Strategy Selection for Supply Chain Responsiveness

A.Ramesh,
National Institute of Technology Calicut, Kerala-673601. India.
ramesh.anbanandam@gmail.com.
D.K.Banwet
Indian Institute of Technology Delhi, New Delhi-110016. India.
dkbanwet@dms.iitd.ac.in,dkbanwet@hotmail.com
Ravi Shankar
Indian Institute of Technology Delhi, New Delhi-110016. India.
ravi1@dms.iitd.ac.in

Abstract

Apparel industry is characterized by short product life cycles, volatile and unpredictable demand, tremendous product variety, and long and inflexible supply processes. These characteristics make apparels supply chain more complex and ineffective. Therefore the companies in this sector have to respond quickly to fulfill the customer needs. Some of the strategies that will improve the responsiveness are supply chain collaboration, adoption of enabling technologies, postponement strategy and outsourcing. In this paper we have developed an analytic network process (ANP) based approach to prioritize these strategies in apparel supply chain.

1. Introduction

The endless variety in apparel products on the consumption side and the need for it on the supply side makes it a mandate for the participant of an apparel supply chain to work towards a common objective of quickly responding to customer's changing needs. Responsiveness is defined as the capability of promptness and the extent to which the supply chain addresses changes in customer demand (Holweg, 2005). Bowersox *et al*. (1999) advocated the need for organizations to be responsive when the penalties associated with uncertainty are higher. The objectives of this paper are to study the various strategies for improving the responsiveness and identify the strategy which is more suitable for Indian apparel industry context.

2. Methodology

Figure1 shows the sequence of steps adopted in this paper to prioritize the supply chain strategies.

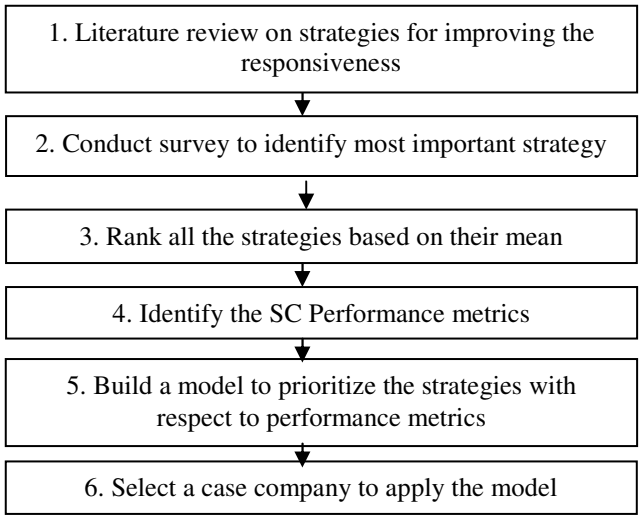

Figure 1: Methodology to prioritize the supply chain strategies

2.1 Strategies for Improving the Responsiveness

According to Towill and Christopher (2002), the end customer in the marketplace determines the success or failure of supply chains. They further state that "getting the right product, at the right price, at the right time to the consumer is not only the linchpin to competitive success but also the key to survival". The companies these days focus on optimizing their core activities so as to maximize the speed of response to customer demand. With increasingly sophisticated customer demand (product variety and customization) (Yang and Burns, 2003) supply chains have to be responsive to constantly changing market and business environment. Hence the most important task of decision makers is to explore the various options for improving the supply chain responsiveness. After review of literature and

discussion with experts in apparel industry, both from Industry and the academia, the various strategies for improving the responsiveness are presented in Table 1.

