# Construction Supply Chain Management Implementation in Libyan Construction Industry

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# ABSTRACT

Researchers in construction management field have recently highlighted the importance of adopting the philosophy of supply chain management SCM in construction industry sector.

The main driver behind considering this philosophy in construction sector was its remarkable successes within other industry sectors such as manufacture industry sector, wherein it was originally appeared. A construction project supply chain CSCM can be introduced as a systematic network includes material suppliers, manufacturing process, contractors and clients. These parties linking together through a flows of materials, data and cash. Therefore, the quality of communication, collaboration and sharing information between contractor companies, their suppliers and clients, determine the degree of achievement of within supply chain process.

This research study presents understanding and analyzing of supply chain management SCM in Libyan construction industry LCI with emphasizing on the importance of relationship among construction supply chain parties including suppliers, contractors and clients along with the effects of SCM implementation on construction performance as well as the significant barriers to CSCM integration in LCI. In this study, the relationship between Libyan construction companies and their supply chain parties (suppliers, contractors and clients) has been investigated by analyzing the importance of the most influential factors affecting the success in supply chain relationship. In addition, Well-known performance indicators were

examined related to adversarial relationships, adding value and developing reliability and information sharing within construction projects. This study intended to propose a conceptual framework for the implementation of SCM in LCI, for this purpose a questionnaire survey has been designed and distributed among Libyan construction companies randomly selected. A total of 62 responses have been collected for data analysis.

Research results reveal that the trust, quality of materials provided and free flow of information among CSCM members impose considerable positive effects on successful relationship between supply chain parties. In addition, the long term and stable relationships are among the most significant factors to improve supply chain process, also inventory and storage considered to be critical functions affecting the efficiency of supply chain organization. Moreover, regarding to adopting SCM in construction performance the results indicates time predictability, effectiveness of communication systems and top management commitment are the most significant factors affecting CSCM performance. However, poor understanding of SCM concept is evaluated among the most significant barriers to integrate SCM conception in LCI.

**Keywords**: Supply chain management, Construction supply chain management, Libya Construction Industry, Framework Model.

# ÖZ

Yapım yönetimi alanındaki araştırmacılar, son zamanlarda inşaat sektöründe tedarik zinciri yönetimi (TZY) felsefesinin benimsenmesinin önemini vurgulamaktadırlar.

Bu felsefeyi inşaat sektöründe değerlendiren başlıca etken, başlangıçta ortaya çıktığı imalat sanayii sektörü gibi diğer sanayi sektörlerinde de göze çarpan başarıydı.Bir inşaat projesi tedarik zinciri yönetimi (İTZY), malzeme tedarikçileri, üretim süreci, müteahhitler ve müşterileri içeren sistematik bir ağ olarak tanıtılır.Bu taraflar, bir dizi materyal, veri ve nakit yoluyla birbirine bağlıdır.Bu nedenle, yüklenici firmalar, tedarikçileri ve müşterileri arasındaki iletişim kalitesi, işbirliği ve paylaşım bilgileri tedarik zinciri sürecindeki başarı derecesini belirler.

Bu araştırma, tedarikçi firmalar, yükleniciler ve müşteriler de dahil olmak üzere Libya inşaat sektöründe (LİS) inşaat tedarik zinciri tarafları arasındaki ilişkinin önemini vurgulayan TZY'nin anlaşılması ve analiz edilmesini,TZY uygulamasının inşaat performansı üzerindeki etkilerini ve İTZY entegrasyonunun önündeki en büyük engelleri anlatır.Bu çalışmada, tedarik zinciri ilişkisinde başarıyı etkileyen en etkili faktörlerin önemi analiz edilerek, Libya inşaat firmaları ile tedarik zinciri tarafları (tedarikçiler, müteahhitler ve müşteriler) arasındaki ilişki araştırılmıştır.Buna ek olarak, inşaat projelerinde karşılıklı ilişkiler, değer katma ve güvenilirlik geliştirme ve bilgi paylaşımı ile ilgili olarak iyi bilinen performans göstergeleriincelenmiştir.Bu çalışma, LİS'nde TZY'nin uygulanması için kavramsal bir çerçeve önerme amacındadır.Bu amaçla, rasgele seçilen Libya inşaat firmaları

arasında bir anket hazırlanmış ve dağıtılmıştır.Veri analizi için toplam 62 yanıt toplanmıştır.

Araştırma sonuçları, güven, sağlanan malzemelerin kalitesi ve İTZY üyeleri arasındaki serbest bilgi akışının tedarik zinciri tarafları arasındaki başarılı ilişkiye önemli derecede olumlu etkileri olduğunu ortaya koymaktadır.Buna ek olarak, uzun vadeli ve istikrarlı ilişkiler tedarik zinciri sürecini iyileştiren en önemli etkenler arasındadır. Ayrıca stok ve depolama, tedarik zinciri organizasyonunun verimliliğini etkileyen kritik işlevler olarak düşünülmektedir.Dahası, inşaat performansında TZY'ni benimsemekle birlikte, sonuçlar zaman öngörülebilirliğini, iletişim sistemlerinin etkinliğini ve üst yönetim taahhütünün İTZY performansını etkileyen en önemli faktörler olduğunugöstermektedir.Bununla birlikte, TZY konseptinin yetersiz bir şekilde anlaşılması, TZY kavramını LİS'ne entegre etmede en önemli engel olarak değerlendirilmektedir.

**Anahtar kelimeler**: Tedarik Zinciri Yönetimi, İnşaat Tedarik Zinciri Yönetimi, Libya İnşaat Sektörü, Çerçeve Model.

# DEDICATION

**This thesis is dedicated to my beloved family**

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| | |
|---|---|
| BIM | Building Information Modeling |
| CLM | Council of Logistics Management |
| CSC | Construction Supply Chain |
| CSCM | Construction Supply Chain Management |
| JIT | Just-In-Time |
| LCI | Libyan Construction Industry |
| LCP | Libyan Construction Project |
| RII | Reliability Importance Index |
| SC | Supply Chain |
| SCM | Supply Chain Management |
| SD | Standard Deviation |
| SPSS | Statistical Package for Social Science |
| TQM | Total Quality Management |

# Chapter 1

# INTRODUCTION

## 1.1 Background

Construction industry sector has always a robust influence on the thorough economy of each country, it is a large and universal activity with several special characteristics when it is compared with other economic activities. Therefore, in order to get better performance as well as to improve productivity in construction sector, several studies have been conducted recently to underline the importance of adopting efficiently integrative of supply chain management SCM within construction sector. (Butkovic et al, 2016).

Supply chain as a concept is usually considered to be related to the production process into industry sector. Various definitions have been given to supply chain management, most of them have described as a chain connecting each element of manufacturing with supply process launching from materials to products and ending to the ultimate clients. A straightforward definition has been specified to supply chain by (Christopher, 1992), he described as "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".

The concept of supply chain management has been originally generated in manufacturing industry sector aiming to improve the efficiency and productivity, and hence resulting in utmost usefulness (Harland, C. M.1996). Regarding to construction sector, the employment of supply chain management philosophy has been comparatively slow, however, the need of adopting such as this philosophy has been also emerged to improve projects' performance and their profitability as well as to eliminate the fragmentation and cost overrun within construction process. (Agapiou et.al., 1998).

Many researchers have emphasized on quality of relationship and communication among supply chain parties including suppliers, contractors and client which is practically considered as the main factor in improving information sharing, reliability and trust within supply chain process resulting in development of whole construction performance. (Martella, B., 2000).

The integration of SCM philosophy in construction industry sector have efficacious effects on the construction performance regarding to an efficient inventory, organized purchasing processes, increased flexibility and decreased transaction costs. In addition, it treats both the operations and the maintenance emphasizing on increasing the probability of adding value whereas decreasing the overall project cost (Horvath, L., 2001).

## 1.2 Problem Statement

The success in construction projects can be evaluated by specific parameters which are quality, cost and time of accomplishing a project. In order to achieve such

parameters within construction process, it is essentially to integrate a quality management of its supply chain.

Although construction industry has witnessed remarkable improvement in Libya specially in last the decades, both public and private construction companies are still suffering from inefficient performance of involving construction parties, poor relations between project stakeholders, fragmentation in construction execution and lack of managerial financial and technical strategies. (Tumi et al. (2009). These problems can lead eventually in delays of project delivery and project time and cost overruns. The new demands for rapid social, economic, political and technological changes will further strain the fragile industry. To meet current and future needs and challenges, new policies, changes and restructuring of the building industry are required. (Ngab (2007).

The quality of relationship and communication between suppliers, contractors and client considered to be the most important key for developing a successful supply chain within construction projects. In developing country like Libya, construction companies spending additional money and time because of the overlapping between suppliers' activities and contractor duties. Huge budget is imposed on construction firms due to lack of coordination and cooperation among supply chain parties, resulting in maximizing the project cost, delay in the project delivery and failure to achieve the project objectives.

The fragmentation or discontinuities within CSC processes can lead to frequent poor project performance regarding to cost, time and quality of the project, which

resulting in reducing the project value, reliability and trust among the supply chain parties.

Consequently, there is an essential requirement for more studies and researches about the implementation of supply chain management in LCI and exploring more solutions to reduce the adversarial relationship within supply chain parties and developing the SCM philosophy in LCI to achieve a healthy projects delivery.

