

A PAPER ON THE EFFECTS OF SUPPLY CHAIN MANAGEMENT IN HIGHWAY CONSTRUCTION

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Abstract: - This paper proposes to study about the effects of the supply chain management of the highway construction projects. Supply chain management identifies the issues that slow down the process of road construction. During recent years, supply chain has become a major subject of management research. The paper presents the main results of the survey and highlights the effects of supply chain management in highway construction that exists in the construction supply chain.

Construction projects are identical in nature and are characterized by one time activity. Such projects are conducted by numerous representatives. The agents hired by clients for construction projects are contractors, sub- contractors, suppliers, project management consultant / third party consultant. The construction industry has recognized the importance of supply chain management (SCM) in improving the execution of projects, but the research in this area is still imperfect.

Key Words: - Supply chain management, highway construction, Relative Importance Index Method, Weighted Average Index Method and Spearman's Rank Correlation Coefficient.

I. INTRODUCTION

This paper attempts to provide the reader a complete picture of supply chain management through a systematic literature review. It presents main activities of supply chain and the step-by-step approach for understanding a complete picture of supply chain. Roads are important for the overall social and economic development of any region. Most of the passenger traffic is carried by road sector. The roads directly or indirectly affect industrial location, housing markets, land prices, internal trade and many other things. The main objectives of the study have been the identification of the effects involved in the completion of the road projects. SCM can be defined as network of different organizations, linked upstream and downstream in a chain, aiming to produce quality and value in the services and products for the end consumers through integrated processes and activities.

II. LITERATURE REVIEW

By using the data obtained from the survey and the knowledge available in the literature, the paper proposes a framework for implementing the concepts and principles of supply chain management in construction companies. The literature review has also demonstrated a number of weaknesses in the progress of construction towards the adoption of SCM relationships and the industries have yet to acquire a thorough understanding for its successful implementation about the SCM.

III. CURRENT SCENARIO OF SCM IN HIGHWAY CONSTRUCTION

- a) There is a significant unawareness about the SCM in highway construction and the benefit of SCM in highway construction is not properly utilized.
- b) Based on the brief interview with Clients, Consultants and Contractors it can be said that in currently the supply chain management in India is not adopted by many of the companies due to various reasons like cost, availability of the local market etc except by some of the big companies.
- c) Client's Pro-active role is missing, their involvement is less and contractors are also not motivated to work to work in the interest of the client.
- d) The interview with the agents involved in the SCM reveals many problems that exist in the local sector of the supply chain.
- e) However, it has been observed that most of the highway construction projects in India have been completed with additional time, money and resource.

IV. METHODOLOGY

It is the process which helps the understanding of construction companies concerning the awareness of supply chain management in Indian construction industry with special emphasis on their relationship to their suppliers, contractors, consultants and client. The research methodology will be done by the help of a survey questionnaire and survey questionnaire data analysis will be done by three different statistical tools that are Relative Importance Index Method, Weighted Average Index Method and Spearman's Rank Correlation Coefficient.

V. DATA COLLECTION METHOD

To obtain adequate information on the study, both primary and secondary data will be collected. The primary data will involve the review of literature on the research topic and related topics from books and journals. The secondary data will be collected through carefully structured questionnaires form to identify and discuss the thoughts and opinions of the Clients, Consultants and Contractors about the implementation of supply chain management in construction of highway.

Table 1:- Rate of responses

| Sr. No. | Respondents | Questionnaire distributed | Responses received | Percentage of responses |
|---------|-------------|---------------------------|--------------------|-------------------------|
| 1 | Client | 18 | 14 | 77.77 |
| 2 | Consultancy | 12 | 10 | 83.33 |
| 3 | Contractor | 27 | 21 | 77.77 |
| Total | | 57 | 45 | 78.94 |

VI. QUESTIONNAIRE DESIGN

The study will be followed by survey design in its conduct by using questionnaires to find out the views and opinions of respondents about certain subject. The questionnaires will be mainly pre-coded questions which enable respondents to tick their preferred options from relevant options which will be based on measurement scale. All the useful and necessary data was collected through the medium of survey in which questionnaire form was distributed to different clients, consultancy and contractors by hand and by means of technology using mail services containing about 20 questions. The five Likert Scale will be used to measure the responses such as practically ignored, seldom used, moderately used, highly used, and extensively used.

