Implementation of Value Stream Mapping in Pump Industry

Maharasi P B[1], Jenina Pushpam G[2], Vigneswaran C[3], Brajesh Kumar Kanchan[4], Madhan Mohan G[5]

{ 21p112@psgtech.ac.in[1], 21p209@psgtech.ac.in[2], cvn.prod@psgtech.ac.in[3], brajeshlean@gmail.com[4], gmm.prod@psgtech.ac.in[5]}

Department of Production Engineering, PSG College of Technology, Coimbatore, India[1,2,3,4,5]

Abstract. The pump industry provides the machinery and systems necessary for fluid movement, making it a cornerstone of modern society and industry. Without pumps, many essential processes across various sectors would be inefficient, if not impossible, to carry out. In order to increase performance across the entire pump industry, the cycle time has been reduced. Lean manufacturing, which has its roots in Japan and was developed there, is regarded as a business strategy to eliminate waste, improving productivity by producing goods of higher quality and accuracy, particularly for small and medium-sized businesses (SMEs). Among all other lean practises, value stream mapping (VSM) and kaizen principles are the most effective in practice. This research clearly reports that the application of those tools as the lean manufacturing effort. Additionally, similar lean technologies are used in pump assembly in medium-sized businesses to find and eliminate waste in this case study. The current value stream mapping (CVSM) used in this instance is used to initially visualize the process route. After monitoring the entire process, wastes that have an impact on the cycle time are then discovered and analysed. The Kaizen principle is then applied to minimize waste in the process, and a future value stream mapping (FVSM) is created to examine the root causes of waste generation. The considering pump industry will undoubtedly be able to increase productivity, competitiveness, and cycle time with the help of this capabilities.

Keywords: Lean Manufacturing, Value Stream Mapping, Kaizen

1. Introduction

Pumps are mechanical apparatuses that mechanically move liquid. They are key parts of industrial processes because they allow the flow of fluids, slurries, solids, semi-solids, and powders, all of which are necessary for different purposes. Due to today's intense competition, pump industries are being driven to adapt the way they manufacture goods on a daily basis. In order to meet client demands in a competitive manner, industries are turning to advanced manufacturing approaches

ICAMDMS 2024, February 23-24, Coimbatore, India

DOI 10.4108/eai.23-2-2024.2347033

including lean manufacturing, and concurrent engineering. In this regard, decreasing waste in the production process will undoubtedly increase productivity and reduce cycle time. Lean manufacturing is the most widely used strategy for waste reduction in the manufacturing process out of all the technologies. Lean is not simply about getting rid of waste; Because of the intense competitive pressure brought on by globalization, the manufacturing industry is becoming more competitive, and businesses must work to increase their efficiency if they hope to solve the problems faced by Medium-sized enterprises. The use of lean manufacturing tools is important in the process of manufacturing in order to solve the challenges faced by SMEs. The use ofkaizen and value stream mapping (VSM) for theassembly of pump in medium-sized company is studied in our case study to reduce waste obtaining. The main focus of this study endeavour is productivity. Examination of the continuous production perspectives that are accessible to lean tools in the current schemes is important for the qualityof a product. Applications of lean concepts in the continuous process field have been significantly more popular, widely adopted [1,2]. Toyota developed lean production, a systematic method to detect and remove waste through continuous improvement intothe manufacturing processes and creating the product to pull towards the consumer along their satisfaction, in the 1960s to remove waste, decrease setup and inventory times [3]. Lean production emphasizes the elimination of all non-valueadded activities, from order to delivery, work in process (WIP) and lead time reduction, quality improvement, increased flexibility, fewer transactions, schedule simplification, lower costs, better deliveries, higher sales, and better utilisation [4,5]. Researchers agreed that LM can help create world-class organisations by using its well-known tools, such as 5S, TPM, poka-yoke,cellular manufacturing SMED, kanban, andkaizen, for better productivity, a decrease in WIP inventory, an increase in quality, a decrease in space utilization, aand improved workplace organisation. determining what is valuable to customers. This is a concise summary of the Lean methodology. Describe the processes that provide value and those that should be eliminated if the client does not pay for non-value-added procedures [6]. One of the most effective Lean tools for a company to implement and advance on the lean path is VSM. The first business to implement lean concepts using VSM methods was the Japanese automaker Toyota Co. VSM helps the organisation to understand how the flow of information and material as the product moves into various stages. It has been analysed, and a group has been formed to improve the system of a manufacturing application [7]. After the value stream has been drawn, the organisation may distinguish between activities that create value and those that don't based on the state of the business today and find kaizen possibilities[8-10]. A description of the VSM tool that offers communication inputs to achieve optimum productivity and theoretical development points to serve as a reference in the redesign methodologies [11]. By utilising the following stages of VSM processes, waste may be eliminated and the firm can be streamlined very effectively. Determine the product or a group of products to be mapped, then build a map of the existing situation. Next, decide where improvements can be made to reduce waste, and finally, draw a map of the future situation. This section does a literature review to examine how VSM is used to SMES of various organisations in a worldwide environment and its applications. A distributor's supplier network for electronic, electrical, and mechanical components was explored in the development and deployment of VSM [12]. Explanation of the VSM technique in manufacturing and service environments, with a comment on administrative procedures [13]. VSM is a fantastic tool for any business looking to include lean [14]. Study of VSM highlights not only communication inefficiencies but also improves by using existing and

