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Research Article

INTERRELATIONS BETWEEN STRATEGIC MANAGEMENT FACTORS IN A SUPPLY CHAIN

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ABSTRACT
With the increasing interest of organizations to join supply chains and achieves the competitive advantages of such an act, the notion of strategic management of organization shifts to strategic management of supply chain as a whole and single entity. In implementing this strategic approach for supply chain, many factors can be influential. These factors are sometimes interrelated and each may impact the other; moreover it is not always possible for decision makers to improve all the factors simultaneously because of the expense it may have. So if they can find in some ways the relations between these factors, then they may be able to improve some of them indirectly by improving others directly. For the same reason this paper studies the most available literature on the issue and identifies 27 major factors and finds the importance of each one from the viewpoint of experts. By this, seven factors which are more influential get identified and then the second questionnaire is developed for applying decision-making trial and evaluation laboratory (DEMATEL) method and it is issued to a group of 18 chosen experts to find the causal relation among these seven factors and to find the key success factors in implementing strategic management of supply chain. The results show that participating suppliers in customers' product development and sharing expertise and technology, and creating a greater level of mutual trust among supply chain members are the key success factors in implementing strategic management of supply chain.

Keywords: *Strategic Management – Supply Chain - Decision Making Trial and Evaluation Laboratory (DEMATEL)*

INTRODUCTION
The notion of strategic management, from the time of its advent in the 1970s (Wells, 2000) has occupied the mind of both scholars and top management of organizations and the best way of putting strategy into practice has always been considered as a controversial issue in the field. "Strategic Management" as a term and concept has variously defined and a number of definitions are identifiable in the field. As one of the many available definitions of the concept of strategic management this paper refers to Gluck's *et al.*, (1980) who define strategic management as "a system of corporate values, planning capabilities, or organizational responsibilities that couple strategic thinking with operational decision making at all levels and across all functional lines of authority in a corporation" (Gluck, *et al.*, 1980). The word "corporation" in this definition whether we call it with other names such as organization or firm, is the main focus of most of the available definitions and they try to propose strategic management for "organization". This concern of strategic management is changing, though; individual firms no longer compete as autonomous entities but rather by joining a supply chain alliance (Shen and Yu, 2009) and they find the shift from the firm level competition to the supply chain level competition as a way to restore profit margins (Eltantawy, *et al.*, 2009). By this change in the interest of organizations and their rise to join supply chains, the notion of strategic management extends to a new realm which is "strategic management of supply chain". The whole chain is being considered as a single entity then (maybe a virtual organization) and strategic management of each member or better to say each partner of the chain is not the main concern, but the chain, as a whole, should be managed strategically.
Strategic management of supply chain or strategic supply chain as it is sometimes called (Farris, 2010; Hult *et al.*, 2004; Hult *et al.*, 2007; Ireland and Webb, 2007; Sodhi, 2003) is a new domain of strategic management and it has been considered from different points of view in different studies. It is the

qualified approach for integrating all partners in the chain and the main discrimination it has with the concept of supply chain management (SCM), is in that here the management demands a strategic approach as Hult *et al.*, (2004) define strategic supply chains as "chains whose members are strategically, operationally, and technologically integrated". To implement strategic management of supply chain successfully, many factors are investigated and introduced in the literature. For example Ireland and Webb (2007) suggest that a source of authority should be identified and a common supply chain identity should be developed. Hult *et al.*, (2007) find knowledge as a strategic resource for supply chain and claim that knowledge should be managed and exchanged as a strategic resource in supply chain. Other factors such as fostering close relationship with a limited number of suppliers, developing long-term strategic relationship (Araz and Ozkarahan, 2007; Chen *et al.*, 2004) and speeding up the data flow (Macbeth and Ferguson, 1991) are among success factors in implementing strategic management of supply chain.

This paper tried its best to study most of the literature available on the issue and identified and elicited 27 success factors in implementing strategic management of supply chain. Then a survey was taken among 173 university professors (in the field of management), top and middle management of some companies and PhD. and MSc. Students of management in four provinces of Iran, namely Fars, Isfahan, Bushehr and Tehran, from June 24, 2010 to August 4, 2010 by asking the importance of each factor with a Likert-type five-point scale, where 1 and 5 represent very unimportant and very important, respectively. The questionnaire given to the respondents was in the Persian language (somewhat translated of what is stated here, yet more understandable for all levels of education of the respondents) and the number of valid questionnaire is 164. The demographic information of these 164 respondents is summarized in Table 1. The cronbach's α is 0.9384, which represents the internal consistency reliability is excellent. The Kaiser–Meyer–Olkin (KMO) value was found to be 0.9006, which is far better than the suggested 0.6 value (Kaiser,1974).

