Integrated Supply Chain Management:

A Key to Enhance Manufacturing Performance

Norma J. Harrison, Hung M. Nguyen

Macquarie Graduate School of Management, Macquarie University
(Norma.Harrison@mq.edu.au; hungsav@hotmail.com)

Abstract

The role of Supply Chain Management (SCM) as an integral part in corporate strategy has been discussed in previous research [1]. The increase in global competition has given managers the impetus to develop innovative relationships in the distribution channel.

The evolution of SCM has been changed radically with regard to customer orientation, organizational and infrastructure changes. As production processes continue to evolve and outsourcing increases, SCM has become critical to the development of manufacturing systems [2]. Competition today is in fact typified more as supply chain versus supply chain, rather than firm versus firm.

The strength of SCM is driven by its integrative management approach [3]. This strategic integration of trading partners is covered in the treatment of SCM concepts [4], [5]. There are, in practice, few examples of truly integrated supply chains [6] and it is not always clear what that integration implies and how it is implemented [7]. Little empirical evidence exists of the relationship between supply chain management practice and performance [8] and how deeply the concepts have become ingrained in manufacturing operations. Researchers are just beginning to investigate the tactical and operational linkages among the functional elements of the SCM.

Using data from the 1996 Australian Manufacturing Futures Project, this paper attempts to analyze the steps necessary for integration of SCM in a diverse group of Australian manufacturers. The first step is developing a classification scheme or taxonomy of supply chain strategy (SCS) using the core processes of manufacturing. The second goal is to empirically test integrated supply chain management (ISCM) initiatives according to different SCS groups. The third goal is to differentiate members of these unique supply chain groups by various manufacturing competitive priorities and analyze resulting overall performance.

1. Introduction

A supply chain is an integrated system wherein a number of various business entities such as suppliers, manufacturers, distributors, and retailers work together to deliver goods and/or services promptly at a competitive price. Some definitions describe SCM just as operational activities whilst some others consider SCM as a new management philosophy [9]. While most of researchers and managers agree to these definitions, there is no clear cut consensus on how best to describe a supply chain [10]. However, it is clear that the strength of SCM is driven by its integrative management approach [3]. Very often in this context scholars refer to the need of integrating the supply chain [5]. Hereafter, we look at several research models on ISCM.

The competitive requirement that not only individual enterprises but also whole channels of supply ceaselessly search for new ways to converge they're operational and strategic strengths to become more creative and responsive to the market place. But how to develop the *integration* among supply chain members is a question of strategic issue in today's business management [9]. This new *integration* has many labels in the literature, including *integrated purchasing strategy*, *supplier integration* and supply base management [2], *buyer-supplier partnerships, strategic supplier alliances*, *supply chain synchronization* [3], and *integrated supply chain management* [8].

2. Models of ISCM

There are different models for analysis of integration process of SCM as outlined below.

2.1 From the Buyer-Supplier Viewpoint

A buyer-supplier partnership is a mutual ongoing relationship involving a high level of trust, joint conflict resolution and the sharing information, risk and rewards to improve competitive performance [11]. Supplier development is a long term cooperative effort between firms to upgrade a supplier's technical, quality, delivery, and cost capabilities [12], requiring companies to treat suppliers as partners.

For a manufacturer, there are upstream integration with suppliers and downstream of customers. For certain manufacturers, there are also large distributor networks to bring goods to customers. Tan et. al. calls them as *customer relation practices and supplier performances* [13]. Attempts to improve performance, encourage trust, and improve communication help to foster long - term cooperation and strategic alliances.

Many organizations have upgraded their purchasing function to be an integral part of the *corporate planning process* [8]. These organizations recognize the benefits and competitive advantages associated with integrating purchasing into strategic planning.

2.2 Process-based ISCM

Frohlich, et al, divides supply chain up to the five fundamental processes [10]. In general, most of manufacturers attempt to integrate two or more of these processes in order to provide the best value to the customers. The five elements are as follows:

Supply Chain Integration

1. The process of introducing new products
2. The process of procuring raw materials and components.
3. The process of transforming physical materials.
4. The process of fulfilling customer's orders.
5. The process of providing product support and services.

