

## **Application of Lean manufacturing techniques in various sectors: A case study**

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### **Abstract**

*Value stream mapping is one of the lean tools that displays all critical steps in the specific process and easily quantifies the time and volume taken at each stage. This paper addresses the implementation of value stream mapping and various other lean manufacturing techniques like 5S, six-sigma, Kaizen etc. in various sectors. This paper covers the review and classification of literature and implementing VSM and Kaizen. It analyzes the information at individual stages about the stage cycle time, through put time, utilization of resources, set up time or change over the time, reduction in excess inventory, WIP, manpower requirement and the information flow from raw material to finished product. It includes all value-added and non-value added activities and also non-value added but essential activities. The VSM method is a lean management method for analyzing the current state and designing the future state for the series of the events.*

**Keywords:** *Value stream mapping, lead time, Kanban, Inventory, Cycle time, Kaizen.*

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### **I. Introduction**

Lean manufacturing originated and practiced in Japan, which is process based on an ideology of maximizing productivity while simultaneously minimizing waste within an operation, especially for small and medium scale enterprises. The lean principle sees waste is anything that doesn't add value that customers are willing to pay for. VSM (value stream mapping) and kaizen principles are most effective in nature. In this review paper we have studied and analyzed various literatures and summarized the implementation of lean tools such as kaizen, VSM. The process starts with collecting data followed by mapping current state, then ideal state is mapped after analyzing, studying and implementing lean tools such as kaizen, VSM, 5S etc, then future state is mapped. All application of lean tools, material flow, and information flow is shown on a chart. This will definitely enable the considering enterprise to achieve cycle time reduction, waste reduction and increasing productivity.

VSM is a process mapping approach that uses dedicated icons to visualize the process clearly and identifies the areas of improvement by reduction or elimination of process wastes. The objective of current state mapping is to map the existing state and find possible ways to implement lean tools, reduce waste, and develop action plans to reach a future state map. VSM helps to identify, demonstrate and decrease waste in processes. There are some processes which are non-value-adding but necessary; all waste cannot be eliminated but it can be reduced, so continuous improvement is required. VSM can serve as a blueprint for Lean Manufacturing.

<b>Lean principles/tools</b>	<b>Sustainable benefits</b>
Pull approach	Reduction of work-in-process, elimination of potential waste from damaged products, lesser floor space utilization
Cellular manufacturing	Reduction in set-up times and change over time hence low energy and resource usage, reduction in defects
Value stream Mapping	Reduction in waste through fewer defects, less scraps, low energy usage, etc.
5S	Reduction in lighting requirements due to clean windows, leaks attended to immediately, reduced consumption of materials and chemicals

Total preventive maintenance	Less hazardous waste due to decreased spills and leaks, increased longevity of equipment
Six sigma	Fewer defects hence less waste, improvement in product durability and reliability hence increase in product lifespan
Pre-Production planning	Reduction of waste at design stage, usage of right sized equipment reducing the complexities of production processes and product design.

## **II. Literature Review**

Lean is one of the essential and most powerful Lean Manufacturing tool for the improvement of the organization by applying the advanced quality management techniques on its lean journey. The Lean Manufacturing techniques were first implemented by the Toyota Production System in Japan. Value Stream Mapping is a lean tool that employs a flowchart documenting every step in the process and it has been analyzed to improve the manufacturing system. VSM is a visual as well as graphical tool which is made using a predefined set of standardized icons that helps the organization to analyze and understand the flow of material and information as the product is manufactured from raw material to a finished product. After applying value stream mapping techniques, it helped to differentiate the whole process into value-added activities and non-value added activities from the current condition and identified kaizen opportunities from it. The real benefit was, it increased the efficiency of the process, reduced the cycle time in the production chain, and built towards a true system based on the flow of materials and information across the entire process flow.

Rahim AR, Muhammad al-Ashraf analyzed production flow using value stream mapping. The implementation of VSM improved the approach in LP initiatives as it overcomes wastes that affect productivity. There was much amount of time spent on the production system in waiting and non-value added activities. , After applying VSM they found the fact that there were substantial gaps between standardized work and real work - this gap meant that workers did not follow strictly assembly standards and improvising the SOP was a key driver in continuous improvement sustainability on the production floor as operators are fully aware on the long-term commitment to practice Lean. The results they achieved after applying VSM were reduction in time by 16.9% and reduction in machine time by 14.17% compared to the original processing method.