Table 1: Respondents' Properties

Categories	Properties	Frequency	Percentage (%)
Gender	Male	115	70.1
	Female	49	29.9
Age group	22-40	63	38.4
	40-58	101	61.6
Education Level	High School	24	14.6
	University	83	50.6
	Graduate	57	34.8
Occupation	University Professor	43	26.2
	Top Management	71	43.3
	Middle Management	35	21.3
	PhD. Student of Management	12	7.3
	MSc. Student of Management	3	1.9
Location	Fars Province, Iran	62	37.8
	Bushehr Province, Iran	35	21.3
	Isfahan Province, Iran	15	9.2
	Tehran Province, Iran	52	31.7

All the 27 factors and the attained importance for each (according to averages) are presented in Table 2. By noting this table it can be grasped that the range of the importance falls between 3.9512 and 4.7804. This shows that all the factors have semi-strong importance and they all worth being considered for successful implementation of strategic management of supply chain, however it is unrealistic to improve all of the criteria simultaneously with limited resources (Shieh *et al.*, 2010); for the same reason and in order to improve the criteria, 7 top factors are elicited out of this list which are (1) Participating suppliers in customers' product development and sharing expertise and technology, (7) Creating a greater level of

mutual trust among supply chain members, (8) Developing long-term strategic relationship, (9) Managing knowledge as a strategic resource in chain management, (11) Promoting open communication among supply chain partners, (12) Generating a common supply chain identity and (22) Developing a supportive culture among the partners.

Table 2: The Importance of Each Factor

Criterion	Importance
1. Participating suppliers in customers' product development and sharing expertise and technology (Araz and Ozkarahan, 2007; Johnsen,2009; Tan *et al.*, 2002; Wagner and Hoegl, 2006)	4.5121
2. Fostering close working relationships with a limited number of suppliers (Chen *et al.*, 2004)	4.3109
3. Developing a customer responsive net and contacting the end user of products to get feedback (Chen *et al.*, 2004; Tan *et al.*, 2002)	4.4695
4. Developing technological and process links with partners (Scott and Westbrook, 1991)	4.1341
5. Identifying a source of authority in the chain (Ireland and Webb, 2007)	4.3536
6. Providing a procedural and interactive justice among the partners (Ireland and Webb, 2007)	4.0426
7. Creating a greater level of mutual trust among supply chain members (Lonngren, 2010; Tan *et al.*, 2002)	4.6219
8. Developing long-term strategic relationship (Araz, and Ozkarahan, 2007; Chen *et al.*, 2004)	4.5914
9. Managing knowledge as a strategic resource in chain management (Hult *et al.*, 2006)	4.7804
10. Combining resources through governance mechanisms (Lonngren, 2010)	4.3902
11. Promoting open communication among supply chain partners (Chen *et al.*,2004; Tan *et al.*, 2002)	4.7073
12. Generating a common supply chain identity (Ireland and Webb, 2007)	4.6768
13. Establishing transparency in partner actions (Ireland and Webb, 2007)	4.2743
14. Developing interest in achieving mutual goals and gains (Meade and Sarkis, 1998)	4.4512
15. Determining the extent of dependence on the chain (Scott and Westbrook, 1991)	3.9512
16. Speeding up the data flow (Macbeth and Ferguson, 1991)	4.3780
17. Extending supply chain beyond immediate suppliers and customers (Tan *et al.*, 2002)	3.9512
18. Developing strategic alliances and virtual relationships and coordinating the whole chain as a single system (Meade and Sarkis,1998; Scott and Westbrook, 1991)	4.3414
19. Deciding on the length and complexity of the chain (Scott and Westbrook, 1991)	4.0121
20. Locating closer to the customer (Tan *et al.*, 2002)	4.1231
21. Communicating future strategic needs to suppliers (Tan *et al.*, 2002)	4.2131
22. Developing a supportive culture among the partners (Saccani and Perona, 2007)	4.5614
23. Utilizing an appropriate IT-solution (Lonngren, 2010)	4.4332
24. Making use of boundary spanning ties (Ireland and Webb, 2007)	4.3514
25. Searching for new ways to integrate SCM activities (Tan *et al.*, 2002)	4.1223
26. Defining legal and formal ties (Scott and Westbrook, 1991)	4.2134
27. Requiring suppliers to locate closer to the focal firm (Tan *et al.*, 2002)	4.5614

After finding these criteria the second questionnaire was developed for applying decision-making trial and evaluation laboratory (DEMATEL) method and it was issued to 18 respondents (13 top managers and 5 university professors) to first prioritize the importance of these criteria and then construct the causal relations among the criteria (Shieh *et al.*, 2010) and by this the key success factors in implementing strategic management of supply chain can be identified and improvement can be made by observing the causal relationships of these key success factors.

