CHAPTER 8

CONCLUSION AND FUTURE SCOPE

Success and survival of an organization is becoming more and more difficult to ensure survival and competitiveness in continuously and unpredictable changing business environment. Agile manufacturing is a new concept in manufacturing intended to improve the competitiveness of firms in uncertain and changing business environment. Basically, the concept of 'Agility' means, the utilization of market-knowledge and virtual cooperation to exploit profitable opportunities in a volatile marketplace. This chapter presents the conclusions of research discussed in this dissertation. Work on this dissertation is started by reviewing the literature and identifying the research gaps, then stating the objectives, explaining the research methodology and finally major tasks on research were undertaken.

8.1 Summary of Findings

The research of this dissertation is based on the agility enablers. Enablers are the critical success factors for implementation of agility in a supply chain. The research work started by identification of the agility enablers based on literature survey and expert opinion, then understanding the interrelationships among enablers is done using ISM. Now the same enablers are used to evaluate the agility of supply chain. After evaluating the agility level, the fuzzy performance importance index is calculated, which helps to identify the barriers within the supply chain and finally an AHP-GP model is developed to maximize agility of supply chain. The AHP is first used to prioritize the agility enablers in a consistent manner. The outcomes of AHP are embedded in GP to develop the AHP-GP model. GP provides desired level of agility to supply chain, deploying input resource limitations. The contributions of research in the present dissertation is summarized as given below

- Identification of ASC enablers is necessary for supply chain managers not only to understand the fundamental preconditions of supply chain agility, but also to provide a practical guide to successful evolution of a truly ASC. A supply chain can be robust and profitable if agility enablers are incorporated properly. It is required to work with all ASC enablers but not essential to give same attention to all enablers. Hence, it is quite important for supply chain managers to understand their relative importance. Keeping this view in the mind seven agility enablers are identified and investigated from literature review, industry and academic experts' opinions. These seven agility enablers are virtual enterprises, collaborative relationship, use of information technology, market sensitivity, customer satisfaction, adaptability and flexibility. After that ISM is used to analyse the enablers, establish interrelationship among enablers and form hierarchy of importance of enablers.
- Contemporary companies have realized that agility in their supply chain is quite essential for the survival and competitiveness. In the way of implementing agility in a supply chain, the issues to be examined are agility, its measurement, agility level and barriers. One of the research agendas in agile manufacturing is the assessment of agility in a supply chain. The assessment of agility in supply chains is quite important as it is an indicator of the strategic agile position. In the second problem to propel toward an agility measurement, a conceptual model with the fuzzy logic approach has been designed. Model developed can be divided into three levels, namely, enablers, attributes and sub-attributes. The first level consists of seven ASC enablers; the second level consists of 25 ASC attributes; and the third level consists of 101 ASC sub-attributes. After using a fuzzy logic approach, it is observed that the organization on which the study was performed is 'very agile'. After evaluating the agility level, the fuzzy performance importance index is calculated, which helps to identify the barriers of

agility in the supply chain. These barriers help decision makers to implement appropriate improvement measures for improving agility level. Overall, 11 barriers were identified in the study.

- In next problem priority weights of agility enablers are calculated using the very consistent method called AHP. To judge the enablers, decision maker has to know on what basis decision has to be taken. This basis is called as selection criteria. Selection process is influenced by a variety of criteria. The criteria can be tangible (i.e., objective) as well as non-tangible (i.e., subjective). For the present problem competency, robustness, responsiveness, cost-effectiveness and quickness are selected as selection criteria. The weights of enablers will be used in the GP model to serve as the contribution that each criterion makes to each enabler.
- In the last problem a hybrid AHP-GP model is developed which include AHP results obtained in previous problem to link the agility index of enablers and the real world resource limitations (*i.e.* operating budget, management hour, employee hour). AHP provides the local and global weights of decision variables (*i.e.* agility enablers) whereas GP incorporates the AHP weights into the model and restricts the value of these enablers in order to optimize agility and other input resources. The use of the proposed model is illustrated in a real world case study. After solving the model the optimal values of seven agility enablers, deviation of each goal constraints and optimized value of objective function are obtained. From results it can analysed that, targeted agility level is almost achieved within the available resource limitations.

