CHAPTER 8

RESULTS AND DISCUSSIONS

8.1 RESULTS FROM CASE STUDY # I

The integration of QFD in VSM framework enables the systematic identification of wastes and techniques for eliminating them. The prioritized wastes in our study include

- Inventory
- Waiting
- Defects and Transport

The prioritized techniques for waste elimination include

- Kanban
- Single Piece Flow
- Quick Change Over
- Kaizen

The improvement techniques are being subjected to implementation in the case organization. In order to minimize the raw material and work in progress inventory, kanban system is under design stage to ensure streamlining of processes.
8.1.1 Single Piece Flow

As plan to work toward the goal of achieving one-piece flow, the future-state map should include the methods or tools that will improve flow. Some improvements necessary for achieving targets are identified. The list of the improvement methods will be necessary for creating and sustaining continuous flow.

1. 5S, Autonomous Maintenance and QCO at Facing & Flange facing Cell.
2. Quick changeover and Autonomous Maintenance at ID turning, Drilling and Deburring Cell
3. 5S at ID turning, drilling and deburring cell and Shipping.

8.1.2 Focus on Leveling the Production

Leveling the production is evenly distributing the work required to fulfill customer demand over a shift or a day. If do not level the production, some cells will fall behind in production causing idle time at downstream while at other times they may be waiting for work.

Reviews the following three facts, most of which are determined earlier in the process of creating the future state.

- It will be necessary to create a kanban system
- The customer has requested a container size of 5 units per container.
- The container can be reusable.
It means that every 31 min a container of 5 units must be packed and ready to ship.

8.1.3 Kanban

It has been decided that the value stream requires the following types of kanbans in the following locations:

1. Withdrawal kanbans just upstream of machining indicate the supplier how many units have been pulled from raw material inventory. These kanbans are pulled from the supermarket.

2. Production kanbans indicate operators in the facing, facing cell and turning/drilling/deburring cell how many units must be produced to fill an again those pulled from the finished-goods supermarket.

3. Signal kanbans at the in-process supermarket between machining and deburring cell how many units have been pulled from the supermarket.

4. Signal kanbans just upstream of machining indicate the material handler how many units have been pulled from raw material and ready to ship, and downstream of machining indicate the material handler how many units have been pulled from raw material inventory.
8.1.4 Mapping of Material and Information Flow

1. An operator from the turning/drilling/deburring - cell will be responsible for pulling required parts from the supermarket between that cell and facing & flange facing - cell. This is shown on the map by drawing a supermarket parts icon and a manual material pull icon between the supermarket icon and the turning/drilling/deburring – cell.

2. When the turning/drilling/deburring cell operator pulls machined parts from the in-process supermarket, the operator will also pull a signal kanban from the container and place it in a special holder on the side of the supermarket flow rack. The facing & flange - cell operator will retrieve signal kanbans when he delivers machined parts to the supermarket flow rack. To mark this activity draws a manual communication arrow and a signal kanban icon from supermarket icon to turning/drilling/deburring – cell icon. It draws a material push arrow running from the turning/drilling/deburring – cell icon to the in process supermarket icon before facing & flange facing - cell.
4. The facing & flange facing – cell operator will also be responsible for pulling signal kanbans from raw material containers and placing the signal kanbans on a special kanban post. The raw materials supplier truck driver will be responsible for collecting the signal kanbans and taking them back to the supplier’s plant. To illustrate this part of the plan, draw a kanban post icon between the supermarket icon and the supplier truck icon. A manual communication arrow and a signal kanban icon are drawn running from the kanban post icon to the supplier icon.

8.1.5 Kaizen

It has been decided to use visual controls, or visual workplace, at the turning, drilling, deburring cell and the heijunka box. It adds these icons to the map along with lead times and total cycle time.

Creating Kaizen Plan

While proceeding with the kaizen planning process, it is necessary to implement these steps:

1. Review the future state map and create a monthly kaizen plan.

2. Determine milestones for each major kaizen activity and create a kaizen milestone chart.

3. Complete the value stream management storyboard.

4. Obtain management approval for kaizen plans through catch ball.
Implementing Kaizen Plan

All the planning and preparation done so far should now allow proceeding to the implementation phase with enthusiasm and confidence. However, remember that when implementation begins in earnest, kaizen activities will have an impact on virtually everyone connected to the target value stream.

