Productivity Improvement of Assembly Line using VSM Technique

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Abstract

This Project seeks to analyze the internal product flow in an Assembly line of the MCCB manufacturing company, located in Vadodara. An objective of the study is to carry out VSM for the product molded case circuit breaker which is manufactured in one of leading companies in India, to identify the non-valued added activities and reduce the same and propose a future state map to reduce the production lead time. The main objective of this study is to increase the productivity against the demand. The Quality related issue regarding material & material shortage online is not in the scope of this study. Taking a value stream perspective means working on the big picture, not a just individual process; and not a just optimization but an actual improvement. It covers value adding as well as non-value-adding activities. This study also includes layout improvement and time study report. This research shows marking benefit associated with the implementation of lean program because this project shows an industrial case study of MCCB manufacturing Assembly line.

Keywords: Value Stream Mapping, Kaizen, Cycle Time, Productivity

I. INTRODUCTION

The research study was carried out in a unit based in Vadodara, India which manufactures molded case circuit breaker also known as MCCB. The objectives for the implementation of the lean in the company are as follows:

- To study the Current State map by collecting the data from the shop floor
- To identify the problems faced by the company in terms of Non-Value Added time and minimize the waste.
- To propose Future State Value Map which can reduce Production lead time, increase the Value added time and reduce non-value added time.

II. VSM METHODOLOGY

Value stream mapping can be a communication tool, a business planning tool and a tool to manage change in process. Value stream mapping initially follows the step shown at below. Notice that future state drawing is highlighted because our goal is to design and introduce a lean value stream. The future state map is most important. Material & information flow are two sides of coin, which included in VSM methodology.

Fig. 1: VSM flow

Fig. 2: VSM Methodology
III. GENERAL OVERVIEW OF LITERATURE REVIEW

Peter Hines, Nick Rich outlined a new typology and decision-making matrices for selecting most promising waste for improvement [1]. Here, the researcher describes the most appropriate method for the particular industry, people and types of problem that exist with waste mapping matrices. The same technique of seven mapping tools for stream mapping is used by William M. In order to manage their supply chain [2]. This research is a case study of VSM implementation at a company that bakes bread and confectionery foods in Zimbabwe. The paper critically analyses the company’s manufacturing processes to identify waste streams. Ritesh R. Bhat, Prof. S. Shiva Kumar reported a noticeable reduction in cycle time and increase in cycle efficiency with an application of Kanban- “pull” system in value stream map [3]. The problems explained in this paper is machine shop are delayed deliveries, long queues, and high work in process inventories, improper utilization. These problems increase overall cost of production [4]. Rhonda R. Lummus, Robert J. Vokurka & Brad Rodeghiero use value stream concept in clinic which is non production sector [5]. Initially, there was a haphazard flow of patients and due to this patients have to wait for service and sometimes they can’t proper service. These all were NVAs for patients and the time and money required to manage them was NVAs for doctors. To manage this flow researcher design a flow pattern and the result was a 25% increase in capacity without additional capital or hospital staff. By diverting patients as per their priority for service, time required for service and allocating right patient to right doctor they achieve balanced value stream. The aim of this paper was to significantly lower patient wait time and increase patient throughput. The new system can increase the capacity of the office without adding people or equipment, lower waiting times for people with scheduled appointments.

IV. CASE STUDY

To start VSM by identifying different waste in the MCCB assembly process and then removing it by applying suitable lean tools in the process, in our case study VSM (Value Stream Mapping) is the better visualization tool to identify NVA in the process, then the FSM can make through the application of Lean principles for decreasing throughput time.

A. CSM

From the below data collected, we have identified areas for development to reduce the throughput time of Process. The current state process and related value stream mapping of as shown in Table 1 and Figures 3 & 4.

Table - 1

<table>
<thead>
<tr>
<th>Assembly Station</th>
<th>Process</th>
<th>Time(seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AS-1</td>
<td>Release Assembly</td>
<td>114</td>
</tr>
<tr>
<td>AS-2</td>
<td>Mechanism Assembly</td>
<td>128</td>
</tr>
<tr>
<td>TS-1</td>
<td>OT/CP Testing</td>
<td>150</td>
</tr>
<tr>
<td>TS-2</td>
<td>Thermal/Magnetic Testing</td>
<td>220</td>
</tr>
<tr>
<td>FS-1</td>
<td>Cover joining</td>
<td>140</td>
</tr>
<tr>
<td>FS-2</td>
<td>Mid-cover joining</td>
<td>168</td>
</tr>
<tr>
<td>Packing</td>
<td>Carton packing</td>
<td>90</td>
</tr>
</tbody>
</table>