VII. DATA ANALYSIS

Once the data had been successfully collected, the researcher sorted the same and coded it appropriately for analysis work. In the thesis work the excel software was used to calculate and analyze the statistical data which was collected by the questionnaire survey so as to carry out the data analysis in this research.

1. Relative Important Index Method :-

Data of all these tables were analyzed by RII method was calculated for each type of claims as follows;

$$\text{RII method} = \Sigma W / (A * N)$$

Where, W = weight given to each factor by the respondents, ranges from 1 to 5

A = highest weight (i.e.5 in this case) and

N = total number of respondents.

2. Weighted Average Index Method :-

Data of all these tables were analyzed by a weighted average was calculated from each type of claims as follows:-

$$\text{WAI} = (W_i * X_i) / N;$$

Where, W_i is the weight assigned to the i^{th} option; X_i is the number of respondents who selected the i^{th} option; and N is the total no. of respondents.

3. Spearman's Rank Correlation Coefficient Method :-

Data of all these tables were analyzed by Spearman’s rank correlation coefficient method was calculated for each type of claims as follows;

$$R = 1 - [(6 \sum D^2) / N(N^2 - 1)]$$

Where, R = spearman’s rank correlation coefficient,

N = Refers to the number of pairs of observations,

D = represents the difference between the pair of same individual in two corresponding rank characteristics

(D= R₁ –R₂).

Table 2:- RELATIVE IMPORTANT INDEX METHOD

| Effects of SCM in highway construction | RII by Client | RII by Consultant | RII by Contractor | Average RII | Rank |
|--|---------------|-------------------|-------------------|-------------|------|
| 1) Supply chain management | 0.61 | 0.5 | 0.57 | 0.56 | 11 |
| 2) Company reputation | 0.65 | 0.6 | 0.64 | 0.63 | 8 |
| 3) Working hours | 0.51 | 0.58 | 0.56 | 0.55 | 12 |
| 4) Working capital problems | 0.72 | 0.7 | 0.82 | 0.74 | 3 |
| 5) Slow payment from project owner | 0.51 | 0.42 | 0.63 | 0.52 | 13 |
| 6) Inadequate technical capabilities | 0.52 | 0.38 | 0.49 | 0.46 | 16 |
| 7) Insufficient information technology | 0.54 | 0.42 | 0.43 | 0.46 | 16 |
| 8) Lack of communication between supply chain partners | 0.58 | 0.5 | 0.76 | 0.61 | 9 |
| 9) Work quality problems | 0.6 | 0.6 | 0.73 | 0.64 | 7 |
| 10) Work method problems | 0.57 | 0.68 | 0.79 | 0.68 | 5 |
| 11) Lack of organization encouragement | 0.42 | 0.54 | 0.58 | 0.51 | 14 |
| 12) Lack of government support system | 0.42 | 0.46 | 0.49 | 0.45 | 17 |
| 13) Lack of top management commitment | 0.72 | 0.8 | 0.73 | 0.75 | 2 |
| 14) Poor quality of human resources | 0.44 | 0.46 | 0.34 | 0.41 | 18 |
| 15) Market competition and uncertainty | 0.35 | 0.48 | 0.60 | 0.47 | 15 |
| 16) Resource planning | 0.75 | 0.86 | 0.84 | 0.81 | 1 |
| 17) Activity sequences | 0.51 | 0.6 | 0.63 | 0.58 | 10 |
| 18) Cost & time in terms of supply of materials | 0.64 | 0.7 | 0.70 | 0.68 | 5 |
| 19) Machinery management | 0.62 | 0.78 | 0.61 | 0.67 | 6 |
| 20) Natural problems | 0.62 | 0.76 | 0.70 | 0.69 | 4 |