future maps [15]. At a sizable integrated steel factory in India, VSM and other Lean principles were implemented to enhance the procedure [16]. Based on a review of the entire world, the degree to which a plastic phone case manufacturer responds to consumer orders as needed in a quick, flexible, and affordable manner from one product group to another product group, VSM is a good tool for redesigning the system efficiency[17]. VSM facilitates shop floor procedures that aim to boost both human and machine productivity [18]. In a hospital case study, the focus was on the wait times and service times for patients attending emergency rooms [19]. Through a mapping team, planning, preparing, and identifying the target, product group, or service were explained [20]. The stages of implementation of lean in the auto parts manufacturing unit were discussed using VSM process symbols [21]. Numerous studies encompassing all facets of manufacturing are available on the application of lean concept, principles, and technologies in manufacturing industries. There didn't appear to be many studies on the production of pumps, though. Few research on lean are accessible outside of India, and the majority of them focus on lean applications in manufacturing industries outside of India, mainly in European nations. While studies on the pump industry in the context of other countries were scarce, this research article has been entirely devoted to the lean application measures in the Indian pump sector. By successfully implementing lean principles globally in the pump sector, this study could close a knowledge gap. Additionally, there aren't many work on the performance evolution of lean applications in the pump iindustry sector or in the setting of India. Another gap is the lack of literature on pump manufacture and the requirement to use lean manufacturing techniques.

2. Methodology

Lean manufacturing has been increasingly common in large-scale enterprises in recent years. The current work focus on the study and examination of a prevailingproblem in the slurry pump assembly area at ABC, India (P) Ltd, a medium-sized enterprise. The current issue is a time delay in pump assembly process caused by the supplier's timely provision of shaft sleeves and some process issues in the assembly line, pump assembly process. Therefore, the focus of this work is on waste reduction from start to finish at a pump assembly plant for a manufacturer of construction equipment.

