PRODUCTION MANAGEMENT BY APPLICATION OF LEAN THINKING FOR INCREMENT OF PRODUCTION EFFICIENCY THROUGH VALUE STREAM MAPPING IN MANUFACTURING COMPANY- A CASE STUDY

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ABSTRACT

Lean manufacturing thinking has potential to be applied to any process in order to identify critical areas of improvement. Value stream mapping is also lean thinking which gives detailed process flow from suppler to customer consists material flow and information flow as well. Current value stream map gives current product or process efficiency and also gives where it can be improved. Accordingly, future state map is generated so that process will be more efficient as compared to previous. In this study first the data is collected from shop floor. Then applying value stream mapping to processing line. Current and future state value stream map is generated for company. The cycle time of machining station is higher than that of the TAKT time hence company cannot able to meet customer demand. Accordingly, action plan generated for the process improvement so that company can meet customer demand. Value stream map is an effective tool to describe overall process from order to delivery. In this study there is lead time reduction by generation current state and future state for process using various techniques. Thus, the main aim of this work to enhance production by reduction of lead time. Finally, gain in production, reduction in lead time and reduction in inventory between the stations are also reported.

Keyword: - *Value stream mapping, current value stream mapping. future value stream mapping, lean manufacturing*

1. INTRODUCTION

Lean manufacturing tools when used appropriately, can make the process industry reduce waste, maintain better inventory control, improve product quality, and obtain better overall operational control [1]. Improved production leads to leaner operations which help to expose further waste and quality problems in the system. Firstly of these is waste and involves unnecessary actions which should be eliminated completely. Examples would include waiting time, stacking intermediate parts and double handling [2]. Lean thinking is a more generic philosophy, and has the potential to be applied to any process in order to identify critical areas of improvement and ultimately bring about such improvements [3]. The process of mapping the material and information flows in a value stream that includes manufacturing, suppliers and distribution to the customer is called as value stream mapping (VSM). VSM has proved effective in identifying and eliminating wastes in a facility with similar or identical product routines, such as in assembly facilities [4]. Value stream map is a mapping tool that is used to map a production process or an entire supply- chain networks. It maps not only material flows but also the information flows. Lean Production development requires the analysis of the ‘value stream’, with all activities both value-added and non-value added [5]. A Current State Map is drawn to document how things actually operated on the production shop floor. Then, a Future State Map is developed to design a lean process flow through the elimination of the waste and through process improvements [6].

Lean thinking concepts in order to manage, improve and develop the product faster while improving performance and quality. Lean thinking concepts encompass a board range of tools and methods intended to produce bottom line results [7]. The implementation of a lean strategy represents a robust contribution to the phase sequence that leads to operational excellence and the continuous improvement through the elimination of non-value added activities [8]. The aim of value stream mapping are to observe material flow and information flow in real time from the final customer to the raw material and to visualize losses in the process, using symbols to represent the process visually and clearly [9]. In its simplest form, lean manufacturing is making the product flow through the process; cutting waste (eliminating non-value adding activities), lowering the total manufacturing lead time [10].

Value stream refers to those specifics of the firm that add value to the product under consideration. Value stream mapping was initially developed in 1995 with an underlying rationale for the collection [11]. A value stream shows the set of activities involved to create a product. Value stream mapping can be defined as a lean manufacturing technique used to analyze the flow of materials and information currently required to forward a product to a consumer [12]. Value stream mapping is used as a tool to detect waste in the process, developing a current mapping; subsequently a future map with the proposed improvements is generated, as well as the working and annual revision plans, used to monitor the implementation project [13]. The utmost aim of lean production is to reduce or eliminate all activities that do not add value throughout the production process. Originally, it was implemented to produce cars in Japan, but its main techniques have been applied to a wide variety of other processes and manufacturing [14]. Value stream mapping is a widely used for analysis of process chains and helps to derive potentials for improvement. The digitization of production according to Industry 4.0 promises new opportunities to make more efficient production lines [15]. Value Stream Mapping is a simple, yet very effective, method to gain overview of the status of the value streams in an industry. Based on this picture flow-oriented value streams are planned and implemented [16]. Bottleneck detection in manufacturing is the key to improving production efficiency. Yet common bottleneck detection methods in industry and academia lack either accuracy or practicability, or both, for dynamic systems [17].