The rest of the paper is organized as follows: section 2 presents a literature review of strategic management of supply chain and DEMATEL method. In section 3 a DEMATEL method is developed to identify the key factors. Section 4 shows the results of the used method. And finally section 5 draws a conclusion.

Literature Review

Strategic management of supply chain has discussed in several studies, within different contexts and by using different methodologies and approaches. To name some examples of these studies one may refer to Chen *et al.*, (2004) that discuss purchasing in supply chain and find purchasing as a strategic topic in supply chain management. They test several hypotheses by studying a 221 sample of American firms and conclude that there is a close relationship between strategic purchase, customer responsiveness, supply chain management and financial performance. In another study by Hult *et al.*, (2006) knowledge is introduced as a strategic resource in supply chain management. They find the fit between knowledge and strategy as a tool to achieve a higher performance in supply chain management. The other finding of the paper supports the view that investment on knowledge in supply chain will result in a higher performance. Meade and Sarkis (1998) assess organization's logistics strategy by means of analytical network process. They evaluate optimum logistical system based on three primary levels: the organizational/supply chain relationship involved, the principles of logistics required, and the attributes of these principles. The principles of logistics are defined and developed as strategies for achieving coordination and integration of the logistics network and supply chain. Another scope of strategic supply chain management is investigated in the work of Georgiadis *et al.*, (2005); in their study they find the necessity of strategic decision in profitability of supply chain. They count inventory management policies, contracts to suppliers, distribution strategies, integration of supply chain, procurement and outsourcing strategies, product design, and IT as examples of these decisions. Ireland and Webb (2007) find strategic supply chain as a competitive advantage of organization and the strategies they discuss are "identifying an authority", "generating a common supply chain identity", "utilizing boundary spanning ties", and "providing procedural and interactive justice". Sabio *et al.*, (2010) present a decision-support tool to address the strategic planning of hydrogen supply chains for vehicle use under uncertainty in the operating costs. Ketchen Jr. and Giunipero (2004) have argued the intersection of strategic management and supply chain management. They investigated how insights from each field can complement and support the other. They concluded that increased interaction between these important areas will benefit knowledge development in both and thereby enhance organizations' ability to meet their goals. Adobor and McMullen (2007) in "Supplier diversity and supply chain management: A strategic approach" find suppliers diversity as a competitive advantage for the organization and they see the requisites to achieve this competitive advantage in top management commitment, supportive culture and the availability of champions to promote the proposal. Fandel and Stammen (2004) define strategic management of supply chain as a long-term view on supply chain management. In this paper a general linear mixed integer model is designed considering the business processes of a product life cycle.

The authors of this paper did not face with any studies, using DEMATEL method in the realm of strategic management of supply chain but there is a good deal of studies based on DEMATEL method in other fields. In order to name just a few numbers of these studies, we can refer to Tsai *et al.*, (2010); they combine DEMATEL, ANP and zero one goal programming to help decision makers about whether to keep IT functions in-house or contract with a third-party service provider. Shieh *et al.*, (2010) use DEMATEL method in identifying key success factors of hospital service quality. Wu *et al.*, (2010)

evaluate performance criteria of Employment Service Outreach Program personnel by DEMATEL method.

Decision making trial and evaluation laboratory method (DEMATEL) was first developed by the Science and Human Affairs Program of the Battelle Memorial Institute of Geneva between 1972 and 1976 to study and resolve the complicated and intertwined problem group (Tzeng *et al.*, 2007; Wu, 2008). In contrast to traditional methods of analytical hierarchy process with the assumption that the elements are independent, in DEMATEL method, as one of the structural modeling techniques, the interdependence of elements is identifiable and can be illustrated by the use of causal Diagram (Shieh, 2010). This paper summarizes the calculation steps of DEMATEL method with reference to the studies of (Shieh, 2010; Tseng, 2010):

Step 1: In the first step of DEMATEL computation, sampled experts should be presented with a questionnaire asking for direct relation between binary factors or criteria. To asking for this relation some studies employ a scale ranging from (0) to (4), as (0) to be 'no influence', (1) 'low influence', (2) 'medium influence', (3) 'high influence', and (4) 'very high influence' and on the other hand some others suggest a scale ranging from (0) to (3) as to present 'no influence', 'low influence', 'high influence' and 'great influence', respectively; (This paper also employs the approach of the second group; (0) to (3) range). Receiving these questionnaires, direct-relation $n \times n$ matrix X^k, should be developed, as k to be the representing number of respondents, n the number of factors, and x_{ij} the elements of these matrices, representing the stated direct influence of factor i on factor j.

