CHAPTER 8

CONCLUSION

8.1 INTRODUCTION

During the recent years, competition has intensified due to globalisation and organisations which have been in the forefront of contributing quality products at competitive prices to the customers who have emerged as winners (Natarajan et al 2011). This initiated the concepts of FTA, FEMA, and TFMEA to integrate the day to day operations and to improve the quality, thus preventing, reducing or eliminating the failures of manufacturing organisations. Modern customers are demanding innovative and complexly designed products in varied volumes (Vinoth et al 2010) which can be produced by batch production. In order to fulfil the customers demand, it has become mandatory for all the manufacturing organisations to implement quality improvement methods. However, the effectiveness of FMEA and TFMEA initiatives in manufacturing organisations is not adequate to reduce or eliminate failures, thus improving quality of products. This is due to the absence of a model which could adequately identify and address the failures occurring along the production process of any manufacturing organisations. During the last two decades, numerous researches and applications of FMEA and TFMEA have been reported in literature (Case et al 2010; Puente et al 2002; Wang et al 2003). Yet these are problem and are industry specific. The literature survey reported in the second chapter of this thesis was conducted to identify the unconquered arenas in products and manufacturing areas. The foundry industry producing castings is one
among them. The doctoral work reported in this thesis has resulted in the contribution of FTFME model and KBFTFME whose implementation would overcome the failures in the manufacturing processes prevailing in contemporary foundry industry.

8.2 MAJOR LOOPTHES IN FOUNDRY INDUSTRY

The FTFME model contributed in this doctoral work will be useful to precisely identify, locate, analyse and reduce or eliminate failures occurring in every stage of the production process of foundry industry. FTFME model would enable the foundry industry to achieve continuous quality improvements in process and performance, through the FTFME team, to identify failures among the various department, their interrelations with other associated department and the recommended actions, to reduce loss due to failures.

Foundry industries need to supply the products with higher degree of quality at competitive prices in time to the consumers, which is hindered by constrains existing in real time scenario, along with the dynamic change in demands. This is due to four reasons.

First, work instructions to operators working in each and every stage of the casting process are not properly conveyed. In some cases, the operators work by presumption rather than sticking to the basic work instructions. This disruption in the working instructional procedure causes failure along the production process.

Secondly, the untrained workers in the foundry industry are the major cause of failure. The foundries are devoid of workers and are getting the workers who are not well educated and untrained. Industry does not take legitimate steps to train and educate them. The language barrier existing
between the workers and the other employees make the situation more difficult to reduce failures. Workers fatigue also plays an important role in occurrence of failures.

Thirdly, production process has not been changed or upgraded over the years with newer technologies due to the high investment required, which ultimately leads to compromise in quality as customers demand products with higher quality and quantity within a short period of time by employing limited resources and associated production utilities.

Fourth, maintenance plays an important role in reducing failures. As foundry is dependent entirely on workers and machines, the failures occurs due to the lack of maintenance. Preventive maintenance is the need of the hour for the foundry industry as the systematic and regular maintenance at regular intervals according to the charts prepared are necessary to prevent machines from breakdown and to eliminate failures due to it. But foundries go for breakdown maintenance rather than preventive maintenance due to lack of workforce and cost incurred.

In the real time scenario, the reasons for the occurrence of the failures are not even noted down to address them, in order to prevent, reduce or eliminate them in future for achieving process and quality improvement. Hence FTFMEA model has been incorporated with the ability to list all the failures, identify their associated departments, defects and analyse their root cause while recommending and implementing the actions required to eliminate or reduce them in the foundry industry. The data about the past failures along with the present can be updated in the databases for future reference for failure prevention by using KBFTFMEA.
8.3 INVESTIGATIONS

After designing FTFMEA, two investigations were conducted to validate the model. These implementations were separately conducted in Foundry-1 and Foundry-2. It was found that loss reduction was achieved to a greater extent by reducing failure and improving quality after implementing FTFMEA. Hence, the FTFMEA was found to be suitable for foundry industry by appropriately addressing the process failures and identifying ways to rectify them. This implementation result led to the design and development of KBFTFMEA.

KBFTFMEA was developed as a FTFMEA model driven system where the steps needed to practice them have been stored in database. In order to validate KBFTFMEA, the implementation was done in Foundry-1 after implementing and using the results of the FTFMEA model. The integration improved the data management and the use of knowledge, development of FTFMEA table and FTFMEA drawing which lead to loss reduction and continuous process, quality and performance implement in Foundry-1 after implementation.

