

Journal of Social and Development Sciences

Vol. 1, No. 3, pp. 109-114, Apr 2011

Analyzing the Risk Factors of Supply Chain Management in Indian Manufacturing Organizations

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Abstract: Today organizations of any magnitude have heavily integrated supply chain. The supply chain management consists of all parties involved, directly or indirectly in fulfilling customer request. There is an immense growth which has expanded from the traditional point of view as not only of physical distribution of materials but also to services. Implementing supply chain risk management has been troubleshooting in many organizations. In practice assessing risk management in supply chain is rather underdeveloped and often dealt with informal and reactive manner. As risk management issues today is subjected to substantial research and the organizations are trying to mitigate the risk issues so as to maintain the smooth operation of supply chain. The purpose of this paper is to identify and prioritize the risk factors in context to supply chain management of Indian manufacturing organizations. The research presented here is specifically targeted to Indian manufacturing organizations which are managing the supply chain operations. This paper deals with the risk issues and thus empirically assesses which risk factors are most influencing one in supply chain operations which must be given careful attention.

Keywords: *SCM, Risk factors, India, factor analysis, PCA*

1. Introduction

Supply Chain Management (SCM) is defined as managing chain of events that strives to balance activities such as promotion, sales, distribution and production. It can also be defined as profit maximization (Hise, 1995; Nelson and Toledano, 1979). In today's competitive and uncertain market supply chain vulnerability has become an issue of significance for many organizations. As of today supply chain is becoming more and more complex due to global sourcing and continuous trend of leaning down and as a result supply chain risk increases. Risk management is emerging as important contributor to most fields of management and decision control. The challenge to business organizations today is to mitigate that risk through creating more resilient supply chains. The motives behind organizations turning towards risk management approaches being the global competition, change in technology, and the continuous contention for competitive advantage (Brindley, 2004). A simple approach for viewing supply chain risk management focuses on two fundamental aspects which are probability of event actually occurring, impact of the event on supply chain and subsequently overall business. MIT Research group on "Supply Chain Response to Global Terrorism" shows that organizations generally concentrate on the type of disruption and not its source in order to know how to get it prepared against risk. Once the risk events are being identified effective methods for managing the risks must be developed. There are wide instances in the literature regarding the risks and vulnerabilities, and complex supply chains. The advancement of globalization in industries of any magnitude has increased uncertainties in both demand and supply and the likelihood of supply chain disruption. Surprisingly there is a lack of conceptual framework and empirical findings to provide clear meaning and guidance to visualize the global supply chain management. Global supply chains require highly coordinated flows of goods, services, information, and cash within and across national boundaries (Mentzer et al, 2001). Effective risk management requires quantifying risk in order to place them in their proper context and to weigh the costs of risk and benefits of making particular decisions. Supply chain risk management offers improved focus on risk and therefore, more effective risk mitigation. This paper thus attempts to identify risk factors pertaining to supply chain management in context to Indian manufacturing organizations.

2. Literature Review

Supply Chain Management issues increasingly becoming more and more complex thus presenting greater risk. While going through the literature it has come to notice the failure and disruptions in proper flow of

supply chain and as a result, organizations had to incur huge loss. Management must come up with the issues responsible for disruption of supply chain. So it has become necessary to identify some of the risk issues. This section deals with some of the risk factors affecting the supply chain management. Mitchell (1995) suggests that risk reducers include: to choose approved list of suppliers, multiple sourcing, choosing a leading organizations/companies, frequent visit to supplier operations, and to make a good communication and relation with suppliers. Zsidisin et al. (2000) focused on supply risks related to design, quality, cost, availability, manufacturability, supplier, legal, and environmental, health and safety. Based on the qualitative literature the researcher identified nine process based tools that helps in assessing supply chain risks from a supply chain context. The findings show, that less formalized processes and tools, are more popular than the formalized tools (Juttner, 2005). It has been argued that further research into frameworks for identifying risk sources from SCM perspective might be a first step in introducing risk management into design of supply chains (Sorensen, 2005). It has been argued that in the area of SCM, risk is less understood than in other disciplines and less developed. They suggest that empirical case studies to investigate: how the organizations actually cope up with themselves to manage supply chain risk, what are the process and techniques the firms use to identify and analyse risk in their supply chains (Khan and Burnes, 2007). Ritchie and Brindley (2007) go on to argue that in order to conduct empirical research on risk in complex supply networks, tools are required for identifying, assessing and managing risk.

