SUPPLIER DEVELOPMENT STRATEGIES: A DATA ENVELOPMENT ANALYSIS APPROACH

Rohita Kumar Mishra, Gokulananda Patel

Abstract

Supply Chain Management (SCM) adopts a systematic and integrative approach to manage the operations and relationship among different parties in supply chain. There are lots of issues for effective implementation of Supply Chain. One of the major issues is supplier development. Studies have investigated how quality management can be employed in SCM to improve performance in the whole supply network. This study will develop an application guideline for the assessment, improvement, and control of quality in SCM using Data Envelopment Analysis. Improvement in the quality of all supply chain processes lead to cost reductions as well as service enhancement. The data is collected from 25 suppliers of food and agro based industry.

Introduction

Supply chain management (SCM) concept has paid much more attention to academician as well as practitioner. It comprises of quality revolution, notion of material management and integrated logistics etc. As the origin of supply chain management is not specific, but its development starts along the line of physical distribution and transport (Croom et al. 2000). Both approaches emphasizes on focusing the single element in the chain that cannot assure the effectiveness of whole system (Croom et al. 2000). Supply chain management is originally introduced by consultants in 1980s and has gained tremendous attention. (La Londe, 1998). A typical supply chain is generally a network of materials, information and services that linked with the characteristics of supply, transformation and demand. The term SCM has not only used to explain the logistic activities and the planning and control of materials and information flow but also used to describe strategic inter-organizational issues (Harland et al., 1999; Thorelli, 1986). Many a subject area such as purchasing and supply, logistic and transportation, marketing, organizational behaviour, network management, strategic management, management information system and operation management has contributed to the explosion of SCM literature. In this paper we examine and consolidate over various articles. This study may be the most comprehensive analysis of the multidisciplinary, wide ranging research on SCM. The supply chain is regarded as a sequence of material suppliers, production facilities, distribution services and customers which are linked together by the flow of goods and information. Supply Chain Management (SCM) is a concept that integrates all parties over the value chain into one whole system and manages them as the assets of an extended enterprise (Simchi – Levi et al., 2000). It involves the removal of barriers between trading partners to facilitate the synchronization of information. It involves not only logistic activities like inventory management, transportation, warehousing, and order processing, etc. but also other business processes such as customer relationship management, demand management, order fulfillment, procurement, product development and commercialization etc. Its main focus is to build trust, exchange information on market needs and developing new products. Supply chain performance plays an important role in any organization. The organization must focus on reduction of waste. In supply chain the term 'variation' has to be considered. In this case the six sigma method is useful for reducing the variation. The high quality of products and services from each level of the supplier network is a major part of successful SCM (Choi & Rungtusanatham, 1999). Houshmand & Rakotobe-Joel (2000-2001) developed an integrated supply chain structural analysis method to identify the priorities for a blood processing centre. In the model all channel member appeared to be in cohesion with their next line in the process. The continuous improvement concepts by Deming, Juran, Feignebaum and Crosby have provided insight into the measurement of supply chain management. Recently, the six sigma improvement methodology has become more popular. The Six-Sigma improvement methodology is a structured tool having the framework of which will enhance strategic business. The supply chain processes will be so designed that thereby cost will be reduced and service can be enhanced. The integration of Six Sigma and supply chain management will definitely beneficial for a company to gain competitive advantage. It is no longer viable for an organization to operate as an "isolated and independent entity" in competition with others. Organizations must seek to work with others in the supply chain to identify sources of competitive advantage. The root of SCM is in logistic literature. The term was first introduced by Oliver and Webber in 1980's to shift attention to cross-functional integration. In an attempt to systematize definitions and understandings, Bechtel and Jayaram (1997) identified four generic schools of thought that so far dominate in SCM literature. Supplier involvement may range from giving minor design suggestions to being responsible for complete development, design and engineering of specific part of assembly. Aleo (1992) discussed Kodak's early supplier involvement programme that involved suppliers in new R& D effort. Kamath and Liker (1994) also examined Japanese product development practices and identified a variety of roles that suppliers may play. Mabert et al. (1992) found supplier involvement to be an important to part of the strategy in five out of six firms. The effective integration of suppliers into new product can yield such benefits as reduced cost and improved access to and application of technology. Firms exchange essential information and engage some suppliers-customers in long-term contract have become the root level of supply chain integration (Spekman et al. 1998). SCM is built on a foundation of trust and commitment. Trust is conveyed through faith, reliance, belief or confidence in the supply partner. Trust is the sense of performance in accordance with intention and expectations. Commitment means the trading partners are willing to devote energy to sustain the relationship. In many cases, commitment makes it more difficult for partners to act in ways that might adversely affect overall supply chain performance. With commitment, supply chain partners become integrated into their major customers' processes and more tied to their goal.