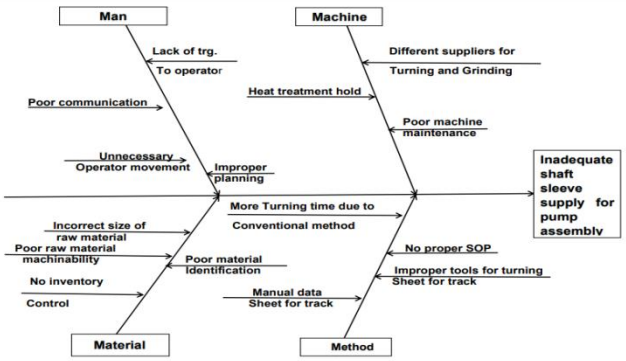
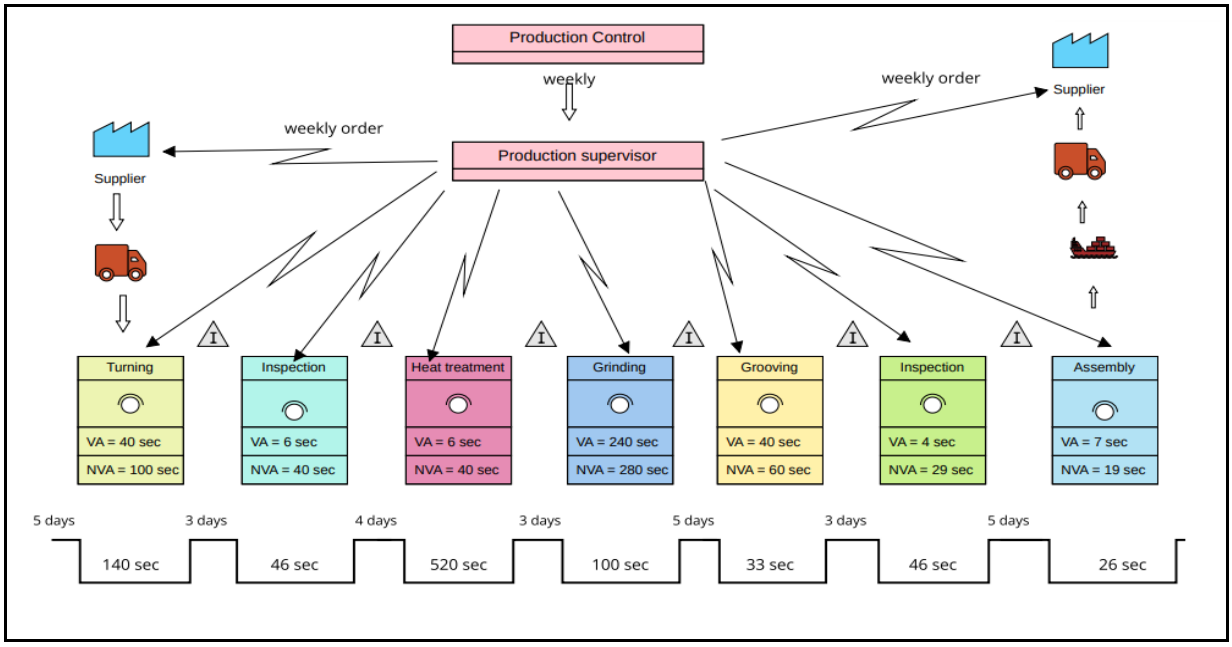


Fig. 1. Fishbone diagram - Pump Assembly



Value Added Time	343 seconds
Non Value Added Time	568 seconds
Gap between Operation	600 hours
Total Time	2160911 sec