2. METHODOLOGY

2.1 Selection of product family

The first step in this methodology is selection of product family [18]. Data regarding all the product families were studied, that is, volumes and amount of revenue generated by particular product family. In this study the product family is selected is axle beam housing. Then, this product family was selected for value stream mapping. The aim of this value stream mapping is to reduce or eliminate waste The processing for this product family starts with inspection. These parts are supplied by one vendor. After general inspection the processing of this part is done in five stations. After processing packaging is done and the product is ready for shipment.

2.2 Generation of Current State Map

current state value stream map shows entire organization process on one paper. It includes material flow, information flow, shop floor data like cycle time, uptime, downtime, inspection time, packaging time and material handling time. Current map shows company's current situation. It includes flow from supplier, intermediate and customer. It gives improvement opportunities where it can be improved. One of the things that differentiates a value stream map from other mapping tools is the inclusion of the information flows and material flow into the map. Current state map must include how the customers order product, frequency and method, and how company translate that back to supplier [19]. Select the relevant measures for process and record actual data at the shop floor. Make the time ladder diagram to give information about total processing time and lead times for inventory throughout the processes. Use the inventory at each stage and the daily demand to calculate the amount of stock in days and add this to the top of the time line which is non value added activity this will allow to calculate a total lead time in the processing line. The cycle time for one product is then placed in the lower portion which is value added activity and this will be added to give a total processing time. It is usual to at this point to have lead times that are several days to weeks and processing times is just few minutes which highlights just how much waste there is in system.

Fig -1: Methodology for Implementation of value stream map

2.3 Generation of Future State Map

The problems arises in the current state map should be tackled one by one. But it need a clear vision of where it should be end up so that company can focus on to achieve an agreed ideal State. The team guided by the expert should create an ideal state value stream map which should envision the absolute best the process could be, this should then be agreed by senior management as the ultimate goal of value stream mapping exercise. This Ideal state is the state where all the problems of current state map is fixed and efficiency of processing line is high as compared to current state map plan [20]. Kanban systems could be utilized to remove the need for planning and scheduling as well as many other ideas that could be considered.

2.3 Analysis of Results

Analysis of results is the last step which is important to detect where the system is efficient or not as per described in the future state value stream map Fig -1. The performance analysis should be done after implementation of action plan [21]. If the process is efficient then make current value stream map for further improvement. If processes is not efficient as compared to current state map. There is need of change in action plan so that processes will work which shows results of future state map plan.