8.1.6 Improvement in Lean Performance Measures

The performance measures of lean practices include productivity, quality, cost, delivery and flexibility (Anand & Kodali, 2009). The improvement in lean performance measures are gathered from the managers of the case organization using a Likert’s scale of range 1-10 (1 indicates least improvement, 5 indicates medium improvement and 10 indicates significant improvement) and the average values are presented in Table 8.1.

Table 8.1 Improvement in lean performance measures

<table>
<thead>
<tr>
<th>Performance measures</th>
<th>Level before the conduct of the study</th>
<th>Level after the conduct of the study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Productivity</td>
<td>7.5</td>
<td>8.7</td>
</tr>
<tr>
<td>Quality</td>
<td>6.5</td>
<td>7.8</td>
</tr>
<tr>
<td>Cost</td>
<td>6.3</td>
<td>8.6</td>
</tr>
<tr>
<td>Delivery</td>
<td>6.5</td>
<td>7.9</td>
</tr>
<tr>
<td>Flexibility</td>
<td>6.7</td>
<td>8.6</td>
</tr>
</tbody>
</table>
8.2 RESULTS FROM CASE STUDY # II

After implementing the proposals, to quantify the benefits, the following measures were determined. In order to quantify the improvements from the perspective of leanness, the values of the parameters before and after implementation of VSM are presented as follows. Non value added time has been reduced from 14 to 8.5 days; Total cycle time has been reduced from 14 to 8.5 days; Work in process inventory between machines has been reduced from 20000 to 18000 units; The above result shows that, there is a significant improvement in leanness after implementing FSM.

8.2.1 Improvements

After analyzing the CSM, few proposals are identified and FSM has been proposed. Using Fuzzy QFD, proposals have been identified as 5S, QCO, SM, AM, VM, VW and WC has been implemented in FSM. To achieve quick change over, automatic loading system has been introduced; CMM has been used to speed up the inspection rate. Two Work cell has been formed by combining machining and face grinding in one cell and by combining the inspection and oil dipping in the other cell. By following autonomous maintenance policy, the non value added time has been reduced. After implementing the proposals, to quantify the benefits, the following measures were determined. The practical feasibility of the proposed approach was validated with industry decision makers who expressed their opinion that this method enables scientific prioritization of improvement proposals. During early stages of implementing lean manufacturing, all improvement proposals cannot be concurrently implemented which consumes significant amount of resources and cost. Also, adequate training needs to be provided for the workforce on various tools of lean manufacturing.
8.2.2 Leanness Performance Measures

In order to quantify the improvements from the perspective of leanness, the values of the parameters before and after implementation of VSM are presented as follows.

Non value added time has been reduced from 14 to 8.5 days;

Total cycle time has been reduced from 14 to 8.5 days;

Work in process inventory between machines has been reduced from 20000 to 18000 units;

On time delivery got increased from 75% to 80%

Defect rate has been reduced to an extent of 6%

Uptime has been increased realistically by 2%

The above result shows that, there is a significant improvement in leanness after implementing FSM.

8.3 RESULTS FROM CASE STUDY # III

The integration of fuzzy QFD and VSM framework enables the systematic identification of lean tools for the expected improvements in the process.

The expected outcomes of our case study include the following:

1. Work place cleanliness
2. Reduction of WIP
3. Reduction of changeover time
4. Reduction of manpower
5. Reduction in transportation

The prioritized lean tools in our case include the following:

1. Quick changeover
2. Kanban
3. Work cell
4. 5S

The improvement techniques are being subjected to implementation in the case organization. In order to minimize the raw material and WIP, Kanban is used.

8.3.1 Single Piece Flow

As plan to work towards the goal of achieving one piece flow, the future state map should include the methods or tools that will improve flow. Some improvements necessary for achieving targets are identified:

1. Work cell and QCO at Processes 1 and 2
2. 5S and Work cell at Processes 3 and 4
3. QCO at process 5
4. Work cell at Processes 6 and 7
8.3.2 **Focus on Leveling the Production**

Leveling the production is evenly distributing the work required to fulfill customer demand over a shift or a day. If leveling the production is not carried out, some cells will fall behind in production, causing idle time at downstream, while at other times, they may be waiting for work.