Trust comes in various forms such as cognitive trust and calculative trust. The calculative trusts have a significant impact on buyer-supplier relationships and consequently supply chain performance. Hill (1990) argues that contrary to the theory of transaction cost economics (TCE) that opportunism generally characterizes exchange. The relationship based on cooperation and trust is the key to survive in the market place. Further a high level of inter-organizational trust, that enhanced supplier performance, lowered costs of negotiations and reduced conflict (Zahar et al. 1998).

Literature Review

Supply Chain Management (SCM) is a concept that integrates all parties over the value chain into one whole system and manages them as the assets of an extended enterprise (Simchi-Levi et al., 2000). It involves the removal of barriers between trading partners to facilitate the synchronization of information. It involves not only logistics activities like inventory management, transportation, warehousing and order processing but also other business processes like customer relationship management, demand management, order fulfillment, procurement, and product development and commercialization etc. SCM adopts a systematic and integrative approach to manage the operations and relationships among the different parties in supply chains. It is aimed at building trust, exchanging information on market needs, developing new products, and reducing the supplier base to release management resources for developing long term, mutual benefited relationships. The high quality of products and services from each level of the supplier network is an essential part of successful SCM (Choi & Rungtusanatham, 1999). An improved SCM process leads to cost reductions, optimum resource utilization and improved process efficiency (Beamon & Ware, 1998). Foker et al. (1997) demonstrate that Total Quality Management (TQM) can influence the quality performance in the supply chain. Wong & Fung (1999) present an in-depth case study of the TQM system of Construction Company in Hong Kong. They examined the strategy, structure, and tasks for managing the supplier-subcontractor relationships that form an integral part of TQM system. Matthews et al. (2000) showed that the concepts of quality management systems and partnering could be effectively incorporated into the construction supply chain. This is because the closer working relationships and the increased technology transfers provide organizations with the opportunity to obtain expert skills from their partners with limited resources. Houshmand & Rakotobe-joel (2001) developed an integrated supply chain structural analysis method to identify the priorities for a blood processing centre operations improvement. In this model, all channel members appeared to be in cohesion with their next line in the process. Romano & Vinelli (2001) discussed how quality can be managed in supply chain. Their case study indicated that the whorl supply network could improve its ability to meet the expectations in quality of the final customer through the joint definition and co-management of quality practices and procedures. Sohn & Choi (2001) develop a fuzzy Quality Function Deployment (QFD) model to explain the fuzzy relationship between customers' needs and design specifications for reliability of supply chain management.

Application Guidelines

The primary attributes comprises of five modules that enables the improvement of the six-sigma in the supply chain network is as follows:

Module 1: Define: This module defines the processes that have the highest priority for improvement, i.e. the key process that will enable maximum leverage and customer satisfaction. Here required activities and the key process output variables that are used to cunt defects and calculate the cost of poor quality. After the activities are identified, they are assigned to process improvement. These processes may include inbound and outbound transport, warehousing, production planning/inventory control, order processing, and customer service.

Module 2: Measure: This module measures the capability of the process. The purpose of this module is to identify performance measures such as cost, productivity, and service levels. Moreover, this measure can help to identify the deviations of current measurements. The goal of SCM should be consistent with organizational goals. This modules helps to create an understanding of the types of quality measures that are currently employed. First the deviations that are associated with the various supply chain management and customer requirement are identified. Then the deviation associated with the quality factor for the process is identified. Numerous quality factors can be used as measures in SCM like reliability, order accuracy, worker standards, customer satisfactions, worker quality and cost.

