

Supply Chain Management In Construction; Revealed

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Abstract: The construction supply chain plays a major role in the construction market competition. Construction supply chain management assists enterprises by helping to improve competitiveness, increase profits and have more control over the different factors and variables within the project. This paper discusses the construction supply chain characteristics, challenges and problems supply chains encounter and the benefits of an integrated supply chain in the construction sector.

Index Terms: Construction supply chain, construction supply chain characteristics, integration, project management, project performance.

1 INTRODUCTION

THE construction sector is one of the oldest industries in the world and is recognised for being traditional and under-developed in many areas such as information technology, innovation and supply chain management (SCM) (Kelly et al, 2002). According to Bank Audi (2015), the Jordanian construction industry represents 5% of the Gross Domestic Product (GDP). Rifai and Amoudi (2015) stated that the construction industry in Jordan is divided into two categories: a) large companies which are companies that tender for and/or undertake multimillion dollar projects and b) small and medium companies, usually family owned and directed by the owner. In contrast to other industries, construction was slow and hesitant in understanding the theory, and significance, of SCM. (Love et al, 2004). According to Khalfan and Mcdermott (2007), Egan and Latham's government supported reports regarding movement for innovation (M4I) have played a major role in leading the need for change and to promote innovation in the construction industry. Egan's report focused on the role of innovation as the only way for companies to achieve profitability, continuous service and improvement. In contrast, Latham's report in 1994, pointed out the importance of the different relationships, and the effect of information sharing and communication channels on the whole supply chain (Briscoe and Dainty, 2005). The establishment and implementation of contracts orientated towards SCM has increased the construction industry's adoption of SCM practices. These include documents supporting the formation of integrated teams and cooperative working in order to eliminate waste and deliver projects. JCT Constructing Excellence and NEC are examples of contracts with documents to support SCM (King, 2011).

2 SCM: THE ROLE IN CONSTRUCTION

Introduced in the manufacturing industry SCM is a vital tool in controlling business processes in a defined and systematic way to improve quality, save time and increase profit (Wisner et.al, 2011). On the other hand, SCM processes in the construction industry are partially adapted and dispersed.

According to their research findings Akintoye et. Al. (2000) claimed that the relationship amongst clients, suppliers and contractors is mainly about purchasing and production planning. This reflects that SCM in the UK construction sector is partially adopted. Vrijhoef and Koskela (2000) contributed that SCM roles in construction are vital and important. They claimed that, within construction, there are four major roles of SCM. These roles can be identified based on the industry concerns, whether it is the entire supply chain, the construction site or both as displayed in Figure 1.

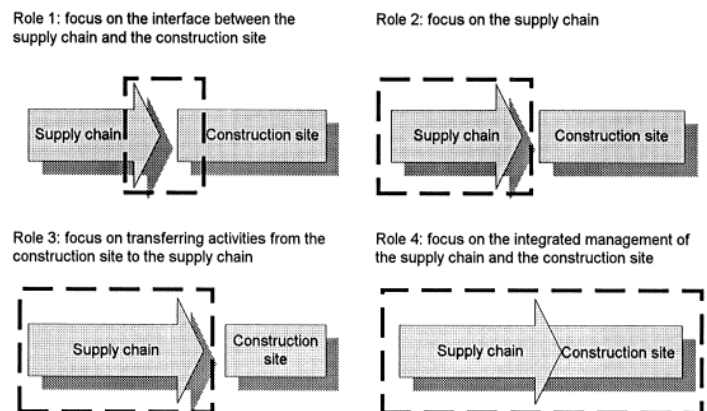


Fig. 1. Supply chain management role in construction (Vrijhoef and Koskela, 2000)

