing of all NVA" Non-value added" activities as inspection.

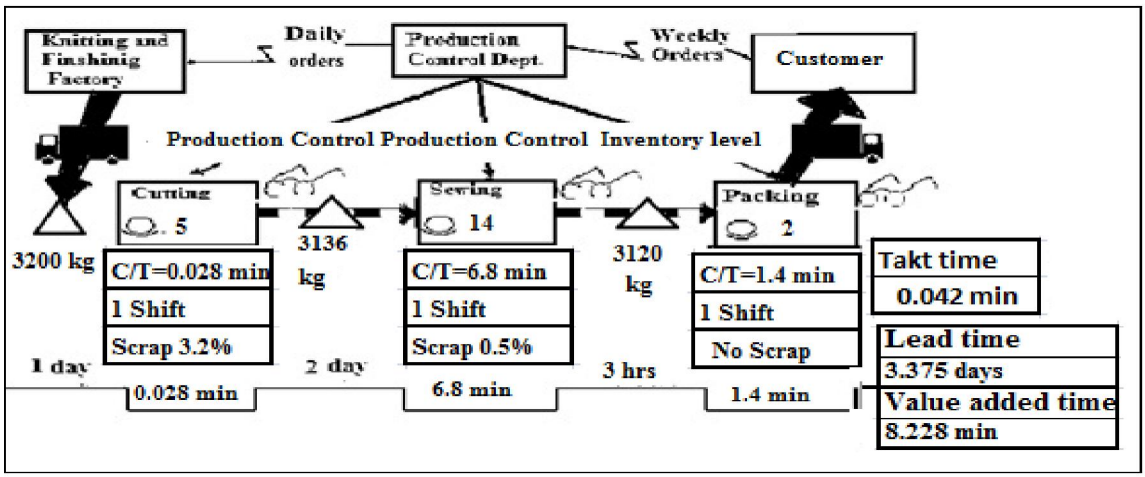


Figure (6) VSM" Value Stream Mapping

Where:

- *C/T: cycle time taken to make one product*

-Takt time: the ratio of available hours worked per day to the required production to meet demand.

(5) ***Overproduction***

Overproduction is one of major problems which facing apparel manufacturing, where companies have to cut more pieces than required to overcome problem of having fabric defects and to be reserve in case of reworks after sewing. It is related to accepted quality level that depends on customer requirements. The suitable lean tools applied to reduce overproduction and then inventory are pull system and JIT. Figure (7a) illustrates Overproduction waste as a difference between actual and desired production for six orders, where the average overproduction is about 9.75%.Figure (7b) shows the effect of using Pull system instead of Push system on overproduction percentage which decreased to 3.7%.

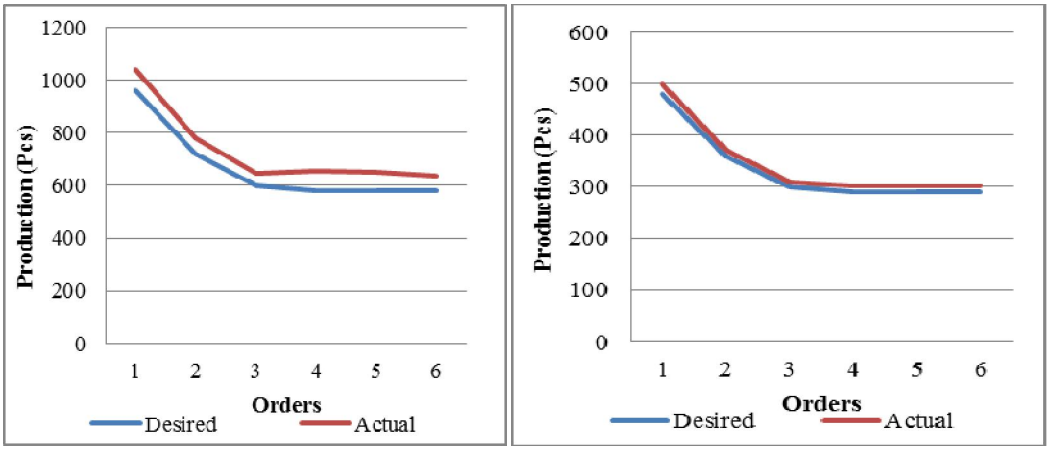


Figure (7a): Overproduction before Lean Figure (7b): Overproduction after Lean

(6) ***Over processing***

A main example of the over processing is having different inspection processes in each section of the mill. As it is known that, inspection process is one of "COPQ" cost of poor quality, which refers to waste of cost for non-value added process. Lean logistics as 5S and VSM used to remove the **three** inspection sections and merging them with the main processes as labor self inspection.