Gilmour et al [14] developed the ISCM model to examine the logistic operations. It is based on process capabilities, technology capabilities and organization capabilities. An organization with an integrative approach to managing logistics will tend to have the majority of these capabilities in place. Five dimensions for each of eleven capabilities were established in order to determine the logistical sophistication by area of managerial activity. These dimensions are strategy and organization; planning; business process and information; product flow; and measurement. As an example of this process, the components for a logistics capability - *Supplier Partnering* - are allocated among these five categories as follows:

- Strategy and organization: supplier selection strategy; purchasing strategy; purchasing organization design; information sharing;
- Planning: order planning; product development;
- Business process and information: transaction automation; purchasing approval;
- Product flow: Delivery point; timeliness of delivery.
- Measurement: supplier performance.

2.3 From the Capability Viewpoint

De Meyer and Kim developed a conceptual model for understanding ISCM [7]. The conceptualisation aims at structuring the different activities in ISCM in four levels and suggests that companies have to gradually build up capabilities in each of these levels, i.e., rationalizing the network; sharing information and problems solving; implementing common systems; and, sharing risks and rewards.

2.4 From the Information Viewpoint

Singh [15] defines supply chain as integrated by combining goods movement with the flow of operational and financial information between the relevant (internal and external) parties, i.e.,
Integrated supply chain = Good movement + information flow.

Supply chain integration encompasses the processes necessary to create, source, make to, and deliver to demand. They use technology to gather information on market demands and exchange information between organizations [16].

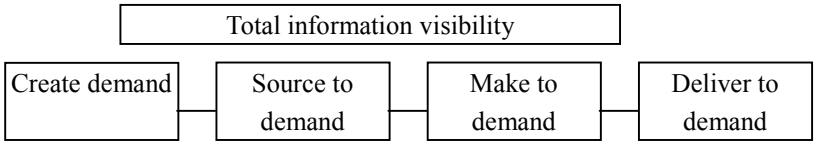

Figure 1: Supply Chain Integration (adapted from Singh, 1996)

3. Research Methodology

A survey instrument was designed around the constructs described above. Respondents were asked to indicate, using a seven point Likert scale, the level of implementation and future importance the extent to which they used the ISCM initiatives in their respective industries. The data from the 1996 Australian Manufacturing Futures Project was used in statistical techniques like cluster analysis and canonical discriminant analysis to evaluate the responses from 115 Australian manufacturing companies. Figure 2 illustrates the framework of the research study.