## 1.3 Research Scope and Objectives

The aim of this research study is to analyze the most important factors affecting the integration of SCM in LCI and also to develop a conceptual framework for implementing the concepts and principles of SCM in LCI sector. In order to fulfill this aim, the following objectives were assigned:

1. To analyze the most important factors affecting the relationship among SCM parties within LCI.
2. To analyze and evaluate the critical factors regarding to SCM dependence on organizational relationships
3. To analyze and evaluate the most important barriers to CSCM integration in LCI.
4. To evaluate the functions affecting the efficiency within supply chain organization.
5. To evaluate the importance of CSCM as a tool to enhance the project performance.
6. To propose a conceptual framework for the implementation of SCM in LCI.

## 1.4 Research Methodology

In order to achieve the mentioned objectives, the following steps were taken in the research procedure:

1) The Literature review: An extensive review of the literature and academic publications was carried out to epitomize the basic concept of SCM and its applications in construction industry sector. This review covered a brief discussion on construction projects and the common issues regarding to its supply chain, the principle conception of SCM and an overview on the implementation of SCM in construction industry sector. Findings from literature preview were used to facilitate designing a conceptual framework for the implementation of SCM in LCI.
2) The questionnaire survey: the questionnaire survey was conducted to collect the data regarding to the most important factors affecting the relationship among SCM parties as well as the functions affecting the efficiency and collaboration within CSCM.
3) The research hypothesis: the hypothesis in this research was set as the last part of the questionnaire survey. These hypothesis was designed to evaluate the effect of SCM on the project performance. Well-known performance indicators were examined related to adversarial relationships, adding value, developing reliability and information sharing within construction projects. The main target from questionnaire survey and research hypothesis is to assist in defining the bold outlines of the conceptual framework for integration of SCM in LCI.

4) The data analysis methods: questionnaire survey was analyzed by utilizing (Statistical Package for Social Science SPSS), in addition, in order to increase the reliability of analyzed results the following tools or tests were used:

- Factor Loading.
- Reliability (Coefficient Alpha Cronbach) (α).
- Relative Importance Index (RII).

## 1.5 Thesis Structure

The presented thesis consists from five chapters. Chapter one introduces a general background about this research study and its main aims and objectives, as well as the methods and approaches used in this study. Chapter two provides a detailed review on the previous literatures regarding to SCM and its applications in construction industry. This review includes general discussion about construction industry issues, the concept of SC, definition and originality of SCM and finally, the implementation of CSCM and its roles, barriers and benefits within construction projects. Chapter three presents description of the research methodology and the data analysis approaches that were applied to obtain the results of this study. Chapter four provides the discussion of the results obtained from the questionnaire survey as well as it introduces the suggested conceptual framework for integration of SCM in LCI. Chapter five gives the conclusion obtained from this study along with some recommendations for future researches regarding to SCM and its implementation in Libyan construction project.

# Chapter 2

# LITERATURE REVIEW

## 2.1 Introduction

Supply Chain Management (SCM) gradually on the increase in all industries as competition increases globally. The concept of supply chain management (SCM) keeps evolving and developing, even as the core value of all firms is centered around customer satisfaction, managers have gradually agreed that their firm is a body among many other on the chain (Soni and Kodali, 2011). The Institute of Management Accountants (1999) has described the rise of the SCM as the future and not just a wave and that as we approach the 21st century, it is becoming clear that SCM is a Tsunami that will whelm everything in its path. Based on this statement, it can be said that making SCM better is the major priority of the corporate world. The supply chain network is of immense importance as its need is of uttermost priority to any Organization. Understanding the concept of SCM is most important and the primary phase to understanding the needs and the gaps of SCM in today's field.

Practically, supply chain can be introduced as a system which includes material suppliers, product distributors, manufacturing process and the end user, these parties linked with each other by means of a flow of materials and a flow of data. The liquidity may be involved in this system as well. Indeed, supply chain is a process involving all activities which are related to providing raw material until delivering the ultimate output. Ali (2014).

This chapter is providing a comprehensive review in a manner that will cover previous research works and literatures publication on construction industrial sector, conception of supply chain (SC), supply chain management (SCM), and finally, an extensive explanation on supply chain management in construction industry (CSCM) and its implementation in this sector.

The literature review which is utilized as a part of this study covers in order the following:

- Construction industrial sector.
- The concept of supply chain (SC).
- supply chain management (SCM).
- Supply chain management in construction industry (CSCM).

## 2.2 Construction Industry Sector

It must be admitted that construction industry is an engine of national economy in each country. In principle, construction projects are different from other industries in that, unlike manufacturing and production activities which at the end will provide standard and similar outputs, construction projects is described as unique activity which has its own characteristics and these characteristics can be varied depending on many factors such as its size, design, location, and economic environments. The different features of construction activities determine how the onsite job will be organizing and how the resources to be allocating (Gray, 1996). Consequently, various projects will have different requirements.

Construction projects have diverse activities which aiming to various functions, from residential projects to facilities projects such as hospitals and schools, in addition, it

includes highways, airports, dams etc. Basically it is proving the most essential portion of funding investment regarding to governments' business, inhabitants and other industry sector. However, by considering it as one-of-kind with various levels of aggregation, construction sector can be characterized as complicated and sometimes underperforming sector. Predominantly, such a projects encounter some obstacles such as scheduling slips, cost overrunning, quality adjusted, so that the criticisms and claims to control such problem has been widely discussed. (Yeo and Ning, 2006). It is acknowledgeable that construction industries often suffering from preference problems which are results from the natural characteristics of this sector such as the highly degree of fragmentation, minimally levels of productivity with immobility, as well as budget and time overrunning, resulting with conflicts and disagreement, time consuming, variation and perversion of quality. (Bane et al., 2008). It is claimed that the incompetent process of project delivering in construction sector is the reason behind its highly fragmented compared with other indusial section.

Consequently, in order to have an integrative approach which can remove this ineffectiveness and overcome such problems, applying supply chain management (SCM) in construction sector has become an essential requirement.

## 2.3 Concept of Supply Chain (SC)

The supply chain (SC) is portion of a selective and expanding hybridized field. It has received an attention since the mid of 1980s and it has been originated mainly from two independent management flows of distribution and production, that are at the end integrated within logistics field (Coyle et al., 1996). Although there are various definitions and canalizations that have been given to supply chain conception, the

confusion regarding its interpretations still considering area of debate among the researchers' community. (New, 1997). Many authors have defined supply chain from different perspectives, some of these definitions are shown in Table 1 below.

Table 1: Supply chain definitions (Hatmoko, 2008).

| Authors' Name | Supply Chain Definitions |
|---|---|
| (Stevens 1986) | "a connected series of activities which is concerned with planning, coordinating and controlling material, parts and finished goods from suppliers to the customer" |
| (Lee and Billington, 1992) | "a network of facilities that procure raw materials, transform them into intermediate goods and then final products, and deliver the products to customers through a distribution system" |
| (La Londe and Masters, 1994) | "a set of companies that pass materials forward" |
| (Towill, 1996) | "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" |
| (Holmberg, 1997) | "A set of organizations performing activities with the purpose of satisfying the ultimate consumer" |
| (Handfeld and Nichols, 1999) | "all activities related to the flow and transformation of products from the raw material through the end customer" |
| (Mentzer et al., 2001) | " a set of three or more companies directly linked by one or more of the upstream and downstream flows of products, services, finances and information from a source to a customer" |
| (Tommelein et al., 2003) | "a group of companies and individuals working collaboration in a network of interrelated processes" |

The general idea that can be concluded from the previous table is that supply chain is an organized network of firms which includes different stages as procurement, operation and distribution linked with each other through a flow to provide raw materials, services, or the required information from its source to the hand of the end user. Figure 1.

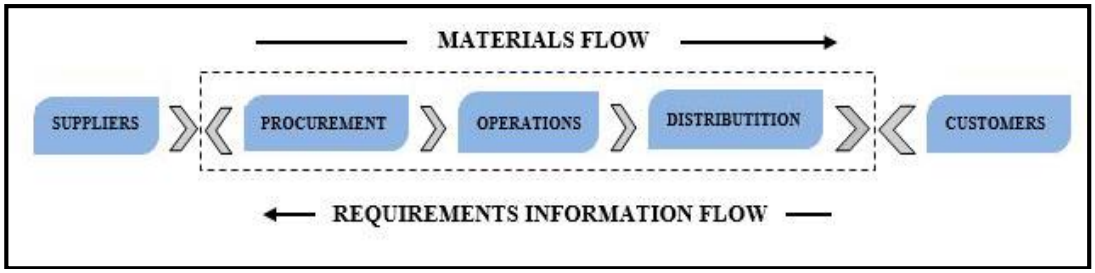



Figure 1: Supply chain process (Christopher, 2005)

As a further analyzing of supply chain conception, Mentzer et al. (2001) has classified supply chain to three types depended on the level of the organizations involving, which are basic, an extended and an ultimate supply chain as it is shown in Figure 2.