Self inspection philosophy is an indicator or both labor skills and quality reference. After collecting production quantity and quality by labor himself each hour, a quick improvement happened during a month of following this technique. So, everyone recognized if there is a need of training as well as he took in his account the error occurred and will not repeat it again which reduce the output rework percent. As a result, over processing waste reduced to the 33% of the original waste. Figures (8a&8b) present the flow diagram of the mill before and after improvement.

Figure(8a):.Flow chart for the whole mill before applying Lean

Figure (8b): Flow chart for the whole mill after applying Lean

(7) ***Defects***

In garment industry, the most percentage of output defects is coming from sewing section rather than any section depends on faults of human power in this section. Figure (9) shows a pare to diagram for sewing defects classified into reworks (5.2%) and scrap(0.5%). For packing section there is not any defect occurred. The prioritization of defect reduction is selected for skipped stitches and seam pucker. Besides, applying self inspection and prevention maintenance" Pokayoke", powerful lean logistics, for all processes. Thus, sewing defects reduced from 5.7% to 4.3% before and after Lean implementation in series.

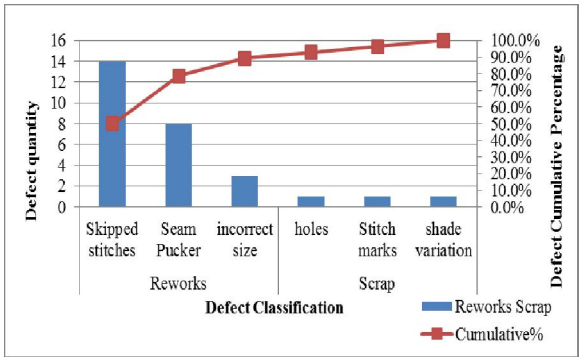


Figure (9). Pareto diagram for sewing defects

Skills waste:

Regardless of the reason, top quality control systems highlight the importance of human skills to set up a disciplined project. Accordingly, rework defect and motion waste decreased by selecting professional labors. So, building professional team work is a complex work which needs more training followed by measuring the improvement occurred. This research work studied some operations causing highly rework percentage at sewing section and increasing the processing time at packing section. Skills waste points out to the difference between processing standard time and actual manufacturing time. The output results shown in figure (10) demonstrate the waste of processing time for the selected operations. In other words, skill waste increased due to absence of professional labor because of illness or labor turning over.

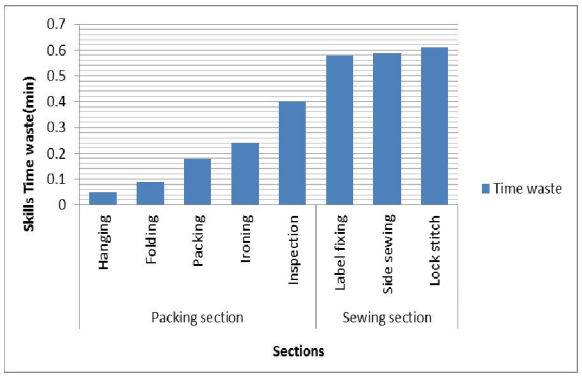


Figure (10): Labor Skills waste

Conclusions

In this paper the Muda waste known as "TIMWOODS" studied at garment mill. Lean logistics were developed in order to reduce all of them wastes as following:

(1) The reduction percent in "T" transportation was about 46% between sewing and packing sections.
(2) Waste percent in "I" inventory is almost 22% and 17% for sewing and packing sections in sequence.
(3) "M" motion time reduced by 53% and 50% for sewing and packing sections in series.
(4) "W" waiting time decreased by using VSM and all of staff member realized the risks of delay.
(5) The reductions percent in "O" over processing is about one-third all over the system.
(6) The reductions percent in "O" overproduction nearly 61.22% all over the system.
(7) The reduction percent in "D" defect is 24.5% sewing and no defect was noticeable at packing where each sample is inspected individually.
(8) Skills waste "S" is affected by absence professional workers. So, there is a need to a continuous training to overcome this situation.
(9) It can be concluded that removal of these wastes runs in a closed loop where some of them depend on others which affect product quality and cost.

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