CHAPTER 6

KNOWLEDGE BASED FOUNDRY TOTAL FAILURE MODE EFFECTS ANALYSIS

6.1 INTRODUCTION

This chapter reports the work carried out during a module of the research in which Knowledge Based Foundry Total Failure Mode Effect Analysis (KBFTFMEA) has been developed. This task was accomplished in three stages. In the first stage, the theoretical design of KBFTFMEA was carried out. During the second stage, the implementation study of KBFTFMEA was carried out in the Foundry-1. During the third stage, the portal of KBFTFMEA was developed. The details of this work are narrated in this chapter.

The foundry industry depends on the machines and human labours which play an important role in the quality of the produced product (Mohan et al 2008a). As a result, foundries face number of rejections due to the various types of defects in the products been cast which can be reduced or eliminated. Even when confronted, the labours does not know the causes of this defects and failures.

The main reason for this is the lack of a data collecting system and information sharing between the concerned department to help, trace and reduce the defects right from the processes, operations and handling (Despres and Chauvel 1999). This can be eliminated by using KBFTFMEA.
6.2 DESIGN OF KBFTFMEA

The design of KBFTFMEA was started by using the FTFMEA Table. The FTFMEA Table was adopted by modifying the FTFMEA table found in Devadasan et al (2003). A unique feature of FTFMEA is that it facilitates spontaneous team formation and also it enables the faster gathering of knowledge within the organisation. So the KBFTFMEA table thus designed during this module of research is shown in Table 6.1.

Table 6.1 KBFTFMEA Table

<table>
<thead>
<tr>
<th>Date</th>
<th>Failure Mode</th>
<th>Cause of Failure</th>
<th>Effects of Failure</th>
<th>Present Control</th>
<th>Rating</th>
<th>Departments</th>
<th>Recommended activities</th>
<th>Approved By</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>M</td>
<td>C</td>
<td></td>
</tr>
</tbody>
</table>

M - Maintenance Department, C – Casting Department

As shown in the table, a column is available to enter the date on which KBFTFMEA process was carried out. This ensures easy traceability of knowledge evolved during the conduct of KBFTFMEA proceedings. In the table, a column for entering the value of rating by using a Likert’s scale of range 0-10 is used to simplify the process of indicating the seriousness of the failure and to correct it with ease.

The procedure to be followed to estimate the rating in KBFTFMEA table is presented elaborately in the next section. Another column enables the entry of the names of department which are associated with the failure and the column allows entering the rating, in regard to their interdependence to the failure being analysed. This facility allows the development of KBFTFMEA table in all the associated departments where the ratings may differ according to the impact of the failure being analysed. This facility helps in the formation of cross functional team because every concerned department is required to depute at least one personnel to analyse and enter the ratings.
Thus the formation of KBFTFMEA table facilitates team building, rating of failures using simple Likert’s scale, evolution and sharing of knowledge impregnated into the organisation to overcome the failures (Abou-Zeid 2002). This process KBFTFMEA implementation would increase the organizations global competitiveness and core competence. Besides, these organizations would also be encouraged to evolve its own portal to enable both local and global knowledge workers to participate in KBFTFMEA process(Call 2005; Davis et al 2005).

The functionality of KBFTFMEA was designed by adopting the one that is specified in Knowledge Management field. The reference model used for this purpose is shown in Figure 6.1 (Despres and Chauvel 1999; Uit Beijerse 2000; Abou-Zeid 2002; Greiner et al 2007; Choo et al 2007; Davies et al 2005; Lian – Yu et al 2006; Randeree 2006; Tseng 2007).

![Figure 6.1 A model of knowledge management](image)

6.3 LIKERT’S SCALE RANKING IN KBFTFMEA TABLE

In the case of KBFTFMEA, the criterion for developing ratings is based on the deliberation of the team members with their department to know the satisfactory level of customers with regard to the failure considered. Also the team members deliberate with themselves with all the inputs given by their department to rate the failures in the Likert’s scale of range 0-10, the reckoner shown in Table 6.2 were developed.
### Table 6.2 Reckoner for rating

<table>
<thead>
<tr>
<th>Category</th>
<th>Value of the response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very difficult to implement</td>
<td>Average value &lt; 3</td>
</tr>
<tr>
<td>Difficult to implement</td>
<td>Average value &gt;3 and less than 6</td>
</tr>
<tr>
<td>Easy to implement</td>
<td>Average value &gt;6 and less than 8</td>
</tr>
<tr>
<td>Very Easy to implement</td>
<td>Average value &gt;8</td>
</tr>
</tbody>
</table>

As shown, the criteria to be considered for allotting Likert’s scale ranking in the range of 0-10 are indicated in those reckoners.