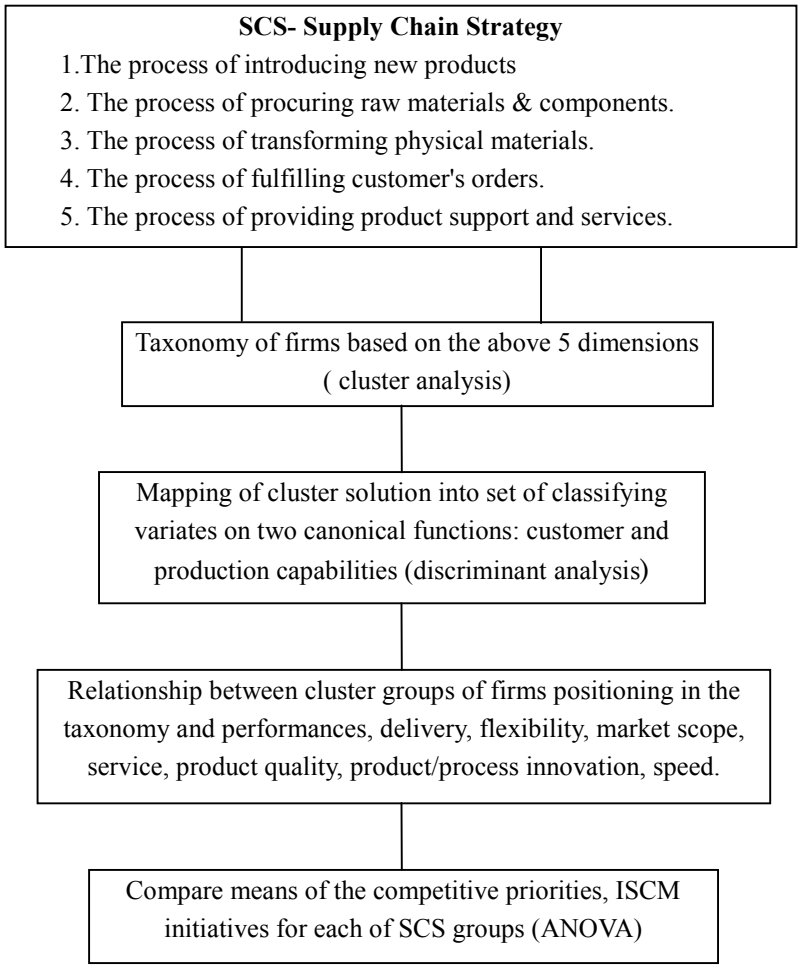

Figure 2. Framework of the research

This paper uses the supply chain classification of Frohlich et. al. [10] to divide supply chains based on five processes. The groups will be exposed to 9 ISCM capabilities used by De Meyer and Kim [7]. The results will suggest that which group of companies might have better performances with gradually build up ISCM capabilities. This progressive model includes four stages in supply chain management as described in Section 2.3 above.

This paper examines the five core processes as shown in Figure 2 and generates cluster groups. The analysis suggests that most manufacturers attempt to integrate two or more of these processes to enhance customer's value. Next, the groups will be tested on nine ISCM capabilities as follows:

- Channel wide management of inventory
- Communication at multiple level
- Distributor base reduction
- Extending time horizon of planning
- Information sharing and monitoring
- Joint planning and problem solving
- Sharing risks and rewards
- Supplier base reduction
- Total cost approach

This analysis then attempts to explore degrees toward ISCM implementation as well as future importance of ISCM practices in Australian manufacturing industry by adapting the four steps to ISCM implementation as outlined by De Meyer and Kim [7].

Five indicators of competitive intensity were identified. These include management perceptions of capabilities to provide products and services with high quality, at competitive price, with high degree of flexibilities, fast and dependable delivery. Business performances were identified by overall business performance, core manufacturing performance, new product introduction performance, and supply chain performance.

3.1 Clustering the Supply Chain Strategies

Two-stage cluster analysis was used to classify 115 companies along five dimensions. Hierarchical cluster analysis was used first with Ward's method to classify the companies according to their processes. The initial cluster group/centre was applied to Quick Cluster to finalise cluster memberships. A 3-cluster solution was found to be best in terms of stability, internal validity, external validity and parsimony. Each of the three clusters seemed to have a very different supply chain strategy.

Table 1 Cluster Size of Supply Chain Strategy

	Cluster size	
	Percent	Number
Cluster 1	48%	55
Cluster 2	29%	34
Cluster 3	23%	26
Total	100%	115

Table 2 Comparison of the Clusters' Fundamental Processes

Fundamental processes	Means	Cluster 1	Cluster 2	Cluster 3	Sig.
The process of introducing new products - NP	5.22(3)	**5.89(4)**	4.97(2)	4.15(4)	0.000
The process of fulfilling Customers' orders - OF	6.24(1)	**6.74(1)**	5.50(1)	6.15(1)	0.000
The process of procuring raw materials- P	5.13(5)	**6.05(3)**	4.70(4)	3.76(5)	0.000
The process of providing product support and services - PS	5.45(2)	**6.30(2)**	3.64(5)	6.00(2)	0.000
The process of transforming physical materials - TR	5.18(4)	**5.76(5)**	4.91(3)	4.30(3)	0.000

These range from 1: least important to 7: most important in providing value to the customer over the next five years.

