CHAPTER 1

INTRODUCTION

1.1 GENERAL

Currently, customer satisfaction and delightfulness is the key to the success of any business in today’s competitive global market (Thammell et al 2004; Upadhya et al 2010). The global market demands higher product quality and service at a very competitive price (Oakland and Tanner 2006). Due to globalization, customers have been empowered to demand varieties of products and services in multiple of volumes (Ahuja and Khamba 2009; Murphy et al 2011; Coa and Doulatshasi 2005). Hence modern companies should be able to cater to the customer demands in a dynamic and cost effective manner (Kess et al 2010; Li et al 2009; Tierney et al 2012).

To obtain this, continuous improvements in the processes has to be done to improve the competitive advantage of the organisation (Ophime et al 2011; Claudio et al 2010; Zervos 1991). During the recent years, there has been an increasing thrust in the area of “Total Failure Mode and Effect Analysis” (TFMEA), which is becoming a key competitive success factor in Manufacturing (Brown et al 2008; Chen et al 2006). In order to retain the customers, amidst the fierce competition, without reducing the profit margin of the organisation, it is mandatory to review the current process failures by using TFMEA. To identify, prioritised corrective actions are to be made in case of defects to reduce or eliminate the failures. It also provides the cause and effect of the potential failures in the organisation for implementing
continuous process improvements (Kutlu and Ekmekcioglu 2012; Chang and Sun 2009; Angell and Chandra 2001).

An outlook of the researches reported in the literature indicates that, TFMEA has been effectively implemented in very few areas and the areas of implementation are based on the product TFMEA and not on process TFMEA. For example, product based TFMEA study is done on a submersible pump to reduce failure and to improve quality of the product developed (Devadasan et al 2003). On realising this observation that many sectors are yet to implement TFMEA for their organisation, this thesis was initiated.

In this thesis, Literature survey has been carried out with the objective of identifying sectors and products, in which TFMEA is yet to be implemented based on the number of sectors and products identified. In this regard, this thesis is based on the foundry sector which produces castings. ‘Process Failures’ was considered as one of the main disruptions excising and affecting the foundry industry. Subsequently, the ‘Foundry Total Failure Mode and Effect Analysis Model’ (FTFMEA) was designed, developed and appraised by conducting case studies. 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 rejection due to the various types of defects in the castings, and which can be reduced or eliminated by data collection, sharing information between the concerned departments and by training the workers. These drawbacks, is the reason behind choosing this area for doctoral work reported in this thesis. All the mechanical components for automobiles, pumps, motors, marine, heavy machines are produced by foundry casting. Hence it was presumed that the application of FTFMEA in the foundry process would lead to reduction in defects, and improve quality which ultimately leads to increased competitiveness of the organisation in the global scenario.
FTFMEA process for evaluating the various processes in the foundry was designed by extending the existing processes. In the foundry, the deviations in the manufacturing process, improper work instructions to operators, untrained workers and irregular systematic maintenance were considered as the main disruptions existing in the foundry which form an impact on the quality of the castings. The implementation studies were conducted in two foundries. During the conduct of the case studies, loss producing events were identified and analysed to achieve loss reduction in the foundry by decreasing the defects in the castings produced. The details of this doctoral work have been organised and presented in the following chapters.

1.2 PROBLEM DEFINITION

The TFMEA is a new quality management tool, which is being reported in quite a few literatures. This trend indicates that TFMEA researchers have been progressing at a significant pace. On the other hand TFMEA researches have not been carried out in many sectors and industries. This was identified as the major problem area in this thesis.

To satisfy the customers with prompt delivery at competitive price, organisations has to keep a check on the cost of the product being produced, as cost of product is directly influenced by cost of production, which is intern affected by reworks and rejections of the casting being produced (Vijayaram et al 2006). Industries are striving to reduce the defects in casting and failures in processes, thus reducing the time and improving the quality of castings being supplied (Sekhar and Mahanite 2006; Das 2008).

In the real time scenario, pitfalls in the manufacturing processes, improper work instruction to operators, untrained workers, workers fatigue and non – maintenance obstructs the manufacturing process activities, resulting in significant adverse effects. Thus the ability to identify the cause,
modes of failure and the recommended actions restrict the impact of defects by using TFMEA (Devadasan et al 2003). Even though many TQM techniques are there for implementation, only a few effective measures are being implemented in the practical scenario (Karthi et al 2011). Therefore, design and development of models to mitigate and reduce defects are essential for achieving loss reduction and survival of the organisation.