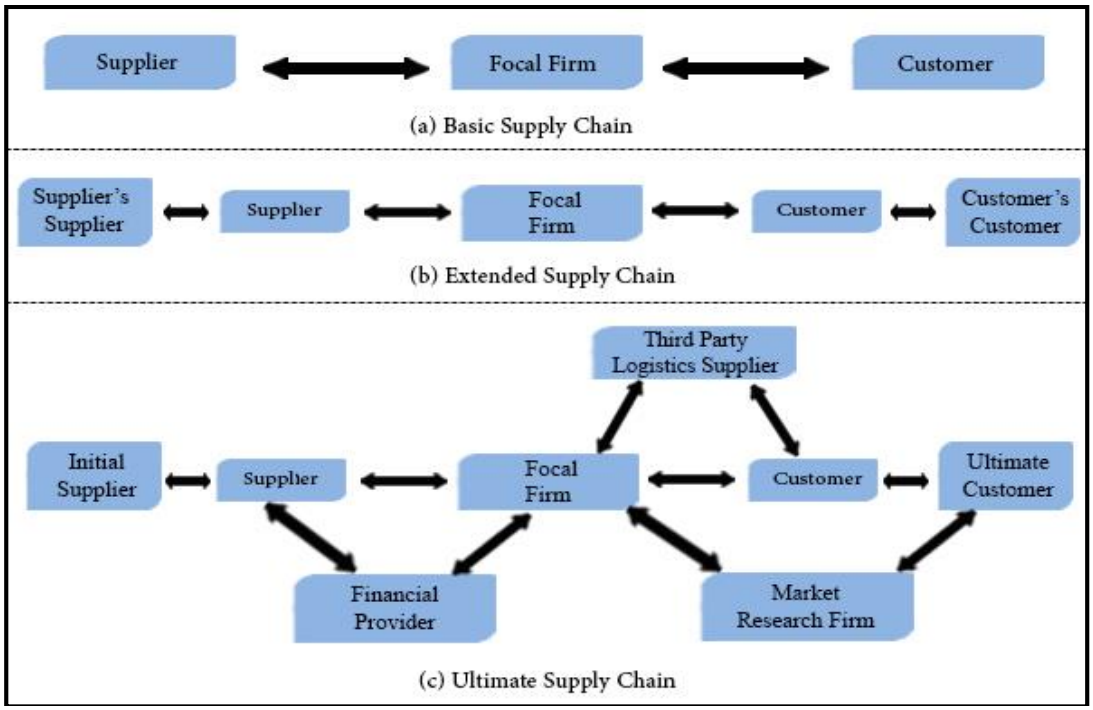


Figure 2: Types of channel relationships (Mentzer et al., 2001)

It can be seen from the above figure that each type of supply chains has its own flow with different components from the others:

- Type one is a basic supply chain which has simple upstream and downstream flows consist of an immediate supplier, a company and a direct customer. (Figure 2 a).
- Type two is an extended supply chain which also has upstream and downstream flows, however, unlike the basic supply chains, it includes direct and indirect supplier, and immediate and unmediated customer with existing of a production company. (Figure 2 b).
- Type three is an ultimate supply chain which has completed flows of upstream and downstream involving all the companies and parties, providing materials, services, and any required information staring from the initial supplier to the final customer. (Figure 2 c).

This classification indicates that the difference between each type of supply chains depended on the number of organizations involved and how they are linked to gather. In another word, the more organizations are involved the more complicated supplying chains are made.

In general, it can be concluded that supply chain in principle is a collaborative approach consists of group-two or more-of independent organizations linked to gather by material, information and financial flows aiming to deliver an output to the ultimate customer. (Stadtler and Kilger, 2008). This conception has been evolved from the perspective regarding to materials flow, which has become later on an integrative part of (SCM). (Forrester, 1961).

## 2.4 Supply Chain Management (SCM)

### 2.4.1 Origin of Supply Chain Management

SCM concept has originally appeared and thrived in the manufacturing industry. The first participation of SCM was in the Just-In-Time (JIT) system, which was utilized by Toyota's company as delivery production system (Shingo, 1988). The main target from applying this system was to reduce inventory drastically by coordinating and regulating the supplies of Toyota motors factory just on the appropriate time with just the appropriate amount, in addition, to improve the interaction between suppliers and production process.

Despite the broadly dominated by logistics, the original SCM approaches with other management concepts as value chain have contributed efficiently towards introducing developed understanding of SCM concept. (Cooper et al., 1997). In fact, SCM is incorporating special characteristics from different conceptions such as

Business Process Redesigning (BPR) and Total Quality Management (TQM). (Van der Veen and Robben, 1997).

### 2.4.2 Defining Supply Chain Management

Supply chain management (SCM) has been considered as a growing field of interest for researchers from different disciplines since it has appeared in 1980s.Many researches have defined it by different ways, which clearly reflect the variations of the researchers' views toward SCM conception. Therefore, due to these varieties there are some interfering in the used terminologies with the basic meanings of SCM literature (Croomet et at., 2000). A long debate has been agitated by various bodies of literature regarding to defining SCM that has been seen from different perspectives. (Mentzer et al., 2001, Croomet at., 2000). A collection of various definitions and classifications of SCM concept that has been received by different authors are presented in Table 2 below.

Table 2: A sample of definitions of supply chain management (Croom et al., 2000)

| Authors' Name | SCM Definitions |
|---|---|
| Jones and Riley (1985) | "An integrative approach to dealing with the planning and control of the materials flow from suppliers to end-users" |
| Ellram (1991) | "A network of firms interacting to deliver product or service to the end customer, linking flows from raw material supply to final delivery" |
| Christopher (1992) | "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 consumer" |
| Lee and Billington (1992) | "Networks of manufacturing and distribution sites that procure raw materials, transform them into intermediate and finished products, and distribute the finished products to customers" |

| | |
|---|---|
| Berry et at. (1994) | "Supply chain management aims at building trust, exchanging information on market needs, developing new products, and reducing the supplier base to a particular OEM (original equipment manufacturer) so as to release management resources for developing meaningful, long term relationship" |
| Saunders (1995) | "External Chain is the total chain of exchange from original source of raw material, through the various firms involved in extracting and processing raw materials, manufacturing, assembling, distributing and retailing to ultimate end customers" |
| Johnston (1995) | "SCM as procedure of strategically dealing with the movement and depot of materials, parts and completed bill of goods from suppliers, through the firm and to clients". |
| Kopczak (1997) | "The set of entities, including suppliers, logistics services providers, manufacturers, distributors and resellers, through which materials, products and information flow" |
| Lee and Ng (1997) | "A network of entities that starts with the suppliers' supplier and ends with the customers' custom the production and delivery of goods and services" |
| La Londe (1998) | "The delivery of enhanced customer and economic value through synchronized management of the flow of physical goods and associated information from sourcing through consumption" |

Broadly, it can be concluded that the initial definitions of SCM has only emphasized on materials flows. However, the later on definitions have been obviously expanded covering more services and information flows, maximizing the productivity, organized networks of relationships, considering customer satisfaction as well as adding value with lowering cost (Stock and Boyer, 2009). Moreover, comparing with early definitions which have focused on the external networks only, the latest definitions of SCM however has been covering both the internal and external networks.

Regarding less, the diverse views of SCM definitions, they are generally focusing on main concepts such as materials, services, financial and informational flows, and long term relationship, organization networks and client appeasement. Nevertheless, according to (Stock and Boyer, 2009) some definitions include supply chain participation in enhancing collaboration between all the parties, whereas others emphasis on flows of materials, services, and information and distributional and marketing channels.

### 2.4.3 Collaboration in Supply Chain Management

Collaboration concept between suppliers, client and even competitors has become an essential part to any organization's business in order to overcome on misunderstanding and overlaps problems between the organizational parties (VargoandLusch, 2004, Zacharia et al., 2011). The collaborative relationship between supply chain management parties can be clearly reflected on project performance and its ability to involve the intricate network within business relationships (Lambert and Cooper, 2000).

According to Power (2005) there is no a strong relation between collaboration and project performance. However, some researchers have claimed that the coordination and cooperation within supply chain process can improve the information sharing, responsibility distribution and enhance the reliability and trust between supply chain parties (Cadden et al., 2013, Zacharia et al., 2011).

### 2.4.4 Evolution of Supply Chain Management

Since it has been defined from different points of view, SCM concept has been evolved according to varied disciplines. According to Rushton (2000) who has evaluated SCM evolution from logistics and distribution perspective view, enhancing the competition between firms is the main point for better output since it leads to

reviewing and reassigning the business goals as well as redesigning the overall systems including logistics, considering that logistics has added a positive value which has an effective role in the business improvement.

Another description of SCM evolution that has been reviewed form production management viewpoint as improving the best practices to control and manage the resources in a firm considering strategic suppliers which emphasizing on the cost and quality. In addition, including the manufacturers roles in selection reliable and certified suppliers for bought products with a view to avoiding duplicated and worthless activities such as frequently examination. In order to improve the productivity across value chain considerable number of manufacturers and retailers have integrated SCM concept in their marketing and distribution function (Tan, 2001).

Regarding to multidisciplinary benefits of SCM evolution Stock, Boyer & Harmon (2010) stated establishing efficient processes and developed frameworks in order to adding value, maximizing efficiency and enhancing customer satisfaction. Considering that SCM system as a strategic technique aiming to preserve quality and encourage innovation which resulting to measurable and remarkable improvement in the entire manufacture industry as well as achieving a 'win-win' outcome for all parties within the supply chain. (Pryke, 2009).

### 2.4.5 Supply Chain Management and Logistics

Several explanations have considered that logistics as a part of SCM which mainly aiming to manage and control frontward and backward flows of services, materials and information linked from the origin production point to final consumption point to achieve the consumers' demands. (Council of Logistics Management (CLM), 2004).

In addition, several investigations have been conducted to clarify the difference between logistics management and operations management within SCM, these investigations have resulted that logistics activities are integrated with both SCM and operations management which clearly indicating that logistics and logistics management are sub-set of SCM. (Mentzer et al., 2008).

Nevertheless, the debates and variations in viewpoints toward the relationship between SCM and logistics still take place. Regarding to these disagreement Larson (2004) have concluded that there are various perspectives that SCM and logistics relationship can be seen from, which are specifically as traditionalist, unionist, re-labeling and intersectional points of view. The SCM and logistics relation from these viewpoints is shown in Figure 3.