Module 3: Analyze: This module analyses when and where defects occur. The purpose is to evaluate current performance and re-evaluate the standards for cost, productivity and service objectives. The best in class standards, e.g. supply material days or cover and customer service level are used to examine the measurements that are collected in module-2. A control chat can be employed to detect whether or not the process is in control. A process is considered as in control when there are no occurrences of special causes of variations. For example, a special variation in a supply chain process may be that a truck arrives late due to bad weather. Once the process is in control, the current data can be used to evaluate the process performance.

Module 4: Improve: This module focuses on how six-sigma improvement technology can be developed, and identifies the critical factors that arise from the control process. The purpose is to identify and implement changes so that the overall supply chain process performance can be improved. The first step in this module consists of identifying and prioritizing improvement areas. Once these areas have been prioritized, the areas that must receive immediate attention, considering time and cost restrictions, are identified. The purpose of continuous improvement is to reduce the amount of common cause variations in the supply chain process. In planning this improvement should be implemented throughout the process. The process should be tested again to determine whether it is in control. If the process is in control, the standards of cost productivity, and service are set to those of the improved process.

Module 5: Control: This module identifies the controls that must be in place to sustain the benefit of the new process. The purpose is to control and monitor productivity and service performance to ensure that the process meets the identified standards.

Application Of Dea To Supplier Development

It is well know that the long replenishment lead-time, large order tots. Expected shortage of products, fluctuated product and limited information sharing are the major obstacles to supply chain coordination. However, one key factor influencing the performance of supply chain relationship is trust. Through the high degree of mutual trust, supply chain partners can develop a strategy to maximize supply chain benefits collaboratively. The development of trust requires a lot of effort, such as the partners' need to value the relationship, identify correct roles, agree with effective contracts, and be willing to resolve the conflict. Then, though a long period of cooperation, the trust can be gradually built up. Therefore it is clear that the supplier development is a major task in supply chain management (Ayer, 2001). Supplier development involves a long term cooperative effort between a buying firm and its suppliers. It is aimed at creating and maintaining a network of competent suppliers. The development activities include supplier selection and monitoring supplier assistance and training, the provision of incentives for continuous improvements and supplier organizational integration. The ultimate objectives of supplier development are supplier base reduction, concurrent engineering reduction in cycle time, reduction, concurrent engineering, reduction in cycle time, reductions in inventories, and increases in customer satisfaction (Hahn et al., 1990). Grieco (1989) suggests that there should have five steps in the supplier certification process like preliminary evaluation, product design and quality certification, a review of the supply process, performance monitoring and certification. The Raytheon process for supplier development has six steps namely the identification of supplier candidates for projects, the definition of objectives and resources, the identification of baseline opportunities and rank, the analysis of selected opportunities, the implementation of projects, and the documentation and realization of improvement. Here we have used both principal component analysis and the Data Envelopment Analysis for evaluating the supplier and compare the result obtained from both.. By evaluation the supplier there is every possibility to develop those suppliers who are lacking in some defined standards.

Basic Of Data Envelopmenet Analysis

The discussion and application of Data Envelopment Analysis (DEA) was initiated after the seminal work by Charnes, Cooper, and Rhodes (1978) and subsequent evidence can be found in (Banker, Charnes, Cooper 1984; Ramanathan 2001; Taluri 2000; Despotis. Dimitris, Smirlis 2002). For an in-depth discussion of DEA, one can refer to Seiford and Thrall (1990). DEA can be used to evaluate the efficiency of a number of producers, generally referred as decision-making unit (DMU). DEA compares each producer with only the "best" DMU in the group, which is better than the comparison with average of the group. In DEA, we can consider number of DMUs, each of them consuming similar inputs to varying level to produce. A fundamental assumption behind this method is that if a given DMU, , is capable of producing units of output with inputs, then other DMUs shall also be able to do the same if they were to operate efficiently. Similarly, if DMU is capable of producing units of output with inputs, then other DMUs should also be capable of the same. DMUs , and others can then be combined to form a composite producer i.e. virtual producer with composite inputs and composite outputs. The emphasis of DEA is on finding the "best" virtual producer for each real producer. If the virtual producer is better than the original producer by either making more output with the same input or making the same output with less input then the original producer is inefficient.