Table 1: Strategies for Supply Chain Responsiveness in Literature

Strategy	Means to achieve supply chain responsiveness.
Supply chain collaboration (Gunasekaran *et al*. 2008; Forza and Vinelli, 2000)	Improving apparel supplier-manufacturer- retailer collaboration
Information technology infrastructure (Gunasekaran *et al*., 2008)	Adoption of either one or more IT tolls like ERP,MRP, Computer numerically controlled(CNC) machine, Computer-aided design (CAD)/computer-aided manufacturing (CAM), Intranet, internet and world wide web, Electronic data interchange (EDI), Computer-aided process planning (CAPP), Point-of-sales data collection (POS), Barcode, RFID etc.
Knowledge management (Gunasekaran *et al*., 2008; Wadhwa and Saxena, 2005)	Managing of knowledge through systematic sharing of supply chain competencies.
Just in Time (Bruce *et al*., 2004; Hall, 1983)	Ensuring the elements of JIT like dependable service, delivery and quality and presence of suppliers nearer to manufacturer which will helps for an organization to achieve the responsiveness.
Postponement Techniques (Van Hoek, 2001)	Delaying the supply chain activities until the demand is realized.
Outsourcing (Loh and Venkatraman, 1995)	Contracts with another company to provide services that might otherwise be performed by in-house employees.
Total cycle time reduction (Mason-Jones and Towil, 1999)	Reducing cycle times by removing inherent latencies in planning, manufacturing and distribution processes.
Flexible Manufacturing System (Jaikumar, 1986)	Adoption of computer controlled grouping of semi-independent work stations linked by automated material handing sub systems.
Concurrent Engineering (Gunasekaran *et al*., 2008)	Integrating of functions like design engineering, manufacturing engineering and other functions in order to reduce the time elapsed to bring a new product to the market.
Third Party Logistics (Vasiliauskas and Jakubauskas, 2007)	Achieving shorter lead times and right delivery to the customer.
Market Sensitiveness (Gunasekaran *et al*., 2008)	Being sensitive to market by capturing the market trend through point of sales data.
Vendor managed inventory systems (Sari, 2007)	Adoption of VMI practices which results in lower inventory monitoring and ordering cost.
Cross-functional development teams (Gunasekaran (1999, Gunasekaran and Yusuf , 2002; Sahin, 2000)	Forming a team which comprises of group of people with different functional expertise working toward a common goal like people from finance, marketing, operations, and human resources departments. Outside an organization (in particular, from suppliers, key customers, or consultants).

2.2. Conduct Survey to Identify the Most Important Strategy

A questionnaire was prepared to identify the most important strategy for improving the responsiveness in apparel supply chain. The questionnaire was administered to 12 top-level managers. The respondents were personally contacted to get the questionnaire filled. The profile of the respondents is given in Table 2.

Table 2: Profile of the respondents

Sl. No.	Industry/academic	Designation	Years of Experience	Education Qualification
1	Apparel Manufacture ring	Vice President	25	PhD

Sl. No.	Industry/academic	Designation	Years of Experience	Education Qualification
2	Knitted Garments	General manager	22	MBA
3	Woven Garments	Regional Manager	20	MBA
4	Apparel Manufacturing	Manager	18	MBA
5	Apparel Knitting	President	19	Engineering Master Level
6	Apparel Manufacturing	Manager	12	Engineering Master Level
7	Apparel Manufacturing	Vice President	21	MBA
8	Apparel Manufacturing	Chief Executive officer	15	MBA
9	Apparel Knitting	Consultant	16	MBA
10	Academic	Professor	30	PhD
11	Academic	Professor	28	PhD
12	Academic	Professor	31	PhD

2.3. Rank all the Strategies Based on Their Mean

The strategies are ranked based on their mean (Table 3).

Table 3: Ranking of Strategies based on Their Mean

Strategies	Mean	Std. Deviation
Supply chain collaboration	4.50	0.52
Information technology infrastructure	4.50	0.52
Postponement Techniques	4.50	0.52
Outsourcing	4.50	0.52
Market sensitivity	3.58	0.51
Flexible manufacturing system	2.50	1.00
Vendor managed inventory systems	2.50	0.52
Concurrent engineering	2.00	0.74
Just in time	1.83	0.94
Total cycle time reduction	1.58	0.51
Cross functional team	1.50	0.52
Third party logistics	1.42	0.51
Knowledge management	1.33	0.49

In the exploratory data analysis, the four strategies namely, improving apparel supplier-manufacturer- retailer collaboration, information technology infrastructure, adoption of postponement techniques and outsourcing, are found equally important for supply chain responsiveness. These strategies are then prioritized, based on various performance measurement criteria using comprehensive multi-criteria decision making methodology namely analytic network process (ANP) in Section 3.2.5 for a case company.

2.4. Identify the expected supply chain performance criteria

In this section the criteria that are to be considered for prioritizing the alternatives of improving the responsiveness of the case company is provided. Table 4 provides the criteria and sub criteria applicable to case company in detail.

5. Build a model to prioritize the strategies with respect to performance criteria

A graphical representation of the ANP model is as shown in Figure 2. It can be seen that the overall objective is to prioritize the responsive

Table 4: Summary of literature for criteria and sub criteria for the case company

