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ENHANCING PRODUCTIVITY BY MINIMIZING WASTES USING LEAN MANUFACTURING TECHNIQUES

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ABSTRACT
This project is targeting the optimization of the production process of a crankshaft industry through the reduction of waste and lead time through the use of lean methodologies, specifically Value Stream Mapping (VSM). This approach was initiated with the gathering of in-depth manufacturing data from the industry, and then a current state map was created. After close examination of the map, some non-value-added activities were recognized, including redundant motions of both the components and employees, inventory accumulation, unnecessary scrap creation, and rework on components. To counteract these inefficiencies, a variety of lean tools, including Kaizen, Poka Yoke, and various quality management practices, were adopted.

Keywords:
Value Stream Mapping (VSM), Lean Tools, Value Added Time, Non-Value-Added Time, Productivity & Wastages.

INTRODUCTION

The goal of Lean manufacturing is to reduce the wastes and to create more value to the current process so that the performance of the system has been enhanced considerably. Lean manufacturing tools primarily emphasizes minimizing all forms of wastes in the manufacturing process that will enhance the manufacturing lead time as well as the quality of the product. Lean Manufacturing enables Small and Medium Enterprises become highly competitive by means of improved the maximum utilization of available resources, also it is to minimize human effort and timely delivery to the customer with the anticipated level of quality.

FIGURE 1 : FIVE LEAN PRINCIPLES

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According to the current process study in the ABC company, the present scenario layout has been created. After a thorough analysis of the present scenario map with TAKT time calculation, the future state layout is suggested with the different possible improvement and an effort has been made in the production line by using the lean tools like bottleneck analysis, make or buy decision and VSM tools. Lean manufacturing, lean production, or lean enterprise, usually simply, "Lean," is a production approach that regards the use of resources for any purpose other than producing value for the final customer to be wasteful, and therefore a target for reduction. The five lean manufacturing principles are indicated in figure 1. Thus, through utilization of this concept, all those resources that do not contribute value to a product, i.e., the "waste", are identified and reduced as much as possible.

OBJECTIVES

By applying lean principles such as Just-in-Time (JIT), Kaizen, and 5S, organizations can develop a culture of continuous improvement, optimize resource consumption, and best customer satisfaction. Further, reducing waste results in a cleaner and greener production system, leading to long-term commercial success and competitiveness within the marketplace.

LITERATURE SURVEY

"The Machine that Changed the World (1990)" by Womack, Jones, and Roos[1] within this book The Value stream mapping was utilized first and subsequently, it is explored in "Lean Thinking(1996)" by Womack and Jones.

Karen Martin and Mike Osterling[2], Value Stream Mapping is the means that indicates wastefulness within operations and the way to see the work, the greater application of value stream mapping as a method of changing leadership thought and ensure customers are being delivered a high level of value.

Antor Habib Chowdhury et al.[3]. Lean tools such as VSM, 5S, kaizen, Kanban are useful to enhance productivity and also serves to smoothen the material flow. It is not easy to employ VSM in the event of numerous flows that converge.

J. Oliveria, J.C. Sa et al.[4], Lean tools application is an easy method and inexpensive solution to obtain productivity and profitability, through a constant emphasis on waste elimination by all the organization. Lean Tools are simplified tools to use, they involve all the organization and ensures the participation of all from top to bottom, they assure are the means to enable the collaborators and make manifest all the outcomes of theirs labor.

Ana Luísa Ramos et al.[5] The packaging line which was unbalanced was balanced through lean manufacturing and Simulation, simulation and lean tools line get balanced and productivity increased merge.

N. Sukdeo[6] 6 S consists of 5S + safety to the idea of safety consciousness in organization, through the utilization of 6 S. eliminates wastages increased quality and greater organizational performance.

F. K. DeLa-Cruz-to et al.[7] The authors utilize 5 S and Kanban cards to minimize the non-value-added time and increase the profit of the company. By simulation study shows that reduce the downtime by 62%.

Wai Kuan Cheong et al.[8] By changing the techniques of working and metrology tools, the author was able to reduce the non-value-added activities such as unnecessary worker movements and design the line ergonomically that assists to boost productivity.

PROBLEM IDENTIFICATION

In all manufacturing sectors, scrap is among the prominent wastes. In the manufacturing process, there were various reasons for scrap generation. A sheet was prepared with the list of all the reasons which resulted in the scrap along with the number of scraps generated for the particular reason. By using this list, the Pareto chart was drawn. From the Pareto chart, most of the scrap was created in the flange hole drilling operation machine. The primary reason was the back loading of the job on the machine. Due to the back loading of the job, excessive scrap was created and the accidents caused by this were in large numbers.

