

Reduction in production time via VSM: A case study

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Abstract

This paper presents the scope of one of the Lean manufacturing tools Value Stream Mapping in identifying of Lean wastes and find ways of reducing the same in a garment manufacturing process.

A garment manufacturing unit in Gurgaon, Manesar industrial zone, India is chosen for the study. A style with relatively longer duration is chosen and is tracked from fabric store to the finishing and packing sections.

Process flows within the specified departments are mapped to be able to determine the production time, Lean Wastes and share of Value Adding and Non-value adding (Necessary and unnecessary) activities. Identified wastes are analyzed through Pareto and 5 Whys' analysis and improvement opportunities are proposed so as to reduce the production time and Wastes and increase the share of Value adding activities. Implementation of selected proposals is also done and findings are shown.

Keywords: lean manufacturing, lean wastes, vsm, pareto analysis, 5 why analysis

1. Introduction

These days, customers demand for high quality apparels at low cost with a minimum delivery time. To meet out these demands manufacturers have adopted various strategies; the recent one in Lean manufacturing.

Lean Manufacturing

Lean manufacturing is all about looking at the time line from the moment the customer gives an order to the point when cash is collected (Ohno, 1988).

Lean approach is used in identifying and eliminating waste from the process.

Wastes can be categorized into seven types which are commonly referred to as "The 7 wastes of Lean" and these account for up to 95% of all costs in non-Lean manufacturing environments (Ohno, 1988). Typically the types of wastes considered in a Lean manufacturing system include,

- Excess Inventory – Inventory costs money. Every piece of product tied up in raw material, work in progress or finished goods have a cost. The waste of Inventory hides many of other wastes.
- Over Production – this is making too much or too early. This is usually because of working with oversized batches, long Lead times, Poor supplier relations etc. Overproduction leads to high level of Inventory which masks many of the problems within the organization.
- Producing Defective products – This can lead to re-consuming of materials and improper labor and time utilization.
- Excess Motion – These are unnecessary motions like movements of man, machine or tools.
- Over processing - Extra processing not essential to value-added from the customer point of view is waste. The waste of Over processing is where inappropriate techniques,

oversized equipments, working to tolerances that are too tight and perform processes that are not required by the customer

- Transportation – Transport is the movement of materials from one location to another. Excess Transportation may be caused by; poor layouts, lengthy or complex material handling systems, large batch sizes, multiple storage locations etc.
- Waiting – The waste of Waiting disrupts flow. Waiting waste may result when two interdependent processes are not completely synchronized, when changeover takes long time and workers spend time to perform rework etc.

In the present work some from the many Lean tools are used in determining, analyzing and finding ways of removing or reducing Wastes and are discussed below.

Value Stream Mapping: the focus of this research is to use value stream mapping as a means of waste minimization and production time reduction. Two types of activities are the concerns of VSM – Value Adding (which the customer is willing to pay for) and Non- Value adding (which the customer is not willing to pay for). The Non-value adding are again divided in to Necessary (which cannot be removed) and unnecessary (which can be removed from the process).

Pareto Analysis: A disproportionately large percentage (which is about 80%) of errors or defects in any process are usually caused by relatively few (by about 20%) of the problems. Pareto analysis helps identify those significant few problems so that they can be the focus of improvement.

5 Whys' Analysis: Five why's is a Root Cause Analysis Tool. It is not a problem solving technique. The outcome of a 5 Why's analysis is one or more root causes that ultimately

identify the reason why a problem was occurred. Even though the discipline is called '5 Whys', It is not always necessary to reach 5 before the root cause of a problem is fully explained. It may take more or less than 5 why's to get to the bottom of it. It depends on the complexity of the process or the problem itself.

2. Objectives

The objective of this research is to suggest and implement ways which could enable a garment manufacturing unit to produce a garment with a less production time.

Specific objectives of the present work are as follows.

- To compare the existing scenario of a manufacturing unit with an improved scenario via VSM
- To identify and eliminate/ reduce waste in the current state manufacturing
- To reduce production time
- To increase the share of Value adding activities

3. Review of Literature

Different works have been done previously in the area of Value Stream Mapping and its application. In this section the previously done works are appraised.