Fig. 2. Current Value Stream Mapping

3. Implementing lean using the kaizen principle and creating future VSM

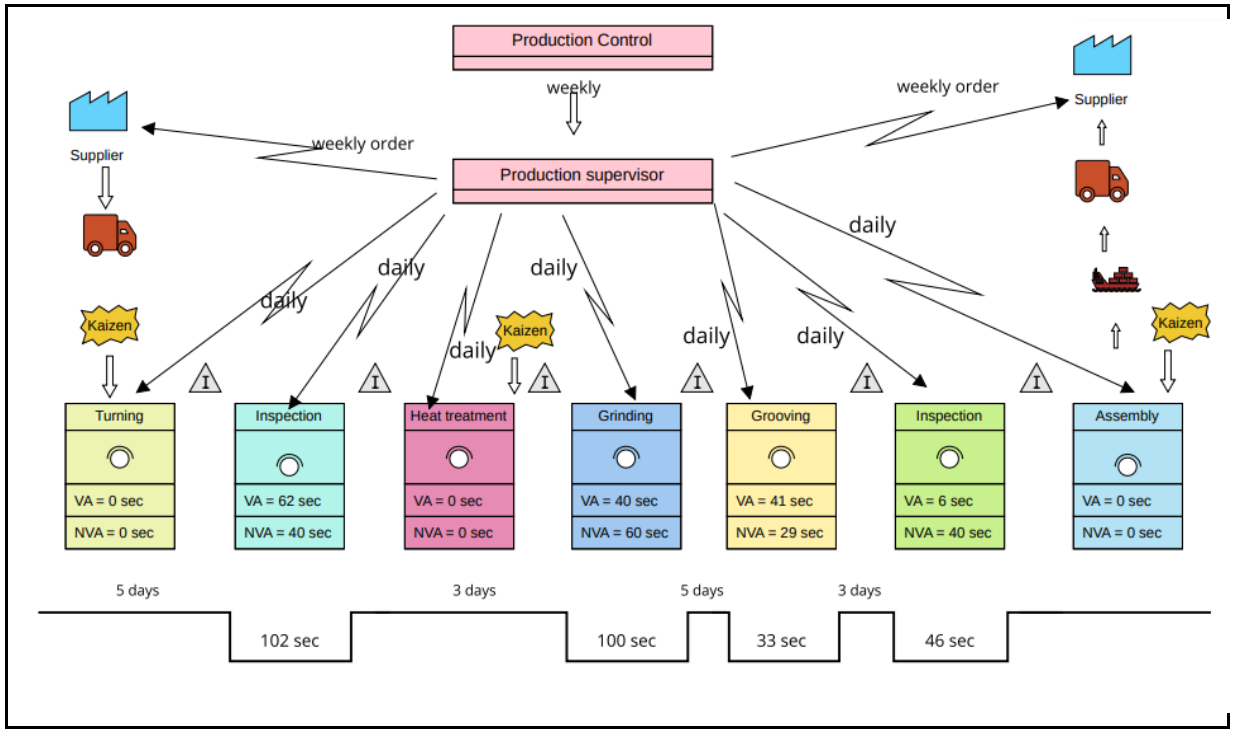
3.1Kaizen principle

Continuously enhancing a value stream as a whole or a specific operation to produce more value with less waste. The Japanese word "kaizen" refers to a shift of perspective for ongoing improvement. In every area of the workplace, only daily, gradual changes based on science can lead to significant achievement. Kaizen refers to a continuous endeavour to not only uphold but also improve standards, which denotes continuous improvement in all spheres of our lives. Kaizen demonstrates a leading role in raising productivity and product quality. In the context of a larger leadership strategy that involves people, their culture, and a customer-driven business model,

kaizen is a plan to integrate ideas, systems, and technologies [22]. The operator's motion and technical skill, inadequate process, time delay in material transfer, and the involved cooling time during heat treatment were identified as the following main NVAs in the brain storming analysis of VSM, for which the recommended lean suggestions are provided as follows.

Table 1 Proposed Lean Solutions

NVA activities	**Lean Suggestions to remove NVA**
Waiting and transport delays	Cross-docking, vendor management
Time delays in materials pickups	Usage of non-contact inspection
Poorsequence schedulingin assembly process	Process planning
Unplanned loading of the furnace and low cooling performance	Use a part transfer mechanism based on the mechatronics principle (PLC)
Poor 5S, operator movement	Use the 5S principles when arranging your tools, and the quality circles principle when hiring employees



Value Added Time	149 seconds
Non Value Added Time	169 seconds
Gap between Operation	384 hours
Total Time	1382718 seconds

Fig. 3. Future Value Stream Mapping

Reducing wastefulness increases the procedure's throughput rate and increases the percentage of time spent adding value [23]. Software was used to balance the assembly line following the development of the present state VSM [24].Green manufacturing and 5S concepts are combined to create a new process model [25].

4. Results and Discussions

The process of pump assembly can reap some immediate benefits if lean technologies like VSM are applied. The shaft sleeve's overall processing time was reduced around 36%, from 600.25 hours (2160911 seconds) to 384.09 hours (1382718 seconds) and it boosted productivity in the areas of inspection, heat treatment, and pump assembly lines such that overall assembly quality increased with a reduction in cycle time, for which we offered the following crucial suggestions for process optimization. Using automated inspection, cross docking and the use of 5S in the assembly, it is possible to order the correct size of raw materials for the pump's assembly line, which reduces the number of assembly line stoppages. In order to increase assembly production, reduce rejects, and increase customer satisfaction, we used lean tools including VSM kaizen and 5S tools.

