CHAPTER 9

CONCLUSIONS

9.1 INTRODUCTION

The increasing use of sophisticated, specialized and modern production machines has necessitated the employment of effective maintenance strategies in manufacturing environment. The primary objective of these strategies is to ensure maximum availability of production machines that are subjected to deterioration and failures due to usage as well as ageing (Bardey et al 2005). Many researchers and practitioners have acknowledged the importance of effective maintenance for eliminating or reducing the failures of machines to improve the performance and subsequently profitability.

The emphasis given on machine maintenance to avoid unnecessary failure costs has increased production costs. In this context, researchers made attempts to minimize maintenance cost by way of optimizing the average time between successive maintenance activities and eliminating or reducing the inventories of maintenance items. Al-Bahi (1993) pointed out that optimization of maintenance activities could be treated as a part of classical inventory planning. However, he has claimed that optimization of maintenance activities alone is inadequate for effective machine maintenance. Deierlein (2005) has insisted on analyzing the failures of machines for identifying the causes and thereby reducing them by taking corrective measures. Further, he has suggested to learn the behavior of the machine from
historical data of maintenance for avoiding losses due to failures. Besides, researchers have pointed out the insufficiency of the existing maintenance models for conducting the failure analysis to plan for efficient and effective preventive measures (Holmgren 2005). The research reported in this thesis has been carried out to overcome these research and practical lacunae.

During the beginning phase of this research work, deficiencies in the previous research works in maintenance engineering area focused on cost reduction were identified through literature survey which were later used to define the research problem. Subsequently, an improved version of maintenance engineering model named as RMM was designed to enable the practitioners for achieving the continuous improvement through the reduction and prevention of machine failures and losses. RMM is flexible in nature wherein modifications could be effected to meet the varying requirements of companies.

Case studies were conducted in two manufacturing companies to investigate the failures of machine parts and spare parts through the framework of RMM for improving the performance. A comprehensive data support system named CDSS was developed to eliminate the difficulties associated with the record-keeping of paper based maintenance records. Further, the appropriateness of training for the performance improvement of employees, processes and machines was evaluated by training a few operators in one of these companies. In all the case studies, remarkable improvements were achieved at the expense of acceptable recurring expenditures.

9.2 LIMITATIONS OF THE RESEARCH

Every care was taken during this research to map theory and practice. Yet due to the inability to study deeper aspects of applying this research in practical environments, certain limitations could not be overcome.
Particularly, two limitations concerning the use of RMM in practice are discernable. The conceptual model RMM was designed with the objective of improving the performance of machines. RMM is encompassed with quality, maintenance, risk management and engineering principles to realize the expected benefits. Hence, it is essential for the practitioners to acquire sufficient knowledge in the area of maintenance engineering and RMP. Implementation of RMM without sufficient domain knowledge would not yield the expected improvements in the performance of machines and may even lead to wastage of investment and related resources.

RMM trusts the principle ‘prevention is better than cure’ for improving the performance of machines. The framework of RMM necessitates the practice of PM to avoid deterioration and failures of machines. It is essential to appraise maintenance expenditures and expected financial benefits of the improvement activity to be carried out through RMM before implementation. The application of RMM is feasible only if there is a gain after accounting the expenditure on preventive measures.

9.3 SUGGESTIONS FOR FUTURE RESEARCH

The research work presented in this thesis has aimed to minimize failures and associated losses through the framework of RMM. Since RMM is flexible in nature, the present research work could be further extended for improving the manufacturing processes carried out in organizations by way of eliminating the inherent deficiencies. The case studies conducted in this research work to validate the contribution of RMM were limited to batch production industries. Application of RMM with necessary modifications could be done for mass production and process industries to meet the manufacturing objectives of concerned industries.
The present research work could be further extended to enhance the reliability of production machines. Reliability considerations are playing an increasing role in all engineering fields to ensure desired availability. Complexity of production machines is often increased to improve their performance. In general, the complexity of a system is usually measured by accounting the number of components required to make it. Reliability would be decreased with addition of each and every component (Lewis, 1987). In this context, the RMM could be applied for enhancing the reliability of components and entire production machines.

9.4 CONCLUDING REMARKS

Results of validation studies reported in chapter 8 indicated the practical compatibility of contributions of the research work. However, its successful implementation in real time situations requires a sound knowledge of maintenance engineering and management. The implementation of RMM facilitates to inculcate the culture of continuous improvement for the nourishment of companies. The progressive changes would enable the organizations to achieve sustained development in their products, processes and business prosperity through higher maintenance quality. In a nutshell, this research work has indicated the opportunity for synergizing the business objectives and maintenance engineering through RMM to achieve business goals. The achievement of business goals would support the organizations to succeed in competitive markets.