3. EXPERIMENTAL WORK

3.1 Production flow process

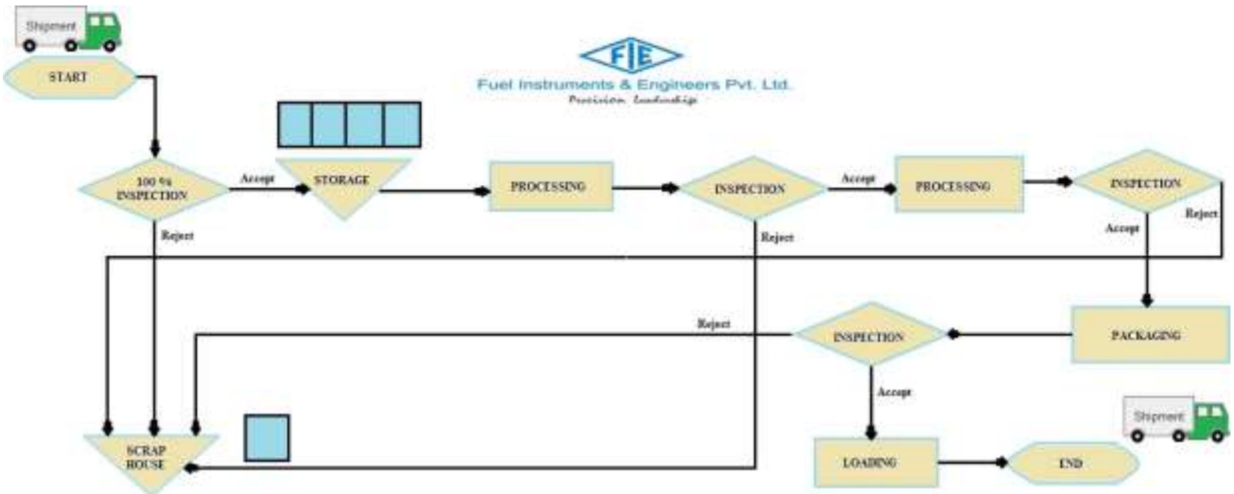

Fig -2: Production flow process for Axle Beam Housing

TATA Pvt. Ltd. gives castings for machining in FIE, Yadrav. The total processing of Axel Beam Housing is done in five work stations. Weekly there are 10 casting arrived in the company. The processing starts with the 100% inspection Fig -2. The inspection is generally done with the help of the naked eyes inspection. If any defects detected at the initial stage of the processing then the defective parts are transferred to the scrap house. From scrap house they returned to supplier Accepted parts are stored in the inventory for 1st stage machining of the axle beam housing. In first station there are 41 operations are done. After processing in the station 1 the castings should go through inspection process where Surface Roughness, weight and different holes are inspected with gauges. Rejected parts transferred to the scrap house. Accepted parts are transferred to station 3 for further processing. Again same process of inspection is done after machining at station 3. Accepted parts are transferred to the packaging area. After packaging there is again inspection, this inspection is different in this case. Accepted parts are dispatched and loading is done in vehicle for shipment and rejected parts are resorted. Here the overall processing of the Axel Beam housing is done.

3.2 Cycle time and Pareto Analysis chart

Pareto principle is also called as 80-20 principle. It states that 80% of problems are arises due to 20% of problems. The Pareto principle is used to decide the order in which the problems are to be tackled. Knowing 80% of trouble is caused due to 20% of problems the that is collected is used to identify these trouble causing problems and tackled them first. Pareto analysis is a technique to determine where to begin rectification process or to display the relative importance of problems or conditions. In this study cycle time for each operation is presented in descending order. The operation are selected from this data which contributes more cycle time in overall cycle time, i.e. if this problems gets solved it eliminates 80% of problems.

The cycle time for each operation is calculated directly on the station 1 monitor reading. Read- ings are arranger in descending order. According to Pareto principle, first 20 operations taken into consideration because first 20 operations contribute much time in overall cycle time. The total cycle time for station 1 is 200.62 minutes Fig -3.

The cycle time for each operation is calculated directly on the station 3 monitor reading. Read- ings are arranger in descending order. According to Pareto principle, first 18 operations taken into consideration because first 18 operations contribute much time in overall cycle time. The total cycle time for station 3 is 187.65 minutes Fig -4.

