Improvement Of Lead Time In Air Compressor Manufacturing SME Using Value Stream Mapping

Manikanda Prasath K[1], Ezhil M[2]
[1]Assistant Professor
[1, 2] Kumaraguru College of Technology, Coimbatore, India

Abstract- *Indian SME's find it difficult to boost customer satisfaction. These days, every manufacturing business aims to boost productivity while cutting waste that arises during the production of a product. The lean mindset is very focused on cutting waste. Lean manufacturing uses value stream mapping as one example. This has great advantages for SME's. Value added and non-value added activities are identified and visualized using VSM. Utilizing VSM can minimize overall production costs, decrease lead times, increase equipment efficiency, and foster improved teamwork and communication. The main goal is to use VSM to increase responsiveness in SME job-type organizations. By the removal of any potential non-value-added activity. The research is being done at a SME that makes air compressors. The current production line value stream map was created using information by direct observations and interviews which have a lead time of 4510 Min. A future state map is prepared with suggestions where 1339 Min of Non value added time is reduced which is 30% of current lead time.*

Keywords- Small Medium Enterprises (SME), Value Stream Mapping (VSM), Lean Manufacturing (LP), Non Value Added Activities (NVA), Value Added Activities (VA)

I. INTRODUCTION

In order to keep a customer in this cutthroat market, one must be able to promptly attend to their needs. Small and Medium-Sized Enterprises (SME) constantly strive to compete with their rivals in terms of product pricing and lead time reduction [1]. Companies need to enhance manufacturing processes in addition to designing and providing better goods and services. Given that time is equal to money, Less lead time is the primary client a prerequisite in the manufacturing industry, according to Roberto Arbulu [2]. Therefore, it would be advantageous to develop a system that shortens lead times and gets rid of waste, as this would lower production costs and accelerate Return On Investment (ROI).There are numerous strategies and tactics available to raise productivity and efficiency. The Lean Manufacturing (LM) system, which has been adopted by numerous manufacturing companies under various names and forms, is one of the most successful management strategies [3]. Lean Manufacturing (LM) is a set of procedures and practices for managing a production or service business, Introduced in 1950s by Toyota Production System (TPS) [4]. To reduce costs and increase production by getting rid of wasteful or non-value-added activities. One of the crucial initiatives that many significant Indian Small and Medium-Sized Enterprises (SME) been attempting to adopt in an effort to maintain their competitiveness in an expanding market is lean manufacturing [5]. This study focuses primarily on reducing lead times by cutting non-value added activities. Large-scale industries are typically the target of lean manufacturing. The majority of case studies are conducted on significant industries. The need for a generic framework that is primarily applicable to small-scale industries (SSI) is imperative. This study presents an attempt to apply VSM ideas to an SME's and examine and assess the outcomes of putting it into practice[6] [7]. One lean manufacturing method that is particularly helpful for SMEs is value stream mapping. VSM is the initial stage in implementing lean manufacturing [8]. Using VSM, value added and non-value added operations are distinguished and shown. By using VSM, one may reduce lead times, boost equipment efficiency, lower overall production costs, and promote better communication and cooperation [9] [10]. According to Rother and Shook, value stream mapping is 'a pencil and paper tool that helps you visualize and understand the flow of material and information as a product makes its way through its value stream'. Using a case study on a Medium Scale Manufacturing Enterprise (MSME), Upadhye and Garg (2010) advised using a lean strategy regardless of the MSME's status. A case study was carried out to decrease the overall lead time (LT) by doing away with non-value-added tasks. This study supports the assertions made by the VSM approach. The manufacturing company met the projected lead time of roughly three days. Through monitoring VSM in real-world scenarios, the article demonstrates its practical success.Mike Rother and John Shook (1999) in their book 'Learning to See', created the foundation for VSM. VSM was explained using a straightforward stamping factory example, and current and future state maps for the same were created [11]. This study looks at how VSM lowers lead time and enhances production lines in the manufacture of air compressors [12][13]. The enhanced area and the use of lean tools are then highlighted on a future value stream map.