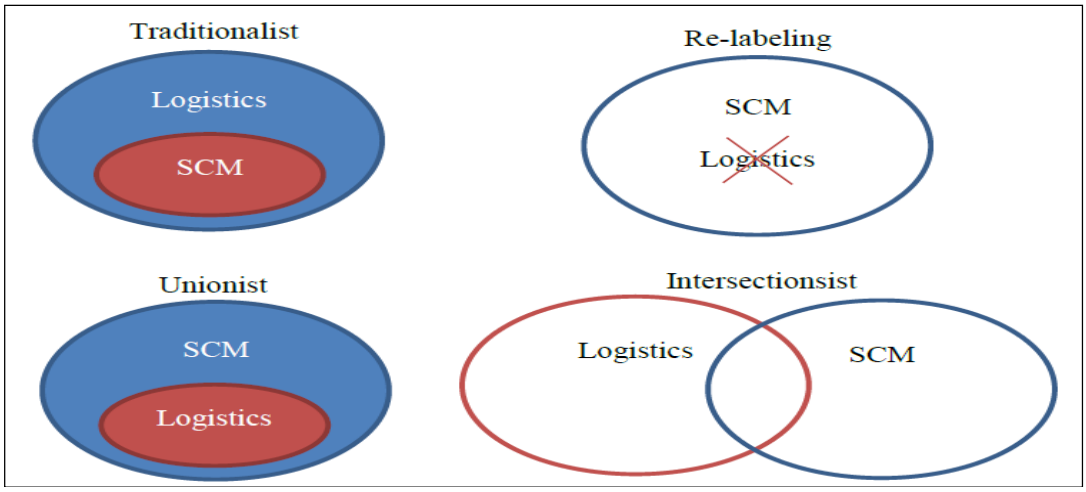


Figure 3: The different perspective between SCM and logistics (Larson, 2004)

Unlike the traditionalist viewpoint which consider that SCM as part of logistics, unionist perspective is quite reversible, it suggests that logistics is a sub-set of SCM, in another word, it corresponds with CLM (2004) description which stated that logistics is small part within SCM as any other parts such as operation, distribution,

marketing and etc., When it comes to relabeling point of view, it excludes logistics as a word from SCM as whole, whereas intersectional perspective considers that SCM and logistics are separate entities, but they interfere with each other in some areas.

## 2.5 Supply Chain Management in Construction Industry (CSCM)

Comparing with other manufacturing processes, construction processes have some specific characteristics such as the highly degree of subcontracting and the differences regarding to a project type, size, location and complexity. Consequently, defining SCM in construction sector is somewhat more complex (Butkovic, et al., 2016).

### 2.5.1 Theoretical Review of CSCM

Due to the considerable successes that have been achieved in manufacturing industry sector by adopting SCM philosophy, many researchers within construction industry sector have started to adopt this philosophy in order to enhance the construction processes and improve the efficiency in this sector. (McDermotti and Khalfan, 2012).

Increasing number of organizations and their overlapping within construction industry have resulted to acknowledging the importance of involving SCM conception (Akintoye et al, 2000; Dainty et al 2001a). Yet, employing this conception in construction sector has been relatively slow and infrequent comparing with the other industry sectors. Despite the SCM efficiency in decreasing the overall cost of construction processes, Crespin-Mazet and Ghauri (2007) have stated that SCM philosophy in construction operation is still undefined clearly. According to Xue et al. (2007) construction supply chain is not an actual chain but it is a multi-organization network and coordinated relationships, consisting of the main flows namely information, materials, products, services and funds flows, which connecting

supplier, contractor, client and the other stakeholders with each other. Since it is described as a single and one-off product, a construction project considers as unique and unparalleled process regarding to SCM implementation (Cox et al, 2006).

Construction supply chain can be divided into three categories, (Muya et al., 1999) as following:

- The fundamental supply chain which is practically delivering the raw materials that are integrated the final construction output.
- The supporting chain which is providing the equipment's and tools that are utilized to assist construction process.
- The human resources supply chain which is supplying the workers or labors who is participating in construction process.

In broad a construction project is launched by the client demand, which leads into periodic alteration in the means of supply chain in construction processes. However, with same targets and similar flows (Cox et al., 2006). Figure 4 provides a typical construction supply chain which illustrates the complexity of the three main flows of materials, labors and equipment.

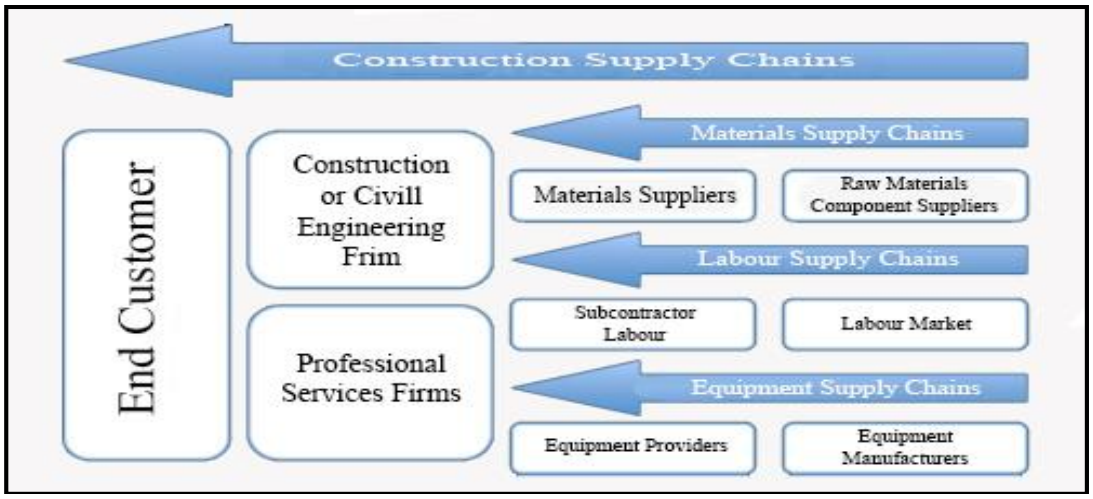


Figure 4: The myriad of construction supply chains (Cox et al., 2006)

According to Proverbs and Holt (2000), the early collaboration and coordination between suppliers and subcontractors or between suppliers and the main contractor during the procurement stage can be efficiently achieved by adopting SCM in construction process, which could result to noticeable reduction in overall construction cost. In addition, enhancing the inter-firm relationships and raising trust are considered from the fundamental stones to improve the communication within overall supply chain parties. Getting ride from usual hindrances of traditional relationships and antagonistic conception, and instead, raising an impartial competitive and an amelioration management framework can play effective roles in construction supply chain implementation (Dainty et al., 2001b).

### 2.5.2 Implementation of SCM in Construction Industry

In construction projects, often several organizations are collaborating, so that systemic network of suppliers could be very complicated. In general, on bigger projects, the total number of supplier firms could be in their hundreds (Dainty et al., 2001). It is thus difficult to manage a lot of different firms, businesses, and materials products; this makes the whole concept of SCM difficult to apply in these bigger projects (Aloini et al., 2012a).

O’Brien (1999) argues that the present manufacturing study in SCM, even though they valuable, they cannot be directly and categorically applied to a construction situation, the reason being that of the transitory nature of production in such situations. The constructionindustry is one of the industries where it is difficult to integrate with all other key industrial sectors (Fearne and Fowler, 2006). Nonetheless, construction supply chain application is filled with a bunch of creative minds trying to improve supply chain network between suppliers and customers (Akintoye et al., 2000; Vrijhoef and Koskela, 2000).

Egan (1998) and Latham (1994) results recognized the key bottlenecks of the construction industry and it also states the major challenges that need to be tackled to foster better integration of construction supply chains. Their reports equally recommend that teamwork at the organizational level which involves suppliers, clients, designers among others is a better way to achieve the desired result. Based on these recommendations, partnering, the use of long-term/strategic arrangements, public-private partnerships, joint venture, supply chain management and prime contracting comes into play so as to develop the lifecycle of the construction project (Akintoye and Main, 2007).

Researchers emphasize that minimizing cost and adding value are important objectives in SCM. Saad et al. (2001) stated that implementing the concept of SCM into the construction sector has to undergo series of trials and attempts. It also entails combining processes in design, paying increased attention to rising opportunities to add value, manufacture process and functions to connect the process in a sequence and to be cost effective. As this concept requires mutual profits, cooperation, and teamwork of team members and participants.

In line with certain authors (e.g., Cooper and Ellram, 1993), the move from the old-style way of handling supply chain to SCM consists of different elements. The old way of handling is fundamentally centered on a transformation (or conversion) opinion on production, while SCM is actually based on a view of production known as the flow view. Similarly, since in construction industry, SCM emanates from the fundamental principle of SCM, the CSCM thus varies from the old-style construction management method (Chunyu, 2013).