The first cluster group places strong emphasis on the entire supply chain. This group had the highest mean emphasis on all of five core processes. Group Two's highest average score was in fulfilling customer's orders and introducing new products. Cluster Three pu a noticeable concentration on the process of product support and services and the process fulfilling customer's orders while paying the least importance on the process of procuring raw materials.

In comparison to USA manufacturers, there were some differences in the groups' emphases on the processes. The groups of USA manufacturers were more concerned about the process of introducing new product (number two) than that of their counterpart in Australia [10]. We proposed to label the three groups as depicting as Strong Integration, New Product Development and Customer Orientation.

- The Strong Integration is strong enough to cover most of supply chain processes.
- The New Product Development considers the process of introducing new product. This cluster group also emphasized on the process of fulfilling customer's order.
- The Customer Orientation places more emphases on the process of customer's order and product support and services.

3.2 Mapping the Cluster Solutions

Discriminant analysis was run to ensure that the three clusters groups were correctly classified. As seen in the table 3, the majority of cluster groups were correctly classified with 86%- 90%.

Table 3 Results of Discriminant Analysis for Cluster Membership

	Percent correctly classified			
	86 % Cluster 1	90% Cluster 2	86% Cluster 3	Total
Cluster 1	46	5	2	55
Cluster 2	2	36	2	34
Cluster 3	1	2	19	26

In this study, a similar canonical procedure to those done by Miller and Roth [17] and Frohlich et. al. [10] was run using the Australian 1996 data. Similar to Frohlich's study, two canonical functions were found statistically significant. The results are presented in table 4. The Wilk's Lambda test indicates significance of the two functions.

Table 4 Canonical Discriminant Functions

	Eigenvalue	Percentage of variance	Cumulative variance	Canonical correlation
Function 1	2.890	71.4	71.4	**.862**
Function 2	1.160	28.6	100.0	**.733**

Note: Canonical Correlation greater than 0.6 is deemed significant.

	Wilks' Lambda	Chi-square	df	Sig.
Function 1	.119	234.167	10	.000
Function 2	.463	84.737	4	.000

Table 5 shows the canonical loading for the two functions. The canonical loading represents the correlations between the five fundamental supply chain elements and each of the two canonical functions. The canonical loading reflects the variance that the observed variable shares with the canonical variate and can be interpreted like a factor loading in assessing the relative contribution of each variable to each canonical function.

The process of providing product support and services and the process of fulfilling customers' orders were the most related to the first function. The first function strongly related to PS, the process of providing product supports and services (0.815). To a much lesser extent this function also related to OF, the process of fulfilling customer orders (0.470). If a cluster has higher correlation with PS and the process of fulfilling customer orders then it will tend to fall at the higher end of the first canonical function. Conversely, if a cluster places less priority in those two processes, they will tend to fall at the lower side (negative) of the first function. Function one, with a higher degree of correlation with the PS and OF will be labeled " Customer capability".

The second function was significant correlated with three processes of production: P, the process of procuring materials and components (0.648); NP, the process of new product development (0.459); and TR, the process of transforming physical materials (0.390). The positive loadings on all three processes mean that manufacturers placing more priority on this capability will tend to fall at the high end of this function. Given the factor loadings on this function, we name this function " Production capability".

We then examined which cluster groups tend to favor one or another function and to which extent their performance and program activities and ISCM initiatives would support those two strategies.

Table 5 Canonical Loading for Function 1 and 2

		Function 1	Function 2
The process of providing product supports and services	- PS	**.815**	-.258
The process of fulfilling customer's order	- OF	**.470**	.110
The process of procuring raw materials	- P	.284	**.648**
The processes of introducing new products	- NP	.174	**.459**
The process of transforming physical materials	- TR	.169	**.390**

Note: Canonical loading greater than 0.4 is significant and bold in print

Table 6 Cluster Means on Canonical Functions

	Function 1	Function 2
Cluster 1	1.446	0.627
Cluster 2	-2.473	0.487
Cluster 3	0.175	-1.964