A study of this rating procedure would reveal that with the increase in the rating in the Likert’s scale, the chance of eliminating the failure is very high so that the quality will improve. Thus the criteria and ratings allotment design of KBFTFMEA table enable the failure prevention from the customers point of view. Moreover the criteria specified are very specific, so that in any case there is little chance that the allotment of ratings will vary according to the individual’s perception on the failures.

### 6.4 ROADMAP FOR IMPLEMENTING KBFTFMEA

Even though Foundry-1, as a company is aiming to grow progressively, the awareness of FTFMEA and KBFTFMEA was not prevailing in its environment. In the earlier chapter the implementation of FTFMEA was studied. As a continuation of improving quality KBFTFMEA is being incited. Hence KBFTFMEA implementation has to be carried out by following a roadmap which will help the companies to follow and lay the foundation for its successful implementation to reap the benefits. In order to meet this requirement, the roadmap shown in Figure 6.2 was designed.
As shown, this roadmap elucidates the importance of KBFTFMEA to the top management. During this stage, the top management is presented the power of information technology for improving the quality of the product. Subsequently the working of KBFTFMEA is to be illustrated using a sample example. The benefit of applying KBFTFMEA as an extension of the FTFMEA is projected clearly during this stage. On completion of this stage, the commitment and support of management towards the implementation of KBFTFMEA shall be obtained. As requested by the management the benefits and the working of the KBFTFMEA is also presented to the team members of FTFMEA for their approval.

In order to express their commitment and support, the top management executives provided the resources there by contributing towards the implementation of KBFTFMEA. Since KBFTFMEA implementation requires advanced knowledge on the processes, Information Technology and team working principles, for implementation, the personnel’s associated with the implementation process should be eager to acquire knowledge management principles and IT knowledge to provide solutions by successfully implementing KBFTFMEA.

Out of all potential areas, one is chosen and KBFTFMEA project is implemented. This kind of restricting the experimentation to a small area is referred to in literature as “Pilot implementation” (Greiner et al 2007; Oakland and Tanner 2006). The results of this implementation shall be examined and a procedure to implement KBFTFMEA in other potential areas may be developed. This implementation procedure ensures uniformity in approach on implementing KBFTFMEA projects. After a specified period, the implementation results are examined.
Educate the importance of KBFTFMEA to the Top Management

Identify potential areas for applying KBFTFMEA

Implement KBFTFMEA in a potential area

Examine the results and develop a procedure to implement KBFTFMEA in other potential areas

Implement KBFTFMEA in all potential areas

Examine the results and if needed, refine the KBFTFMEA implementation procedure

Develop vision, policy, procedures and work instructions to suit KBFTFMEA implementation

Review the results periodically and improve the performance of KBFTFMEA programme in the company

Figure 6.2 Roadmap for KBFTFMEA
If need arises the implementation procedure shall have to be modified and refined. Since KBFTFMEA implementation aims for the upliftment of the company towards its vision, therefore the company’s policy, flow processes and work instructions need to be refined and improved at each and every stage. Since KBFTFMEA is a continuous improvement process, its implementation results are to be reviewed periodically. If found necessary, the implementation aspects need to be refined and improved so that the performance of KBFTFMEA programme leads to the reaping of its authentic benefits.

6.5 IMPLEMENTATION STUDY

The practicality of KBFTFMEA in an industrial scenario was examined by conducting an implementation study at Foundry-1. The examination of practicality of KBFTFMEA at Foundry-1 was started after completing and implementing the FTFMEA model. The failures reported by various departments were gathered from the records and by consulting the team members associated with the foundry process. Finally a statistics of the failure and their frequencies were gathered. These details are pictorially depicted in Figure 6.3

According to the frequency of the failure as well as the opinions of the concerned personnel, the FTFMEA Tables were developed. By using the FTFMEA Tables developed in the previous chapters as the database for the corrective action to be implemented in the Foundry-1.
### Figure 6.3 Failure statistics

The major failures in the tables were considered for examining the practicality of KBFTFMEA.