3 CONSTRUCTION SUPPLY CHAIN CHARACTERISTICS

Construction supply chains (CSC) can be very complex particularly in large projects. This complexity, one of the main characteristics, can be attributed to the variety of site materials and parties (suppliers and sub-contractors) required for a construction project. The project can become more complex as more people get involved. i.e. first tier, second tier suppliers and other tiers of sub-contractors etc. Moreover, there is a correlation between the increase of the scope of the project and the complexity of the supply chain as more manpower, parties and materials are necessary for the completion of the project. This requires a great deal of planning, organising and collaboration between supply chain partners which may cause the complexity. A large construction company may interact with hundreds or thousands of suppliers and sub-contractors per a year in order to deliver a project. For example, in 1999 the Wates Construction Company paid more than 3000 suppliers and sub-contractors that were involved in projects they delivered (Scott et al, 2001). Vrijhoef (1998) carried out

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research on residential building and contributed that CSCs are normally converging, make to order, fragmented and temporary, as described below:

1. **Converging supply chain.** Normally in construction projects, operation capacity, documents, materials and so on, are to be assembled and delivered to site by subcontractors and suppliers under supervision of the main contractor. Usually, the end user is one or a limited number of people. As a consequence, the CSC is converging in nature unlike the manufacturing supply chain, which is most likely to be diverging.
2. **Make to order supply chain.** Clients drive the creation of construction projects. This can be the result of the end user's tradition to take the initiative and start a construction project. Therefore, end user becomes involved in the whole production process.
3. **Fragmented supply chain.** This characteristic is the main feature within this industry. Construction contractors, suppliers and other participants are active in different stages, and the distribution of responsibility and authority changes during the project.
4. **Temporary supply chain.** For any construction project, on completion, all participants and companies involved are normally dismissed and this can be traced to the project based nature of construction. Consequently, all participants in the project must finish their roles and duties. This short-term partnership with different members may cause problems and fluctuations in performance and productivity.

On the other hand, Muya et al. (1999) pointed out other CSC features as follows:

1. **The primary supply chain.** This delivers the materials that are incorporated in the final stage of the construction process, such as: sub-assemblies, components, raw materials and electrical and mechanical equipment.
2. **The support chain.** This chain is responsible for providing expertise and equipment that smooth and facilitate the construction process such as: scaffolding and excavation supports.
3. **The human resource supply chain.** This is responsible for the supply of supervisory staff and labour as inputs to the construction process.

Given the uniqueness of the construction industry characteristics this differentiates the CSC from other industries, such as manufacturing. To sum up, the CSC consists of the human resource supply chain, the support chain and the primary chain, and is characterised as temporary, make to order, complex and converging supply chains. Below are further discussions regarding the complexity of supply chains and the problems associated during the construction process.

4 CONSTRUCTION SUPPLY CHAINS AND CONSTRUCTION INDUSTRY PROBLEMS

The construction industry and its supply chain suffer from many problems that affect it in a negative way. According to Yeo and Ning (2002) problems affecting the construction industry include: budget overruns, delays, low profit margin and many legal claims and counter claims. Vrijhoef and Koskela (2000) stated that "waste and problems are largely caused by myopic control of the construction supply chain".

The CSC characteristics may antagonize the application of SCM to construction through reinforcement of the problems. Therefore, further research and analysis of construction SCM should be undertaken. Construction industry problems can also be seen in Cox, Ireland and Townsend (2006) work from a demand and supply perspective. They stated that problems in the construction industry resulted from supply, demand, and common issues. Demand issues contain inappropriate selection criteria, discontinuous and low demand problems, inappropriate allocation of risk and frequent changes in specification.

1. **Inappropriate selection criteria.** This problem refers to the practice of awarding a contract in the construction industry to the contractor that offered the lowest price, disregarding the value of the offer. As a consequence, the awarded contractor may provide lower quality and service which may lead to problems such as: less trust, resistance to design changes and claims for additional fees.
2. **Discontinuous and low demand problems.** The economic recession and the difficult financial situation leads to a decline in public investment, which results in such problems occurring.
3. **Inappropriate allocation of risk.** This refers to the imbalanced risk distribution in the project between the main contractor and the client.
4. **Frequent changes in specification.** This problem is due to the client and occurs while the project is underway. This causes serious implications regarding the plan, cost and other factors.