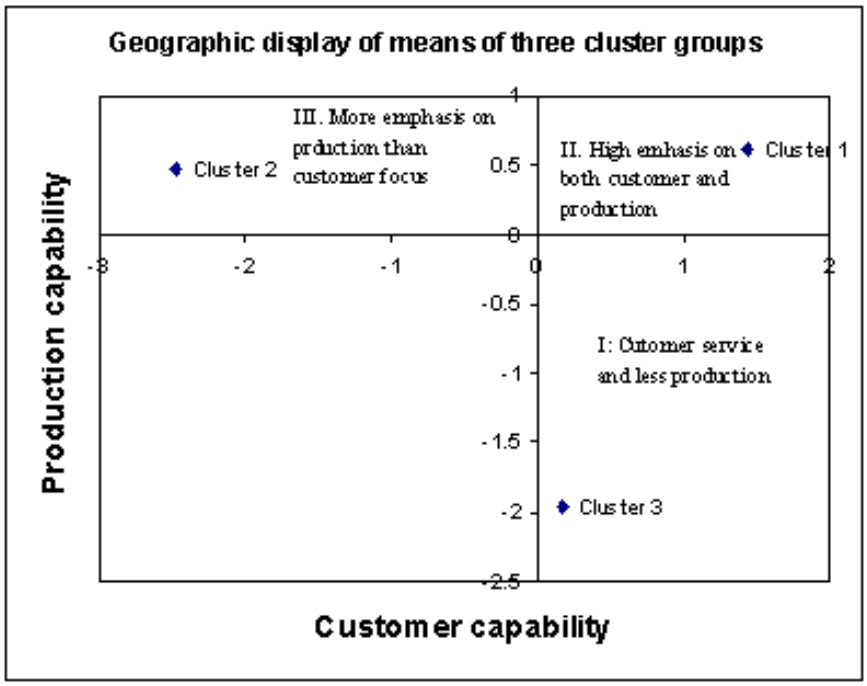

Fig. 3 Means of Clusters

4. Relationship of Cluster Groups with Practices and Performance

4.1 Core Capabilities

As shown in table 7, there were significant differences between the three clusters with their different supply chain strategies. Three clusters place strong focus on capability to deliver reliable product at a competitive price with high dependability. The Strong Integration group seems to develop significantly higher importance on these core capabilities than the other groups.

Table 7 ANOVA Results for Core Capabilities

	Strong Integration	New Product development	Customer Orientation	Anova Sig.
Capability to offer products with leading-edge technology	**5.95(3)**	4.00(3)	5.00(3)	.000
Capability to deliver reliable product at a competitive price with high dependability	**6.67(1)**	6.03(1)	6.42(1)	.000
Capability to tailor products to match exactly requirement of the selected market.	**6.07(2)**	5.12(2)	5.23(2)	.000

These range from 1: least important capability to 7: most important capability to the MBU over the next five years.

4.2 Competitive Priorities

The relationships across 16 competitive priorities were examined for the three supply chain strategy groups. As shown in table 8, there were significant differences between the three clusters and eleven competitive priorities were seen to be significant in the areas of delivery, flexibility and quality.

Table 8 ANOVA Results for Competitive Priorities

	Strong Integration	Customer Orientation	New Product development	Anova Sig.
Delivery				
➢ Ability to provide dependable deliveries	**4.95**	4.93	4.53	0.000
➢ Ability to provide fast delivery	**6.27**	5.50	5.57	0.001
Flexibility				
➢ Ability to offer a broad product line	**4.81**	4.87	4.50	0.009
➢ Ability to make rapid change in design	**5.41**	4.51	4.42	0.002
➢ Ability to introduce new product	**5.90**	4.91	4.61	0.000
➢ Ability to make rapid product mix change	**5.71**	4.54	4.61	0.000
➢ Ability to make rapid volume change	**5.51**	4.61	4.11	0.000
Quality				
➢ Ability to provide durable product	**5.90**	4.42	4.96	0.000
➢ Ability to provide high performance product	**4.98**	4.18	4.68	0.000
➢ Ability to offer consistent quality with low defects	**5.01**	4.82	5.34	0.000
➢ Ability to provide reliable product	**6.55**	5.78	6.15	0.000

These range from 1: least important competitive priority to 7: most important competitive priority to the MBU to compete in the marketplace over the next five years.