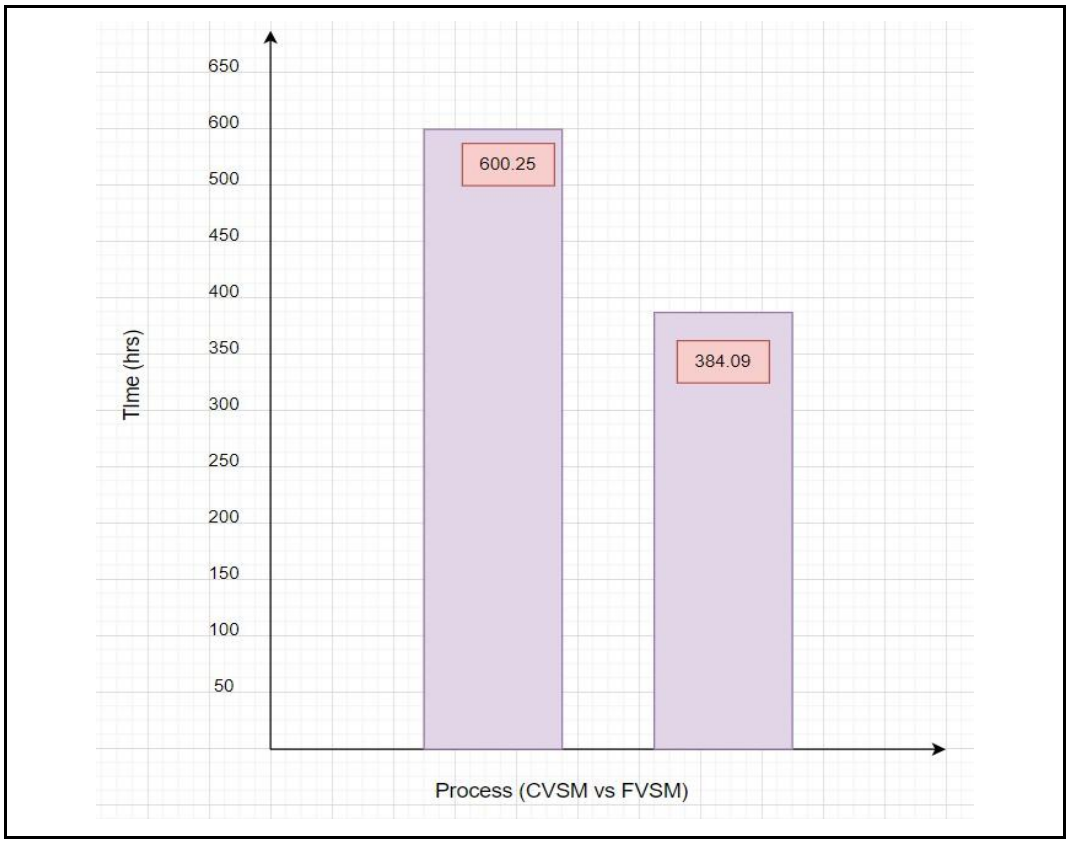


Fig. 4. Process vs. Time

5. Conclusions

Today, it is more important than ever to provide customers with a wide range of items in various volumes and kinds at a fair price. Eliminating waste and cutting down on delays, particularly on the shop floor, can affect market prices and total customer satisfaction. Here, the goal is to create a low-cost with a shorter cycle time or throughput time. The ability to improve processes is made possible to shop floor practices that are effective at increasing both human and machine efficiency. VSM assists in identifying NVA activities in the process. VSM is a significant lean manufacturing that assists in map current and future value stream maps for the process. This allows industries to comprehend and continuously improve their goals in order to accomplish lean. It also facilitates concise and clear communication about lean expectations between management and shop floor teams. The major objective is to determine, show, and reduce the operations that did not add any value to the finished product. However, based on the results of derived validation, VSM may be successfully used to medium-sized industries as the first stage of waste detection. By using this VSM tool, it is feasible to map the current situation and then analyse waste removal using Lean concepts. Here, the present study shows the value of the VSM tool in achieving an efficient process improvement approach to reduce cycle time. In this case study, using the VSM tool in the pump manufacturing industry,

1. A current map is built to identify non-value-added processes
2. A future map is created by removing non-value-added processes from the process.
3. The shaft sleeve for pump assembly process has significantly improved, as shown by the VSM future state map, and its throughput time has decreased by 36%, from 600.25 hours to 384.09 hours.

These improvements illustrate that value stream mapping may be used to analyse any delays. By focusing on reducing NVA activities, increasing productivity and reducing cycle time through kaizen and VSM principles, the current study offers a case study of the improvement of the pump manufacturing industry. It can be concluded that kaizen and VSM are the most useful tools for detecting and removing process wastes. This study has confidently advised these tools to introduce for the medium scale firms by performing the technical suitability, economic reasons, and feasibility study.