Criteria	Sub-criteria	Explanation
Market oriented performance	Market Share (Tan *et al*. 1998; Frohlich and Westbrook, 2001)	Total available market or market segment that is being serviced by the company
	Market Share Growth(Tan *et al.,*1999)	Annual Growth of market share
	Overall Competitive Position (Tan *et al.,* 1999)	Time, effort, resources and managerial attention required to keep up with competitors, number of competencies (i.e. things a firm must do well) required to survive and amount of time spent analyzing major competitors' strategies and actions.
Flexibility	Source flexibility (Agarwal and Shankar, 2002)	Ability of an organization to change sourcing decisions such as the number of suppliers per part and delivery schedule is called source flexibility. Sourcing flexibility facilitates a faster response when there is uncertainty.
	Manufacturing flexibility (Agarwal and Shankar, 2002)	Ability of an organization to reconfigure its manufacturing resources so as to efficiently produce different products of acceptable quality is called manufacturing flexibility.
	Delivery flexibility (Agarwal and Shankar, 2002)	Capability of an organization's capability to adapt the changes of volume, time, and frequency of delivery is called delivery flexibility.
Innovation	Product Innovation (Scannell *et al*, 2000; Li *et al*., 2006; Rondeau *et al*., 2000.)	Ability to develop new products and/or technologies in anticipation of, or in response to, customer requirements.
	Speed of Product Development(Frohlich and Westbrook, 2001)	Speed in which the new product is developed.
	Number of New Products Developed (Frohlich and Westbrook, 2001)	Number of new products developed in a year
	Process Innovation(Scannell *et al*, 2000)	Ability to develop new processes using the latest technologies in anticipation of, or in response to, customer requirements.
Cost	Total Production Cost (Tan *et al*, 1998; Scannell *et al*, 2000)	Costs associated with production
	Total Distribution Cost (Gunasekaran *et al*., 2004)	Costs incurred in moving goods from the point of production to the point of consumption.
	Inventory Cost (Beamon, 1999; Gunasekaran *et al*., 2004, Dobler & Burt, 1996)	Total costs associated with the inventory consists of the following: opportunity cost consisting of warehousing, capital and storage; cost associated with inventory as incoming stock level, work in progress; service costs, consisting of costs associated with stock management and insurance; cost held up as finished goods in transit; risk costs, consisting of costs associated with pilferage, deterioration, damage; cost associated with scrap and rework and cost associated with shortage of inventory accounting for lost sales/lost production.
Customer Services & Satisfaction	Customer Service Level (Tan *et al*., 1998; Frohlich and Westbrook, 2001)	Level of service provided to the customer
	Customer Satisfaction (Stank *et al*., 2001; Frohlich and Westbrook, 2001)	Degree to which customers are satisfied with the product and/or service received, and can be applied to internal customers or external customers
	Service Level Compared to Competitors (Gunasekaran *et al*., 2001)	Service performance compared to their competitors.
	Customer Query Time(Bhagwat and Sharma ,2007)	Time taken for a firm to respond to a customer enquiry (status of an order, stock availability and enquires related delivery) with the required information.

strategies. There are four main criteria for prioritizing the strategies namely market oriented performance, flexibility, innovation, cost and customer service & satisfaction which are interdependent. Each criterion has its own sub-criteria and there is some interdependence among sub-criteria.

2.6. Select a case company to apply the model

A case company was selected to apply this model. The case company is India's leading apparel manufacturing and retail company and its turnover is Rs. 35548 million. It has perpetual license for major premier brands in the world and also plays a preferred supplier for international brands. The case company has plan of improving the responsiveness of the supply chain. The management of case company was requested to form a panel of four managers to participate in this process. Then literature on the four strategies and list of performance criteria were circulated among them. The opinion of the panel members is sought to compare pair-wise each alternative with respect to each criteria and sub criteria. In this paper, mainly for the purpose of brevity, results of the innovation criteria are illustrated. Similarly the results of other four criteria would be used in the calculation of prioritizing the strategies. The profile of the panel members is given in Table 5.

Step 1:Pair-wise comparison of criteria

In this step, a pair-wise comparison matrix is prepared for determining the relative importance of each of the criteria (market oriented performance, flexibility, innovation, cost and customer service & satisfaction). In such comparisons, a scale of 1–9 is used to compare two options (Ravi *et al*., 2005). In this a score of 1 indicates that the two options under comparison have equal importance, while a score of 9 indicates the overwhelming dominance of the component under consideration (row component) over the comparison component (column component) in a pair-wise comparison matrix. In case, a component has weaker impact than its comparison component, the range of the scores will be from 1 to 1/9, where 1 indicates indifference and 1/9 represents an overwhelming dominance by a column element over the row element. For the reverse comparison between the components already compared, a reciprocal value is automatically assigned within the matrix, so that in a matrix a_{ij} a_{ji} =1. The pair-wise comparisons of criteria with the e-vectors are shown in Table 6.The e-vectors (also referred to as local priority vector) are the weighted priorities of the determinants and shown in the last column of the matrix. In this paper, a two-stage algorithm (Ravi *et al*., 2005a) is used for computing e-vector. These e-vectors would be carried as P_j in Table 12 for the calculation of prioritizing the strategies.