Table 3:- WEIGHTED AVERAGE INDEX METHOD

| Effects of SCM in highway construction | WAI by Client | WAI by Consultant | WAI by Contractor | Average WAI | Rank |
|--|---------------|-------------------|-------------------|-------------|------|
| 1) Supply chain management | 3.07 | 2.5 | 2.85 | 2.80 | 11 |
| 2) Company reputation | 3.28 | 3 | 3.23 | 3.17 | 9 |
| 3) Working hours | 2.57 | 2.9 | 2.80 | 2.75 | 12 |
| 4) Working capital problems | 3.64 | 3.5 | 4.14 | 3.76 | 2 |
| 5) Slow payment from project owner | 2.57 | 2.1 | 3.19 | 2.62 | 12 |
| 6) Inadequate technical capabilities | 3.21 | 1.9 | 2.47 | 2.52 | 14 |
| 7) Insufficient information technology | 3.42 | 2.1 | 2.19 | 2.57 | 13 |
| 8) Lack of communication between supply chain partners | 3.28 | 2.5 | 3.80 | 3.19 | 8 |
| 9) Work quality problems | 3 | 3 | 3.66 | 3.22 | 7 |
| 10) Work method problems | 2.85 | 3.4 | 3.95 | 3.4 | 5 |
| 11) Lack of organization encouragement | 1.57 | 2.7 | 2.90 | 2.39 | 15 |
| 12) Lack of government support system | 2.14 | 2.3 | 2.47 | 2.30 | 16 |
| 13) Lack of top management commitment | 2.57 | 4 | 3.66 | 3.41 | 4 |
| 14) Poor quality of human resources | 2.57 | 2.3 | 1.71 | 2.19 | 17 |
| 15) Market competition and uncertainty | 1.78 | 2.4 | 3 | 2.39 | 15 |
| 16) Resource planning | 3.78 | 4.3 | 4.23 | 4.10 | 1 |
| 17) Activity sequences | 2.57 | 3 | 3.19 | 2.92 | 10 |
| 18) Cost & time in terms of supply of materials | 3.21 | 3.5 | 3.52 | 3.41 | 4 |
| 19) Machinery management | 3.14 | 3.9 | 3.09 | 3.37 | 6 |
| 20) Natural problems | 3.14 | 3.8 | 3.52 | 3.48 | 3 |

VIII. RESULT AND DISCUSSION

The factors that effect the supply chain management in highway construction projects have been clearly identified with thorough study of the literature and by the project report.

Table 4:- Spearman's Rank Correlation between Client and Consultancy

| Effects of SCM in highway construction | Rank by Client | Rank by Consultant | Diff | Diff ² |
|--|----------------|--------------------|------|-------------------|
| 1) Supply chain management | 6 | 10 | -4 | 16 |
| 2) Company reputation | 3 | 7 | -4 | 16 |
| 3) Working hours | 12 | 8 | 4 | 16 |
| 4) Working capital problems | 2 | 5 | -3 | 9 |
| 5) Slow payment from project owner | 12 | 13 | -1 | 1 |
| 6) Inadequate technical capabilities | 11 | 14 | -3 | 9 |
| 7) Insufficient information technology | 10 | 13 | -3 | 9 |
| 8) Lack of communication between supply chain partners | 8 | 10 | -2 | 4 |
| 9) Work quality problems | 7 | 7 | 0 | 0 |
| 10) Work method problems | 9 | 6 | 3 | 9 |
| 11) Lack of organization encouragement | 14 | 9 | 5 | 25 |
| 12) Lack of government support system | 14 | 12 | 2 | 4 |
| 13) Lack of top management commitment | 2 | 2 | 0 | 0 |
| 14) Poor quality of human resources | 13 | 12 | 1 | 1 |
| 15) Market competition and uncertainty | 15 | 11 | 4 | 16 |
| 16) Resource planning | 1 | 1 | 0 | 0 |
| 17) Activity sequences | 12 | 7 | 5 | 25 |
| 18) Cost & time in terms of supply of materials | 4 | 5 | -1 | 1 |
| 19) Machinery management | 5 | 3 | 2 | 4 |
| 20) Natural problems | 5 | 4 | 1 | 1 |

Here,

$N = 20$, $N^2 = 400$, $D^2 = 166$

$R = 1 - [6 * \Sigma D^2] / [N * (N^2 - 1)] = 0.875$

Here, Spearman's rank is 0.875 which is nearer to 1 so result is Reliable.