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METHODOLOGY

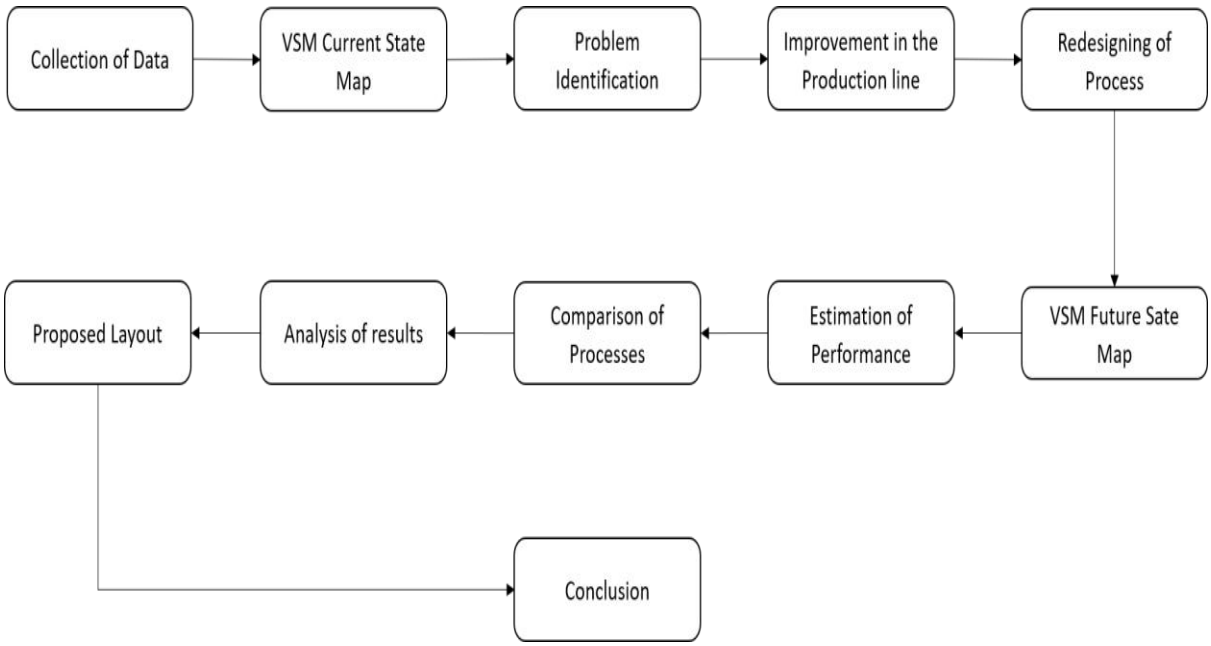

FIGURE 2: FLOW CHART

WORKING

Initially, the data was gathered from the production line. This includes process layout, process flow, cycle time for each operation, no. of inventory, the distance between two machines, distance travelled by the product from beginning to end, etc. Using this data, the Value Stream Map (VSM) was sketched. From VSM, the values of value-added time, nonvalue added time, process ratio, distance travelled by the component, number of inventories within the manufacturing line were purchased. To minimize these issues, lean tools like Kaizen, Poka Yoke, Pareto chart, and some other quality tools were implemented. Once these tools were applied, there was a minimal improvement in the process. So, the process was reengineered. Then the Future State Map was charted with the enhanced processes and data related to it. Then the comparison of both the outcomes is completed from future and current state maps in order to obtain the difference. This assumes that the process ratio was enhanced and nonvalue added time was cut significantly. Through the lean tools, productivity was enhanced. The working methodology is presented in figure 2. Utilizing lean manufacturing not only enhances productivity but also has a considerable environmental as well as financial impact. Through decreasing material waste, energy consumption, and emissions, lean supports sustainable production methods. In addition, lean organizations have better financial performance as a result of reduced costs from optimized usage of resources and waste\removal. In extremely competitive environments, lean-using companies can react quicker to shifting customer needs, change their offerings to match the market's changes, and have an excellent competitive advantage. Finally, lean manufacturing is not merely reducing waste—it is about creating a culture of efficiency, responsiveness, and ongoing expansion.