Rother and Shook (1999) explained that a value stream is comprised of all actions (both value added (VA) and non-value added (NVA)) that are required to bring a product or a group products from raw materials to the arms of customer. Elkins D., (2002) ^[8] using VSM creates a common basis for the production process, thus facilitating more thoughtful decisions to improve the value stream. Grewal C. (2008) underlined VSM enables a company to see the entire process in both its current and desired future state, which develop the road map that priorities the projects or tasks to bridge the gap between the current state and future state. Gurumurthy, A. and Kodali, R, (2011) defined VSM as a pencil and paper visualization tool that shows the flow of material and information as a product makes its way through the stream.

Damodaran (2011) ^[4] implemented VSM in one of the leading garment industries in India and found out that the material flow line contains various forms of Non-Value Added Activities such as: long distance shop floors and high machine setup time. After implementation of suggestions 85.2% reduction in transport waste was achieved. R.M. Belokar, (2012) ^[9] studied that VSM process is analyzed for opportunity to drastically reduce and simplify it to the fewest actions necessary. By reducing waste, the proportion of value adding time in the whole process rises and the process throughput speed is increased. This makes the redesigned process more effective and more efficient. Rahani & Muhammad (2012) ^[10] suggested that as VSM involves in all of the process steps, both value added and non-value added are analyzed and using VSM as a visual tool which helps to see the hidden waste and sources of waste. A current state map is drawn to document for knowing how things are actually operated on the production floor. Then, a Future State Map is developed to design a lean process flow through elimination of the root causes of waste.

Silva, S. (2012) discussed the application of value stream mapping in apparel industry in Sri Lanka. While drawing the current state map, all the 7 wastes of Lean were identified at

some point of the production process. After drawing a proposed state map by progressive elimination of waste in the process and applying a pull inventory control system in contrast to the previous system, the total value added and unavoidable non-value added time is reduced from 18314.5 minutes to 821.34 minutes.

Masudul H. (2013) used value stream mapping, cellular manufacturing and Kanban in cutting, sewing and finishing sections of a selected garment factory in Bangladesh to identify the existing wastes and to reduce the same.

Chowdury (2015) ^[3] conducted a research to identify and reduce various wastes that occur in a garment production system with a focus on cutting, finishing and on a particular production line of sewing section in a selected garment factory. It is identified that the non-value adding time has contributed significantly in total production time. And future state map is also proposed a future state map that would be beneficial for productivity improvement of the existing production system as well as to reduce the non-value adding time.

4. Methodology

The research methodology for the proposed research is depicted in Figure 1.

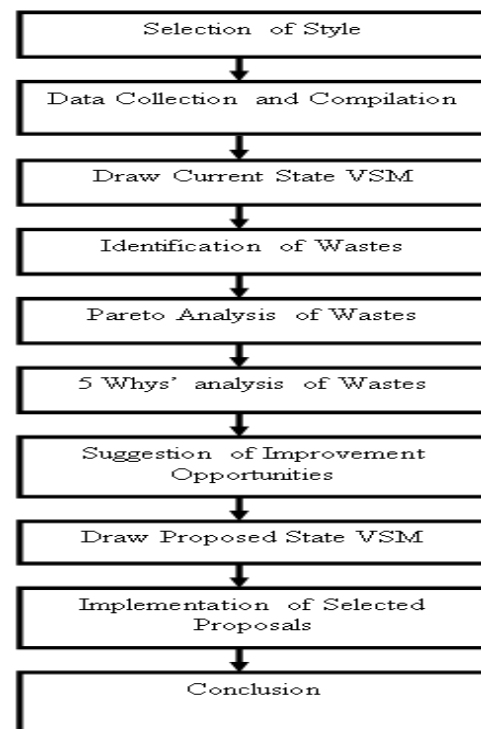


Fig 1: Methodology

- **Selection of style:** A specific garment style is identified to be tracked from fabric store to finishing and packing sections.
- **Data collection and compilation:** For the selected style, tracking of material and information is done at the specified departments (fabric store to finishing and packing). This will help in determining the durations at different stations and ways of handling it for developing the VSM for the current state of production. The collected

data is compiled for all the departments and to further determine the production time.