Step 2: Pair-wise Comparison Matrices between Component Levels

In Table 7, the relative importance of product innovation and number of new product developed with respect to innovation, in achieving the responsiveness is five. From Table 7, it is observed that for the case company, the priority vector is 0.573, which has maximum priority than other sub-critera. The number of such pair-wise comparison matrices depends on the number of criteria in the ANP model. In this model, four such pair-wise comparison matrices are formed. The e-vectors obtained from these matrices are imported as A_{kj}^{D} in Table 12.

Step 3: Pair-wise comparison matrices of sub-criteria interdependency

Pair-wise comparisons are done to consider the interdependencies among the sub criteria. One such comparison is presented in Table 8. The question asked to the panel members for evaluating the interdependencies is 'Under innovation criteria, what is the relative importance between process innovation and speed of new product development?'.The panel's weightage is 5.

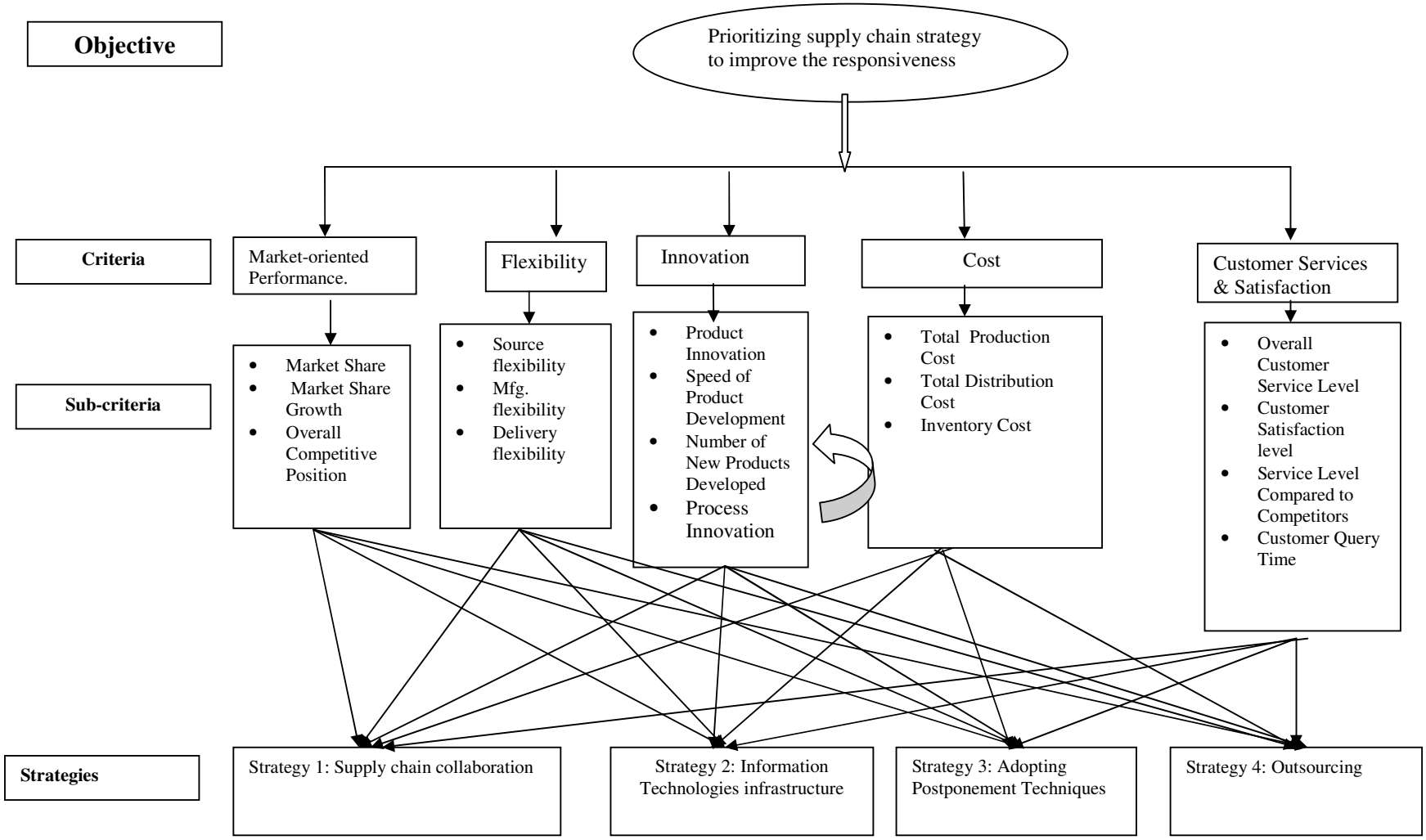

Figure 2: ANP Model for Prioritizing the Responsiveness Strategies

Table 5: Profile of the Panel members

Sl. No	Function	Designation	Years of Experience	Education Qualification
1	Supply chain	Manager	10	PhD
2	Supplier Development	Manager	8	MBA
3	Production	Manager	6	MBA
4	Finance	Manager	12	MBA

