CHAPTER 8
CONCLUSIONS AND SUGGESTIONS FOR FUTURE WORK

8.1 INTRODUCTION

The main objective of this thesis is to resolve the advanced manufacturing technologies used by the manufacturing industries and surrogate pairings of variables for the adoption of AMT. The study is focused on the analysis of different AMT practices, sources of information support, perceived benefits of the implementation and the forms of AMT implemented by Indian manufacturing industries. The analysis has been performed by product and industry in order to isolate differences due to the competitive markets in which the industry resides.

The following section recapitulates the advanced manufacturing technologies and performances of manufacturing industries. It is then followed by case study to investigate phenomenon deeply within the perspective of their natural context and last but not the least, an overview of the chapter provides a holistic view of the thesis.

8.2 SUMMARY OF THE WORK DONE

With the existence of diverse advanced manufacturing technologies, more and more functions or tasks are performed by machineries instead of human labor. Generally, industries within the same sector come across a common set of technological opportunities. However, it is noticeable that technological differences exist among the industries. In fact, a probe of AMT studies often divulges that industries with a particular manufacturing strategy will invest in specific type of AMT that can help them to achieve their intended
manufacturing performance. The data have been collected from four sectors of manufacturing industries. The majority of respondents are from automobile sectors, followed by process sectors, electrical & electronics sectors and industrial machinery and equipment sectors. Respondents were requested to choose a response on five point likert scale; anchored at one end with ‘least important’ meriting a score 1 and the other by ‘most important’ meriting a score of 5. First of all to find out the correlation for each variable which are involved in manufacturing industries, then further test their need to be carried out on factors generated to see whether they are normally distributed in order to make meaningful inferences. After which the hypotheses testing have been performed by testing the level of conformity between the variables. The manufacturing strategies of Indian manufacturing industries are dependent on different sectors.

The various advanced manufacturing strategies can be described as:

- The study corroborates that quality is considered as important for any industry. There is a strong conformity between the four sectors in providing quality products which are reliable and offer high performance in order to compete effectively in the market. It is perceptible that the cost is considered as the least competitive priority by all industries.

- All manufacturing industries emphasise on almost the same competitive strengths. All sectors relied on quality, responsiveness, flexibility, advanced manufacturing technologies, product customization, information technology, sales and marketing, manufacturing functions and innovativeness.

- All sectors emphasise to implement the automation in manufacturing industries. In all sectors, development and implementation is an important factor. Different automation steps vary according to the sector it has been applied to.
The measurement of advanced manufacturing technologies is derived from its level of investment. Industries were asked to indicate the amount of investment in the individual technology, on a five point scale of 1 to 5, where 1 indicates no investment and 5 to show heavy investment. The level of investment by different sectors is different in advanced manufacturing technologies. The various advanced manufacturing technologies can be described as:

- The most common advanced design technology among the industries surveyed is CAD. CAD is the most popular technology and GT is the least favorable technology for manufacturing industries. Process industries have invested relatively less in advanced design and engineering technologies than automobile and electronics industries. Although all industries choose to have investments in advanced design and engineering technologies, all sectors agree almost to the same fact that investment in CAD takes the most vital position followed by CAM and CAE, while GT is the least significant field of investment.
- The most important investments are made in CNC technology. All the manufacturing industries have invested less in robotics technology. In automobile industries the maximum investments have been made in CNC technology followed by NC/DNC and flexible manufacturing system. In electronics industries & machinery industries the maximum investments have been made in CNC followed by flexible manufacturing system and NC/DNC. In process industries the investments have been made in flexible manufacturing and CNC are almost same, followed by NC/DNC. Except the automobile industries, all other industries have invested less on robotics technology.
- The automobile industries have invested more in MRP followed by MRP II, ERP and ABC analysis. Electronics industries have invested more in MRP followed by MRPII, ERP and ABC analysis. Machinery industries have invested more in MRP II followed by MRP, ERP and
ABC analysis. Process industries have invested more in ERP followed by MRP, MRP II and ABC analysis.

