IMPROVING PRODUCTIVITY BY REDUCING CYCLE TIME THROUGH VALUE STREAM MAPPING IN PUMP MANUFACTURING INDUSTRY

1ANIKET B. PAWAR, 2C. A. WAGHMARE

1P.G. Student, Department of Mechanical Engineering, Rajarambapu Institute of Technology, Rajaramnagar, Islampur - 415 409, Maharashtra, India
2Professor of Mechanical Engineering Department, Rajarambapu Institute of Technology, Rajaramnagar, Islampur - 415 409, Maharashtra, India

Abstract- The value stream has all activities involved in designing, producing, delivering goods and services to customers. This paper considers the implementation of value stream mapping technique in manufacturing split case pump by pump manufacturing company. It focuses on product family current state map improvements and the future state map. The aim of work is to improve the pump productivity of the company by identify bottlenecks and non value added activity through reducing cycle time. Current state map is prepared to describe the existing position and various problem areas. Future state map is prepared to show the proposed improvement action plans. Reduction in lead time, cycle time and inventory level achieved from value stream implementation. It was found that even a pump manufacturing company can make significant improvement by adopting VSM technology. It was revealed that if we adopt the VSM technology, the company could improve productivity from 481 to 660 pumps per month.

Keywords- Cycle time, Current state map, Feature state map, VSM,

I. INTRODUCTION

Productivity has now becomes an everyday watchword. It is a crucial to welfare industrial firm as well as for the economic progress. High productivity refers to doing work in a shortest possible time with least expenditure on input without sacrificing quality and with minimum wastage of resources. Lean manufacturing is one of the initiatives that automotive companies have been trying to adopt in order to remain competitive in an increasingly global market. The focus of the approach is on cycle time reduction by eliminating non-value added activities.

This paper will show how the cycle time reductions can be made throughout the process by using value stream mapping. It analyses the processes involved in manufacturing and identifies the key areas of wastage and possible solution to overcome them. Value stream mapping was chosen as a tool to gather information on Pump manufacturing because it has been used successfully by much organization to plan and identify internal improvement.

Value Stream Mapping can be defined as the simple process of directly observing the flow of information and material as they now occur summarizing them visually and then envisioning a future state with much better performance.

The ultimate goal of VSM is to identify all types of waste in the value Stream and to take step to try and eliminate these. Waste can be part of a process that takes time and resources but adds non value to the product.

The objective of this research was to:
- To Improve Productivity Through value Stream mapping at split case pump
- Use of VSM method for data collection, draw current state map for Process Information; calculate Takt time and identification of bottlenecks.
- Preparation of action plans based on bottlenecks.
- Generation of future state map.
- Implementation of action plan.
- Monitoring result and find out the improvement productivity.

II. METHODOLOGY

To start improving productivity by identifying waste and then removing it by implementing lean principle in the Industry there is no other tool better than VSM. The Value Stream Mapping method (VSM) visualization and streamline work processes using the tools and techniques of Lean Manufacturing. The goal of VSM is to identify, demonstrate and decrease waste in the process. A manufacturing system operates with timing of step-by-step activities shown in fig 1.

“Fig.1 Steps for value stream mapping”
III. VALUE STREAM MAPPING

A. Data Collection
This section selects first the split case pump product and study of various types of pumps in split case pump. There are three types of pump models such as DSM, UP and THROUH BORE. The various machines installed in company on split case department such as VTL, VMC. Two Co-ordinate drilling machine, Rough boring machine, Rough fore side, Doosan HMC, SPM, Radial drilling machine. These machines are carried out various operations such as milling, drilling, chamfering, tapping, boring, grooving. After study of various machining operations collection data of machining cycle time. The data collection of machining time of major five type of split case pump. The data collection of cycle times in operations and machines as shown in table I.