Notations

To develop the DEA model, we use the following parameters and variables:

$n = Number\ of\ DMU\ \{j = 1, 2, ..., n\}$

$s = Number\ of\ outputs\ \{r = 1, 2, ..., s\}$

$m = Number\ of\ inputs\ \{i = 1, 2, ..., m\}$

$y_{rj} = Quantity\ of\ r^{th}\ output\ of\ j^{th}\ DMU$

$x_{ij} = Quantity\ of\ i^{th}\ input\ of\ j^{th}\ DMU$

$u_r = weight\ of\ r^{th}\ output$

$v_i = weight\ of\ i^{th}\ output$

DEA Model

The relative efficiency score of J_0 DMU is given by

$$\max h_{j0}(u, v) = \frac{\sum_{r=1}^{s} u_r Y_{rj0}}{\sum_{i=1}^{m} v_i x_{ij0}}$$

$$subject\ to \sum_{r=1}^{s} u_r Y_{rj} - \sum_{i=1}^{m} v_i x_{ij} \leq 0\ \ j = 1, 2, ..., n$$

$$u_r, v_i \geq \forall r, i$$

The decision variables $u = (u_1, u_2, ..., u_r, ..., u_s)$ and $v = (v_1, v_2, ..., v_i, ..., v_m)$ are respectively the weights given to the s outputs and to the m inputs. To obtain the relative efficiencies of all the units, the model is solved n times, for one unit at a time.

The fractional program (1) can be reduced to Linear Programming Problem (LPP) as follows:

$$\max h_{j0} = \sum_{r=1}^{s} u_r y_{rj0}$$
$$subject\ to \sum_{i=1}^{m} v_r x_{ij0} = 1$$
$$\sum_{r=1}^{s} u_r y_{rj} - \sum_{i=1}^{m} v_r x_{ij} \leq 0 \ j = 1, 2, ..., n$$
$$u_r, v_i \geq 0 \ \forall \ r, i$$

This model is called CCR output maximization DEA model (Charnes, Cooper, Rhodes 1978). The routine computation of DEA can be performed using generalized LP software or specialized DEA software. The non-computational aspects are also important in the application procedure of DEA.

Specification Of Inputs And Outputs

Inputs	Outputs
X_1: Quality management practices	Y_1: Quality of the product
X_2: Employee training	Y_2: Price of the product
	Y_3: Delivery of the product

For illustration we have collected process improvement measurement data from 25 suppliers of steel industries. A detailed questionnaire covering the four statements is given to the executive of the purchasing department and production department. We got the response of 45 executives. These five variables are measured with a score from 0 to 100 in which the higher score is the higher performance. The performance of an individual process improvement effort can be measured by the ratio of the level of output produced by the process effort and the level of process effort. Here we have calculated the rank in both in Principal Component Analysis approach and Data Envelopment Analysis approach and compare the result obtained from the both process.

The performance of the supplier can be measured by all the ratios of output and input measurement data relevant to the process improvement programs of a supplier. The PCA ranking procedure is based on the ratios of individual inputs and outputs, and one more variable takes into account the overall performance of each supplier as follows:

$$D_1 = Y1/X1, D_2 = Y1/X2, D_3 = Y2/X1, D_4 = Y2/X2, D_5 = Y3/X1, D_6 = Y3/X2, D_7 = \sum_{i=1}^{6} D_i$$

