

# Risk Assessment of Supply Chain Management in Construction Projects

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**Abstract**— Construction plays a key role in economic development of a country. It is vital for growth on account of industrialization, urbanization, and infrastructure development. Construction sector is very diverse and unorganized in nature. Also most of the construction companies are small and medium scale enterprises. Efficient and sustainable supply chain management (SCM) is pivotal for the delivery of a successful project. However, the application of SCM in construction industry is still evolving. Purpose of present study is to examine the current practices of SCM used in the construction industry and identifying the risk factors of SCM in Construction projects. To fulfill these objectives questionnaire survey approach was adopted in which 35 respondents were involved. The construction industries lack in implementing Supply Chain Management (SCM) concept and develop models that support the decision-making and planning. This study will ensure the effective implementation of Supply Chain Management in Construction Industry.

**Keywords:** Supply Chain Management, Construction Industry, SCM in Construction Industry

## I. INTRODUCTION

Construction plays a key role in economic development of a country. A construction project supply chain may contain hundreds of firms, contractors; subcontractors; material and equipment suppliers; engineering and design firms; and consulting firms etc. It remains highly fragmented and involves many small and medium size suppliers and subcontractors. Also construction projects need a high level of coordination among various stakeholders, who have conflicting interests during the life of the project and involve various short and long-term business to business relations.

Procurement of each material and service involves risks at various nodes of the procurement channel. Risk management decisions in construction supply chains and can be used for various different projects would bring enormous savings to construction firms.

The construction industries lack in implementing Supply Chain Management (SCM) concept and develop models that support the decision-making and planning. This study gives idea about improvement in implementation of SCM in Construction industry effectively.

### A. Objectives of the Study

- 1) To examine SCM practices used in construction project
- 2) To identify and classification of Risk factors affecting SCM in construction project
- 3) To provide recommendations for improvement in SCM practices in construction projects

## II. CONCEPT OF SUPPLY CHAIN MANAGEMENT

SCM is a concept that started in the manufacturing industry. It is seen as a demanding innovation that is built on previous

changes such as Total Quality Management (TQM) and Just-in-time (JIT). The supply chain is “the network of organizations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services in the hands of the ultimate customer.” Similarly, a supply chain has been conceptualized as “a system whose constituent parts include materials supplies, production facilities, distribution services and customers linked via the feed forward flow of materials and the feedback flow of information”.

In the construction sector, the supply chain presents a growing economic burden associated with poor performance and a poor quality of the final product, which leads to a low customer satisfaction, and a decline in productivity and efficiency, while competition in this sector increases. This is due to the constant delays in the work site because of late deliveries, lack of integrated management and lack of collaboration between the various stakeholders involved in the project, leading to the need for a thorough analysis of these Supply chain in the industry.

Therefore, there has been an increasing interest in SCM applied in the construction industry, with the objective to understand and characterize failures and to propose solutions in order to improve the coordination of the many subcontractors and suppliers of the construction industry supply chain.

Hence, the implementation of SCM in the construction industry aims to, reduce the storage of raw materials and equipment, perform more advantageous purchases and streamline transportation, eliminate waste and add value to the final product, i.e., making the supply chain more efficient and effective. When deadlines are reliable, when service exists in case of an emergency, order placement is easy and there is a quality after-sales service, value is added to the final product, which only happens if there is a good relationship and trust between contractors, suppliers and subcontractors.

## III. METHODOLOGY

The methodology followed in this study is divided into three sequential steps. These steps will be significantly helpful in order to conduct this study. This study is based on questionnaire which is an outcome of literature review and interviews conducted in-person.

First, Questionnaire will be prepared based on the literature review from available resources which will directly or indirectly support the interview or discussion.

Second, the interviews or discussion will be conducted. The criteria for selecting the participants will be based on their previous experience in construction projects, interest in relevant field and qualification.

Third, collected data from questionnaire or interviews will be analyzed and factors will be classified which might affect SCM practices in construction projects.