- **Draw current state VSM:** The current state VSM is drawn showing the various activities of the process steps together with their durations. The value adding, necessary non-value adding and unnecessary non-value adding activities are identified. The Production time (from fabric store to final packing of the garment) is as well shown by the current state VSM.
- **Identification of wastes:** Once the current state is drawn, existing wastes (among the seven wastes of Lean) in each of the departments is clearly identified and explained.
- **Analysis of Wastes:** Pareto chart analysis (80/20 principle- 80% of the errors occurred are due to 20% of the problems) is made to identify the types of wastes which take the highest share in the production time so that interventions can be made accordingly. In addition, 5 Whys' root cause analysis is done to reach at the root causes of the problems identified.
- **Suggestion of improvement opportunities:** Once the root cause of the identified wastes is known, improvement

ideas are suggested so as to reduce/eliminate the non-value adding activities (wastes) from the process.

- **Draw proposed (future) state VSM:** An ideal value stream map based on the findings of preceding steps is developed. A reduced production time, reduced share of non-value adding activities and increased share of value added activities are the main features of this map. The map also indicates the reduction in production time.
- **Implementation of selected proposals:** Selected suggestions and improvement opportunities are implemented on selected areas and findings are shown
- **Conclusion:** Findings of the present work are concluded.

5. Production Time in Current State

The garment style chosen for this research is ladies dress which has 16 rolls or 1236.98 meters of fabric in it. The equivalent number of pieces cut from the rolls happened to be 604 pieces. All the activities in each of the departments are listed together with their respective production time and share of VA, NNVA and NVA activities. The summarized data for the production time is listed in Table 1.

Table 1: Production time in current state of production

Section	Type of Activity	Quantity	Duration (min)
Fabric Store	Value Adding	-	-
	NNVA	19	1413.47
	NVA	3	175
Cutting	Value Adding	1	57
	NNVA	17	567.27
	NVA	4	1495
Sewing	Value Adding	1	144.74
	NNVA	13	737.12
	NVA	5	151.54
Dispatch (to finishing and packing)	Value Adding	-	-
	NNVA	6	1446.3
	NVA	2	1306
Finishing and Packing	Value Adding	-	-
	NNVA	28	2897.97
	NVA	2	310
Total		101	10676.41 min days)

5.1 Value Stream Map for Current State of Production

The process flow for the current state from the fabric store to the finishing and packing sections is depicted in figure 2. The

share of VA, NNVA and NVA activities are as well determined by the map.

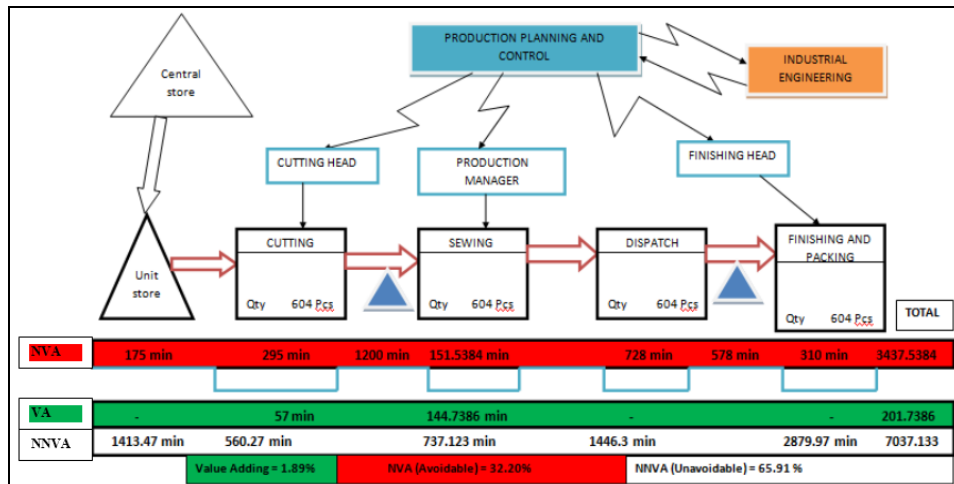


Fig 2: Current State VSM

6. Identification and Analysis of Wastes

Wastes and time consumed in each section are identified. These are described in terms of the standard Lean wastes i.e. Inventory, Waiting, Motion of workers, Transport of tools and

material, over production, over processing and Production of Defective pieces. Table 2 summarizes the wastes identified in each of the sections.