References

[1] Abdulmalek F, Rajgopal J, Needy KL: A Classification scheme for the process industry to guide the Implementation of lean. Engineering Management Journal, Vol. 18, pp. 15-25, (2006).

[2] Fawaz A, Abdulmalek, Rajgopal J: Analyzing the benefits of Lean Manufacturing and Value Stream Mapping via simulation: A Process Sector case study. Int J Prod Econ, Vol. 107, pp. 223-226, (2007).

[3] Gupta S, Jain SK: A literature review of Lean Manufacturing. International Journal of Management Science and Engineering Management, Vol. 8, pp. 24-249, (2013).

[4] Reichhart A, Holweg M: Lean distribution: Concepts, Contributions, Conflicts. Int J Prod Res, Vol. 45, pp. 3699-3722, (2007).

[5] Taj S: Lean manufacturing performance in china: assessment of 65 manufacturing parts. Journal of Manufacturing Technology Management, Vol. 19, pp. 2179-237, (2007).

[6] Womack JP, Jones DT: Lean Thinking (2ndedn.) Simon & Schuster, Inc., New York, pp. 16 -26, (2003).

[7] Lasa IS, Labura CO, Castro Vila RD: An evaluation of Value Stream Mapping Tool. Business process management Journal, Vol. 14, pp. 39-52, (2008).

[8] Liker JK, Meier D: The Toyota Way Field Book. Tata McGraw -Hill Edition, New Delhi, (2007).
[9] Belokar RM, Kharb SS, Kumar V: An Application of Value Stream Mapping In Automobile Industry: A Case Study. International Journal of Innovative Technology and Exploring Engineering, Vol. 1, pp. 2278-3075, (2012).
[10] Miltenburg J: One-piece flow manufacturing on U-shaped production lines: a tutorial. IIE Transactions, Vol. 33, pp. 303-321, (2001).
[11] Serrano I, Ochoa C, De Castro R: Evaluation of value stream mapping in manufacturing system redesign. Int J Prod Res, Vol. 46, pp. 4409-4430, (2008).
[12] Hines P, Rich N, Esain A: Value Stream Mapping: A distribution industry application. Benchmarking International Journal, Vol. 6, pp. 60-77, (1999).
[13] Keyte B, Locher D: The Complete Lean Enterprise: Value Stream Mapping for Administrative and Office Processes. New York, (2004).
[14] Emiliani ML, Stec DJ: Using Value Stream Maps to improve leadership. The Leadership and Organization Development Journal, Vol. 25, pp. 622-45, (2004).
[15] Tapping D, Shuker T: Value Stream Management for the Lean Office. Productivity press, New York, (2003).
[16] Abdulmalek FA, Rajgopal J: Analyzing the benefits of Lean Manufacturing and Value Stream Mapping via Simulation: A process sector case study. International Journal of Production Economics, Vol. 107, pp. 223-236, (2007).
[17] Pan G, Feng D, Jiang M: Application research of shortening delivery time through Value Stream Mapping Analysis. IEEE Org, Vol. 733-736, (2010).
[18] Gill PS: Application of Value Stream Mapping to Eliminate Waste in an Emergency Room. Global Journal of Medical Research, Vol. 12, (2012).
[19] Martin K, Osterling M: Value Stream Mapping: How to visualize work and align leadership for organizational transformation. McGraw-Hill, New York, (2013).
[20] Harwinder S, Amandeep S: Application of Lean Manufacturing using Value Stream Mapping in an auto-parts manufacturing unit. Journal of Advances in Management Research, Vol. 10, pp. 72-84, (2013).
[21] Dal Forno AJ, Pereira FA, Forcellini FA, Kipper LM: Value Stream Mapping: A study about the problems and challenges found in the literature from the past 15 years about application of Lean tools. The International Journal of Advanced Manufacturing Technology, Vol. 72, pp. 779-790, (2014).
[22] Marksberry P, Badurdeen F, Gregory B, Kreafle K: Management directed kaizen: Toyota's Jishuken Process for Management Development. Journal of Manufacturing Technology Management, Vol. 21, pp. 670-686, (2010).