RESULTS AND DISCUSSION

The implementation of lean manufacturing techniques has led to significant improvements in productivity by minimizing waste and optimizing operational efficiency. Companies that have adopted lean principles report reduced production costs, faster cycle times, and enhanced product quality. The elimination of non-value-added activities such as overproduction, excess inventory, and unnecessary transportation has streamlined processes, resulting in smoother workflows and better resource utilization. Additionally, methods like Just-in-Time (JIT) and Kanban have helped organizations reduce lead times and ensure that materials are supplied only when needed, minimizing storage costs and waste. Another key result of applying lean manufacturing is the increase in workforce efficiency and engagement. Employees are essential in the role of pinpointing inefficiencies and

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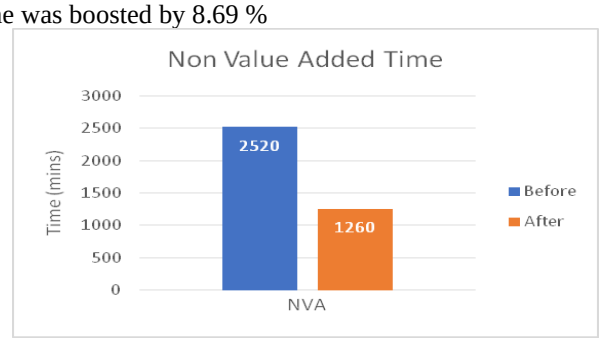
process improvements by means of initiatives like Kaizen (continuous improvement) and Gemba walks. This not only increases productivity but also promotes a culture of innovation, teamwork, and accountability within the organization. Furthermore, error-proofing techniques like Poka-Yoke have led to a significant reduction in defects and rework, improving overall product reliability and customer satisfaction. From a financial perspective, lean manufacturing has helped businesses achieve substantial cost savings. By optimizing supply chain management and reducing excess inventory, companies have been able to free up working capital and invest in further process improvements. The integration of lean with advanced technologies such as automation, data analytics, and artificial intelligence has further amplified these benefits, allowing for real-time monitoring and predictive maintenance to prevent unexpected downtime.

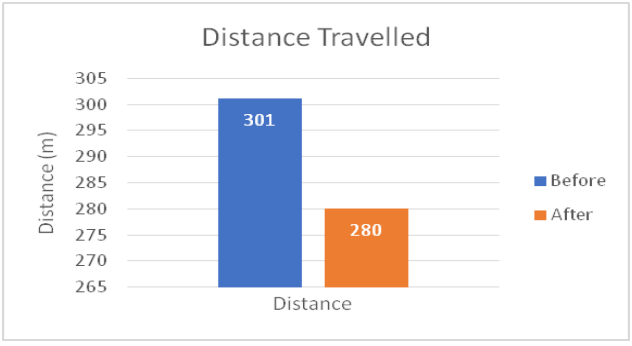
Sr.No.	Parameters	Before	After
1	VA	349.27	332.12
2	NVA	2520	1260
3	VA / VA + NVA Ratio	12.17	20.86
4	Distance Travelled	301	280
5	Inventory	66	33

TABLE 1: COMPARISON OF RESULTS

From table No. 1, by implementing the lean tools the reduction of the non-value-added time was from 2520 mins to 1260 mins. The waste of motion and travelling distance for transportation of the component was reduced by 21m. By reducing these wastes, the inventory was also reduced. The most key driver for which the lean tools were deployed was productivity. By using these tools and by the decrease of all forms of wastes the efficiency of the production line was boosted by 8.69 %



GRAPH 1: COMPARISON OF NVA TIME.



Graph 2: Comparison of the Distance Covered by the Component.

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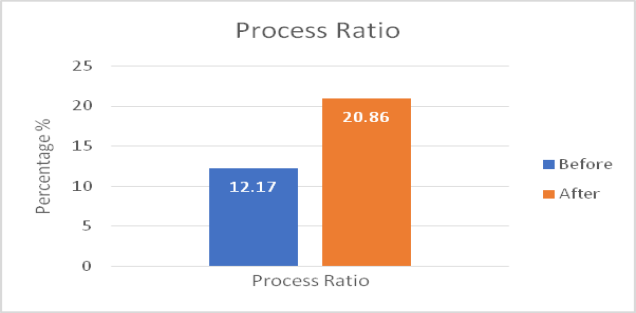

Graph 3: Comparison of the Process Ratio.

CONCLUSION

The lean tools are the instruments used for locating and eliminating the waste. The present paper aims to implement some of the lean tools into the crankshaft industry. The tools implemented within this industry were Value Stream Map, Kaizen and Poka-yoke. The manufacturing line used instruments have demonstrated exceptional result. Due to implementing the lean tools into the manufacturing line, the non-value-added time was minimized that results in customer satisfaction. The scrap generation percentage and lead time were also decreased and the manufacturing line process ratio was enhanced. As per the information gathered from the company, these methods have aided significantly in the manufacturing of more components in shorter time. It also aids in meeting the customer demand prior to the deadline.

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