Table 6: Pair-wise comparisons of Criteria

Criteria	MOP	Flexibility	Innovation	Cost	CSS	e-vector
MOP	1	3	3	9	9	0.470
Flexibility	1/3	1	7	7	9	0.343
Innovation	1/3	1/7	1	3	3	0.103
Cost	1/9	1/7	1/3	1	3	0.052
CSS	1/9	1/9	1/3	1/3	1	0.032

Table 7: Pair-wise Comparison of Sub Criteria under Innovation

Sub-criteria	PI	SPD	NNPD	Pr I	e-vector
PI	1	3	5	9	0.573
SPD	1/3	1	3	7	0.271
NNPD	1/5	1/3	1	3	0.110
Pr. I	1/9	1/7	1/3	1	0.045

That means that process innovation is more important than 'speed of product development' for the case company and among three sub criteria 'process innovation' has got higher weightage is (0.751). For each criterion, there will be 17 such matrices at this level of relationship. The e-vectors from these matrices are used in the formation of super matrices.

Table 8: Pair-wise Comparison Matrix for Sub-criteria regarding Innovation with respect to Product Innovation

Product innovation	SPD	NNPD	Pr I	e-vector
Speed of Product Development	1	3	1/5	0.178
No. of new product Developed	1/3	1	1/9	0.07
Process innovation	5	9	1	0.751

Step 4: Evaluations of strategies

The final set of pair-wise comparisons is made for the relative impact of each of the strategies (supply chain collaboration, IT infrastructure, postponement strategies and outsourcing). The number of such pair-wise comparison matrices is dependent on the number of sub criteria that are included in each of the criteria. In the present case, there are 17 sub criteria therefore 17 such pair-wise matrices. One such pair-wise comparison matrix is shown in Table 9. The e-vectors from this matrix are used in columns 6-9 in Table 12 which corresponds to supply chain partnerships, adoption of enabling technologies, postponement strategies and outsourcing respectively.

Table 9: Pair wise comparison of strategies under product innovation

Product innovation	Supply chain partnerships	Adoption of enabling technologies	Adoption of postponement strategy	Outsourcing	e-vector
Supply chain collaboration	1	3	5	7	0.556
Adoption of enabling technologies	1/3	1	3	5	0.259
Adoption of postponement strategy	1/5	1/3	1	5	0.136
Outsourcing	1/7	1/5	1/5	1	0.049

Step: 5 Super Matrix Formations

The super matrix allows for a resolution of the interdependencies that exist among the elements of a system. The values of the elements of the super matrix M have been imported from the pair-wise comparison matrices of interdependencies (for example, Table .8). As there are 17 such pair-wise comparison matrices, there will be 17 non-zero columns in this super matrix. Each of the non-zero values in the column is the relative importance weight associated with the interdependent pair-wise comparison matrices. In the next stage, the super matrix M is made to converge to obtain a long-term stable set of weights. For convergence to occur, super matrix needs to be 'column stochastic', i.e. the sum total of each of the Columns of the super matrix needs to be one. Raising the super matrix M to the power 2^{k+1}, where k is an arbitrarily large number, allows for the convergence of the interdependent relationships (Ravi *et al*., 2005a). The converged super matrix is shown in Table 9.

Step 6: Prioritizing Strategies

The priority of the strategies depends upon the outcome of the 'desirability index'. The desirability index, D_i, for strategy i and the criteria 'A' is defined as (Ravi *et al*., 2005)

$D_i = \sum_{j=1}^{J} \sum_{K=1}^{Kj} P_j A_{kj}^{D} A_{kj}^{I} S_{ikj}$ Where P_j= is the relative importance weight of criteria for strategy j, A_{kj}^{D} is the relative importance weight for sub criteria k of criteria of strategy j, A_{kj}^{I} =stabilized relative importance weight (determined by the super matrix), S_{ikj} = is the relative importance of strategies i on sub criteria k of criteria j, K_j= is the index set for strategies with respect to criteria j J = index set for the criteria