Finally, discussion will be presented regarding the improvement in implementation and applicability of SCM in construction project.

#### IV. FACTORS IDENTIFICATION

According to the methodology followed in this study literature survey and discussion were conducted in the SCM field focusing on the material supply for construction projects. For this various journals and research papers are referred from the articles published by world –wide journals: ASCE, Science Direct (Elsevier), Springer, etc.

After selecting the research papers, they were reviewed in order to identify relevant risk factors. Total of 9 risk factors are identified which will affect the SCM in material supply for construction project. These factors are mentioned below:

- 1) Awareness about SCM Benefits
- 2) Training and Instruction about SCM in an organization
- 3) Communication between participants
- 4) Number of Suppliers (Specific for material)
- 5) Selection of suppliers
- 6) SCM relationship with the supplier
  - a) Simplify the ordering process
  - b) Cost benefits
  - c) Simplify the construction process
  - d) Better quality service
- 7) Internal organizational functions
  - a) Transport of Material
  - b) Inventory
  - c) Storage of material
  - d) Purchasing of material
- 8) IT system for SCM
- 9) Conflict resolution procedure

These are the relevant critical factors, according to which further study will be done. Effect of these factors on SCM in construction project will be studied based on the questionnaire survey. Accordingly these nine risk were classified as follows:

Type of Risk	Risk Factor	SCm Sub-context
Strategic	Lack of Awareness of SCM Benefits	Lack of Awareness of SCM Benefits
	Internal organizational functions	Inventory
		Purchasing
		Transport
		Storage
Operational	Inadequate Training and Instruction	Inadequate Training and Instruction
	Inadequate IT system	Inadequate IT system
Supply	Inadequate Communication	Inadequate Communication
	Number of Suppliers	Number of Vendors
	Inadequate Selection of suppliers	Recommendation
		Price
		Experience
		Market reputation
	SCM relationship with the supplier	Geographic location
		Cost Beneficiary
		Better Quality Services
	Absence of a Conflict resolution procedure	Simplified Ordering Process
Simplified construction Process		

Fig. 1: Classification of Risk Factors

#### A. Questionnaire Preparation

Questionnaire are certainly the best known of the research instruments used for gathering information from people. Its purpose is to collect the required data from the respondents. Questionnaire will be administrated by phone call, mail or personal interview.

While designing the questionnaire, steps were followed as mentioned below:

- 1) Decide the information required:

The first step is to decide what are the things required to know from the respondent

- 2) Choose the methods of reaching your target respondents:

Following are the methods of reaching the target respondents:

- a) Personal Interview
- b) Mail
- c) Phone Call

- 3) Decide the question content

- 4) Develop the question wording:

It provides the respondent with an easy method of indicating his answer- he does not have to think about how to articulate his answer. Responses can be easily classified, making analysis very straight forward. It permits the respondent to specify the answer categories most suitable for their purpose.

- 5) Ordering the questions:

Following is the order to be followed:

- a) Opening questions.
- b) Question flow
- c) Question variety
- d) Closing Question

- 6) Check the length of questionnaire:

In general, it is best for a questionnaire to be as short as possible. A long questionnaire leads to a long interview and this is open to the dangers of boredom on the part of respondent.

- 7) Pre-test the questionnaire:

Test the questionnaire on a small sample of your subject first this is possible at least it on colleagues or friends. The aim here to detect any flaws in question and correct these prior to main survey.

- 8) Develop the final survey form:

It means designed questionnaire will be administered among the selected sample respondents to the study.