4.3 ISCM Initiatives

Means of nine ISCM initiatives were tested for significant differences between the three clusters. Different supply chain strategies tend to be related to different ISCM capabilities as indicated in table 9. There were 6 ISCMs significant at 0.07 or better.

Table 9 Means of ISCM Initiatives

ISCM initiatives	Strong Integration	New Product	Customer Orientation	Anova Sig
Channel wide inventory management	2.47(6)	**2.85(5)**	1.68(6)	.012
Distributor base reduction	3.14(4)	**3.39(3)**	3.39(1)	.043
Extending time horizon of planning	3.42(2)	**3.94(1)**	2.36(4)	.001
Joint planning and problem solving	**4.06(1)**	3.91(2)	3.16(2)	.044
Sharing risks and rewards	**3.17(3)**	2.73(6)	2.28(5)	.073
Total cost Approach	2.98(5)	**3.19(4)**	2.88(3)	.066

These range from 1: not attempted yet, to 7: completely implemented initiative towards achieving ISCM.

4.4 Performance

Differences between the three cluster's performances were analyzed for the previous complete fiscal year. The Scheffe method was used to test the three cluster's mean differences between performance along 24 measures spanning the overall business unit, core manufacturing, supply chain and product development areas. The significant findings (0.05 or better) are listed in Table 10.

Table 10 Significant Performance Indicators

Performances	Strong Integration	New Product	Customer Orientation	Anova Sig.
Productivity of direct production worker	113.18	106.77	**116.41**	.027
Profitability	111.43	107.19	**133.09**	.031

Figures denote Index Improvements, end 1993 - end 1995 (end 1993=100)

Objective of supply chain management

Supply Chain Objectives	Strong Integration	New Product	Customer Orientation	Anova test Sig.
Minimising cost to end customers	**4.55**	3.70	3.78	.010
Meeting end-user's quality requirement	**5.08**	4.40	4.43	.024
Optimising inventory level	**4.36**	3.60	3.87	.035
Reducing supply chain cycle time	**4.72**	4.00	4.15	.046
Rapid response to demand volume change	**4.38**	3.55	3.87	.047

These range from 1: serious bottleneck to 7: chain-wide benchmark in current capability.

4.5 Action Programs

The three clusters' means of action programs using ANOVA and Scheffe method were examined. The programs with significant differences (at 0.08 or better) in the 1996 data are listed in table 11. There are 10 action programs recorded significant different between the three groups. Strong Integration invests more than any others in those programs do, indicating their willingness to integrate all processes for gaining competitive advantages. The program of customer partnership recorded the highest mean in Customer Orientation.

Table 11 ANOVA Results for Action Programs

Action programs	Strong Integration	New Product	Customer Orientation	Anova Sig.
Simple pick and place robot	3.60	1.40	3.29	.065
Flexible manufacturing cell and systems FMS	4.17	2.20	2.50	.002
Computer integrated manufacturing CIM	3.96	2.44	2.94	.040
Electronic data interchange -EDI	3.40	2.67	2.54	.068
Computer aided manufacturing	4.73	2.93	3.65	.003
Developing new process for old product	4.24	3.00	4.03	.009
Certification to customer's quality standard	4.62	3.56	3.63	.037
Computer aided design CAD	4.64	3.89	3.71	.053
Customer partnership	4.69	3.92	4.13	.086
Supervisor training	4.65	4.21	3.76	.015

These range from 1: little payoff to 7: great payoff from these programs in the past two years.

5 Conclusions

The study found three main conclusions. First, there is very consistent evidence that there are applicable supply chain strategies. Three groups of companies seem to have appropriate structure to describe supply chain strategies in manufacturing industry. One group dominates on all areas of SCM. These companies have invested many efforts in ISCM implementation and corresponding action programs. Another group places strong emphasis on product development. The third group seems to provide strong product and after sales services.