Table I. Operation and cycle time

<table>
<thead>
<tr>
<th>Machine &amp; Operation</th>
<th>Cycle Time (Min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VTL &amp; VMC – Milling</td>
<td>36.8</td>
</tr>
<tr>
<td>Co-Drilling – Drilling</td>
<td>25.5</td>
</tr>
<tr>
<td>SBM- Boring</td>
<td>31.6</td>
</tr>
<tr>
<td>Doosan- Flange Milling, boring Drilling, chamfering</td>
<td>54.8</td>
</tr>
<tr>
<td>Radial drilling- final drilling</td>
<td>14.5</td>
</tr>
</tbody>
</table>

B. Current state map
A current state map shows work processes as they currently exist. These understand needs for change and understand where opportunity can be found. The value stream mapping appear complex, their construction was easy taken in logical steps. The current state maps should take a snapshot of current practices and material usages rates for all process. A current state map should also record where environment impact occurs in the production line. A Current state of VSM will enable you see the complete door to door flow in your facility and identify value stream wanted to analyze shows in fig 2.

C. Takt Time
Takt demonstrates the rate at which the customer buys the product. Takt reflects the frequency at which the product has to come out of the manufacturer to meet the customer demand. TAKT time is calculated by dividing available working days per month (in min) to customer requirement of parts produced per month.

Available working days in month = 25 days.
Available working time in day = 22 Hrs. Breakdown Efficiency = 0.9.

Monthly demand = 1250 pumps.
Takt Time (TT) = Available Working Time per month / Monthly demand.

\[
TT = \frac{25 \times 22 \times 0.9 \times 60}{1250} = 23.76 \text{ min}
\]

TAKT Time of 23.76 min represents, every operation has be completed each machine in every 23.76 min.

D. Identification of Bottlenecks
The reference of determined the presence of bottlenecks in the line, at any point where the cycle time is more than the TAKT time. Which machine cycle time is more than TAKT time these machines are called as bottlenecks machines. The following graph of machining operation w.r.t cycle time and determined bottleneck as shown in fig.3. The VTL-VMC, Co-ordination drilling, SBM and DOOSAN machines operation cycle time more than takt time means these machines are bottleneck machines.

“Fig. 2 Current state map”
E. Future state map

Feature state map is visual tools that show how a value stream can look after improvements have been implementing shown in fig 4. When cycle time for each process is compared with takt time it is found that cycle time of Doosan machine exceeds the takt time, so there is need to reduce cycle time of Doosan machine to meet the demand of customer within the time. So it can be improved by using various lean tools but here we are improving the cycle time of the process in the following area such as Doosan, VTL-VMC and Co-ordinate drilling machines. We are decided action plan for reduce takt time. These decided actions on brainstorming process are follows:

- Machining allowances reduction at flanges, mating faces and fit of bottom.
- Combination of boring bar to reduce boring cycle of Doosan machine.
- Use SPM and foreside milling for rough bore and flanges to achieve TAKT time by splitting Doosan machine operation.
- Convert non through bore pumps design to through bore pumps design.
- VMC machine up gradation to increase depth of cut up to taken 4 mm.
- Reduction of gap between two tools in VTL machine.
- Implementation of combination tool drill with chamfer.
- Implementation of indexing Table on radial drilling machine by splitting drilling operation of Doosan machine.
- Sister tooling arrangement on Doosan HMC machine.

These improvements are made to reduce the cycle time of the split case pump department and meet to customer demand.

IV. RESULT

Table II. Comparision of existing versus proposed (cycle time)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Current</th>
<th>Improved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production cycle</td>
<td>163 min</td>
<td>130min</td>
</tr>
<tr>
<td>variable</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The above table II shows the comparison of the existing system and the improved system. The
production cycle time has been reduced from 163 mints to 130 mints and production capacity increased from 481 to 660 respectively.

Production capacity per month \( P \) = total available time per months / maximum cycle time.

\[
P = \frac{25 \times 1056}{54.8} = 481
\]

Improvement in production \( I \) is given by

\[
I = \frac{(660 - 481)}{481} \times 100 = 37.2\%
\]

The production is increased by 37.2%

CONCLUSION

For various operation of split case pump line, data were collected from machine shop by using value stream mapping process. Based on study and data collection, sketch current state map and hence to calculate takt time from it. This takt time compare with cycle time for identification of bottlenecks and non value added activity. With the help of brainstorming process certain implementations made on shop floor for productivity improvement from 481 to 660 pumps per month. Production per month can be improved up to 37.2 %. VSM have proven to a great useful tool to eliminate some waste in a cycle and helped to more waste in next cycle.

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