

# Collaboration: The key to success in construction supply chain

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## Abstract

Construction Supply Chain (CSC) is one of the most important fields in developing countries such as Iran. The paper details the results of a questionnaire survey of supply chain collaboration and management in Iranian construction industry. Toward this goal, through extensive literature review and data collected via questionnaire in large supply chain firms in construction industry, this research focuses on importance of implementing the collaboration method between construction supply chain members. This study uses analysis of variance (ANOVA) test to identify the importance of collaborating in CSC. To this end, a questionnaire has been sent to 36 experts in construction supply chain. With using ANOVA test, causal relations are determined. The results indicate the formation of an important number of partnerships/collaborative agreements between contractors, suppliers and clients. It appears that construction supply chain management (SCM) in Iran is still at its infancy, however, some notification of the philosophy is evident.

**Keywords:** Construction industry, Supply chain, Collaboration, Sustainability, Effective factors, Positive results.

## 1. Introduction

The construction industry has been at the forefront of developing SCM for many years [1]. For analyzing the application of SCM to construction, it is first necessary to present the characteristics of construction in terms of SC concepts [2]. Supply chain in the construction industry includes the hierarchical structure of the client, general contractor, sub-contractor, supplier and the consumer [3], [4]. Supply chain members that do not stay together have no chance of making the additional improvements that improve efficiency of the project over the long term [5]. Due to some challenges in the construction industry, moving from traditional construction supply chain to the partnership class is essential [6]. Collaboration is a method that can facilitate achieving this goal. Supply chain collaboration and management have been applied to several industries, notably in construction industry.

Collaboration is the process that companies can share their information, resources and responsibilities to plan,

implement and evaluate activities in order to achieve a common goal. Nowadays, collaboration is one of the main features of a successful company and it also helps units to make more appropriate decisions [7], [8]. A unit, which cannot compete alone, can combine its competitive advantages with cooperation in supply chain and can provide better services in the global market [9], [10]. There are four levels of collaboration, these levels are listed as following:

A) Networking: Communication and information exchange is done for the benefit of both sides. At this level of collaboration, there is no common purpose and structure for sharing information and experiences, to organize the timing and manner of participating institutions.

B) Coordination: In addition to the exchange of information, parallel activities or variable activities are done.

C) Cooperation: At this level of interaction, not only the exchange of information occurs, but also when different companies work together to achieve the same goals, they share their resources (including financial resources, manpower, etc.)

D) Collaboration: Collaboration concept refers to the process by which others are involved in the process. Therefore, when companies collaborate with each other, they reinforce their abilities. At this level, they share information, resources and responsibilities to design, implement and monitor their activities [11].

Over the past decade, collaboration has been acknowledged in Iran as an innovative relationship of construction projects. In recent years, the application of the collaboration has not been limited to refinery construction projects. In particular, there are some projects used collaborative approach such as Joint-venture/Consortium projects. To investigate the most important effective factors for collaboration as applied in the construction industry, this research is meant to evaluate and prioritize them.

## 2. Framework for collaboration in construction supply chain

The following framework is presented through extensive literature review of collaborative procurement and employing interviews with experts and active project managers. The framework shows the methodology of the research (Figure 1).

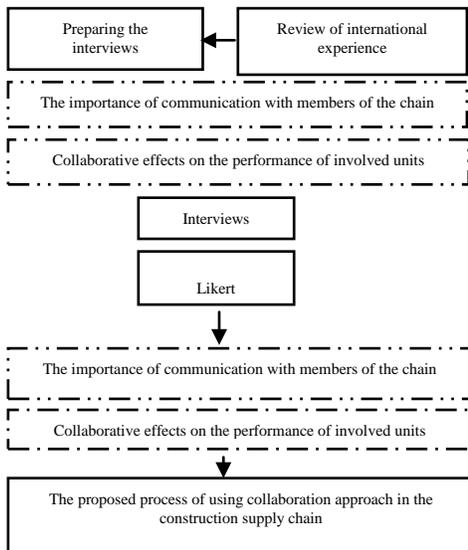


Fig 1: Framework for collaboration in construction supply chain

### 2.1 Effective factors

Table 1 provides an overview of effective factors in the papers considered in this study. The review of these papers indicated that there are some sub-factors in these areas. For instance, in managerial factor, project management capability [12], [13] is the most important factor. Some of the researchers emphasize on other subsets including measuring and selection of subcontractor [14], leadership [15], Project manager’s goal commitment [12] and top management support [16]. Trust is the most important sub-factor. Trust leads to make a commitment among members [15]. The project manager should motivate the project team to perform their duties, and convince the project team to cooperate with each other. Project manager should control schedule, cost and quality, because it might be changing during the entire process.