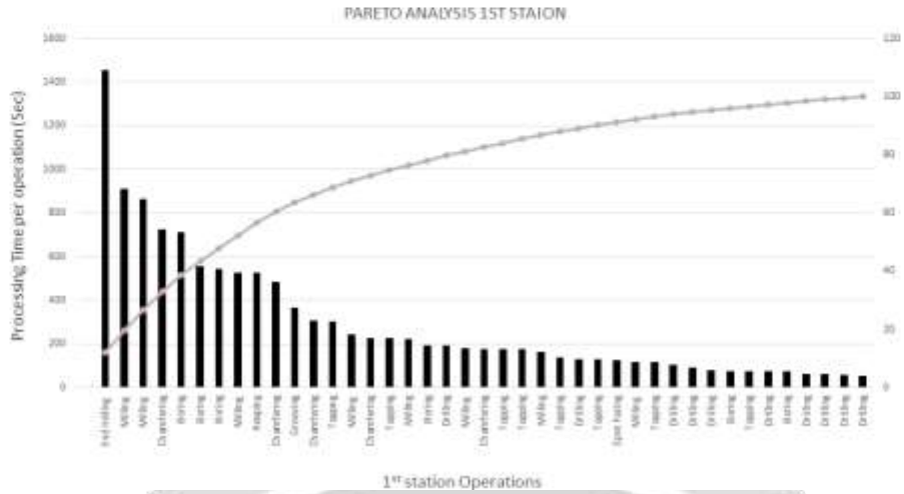

Fig -3: Pareto chart for Station 1

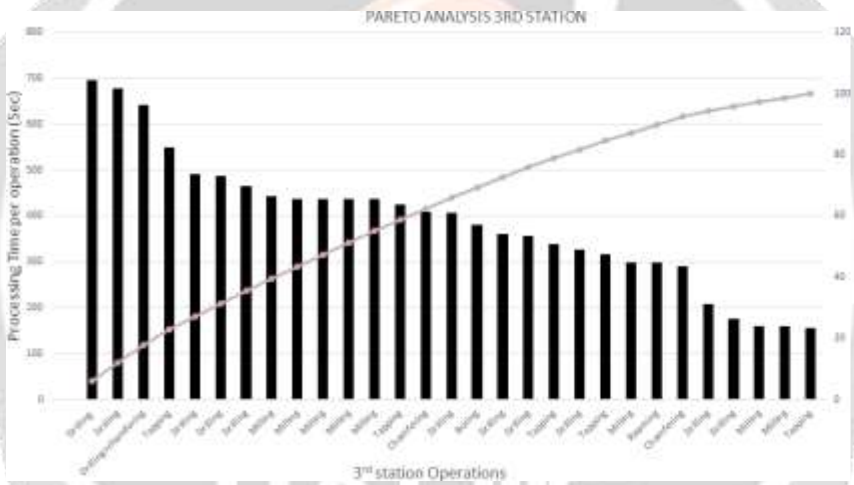

Fig -4: Pareto chart for station 3

3.3 Current Value Stream Map Plan

After selecting a product family, the next step was to draw a current state map of the existing process. Current state map was prepared with a pencil and paper using icons for various processes to visualize the flow of material and information. The manager at production control department receives the information from the customers and forecasts the exact demand. He sends this information to the supervisors at the company for preparation of schedules for processing of axle beam housing. This information is sent to supplier. When supplier get information, they estimate the date by which they think they can make it. There are one supervisor, who deals with the supply of casting of axle beam housing. This schedule becomes the basis to monitor day-by-day and week-by-week increments against how well they are in accordance with the schedule. All the data for current state map were collected from shop floor like cycle time, uptime, downtime, material handling time and packaging time. The data boxes are prepared in the value stream map to capture the data from shop floor. The information flow is also captured between customer to production control department and supplier. Supplier is supplying 10 castings per week of axle beam housing. The first station is processing station where 41 operation are done on the product. Then it moves towards station 2 which is inspection station where inspection of surface roughness, weight, holes of different diameter were checked. The production lead time and value-added time were noted on the current state map. Inventory storage points in between the stages are shown in triangles [22]. The timeline at the bottom of the current state map has two components. The first component is the production lead time (non-value added) and second component is value-added time or processing time. Value-added time is calculated by adding the cycle time for each station in the value stream. The cycle time for each is the average cycle time, which is determined by using actual data from the company. This current state map provides a picture of existing positions and guide about the gap areas [23]. It helps to visualize how things would work when some improvements are incorporated. The gap area in the existing state results in a road map for improvement. The total lead time and processing time 4.6 days and 408.27 minutes respectively Fig -5.

