CHAPTER 7
RESULTS AND DISCUSSION

7.1 INTRODUCTION

The last two chapters presented the statistical effects based on the data collected from the different manufacturing industries. This chapter will discuss the results of the practices of the sampled industries in comparison with the current literature in the pertinent area such as manufacturing technologies, manufacturing management and manufacturing performance etc.

The chapter begins with a brief recap of surveyed industries profiles, followed by discussion of verdicts. The discussion of verdicts consists of the practice of surveyed industries in relation to their manufacturing strategy orientation, their approach towards investment in advanced manufacturing technologies, and their perceptible manufacturing performance. It also concentrated on the statistical approach in defining the investment of AMT and performance on manufacturing industries. Case study has been developed to validate the results in the survey. The conclusion section recapitulates the chapter with the major verdicts of the study.

7.2 SURVEYED INDUSTRIES PROFILES

The survey has been accomplished via questionnaires to 68 selected Indian manufacturing industries. Informants are from the top management level and involved in some type of decision making at the strategic level for the manufacturing function. All the informants have been in their particular position for an average of 12 years. These have enhanced the creditability and dependability of the data collected in the study.

The study intends to find out the behavior of Indian manufacturing industries on AMT diffusion in regards to their industries’ manufacturing competitive
priorities and its impact on the manufacturing performance. The samples have been collected from four sectors of manufacturing industries. The maximum number of respondents are from automobile sector (22 respondents), followed by process sector (18 respondents), by electrical & electronics sector (16 respondents) and industrial machinery and equipment sector (12 respondents). Respondents were requested to choose a response on five point interval 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 is 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.

Being the largest group amongst the surveyed industries, automobile industries have the highest level of investment in ADT, AMcT, APT and AMS but the lowest in advanced material handling systems. They also adopt the highest level of competitive strategy. In contrast, process industries have invested least in APT, AMHS and AMS.

The automobile sector has extensive investment in CAD, CAE, CNC, MRP and MRPII. The automobile industry takes particularly high initiative in product innovation, for instant launching new products lines and new models. The automobile industry adopts dominant strategies such as providing consistent products and high performance products, cutting costs, having a wide product range, supplying excellent after sales services, and aiming at commencing newly manufactured goods’ lines. On the other hand, industries contribute to the same views on their performance. Generally, they do the best in providing reliable and high quality manufactured goods, and providing excellent after sales services. The competitive priority of all sectors of manufacturing
industries is quality and they emphasise less on cost. The competitive strength of different sectors varies according to requirements. The level of investment on advanced manufacturing technologies by different sectors is different. The automobile industries have invested more on advanced manufacturing technologies as compared to other sectors. Process industries have invested less on advanced manufacturing technologies as compared to other sectors. Industries have not adopted the advanced manufacturing technologies due to basic change in setup and lack of infrastructure.

7.3 FACTS OF MANUFACTURING STRATEGIES

There are numerous ways of defining manufacturing strategies that an industry can follow, for example, Slack et al (1995) identifies four strategies, namely quality, flexibility, delivery and cost. Industries that adopt the differentiation strategy intend to gain a competitive advantage by offering a unique product or service, in term of the quality, flexibility and delivery dimension of the products. All the industries surveyed, despite of their sector, agree that providing quality products is the most vital manufacturing strategy. This approach is not significantly influenced by any other factor such as size, possession, sector or era of the business. The result shows that after the quality, flexibility is the second most significant priority of any industry. Industries competing on delivery strategy can compete on dependability, i.e. on timely delivery and promptness in reaching at the customer’s end. The cost is considered as the least crucial competitive priority by all the sectors. Competitive strength is having two important dimensions namely, how capable an industry is compared with those that desire to bang it and how competent it is to justifying the impact of those forces that can reason it to be packed down. Overall, it is concluded that industries surveyed do not contend on any particular strength alone, rather a combination of different dimensions of competitive strength i.e. quality cost, responsiveness, flexibility, advanced manufacturing technologies, product customization, information technology,
sales and marketing, manufacturing function and innovativeness. In all sectors
development and implementation is an imperative factor. Different automation
steps vary according to different sectors. In automobile sector, first preference
is given to development & implementation followed by planning, technology
assessment, cost, concept, training and post evolution. In electronics industries,
first preference is given to planning followed by concept development, cost,
technology assessment, development & implementation, training and post
 evolution. In machinery industries the first preference is given to development
 & implementation followed by planning, technology assessment, cost, concept,
training and post evolution. In process industries first preference is given to
cost analysis followed by technology assessment, development &
implementation, planning, concept development, training and post evolution.

7.4 FACTS OF ADVANCED MANUFACTURING TECHNOLOGIES

The study employs the classification of AMTs based on its function in the
context of manufacturing capabilities. 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 interval scale of 1 to 5, where 1 indicates no investment and 5 to
show heavy investment. The AMTs investigated in this study can be grouped
into six domains based on the literature of AMT studies which are as follows:

- Advanced design and engineering technologies: It comprises of design
  and engineering technologies such as CAD, CAM, CAE, and GT.
- Advanced machining technologies: It comprises of computer numerical
  control machines (CNC), numerical control/ direct numerical control
  machines (NC/DNC), flexible manufacturing system (FMS), and
  robotics.
- Advanced planning technologies: It comprises of logistic planning such
  as MRP, MRPII, ERP and ABC analysis.
Advanced material handling technologies: It comprises of handling of materials such as AS/RS, AGV, and AMHS etc.

Advanced management systems: It comprises of production management tools such as TQM, BPR, SPC, and JIT.