The second main factor is the organizational factor, which is composed of capability [15] and culture [17]. The content of information is an important factor that affects communication. Information must be managed to bring in value. The quality of information received, the timeliness

of the manner it is received and the cost-effectiveness in obtaining the information, determine the efficiency of a project partner [18].

The last main factor is financial. The majority of the contractors like to have cost benefit in the relationship with sub-contractor [16]. Therefore, subcontractors may hesitate to establish or maintain a relationship with a general contractor if the financial condition of the general contractor is questionable [13]. On the other hand, general contractors should consider ways to expedite payments to subcontractors in order to enhance relations and gain favored pricing on bids [13].

Table 1: Effective factor for collaborating in CCSC

	<i>Managerial</i>	<i>Organizational</i>	<i>Financial</i>
Ref. [4]		*	
Ref. [16]	*	*	
Ref. [14]	*	*	
Ref. [15]	*	*	
Ref. [12]	*		*
Ref. [13]	*		*

### 2.2 Positive results

Nowadays by increasing globalized and competitive economy where organizations are parts of a network, an important prerequisite of collaboration in construction supply chain appears. There is a literature review regarding the advantages that collaboration provides for the construction supply chain partners. Collaboration significantly contributes in reducing supply chain costs, time and increasing quality. Expected benefits from relationship include improvement of efficiency and cost effectiveness, increase of opportunities for innovations and the continuous improvement of quality products and services [14]. Collaboration allows the implementation of an on-site evaluation system [19]. Table 2 reflects the number of positive result that have been employed in the surveys. Collaboration results in efficiency, with an incentive to design and build the project right the first time, reducing redundancy in the document phase and lowering the risk of additional costs delays in the construction phase [14].

Table 2: Positive result of collaboration in CSC

	<i>Cost</i>	<i>Time</i>	<i>Quality</i>
Ref. [14]	*		*
Ref. [13]	*	*	*
Ref. [16]	*		*
Ref. [4]	*		
Ref. [7]	*		
Ref. [10]	*		
Ref. [15]			*

### 3. Methodology

The key factors of collaboration can be observed in many projects in Iranian construction industry. This research goes through the project management in projects, interviewing and asking them to fill the questionnaire. Studied populations are the companies involved the chain such as client, consultant and contractor working in this area. Thirty-six experts (Project Manager / Procurement Manager / Executives managers) of them have been selected randomly.

This research wants to increase awareness and knowledge of the companies with identifying the importance of collaborating and ultimately helps to improve supply chain performance in the construction industry. As in all scaling methods, such as Likert, at first we define what it is we are trying to measure. Hence, we create the set of potential scale items. These items have been rated on a 1 to 5 (Disagree/Agree) response scale. The questionnaire for ANOVA test composed of two parts. The first part was about the importance of communication with members of the chain. In this section we asked participants to rate the importance of communicating with owner, general contractor, sub-contractor, supplier and consultant. The second part was about collaborative effects on the performance of involved units. The reliability of the questionnaire is measured with Cronbach's alpha metric. In this study, Cronbach's alpha coefficient is calculated more than 0.7, so the Reliability of the questionnaire assessment is favorable.

### 4. Research findings

#### 4.1 Research hypotheses test about the relationship between construction supply chain members

To evaluate the participant's opinion on the importance of relationships with other members, two statistical hypothesis are defined (Figure 3). The test of hypothesis is used by one-way analysis of variance (ANOVA).

The second variable is the level of participant's collaboration with other members, which are divided into four groups; companies, which are in the first, second, third, and fourth level of collaboration with other members respectively (Figure 2).