Supply issues contain poor public image, inefficient methods of construction and poor quality.

1. **Poor public image.** The construction industry failed to retain and attract highly qualified and experienced individuals. In addition, certain conditions are attributed to the industry such as: unhealthy, dangerous, uncertain and low job security.
2. **Inefficient method of construction.** This problem is common in the house-building sector. The optimal solution to overcome this problem is by making an integration process of the design with the construction method to maintain project buildability.
3. **Poor quality.** Latham (1994) stated that poor quality stems from both the lack and simplicity of rules to enter the construction industry. This allowed new and inexperienced companies to enter the industry, destroy its reputation and affect the quality of the whole industry.

On the other hand, the common issues contain fragmented industry structure, adversarial culture, inadequate investment and poor management.

1. **Fragmented industry structure.** Fragmentation here refers to the size and number of construction companies, diversity of trends and professionals, contractors intend to use subcontractors but sub-contractors are using other sub-contractors to carry out the work. Some of the sub-contractors are not trained or have sufficient experience to meet the job specifications, which, may lead to a fragmented industry structure.
2. **Adversarial culture.** This problem has been recognized for years and may lead to some negative influences on the client and the contractor. Moreover, this problem may lead to failure regarding adoption of the new procurement

process.

3. **The inadequate investment in training.** There is a clear lack of research and development in the construction industry, which may affect the quality.
4. **Poor management.** This may occur at site level or company level and may lead to low performance levels.

5 SUPPLY CHAIN MANAGEMENT BENEFITS IN CONSTRUCTION

Modern-day approaches to methods involving the procurement process are the movement towards an integrated supply chain. This method enables parties within the supply chain to have goal congruence, through alignment of objectives, which in turn provides the client with added value. Traditionally, the relationship between companies and the client was by means of contracts only, with predetermined prices and predefined specifications. Clients were not heavily involved, contractors were not motivated to work in the interest of the client and often had one contract with the client and a separate contract with designers. The movement towards an integrated supply chain enables provision of SCM to be wholly incorporated. Benefits of integrated supply chains for companies are as follows:

1. Cost reduction and waste reduction
2. Risk reduction, with a more certain final project cost
3. Value for client
4. Enables long-term planning
5. Ongoing business or repeat business (with client)

Ultimately, clients and end users gain by being party to an industry which facilitates users' needs. Projects are completed in a timely manner to cost and defects are minimized, resulting in customer satisfaction and indeed a greater confidence in the construction industry. Moreover, Erikson (2010) contributed that integrated supply chain in construction offers more control and aids in cost reduction.

6 SUPPLY CHAIN MANAGEMENT INTEGRATION

According to Hall (2001), improving communication and in particular integration through the supply chain is necessary in order to progress and develop the construction industry. To facilitate the improvements several issues need to be addressed. Firstly, a shift from the selection of contractors based on lowest bid to selection based on best value. Secondly, a shift from contractor/client orientated relationship to involve all supply chain partners and thirdly, a shift from a disbanded project team on completion of a project to a continuation of the supply chain relationships in new projects. Various research regarding the willingness of the construction industry to adopt the philosophies of integration has been conducted (Khalfan et al., 2001, Khalfan et al., 2002). Interviews with many SME's were also conducted by Briscoe et al. (2004), in order to assess the appropriateness of their skills, attitudes and current knowledge to achieve improved supply chain integration.

6.1 Integration barriers and drivers

Tan (2010) identified five key components when moving towards a more fully integrated supply chain:

1. Transformation in corporate culture
2. Communication and trust between all relevant parties
3. Sharing of knowledge/information
4. Incorporation of supplier evaluation in the development

process

5. Sharing common objective regarding both increased efficiency and waste elimination

It is vital to remove the deep-seated barriers of traditional relationships within the construction industry and replace it by introducing a 'change management framework', at operational level, in order to implement supply chain management. The barriers relating to integration are attributed to an adversarial contractual relationship, lack of trust and fragmented project deliver. Dainty et al. (2001b) proposes solutions to this deficiency within the supply chain, namely: a) the formal integration of subcontractors and suppliers regarding reporting and communication with the organisational structure of the project, b) the development of soft skills and communication skills of the project staff Akintoye et al. (2000), also identified integration barriers including: workplace culture, unsuitable support structure, uncommitted senior managers, trust issues and unfamiliar regarding the concept of SCM and its implications. According to Barratt (2004), barriers include extensive use of IT for the implementation of integration and collaboration issues i.e. with who should we collaborate within the supply chain.