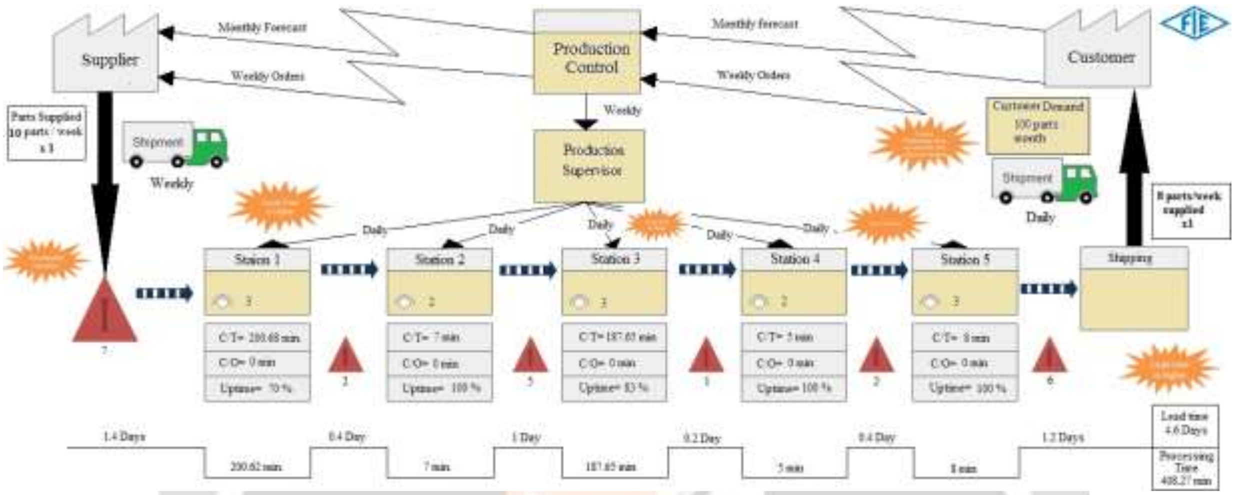

Fig -5: Current Value Stream Map Plan

3.4 Future State Map Plan

Value stream mapping means it is the graphical representation of all entire processes of the organization on one paper. The upper parts represents Supplier, customer and Production control department of the organization. While lower part of future value stream is time ladder which consists Value added and Non-value added part. The upper part of the time ladder diagram represents Non Value added activities and lower part of the time ladder diagram represents Value added activities. The time on the ladder diagram represents time required for respective operation [24]. The orange bursts represent " Kaizen" bursts i.e. it shows improvement opportunities. Maroon triangle represents inventory between the stations. The non-value added time can be calculated by taking ratio of Inventory count to customer demand at each station. The lower right part of the paper represents overall time i.e. lead time [25]. The TAKT time calculated according to available time and customer demand is 154 minutes per part Fig -6.

In this case supplier and customer are same. Customer sends monthly forecast and weekly orders to production control department via Email at company. Then production control sends weekly orders to supplier. According to future state Supplier will send 25 parts per week. This 25 parts are stored at the initial stage of the processing line which controlled inventory. In this case the controlled inventory count of part is 5. Then the parts are transferred to station 1 of cycle time 130 min and having uptime is 70% while station 2 is inspection station having cycle time 7 minutes. Station 3 is processing station will have cycle time 115 minutes and 4^{th} and 5^{th} stations are inspection and packaging stations having cycle time of 5 and 8 min respectively Fig -7. The time line is shown at the lower part of the map, which shows Value added time and Non-Value added time. If this improvement achieved the total lead time is will be reduced from 4.6 days to 3.4 days and total processing time from 408.27 to 245 min. The inventory count divided by customer demand gives lead time between stations. According to this company can make 5 parts per day hence production will be improved. For that action plan should be generated replace those cutter which have cycle time more with new cutters which are more efficient than previous cutters. Because station 2, 4 and 5 have cycle time is much less as compared to station 1 and 3, the idleness of the station 2,4 and 5 is high. If the cycle of station 1 and 3 lowered the idleness of the station 2, 4 and 5 will be lowered hence there also increment in productivity.