Based upon the 9 critical factors identified from the literature survey as mentioned questionnaire were prepared. By following above steps questionnaire were designed as mentioned below:

**“Risk Assessment of Supply Chain Management in Construction Project”**

**Questionnaire Survey for the Study of M-Tech Dissertation**

Surveyor’s Name: Rishikesh Sanjay Aher

Qualification: M-Tech in Construction Management (SY)

Institute: Government College of Engineering, Karad

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**“Questionnaire”**

**Part A: General Information**

Name of Company: \_\_\_\_\_

Type of Project: \_\_\_\_\_

Expected Completion Duration of Project: \_\_\_\_\_

Approximate Budget of Project (if comfortable to share): \_\_\_\_\_

Name of Respondent: \_\_\_\_\_

Educational Qualification: \_\_\_\_\_

Designation of Respondent in an Organization: \_\_\_\_\_

Work experience:  1 to 5  6 to 10  11 to 15  More than 15

Gender:  Male  Female

**Part B:**

1. Your opinion about implementation of SCM in construction projects:

it can help to save cost

it can help to save time

**B. Data Collection**

To collect the required data, responses were taken from various respondents. For this “Questionnaire Survey” method were adopted. Questionnaire are certainly the best known of the research instruments used for gathering information from people. Its purpose is to collect the required data from the respondents. Questionnaire were be administrated by phone call, mail or personal interview.

**C. Data Analysis**

Data and information that was collected during the study was reduced into summary form that was processed by using Software Package for Social Scientists (SPSS). For this single factor ANOVA test was employed. The findings of the research study were organized and the data were presented in the form of words, numbers and percentages by using tables and graphs. Data collected from questionnaires was presented in tables and figures.

This section presents and interprets the results from the data analysis. These results include results of the study findings. The data in this section were generated from questionnaires filled by 35 respondents in construction industry. Data and information that was collected during the study was reduced into summary form that was processed by using Software Package for Social Scientists (SPSS).The findings of the research study were organized and the data were presented in the form of words, numbers and percentages by using tables and graphs. Data collected from questionnaires was presented in tables and figures.

**D. Supply Chain Management Practices**

The study first examined supply chain management practices used in construction industry. Accordingly respondents were given questionnaire to look at supply chain management practices in an organization and put their responses in open ended question. By collecting responses, most of the practices of SCM that are employed in construction projects are listed below:

**E. List of Practices in SCM**

- Supplier relationship management
- Adopt MIS based System for data management
- Early Involvement of Vendors in a Project
- Product development management
- Customer service management
- Demand management
- Follow Work Breakdown Structure
- Return management
- Audit performance of supply chain

**F. Key Factors in effective SCM in Construction**

In this section key factors of SCM which may be effective on construction project are analyzed. Accordingly respondents were given questionnaire with some variables such as “Awareness about SCM, IT System for data management, Communication between vendors, Training and Instruction Programme, Conflict Resolution System, No. of Supplier” and told to rate how these variables have impact on implementation of SCM in construction projects. In which respondent were told to rate their opinions on the Likert scale ranging from Not Important (1) to Very Important (5). The mean scores and single factor ANOVA test values were employed to compute for these variables in supply chain management. The analysis based on the mean scores and ANOVA test reflected the strengths and weaknesses of the said variables in terms of supply chain management. To interpret the obtained data, the following numerical values and interpretations were used to measure their application in supply chain management in construction project.

Mean range	Response Mode	Interpretation
4.21-5	Very Important	Strongly Effective
3.41-4.2	Important	Effective
2.61-3.4	Moderate	Low effective
1.81-2.6	Low Important	Ineffective
1.0 to 1.8	Not Important	Strongly ineffective

According to the data from above table, respondents were rated high for factors Awareness about SCM, IT System for data management, Communication between vendors, Training and Instruction Programme, Conflict Resolution System, No. of Supplier 3.45, 4.03, 4.23, 3.54, 3.41 and 3.68 respectively. This implies that these factors are effective and had a more important for implementation of SCM in construction projects. According to the responses given by respondent, among these six factors highest focus should be given to “Communication between vendors” (mean score= 4.23) and after that IT System for data management (4.03), No. of Supplier (3.68), Training and Instruction Programme (3.54), Awareness about SCM (3.45) and Conflict Resolution System(3.41).