Dushyanth Kumar KR, Shivashankar GS and Rajeshwar SK carried a case study on application of value stream mapping in pump assembly process. Their task was to analyze waste that could be reduced at a pump assembly line. They implemented lean tools such as kaizen, VSM to reduce or eliminate waste and productivity. After the implementation of lean tools like VSM, kaizen the total time of shaft sleeve was reduced from 241.7 hr to 148.3 hr (61%) and increased the efficiency of inspection, heat treatment and assembly line of pump. They also suggested few points to improve the process like the right size of material can be ordered. In this analysis they found major non-value added activities like operator's movement and their skill, poor process, delay in material transfer to furnace and cooling time in heat treatment.

Subrata Talapatra and Jannatul Shefa applied value stream mapping to improve financial performance of a production floor of furniture industry. To reach this objective, based on the selection of product families and collection of necessary data, a current state map of the existing process was designed. Then this map was analyzed thoroughly to investigate the shortcomings and wastes and suggestions were proposed to overcome them with the help of lean tools like VSM, kaizen, etc. In light of the suggestions, the future state map was portrayed. The anticipated outcome from the proposed future state map was a reduction in production lead time by 66.67 % and cost reduction by 11.25 % with the inclusion of limitations of this research and scope of future work.

Tomas Rohac and Martin Januska presented a case study with the view of applying value stream mapping to transportation process flow in a company of raw material and semi-finished products starting from supplier to final delivery of finished products to a customer. After collecting the required data, the next step was to draw a current state map. Then the task was to identify bottleneck processes and possible improvements at all stages of the process. The company had a total lead time of 296 days and total value added time was 7983 seconds. After suggested improvements and applying lean tools it was found that there was reduction in total lead time from 296 days to 96 days (208.7 %)

R.M.Belokar et.al analyzed that VSM process is studied for the opportunity to drastically reduce and eliminate the waste from the flow and to simplify the process the few actions are required. By reducing the wasteful things, the proportion of value adding things was increased in the whole process and cycle time and throughput time of the processes was reduced. These things make the redesigned process more effective and

efficient.

S. Santhosh Kumar and M. Pradeep Kumar suggested that techniques of lean manufacturing and line balancing are used to reduce the cycle and throughput time in an assembly plant, which contains non-value added activities and work.

Danijela Gracanin *et.al* proposed the framework for value stream mapping optimization by combining the VSM principles and cost-time profile. Value Stream Mapping came put forward as a very efficient tool for analyzation of activities within the production flow on various activities which directly affected the cycle time and overall efficiency with the purpose to eliminate the non-value added activities from the flow. It also implemented 5s and kaizen techniques while analyzing the current workflow and subsequently making the future state flow. Besides shortening lead time, cost reduction is also imperative for every company, so monitoring and controlling manufacturing costs over time can be very beneficial for the company improvement.

Rahani and Muhammad al-Ashraf put their suggestion that as the VSM involves all of the processes of the working flow, both value added and non-value added are analyzed and using VSM as visual tool which helps to figure out the waste and sources of waste from the processes in the form of non-value added activities. First of all, a current state map was drawn to document every step in the process and how many processes are actually operated on the production floor. Then, a future state map was developed to design a lean process flow through the elimination of the root causes of the waste, and after that the process was improved.

Anup Chapale and Balkrishna Narkhede-Provides an up to date, review of value stream mapping. A systematic methodology is presented in this paper for selecting product family and processes for improvements. The various tools of lean manufacturing are discussed to establish improvement road map. The improvements are evaluated on key performance indicators such as lead time, inventory reduction and increased value addition. This study gives a complete overview of conducting value stream studies. This study was conducted in discrete manufacturing scenario represented by low volume with high variety products.

Mohamed shihab *et.al*- This study on process improvement their work and analysis focused on single line of manufacturing and packing which produces two of the variants. This work was started by understanding working facility at the manufacturing unit and they followed structured methodology to understand the problems which are presented and find out ways of countering these problems. During the main study it was seen that, packaging defects account to about 27.3% of overall defects. After the detailed study, suggestions for improvements were given to reduce the packaging defects in the unit along with the reduction in the manufacturing defects.

Dinesh Seth and Vaibhav Gupta applied VSM to achieve productivity improvement at supplier end for an auto industry from in Indian perspective. They analyzed the need to reduce WIP and finished goods inventory affecting productivity. Also, they analyzed TAKT time needs to be improved as per the customer demand, and their results after applying VSM were as, production per person was improved from 13.95 to 17.54. Lead time was reduced from 3.215 days to 0.54 days and cycle time was improved from 15.67 min to 14.13 min.