- Melting Composition Failure
- Cold Lab
• Sand Diffusion
• Blow Holes
• Box Leak
• Short Pour
• Sand Inclusion
• Core Defect
• Shrinkage
• Broken
• Excess Grinding
• Slag Inclusion
• Mould Break
• Fusion
• Chilling
• Inclusion
• Scabbing
• Pin Holes

Subsequently a KBFTFMEA team is formed which includes the members of the FTFMEA team who are familiar with the IT and new members with the knowledge of IT are added to the formed team to deal with those failures. The KBFTFMEA members interacted with each other and generated the knowledge required for solving the failure and the method of using KBFTFMEA Table as well.
PORTAL FOR KBFTFMEA

While conducting the proceedings of KBFTFMEA, a prototype of KBFTFMEA portal was developed by using Netbeans 7.0 software, JSP as front end, MS Access as back end and Dreamweaver as the designing tool. The functionality of this portal is explained in this section. On invoking the KBFTFMEA portal, its home page shown in Figure 6.4 appears. In order to initiate its working, the administrator has to appoint a Coordinator.

![Portal of Knowledge Based Foundry Total Failure Mode Effect Analysis](image)

**Figure 6.4 Home page of KBFTFMEA portal**

In case an already appointed coordinator is to be removed, based on the description of the top management, that process can be done by the administrator using the same window. After appointing the coordinator and assigning his/her password, the same information is passed to him/her through email. Now the coordinator enters the portal of KBFTFMEA and the window shown in Figure 6.5 appears through which the coordinator is able to initiate
the formation of KBFTFMEA team (hereafter referred to as team) for the failures to be considered.

![Figure 6.5 KBFTFMEA Team leader formation window used by the Coordinator](image)

For this process he/she is required to enter the department to identify the KBFTFMEA team leader (hereafter referred to as team leader). During this process, the team leader is allotted a password. Also his/her email address is entered. Then the interactive departments associated with the failure are also identified. This window also enables the coordinator to prepare the report of the team based on the knowledge shared and its performance. The coordinator is also permitted to remove a team using this window.
After coordinator informs the respective team leader about the formation of team, the team leader nominates the KBFTFMEA team members (hereafter referred to as team members). The window enabling the team leader to carry out this process is shown in Figure 6.6.

![Figure 6.6 Window enabling the formation of team members by the team leader](image)

**Figure 6.6  Window enabling the formation of team members by the team leader**

Now the team leader informs the team members about their nomination and passwords allotted to them. Team members access the KBFTFMEA portal by entering their passwords. The team members can now view the details like the various processes, failure analysis report and KBFTFMEA drawings. The team member who wishes to enter the details in the KBFTFMEA table can do so by pressing the button ‘KBFTFMEA Table Entry’. On pressing this button, the window enabling to make entries in KBFTFMEA Table shown in Figure 6.7 appears.
As shown, this window enables the team members to enter the relevant details which include the date of entry. The screen also displays the departments associated with the failure and its rating. On submission, the team member can view KBTFMEA Table and verify the contents. One of such screens is shown in Figure 6.8.

When the members complete entering the details in KBTFMEA Table, the coordinator can prepare the report by pressing the button ‘Failure details’, in KBTFMEA formation window (Figure 6.4). During the preparation of this report, coordinator can view KBTFMEA tables completed by the team members and utilize the extracts of them to prepare the report. The coordinator is also permitted to upload the drawing of the failure and defects considered to indicate the KBTFMEA ratings. One of such drawings which can be viewed by pressing the button ‘KBTFMEA Drawing’ is shown in Figure 6.9.
Figure 6.8  Window displaying a KBFTFMEA table

Figure 6.9  A drawing uploaded by the coordinator
As shown, by clicking this drawing a window opens showing the interactive departments with regard to the failure.

![Defect Table]

**Figure 6.10 Failures in the interactive department related to the drawing uploaded by the coordinator**

These details are automatically added by the portal of KBFTFMEA after the uploading of the drawing and the members entering the necessary details in the KBFTFMEA tables. On choosing the department, the KBFTFMEA table pertaining to that department appears (Figure 6.11).

The system also provides a way for the employees to communicate between them. By using the problem reporting screen the problems encountered by the workers in the processes can be entered so that it can be seen by all the members of the team (Figure 6.12). The suggestions screen shows the answers to those questions given by the team members (Figure 6.13). This system can be prolonged to an extend where all the employees can open the portal and type the problems faced in their day to day activities and
the suggestion to rectify them can be entered by any employee of the company including the team members.

![Table of Failure Information](image)

**Figure 6.11 Window displaying a KBFTFMEA table reported for the drawing uploaded**

This creates a platform to share and communicate knowledge within employees and it paves the way to prevent, reduce or eliminate failures which the employees are not ready to disclose as these failures may be due to their carelessness or misunderstanding for which they might be held responsible.