Fig. 3: Graphical Representation of Station Timing before VSM
Calculations of CSM Ratio
- Percentage of NVA Time=Total NVA time in seconds/Total processing time in seconds × 100 = 38880/40117 × 100 = 95.5%
- Percentage of VA Time=Total VA time in seconds/Total processing time in seconds × 100 = 1230/40117 × 100 = 04.5%
- VSM Ratio=VA / (VA+NVA) =03.07 %

B. Takt Time
After completing CSM we identified the Key characteristics of the Future State and are reviewed with the Top management to obtain input and gain mutual agreement on the direction of the Future State. Looking at the current state map for several things showed up. From the German word, Takt is the word for the wand a conductor uses to control his Orchestra’s speed, beat and timing. In manufacturing, it refers to the frequency of a part or component must be produced to meet customers’ demand. [6]

Described mathematically, Takt time is:
Available time for production / required units of production
In our Case Demand is 250 units/day.
Available time for a shift is 25500 seconds.
So, Takt time = 25500/250 =102 Breaker/shift

C. Lean implementation through kaizen and development of FSM
Kaizen shows a lead role in improving the productivity and quality of the products. Kaizen is a strategy to include concepts, systems and tools within the bigger picture of leadership involving people and their culture all driven by the customer. The brain storming analysis of VSM revealed the following major NVA identified as operator’s movement and their skill, poor process, delay in material transfer and cooling time for which the proposed lean solutions are suggested as follows. Table 2 and Figures 7 and 8.

<table>
<thead>
<tr>
<th>Station</th>
<th>Task Involved</th>
<th>NVA Activities</th>
<th>Proposed solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>AS-1</td>
<td>Release inserting in Housing</td>
<td>Delay in material Pick up</td>
<td>Rake provide near Station</td>
</tr>
<tr>
<td>AS-2</td>
<td>Trip plate Inserting</td>
<td>Manually trip plate Cutting</td>
<td>Mould modification</td>
</tr>
<tr>
<td>TS-1</td>
<td>Doing CP testing manually</td>
<td>Take reading Manually &amp; note down in a register.</td>
<td>Automated set up for CP testing</td>
</tr>
<tr>
<td>TS-2</td>
<td>Thermal /magnetic Testing</td>
<td>Cooling time</td>
<td>Increase Shift timing</td>
</tr>
<tr>
<td>FS-2</td>
<td>Cover Assembly on Breaker</td>
<td>Waiting &amp; transport Delay</td>
<td>Re-lay outing</td>
</tr>
</tbody>
</table>
Fig. 6: Graphical Representation of Station Timing after VSM

Fig. 7: Future State Map

Fig. 8: Timeline Diagram of Future State Map

2) Calculations of FSM Ratio
Percentage of NVA Time=Total NVA time in seconds/Total processing time in seconds × 100 = 7650/8548 × 100 = 89.5%
Percentage of VA Time=Total VA time in seconds/Total processing time in seconds × 100 = 898/8548 × 100 = 10.5%
VSM Ratio=VA / (VA+NVA) = 10.51%

V. CONCLUSION

In our case study, applying VSM tool for the MCCB assembly, a current scenario is developed as a part of CSM to find the non-value added activities and an FSM is created by eliminating non-value added activities of the process VSM future state map shows significant improvement in the MCCB assembly process and its throughput time is also reduced to 1230 seconds to 898 seconds, Which demonstrate that any delay can be analysed through Value stream mapping. The present study provides a case study of the improvement of MCCB manufacturing industry by focusing reducing NVA activities, cycle time and increasing productivity through VSM and kaizen principles, it can be concluded that VSM and kaizen are the effective tools for identifying and reducing the process wastes respectively. By performing the technical suitability, economical justifications and feasibility analysis, we have suggested the recommendations of these tools to induct for the medium scale enterprises confidently.
APPENDIX

- Available Production Time: Available time is the shift time minus planned breaks and is measured in minutes.
- Available Operating Time: Available production time minus change over time measured in minutes.
- Lead Time: The amount of time that elapses between when a process starts and when it is completed.
- Takt time: Derived from the German word Taktzeit, translated best as meter, is the average unit production time needed to meet customer demand.
- MCCB: Molded Case Circuit Breaker
- CSM: Current State Map
- FSM: Future State Map
- VSM: Value Stream Mapping

REFERENCES

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[10] "Lean Solutions" by Jim Womack & Daniel Jones, FreePress, 2005