Second, there are two major competitive dimensions that manufacturers compete on. They are customer service and production capability. Manufacturers are now more aware of the importance of customer services and "breaking down the wall" between customers, suppliers and manufacturers are essential strategy. The other dimension is placing more emphasis on production capability to gain competitive advantage.

Third, there are many factors helping manufacturers to differentiate their supply chain strategies. Supply chain objectives and action programs are the major differentiators. The emphasis is on the link between manufacturing/supply chain strategy and business strategy.

In conclusion, the five core fundamental processes of manufacturing strategies were useful in deriving the supply chain strategies. The relationship between manufacturing and supply chain strategy is becoming an interesting and important subject for researchers. Future research on integrative perspectives of supply chain management could focus on a set of new dimensions, such as information strategy and organizational strategy.

References

1. Monczka, R.M. and Morgan, J., Questions you need to ask about your supply chain. Purchasing; Boston; May 21, 1998.
2. David, T., Effective supply chain management. Sloan Management Review, Vol. 34, No. 4, pp. 35-46, 1993.
3. Bechtel, C. and J. Jayaram, Supply Chain Management: A Strategic Perspective. The International Journal of Logistics and Management, Vol 8, No.1, pp15-34, 1997.
4. Walton S.V. and Gupta N.D., Electronic data interchange for process change in an integrated supply chain. International Journal of Operations and Production Management, Vol. 19 No. 4, 1999.
5. Johnston R. and P. Lawrence, Beyond vertical integration - the rise of value adding partnerships. Harvard Business Reviews, pp94-101, July - August 1998.
6. Handfield, R.B. and Nichols, E.L., Introduction to supply chain management. Upper Saddle River, NJ: Prentice Hall, 1998.
7. De Meyer A. and Kim J., Understanding integrated supply chain management (ISCM). Proceedings of the Fourth International Decision Science Institute Conference Incorporating the 1997 Asia-Pacific Meeting, Vol. 2, pp594-596, 1997.

8. Kannan V.R., Tan K.C. and Handfield R.B., Managing competition, quality, customer relations, and the supply base, and its impact on firm performance. Decision Sciences Institute, Vol 3, pp1259-1261, 1998.
9. Ross F., Competing through supply chain management, Prentice - Hall International, 1998.
10. Frohlich M., Dixon J., and Arnold P., A Taxonomy of Supply Chain Strategies. Proceedings of 1997 Annual Meeting, Decision Science Institute, San Diego, California, vol. 3, pp1281-1283, 1997.
11. Ellram L., The supplier selection decision in strategic partnerships. Journal of Purchasing and Material Management, Vol. 26, No.4, pp.8-14, 1990.
12. Hahn, C., C. Watts and C. Kim, The Supplier Development Program: A Conceptual Model. International Journal of Purchasing and Materials Management, Vol. 26(2), pp2-7, 1990.
13. Tan, K.C., Kannan, V.J., and R.B. Handfield, Supply Chain Management: Supplier Performance and Firm Performance. International Journal of Purchasing and Material Management, pp2-9, August 1998.
14. Gilmour P., Harrison, N. and Moore, P., The Role of Logistics in the Formulation and Deployment of Strategy: An Empirical Analysis of Australian Packaged Consumer Products Manufacturers. International Journal of Logistics: Research and Applications**,** Vol. 1, No.3, pp265-282, 1998.
15. Singh J., The importance of information flow within the supply chain. Logistics Information Management, Vol. 9 Issue 4, pp28-30, 1996.
16. Lummus R.R. and Vokurka R.J. Defining supply chain management: a historical perspective and practical guidelines. Industrial Management & Data Systems, Vol. 99, Issue 1, pp11-17, 1999.
17. Miller, J G and Roth, A. V., A Taxonomy of Manufacturing Strategies. Management Science, Vol. 40, No. 3, pp285-304, March 1994.