3. Research Methodology

Based on the review of literature and from the questionnaire survey from the organizations the researchers identified certain risk factors that need to be controlled. The content validity of these constructs was tentatively established by extensive review with top executives and other stakeholders. Some items were removed from the construct if their removal results in an increase in the reliability estimates, however care was taken to ensure the validity of the measures is not threatened by the removal of a key conceptual element. The different risk factors identified are:

Disruption of supply, quality issues, technology uncertainty, breakdown of operations, technology change, introduction of new product, chaos in the system, IT security, interest rate, exchange rate, vandalism, govt. action, unanticipated resource requirement.

Survey Methodology: In this study a survey based questionnaire is distributed in various manufacturing organizations to capture the perception and judgement of the concerned supply chain persons working in this domain. Invitations to participate in the survey requested responses from those experts who have experienced in this field of managing supply chain and logistics. The researchers framed the questionnaire based on 5 point likert scale, where 1 meant “strongly disagree” and 5 meant “strongly agree”. A postal survey questionnaire was used as the research instrument. The questionnaire is focused on the importance of critical risk factors that clarified from literature review and from the survey. For each of these factors, a number of elements or statements were formulated through the definition and description of each one in the literature. It was a deliberate attempt not to collect any response in presence of the researcher so as to reduce the chance of any biasness. The objective of this research is to prioritize the risk factors and to put the results before the industries so that no disruption takes place for the operation of smooth supply chain management.

Data Collection Procedures: The data collection phase of the literature review has involved exhaustive search of many of the prime Management journals including that the researchers could access. In addition to, the preceding journals, some conference papers, articles, were also accessed as well as ,the following databases were searched like Emerald, Science Direct, Proquest, Ebscohost, Springer, J Store etc. Invitations to participate in the survey requested responses from the organizations that were small scale industries in nature and the target respondents in each organizations were Director of logistics, Chief operation manager, Controller of stores, and other officials and people who were directly or indirectly involved in managing proper supply chain and logistics operation in those organizations. Overall 90 respondents were obtained for overall analysis.

4. Data analysis and Results

In this research, the raw data was captured in a spread sheet software package. The spreadsheet was then converted into statistical software package (SPSS.17). The researchers performed factor analysis on the explanatory variables with the primary objective of determining minimum number of factors that account for maximum variance in data. Here, principal component method with varimax rotation has been applied. It is used so as to reduce the number of variables (Jolliffe, 2002). It gives loading for each combination of variables and loading factors. Higher loadings mark a higher correlation between variable and factor. Thus, the factor can be interpreted as underlying latent variables. In this study, we follow the Kaiser criterion (Kaiser, 1960), which suggests selection of those factors with Eigen values having values greater than 1. PCA is a procedure, which is widely accepted in various applications of information systems domain and also proved to be feasible in research method (Karimi et al., 1996; Chang & King, 2005).

Table 1 summarizes the proportion of each factors variance explained by the other factors. Initial communalities are the estimates of the variance in each variable accounted for all components or factors. Extraction communalities are the estimates of the variance in each variable accounted for by the factors (or components) in the factor solution. Smaller values indicate those variables, which do not fit well with the factor solution, and we must eliminate them from the analysis. Table 1 represents the communalities table. Communalities indicate the amount of variance in each variable that is accounted for.

Table 1: Communalities

Factors	Initial	Extraction
Disruption of supply	1.000	.699
Quality issues	1.000	.774
Technology uncertainty	1.000	.790
Breakdown of operation	1.000	.841
Technology change	1.000	.751
Introduction of new product	1.000	.670
Chaos in system	1.000	.767
IT security	1.000	.665
Interest rate	1.000	.727
Exchange rate	1.000	.615
Vandalism	1.000	.602
Govt. action	1.000	.762
Resource requirement	1.000	.770

The data collected on failure factors of SCM first being examined to check whether the data could be analyzed by doing factor analysis or not. The results of this analysis indicate that the correlations among the factors were high and also the Bartlett's test of sphericity was significant. The data were hence found suitable for factor analysis. The researchers performed exploratory factor analysis on the different measures to purify the instrument and in order to validate the various dimension of failure factors for supply chain management.

Table 2 below presents the Eigen values in decreasing order. Only Eigen values greater than one are included in final solution. Eigen value gives the ratio of variation in the data explained by each factor to the variation in the data explained by all the variables. It shows cumulative variance of 72.57% which means that factor analysis is satisfactory. Here factor analysis has been performed on 13 items leading to the extraction of 6 components.