Table-1: Dataset of Inputs and outputs

Supplier	X1	X2	Y1	Y2	Y3
S-1	73	99	60	50	35
S-2	45	67	87	45	50
S-3	78	87	43	35	60
S-4	54	67	70	60	75
S-5	76	80	60	70	65
S-6	86	80	45	65	68
S-7	48	68	65	56	46
S-8	58	54	80	54	54
S-9	76	56	80	64	56
S-10	98	65	70	86	76
S-11	59	78	57	96	70
S-12	76	60	60	54	60
S-13	78	68	68	65	60
S-14	65	67	69	76	65
S-15	64	54	70	76	60
S-16	65	43	78	80	57
S-17	68	78	75	85	58
S-18	62	54	74	65	55
S-19	65	78	73	66	50
S-20	80	80	75	54	50
S-21	90	80	76	55	70
S-22	70	70	75	70	60
S-23	78	58	76	75	60
S-24	76	75	77	65	66
S-25	78	65	65	56	70

Table-2: The eigenvalue and eigenvector analysis of the correlation matrix

Eigen Value	4.2409	1.3134	0.8504	0.5703	0.0118	0.005	0
Proportion	60.70%	18.80%	12.10%	8.10%	0.00%	0.00%	0.00%
Variable	PC1	PC2	PC3	PC4	PC5	PC6	PC7
D1	-0.302	0.523	-0.541	0.035	0.527	-0.12	-0.223
D2	-0.393	-0.235	-0.556	0.058	-0.646	0.083	-0.231
D3	-0.366	0.295	0.383	-0.577	-0.255	-0.444	-0.192
D4	-0.401	-0.405	0.153	-0.372	0.382	0.558	-0.236
D5	-0.31	0.463	0.425	0.522	-0.197	0.423	-0.136
D6	-0.359	-0.452	0.211	0.5	0.235	-0.539	-0.159
D7	-0.484	0.016	-0.055	-0.031	0.023	0.012	0.872

Table-2 gives the eigen value and eigen vector analysis of the correlation matrix of the above seven variables. We have four principal components, PC1, PC2, PC3 and PC4 (60.7%, 18.8%, 12.1% and 8.1%) accounts for 99.7%, of the total sample variance.

Table-3: Performance Score of Suppliers

Supplier	Performance Score	Rank
S-16	6.086872	1
S-15	4.969999	2
S-2	4.888772	3
S-18	4.801562	4
S-8	4.777451	5
S-11	4.541095	6
S-23	4.525728	7
S-9	4.452767	8
S-17	4.391011	9
S-14	4.381763	10
S-4	4.334663	11
S-7	4.287344	12
S-22	4.130429	13
S-10	3.979861	14
S-19	3.908751	15
S-24	3.750469	16
S-13	3.650028	17
S-25	3.402582	18
S-12	3.3898	19
S-5	3.32552	20
S-20	3.215325	21
S-21	3.083776	22
S-6	2.646108	23
S-1	2.610107	24
S-3	1.890862	25

Table-4: Efficiency and Weight of Inputs and Outputs of each DMU (Output Oriented DEA, Scale Assumption: CRS)