- The automobile and electronics industries have made moderate investments in material handling technologies. It is concluded that material handling technologies (AMHS, AS/RS, AGV) get the least attention in manufacturing industries.

- Automobile industries have invested the maximum on TQM followed by BPR, SPC and JIT. Electronics industries have invested the maximum on TQM followed by SPC, BPR and JIT. Machinery industries have invested the maximum on TQM followed by SPC, JIT and BPR. Process industries have invested the maximum on TQM followed by SPC, JIT and BPR.

- Automobile industries have invested the maximum on kaizen followed by management training, recycling and benchmarking. Electronics industries have invested the maximum on management training followed by, recycling, benchmarking and kaizen. Machinery industries have invested the maximum on kaizen followed by management training, recycling and benchmarking. Process industries have invested the maximum on kaizen followed by recycling, management training, and benchmarking.

The manufacturing performance is affected by using advanced manufacturing technologies in manufacturing industries. Manufacturing industries’ performance measurement by adoption of advanced management technology can be categorized into four different factors such as increasing cost effectiveness, development team based commitment, estimate artificial division and improved quality of working. Respondents were asked to rate the industry
performance on a 1 to 5 point level scale, where 1 indicates lower performance, 3 indicates average and 5 indicates well above performance.

In automobile, electronics and process industries, owing to the adoption of advanced management systems, cost effectiveness has increased followed by development team commitment, estimate artificial division and improved quality of working.

The investment in AMT represents a strategic option, the value of which increases in a competitive environment and market uncertainties. Respondents were asked to rate the industry efficiency in term of productivity, plant efficiency, product management and market performance on a 1 to 5 point level scale, where 1 indicates lower efficient, 3 indicates average and 5 indicates well above efficient.

It is observed that owing to adoption of advanced manufacturing technologies, the factors such as productivity, efficiency, product management, market performances have improved. It is concluded that efficiency enhancement of manufacturing industries takes place through advanced manufacturing technologies.

The various valuable improvements incorporated in the case studies can be summarized as:

- Industry A: Process Improvement by Advanced Technologies
- Industry B: Efficiency Improvement by Advanced Design
- Industry C: Productivity Improvement by Advanced Cutting Tool Technology
- Industry D: Process and Efficiency Improvement by implementing Kaizen and Advanced Training Techniques
- Industry E: Improvement in the Effectiveness of the equipment through Product Modification.
Advanced manufacturing technologies are not implemented by the industry due to basic problem of change, lack of understanding by managers, ability to manage automation and lack of infrastructure facilities.

Respondents were asked to agree or disagree from the above reasons for manufacturing industries on a 1 to 5 point level scale, where 1 indicates total disagreement and 5 indicates total agreement. The most significant reason for advanced manufacturing technologies not being implemented or adopted in manufacturing industries is the basic problem of change. The other reasons for not adapting advanced manufacturing technologies are different in different sectors.

8.3 CONTRIBUTION OF THE RESEARCH

This thesis has endeavored to fill some of the gaps in the contemporary research on advanced manufacturing technologies, especially in Indian context. An extensive multi sector survey of Indian manufacturing industries on AMT has been conducted. The study represents that AMT of most industries is focused on improving product and process quality and delivering products on time. Quality is the most important competitive priority for the Indian manufacturing industries. The rivalry from multinationals has made the Indian industries quality cognizant. Traditional quality control is now moving to preventive measures reflected in wide adoption of TQM practices. Major contributions of the research can be highlighted as:

- A comprehensive bibliography has been prepared and literature has been classified accordingly.
- Sector wise competitive priority and advanced manufacturing technologies have been identified.
- Indian industries are emphasizing more on investment in AMT.
- Manufacturing contributes to competitive success.
• AMT is not limited to a few key verdicts about technology, capacity, etc. but it is defined by the total pattern of verdict across the full range of manufacturing systems.

• Automobile and electronics sectors are exposed to global competition much faster as compared to machinery and process sectors. Therefore, owing to strong global pressures, these industries adopted manufacturing practices in line with global trend.