Table 2: Identified Wastes

Waste	Section	Duration
Fabric store	Waiting	170 min - Waiting to get approval of lots before issuing fabric to cutting section
	Transport	40 min - Pressing of shrinkage test samples and get approval of lots
Cutting	Waiting	160 min - To get signed shrinkage report from R&D department
	Waiting	15 min - Lay waiting for cutting operators
	Waiting	120 min – bundling process waiting for bundle tags to arrive
	Inventory	1200 min – Cut pieces stored in cutting
	Transport	39 min – Transporting rolls to cutting section and taking tied cut pieces to ticketing area
Sewing	Motion	61.19 min- Operators uncontrolled movement to wash rooms
	Transport	18.63 min – for taking cut pieces to sewing and transporting tools and material in the sewing floor
	Waiting	119.48 min- material kept on waiting mode due to rethreading, waiting for work and operators negligence
	Defect/Rework	22.34 min – Correction of defective pieces
Dispatch area	Transport	12 min – out puts of sewing transported to washing and Kaj button
	Inventory	1306 min- Before sending garments to production line for further processing and then to finishing and packing
Finishing and Packing	Transport	4 min- taking pieces to final audit point
	Inventory	310 min- At audit point and after pieces are ploy bag packed
Total Wastes Identified		3598.43 inutes

6.1 Pareto Analysis of Wastes

A Pareto analysis of wastes is depicted in Figure 3. The x-axis shows the types of wastes, y-axis (left) shows their share in

terms of minutes and y- axis (right) shows their cumulative percentage values. The cumulative values are represented by the curve in the graph.

Table 3

	Category	Amount (minutes)	Cumulative amount	Cumulative %
1	Inventory	2816	2816	78.26
2	Waiting	584.48	3400.48	94.50
3	Transport	113.63	3514.11	97.67
4	Motion	61.98	3576.09	99.38
5	Defect	22.34	3598.43	100

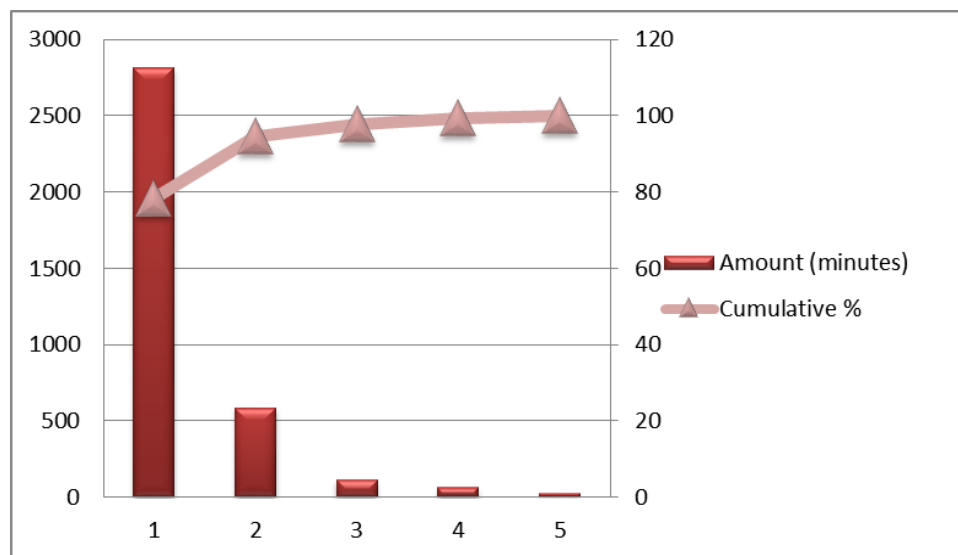


Fig 3: Pareto Analysis of Wastes

The curve in the chart touches Inventory waste indicating that it is the dominant waste and be the focus of improvement. It can also be seen that Waiting and Transport wastes follow Inventory waste.