8.4 CONTRIBUTIONS

The contributions of the doctoral work reported in this thesis are highlighted below:

- The literature was surveyed in TQM, FTA, FMEA and TFMEΑ domains. The results of the literature survey were used to select the TFMEΑ due to its holistic approach, inherent advantages and ease of implementation.
• Identification of engineering products and manufacturing sectors unconquered by the researchers and practices.

• Through the conduct of literature survey, the knowledge required to achieve continuous quality and process improvement in TFMEA was gathered. This knowledge was used to design FTFMEA model.

• During the doctoral work, distinct 8 implementation steps of FTFMEA were evolved. These steps would be useful to the practitioners for implementing FTFMEA model in foundry industry to achieve continuous quality and process improvement.

• Implementation studies on FTFMEA were conducted in two foundries. The illustrations of these investigations presented in Chapter 4 and 5 of this thesis which were implemented by employing its eight steps.

• The experience and results obtained in implementing FTFMEA model in two foundries were used to design and develop KBFTFMEA which was implemented in Foundry-1 and investigated.

On the whole, the doctoral work reported in this thesis had contributed the FTFMEA model and KBFTFMEA whose design and development was carried by making use of scientifically tested research practices and investigated by conducting the implementation studies.
8.5 LIMITATIONS OF THE RESEARCH

Emphasis was given during this doctoral work to strike a cord between theory and practice. Yet due to the inability to study the intriguing aspects of applying this research in practical real-time environment, certain hurdles could not be avoided. They are highlighted below:

- The rationale behind allotting the ratings for the failures and their interrelated departments is not supported by research findings.

- The benefits of FTFMEA model can be encompassed only when the practitioners are aware of the quality improvement principles. Due to the lack of awareness about the importance of quality improvement and a system standard to eliminate failure the management do not instigate any training programme to educate their employees for successful implementation of FTFMEA.

- The workers are all from other states who are not well educated, unqualified, untrained and do not work at one industry for a long time. So the management are not willing to invest money or time to train and educate them, also interacting with them was not possible due to the language barrier and unwillingness nature of the workers.

- The model developed was based on the process and not the product. So an attempt can be made to include both product and process FTFMEA model.

- The proposals derived to reduce failures in Foundry-1 have been only practically accepted by the management of Foundry-1.
Despite the above limitations, it was encouraging to see the results of FTFMEA model which was used to implement and investigate the model in Foundry-1 and could also be implemented in Foundry-2 successfully. Hence, the FTFMEA model, KBFTFMEA will be helpful to prevent and eliminate failures in any type of foundry.

8.6 SCOPE FOR FUTURE RESEARCH

Since FTFMEA is flexible in nature, the doctoral work reported in this thesis could be further extended for improving the manufacturing processes carried out in the foundry industry to reduce failures. This model could also be extended to other manufacturing industries and the practical capability of FTFMEA in achieving continuous quality and process improvements by reducing failures could be studied. These results could be used either to affirm the practicality of FTFMEA model in any manufacturing industry. Alternatively, these results may be used to refine and improve FTFMEA model so as to make it more effective in reducing or eliminating failures.

The model developed was based on the process and not based on the product. So the future researches can look for means and ways to combine both the product and process to implement a model to enhance the model capabilities.

The KBFTFMEA was found to be helpful to reduce paper based record keeping, achieving loss, and reducing failure through failure elimination, carrying out futuristic FTFMEA initiatives, implement proactive strategies and thus achieving continuous quality and process improvement. However, KBFTFMEA possess scope for further improvement by including video conferencing, electronic data interchange, automatic warning and failure detection system, for each and every product being made. Concepts
like fuzzy logic and artificial intelligence (Li et al 2009 and Ganzalez et al 2009) can also be incorporated in it.

8.7 CONCLUSION

The results of the doctoral work reported in this thesis and their analysis revealed that FTFMEA model could be employed for reducing or eliminating failures in the production process of a foundry industry. It would facilitate the inculcation of continuous quality improvement culture to prevent and reduce losses. The endeavours made in this direction will enable the foundry industries to face the onslaught of global competition through sustained development of process and products in response to the dynamic demands of the customers and to achieve business prosperity. However, the FTFMEA model can still be improved and refined by incorporating the results of conducting many case studies, to examining its implementation aspects. This will make FTFMEA model more powerful in enabling the modern manufacturing organisations to implement, and reduce failures thus improve quality to achieve their business goals. The KBFTFMEA could be used as a supporting tool for successfully implementing FTFMEA in manufacturing organisations.