II. RESEARCH METHODOLOGY

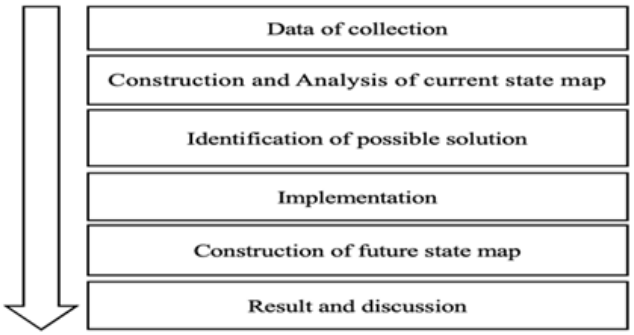

Figure. 1. Research workflow

III. EXPERIMENTAL WORK

This case study is based in a small business in Coimbatore, Tamil Nadu called Air Wing Engineering Equipment's (AWEE). AWEE employs 12 people and has 2100 square feet for its shop floor and inventories. AWEE produces 31 different types of air compressors, including single-stage, multi-stage, and high-pressure models. The complete production process is depicted in Figure 2. The model AW21, a two-cylinder, 2hp single-stage air compressor with a 200-liter tank capacity, is the most in-demand of the 31 different products that AWEE produces on a make-to-order (MTO) basis. Orders for components and customer requests are handled by AWEE's production control. The company operates six days a week in one shift of ten hours each, with two fifteen-minute tea breaks, a thirty-minute lunch break, and a ten-minute employee meeting and prayer time.

Construction of Current state VSM

The VSM begins in the top corner to the right as soon as a customer gets in touch. Following the placement of an order by a client. Production control places orders with suppliers based on the order. One days is the lead time that the supplier. Work orders are then generated by production control. The shop floor receives the work orders, and this determines the batch production. Figure 3, depicted the company's current situation. Information is sent via AWEE production control from the client to the vendor. when the movement of material is counter to the flow of information. The progression is depicted through the use of small box plots. Furthermore, each process is a data box containing the following: the number of shifts, the number of operators, the cost per shift, cycle time (CT), changeover (CO), and calculated uptime. A stopwatch was used to measure the cycle time for each procedure. Since the currents map is intended to reduce the total lead time in the production of an air compressor, the WIP inventory is regarded as a time period. The current state map has a timeline with two components on the underside. The first component deals with the production WIP waiting time, which is calculated by adding time from each inventory triangle which is WIP timings for the motor testing (2800 minutes), cylinder assembly (40 minutes), cylinder testing (60 minutes), painting (1440 minutes), final assembly (30 minutes), and quality check (60 minutes). The lead time in all of this is 4510 minutes. Value added time, which is the second element of the timeline, is computed by totalling the processing times of all the value flow steps. This accounts for the following: motor testing (30 minutes), cylinder assembly (37 minutes), cylinder testing (30 minutes), painting (4.37 minutes), final assembly (70 minutes), quality check (40 minutes) and packing (20 minutes). In all, 231.37 minutes represent the value-added time.

The uptime formula:

Uptime = Time available for production – (Changeover time + Downtime) / Time available for production
Time available for production, 1 shift 10hrs = 10hrs * 60 min/hr = 600 min/shift
Downtime = Lunch (30 min) +Tea Break * 2 (15 min) + Prayer and Meeting (10 min) = 55 min/shift

Current state Analysis and recommendations

The company's present situation and ongoing challenges indicate that customers are switching to other manufacturers due to lengthier lead times. Given that make-to-order manufacturing is the basis of operations. The current state VSM was created using observed data from the industry on labour associated with the product, cycle time, changeover time, work-in-progress (WIP), and process flow. The map was extensively analysed in order to determine the cause of the extended lead time. It was discovered that NVA in the manufacturing process the waiting period for WIP inventory, time wasted hunting for a tool, and lack of pull was the primary cause of the longer lead time. The NVA rate overall was 95%, as the pie chart in figure 5 illustrates.. This product had a lead time of nearly 3 days.

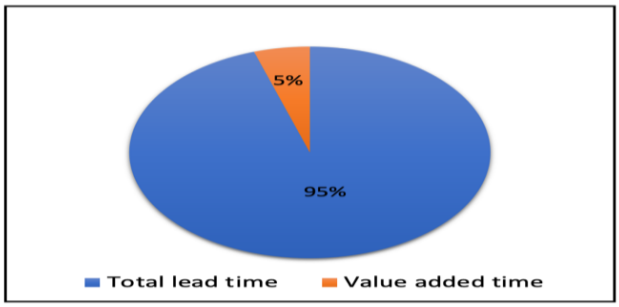

Figure.2. Pei production time percentage

5s activity

The concepts of the 5S system are the workplace organizing technique [14]. Implementing 5S in a small-scale manufacturing company and increasing efficiency by getting rid of various wastes [15]. Color coding is often utilized as part of the visual management component of the 5S system to make items simpler to discover and recognize immediately [16]. Three primary color tags, red for rejection or defect, yellow for rework, and green for an acceptable product are employed in this study to indicate work-in-progress. Movement is one of the eight lean wastes and is important to the production process. A well-designed production process minimizes worker mobility. While there are specialized methods for doing value-added analysis to detect waste movement in a manufacturing process, we shall utilize a simplified technique for our purposes. Choose a product from the shop floor, track it through the whole manufacturing process from raw