6.2. 5 Whys' Analysis of Wastes

After identifying the dominant wastes using Pareto, the root causes for the same is determined through 5 whys analysis. The findings of the 5 whys analysis for the three dominant

wastes identified are summarized in Table 4. Remaining wastes are also intervened though their share is very small as compared to the dominant wastes.

Table 4: Findings of 5 Whys analysis

Waste	Root cause (s)
Inventory	Company policy. Bundles are kept in cutting section at least 2 days in advance before issuing to sewing. (Cutting section)
	Lack of timely communication between the dispatch area and production section. (Dispatch)
	There is no proper and systematic way of communication b/n dispatch and finishing and packing sections. (Dispatch area)
	Reluctance of workers and lack of proper communication in issuing garments to the final carton packing area (Finishing and Packing section)
Waiting	Company policy. Merchants who are responsible to approve lots sit only in the main office.(Fabric store)
	Lack of proper systematic/timely communication b/n bundle tag personnel and ERP section. (Cutting section)
	To minimize the chance of making errors while shrinkage test, the test is done twice within the unit and one of them has led to waiting in cutting to start laying of fabrics. (Cutting Section)
	IE personnel lack knowledge and skill of proper line balancing. (Sewing Section)
Transport	Some sewing machines are not supported with bobbin thread package.(Sewing Section)
	Lack of flexibility of the way shrinkage test is performed. (Fabric Store)
Motion	Many steps involved in changing of broken needle because of company’s needle change policy. (Sewing Section)
Defect	There is no proper controlling mechanism of movement of workers at all.(Sewing Section)
	Lack of proper controlling mechanism for operators who produce more defects. (Sewing)

7. Production Time in Proposed State

After suggestions of improvement opportunities are given based on the findings of the 5 Whys analysis, the production

time is recalculated and presented. Table 5 shows the production time for the proposed state of production and the reduction in production time which can be achieved.

Table 5: Proposed state production time

Section	Type of Activity	Quantity	Duration (min)
Fabric Store	Value Adding	-	-
	NNVA	19	1413.47
	NVA	-	-
Cutting	Value Adding	1	57
	NNVA	17	560.27
	NVA	2	495
Sewing	Value Adding	1	191.62
	NNVA	13	716.68
	NVA	5	103.99
Dispatch (to finishing and packing)	Value Adding	-	-
	NNVA	6	1446.3
	NVA	2	600
Finishing and Packing	Value Adding	-	-
	NNVA	28	2879.97
	NVA	2	110
Total		96	8574.3 min (17.86 days)
Reduction in Production time		3.48 days or 19.69 % of the current state of production	

7.1 Value Stream Map for Proposed State of Production

A VSM for the proposed state of production is drawn showing

increased share of Value adding and reduced share of Non-value adding activities.

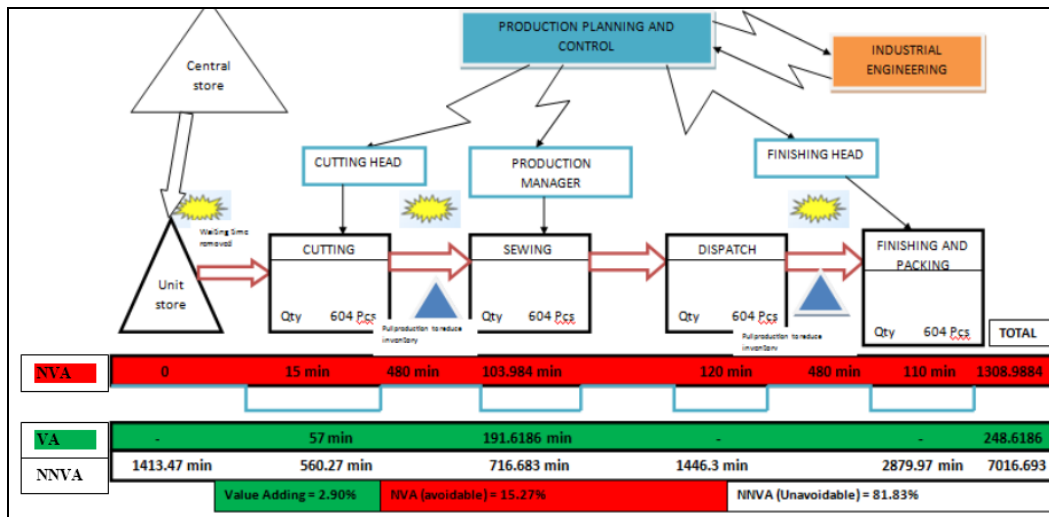


Fig 4: Proposed State VSM

A summary of all the improvements made by the proposed state of production is presented and compared with the same