SCM application is a way of improving both vertical and horizontal integration with the construction, operation, and design so as to make the most of the opportunities to add value and reduce overall cost. This application necessitates a significant mindset of the collaborators, customers, main contractor consultants and other members of the team for shared benefits (Saad et al., 2001). Three kinds of flows are connected to the SCM (Figure 5) and they can be grouped as:

- Material flow: This consist of the flow of physical product to customers from the suppliers via the chain, and the reverse as well through product return, disposal, and recycling.
- Information flow: Information flow involves order transmission, demands forecasts.
- Cash-flow: This encompasses of payment schedule, commercial information, ownership arrangements and consignment details

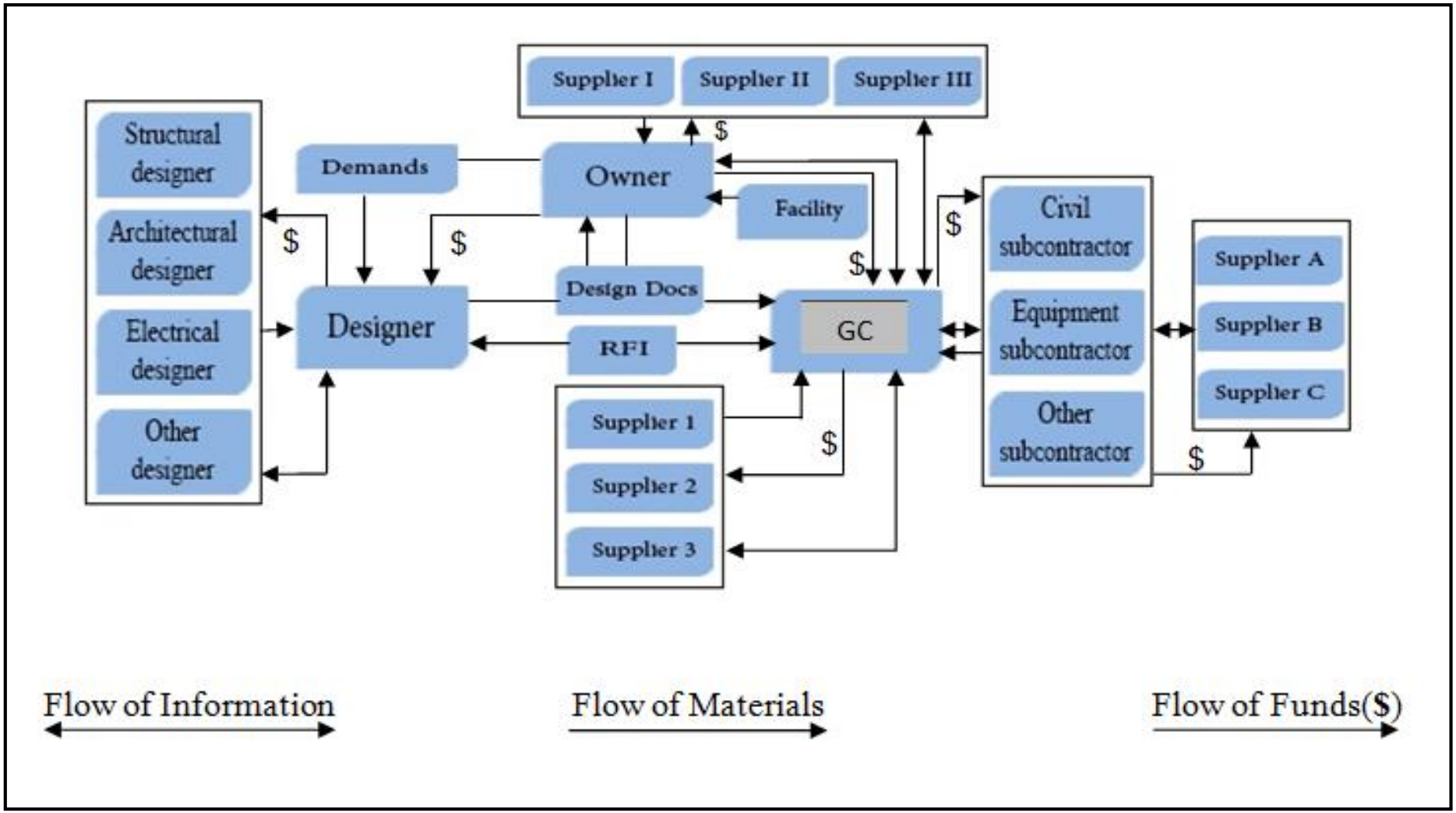



Figure 5: Construction supply network (Xue et al., 2007)

It is essential to differentiate between the construction process and the factory production when applying supply chain management in construction. The following are some of the characteristics:

- At most times the construction product is one client per time.
- There is a unique product per project.
- The equipment, the place, and the methods of production are rarely constant; construction professionals, on the other hand, have a high rate of rotation index in the course of construction and even between projects.
- All construction materials and parts cannot be available onsite at the same time, and finally,
- It is not simple to benefit from learning and economies of scale.

The construction process differs from production processes in factories and supply chain management is effective and useful in the construction process (O'brien, 1999). Modern supply chain enables production without errors and delays thereby allowing goods to be manufactured and delivered to the exact places, in the right quantities, at the right time and in a quite cost effective way (Christopher and Peck, 2004: 2). The great set back in the construction process caused by the inability of its supply chain to integrate has turned supply chain management into a very appealing approach to accomplish integration between external and internal suppliers, contractors, designers, clients and subcontractors (Serpell and Heredia, 2006).

It is important to take into consideration that every construction firm has equal supply chains as its construction projects because the requirements per projects differ from one project to another. In construction, the supply chain connotes a structure of

several suppliers. The reason for incorporating the concept of SCM in construction, therefore, is to achieve comparative and competitive advantage via the creation of value, reduction of cost and the incorporation of all parties in the process of construction having the satisfaction of both external and internal clients as the goal. Sterziet al. (2007) affirm that SCM may be looked at as the improvement of tools and techniques which foster healthy competition among firms. In the actual sense, it deals with the managerial development and integration of the entire supply chain via a close alliance between the suppliers and focal companies.

### 2.5.3 Roles of Supply Chain Management in Construction

Four main roles for SCM in construction were presented by Vrijhoef and Koskela (2000). Which may be considered from the angle of the construction site, the supply chain itself, or even both. Theymaybefrequently used jointly as they are not mutually exclusive.

First, the emphasis may be on the effects of the supply chain on activities on site, whose aim is to reduce cost and time spent on projects and site activities. Focus are on making sure the constant and continuous supply of materials and labor on site to avoid distortion to the work flow, it is the duty of the main contractor to adopt this focus.

Second, focus is on the supply chain itself. It aims at reducing the cost associated to lead time, logistics and inventory. This role majorly may be adopted for material and component suppliers.

The third focuses on transferring site activities to earlier stages of the supply chain and aims at reducing the duration and overall costs. This focus may be started by contractors and/or suppliers.

The fourth focuses on the integrated development and managementof the site production and the supply chain, in which case the site production is incorporated into SCM. This particular focus may be introduced by clients, contractors or suppliers. Figure 6 sums up all the four roles of SCM in construction.

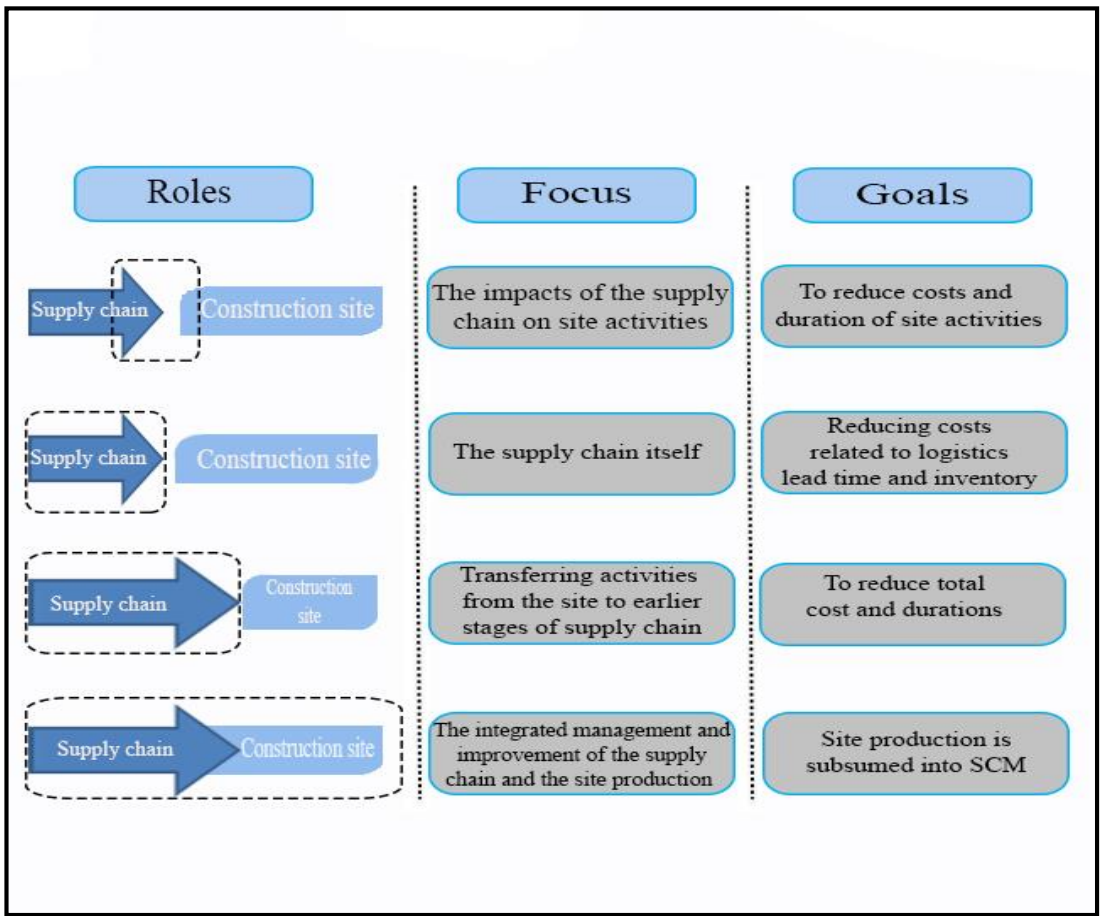



Figure 6: The four roles of supply chain management in construction (Vrijhoef and Koskela., 2000)

### 2.5.4 Barriers of Construction Supply Chain

Although in the construction industry SCM offers promises, it also presents intense challenges on how to implement SCM and supply chain benefits hereby posing a threat to any strategic operational efficiency and benefits. Possible threats of construction supply chain that hampers the improvement of integrated supply chain and also makes the carrying out of projects particularly problematic are; fear of loss of control, not sharing project information, absence of awareness, not understanding the supply chain, lack of understanding the project requirements, shallow thinking and strategies among others. While complete SCM may be out of reach for a lot of construction firms, effective application of this concepts will make them more competitive (Benton and McHenry, 2010).