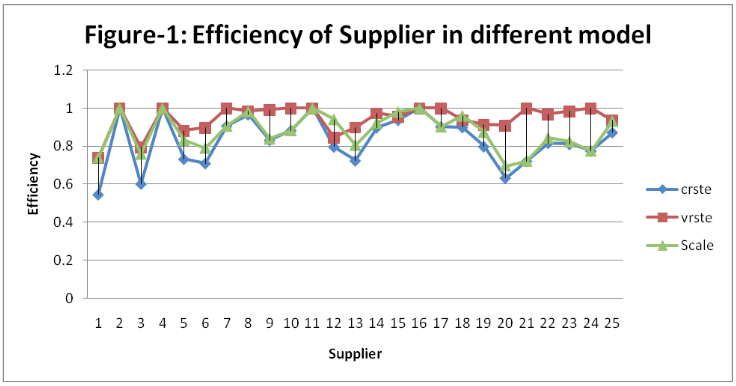
Supplier	Eff.	W_{x1}	W_{x2}	W_{y1}	W_{y2}	W_{y3}
S-1	0.545418	1.459838	0.373619	0.459551	0.540449	0
S-2	1	1	0	1	0	0
S-3	0.601862	0.379833	1.281677	0	0	1
S-4	1	0.486411	0.513589	0.437815	0	0.562185
S-5	0.732617	0.749318	0.615651	0	0.35668	0.64332
S-6	0.709511	0.369521	1.0399	0	0	1
S-7	0.907325	1.102141	0	0.429408	0.570592	0
S-8	0.966631	0.577199	0.457322	0.552803	0	0.447197
S-9	0.830973	0.582955	0.620455	1	0	0
S-10	0.882817	0.376757	0.75598	0	0	1
S-11	1	0.512436	0.487564	0	1	0
S-12	0.797443	0.370093	0.883915	0	0	1
S-13	0.723797	0.379833	1.001771	0	0	1
S-14	0.898324	0.862258	0.250927	0.302734	0.396285	0.300981
S-15	0.937431	0.643169	0.423576	0	0.394718	0.605282
S-16	1	0.511364	0.488636	1	0	0
S-17	0.902665	0.910693	0.197138	0.384703	0.615297	0
S-18	0.899932	0.638179	0.473016	0.52889	0	0.47111
S-19	0.798203	1.021487	0.231327	0.439383	0.560617	0
S-20	0.632663	0.853926	0.726694	0.555872	0	0.444128
S-21	0.72158	0.375659	1.010189	0	0	1
S-22	0.816199	0.955446	0.269746	0.338577	0.375557	0.285866
S-23	0.810186	0.379833	0.854452	0	0	1
S-24	0.775169	0.701183	0.588858	0.493278	0	0.506722
S-25	0.872334	0.325571	0.820779	0	0	1
Mean	0.830523	0.661004	0.574671	0.316921	0.192408	0.490672

In Table-4 weights and efficiency scores of suppliers is given. Supplier, S2, S4, S11, S16 are relatively efficient. The efficiency scores of suppliers, S7, S8, S15, S17 are more than 90%, and that of S9, S10, S14, S18, S22, S23 and S25 are more than 80%. The least efficiency score is 54.5% which is of supplier-1.

Table-5: Comparison between various Rankings

Supplier	crste	vrste	Scale	Benchmarking Units (CRS)	Benchmarking Units (VRS)
S-1	0.545418	0.73913	0.737918471	S2, S11, S16	S2, S16
S-2	1	1	1		
S-3	0.601862	0.794224	0.757798973	S4, S16	S4, S10
S-4	1	1	1		
S-5	0.732617	0.881258	0.831331207	S4, S11, S16	S4, S10, S11, S16
S-6	0.709511	0.897959	0.79013725	S4, S16	S4, S10
S-7	0.907325	1	0.907325	S2, S11	
S-8	0.966631	0.982936	0.983412087	S2, S4, S16	S2, S4, S10, S16
S-9	0.830973	0.990674	0.838795721	S2, S16	S2, S10, S16
S-10	0.882817	1	0.882817	S4, S16	
S-11	1	1	1		
S-12	0.797443	0.846974	0.941520024	S4, S16	S4, S10, S16
S-13	0.723797	0.898618	0.805455977	S4, S16	S2, S4, S10, S16
S-14	0.898324	0.973026	0.923226876	S2, S4, S11, S16	S4, S10, S11, S16
S-15	0.937431	0.956185	0.980386694	S4, S11, S16	S4, S10 ,S11, S16
S-16	1	1	1		
S-17	0.902665	1	0.902665	S2, S11, S16	
S-18	0.899932	0.937709	0.95971344	S2, S4, S16	S2, S4, S10, S16
S-19	0.798203	0.912754	0.874499952	S2, S11, S16	S2, S16
S-20	0.632663	0.908866	0.696101661	S2, S4, S16	S2, S10, S16
S-21	0.72158	1	0.72158	S4, S16	
S-22	0.816199	0.968552	0.842700606	S2, S4, S11, S16	S2, S4, S10, S16
S-23	0.810186	0.983828	0.82350403	S4, S16	S2, S10, S16
S-24	0.775169	1	0.775169	S2, S4, S16	
S-25	0.872334	0.935335	0.932642916	S4, S16	S4, S10, S16
Mean	0.830523	0.944321	0.876348075		

Note: crste = technical efficiency from CRS DEA ;vrste = technical efficiency from VRS DEA; scale efficiency = crste / vrste



In Table-5 a comparative analysis is made between the rankings done by ranking obtained using DEA with various scale assumptions. In DEA (VRS), except S2, S4, S11, S16 other suppliers like S7, S10, S17, S21 and S24 are also efficient. From Figure-1 We have seen wide variation between the two assumptions of scale, i.e. CRS and VRS. In case of scale efficiency S2, S4, S11 and S16 are efficient. The benchmarking units of the inefficient suppliers are given in Table-5.