3. Discussion and managerial implications

The ANP model has been used to prioritize the strategies for improving the responsiveness with respect to some important performance criteria which are applicable to apparel retail industry. The priority values for the criteria are presented in Table 6. From the table 6, it has been observed that the 'market oriented performance' (0.470) is the most important criteria in prioritizing the strategies. The priority values for all the strategies are also given in Table 12. The highest priorities is to 'supply chain collaboration' (0.577), followed by 'IT infrastructure' (0.271069998), 'adoption of postponement techniques' (0.1043) and outsourcing (0.047). These results corroborate the finding made by Liu and Kumar (2003) that collaboration plays a key role in achieving responsiveness. Generally, a single organization often may not be able to respond quickly to changing market requirements. Collaboration with partners helps to improve responsiveness of organizations (Gunasekaran and Yusuf, 2002). Supply chain collaboration helps to integrate all the partners of the supply chain that leads to integrated supply chain which is essential for responding quickly to the customer demand. In a apparel industry environment, partnership with supply chain partners can help to achieve competitive advantage by receiving the merchandise in a short supply, information on new best selling products and competitive activity, best allowable prices, and advertising and markdown allowances. By giving importance to supply chain partnerships the responsiveness can be enhanced this is where the Spanish retailer Zara is leaping ahead of their competitors in satisfying consumer's desire for fashion on a timely basis every day.

4 Conclusions

This paper presents a framework for prioritizing the strategies for improving the supply chain responsiveness. Different strategies have been identified from the literature and the respondents' were asked perception regarding strategies which are responsible for achieving the supply chain responsiveness. The strategies have been ranked based on their mean. Four strategies namely supply chain collaboration, adoption of postponement techniques, outsourcing and improving the IT infrastructure have been ranked equal. Then these top four strategies have been prioritized with respect to certain performance criteria by using ANP based methodology. The outcome of ANP is that case company should focus on supply chain collaboration for improving the responsiveness.

Table 10: Super Matrix (M) after Convergence

	MS	MSG	OCP	SF	MF	DF	PI	SPD	NNPD	PI	LPC	TDC	IC	OCSL	CSL	SLCC	CQT
Market Share (MS)	0.388	0.388	0.388														
Market Share Growth (MSG)	0.440	0.440	0.440														
Overall Competitive Position (OCP)	0.170	0.170	0.170														
Source flexibility (SF)				0.397	0.397	0.397											
Mfg. flexibility (MF)				0.459	0.459	0.459											
Delivery flexibility (DF)				0.143	0.143	0.143											
Product Innovation (PI)							0.306	0.306	0.306	0.306							
Speed of Product Development (SPD)							0.163	0.163	0.163	0.163							
Number of New Products Developed (NNPD)							0.076	0.076	0.076	0.076							
Process Innovation(PI)							0.399	0.399	0.399	0.399							
Low Production Cost(LPC)											0.700	0.700	0.700				
Total Distribution Cost(TDC)											0.949	0.943	0.949				
Inventory Cost(IC)											0.662	0.662	0.662				
Overall Customer Service Level (OCSL)														0.352	0.352	0.352	0.352
Customer Satisfaction level (CSL)														0.431	0.431	0.431	0.431
Service Level Compared to Competitors (SLCC)														0.138	0.138	0.138	0.138
Customer Query Time (CQT)														0.068	0.068	0.068	0.068

Table 12: Desirability Indices

Criteria	P(j)	Sub criteria	A_{kj}^{D}	A_{kj}^{I}	Strategies S1	S2	S3	S4	Supply chain collaboration	IT Infrastructure	Adoption of postponement strategy	Outsourcing
MOP	0.47	MS	0.731	0.388	0.571	0.257	0.11	0.062	0.076	0.034	0.014	0.008
MOP	0.47	MSG	0.188	0.440	0.652	0.216	0.09	0.042	0.025	0.008	0.003	0.001
MOP	0.47	OCP	0.081	0.170	0.559	0.264	0.14	0.037	0.003	0.001	0.001	0.001
Flexibility	0.343	SF	0.637	0.388	0.652	0.216	0.09	0.042	0.055	0.018	0.007	0.003
Flexibility	0.343	MF	0.258	0.397	0.566	0.267	0.127	0.04	0.019	0.009	0.004	0.001
Flexibility	0.343	DF	0.105	0.459	0.657	0.203	0.094	0.046	0.010	0.003	0.001	0.001
Innovation	0.103	PI	0.573	0.306	0.556	0.259	0.136	0.049	0.010	0.018	0.002	0.001
Innovation	0.103	SPD	0.271	0.1631	0.652	0.216	0.09	0.042	0.002	0.001	0.001	0.001
Innovation	0.103	NPD	0.11	0.0766	0.565	0.262	0.118	0.055	0.001	0.001	0.001	4.7733E-05
Innovation	0.103	PI	0.045	0.3991	0.652	0.216	0.09	0.042	0.001	0.001	0.001	7.7693E-05
Cost	0.052	LPD	0.178	0.7009	0.539	0.323	0.094	0.044	0.003	0.002	0.001	0.001
Cost	0.052	TDC	0.751	0.9493	0.546	0.286	0.126	0.041	0.020	0.010	0.004	0.001
cost	0.052	IC	0.07	0.6628	0.657	0.094	0.203	0.046	0.001	0.001	0.001	0.001
CSS	0.032	OCSL	0.645	0.3524	0.561	0.279	0.123	0.037	0.004	0.002	0.001	0.001
CSS	0.032	CSL	0.216	0.4318	0.558	0.303	0.095	0.043	0.001	0.001	0.001	0.001
CSS	0.032	SLCC	0.087	0.1386	0.558	0.303	0.095	0.043	0.001	0.001	3.66569E-05	1.6592E-05
CSS	0.032	CQT	0.052	0.068	0.546	0.286	0.126	0.041	6.1781E-05	3.2361E-05	1.42572E-05	4.6392E-06
							Total Desirability Index		0.237	0.111	0.042	0.019
							Normalized Desirability Index		0.577	0.271	0.104	0.047