### 2.5.5 Benefits of SCM in Construction Performance

Completion of projects within specific time, lowest cost and good quality are the major targets in any construction project (Chua et. al., 1999), which can lead to an uptake in a number of concepts like the TQM and process re-engineering even thou results haven't shown a holistic development (Ahmed et al., 2002).

A success recorded through SCM in other industries such as production and manufacturing industries gives headway that in the construction industry, the same successes could be achieved. Studies related to construction SCM have shown numerous ways that SCM is of benefit to the construction industry. SCM makes it possible to effectively utilize resources all through the supply chain (Dubois and Gadde, 2000), thereby causing efficient inventory (Turner, 1993), well-organized procurement and purchasing processes, improved productivity, effective marketing, increased flexibility fulfillment of order (Horvath, 2001) cost saving, (Cheng et al., 2010) and reduced transaction costs (Stanford et al., 1999). SCM makes all

teamwork transparent, makes all transaction clear and increases honesty among team members and partners. It also reduces paperwork (Turner, 1993), brings about better coordination (Ahmed et al., 2002) as well as eradicating unpleasant behaviors (Briscoe et al., 2004). Trust level is on the increase and commitment of every team member is built (Ali et al., 1997). Consequently, the responsiveness level could be enhanced and customer satisfaction is achieved (Turner, 1993).

The construction supply chain has enormous advantages to the performance of the construction, not just in increasing vertical integration in the design and construction processes but also in operations and maintenance aimed at taking advantage of all opportunities that add value to any project and is also cost efficient. It is important to note that SCM requires the cooperation of team members to achieve mutual benefits. A few of the benefits are:

- Accurate estimations resulting in reduced inventory cost, in construction execution.
- Reduces the total cost of construction by restructuring the process of supply flow to the execution process and by enhancing the flow of information amongst the agencies.
- Client/ customer satisfaction by offering more quality projects, prompt completion of projects and reduced cost.
- Lessening of the top up time of the supplies at the sites of construction
- Helps in forecast accurately the change of orders and making actual estimation information available to all levels.
- Helps in lessening the cost of administration at the site and the execution cost and time.

The following are important drivers of integrated supply chains, as identified in recent researchers. Modifications in the corporate culture, information sharing, trust and communication amongst all the parties, and sharing mutual goals of increased efficiency and waste eradication. (Dainty et al., 2001) recommended means of making integration of supply chain successful. Furthermore, greater levels of trust encourage knowledge and information sharing through the supply chain as well (EdumFotwe et al., 2001) which will lead to better information flow (Love et al., 1998b; Ahmed et al., 2002), prompt and precise dissemination of information, and also expedites good decision making (Cheng et al., 2010). This, in turn, leads to better performance, as well as competitiveness (Burgess, 1998) for individual organizations and the team via improvement in practices and recently developed skills as a result of sharing practices. Consequently, delivery of projects and the satisfaction of customers would improve (Horvath, 2001), and disputes and conflicts will be reduced (Briscoe et al., 2004). This will ultimately lead to an ongoing upgrade in products, practices, methods of construction in the inter-organizational and intra-organization relationships, as well as the individual organizations. In the end, a very competitive industry will materialize as an outcome of SCM initiatives (Stanford et al., 1999).

## 2.6 Factors Affecting SCM Implementation in Construction Industry

A collection of well-known factors affecting SCM application in construction project considering both relationships between CSCM parties and effects of CSCM on performance of project are presented in this section along with their brief description and references.

### 2.6.1 Organization's Relationships Between CSCM Parties Including Suppliers, Contractors and Clients

The success of supply chain processes within construction industry sector are strongly depended on the quality of the relationship and communication among CSCM parties. The following table provides the most important factors affecting the successful supply chain relationship along with its reference as well as a brief description of these factors.

Table 3: Factors affecting successful relationship among CSCM parties

| Factor | Description | Reference |
|---|---|---|
| Reliable delivery date | It is measured by perfect order fulfillment and demonstrates the degree to which a supplier is able to serve its customers within the promised delivery time. | Tan and Kannan (1998), Akintoye, A., McIntosh, G., & Fitzgerald, E. (2000). |
| Accurate order fulfillment | It is the adjusting of delivering process orders to end customers**.** | Akintoye, A., McIntosh, G., & Fitzgerald, E. (2000). |
| Delivery at specified time | It is the ability of the supplier to deliver the products at particular time | Akintoye, A., McIntosh, G., & Fitzgerald, E. (2000). |
| Flexibility | A reactive means to deal with uncertainty | Stevenson, M., & Spring, M. (2007). Akintoye, A., McIntosh, G., & Fitzgerald, E. (2000). |
| Fast order cycle time | The period required to complete the ordered products in one cycle of an operation | Wong, A. (1999). Akintoye, A., McIntosh, G., & Fitzgerald, E. (2000). |
| Handling of complaints | The ability to deal with the encountered problems | Akintoye, A., McIntosh, G., & Fitzgerald, E. (2000). |
| Added value | It is the improving of function and reducing the whole life cost of the project | Serpell, A., & Heredia, B. (2004), Vrijhoef, &Koskela, L. (1999) |

| | | |
|---|---|---|
| More frequent meetings | The frequency of the periodic meeting between the CSCM parties, which improve the communication and information sharing among the project parties | Vrijhoef, R., & Koskela, L. (1999, July). Akintoye, A., McIntosh, G., & Fitzgerald, E. (2000). |
| Free flow of information | The smoothness of sharing the information and exchange the views between the project members | Akintoye, A., McIntosh, G., & Fitzgerald, E. (2000). |
| Top management support | It is the project manager support which has high effect on construction success | Akintoye, A., McIntosh, G., & Fitzgerald, E. (2000). |
| Trust | Trust and reliability between the CSCM parties considered to be one of the most influential factors in supply chain process | Tan, K. C., Kannan, V. R., & Handfield, R. B. (1998). Monczka, R. M., & Morgan, J. P. (1996), Akintoye, A., McIntosh, G., & Fitzgerald, E. (2000). |

### 2.6.2 The Effects SCM Implementation on Construction Performance

The adopting of SCM in construction project can be practically useful regarding to the project performance which could result in an efficient inventory, improving productivity, purchasing processes, increasing flexibility, reducing transaction costs, eliminating fragmentation in the construction process, cost saving, adding value to the project, improving commitment towards project team, improving information sharing and reliability among project parties  Consequently, the level of construction performance could be improved as well as provide better quality services to end customers.

The categorizes of the most important functions of SCM in construction project are provided in Table 4 as well as the most operative factors which may affect this these functions.

Table 4: The factors affecting functions of CSCM performance in construction projects.

| Functions Categorize | Description | Factors | Reference |
|---|---|---|---|
| **Reducing adversarial relationships in construction project** | Involving SCM in construction industry can contribute in reducing unpleasant behaviors among project parties, the relationship management cannot be legislated, but its development according to a solid underpinning in the project contract | Time predictability<br>Cost predictability<br>Occupational health and safety<br>Site productivity | Jefferies, M. C., Rowlinson, S., & Cheung, Y. K. F. (2006), Emuze, F. A. (2010). |
| **Adding value to the overall construction project** | Increasing the project value can be achieved by adopting SCM in construction process. CSCM can facilitate to reduce supply chain costs, direct labor and Increase the client satisfaction. | Increased client satisfaction<br>Reduce supply chain costs<br>Reduce working capital<br>Reduce direct labor and material<br>Transform fixed costs to variable costs | Handfield, R. B., & Nichols, E. L. (2002). Emuze, F. A. (2010). Gann, D. M., & Salter, A. J. (2000). O'brien, W. J. (1999, August). |
| **Improve information sharing in the construction process** | The smoothness in information flows within CSC process can effectively create high-performing value systems. Improving information sharing in construction process can be achieved by frequency of contractual claims and frequent meeting between CSCM members | Effectiveness of communication systems<br>Magnitude and frequency of contractual claims<br>Magnitude and frequency of contractual dispute<br>Reduction of paperwork and request for information documents | Emuze, F. A. (2010). Akintoye, A., McIntosh, G., & Fitzgerald, E. (2000). |
| **Improve reliability between project partners** | Reliability and trust based on long-term relationship between the project parties, which resulting in win-win situation between both supplier, client and contractor. The | Trust between project partners<br>Top management commitment<br>Frequency of arbitrations and law suits | Akintoye, A., McIntosh, G., & Fitzgerald, E. (2000). Emuze, F. A. (2010). Jefferies, M. |

| | | | |
|---|---|---|---|
| | development of reliability between organizations is seen as a function of the length of the relationship between them. | | C., Rowlinson, S., & Cheung, Y. K. F. (2006), O'brien, W. J. (1999, August). |

# Chapter 3

# METHODOLOGY

## 3.1 Introduction

Involving SCM has been considered to be essential part not only for manifesting sector but also construction organization as well (Punniyamoorthy et al., 2011). Employing SCM in construction industry can contribute to improve the project performance, vertical integration of project design, construction process, maximizing project value and minimizing project cost and time. However, the quality of communication and coordination among the CSCM members including suppliers, contractors and clients considers to be one of the fundamental factors to achieve the desired target from involving this concept.