Conclusion

When a company attempts to improve the performance of SCM, it is crucial for it to understand the quality of the supply chain network. Hence, the five steps of the six sigma model are designed to facilitate continuous improvement and process control. The continuous improvement itself is a dynamic process of the supply chain network. When multiple dimensions are simultaneously considered in evaluating the overall competence of a supplier, the performance socre of each supplier can be obtained by the PCA method and DEA approach. The average technical efficiency score obtained through CRS model is 0.830 and the average efficiency score obtained through VRS model is 0.944 which is higher than the CRS score. Suppliers with high performance scores are likely to sustain a high level of capabilities, and are better candidates for inclusion in an optimized supplier base. So improvement in the quality of all supply chain processes reduces costs and improves the level of customer services. Future research can be possible by taking different factors relating to the supplier side by the help of multi-criteria decision making approach like Fuzzy Logic and others.

References

Beamon, B.M., & Ware, T.M. (1998). A process quality model for the analysis, improvement and control of supply chain systems. International Journal of Physical Distribution & Logistics Management, 28, 704-715.

Charnes.A , Cooper W.W. & Rhodes, E. (1978). Measuring efficiency of decision making units. European journal of Operational Research, 2, 429-444.

Choi, T.Y., & Rungtusanatham, M. (1999). Comparison of quality management practices: across the supply chain and industries. The Journal of Supply Chain Management, 35, 20-27.

Croom, S.R., Romano, P. & Giannakis, M. (2000). Supply Chain Management: An analytical framework for critical literature review. European Journal of Purchasing and Supply Management, 6, 67-83.

Despotis, K., Smirlis, G. (2002). Data envelopment Analysis with Imprecise Data. European Journal of Operational Research, 140, 24-36.

Foker, L.B., Mendez, D., & hershauer, J.C. (1997). Total Quality Management in Supply Chain: what is its impact on performance?, International Journal of Production Research, 35, 1681-1701.

Harland, C. M., Lamming, R. C. & Cousins, P. D. (1999). Developing the concept of supply strategy, International Journal of Operations and Production Management, 19, 650-673.

Houshmand, A. A., & Rakotobejoel, T. (2001). Integrating the supply chain management and continuous quality improvement approaches by use of the integrated supply chain structural analysis method, Quality Engineering, 13, 91-106.

Hill, C. W. L. (1990). Cooperation, Opportunism, and the invisible hand: Implications for transaction cost theory, Academy of Management Review, 15, 500-513.

Kamath, R. R., and liker, J.K. (1994). A second look at Japanese product development, Harvard Business Review, 72, 155-170.

La Londe, B.J. (1998). Supply chain evolution by the numbers, Supply Chain Management Review, 2, 7-8.

Matthews, J., Pellew, L., Phua, F., & Rowlinson, S. (2000). Quality relationships: partnering in the construction supply chain. International Journal of Quality & Reliability Management, 17, 493-510.

Ramanathan, R. (2001). A Data Envelopment Analysis of comparative performance of schools in Netherland. Opsearch, 38 (2), 160-182.

Romano, P., & Vinelli, A. (2001). Quality management in a supply chain perspective: strategic and operative choices in a textile apparel network. International Journal of Operations and Production Management, 21, 446-460.

Simchi-Levi, D., Kaminsky, P., & Simchi-Levie, E. (2000). Designing and Managing the Supply Chain- Concepts, Strategies and Case Studies: McGraw Hill, New Delhi.

Talluri, Srinivas. (2000). Data Envelopment Analysis: Model and Extension. Decision Line, 8-11.

Thorelli, H. (1986). Networks between markets and hierarchies. Strategic Management journal, 7, 37-51.