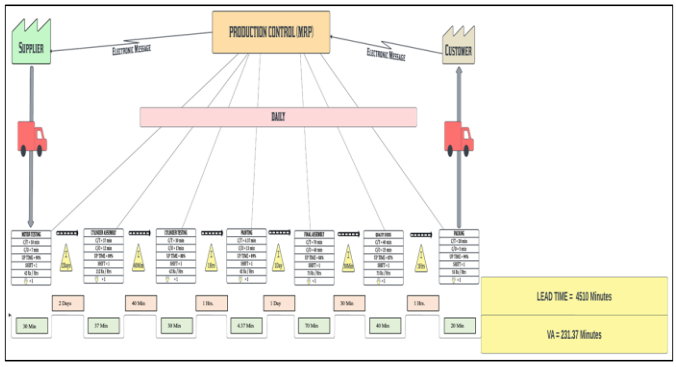

Figure.3. Current state VSM

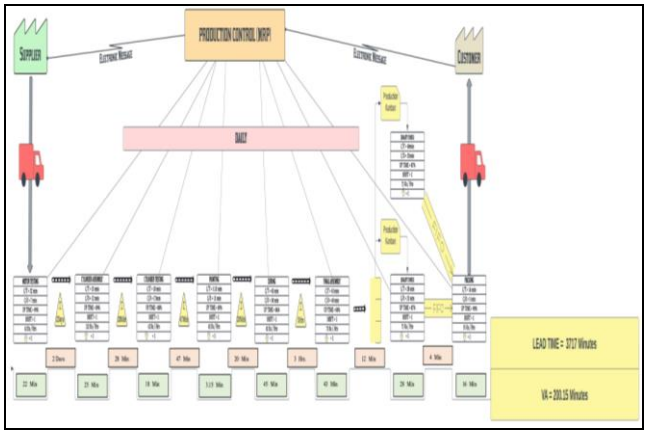

Figure. 4. Future state VSMmaterials to delivery, and record every action a worker does on the product, step by step and within the agreed-upon timings. Enumerate the employee's undesired movement timing. Analyse and remove as necessary.

Supermarket pull system

In this instance, the production type is an MTO batch production system. Whenever feasible, a one-piece result should be obtained [17]. A pull system for the quality control process may be created using the supermarket system after the final assembly process. A process's WIP waiting time might be shortened by using a withdrawal Kanban. In the future VSM, a Kanban will be utilized to indicate which product operations need to be completed.

Upgradation

Process upgrades, often called process improvement, are modifications made to existing processes with the goal of enhancing overall performance and boosting efficacy and efficiency. Continuous effort is needed to adjust to evolving customer needs, corporate situations, and technological advancements. The stronger will prevail and take the lead, according to the principles of natural selection. Nevertheless, as Small and Medium-Sized Enterprises (SME) make clear, many of the benefits of Higher productivity and improved quality can be obtained by adaptation modernization [18]. It is time for the industry to prepare itself to face the problems the market presents with conscience and effectiveness. Current trends further demonstrate that businesses that could quickly adjust to the demands of any given circumstance prospered over the long term.

IV. RESULTS AND DISCUSSION

Following the recommendations for modifications to the current VSM, a future VSM was created and presented in figure 4. The suggested modifications integrated into the current production scenario are depicted in the future state map. The use of 5S principles aims to eradicate waste that arises from an ill-organized workspace. In order to remove waste from inventory in between final assembly and quality inspection, a supermarket and the Kanban approach were then offered. The one-day of work-in-progress waiting interval between painting and the final assembly process is depicted in figure 4 current state VSM. Where by a digital semi-automatic paint curing oven, a novel method of curing, was introduced with. Following a month of installation, industry data was gathered to create the map of the future state. Following the improvement, the dramatic results were noted and acquired. Value-added time decreases from 231.37 minutes to 200.15 minutes, while lead time drops from 4510 minutes to 3171 minutes.

V. CONCLUSION

This article describes VSM is a crucial tool for implementing lean concepts in SME's [19]. Current state maps

are created during the research to show and identify various wastes in the chosen value stream. The wastes were WIP waiting period, hunting timing of tools, lack of pull. Suggestions are produced based on the organization's existing situation, which helps to eliminate NVA from the production setup. This strategy can assist SMEs in raising customer satisfaction levels [20]. Corrective steps have been implemented based on the present and future map computations, resulting in a 29% decrease in lead time.

VI. ACKNOWLEDGEMENT

completion of this case study research. First and foremost, we extend our heartfelt thanks to the Air Wing Engineering Equipment's (AWEE) shared their time, experiences, and insights, without whom this study would not have been possible. We are also immensely grateful to Kumaraguru college of technology, Coimbatore for their support and cooperation throughout the research process. Lastly, we extend our appreciation to our families and friends for their unwavering support and understanding during the course of this endeavour.

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