Step 2: Develop the average matrix A, in which a_{ij} is the mean of the corresponding elements in the experts' direct matrices. Thus matrix A can be reached by the following Eq. (1). In this equation H is the number of respondents:

$$A = [a_{ij}], a_{ij} = \frac{1}{H}\sum_{K=1}^{H} X_{ij}^{k} \qquad (1)$$

Step 3: In this step the normalized initial direct-relation matrix N should be calculated, using Eq. (2):

$$N = A \times \frac{1}{b} \qquad (2)$$

Here a difference in approaches in calculating the fixed number b, is found in the literature again. Some scholars believe that to calculate b, Eq. (3) should be calculated:

$$b = max\left\{\max_{1 \le i \le n}\sum_{i=1}^{n} a_{ij}\ , \max_{1 \le i \le n}\sum_{j=1}^{n} a_{ij}\right\} \qquad (3)$$

While other authors suggest Eq. (4) for the same calculation:

$$b = \max_{1 \le i \le n}\sum_{j=1}^{n} a_{ij} \qquad (4)$$

This paper employs Eq. (3) to calculate the normalized initial direct-relation matrix N.

Step 4: Now matrix T, the total direct/indirect influence matrix, should be calculated. Of course call T a total relation matrix. Then T is calculated by Eq. (5). In this equation I is an $n \times n$ identity matrix:

$$T = N(I - N)^{-1} \qquad (5)$$

Now let r be an $n \times 1$ vector representing the sum of rows in matrix T. If r_i is the sum of the ith row in matrix T, then r_i summarizes both direct and indirect effects of factor i on all the other factors.

Let c be a $1 \times n$ vector representing the sum of columns in matrix T. if c_j is the sum of the jth column in matrix T, then c_j summarizes both direct and indirect effects that all the other factors have on factor j.

Considering $i=j$, (r_i+c_j) and (r_i-c_j) should be calculated. Lee et al.,(2010) define (r_i+c_j) as the prominence and (r_i-c_j) as the relationship. That is, (r_i+c_j) illustrates the importance of the factors (the strength of both given and received influences of this factor to and from other factors), and (r_i-c_j) may separate the factors

into a cause group and an affected group. In general when (r_i-c_j) is positive the factor is a part of the cause group and if it is negative, the factor is of the affected group.

To identify other connotation of (r_i+c_j) and (r_i-c_j), under the conditions stated below, it is worth to note that:

$If\ r_i - c_j < 0\ and\ r_i + c_j = \delta$ (δ is a big value) then:	Factor *i* is the core problem to be solved. However, it is not to directly improve the variable.
$If\ r_i - c_j > 0\ and\ r_i + c_j = \delta$ (δ is a big value) then:	Factor *i* is the driving factor of solving the core problem and shall be listed as the priority.
$If\ r_i - c_j < 0\ and\ r_i + c_j = \varepsilon$ (ε is a small value) then:	Factor *i* is more independent and there are less factors which will impact the variable.
$If\ r_i - c_j > 0\ and\ r_i + c_j = \varepsilon$ (ε is a small value) then:	Factor *i* is also independent and can impact a few other variables.

Step 5: The final step in DEMATEL method is developing the ultimate impact relation map (IRM), also known as causal diagram. To construct IRM, the total relation matrix *T*, should be considered. In this matrix elements show the impact of each factor on other factors but in IRM we do not need all of them and they should be filtered through threshold value. Threshold value is a value that is decided by experts or decision-makers through discussions and elements lower than this value are not considered as impacting other factors in IRM. For example if a_{ij}= 2.1235 and the threshold value= 3.4323 then there is no arrow from factor *i* to factor *j* in IRM, but if the threshold value= 1.85 then there is an arrow from *i* to *j* in IRM showing that there is an impact from *i* on *j*. It should be noted that threshold value should not be too low or too high; if the threshold value is too low, the map will be too complex to show the necessary information for decision-making. In contrast, if the threshold value is too high, many factors will be presented as independent factors, without showing the relationships with other factors. In IRM the horizontal axis is r_i+c_j and vertical axis is r_i-c_j. The purpose of IRM is simplifying the complicated causal relationship to the visual structure that is easy to understand.