Sr. No.	Type of Risk	Risk Factor	Sub-Context	No. Of Respondents (N)	Total Weightage (W)	Average Mean Score (M)	Ranking of Risk
1	Supply	Inadequate Communication	Inadequate Communication	35	148	4.23	1
2	Supply	Inadequate Selection of suppliers	Recommendation	35	146	4.17	2
3	Operational	Inadequate IT system	Inadequate IT system	35	141	4.03	3
4	Supply	Inadequate Selection of suppliers	Price	35	139	3.97	4
5	Supply	Inadequate Selection of suppliers	Market reputation	35	131	3.74	5
6	Supply	Number of Suppliers	Number of Vendors	22	81	3.68	6
7	Operational	Inadequate Training and Instruction	Inadequate Training and Instruction	35	124	3.54	7
8	Supply	Inadequate Selection of suppliers	Experience	35	123	3.51	8
9	Strategic	Lack of Awareness of SCM/Benefits	Lack of Awareness of SCM Benefits	22	76	3.45	9
10	Supply	Absence of a Conflict resolution procedure	Absence of a Conflict resolution	22	75	3.41	10
11	Supply	Inadequate Selection of suppliers	Geographic location	35	119	3.4	11
12	Strategic	Internal organizational functions	Inventory	33	106	3.21	12
13	Supply	SCM relationship with the supplier	Better Quality Services	22	63	2.86	13
14	Supply	SCM relationship with the supplier	Cost Beneficiary	22	60	2.73	14
15	Strategic	Internal organizational functions	Purchasing	33	88	2.67	15
16	Strategic	Internal organizational functions	Storage	33	75	2.27	16
17	Supply	SCM relationship with the supplier	Simplified construction Process	22	38	1.73	17
18	Strategic	Internal organizational functions	Transport	33	57	1.73	18
19	Supply	SCM relationship with the supplier	Simplified Ordering Process	22	36	1.64	19

### G. Selection of Supplier

According to the data given from above table, respondents were rated high for factors Recommendation, Price, Experience, Market reputation and Geographic location at mean score 4.17, 3.97, 3.51, 3.7 and 3.4 respectively. This indicates that selection of supplier for construction project is an important event and more focus should be given during planning and management phase. Respondents given highest rating to the factor Recommendation (mean score= 4.17) and after that Price (3.97), Market reputation (3.7), Experience (3.51) and lowest rating to Geographic location (3.4). This indicates that on the basis of recommendations, selection of supplier is done in SCM for construction projects while geographic location of supplier is low effective.

### H. SCM Relationship with the Supplier

According to the data given in above table, respondents gave medium rating to the Cost Benefits and Better Quality Services at mean score 2.73 and 2.86 respectively and lower rating to Simplifying ordering process and Simplifying the construction process at mean score 1.64 and 1.73 respectively. This implies that SCM relation with supplier are mostly based on the cost benefits and better quality services. Overall average mean score (2.24) of this factor indicates that

it is not much effective while implementation of SCM concept in construction project.

### I. Internal Organizational Functions

The responses given for this factor rated medium for inventory and purchasing at mean score 3.21 and 2.67 respectively and rated low for transport and storage at mean score 1.73 and 2.27 respectively. This implies that inventory and purchasing are the most critical factors in internal organizational functions of SCM in construction project. Storage and transport are also important factors of internal organizational function in Construction Company but not at much as inventory and purchasing. Overall average mean score (2.47) indicates that internal organizational functions are not much effective while implementing SCM in construction projects.

### J. Comparison of Risk Factors

The risk factors which were identified earlier were compared on the basis of above analysis. The various nine factors were compared and ranking given accordingly. Factors which are critical are listed in following table. This shows the factor's mean score and their ranking accordingly.