Advanced process improvement systems: It comprises of advanced process improvement technologies such as Benchmarking, Kaizen, Training, and Recycling.

The level of investment by different sectors is different in the context of advanced manufacturing technologies. The manufacturing performance is affected by using advanced manufacturing technologies in manufacturing industries.

7.4.1 Advanced design and engineering technologies:

Advanced design and engineering technologies are used to assist designing and testing products, that comprise computer aided design (CAD), computer aided manufacturing (CAM), computer aided engineering (CAE), and group technology (GT). This is the category of advanced manufacturing technology that has the largest level of investment. CAD is the most accepted technology and GT is the least accepted technology for manufacturing industries. Process industries have invested relatively less in advanced design and engineering technologies as compared to automobile and electronics industries. Although most industries prefer to have investments in advanced design and engineering technologies, all sectors agree almost to the fact that investment in CAD takes the most vital position followed by CAM and CAE, while GT is the least significant field of investment.

7.4.2 Advanced machining technologies:

Advanced machining technologies are broadly useful for frequently repetitive purposes. Computer numerical control machines (CNC), numerical control/direct numerical control machines (NC/DNC), flexible manufacturing system
(FMS), and robotics are used to execute repetitive functions and work without permanent modification in the equipments. 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 made in flexible manufacturing and CNC are almost same, followed by NC/DNC. Except the automobile industries all other industries have invested less in robotics technology. It is concluded that different sectors have made different levels of investments in advanced machining technologies.

7.4.3 Advanced planning technologies:

Material requirement planning (MRP), Manufacturing resources planning (MRP II), Enterprise resources planning (ERP) and Activity based counting (ABC analysis) are used as advanced planning technologies in manufacturing industries. They are mainly used to assist in planning, scheduling, controlling of material and resources’ requirements for production in manufacturing industries.

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 level of investment in advanced planning technologies is variable in different sectors.
7.4.4 Advanced material handling technologies:

Material handling technology is the least invested technology in this study. AMHS, AS/RS, AGV are used by manufacturing industries to facilitate the handling of material in manufacturing operations. The automobile and electronics industries have moderate investment in material handling technologies. It is concluded that material handling technologies gets the least attention in manufacturing industries.

7.4.5 Advanced management systems:

Advanced management system can be classified as TQM, BPR, SPC, and JIT. Automobile industries have invested the maximum resources on TQM followed by BPR, SPC and JIT. Electronics industries have invested the maximum resources on TQM followed by SPC, BPR and JIT. Machinery industries have invested the maximum resources on TQM followed by SPC, JIT and BPR. Process industries have invested the maximum resources on TQM followed by SPC, JIT and BPR. The level of investment on advanced management system is different in different sectors.

7.4.6: Advanced process improvement systems:

Bench marking, kaizen, training and recycling are some advanced process improvement systems in manufacturing industries. Automobile industries have invested the maximum resources on kaizen followed by management training, recycling and bench marking. Electronics industries have invested the maximum resources on management training followed by recycling, bench marking and kaizen. Machinery industries have invested the maximum resources on kaizen followed by management training, recycling and bench marking. Process industries have invested the maximum resources on kaizen followed by recycling, management training and bench marking. It is concluded that the investment on advanced process improvement system is different in different sectors.
7.5 MANUFACTURING PERFORMANCES

With the prominence on reducing costs and increasing manufacturing efficiency, a record number of industries are embarking on different forms of advanced manufacturing technologies. It has been observed that due to adoption of advanced management systems, performances of manufacturing industries have improved and performance factors are different for different sectors. In automobile, electronics and process industries owing to adoption of advanced management systems, cost effectiveness has increased followed by development team commitment, estimate artificial division and improved quality of work. In machinery industries due to adoption of advanced management systems, estimate artificial division and quality improvement has been achieved followed by cost effectiveness and development team commitment. It has been observed that in automobile industries overall performance is improved by adoption of advanced manufacturing technologies. Automobile industries are mostly affected by productivity followed by plant efficiency, market performance and product management. Electronics industries are mostly affected by plant efficiency followed by productivity, market performance and product management. Machinery industries are mostly affected by plant efficiency followed by productivity, product management and market performance. Process industries are mostly affected by plant efficiency followed by productivity, market performance and product management. It is concluded that efficiency enhancement of manufacturing industries can be achieved through advanced manufacturing technologies.

7.6 CASE STUDIES

The purpose of the case studies presented in this study is to discover the impacts of AMT in manufacturing industries, to identify the critical factors that influence such impacts and to develop a tool to assist industries in the implementation of AMT. The various valuable improvements implemented 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.

The implementation of new technology within an industry for the purpose of improving efficiencies, developing flexibility and enhancing output represents an innovative development.

7.7 CONCLUSION

In this research, a survey of Indian manufacturing industries has been carried out to study various AMT issues. Four main sectors have been encompassed in the survey which are automobile, electrical and electronics, machine tools and process sector. All sectors emphasise on quality as competitive priority. The largest groups of surveyed industries i.e. automobile industries have the highest level of investment in ADT, AMcT, APT and AMS but it has the lowest investment in advanced material handling systems. In contrast, process industries have invested least in APT, AMHS and AMS. The level of investment on advanced manufacturing technologies by different sector is variable. The purpose of the case studies presented in this study is to ascertain the impacts of AMT in manufacturing industries. The implementation of new technology within an industry for the purpose of improving efficiencies, developing flexibility and enhancing output represents an innovative development. It is concluded that efficiency enhancement of manufacturing industries can be accomplished through advanced manufacturing technologies.