Method Development

After identifying seven major criteria during the first survey, which were (A) Participating suppliers in customers' product development and sharing expertise and technology, (B) Creating a greater level of mutual trust among supply chain members, (C) Developing long-term strategic relationship, (D) Managing knowledge as a strategic resource in chain management, (E) Promoting open communication among supply chain partners, (F) Generating a common supply chain identity and (G) Developing a supportive culture among the partners, the second questionnaire was developed based on these seven criteria and was issued to 18 respondents (13 top managers and 5 university professors), and they were asked to evaluate the direct influence between any two factors by an integer score ranging from 0, 1, 2, and 3, representing ''no influence", ''low influence", ''medium influence", and ''high influence", respectively. Thus, the computation of using DEMATEL method is based upon these 18 experts' opinions.

The outcome of the second questionnaire is 18 7× 7 non-negative matrices, as follows:

$$X^1=\begin{bmatrix}0&3&3&1&3&3&2\\3&0&3&2&3&3&3\\2&2&0&1&1&2&2\\1&1&1&0&2&1&2\\2&1&1&2&0&2&0\\3&2&2&1&1&0&2\\2&2&1&0&2&2&0\end{bmatrix}\quad X^2=\begin{bmatrix}0&2&3&2&2&3&2\\2&0&3&1&2&1&3\\2&1&0&2&2&2&3\\2&1&0&0&3&2&1\\2&2&1&2&0&2&1\\2&2&3&1&2&0&2\\3&2&2&0&0&1&0\end{bmatrix}\quad X^3=\begin{bmatrix}0&2&2&1&2&1&1\\3&0&3&2&2&3&2\\1&1&0&2&2&2&3\\2&2&2&0&1&2&2\\3&2&2&1&0&2&0\\3&2&3&2&2&0&3\\3&3&0&1&2&2&0\end{bmatrix}$$

$$X^4=\begin{bmatrix}0&2&3&2&3&3&3\\2&0&2&3&2&2&3\\1&1&0&1&0&2&2\\1&0&0&0&2&1&3\\2&1&2&2&0&3&1\\2&2&1&1&2&0&3\\1&1&1&1&3&2&0\end{bmatrix}\quad X^5=\begin{bmatrix}0&2&3&2&3&2&2\\2&0&2&2&2&3&2\\1&1&0&2&2&2&3\\2&3&0&0&3&1&2\\2&1&3&1&0&1&3\\2&3&1&0&2&0&1\\2&1&2&1&3&1&0\end{bmatrix}\quad X^6=\begin{bmatrix}0&2&3&2&1&2&3\\2&0&1&2&1&2&3\\2&1&0&3&2&2&1\\2&1&3&0&3&2&1\\1&2&2&1&0&3&1\\2&3&1&2&1&0&2\\3&3&2&0&1&1&0\end{bmatrix}$$

$$X^7=\begin{bmatrix}0&2&3&2&2&2&1\\2&0&3&1&2&3&2\\2&1&0&2&2&3&2\\2&1&2&0&3&0&1\\3&3&3&1&0&1&1\\2&2&2&3&2&0&1\\1&1&0&1&3&2&0\end{bmatrix}\quad X^8=\begin{bmatrix}0&1&1&3&2&3&2\\2&0&1&1&2&1&2\\2&3&0&2&0&1&3\\2&2&3&0&1&2&2\\3&2&1&3&0&3&1\\2&2&1&0&1&0&3\\2&1&1&2&1&3&0\end{bmatrix}\quad X^9=\begin{bmatrix}0&3&1&2&2&3&3\\2&0&1&2&3&2&3\\2&3&0&2&2&3&0\\1&2&2&0&1&2&1\\2&2&2&1&0&2&2\\1&3&2&2&2&0&2\\1&2&3&2&0&3&0\end{bmatrix}$$

$$X^{10}=\begin{bmatrix}0&2&1&1&2&2&1\\2&0&1&3&1&2&1\\3&2&0&0&2&1&1\\2&3&1&0&2&1&1\\3&2&0&2&0&2&3\\3&2&3&2&1&0&0\\3&3&2&3&1&3&0\end{bmatrix}\quad X^{11}=\begin{bmatrix}0&3&2&0&2&2&1\\2&0&2&1&2&1&2\\1&1&0&0&0&1&1\\1&2&1&0&1&0&1\\1&1&2&3&0&1&1\\2&3&1&2&1&0&2\\3&1&1&1&3&2&0\end{bmatrix}\quad X^{12}=\begin{bmatrix}0&2&2&1&3&1&1\\3&0&2&1&2&1&2\\2&3&0&1&1&2&2\\3&2&0&0&3&1&2\\1&3&2&1&0&3&1\\2&3&2&3&2&0&1\\2&1&0&2&3&2&0\end{bmatrix}$$