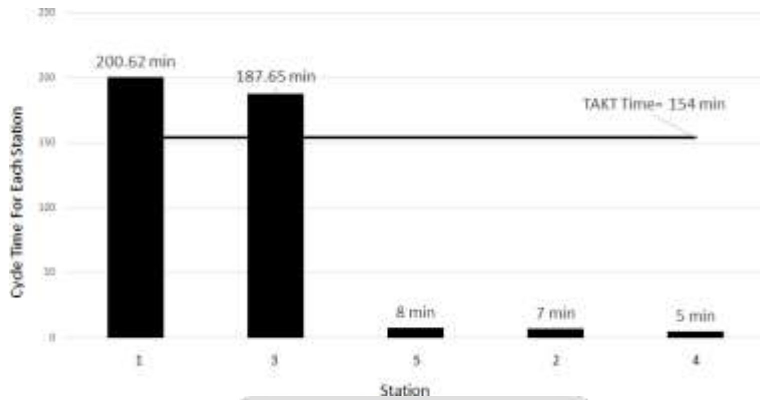

Fig -6: TAKT time graph

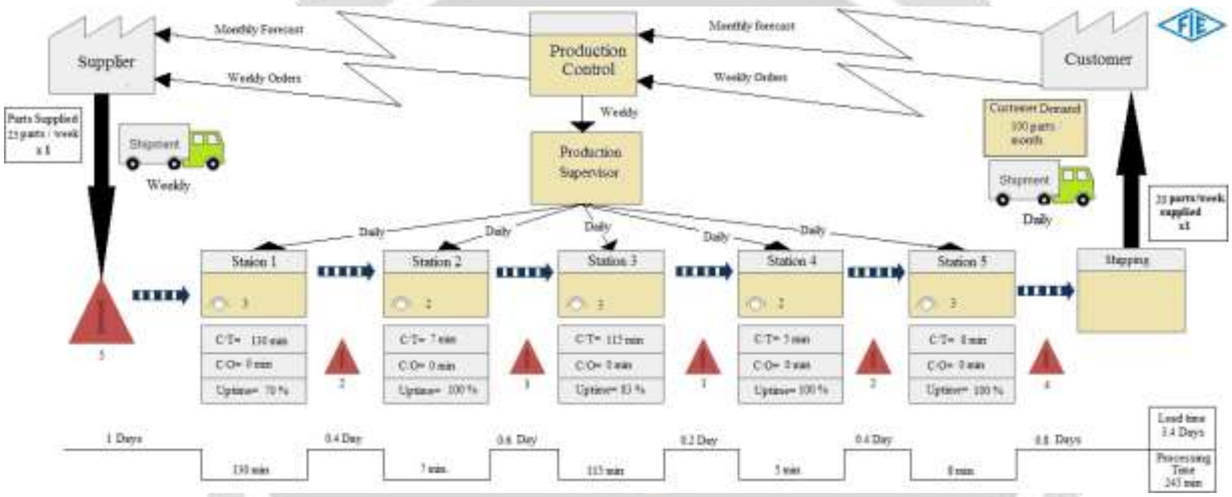

Fig -7: Future State Map Plan

4. RESULTS

The work reported in this paper develops the principles of lean information management and defines the categories of waste within the context of information, systems for its management and the information consumer. The cycle time is reduced from 200.67 minutes to 121.33 minutes for station 1 while cycle time is reduced from 187.65 minutes to 111.75 minutes. Value stream mapping is successfully implemented because the goal of future stream mapping is successfully achieved. This decreased in the cycle time increases the production of the company from 1 part per day to 5 parts per day.

5. CONCLUSION

The value stream mapping is successfully implemented because the actual lead time of the days to 3.3 days. In future research, a more detailed design of the individual steps will be developed. For example, relevant methods and tools in the different phases of value stream map must be analyzed. Additionally, the method should be applied to other companies and branches.

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