Besides the coordinator, team leader and team members, the portal of KBFTFMEA can be enabled to make the external users to access it. Those members can choose ‘Others’ in the Home Page (Figure 6.4). After registering they can enter as ‘External user’. They can view the details namely the company profile, process details, product details, failure analysis report and KBFTFMEA table. They can also write their suggestions. The coordinator may also consider those suggestions while preparing the report.
Figure 6.12 Problem entry screen

Figure 6.13 Suggestions screen
A study of the portal of KBFTFMEA would indicate that it enables the creation, acquisition, sharing and utilization of knowledge which are essential to enhance the performance of KBFTFMEA projects. As mentioned above, the KBFTFMEA portal enables four users to use the global knowledge for executing KBFTFMEA projects. In order to allow the tactical usage of global knowledge, the users are allowed to use only the relevant facilities of the KBFTFMEA portal. Those details are shown in table below.

**Table 6.3 Facilities allowed for usage to the four categories of KBFTFMEA portal users**

<table>
<thead>
<tr>
<th>Facilities</th>
<th>Coordinator</th>
<th>Team Leader</th>
<th>Team Member</th>
<th>Others (External users)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company Profile</td>
<td>Allowed</td>
<td>Allowed</td>
<td>Allowed</td>
<td>Allowed</td>
</tr>
<tr>
<td>Products</td>
<td>Allowed</td>
<td>Allowed</td>
<td>Allowed</td>
<td>Allowed</td>
</tr>
<tr>
<td>Failure Analysis Report</td>
<td>Allowed</td>
<td>Allowed</td>
<td>Allowed</td>
<td>Not Allowed</td>
</tr>
<tr>
<td>KBFTFMEA Drawing</td>
<td>Allowed</td>
<td>Allowed</td>
<td>Allowed</td>
<td>Allowed</td>
</tr>
<tr>
<td>KBFTFMEA Table</td>
<td>Allowed</td>
<td>Allowed</td>
<td>Allowed</td>
<td>Allowed</td>
</tr>
<tr>
<td>Write Knowledge</td>
<td>Not Allowed</td>
<td>Allowed</td>
<td>Allowed</td>
<td>Not Allowed</td>
</tr>
<tr>
<td>View Knowledge</td>
<td>Allowed</td>
<td>Allowed</td>
<td>Allowed</td>
<td>Not Allowed</td>
</tr>
<tr>
<td>View Suggestions</td>
<td>Allowed</td>
<td>Allowed</td>
<td>Allowed</td>
<td>Not Allowed</td>
</tr>
<tr>
<td>KBFTFMEA Table Entry</td>
<td>Not Allowed</td>
<td>Not Allowed</td>
<td>Allowed</td>
<td>Not Allowed</td>
</tr>
<tr>
<td>Write suggestions</td>
<td>Allowed</td>
<td>Allowed</td>
<td>Allowed</td>
<td>Allowed</td>
</tr>
</tbody>
</table>

As shown, ‘Others’ are not allowed to use facilities like KBFTFMEA Table entry. Thus KBFTFMEA portal can be used to link with world wide web but would ensure that the company’s confidential data and information are not leaked to the outside world.
6.7 CONCLUSION

In Foundry-1, after the application and implementation of FTFMEA model, the practical implications of KBFTFMEA was designed and implemented with the help of the data collected from the FTFMEA Table. The experiences of conducting the implementation study indicate that the implementation of FTFMEA model in the company had helped to a great extent in the implementation of KBFTFMEA in the foundry.

As a whole the KBFTFMEA was helpful in understanding the mistakes done by the workers and by using the tables and drawings the hesitance of the worker to ask their doubts, carelessness and their misunderstanding of the process has reduced thus reducing the defects. It also gave them a platform to share and communicate knowledge within the foundry to reduce the failures.

The main ingredient of successful KBFTFMEA would be the commitment of both the management and the employees to gather knowledge and applying them to prevent the recurrence of failures. During this process, both the management and employees shall have to spend certain amount of time to access the global knowledge through portals. The FTFMEA Tables and the FTFMEA drawings can be taken as printout and can be displayed at processing areas where the failures are to be eliminated. It also helps in training the workers about the work instructions and understanding the work procedures by seeing the drawings. From the KBFTFMEA implementation study the inference that was noted are that, irrespective of the level of education both the management and the employees would be able to reap the benefits of this user friendly and interactive concepts of KBFTFMEA and exploit it to acquire global knowledge through IT and thereby achieve continuous quality improvement.