The widely published methodologies like FTA, FMEA may be effectively used in solving problems by continuous quality improvements (Baghdasaran et al 2010; Tapia et al 2011). Yet, due to the time consumption, expensiveness in implementation, arbitrary promotion of the rating scale values for calculating RPN and inconsistencies in description of the functions and failures of the object being analysed, are the some of the pitfalls which lead to non – effectiveness in reducing or eliminating or preventing the failures due to defects (Hassan et al 2010; Ginn et al 1998; Estorillo and Posso 2010). However there is no further specific model being reported in the literature that would address the identification of all the failures due to defects in any manufacturing organisations. Even the few literatures regarding TFMEA implementation is for the product being manufactured and not for the processes of manufacturing the product. In this context, TFMEA in the foundry industry was selected as a broad area of this research. The results of the detailed literature survey were used to define the problem in the research. Accordingly the problem definition of this research work was defined as, absence of a responsive dynamic model for preventing failures along with a system for identifying the failures modes and their effects that occur due to the inconsistencies in production processes of any organisation. One among those industries which is yet to witness a systematic way of infusing process TFMEA in its production is the foundry industry.
1.3 RESEARCH OBJECTIVES

After defining the research problem, the following objectives were set in the beginning of this work.

i. To collect and study the literature reported in TFMEA and FMEA.

ii. To study and identify the advantage of TFMEA reported in the literature.

iii. To study, classify and identify the engineering products and industrial sectors unconquered by TFMEA researchers.

iv. To develop an effective FTFMEA model for analysing failures in industries.

v. To apply the developed FTFMEA model in two different types of foundries for investigating its effectiveness in failure prevention, reduction and subsequent loss reduction.

vi. To design and develop knowledge based FTFMEA (KBFTFMEA) for supporting the implementation of the designed model in a foundry.

Above research objectives were attained by following the research methodology developed to achieve failure prevention, loss reduction, improve quality and continuous process improvement.

1.4 RESEARCH METHODOLOGY

The research methodology shown in Figure 1.1 was adopted to attain the research objectives reported in this thesis.
As shown in the below Figure 1.1, this doctoral work was done studying the various literature relating to quality improvement. The literature survey was segregated into four groups for carrying out the following tasks:

![Diagram of research methodology]

**Figure 1.1 Research methodology**
• Studying, classifying and identifying various continuous quality improvement techniques.

• Studying and identifying the limitations of existing techniques.

• Studying and identifying the advantages of TFMEA model

• Studying the application of TFMEA in products and industrial sectors.

The information and knowledge gathered by performing the above 4 tasks led to the development of FTFMEA model. Two case studies were then conducted in the process improvement of the foundry being selected. After implementing the process FTFMEA, a knowledge base FTFMEA model was developed and implemented to improve the performance of the company holistically.

1.5 CHAPTER ORGANIZATION

The thesis report has been organised in eight chapters. The organisation of the chapters are depicted in Figure 1.2.

Followed by the introduction chapter, the literature review carried out is presented in Chapter 2. The rationale behind the designing and developing FTFMEA for implementing in foundry is presented in Chapter 3. In this chapter the FTFMEA model, failure modes of foundry and the roadmap for FTFMEA implementation are explained. In Chapter 4 and 5, the details of two different case studies of foundry implementation are presented. In the Chapter 6, efforts to design, develop and implement knowledge based foundry TFMEA system for a foundry has been discussed. The results of this doctoral work have been discussed in Chapter 7.
This thesis is concluded in Chapter 8, in which contributions and limitations of this doctoral work along with the scope of future work to improve the efficiency of the foundry by applying FTFMEA and knowledge based foundry TFMEA have been presented.

![Diagram of chapter organization]

**Figure 1.2 Chapter organization**
1.6 CONCLUSION

In today’s economic scenario, the world is witnessing a drastic increase in competition among industries (Ahuja 2011, Beatty 2006). In order to cope with this competition and to be in the business, the industries are finding ways for imbibing competitive strength. By producing products in batches, with quality and reduced defects, industries are offering products at a competitive price. To obtain this in the literature arena, the researchers are using the continuous quality improvement techniques.

The research work progressed systematically by developing the FTFMEA for achieving prevention, reduction in failures, improving quality and performance of the industry. The development of knowledge based foundry TFMEA will be helpful in record keeping, systematic tracking of failures and achieving continuous process improvement. This thesis is written in such a way that the contributions of this work could be utilised by both researchers and practitioners to apply FTFMEA for real time case studies in any foundry industry.