6.2 Integration benefits

Supply chain integration aids to the efficiency and stream-lines the objectives of all parties involved, helping to achieve goal congruence, productivity and the minimisation of waste (Maqsood and Akintoye, 2002). To implement supply chain integration, the following are required according to Swan et al., (2001): a shift from the traditional contractual framework, the integration of organisational processes regarding all participants together with long term commitment and trust. Hall (2001) is confident that integration would benefit the client regarding the overall delivery of the final project but moreover, increased profit margins, decreased aggravation and stress, development of both no-blame culture and of mutual understanding and the attainment of enhanced reputations for the contractor.

6.3 Integration culture requirements

Barratt (2004) suggests a 'collaborative culture' for the integration and collaboration of the supply chain within the construction industry which consists of the following elements:

1. Internal and external trust
2. Mutual benefits
3. Exchange of information within the supply chain
4. Quality of information and transparency of information
5. Good understanding and communication between all parties
6. Goal congruence
7. Corporate emphasis/attention on SCM

Dainty et al. (2005) proposes required changes for supply chain integration as follows: early involvement of all parties, education of project staff, fair payment, have knowledge of the benefits of integration, and be familiar with and have an understanding of new contractual documents.

6.4 Effective integration

Vrijhoef (2011) believed that should all parties within the supply chain be targeted, including the main contractor, subcontractor and suppliers, often referred to as 'downstream

strategic alliances' (DSA's), overall costs of construction would reduce. They also conclude subcontractor and supplier early involvement is as necessary as early contractor involvement. This early involvement of all parties would allow the exchange of expertise which may help to reduce costs. Furthermore, early involvement integration would enable suppliers to be service providers as oppose to providers of products. To summarise, Supply chain integration aids to the efficiency and stream-lines the objectives of all parties involved helping to achieve goal congruence, productivity and the minimisation of waste. To implement supply chain integration, a shift from the traditional contractual framework, the integration of organisational processes regarding all participants together with long term commitment and trust. The integration process of SCM would benefit the client regarding the overall delivery of the final project but moreover, increased profit margins, decreased aggravation and stress, development of both a no-blame culture, mutual understanding and the attainment of enhanced reputations for the contractor.

7 CONCLUSION

SCM provides the construction industry with opportunities to have more control on projects, increase profits, and reduce time, cost and waste. The CSC consists of many groups, although the material and the construction chains are the largest. Integrating the construction and material chains helps in establishing more collaboration, smoother information flow and more efficient information sharing through the construction chain which assists the decision making process. SCM in the construction industry encounters many challenges linked to poor logistics planning, lack of partnerships and strategic alliances with suppliers, resistance to change and communication problems. In order to establish an efficient integrated supply chain, clients, suppliers, contractors and other parties in the supply chain need to establish long term partnerships, form transparent communication channels and benefit from each other's experience for the greater good. The Jordanian industry should make corrective actions to allow the efficient supply chain integration to take place such as: early involvement of all parties, education of project staff, fair payment, have knowledge of the benefits of integration, be familiar with and have an understanding of new contractual documents. Should all parties within the supply chain be targeted, including the main contractor, subcontractor and suppliers, overall costs of construction would reduce. In addition, early involvement of the subcontractor and supplier is as necessary as early contractor involvement. This early involvement of all parties would allow the exchange of expertise which may help to reduce costs furthermore, early involvement integration would enable suppliers to be service providers as oppose to providers of products

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