8.2 Managerial Implications

It is important for the management of a firm to understand characteristics and interrelationships among agility enablers for building agility in the supply chain. With the help of interrelationship among enablers, supply chain manager can better understand how

agility enablers of supply chain interact with each other to make the supply chain agile and which elements should be more focused. Manufacturing companies can improve their capabilities if agility providers are identified and implemented in various stages of the supply chain.

Agile manufacturing has become an important avenue in recent times for supply chain managers in order to become competitive in uncertain and changing business environment. It is necessary for supply chain managers to know where their supply chain agility stands. For this purpose, evaluation of agility is important. Evaluation of the agility is like agility metric, which is an important indicator for the performance measurement of the supply chain. Few researchers have contributed towards approaches for measuring agility in the supply chain. To obtain better results, it is recommended to select appropriate ASC enablers and attributes. Hence, contemporary supply chain managers have to measure the agility level of a supply chain periodically. The agility level would ensure that the practicing managers to know about how much their supply chain agility are short of being 'extremely agile'. If there is a gap between their agility level and standard agility level, then it is recommended to identify the barriers within the supply chain for agility improvement. The obstacles within the supply chain can be used to improve the performance of the organization.

At last, a decision aid in the form of hybrid AHP-GP model is developed which allows the decision maker to maximize the agility of supply chain by deploying the input resources. The Proposed hybrid model offers to supply chain managers, a systematic and easy-to-use approach to identify the degree of focus of each enabler in their manufacturing organisations. Each agility enabler would require various levels of input resources in order to accomplish agility in supply chain. These resources are cost of operation, management hour and employee hours. In this model, supply chain managers can set the desired level of

agility and the maximum available input resources. The GP model will restrict the value of decision variable (*i.e.* enablers) in such a way that the targeted agility level will be achieved within the available resources. AHP weights of enablers are also used in the GP model to serve as the contribution of each criterion, makes to each enabler.

8.3 Limitations of the present work

Present work is solely dependent on the seven ASC enablers, which were identified through the literature review and expert opinion. There may be other enablers to the issue but an increase in the number of enablers may increase the complexity of the problem. Hence only the most important and relevant enablers are considered for the present dissertation, while other enablers which are least affecting to the issue have been omitted from consideration.

In Chapter 5, linguistic scale and the corresponding fuzzy numbers are chosen from previous studies for collecting expert opinion (human judgment) in order to evaluate the agility of supply chain. In the proposed fuzzy based decision support systems, triangular fuzzy numbers are used to assess the expert responses. However, there are various fuzzy numbers available in literature such as triangular fuzzy numbers, trapezoidal fuzzy numbers and interval-valued fuzzy numbers. Author of present dissertation cannot ascertain which fuzzy numbers are most capable of providing the most reliable prediction result. It can be considered as the scope for future work.

In present dissertation experts responses are gathered from case-organization to explore the interrelationship of agility enablers (Chapter 4), to evaluate the agility of supply chain (Chapter 5) and to prioritize the agility enablers (Chapter 6). The responses always depend on the knowledge and experience of the experts and their familiarity with variables. The responses may be affected due to subjective bias of the respondent. To avoid the subjective

biasness of the respondent, it is tried to take responses from experts who have sufficient practical experience and knowledge in supply chain domain.

To solve the agility maximization problem in Chapter 7, yearly input resources data are taken from the case-organization. However, all input resources data for each agility enabler presented in Table 7.1 are not exact; sometimes they are approximated by senior executive of the case-organization 'ABC' for the sake of developing the model.

8.4 Scope for future work

In present dissertation, a serious effort is made to fill all the research gaps identified in Chapter 2. There is, however, a lot of scope for the future research.

- ISM framework does not incorporate the feedback concept. These issues may be tested to develop system dynamics models in future.
- In course of agility evaluation and related decision-making, attempts have been made towards identifying agility barriers. However, necessary actions can be taken (future plan of action) to improve agility barriers.
- Which fuzzy numbers are more capable of providing the most capable prediction result can be considered as the scope for future work.
- The AHP-GP model can also be expanded to include other resource limitation such as advertisement costs, employee training costs etc.
- Since this case study cannot reveal entire industrial agile scenario of a country, further studies can be explored in different case organizations towards visualizing real picture of the industrial agile status for the country.