As it has been mentioned previously the current study is aiming to analyze the factors affecting the relationship of CSCM members, SCM dependence on organizational relationships, efficiency of supply chain organization , collaboration within CSCM , the barriers to supply chain integration in construction sector and the effect of SCM on the construction performance In order to achieve the research objectives, appropriate methods has been chosen which are described in details in this chapter. The outline of this chapter consists of the following items:

- A review of data resource in this research which includes a primary and a secondary source.
- Research categories

- The questionnaire design.
- Reliability of research instrument.
- Data collection.
- Data analysis

## 3.2 Source of Data

In clarifying the methodology of this study, it is significant to show the sources being adopted, which accommodateswide-ranging deliberations from different perspectives relating to the focus of the subject. Taking the Libyan construction industry as a case study, this section describes the effects of SCM implementation on the construction industry.

### 3.2.1 Primary Source

Questionnaires have been shared by giving hand to hand copies to relevant and appropriate numbers of respondents and also by using the internet Google forms. This questionnaire contained a brief easy to comprehend introduction to the concept of supply chain management in construction projects and was designed to be easy to read and understand, simple and clear with adequate information made available by translating it to Arabic language that is the main language in Libya to ensure respondent participate in the sample survey.

### 3.2.2 Secondary Source

Research journals, previous academic thesis, and conference papers are the main source of data gathered, works related to SCM were studied carefully putting in great consideration the methodology of their research, the challenges faced during the research and how they proffered solution to this challenges. The secondary data assisted in shaping the format of the research questionnaire. This basically forms the literature review.

## 3.3 Research Categories

The Categories are usually descended through various sources of raw data, previous research, and scientific theories. Researchers may tend to develop categories of some data to enable them analyzing and describing a specific phenomenon, this can be efficiently useful for developing the theories and hypothesis. In this research study, in order to cover most of the substantial parts regarding to CSCM, the influential factors affecting the implementation of SCM in construction industry have been categorized into five parts as it is shown in Table 5.

Table 5: Categorization of the factors affecting the CSCM implementation

| Categorize | Factors |
|---|---|
| **The relationship among CSCM parties (suppliers, contractors, client)** | Reliable delivery date |
| | Accurate order fulfillment |
| | Delivery at specified time |
| | Flexibility |
| | Fast order cycle time |
| | Handling of complaints |
| | Added value |
| | Quality of materials |
| | Quality of service |
| | More frequent meetings |
| | Free flow of information |
| | Top management support |
| | Trust |
| **SCM dependence on organizational relationships** | Long term and stable relationships |
| | Reduction the number of suppliers and customers |
| | Open exchange of data and information |
| | Earlier involvement |
| | Clearer negotiation of common objectives |
| | Sharing learning and innovation |
| | Greater trust in relationships |

| | |
|---|---|
| **The efficiency of CSCM organization** | Inventory |
| | Transportation |
| | Lead Time |
| | Purchasing |
| | Production Planning |
| | Storage |
| **Developing CSCM collaboration** | Improved customer service |
| | Overall supply chain reduction |
| | Increased profitability |
| | Reducing bureaucracy/ paperwork |
| | Cost reductions within your organization |
| | Benefits to the client |
| | Benefits to your supplier |
| | Improved quality assurance |
| **Barriers to CSCM integration** | Lack of top management commitment |
| | Fragmentation of construction supply chain |
| | Failure to share project information |
| | Poor understanding of SCM concept |
| | Inappropriate organization structure to support system |
| | Unrealistic program times |
| | Low commitment of partners |
| | Strategic benefits unclear |
| | Lack of appropriate information technology |

Regarding to the categories of the research hypotheses factors, well-known performance indicators factors have been categorized according to their effects on the construction performance from various aspects as it is provided in Table 6.

Table 6: Categorization of the factors affecting CSCM performance

| Categorize | Factors |
|---|---|
| **Reducing adversarial relationships in construction project** | Time predictability |
| | Cost predictability |
| | Occupational health and safety |
| | Site productivity |
| **Adding value to the overall construction project** | Increased client satisfaction |
| | Reduce supply chain costs |
| | Reduce working capital |
| | Reduce direct labor and material |
| | Transform fixed costs to variable costs |
| **Improve information sharing in the construction process** | Effectiveness of communication systems |
| | Magnitude and frequency of contractual claims |
| | Magnitude and frequency of contractual dispute |
| | Reduction of paperwork and request for information documents |
| **Improve reliability between project partners** | Trust between project partners |
| | Top management commitment |
| | Frequency of arbitrations and law suits |

## 3.4 Questionnaire Design

The Survey questionnaire is a method or tool used to measure and evaluate the opinions of a particular group about a specific topic. Practically the surveys applied to collect a series of certain data from a designed sample of people in order to investigate and analyze particular issues (Karataş, A. 2009). The questionnaire survey in this research study was prepared and organized to serve out a thorough source of information and it consists from four main sections as the following:

Section (1): consists of general closed-ended questions regarding the respondents and their companies.

Section (2): addressed the importance of main factors which may affect the successful relationship between the supply chain parties including suppliers, contractors and clients. In addition, this section considers the important factors regarding to SCM dependence on intra and inter organizational relationships. In order to evaluate the importance of these factors the respondents were asked to use 1-5 point Likert scale as "1" referring to "unimportant", "2" referring to "less important", "3" referring to "normal", "4" referring to "important" and "5" referring to "very important".

Section (3): addressed the major functions affecting the efficiency of supply chain organization as well as the evaluation of the main objectives in developing construction supply chain collaboration. In addition, this section considering the common barriers to construction supply chain integration. In order to evaluate the agreement on these factors the respondents were asked to indicate their extent of agreement by using 1-5 point Likert scale as 1 referring to "very small extent", "2" referring to " a small extent", "3" referring to " a moderate extent", "4" referring to "a great extent" and "5" referring to "a very great extent".

Section (4): this section was designed to evaluate factors affecting CSCM performance. Familiar key performance indicators were used for irrigation poll of responses about the influence of proactive supply chain management on the propagation of reducing adversarial relationships in construction, adding value, improving of reliability and information sharing within construction process. In this

section the respondents were asked to evaluate the effect of proactive supply chain management on project execution by using 1-5 point Likert scale as 1 referring to "very poor", "2" referring to "poor", "3" referring to “moderate", "4" referring to "good" and "5" referring to "very good".

To sum up, the questionnaire form was designed to display the understanding of supply chain management concept as well as analyzing the factors affecting the relationship and efficiency of supply chain management in Libyan construction industry. A sample of the questionnaire form can be seen in Appendix.

## 3.5 Reliability of Research Instrument

Respondents were chosen from various famous and reliable construction firms in Libyan such as (Arabian Consulting Engineering). The questionnaire attributes easy, clear to understanding along with introduction to the CSCM concept and translating it to the Arabic language made it simpler for respondents’ answers.

## 3.6 Data Collection

The data collection stage has been considered as the most important part of this study. The questionnaire form has been distributed among Libyan construction companies by using both hard copy submission and Google Forms application in order to reach to the sufficient number of the targeted respondents in LCI. The survey has been conducted in Jun, 2017, however, the result has not be ready until the beginning of July. Out of (80) invitations have been sent to participating in the survey, a total of (62) completed form have been received, which representing about 78% as response rate.

## 3.7 Data Analysis

Statistical analysis, factor analysis, Causal relationship and reliability test are considered. SPSS was used to analyze data gathered from questionnaires; this analysis is a statistical examination to confirm the internal consistency of items measured in a construct. Bar charts and pie charts are plotted, frequencies and percentages for each question were analyzed. The data summary interprets the sample characteristics including statistical tests for inferential discrepancies amongst groups. Ranks were obtained taking the standard deviation and mean score from the descriptive statistics. A statistical test used to lessen the quantity of variables to a manageable size and recognize sets of variables that measure same things is the factor analysis. The causal relationship analysis, on the other hand, is a statistical analysis used to evaluate the power of the relationship between two variables. And finally, the reliability tests analysis is used in this study to confirm the factor analysis.

### 3.7.1 Factor Loading

Factor loading shows how much a factor could explain a particular variable in factor analysis, it shows the relationship agreement between considered factors, and thus factor loading stands for the correlation of the factor and the variable. Using Ensuring Practical Significance approach, the first proposition is not reliant on any mathematical suggestion but relates more to practical significance (Livesley et al., 1998).

Ensuring Practical Significance is a rule of thumb used regularly as a way of making an initial evaluation of the factor matrix. Factor loadings greater than ±.30 are taken to meet the minimal level; loadings of ±.40 are taken more with more importance;

and if the loadings are ±.50 or more, they are regarded as practically significant. Therefore, the larger the entire size of the factor loading, the more significant the loading in construing the factor matrix, because factor loading shows the connection of the factor and the variable.

The squared loading is the quantity of the variable's total variance accounted for by the factor. Thus, a 0.30 loading signifies roughly 10% explanation, and a 0.50 loading connotes that 25% of the variance is accounted for by the factor. The loading must be higher than 0.70 in other for the factor to account for 50% of the variance. The examiner should know that very high loadings (0.80 and above) are not usual and that the practical significance of the loadings is a significant criterion. The emphasis in this approach is practical, not statistical, significance (Livesley et al, 1998).

### 3.7.2 Reliability (Coefficient Alpha Cronbach) (α)

According to Cronbach (1951) reliability can be expressed in terms of stability, equivalence, and consistency. Consistency check, which is commonly expressed in the form of "Cronbach Coefficient Alpha".