• It is observed that Indian manufacturing industries are giving the least preference to advanced material handling technology.

8.4 IMPLICATION OF THE STUDY

AMT is often measured using the extent of use, or the level of investment. The study employs the measurement of AMT derived from its level of investment. The mean score of each of the six categories is derived by taking the average of its investment score. This measurement is used owing to the fact that all AMTs can be integrated to achieve their ability to facilitate enterprise wide incorporation. Thus, this study provides a diverse measurement option for AMT in terms of its level of investment. The study provides a better understanding of the AMT diffusion in the Indian manufacturing sector that produces diversified products. The most important implications of the effects for manufacturing industries are that AMT investment in manufacturing facilities is well worth pursuing.

The general observation is that the majority of the industries that have high investments on AMT achieved higher performance. It thus becomes apparent that the management team and indeed all those involved in the strategic verdicts of the manufacturing industries, develop a much more refined perceptive of what AMT is, and that the successful implementation of an AMT requires a consideration of the levels of investment of AMTs, i.e. how the levels of investment of each AMT enhance the manufacturing performances.
Moreover, by understanding the AMTs, managers are better able to plan the deployment and implementation process. Once the industries have decided the manufacturing strategy, managers will be able to identify the appropriate levels of investment in AMT to accomplish the intended performances.

Advanced manufacturing technology presents enormous prospective to increase both effectiveness and efficiency of the manufacturing endeavor. It is competent to influence strategic capabilities across manufacturing industries and permits industries to compete on a higher level of customer requirements. In the future, it will be important for manufacturing managers or directors to comprehend how the technology works and identify when to employ a particular technology.

Government organizations and other funding bodies should persist and expand the financial support offered to industries who wish to pursue investment in AMT. Government organizations should gravely look into creating more funding opportunities or financial assistance to enhance the industries’ manufacturing competencies through more advanced manufacturing technologies.
8.5 SUGGESTIONS FOR FUTURE WORK

The study is focused on AMT diffusion in manufacturing industries that produce distinct products. It looks at how an industry prefers to invest and manage its AMT in relation to its manufacturing strategy. The four major manufacturing sector industries (automobile, electrical & electronics, machinery and process) have been included in this study. Responses of the questionnaire have been received from almost all parts of the country. This study has some suggestions, which future researchers could consider. The suggestions are as follows:

- The performance measurement used for the study is self evaluated and based on supposed performance which limits the objectivity of performance measures.
- This study is focused on four manufacturing sector industries (automobile, electrical & electronics, machinery and process), other sectors can be included.
- The study disregards the learning effect, owing to the duration the industries have implemented the part of AMT.
- It does not permit the assessment of performance impact of AMT implementation over time.

The analysis has proposed several possibilities for future research. There are two main areas where future research could be performed. The first is with respect to the method chosen for the AMT analysis. The second is with respect to the nature of the data chosen to analyze. Both of these areas offer many different possibilities for future research and the development of this topic area in the literature. This is only true that if the time of implementation of the technology or business practice is known, the impact of the implementation can be more readily detached. Another way in which to look at growth measures would be to use a longitudinal dataset. The choice of individual variables to include would depend on the size, class or industry chosen. The use of a more
detailed, perhaps industry specific, survey would also allow for results that are more detailed. If a more specific survey is developed then there would be a greater possibility to use industry sub-classes and to deal with the more pervasive technologies and practices that occur in the industry.

8.6 CONCLUSION

In conclusion, this study has fulfilled its goal and expectations initially set for the study. The basis of advanced manufacturing technologies is the concept of making dynamic changes in the manufacturing structure, so as to create competitive advantage and avoid a static non response to the change. Advanced manufacturing technologies’ concept is addressed directly by providing a strategic framework in manufacturing into which the individual decision about AMT can be properly addressed. The findings in this study reaffirm the importance of the infrastructure in the software (management tools), in a sense that an industry employs to select and control the performance of its hardware (technical tools). These systems should be designed to encourage the continual adaption and improvement of an industry talent base.