Since the case company is representative of similar companies in apparel industry this result can be generalized to other companies in this industry. The ANP in this paper has a few limitations as well. For example, the outcome of the model is dependent on the inputs provided by the few manager of the case company. The possibility of bias of the decision-maker cannot be ruled out while applying this model. Moreover, the formation of pair-wise comparison matrices is a time-consuming and complex task. Inconsistency may also occur in the pair-wise comparison of matrices, which may give wrong results.

REFERENCES

1. Agarwal, A. and Shankar, R. (2003), "On-line trust building in e-enabled supplies chain", *Supply Chain Management: an International Journal*, Vol. 8, pp.324–334.
2. Bhagwat, R and Sharma, M. K (2007), "Performance measurement of supply chain management: A balanced scorecard approach", *Computers & Industrial Engineering*, Vol.53, pp.43–62.
3. Bowersox, D.J., Closs, D.J., and Stank, T.P. (1999), 21st Century Logistics: Making Supply Chain Integration a Reality, The Council of Logistics Management, Oak Brook, IL.
4. Bruce, M., Daly, L and Towers, N. (2004), "Lean or agile A solution for supply chain management in the textiles and clothing industry?", *International Journal of Operations & Production Management,* Vol.24, No.2, pp. 151-170.
5. Dapiran, P. (1992), "Benetton – global logistics in action", *International Journal of Physical Distribution & Logistics Management,* Vol.22, No.6, pp.1-5.
6. Dobler, D. W., & Burt, D. N. (1996). Purchasing and Supply Management. New York, NY: The McGraw-Hill Companies.
7. Fisher, M. and Raman. A.(1996), "Reducing the cost of demand uncertainty through accurate response to early sales", *Operations Research*,Vol.44, No.1, pp.87.99.
8. Forza, C and Vinelli, A. (2000), "Time compression in production and distribution within textile and apparel chain", *Integrated Manufacturing Systems,* Vol.11, No.2, pp.138-146.
9. Forza, C, Vinelli, A (1997), "Design towards quick response: an analytical scheme for the change", *International Journal of Clothing Science & Technology*, Vol.8, No.4, pp.28-43.
10. Gunasekaran, A. (1999), "Agile manufacturing: a framework for research and development", *International Journal of Production Economics,* Vol. 62, No.1/2, pp.87-106.
11. Gunasekaran, A., Lai, K.H and Cheng, T.C. Edwin (2008) "Responsive supply chain: A competitive strategy in a networked economy", *Omega*, Vol.36, pp.549-564.
12. Gunasekaran, A., Patel, C. and Mc Gaughey, R.E. (2004), "A framework for supply chain performance measurement", *International Journal of Production Economics*, Vol. 87, pp.333-347.
13. Gunasekaran, A., Yusuf, Y. (2002), "Agile manufacturing: a taxonomy of strategic and technological imperatives", *International Journal of Production Research,* Vol. 40, No.6, pp.1357-1385.
14. Hall, R.W (1983), "Zero Inventories", Dow Jones-Irwin, Homewood, IL.
15. Holweg, M. and Pil, F. K. (2001), "Successful Build-To-Order Strategies Start with the Customer", *MIT Sloan Management Review*, Vol.43, No.1, pp. 74-84.
16. Hunter, N.A. (1994), Quick Response in Apparel Manufacturing, *The Textile Institute,* Manchester, 1–271.
17. Jaikumar, R. (1986), "Post industrial manufacturing", *Harvard Business Review,* pp.69-76.
18. Li , S., Ragunathan, B. Ragunathan, T.S. and Rao, S.S., (2006), "The impact of supply chain management practices on competitive advantage and organizational performance", Omega, Vol.34, No.2, pp. 107-124
19. Liu, E. R. and Kumar, A. (2003), "Leveraging Information Sharing to Increase Supply Chain Configurability", Twenty Fourth International Conference on Information Systems, pp.523-537.
20. Loh, L and Venkatraman, N.(1995), "An Empirical Study of Information Technology Outsourcing: Bene_ts, Risks, and Performance Implications", International Conference on Information Systems (ICIS), available at http://aisel.aisnet.org/cgi/viewcontent.cgi?article=1068&context=icis1995.
21. Martin, J. H. and Grbac, B. (2003), "Using supply chain management to leverage a firm's market orientation", *Industrial Marketing Management*, Vol.32, No.1, pp. 25-38.
22. Mason-Jones, R. and Towill, D.R. (1999), ''Total cycle time compression and the agile supply chain'', *International Journal of Production Economics*, pp. 61-73.
23. Narasimhan R. and Das A. (2000), "Manufacturing Agility and Supply Chain Management Practices",