8.3.3 **Kanban**

It has been decided that the value stream requires a production Kanban which indicates operators in process 6 and 7 cell how many units must be produced to fill up against those pulled from finished goods supermarket.

8.4 **RESULTS FROM CASE STUDY # IV**

The results derived from the study are discussed as follows. The wastes and corresponding improvement proposals are

- Inspection has been removed to eliminate unnecessary Operation
- 5S should be deployed to improve the workplace cleanliness
- EHS is ensured for processes by reduction of material usage
- Defects reduction is achieved by implementing Poka Yoke
- Process Capability study need to be performed for reduction of change overtime
8.4.1 Improvement in Performance Measures

The improvements in various performance measures as a result of the conduct of the case study are mentioned as follows:

- Lead time has been decreased from 15,440 to 15,080 minutes.
- Total cycle time has been reduced from 286 to 250 minutes, refer Figure 8.1
- Reduction of work-in-progress inventory from 2910 to 2800 units, refer Figure 8.2
- Reduction in raw material inventory from 385 kg to 300 Kg, refer Figure 8.3

![Figure 8.1 Cycle time Reduction](image)
Figure 8.2 WIP reduction

Figure 8.3 Material usage Reduction
8.5 INDUSTRIAL IMPLICATIONS

The conduct of the study enabled the industry practitioners to realize the importance of lean manufacturing for ensuring environmental performances. Several sessions need to be organized for training the management and team members on the principle of waste elimination and lean extension to sustainability. This will be followed by the identification of candidate assembly line, development of current state map, scientific prioritization of wastes and improvement proposals and the development of future state map. Finally the performance measures need to be quantified in term of leanness and environmental perspectives.

8.6 MANAGERIAL IMPLICATIONS

The implementation of proposals suggested in the case study has lead to the formation of cross functional teams; management implementation towards the successful implementation of proposals has been ensured. In order to systematically implement this methodology in organizations the following steps have to be practiced. An orientation program on fuzzy QFD technique has to be conducted to the managers. They have to be informed about the steps to be followed and the resources required for its successful conduct. Then the features of fuzzy QFD technique have to be explained to the employees in an orientation program. These steps are not only aimed at creating awareness on improvements to be brought in the organization but also at laying strong foundation for successfully anchoring fuzzy QFD in the company.
After creating awareness on fuzzy QFD, and deriving the expected outcomes, lean tools have to be identified. For each problem a fuzzy QFD team may be formed. The entire fuzzy QFD program may be coordinated by a fuzzy QFD coordinator. Followed by that, meetings shall be conducted to develop the fuzzy QFD steps. At the end of these meetings, the prioritized variables have to be deduced. The proposals need to be put into implementation. The impact of this implementation shall be studied after a gestation period. Depending on the impact of agility and quality, the fuzzy QFD programme may be expanded to different levels.

8.7 ROADMAP FOR IMPLEMENTING FUZZY QFD INTEGRATED VSM

The generic roadmap for implementing Fuzzy QFD integrated VSM is presented in Figure 8.4. Initially, a Cross Functional Team (CFT) with members from different divisions of the organization needs to be identified. The team members need to be trained on the procedure of VSM and the need for Fuzzy QFD Integration. Next, a product line for trial implementation need to be identified, the team must develop the current state Value Stream Map. This will be followed by analysis of current state map to identify the wastes and improvement proposals. Then the improvement proposals will be prioritized using fuzzy QFD. The prioritized proposals will be subjected to implementation in the case organization. Finally, the improvement in lean performance measures will be computed.
Figure 8.4 Roadmap for implementing Fuzzy QFD integrated VSM

1. Form a cross functional team
2. Train the members on VSM procedure and fuzzy QFD framework
3. Identify the product line for trial implementation
4. Draw the current state Value Stream Map
5. Identify the wastes and corresponding improvement proposals
6. Develop fuzzy QFD for prioritising wastes and corresponding proposals
7. Develop future state Value Stream Map incorporated with improvement proposals
8. Measure the improvement in lean performance measures