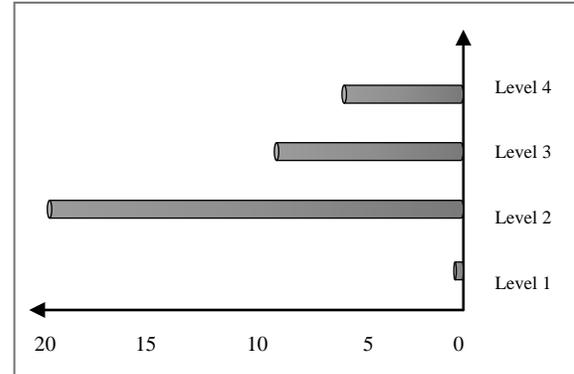


Fig. 2 The level of companies' collaboration with other member

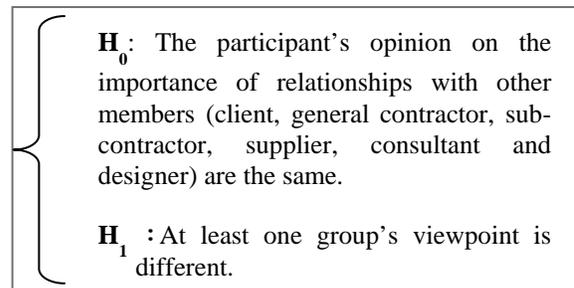


Fig3: Statistical hypotheses for the first part

#### 4.2 The output interpretation of hypotheses tests

The research approach used in this paper is an analysis of variance (ANOVA) which analyzes the current state of Iranian general contractors. In order to develop our investigation, we collected Information about collaboration in some big construction projects. The study focuses on three specific types of collaboration: communication exchange, information exchange and knowledge exchange. The communication exchange reflects the current communication that exists between project general contractors and other member in the construction supply chain.

Table 3: The output interpretation of hypotheses test about the importance of collaboration with client

The collaboration level with other members	N	Std. Dev.	Min	Max
2	15	0.883	3.0	5.00
3	5	0.447	4.0	5.00
4	2	0.00	4.0	4.00
Total	22	0.789	3.0	5.00

Respondents were asked to provide comments on the importance of supply chain collaboration between client and other members. Most of respondents completed this section of the questionnaire and agreed with the negligible rule of client in achieving the best quality of the project (Table 3). In all companies that participated in our research, integrated projects are uniquely recognized by collaboration among the owner and other members in CSC.

Table 4: The output interpretation of hypotheses test about the importance of collaboration with General contractor

The collaboration level with other members	N	Std. Dev.	Min	Max
2	5	0.447	3.00	4.00
3	3	0.577	4.00	5.00
4	2	0.000	4.00	4.00
Total	10	0.471	3.00	5.00

As all the participants mentioned in the interviewing, general contractor is able to manage the project based on clear understanding of project and fast communications. Therefore, they can solve problems in a respectful and timely manner. The results of this section also shows that general contractor has important responsibilities dealing with time, cost and quality (Table 4). Due to these crucial roles in the chain, other members should share the information and collaborate with general contractor, which would be suitable for them to establish their goals.

Table 5: The output interpretation of hypotheses test about the importance of collaboration with sub-contractor

The collaboration level with other members	N	Std. Dev.	Min	Max
2	7	0.975	2.00	5.00
3	4	1.29	2.00	5.00
4	-	-	-	-
Total	11	1.03	2.00	5.00

In an integrated project, all supply chain members especially subcontractors understand the value of collaboration and are committed to work as a team in the best interests of the project. In consequence, all participants or team members benefit from collaboration. Most of respondents agreed with the importance of collaboration with sub-contractor (Table 5). Because the integrated process requires early involvement by more members, they could decide based on the value added to achieving project goals. These kinds of projects use innovative business models to support collaboration and efficiency.

Table 6: The output interpretation of hypotheses test about the importance of collaboration with supplier

The collaboration level with other members	N	Std. Dev.	Min	Max
2	7	0.487	4.00	5.00
3	2	0.707	4.00	5.00
4	-	-	-	-
Total	8	0.500	4.00	5.00

General contractor shall conduct reviews in collaboration with the supplier, to determine that the methods and vehicles will result in construction that are sufficiently complete, accurate and coordinated to reduce the risk of disruption. All the participants mentioned the important rule of supplier in achieving the goal (Table 6).