The Journal of Enterprise Resource Management- Australasian Production and Inventory Control Society, Vol.3, No.3, pp. 11-17.

24. Ravi V., Shankar R. and Tiwari M.K. (2005), "Analyzing alternatives in reverse logistics for end-of-life computers: ANP and balanced scorecard approach", *Computers and Industrial Engineering*, Vol.48, No.2, pp. 327-356.

45 Rondeau, P. J., Vonderembse, M. A., and Ragu-Nathan, T. S., (2000), "Exploring Work System Practices for Time-Based Manufacturers: Their Impact on Competitive Advantage", *Journal of Operations Management*, Vol.18, pp. 509-529.

46 Saaty, T.L. (1996), Decision Making with Dependence and Feedback: The analytic network process, Pittsburgh: RWS Publications.

47 Sahin, F. (2000), "Manufacturing competitiveness: different systems to achieve the same results", *Production & Inventory Management Journal*, Vol.41, No.1, pp.56-65.

48 Sari, K (2007), "Exploring the benefits of Vendor Managed Inventory", *International Journal of Physical Distribution & Logistics Management*, Vol.37, No.7, pp. 529-545.

49 Scannell, T., Vickery, S., Droge, C. (2000), "Upstream supply chain management and competitive performance in the automotive supply industry", *Journal of Business Logistics,* Vol. 21, No.1, pp.23-48.

52 Stank, T.P., Keller, S.B. and Daugherty, P.J. (2001), "Supply chain collaboration and logistical service performance", *Journal of Business Logistics*, Vol.22 No.1, pp. 29-48.

54 Towill, D. and Christopher, M. (2002), "The Supply Chain Strategy Conundrum: To be Lean or Agile or To be Lean and Agile?", *International Journal of Logistics*,Vol.5, No.3, pp. 299-309.

55 Tu, Q., Vonderembse, M.A., Ragu-Nathan, T.S. and Ragu-Nathan, B. (2004), "Measuring modularity-based manufacturing practices and their impact on mass customization capability: a customer-driven perspective", *Decision Sciences*, Vol.35 No. 2, pp.147-168.

57 van Hoek, R.I.(2001), "The rediscovery of postponement a literature review and directions for research", *Journal of Operations Management,* Vol.19, pp.161–184.

59 Vasiliauskas, A.V. and Jakubauskas, G. (2007), "Principle and benefits of third party logistics approach when managing logistics supply chain", *Transport,* Vol.22, No. 2, pp.68–72.

60 Wadhwa, S. and Saxena, A. (2005), " Knowledge Management based Supply Chain: An Evolution Perspective", *Global Journal of e-Business and Knowledge Management,* Vol.2, No.2 , pp.13-29

62 Yang, B. and Burns, N. (2003), "Implications of postponement for the supply chain", *International Journal of Production Research,* Vol.41, No.9, pp.2075-2090.

Biography

A.Ramesh is an Assistant Professor at the Department of Mechanical Engineering, National Institute of Technology Calicut, Kerala, India. His research interests are in the area of Supply Chain Management and Operations Management. He is corresponding author to this paper.

D.K. Banwet is Professor and Former Head at the Department of Management Studies, Indian Institute of Technology, Delhi, India. His areas of interest are production and operations management, management science, entrepreneurship and technology management, general management/strategic management, project management, SCM, etc. He has published research papers in journals like The TQM Magazine, Journal of Educational Planning and Administration, Productivity, Journal of productivity and Performance Management, Asian Academy of Management Journal, Journal of Global Competitiveness, and Management Review.

Ravi Shankar is Professor at the Department of Management Studies, IIT Delhi. His areas of interest are Industrial Engineering/Operations Management, Supply Chain Management, e-Business, Operations Research, and Fuzzy Modeling. His research papers have appeared in the International Journal of Production Research, International Journal of Production Economics, European Journal of Operational Research, Supply Chain Management: An International Journal, International Journal of System Dynamics and Policy Making, Computers and Operations Research, Computers and Industrial Engineering etc.