Table 2: Total Variance Explained

Component	Initial Eigen Values			Extraction sums of squared loadings			Rotation sums of squared loadings		
	Total	% of Variance	Cumulative %	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	2.427	18.668	18.668	2.427	18.668	18.668	1.832	14.092	14.092
2	1.665	12.807	31.475	1.665	12.807	31.475	1.608	12.366	26.459
3	1.635	12.574	44.048	1.635	12.574	44.048	1.585	12.196	38.655
4	1.389	10.681	54.729	1.389	10.681	54.729	1.538	11.834	50.489
5	1.303	10.025	64.754	1.303	10.025	64.754	1.463	11.250	61.739
6	1.017	7.820	72.574	1.017	7.820	72.574	1.409	10.835	72.574
7	.795	6.112	78.686						
8	.683	5.252	83.938						
9	.632	4.864	88.802						
10	.462	3.552	92.355						
11	.444	3.415	95.769						
12	.301	2.314	98.084						
13	.249	1.916	100.000						

Extraction Method: Principal Component Analysis

As it can be seen the researchers used principal component as the extraction technique and rotation method used is Varimax. Table 3 summarizes the results of factors identified of orthogonal rotation called Varimax. Factor Loading is considered as simple correlation between the factors and variables. It is used to decide which variable belongs to which factor. The judgement can be best suited for rotated factor matrix. Each variables belongs to the factors with which it has the highest loading (neglect the negative sign). Rotation is a method that simplifies the interpretation of factor analysis. Varimax aims to maximize the variance of squared loadings on a factor to produce some high and low loadings for each factor (Kim and Muller, 1978). Here the factors are being rotated among each other so that they are mutually orthogonal i.e. perpendicular in n dimensional plane.

Table 3: Rotated Component Matrix

Factors	Component					
	1	2	3	4	5	6
Disruption of supply	-.127	-.012	.075	-.266	.733	.264
Quality issues	.143	.854	-.067	-.035	-.025	.134
Technology uncertainty	-.029	.881	.056	-.020	.091	.038
Breakdown of operation	-.040	.132	-.056	.027	.154	.892
Technology change	.594	.077	.026	.058	.411	.468
Introduction of new product	.767	.166	.182	.028	.120	.079
Chaos in the system	.332	.135	-.147	.287	.724	-.097
IT security	-.203	-.066	.046	.786	.009	.004
Interest rate	-.695	.137	.142	.365	.169	.208
Exchange rate	.103	-.001	-.002	.773	-.054	.067
Vandalism	.427	.081	.057	.167	-.378	.489
Govt. action	-.054	.028	.869	-.007	.047	.023
Resource requirement	.151	-.038	.856	.054	-.086	-.052

Extraction Method: Principal Component Analysis

Rotation Method: Varimax with Kaiser Normalization

Rotation converges in 13 iterations

The rotation minimizes the number of variables having higher correlations on factor. As the rotation is orthogonal the resulting factors will be uncorrelated. In the rotated factor variables with higher factor loading is considered as most important. Thus from Table 3, the most influencing risk factors affecting supply chain operations are: new product introduction, technology uncertainty, govt. action, IT security, disruption of supply, breakdown of operation.

For reliability analysis we calculate Chronbach's alpha which assesses how well a set of items measures a single unidimensional latent construct. Alpha is a measure of the items that provides a test for surveys internal consistency (Reynaldo and Santos, 1999). However the cronbachs alpha in our case is more than the minimum suggested level as per Hair et al., (1998). As per higher factor loading we prioritize the risk factors:

Table 4: Priorities of six most influencing factors

Factors (Components)	Factor Loading	Priority / Rank
Introduction of new product	.767	5
Technology uncertainty	.881	2
Govt action	.869	3
IT Security	.786	4
Disruption of supply	.733	6
Breakdown of operation	.892	1

The results above shows the prioritized factors with the objective that if these factors are given proper attention then it would lead to proper functioning of supply chain management.

5. Conclusion

Even after devising strategies and prioritizing the risk factors in supply chain in context to Indian manufacturing organizations, all risks cannot be avoided. Risk mitigation planning provides an organization with a more mature decision making process in facing unexpected losses being caused by unexpected events. Existence of supply chain can be seen in both service industries as well as in manufacturing industries and the complexity variation occurs from industries to industries and from firm to firm. Beside other issues organizations must consider the overall costs including cost of space, expenses related to doing businesses outside country. With this the socio – economic, political and cultural dimensions can be considered as important issues in order to manage the supply chain risks.

This study provides a partial support for the explanation of risk mitigating issues in context to Indian supply chain matters. The prioritized factors would help supply chain managers to identify, assess and plan for risk. It is expected that the outcome of the results from this research study will be beneficial to the organizations which wishes to leverage the benefits of smooth operations of supply chain management. If the risks are being controlled effectively the efficiencies of supply chain would maintain a balance between financial considerations and that of the customer.

This research study has also some limitations that the study is specifically targeted to manufacturing organizations. Apart from manufacturing in particular the researchers also can consider other variety of organizations like Retail, Pharma, aviation, construction, etc. There is scope to enhance this study by taking different industries and increasing the number of respondents into consideration.

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