Table 7: The output interpretation of hypotheses test about the importance of collaboration with consultant and designer

The collaboration level with other members	N	Std. Dev.	Min	Max
2	5	0.547	4.00	5.00
3	2	0.000	4.00	4.00
4	-	-	-	-
Total	7	0.487	4.00	5.00

Table 7 proposed the results of one-way analysis of variance (ANOVA) on research hypotheses test about the relationship between designer and other construction supply chain members. Considering that a meaningful amount for each hypothesis is more than 0.01, we conclude that in meaningful level of 0.01,  $H_0$  hypothesis will be accepted. As the results show, full collaboration through information sharing early in the project process is most likely to achieve the success in the project.

#### 4.3 Research hypotheses test about the importance of using collaboration in construction supply chain

In this part, the second variable is the companies' activities; (1) General contracting, (2) consulting, (3) contracting and consulting (Figure 4). The final section of the questionnaire looks at supply chain collaboration and management using a Likert scale. Two statistical hypothesis are defined in Figure 5. Considering that a meaningful amount for this hypothesis is more than 0.01, we conclude that in meaningful level of 0.01,  $H_0$  hypothesis will be accepted.

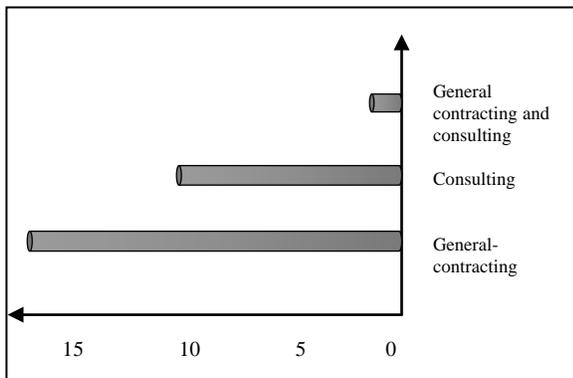


Fig 4: The companies' activities

$H_0$ : The participant's opinion on the importance of using collaboration in construction supply chain are the same.

$H_1$ : At least one group's viewpoint is different.

Fig 5: Statistical hypotheses for the second part

In this study, there is a common opinion that collaboration has positive effects on project performance (Table 8). Collaborative spirit among project members have been found to reduce costs. Furthermore, construction projects with emphasis on collaboration rather than price and authority are more likely to eliminate time overruns [20]. Collaboration among project actors has also been found to improve quality by replacing the more traditional adversarial relationship with an atmosphere that fosters teamwork to achieve joint objectives [21].

Table 8: The output interpretation of hypotheses test about the importance of using collaboration

The companies' activities	N	Std. Dev.	Min	Max
General-contracting	21	0.740	3.00	5.00
Consulting	13	0.630	3.00	5.00
General contracting and consulting	2	0.000	5.00	5.00
Total	36	0.687	3.00	5.00

## 4. Conclusions

Collaboration between project partners from the first idea of the project is fundamental for sustainability and any global optimization of a construction project. Without an efficient collaboration process, each partner is limited to optimize only in his own field of responsibility. Through extensive literature review, questionnaire in large contractor firms in construction industry, presented conceptual framework for assessing applicability of collaboration in the region.

The results of ANOVA test, shows that if collaborating and information sharing are improved, then the following activities will be facilitated. Combining these results, the evaluating of ANOVA test prove that all members of project impact on collaboration in Iran's construction supply chain. Since collaboration is affected by the level of management, so the first step for achieving this goal is managerial substructure reformation. This aim would be possible through the promotion and strengthening management commitment to the goals. The second step is structural change. This change is the result of the recognition of collaboration. Changes in concepts require moving forward to more collaborative approach. Structural changes involve changes in culture of cooperation within the organization and the correct definition of the responsibilities in the organization chart. The result of this study improves our knowledge about the importance of using collaboration in CSC. The challenges that the construction industry has been faced in recent years has led experts to use the collaboration network as an innovative approach for CSC. The main goal of the modern construction supply chain can be attributed to coordinate and integrate all logistics activities.

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