Sr. No.	Factors	Mean Score	Ranking
1	Communication between vendors	4.23	1
2	IT System for data management	4.03	2
3	Selection of Supplier	3.75	3
4	No. of Supplier	3.68	4
5	Training and Instruction Programme	3.54	5
6	Awareness about SCM	3.45	6
7	Conflict Resolution System	3.41	7
8	Internal organizational functions	2.47	8
9	SCM relationship with the supplier	2.24	9

### V. DISCUSSION AND RECOMMENDATION ON RESULTS

In this section discussion will be made on results obtained from data analysis. According to the analysis done in previous chapter, higher ranking identified 1 to 5 to the risk factors. As comparison was done among the risks and the overall ones, the whole identified risks were included in the overall case risks. Considering this following are the five major risk factors:

- Inadequate Communication
- Inadequate IT system
- Inadequate Selection of Supplier
- Number of Supplier
- Inadequate Training and Instruction programme

### A. Inadequate Communication

According to the results obtained from data analysis the highest rated risk factor was “Inadequate Communication” between vendors. The impacts of this factor are, inadequate coordination, no sharing of knowledge and misusing technology can be notified. The risk factor is a subjective limitations and its decisional level is the operation stage, and all the involved parties in the project, including client or owner, contractor, designer and supplier, may be responsible for it.

To deal with this risk, mitigation is known to be the appropriate response. To mitigate the risk and the associated problems, especially in employment of SCM strategies, and provide effective communications throughout the chain, Information Technologies are considered as the best possible tools. Information Technology can be employed to improve communication throughout the chain, between various sides, including suppliers, retailers, logistics etc. By means of IT, communication processes between the vendors are accelerated, and by this acceleration, advancements such as enabling the company to satisfy various demands, improving the competitiveness, innovation and customer services, will be achieved. By means of this improvement in SCM practices in construction projects can be achieved.

### B. Inadequate IT System

The reason of this risk can be weak integration of materials and information flows and communication. Because of the potentiality of high amount of suppliers in the market, to manage and record the necessary documents and information, every business employs certain software programs. The produced files in each program are having different formats. To keep sharing and exchanging the necessary information and documents, format conversion is needed an important operation. Because of differences in methods, about the existing documents, it is difficult to employ them. Therefore, there is limitation about the employment of existing information in a document, in future as well. Operation stage is the decisional level, and it is known to be a subjective limitation. To deal with this risk factor is avoiding it, by means of adopting technological standards. Businesses can benefit from combining their specific Enterprise Resource Planning's (ERP), to reuse the information in Business Process Reengineering (BRP), to achieve efficient operating processes.

### C. Inadequate Selection of Supplier

Selection of suppliers is one of the most important decisions in the process of purchasing. Inadequate selection of suppliers can be the reason of weak strategic sourcing. Selecting the adequate supplier is more difficult and complicated due to uncertainty and more number of suppliers involved in a project. The decisional level is in the strategic stage. To deal with this risk, following elements should be consider:

- ISO Certification of Supplier
- Visit Supplier's Site
- Financial analysis of Supplier
- Considering more suppliers as backup
- Good references and recommendations

## VI. CONCLUSION

Employing supply chain management (SCM) is accepted to be essential for the business organization success, in the competitive environment of nowadays world. The methodology followed in this study was divided into three sequential steps. These steps significantly helpful in order to conduct this study. This study was based on questionnaire which was an outcome of literature review and interviews conducted in-person.

Based on the literature review from available resources nine factors were identified which can affect the implementation of supply chain management in construction projects. Based on this questionnaire were prepared to take responses from various respondents in construction industry. The detailed questionnaire survey were conducted from 35 respondents who are working in construction industry.

The collected data from questionnaire survey were analyzed and factors were classified as strategic risk, operational risk and supply risk which affects SCM practices in construction projects. According to the results obtained from analysis, high rated risk factors of SCM are “Inadequate Communication, Inadequate IT System, and Inadequate Selection of Supplier, number of Suppliers and Inadequate training and Instruction Programme” which affects the implementation of SCM in construction projects. Finally, discussion were presented regarding the recommendations for the improvement in implementation of SCM in construction project.

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