scenario in the current state of production and is depicted in Table 6.

Table 6: Summary of improvements made by proposed state of production

S. No	factor	current state (min)	proposed state (min)
1	Inventory time	2816	1190
2	Waiting time	584.14	87.6022
3	Transport time	113.6282	103.488
4	Motion of workers	61.1982	45.8982
5	Defect/ reworking time	22.3422	21.6722
6	Value added time	201.7386	248.6186
7	Non-Value Added Time (avoidable)	3437.5384	1308.9884
8	Non-Value Added time (unavoidable)	7037.133	7016.693
9	Total production time	10676.41 (22.24 days)	8574.3 (17.86 days)
	Reduction in Production Time	4.38 days	

8. Implementation of Selected Proposals and Findings

Implementation of all the proposals is not possible because of the following reasons.

- The root cause for the wastes which take majority of the time is related to the policy of the company. Changing the policy of the company requires involvement of many personnel at different levels and it is not possible to achieve this during the present research project time span.
- Some of the root causes of the wastes identified is related to the requirement set by buyers and not possible to change

at this time.

- Some suggested improvement opportunities required a long term training to be given to personnel like IE personnel.

As a result, Implementation of improvement opportunities is done on some parts of the three major/dominant Wastes; Inventory, Waiting and Transport.

Table 7 compares the scenario of the current state production (before implementation) against that after implementation (proposals converted to action).

Table 7: Summary of process scenarios before and after implementation

Section	Waste	Before Implementation	After Implementation
Dispatch	Inventory Before (728 min) After (120 min)	- Incoming pieces are stored in dispatch area - Production section is informed about garment pieces by the time they are told to take the same for further processing	- As soon as dispatch area starts receiving pieces from dyeing, information is passed to production section
		- Lay out of machines in the production area is done when/after pieces are received from dispatch area	- Lay out of machines is done before pieces are received from dispatch
		- Pieces are kept in production area for a while before the start of further processing	- Further processing starts as soon as pieces are received by production
Cutting	Waiting Before (120 min) After (0 min)	- Bundle tag person sits idle for a long time	- Bundle tag person observes the status of cutting by going to cutting area
		- Request for bundle tags is placed at ticketing stage	- Request for bundle tags is placed as soon as pieces start coming out of cutting
		- Bundle tags start getting prepared by the time ticketing is already in process	- Bundle tags start getting prepared way before ticketing. They get prepared at the end of cutting and beginning of tying up of cut pieces.
Fabric Store	Transport Before (5 min) After (0 min)	- Washed shrinkage test samples are taken to finishing section for pressing	- The Place for pressing of washed shrinkage test samples is changed from finishing section to washing section
Sewing	Transport Before (14.85min) After (10.7 min)	- 2 broken needle piece collectors (magnets) were used for all the 12 sewing lines - Broken needle piece collectors are kept in needle room and sewing record keepers have to go there to bring them.	- Needle piece collectors are bought. 1 broken needle piece collector is provided for 2 lines. - Broken needle piece collectors are kept with the sewing line in charges and record keepers.

8.1 Summary of Findings: Waste Reduction, Reduction in Production Time and Increment of Share of VA Activities

The major findings of implementation of improvement

opportunities for selected proposals as compared with those in current and proposed state of productions are depicted in figures 5, 6 and 7.