$$X^{13}=\begin{bmatrix}0&2&3&2&3&2&2\\1&0&3&1&3&3&3\\2&3&0&2&1&2&2\\2&2&1&0&3&2&1\\3&2&2&1&0&3&1\\3&2&3&1&1&0&1\\3&2&1&1&3&2&0\end{bmatrix}\quad X^{14}=\begin{bmatrix}0&2&1&3&3&2&1\\2&0&3&2&2&1&2\\3&3&0&2&1&1&2\\2&1&2&0&3&2&3\\2&2&0&3&0&3&1\\3&3&1&0&1&0&1\\2&1&2&1&3&2&0\end{bmatrix}\quad X^{15}=\begin{bmatrix}0&2&1&2&3&2&3\\2&0&2&1&3&1&2\\3&1&0&2&3&1&2\\2&1&3&0&2&1&1\\2&3&1&3&0&2&1\\2&3&1&3&1&0&2\\2&3&1&2&3&2&0\end{bmatrix}$$

$$X^{16}=\begin{bmatrix}0&2&1&2&2&3&3\\1&0&2&3&1&2&2\\3&2&0&2&1&1&2\\2&2&1&0&3&2&3\\2&1&2&1&0&0&3\\3&2&1&1&3&0&2\\2&2&3&0&2&2&0\end{bmatrix}\quad X^{17}=\begin{bmatrix}0&3&2&1&3&3&2\\2&0&3&1&3&3&3\\1&2&0&1&2&3&2\\3&1&1&0&3&1&3\\2&3&1&2&0&2&1\\2&2&3&2&1&0&1\\3&2&2&1&3&3&0\end{bmatrix}\quad X^{18}=\begin{bmatrix}0&2&3&1&2&2&1\\2&0&3&3&2&3&2\\1&1&0&3&1&1&2\\2&1&2&0&3&2&3\\2&2&1&3&0&2&0\\2&1&2&2&2&0&1\\1&2&1&1&3&1&0\end{bmatrix}$$

The second step is to construct average matrix *A* based on the equation below:

$$A=[a_{ij}]\,,a_{ij}=\frac{1}{7}\sum_{K=1}^{7}X_{ij}^{k}$$

$$A=\begin{bmatrix}0.0000&2.1667&2.1667&1.6667&2.3889&2.2778&1.8889\\2.0556&0.0000&2.2223&1.8334&2.1112&2.0556&2.3334\\1.8889&1.7778&0.0000&1.6667&1.3889&1.7778&2.0556\\1.8889&1.6667&1.3887&0.0000&2.3334&1.3889&1.8334\\2.1112&1.9445&1.5556&1.8334&0.0000&2.0556&1.2223\\2.2778&2.3334&1.8334&1.5556&1.5556&0.0000&1.6667\\2.1667&1.8334&1.3889&1.1112&2.1667&2.0000&0.0000\end{bmatrix}$$

Now the normalized initial direct-relation matrix *N* should be calculated, using the equation below:

$$N=A\times\frac{1}{b}\,,b=max\left\{\max_{1\le i\le 7}\sum_{i=1}^{7}a_{ij}\,,\max_{1\le i\le 7}\sum_{j=1}^{7}a_{ij}\right\}$$

From our average matrix *A*, the fixed number *b*, which is the maximum of the sum of elements of each row and the sum of elements of each column, is the sum of second row which is *b*= 12.6115. So matrix N is as below:

$$N = \begin{bmatrix} 0.0000 & 0.1719 & 0.1719 & 0.1322 & 0.1895 & 0.1806 & 0.1498 \\ 0.1630 & 0.0000 & 0.1763 & 0.1453 & 0.1675 & 0.1630 & 0.1851 \\ 0.1498 & 0.1410 & 0.0000 & 0.1322 & 0.1102 & 0.1410 & 0.1630 \\ 0.1498 & 0.1322 & 0.1101 & 0.0000 & 0.1851 & 0.1102 & 0.1453 \\ 0.1675 & 0.1542 & 0.1234 & 0.1453 & 0.0000 & 0.1630 & 0.0969 \\ 0.1806 & 0.1851 & 0.1453 & 0.1234 & 0.1234 & 0.0000 & 0.1322 \\ 0.1718 & 0.1454 & 0.1101 & 0.0881 & 0.1719 & 0.1586 & 0.0000 \end{bmatrix}$$