Rhonda R. Lummus, J.Vokurka and B.Rodeghiero studied a physician's clinic and applied VSM for improving time delay. The task was to reduce waiting time and provide more value to patients. For doctors initially Non-Value added activity was to manage patients and waiting time was Non-Value added for patients. They designed a flow cart to manage that problem and found a 25% increase in capacity without additional investment or hospital staff after implementing the flow chart. Target was achieved by diverting patients as per their service priority, required time for that service and allocation of right patient to right doctor so that they can achieve balanced value stream.

Markus L Stamm and Thomas Neitzert have proposed a lean principle of value stream mapping in the manufacturing sector to set up the environment, considering a study related to the mold-making industry. After the implementation of value stream mapping in two projects, they came to know that the relative velocity of the flow of the material was improved from 6.0 to 2.3, which was clearly noticing that in waiting time directly affected to the overall improvement of the lead time of the process.

Bhim Singh and S. K. Sharma had put their opinions about VSM that Value Stream Mapping is the versatile tool for the implementation of the lean techniques by analyzing an Indian case study of manufacturing industry of small and medium scale components which are required for the maintenance of railways. If the existing stage of manufacturing is analyzed with help of value stream mapping process symbols and they found that there are many things that can be improved a lot such as lead time, cycle time, excess inventory etc. After carefully observing the process, some modifications were suggested and according to that future state map were designed. Further, TAKT time was calculated to fix the speed of the production process. Later, both the current and future state maps were compared and from that the result came to know that 2.17% reduction in cycle time, 97.1% reduction in WIP and about 26% reduction in manpower requirement. This case study proved that VSM is a powerful weapon for the implementation of the lean principles that allow every industry to understand and continuously improve the performance of the overall chain of production.

Lixia Chen has put his opinion about the various applications of value stream mapping based on the lean manufacturing techniques for Chinese enterprise to help them to implement lean production system step by step which could make them to look at overall efficiency and value added processes through overall chain. This study focuses on the identification and elimination of the reasons of the wastes in the flow, improvement in the cycle time of the every process and to increase the capability and competitive ability of the Chinese enterprises. The result of the application of VSM was indicating the reduction in cycle time from 1.46 hrs to 21.9 minutes; reduction in setup time from 3.2 hrs to 0.3 hrs; lead time from 67 days to 16 days.

S. Vinodh , K.R. Arvind and M.Somnaathan utilized the concept of Value Stream Mapping in an Indian organization of the camshaft manufacturing. The purpose of the study was to implement VSM for enabling the efficiency, cycle time of the production flow in an Indian camshaft manufacturing organization. They had chosen the stiffer unit camshaft for the case study; it is because of that the demand for the stiffer unit camshaft was more by the customers when it was compared to other products. According to standard methodology, first of all current state map was developed by analyzing the current workflow of the camshaft and based upon current state map; future state map is developed by adding all improvements by taking considerations, all advance techniques of lean manufacturing and VSM. By taking into account all improvements, the results were concluded that idle time was decreased from 19660 to 19449 minutes, total cycle was minimized to 539 to 525 minutes, on time delivery improvements from 70 to 85%, reduction in defects achieved about 4%.

K.Eswaramurthi and P.V.Mohanram has applied VSM in inspection process. They collected data and categorized that into three types as value-added, non-value-added and non-value-added but necessary activities. By categorizing it helped them to directly eliminate possible non-value-adding activities. After elimination of NVAs, the total time was reduced by 30% and NVA by 70%. Based on this study, they suggested that improved sequence of processes can help the company achieve higher productivity rates; eliminate unnecessary transportation, and reduction in cycle time.

### **III. Summary**

After reviewing all these case studies, we can say that Lean technique and its tools such as Value Stream Mapping, Kaizen, 5S, etc. Have a very wide scope of application and this is not limited to any one field, industry or organization. Objectives such as reducing cycle time, TAKT time, WIP, cost, inventory and other waste or increasing productivity. Terms like PQCDSM, VAR can be used to achieve above objective after identifying Value-adding and Non-Value-adding activities. VSM is a world magnificence manufacturing tool that can be used to achieve all objectives stated above. Organizations are experiencing a heavy stress due to globalization; hence they cannot manage to pay to perform with waste in their procedure. The main focus of VSM should be to perceive and get rid of waste and waste-associated activities as it has been tested via previous studies and literature that most of the issues in manufacturing environment are being birthed by means of all categories of waste.

### **IV. Conclusion**

In this paper the available literature on VSM has been categorized focusing on their aim and findings after implementation of VSM. Based on the literature, we can say that VSM also works for the integration of man, machine and material along with methods. VSM should not end with one improvement; it should continue with continuous improvements.

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