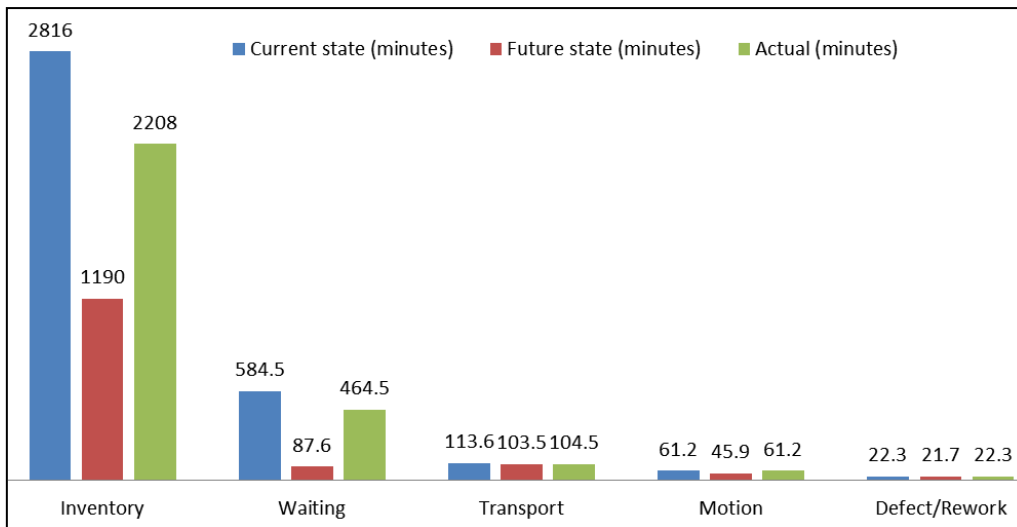


Fig 5: Findings of implementation in terms of Waste

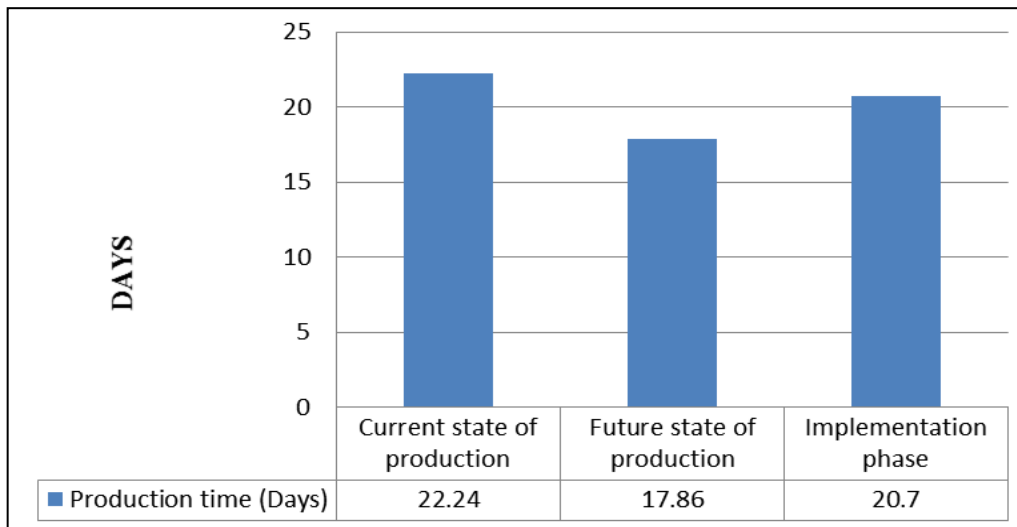


Fig 6: Findings of implementation in terms of production time

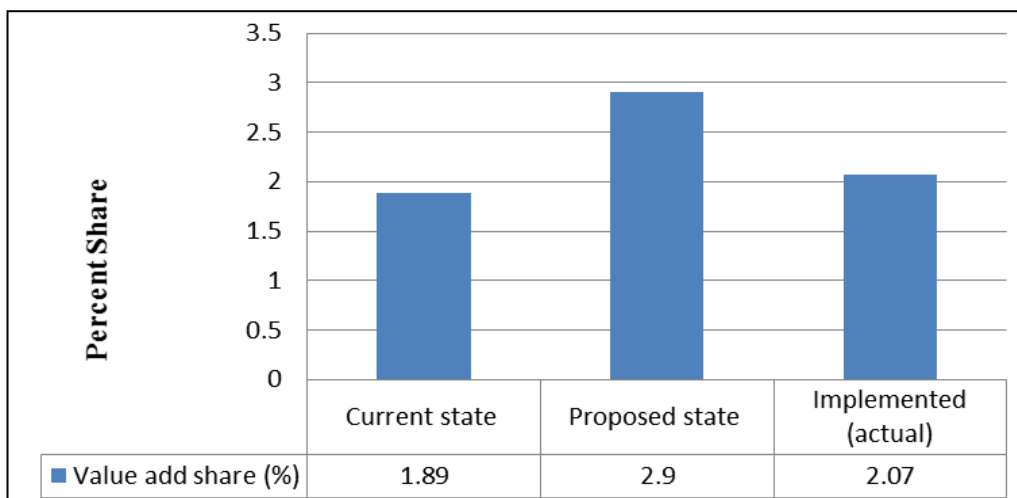


Fig 7: Findings of implementation in terms of share of VA activities

9. Conclusion

The main goal of this research work is to find out the scope of

VSM in reducing the production time of a garment. It is concluded that VSM can be a simple and effective Lean

manufacturing tool in visualizing wastes in a process and indicate ways of reducing the same with almost no expenditure of money.

This research work has shown the possibility of,

- Increment of Value added activities from 1.89% to 2.9%
- Decrement of Inventory time from 2816 minutes to 1190 minutes
- Decrement of Waiting time from 584.14 minutes to 87.6 minutes
- Decrement of transport time from 113.63 minutes to 103.49 minutes
- Decrement of Motion of workers from 61.2 minutes to 45.9 minutes
- Production time reduction from 22.24 days to 17.86 days which is about 19.6% (4.38 days)

Suggested improvement opportunities are also implemented on selected areas and the following actual results were obtained.

- Share of Value added activities was increased from 1.89% to 2.07%
- Decrement of Inventory time from 2816 minutes to 2208 minutes
- Decrement of waiting time from 584.14 minutes to 464.48 minutes
- Decrement of transport time from 113.63 minutes to 104.48 minutes
- Production time reduction from 22.24 days to 20.7 days which is about 6.9% (1.54 days)

10. References

1. Retrieved, from leanmanufacturingtools.org, 2016.