The next step is to calculate matrix *T*, which is the total relation matrix, by the equation below:

$$T = N(I - N)^{-1}$$

$$T = \begin{bmatrix} 1.3340 & 1.4228 & 1.3142 & 1.1914 & 1.4491 & 1.4169 & 1.3281 \\ 1.4763 & 1.2774 & 1.3184 & 1.2020 & 1.4357 & 1.4055 & 1.3572 \\ 1.2774 & 1.2205 & 1.0035 & 1.0395 & 1.2105 & 1.2099 & 1.1721 \\ 1.2700 & 1.2064 & 1.0958 & 0.9182 & 1.2617 & 1.1798 & 1.1491 \\ 1.3115 & 1.2514 & 1.1332 & 1.0687 & 1.1305 & 1.2463 & 1.1393 \\ 1.3723 & 1.3232 & 1.1955 & 1.0921 & 1.2902 & 1.1553 & 1.2140 \\ 1.3113 & 1.2412 & 1.1190 & 1.0198 & 1.2730 & 1.2410 & 1.0442 \end{bmatrix}$$

Now we let *r* be a *7×1* vector, representing the sum of the rows in total relation matrix *T*, and also *c* be a *1×7* vector representing the sum of the columns in total relation matrix *T*.

$$r = \begin{bmatrix} 9.4565 \\ 9.4725 \\ 8.1334 \\ 8.0810 \\ 8.2809 \\ 8.6426 \\ 8.2495 \end{bmatrix} \quad c = \begin{bmatrix} 9.3528 & 8.9429 & 8.1796 & 7.5317 & 9.0507 & 8.8547 & 8.4040 \end{bmatrix}$$

In the next step we should calculate (r_i+c_j), where i=j. It illustrates the importance that factor *i* plays in the entire system. And also (r_i-c_j) denotes the relationship. (r_i+c_j) and (r_i-c_j) are calculated and demonstrated for factors (A) to (G) in Table 3.

Table 3: The Sum of Influences Given and Received Among Factors

Dimensions	**r_i+c_j**	**r_i-c_j**
(A) Participating suppliers in customers' product development and sharing expertise and technology	18.8093	0.1037
(B) Creating a greater level of mutual trust among supply chain members	18.4154	0.5296
(C) Developing long-term strategic relationship	16.3130	-0.0462
(D) Managing knowledge as a strategic resource in chain management	15.6127	0.5493
(E) Promoting open communication among supply chain partners	17.3316	-0.7698
(F) Generating a common supply chain identity	17.4973	-0.2121
(G) Developing a supportive culture among the partners	16.6535	-0.1545

The final step is to construct the causal diagram (or IRM). The horizontal axis in this diagram is r_i+c_j and the vertical axis is r_i-c_j. The arrows show how each factor impacts the other. When the arrow is a one way arrow from factor B to C, as it is in our diagram in Figure 1, it means B impacts C; and when it is a two way arrow from factor A to B and vice versa it means that both of them impact each other. As earlier was told (in section 2 of the paper) these relations are adopted from matrix T, filtering its elements by the threshold. The threshold value for our purpose is determined with the vote of our experts, to be 1.33.

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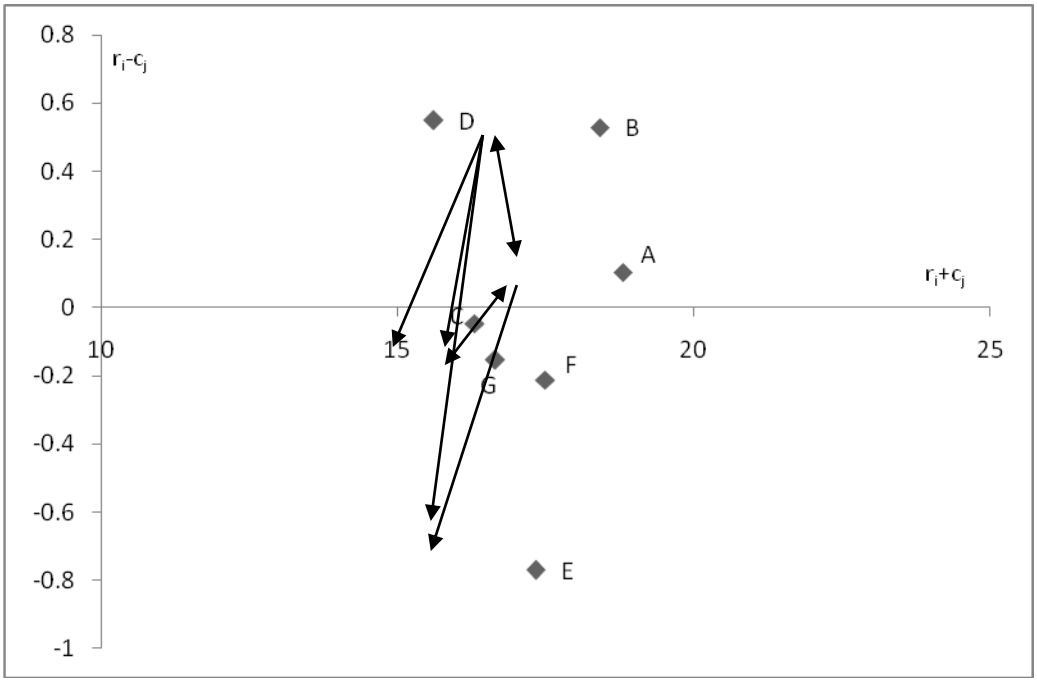