$\Sigma 166$

Table 6:- Spearman's Rank Correlation between Consultancy and the Contractor

| Effects of SCM in highway construction | Rank by Consultant | Rank by Contractor | Diff | Diff ² |
|--|--------------------|--------------------|------|-------------------|
| 1) Supply chain management | 10 | 12 | -2 | 4 |
| 2) Company reputation | 7 | 7 | 0 | 0 |
| 3) Working hours | 8 | 13 | -5 | 25 |
| 4) Working capital problems | 5 | 2 | 3 | 9 |
| 5) Slow payment from project owner | 13 | 8 | 5 | 25 |
| 6) Inadequate technical capabilities | 14 | 14 | 0 | 0 |
| 7) Insufficient information technology | 13 | 15 | -2 | 4 |
| 8) Lack of communication between supply chain partners | 10 | 4 | 6 | 36 |
| 9) Work quality problems | 7 | 5 | 2 | 4 |
| 10) Work method problems | 6 | 3 | 3 | 9 |
| 11) Lack of organization encouragement | 9 | 11 | 2 | 4 |
| 12) Lack of government support system | 12 | 14 | -2 | 4 |
| 13) Lack of top management commitment | 2 | 5 | -3 | 9 |
| 14) Poor quality of human resources | 12 | 16 | -4 | 16 |
| 15) Market competition and uncertainty | 11 | 10 | 1 | 1 |
| 16) Resource planning | 1 | 1 | 0 | 0 |
| 17) Activity sequences | 7 | 8 | -1 | 1 |
| 18) Cost & time in terms of supply of materials | 5 | 6 | -1 | 1 |
| 19) Machinery management | 3 | 9 | -6 | 36 |
| 20) Natural problems | 4 | 6 | -2 | 4 |

Here,

$$N = 20, N^2 = 400, D^2 = 192$$

$$R = 1 - [6 * \Sigma D^2] / [N * (N^2 - 1)] = 0.855$$

Here, Spearman's rank is 0.855 which is nearer to 1 so result is Reliable.

Σ 192

Table 7:- Spearman's Rank Correlation Client and Contractor

| Effects of SCM in highway construction | Rank by Client | Rank by Contractor | Diff | Diff ² |
|--|----------------|--------------------|------|-------------------|
| 1) Supply chain management | 6 | 12 | -6 | 36 |
| 2) Company reputation | 3 | 7 | -4 | 16 |
| 3) Working hours | 12 | 13 | -1 | 1 |
| 4) Working capital problems | 2 | 2 | 0 | 0 |
| 5) Slow payment from project owner | 12 | 8 | 4 | 16 |
| 6) Inadequate technical capabilities | 11 | 14 | -3 | 9 |
| 7) Insufficient information technology | 10 | 15 | -5 | 25 |
| 8) Lack of communication between supply chain partners | 8 | 4 | 4 | 16 |
| 9) Work quality problems | 7 | 5 | 2 | 4 |
| 10) Work method problems | 9 | 3 | 6 | 36 |
| 11) Lack of organization encouragement | 14 | 11 | 3 | 9 |
| 12) Lack of government support system | 14 | 14 | 0 | 0 |
| 13) Lack of top management commitment | 2 | 5 | -3 | 9 |
| 14) Poor quality of human resources | 13 | 16 | -3 | 9 |
| 15) Market competition and uncertainty | 15 | 10 | 5 | 25 |
| 16) Resource planning | 1 | 1 | 0 | 0 |
| 17) Activity sequences | 12 | 8 | 4 | 16 |
| 18) Cost & time in terms of supply of materials | 4 | 6 | -2 | 4 |
| 19) Machinery management | 5 | 9 | -4 | 16 |
| 20) Natural problems | 5 | 6 | -1 | 1 |

Σ 248

Here,

$$N = 20, N^2 = 400, D^2 = 248$$

$$R = 1 - [6 * \Sigma D^2] / [N * (N^2 - 1)] = 0.813$$

Here, Spearman's rank is 0.813 which is nearer to 1 so result is reliable.

IX. CONCLUSION

The highway construction supply chain network has the main contractor at the centre of the core, which has a links to client, main supply agencies (i.e. sub-contractor and suppliers), and design services. The representatives involved in the Indian construction industry have either no or limited knowledge about the SCM concept and its application in the construction industry. The paper concludes that there is a lack of cooperation in the terms of improvement in construction supply chain management.

It can also be seen in the result that spearman's rank correlation between Client and Consultancy is 0.875, Consultancy and Contractor is 0.855, Client and Contractor is 0.813. This means that there is a positive spearman's rank correlation in the views of client, consultancy and contractor which is coming about 0.84 that means correlation between them is almost same.

One of the principal conclusions of the paper is that the application of SCM in the local construction sector will require the introduction of several changes in the way that participants of the supply chain interact currently. Some of these changes are analyzed and discussed.

Based on the result of this work, it can be concluded that resource planning, working capital problems, natural problems, lack of top management commitment, work method problems, machinery management, work quality problems and company reputation are the top 8 critical factors which effects the supply chain management in highway construction projects.

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