2. CG. An Initiative to Implement Lean Manufacturing Using Value Stream Mapping in a Small Company. *International Journal of Manufacturing Technology and Management*. 2008; 15(3/4):404-417.
3. Chowdury M, MK. Study and analysis of the Scope of Value Stream Mapping Technique in a Selected Garment Factory of Bangladesh. *Shahjalal University of Science and Technology, Department of Industrial and Production Engineering, Shahjalal*, 2015.
4. Damodaran MP, MK. The Development and Implementation of Lean Manufacturing Techniques in Indian Garment Industry. *Pallavan College of Engineering, Anna University, Department of Mechanical Engineering, Kanchipuram*, 2011.
5. Gurusurthy AKR. Design of Lean Manufacturing Systems Using Value Stream Mapping with Simulation. *Journal of Manufacturing Technology Management*. 2011; 22(4):22:444-473.
6. JRM. *Learning to See: Value Stream Mapping to Add Value and Eliminate Muda*. Brookline, 1999.
7. Masudual HMA. Waste Reduction and Productivity Improvement through Lean Tools. *International Journal of Scientific and Engineering Research*. 2013, 4.
8. McDonalds TED. Utilizing Simulation to enhance Value Stream Mapping: A manufacturing Case Application. *International Journal of Logistics Research and Applications*. 2002; 5(2):213-232.
9. Belokar RMSS. An Application of Value Stream Mapping in Automobile Industry. *International Journal of*

Innovative Technology and Exploring Engineering. 2012, 2278-3075.

10. Rahani AR, MAA. Production Flow Analysis through Value Stream Mapping: A Lean Manufacturing Process Case Study. *Procedia Engineering*. 2012, 1727-1734.
11. SKPN S. Applicability of Value Stream Mapping in the Apparel Industry in Sri Lanka. *Sri Lanka Institute of Information Technology, Department of Electronic and Computer Engineering, Malabe*, 2012.