Figure 1. The Impact Relation Map

RESULTS AND DISCUSSION

Results

Determining Table 3 and Figure 1, now we can draw the results of our DEMATEL method computations. According to Table 3, where r_i+c_j illustrates the importance of factor *i*, it can be understood that the priority of the importance of factors in the whole system is as $A > B > F > E > G > C > D$. That is, (A) participating suppliers in customers' product development and sharing expertise and technology, with the value of 18.8093, plays the most important role in implementing strategic management of supply chain, and (D) Managing knowledge as a strategic resource in chain management, with the value of 15.6127, is the least important criterion among the known criteria. On the other hand, considering r_i-c_j, we can separate the factors into a cause group and an affected group; thus (A) participating suppliers in customers' product development and sharing expertise and technology, (B) Creating a greater level of mutual trust among supply chain members and (D) Managing knowledge as a strategic resource in chain management, are in the cause group whereas (C) Developing long-term strategic relationship, (E) Promoting open communication among supply chain partners, (F) Generating a common supply chain identity and (G) Developing a supportive culture among the partners, are in the affected group.

Regarding Figure 1, it can be understood from the impact diagram that factor (A) participating suppliers in customers' product development and sharing expertise and technology, influences three factors, which are (B) Creating a greater level of mutual trust among supply chain members, (E) Promoting open communication among supply chain partners and (F) Generating a common supply chain identity. Moreover, the same factor is influenced by only one factor, which is factor (B) Creating a greater level of mutual trust among supply chain members.

Factor (B) Creating a greater level of mutual trust among supply chain members, influences factors (A) participating suppliers in customers' product development and sharing expertise and technology, (E) Promoting open communication among supply chain partners, (F) Generating a common supply chain identity and (G) Developing a supportive culture among the partners, and it is influenced by (A) participating suppliers in customers' product development and sharing expertise and technology.

There are also mutual interactions between factors (A) participating suppliers in customers' product development and sharing expertise and technology, and (B) Creating a greater level of mutual trust among

supply chain members, and between factors (A) participating suppliers in customers' product development and sharing expertise and technology, and (F) Generating a common supply chain identity. Factors (D) managing knowledge as a strategic resource in chain management, and (C) Developing long-term strategic relationship, on the other hand, show to be relatively independent in the system and they are not affected by any factors nor affecting any factors.

To sum up all the connotations of our DEMATEL computation results, we can say, to implement strategic management of supply chain, the group of cause factors which are (A), (D) and (B) should be given greater attention rather than the affected factors (C), (E), (F) and (G). The reason is obvious; when a cause factor gets improve, it causes improvement in the factor it affects. That is improvement in factor (B), as an instance, can result in some improvement in all the other factors (A), (C), (F) and (E). To be more specific, it can be claimed that factors (A) participating suppliers in customers' product development and sharing expertise and technology, and (B) Creating a greater level of mutual trust among supply chain member are the key success factors in implementing strategic management of supply chain. The more resources are devoted to develop and improve these two factors, the more they affect other factors and the better supply chain gets managed, strategically.

Conclusion

This paper first studied most of the literature available on the issue of strategic management of supply chain and identified and elicited 27 success factors in implementing this approach. Later by a survey, seven major criteria were elicited and were chosen to be evaluated by DEMATEL method. DEMATEL method, unlike the traditional multiple criteria decision-making techniques, is not just in seek of identifying the importance of each independent criteria, but takes one step further and also represents contextual relationships among those criteria. That is, DEMATEL method helps the decision makers in identifying the casual relationships among criteria. The computations and results of our DEMATEL method show that in implementing strategic management of supply chain, participating suppliers in customers' product development and sharing expertise and technology, and creating a greater level of mutual trust among supply chain members, are the most essential factors. These two factors, not only interact each other and improvement in one can result improvement in the other, and vice versa, but also they influence other success factors like generating a common supply chain identity, developing a supportive culture among the partners, and promoting open communication among supply chain partners. On the other hand developing long-term strategic relationship and managing knowledge as a strategic resource in chain management are relatively independent factors and play less important role.

Thus, the decision maker of the chain should put more of its energy and resources on improving participation of suppliers in customers' product development and creating a greater level of mutual trust among supply chain members with the hope that this investment will result in a better performance of other success factors and from this a better implementation of strategic supply chain.

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