Cronbach's alpha is often used when having multi-items scales (e.g., measurement procedure, such as a survey with multiple questions). It is also a versatile test of reliability as internal consistency because it can be used for attitudinal measurements (e.g., attitudinal measurements include Likert scales with options such as very poor, poor, neutral, good, very good), which are popular among researchers. However, Cronbach’s alpha does not determine the multi-dimensionality of a measurement procedure (i.e., that a measurement procedure only measures one construct). This is

because getting a high Cronbach's alpha coefficient (e.g., 0.80) when testing a measurement procedure that involves two or more constructs.

### 3.7.3 Relative Importance Index (RII)

Following formula is used to calculate Relative Importance Index (RII) (Mbamali, 2012):

$$Rll = \frac{\sum Fx}{\sum F} * \frac{1}{K}$$

(Mbamali, 2012) classified the variables into 5 groups on Likert Scale.

RII: Relative Importance Index.

X: Point on Likert Scale (1, 2, 3, 4, and 5).

F: Frequency of choices selected by respondents.

K: Max point for Likert scale (5).

It is important to also note that ranks of factors or items using RII are taken in increasing order i.e., the highest value takes the 1st rank, the following one takes the 2nd rank and so on until the lowest rank (Mbamali, 2012).

The following limitations are used in the interpreting of RII results in accordance with (Mbamali, 2012):

RII < 0.60 refers factor or item is a low rating.

0.60 ≤ RII ≤0.80 refers factor or item is High rating.

RII > 0.80 refers factor or item is Very High rating.

### 3.7.4 The p Value Test

The p-value, which is the level of significance for the test was 5%. The p-value is the probability that the test statistics equal the observed value or a value even more extreme (Agresti and Franklin, 2007).

It is calculated by presuming that the null hypothesis $H_o$ is true. In plain English, the p-value is a tail probability beyond the observed test statistics value. Smaller p values provide stronger evidence against the null hypothesis. The Unit for Statistical Support affirmed that the value is appropriate for the research analysis.

### 3.7.5 Research Hypotheses Using t-test Method

In order to test research hypothesis t-teat method has been used by applying SPSS. The hypothesis considered for section 4 regarding the effects of SCM on construction performance. The test was conducted depending on the (ρ-value), if it is more than 0.05, the null hypothesis($H_0$) failed to be rejected otherwise it should be rejected.

# Chapter 4

# RESULTS AND DATA ANALYSIS

## 4.1 Introduction

This chapter presents the results of the data collected from the questionnaires survey as well as the analysis and discussion of these results. As it has been mentioned previously, the respondents have been invited to participate in the survey by sending both a hard copy and Google forms application to the firms and individuals who are involving in construction industry filed.

This chapter includes a review of the questionnaire responding rate, displaying and interpreting of the respondents' background information, then analyzing and ranking of the factors affecting SCM implementation in LCI sector. In addition, examining and interpreting the hypothesis research regarding to effects of SCM on construction performance. The raw data was analyzed by using "Statistical Package for Social Science" SPSS, version 18, and "Relative Importance Index", RII was computed to rank the factors.

## 4.2 Questionnaire Response Rate

In order to obtain valid results, the participators have been chosen guardedly from different well-known and reliable construction companies in Libyan. Although the increasing of questionnaire response rate was relatively slow, (62) completed questionnaire forms were obtained from (80) invitations were sent to the respondents to complete the survey. The percentage of the questionnaire respondents has obtained

in this study was (78%), which is considered as moderate rate of response found in most of questionnaire surveys regarding to construction industry researches (Akintoye, 2000; Yang, 2014).

## 4.3 Respondents' Information

This section provides general background information about the respondents and their companies who have participated in the survey. This section aiming to display respondents' qualifications, work experience, and their positions in their firms. Moreover, specific details related to respondent's companies along with their suppliers and number of annual projects are also illustrated in this section.

### 4.3.1 Working Position

The responses obtained detailed respondents positions work in their firms shown as percentage in Figure 7. It can be seen that the majority of the respondents who has completed the questionnaire was site engineers with (60%), followed by contractors with (35%), and then project managers by (20%). However, the lowest percentages of respondents was from owners and quality mangers by (6%) and (3%) respectively.

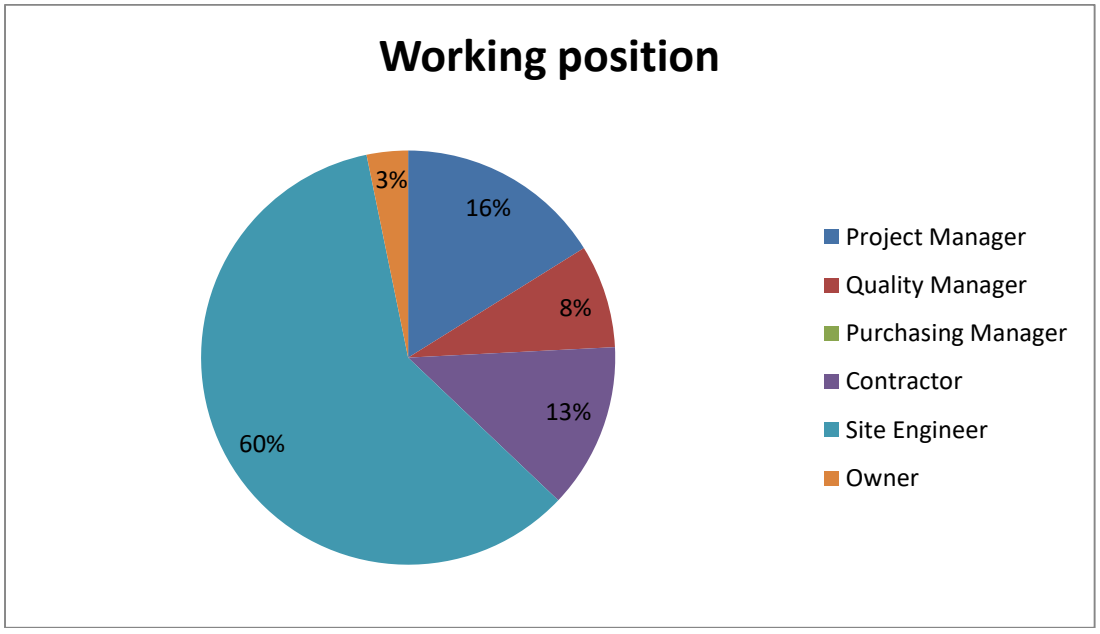



Figure 7: The respondents' work positions in their organizations

### 4.3.2 Educational Qualification

As it shown in Figure 8, the respondents participated in the questionnaire survey had gained uneven level of academic qualification. It is clear that most of the respondents with 57% have attended bachelor degree level, whereas, only 19% from the respondents were PhD and MSc holders and 24% have a diploma certificate.

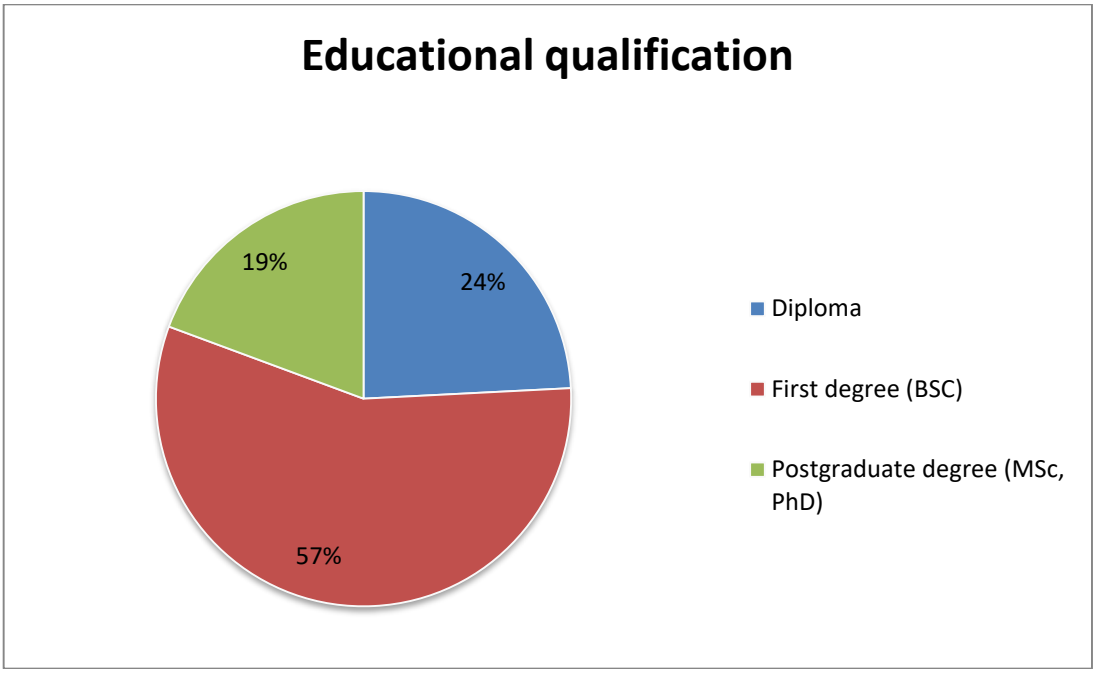



Figure 8: Respondents educational qualification

### 4.3.3 Experience in Libyan Construction Industry

Figure 9 demonstrates the respondents' experience in LCI sector. It can be noted that highest percentage of respondents by 45% have worked from 1 to 5 years in construction project field, followed by 40% and 9% of participators who have 6 to 10 and 11 to 15years of experience respectively. While only 6% of respondents have employed more than 15 years in LCI.

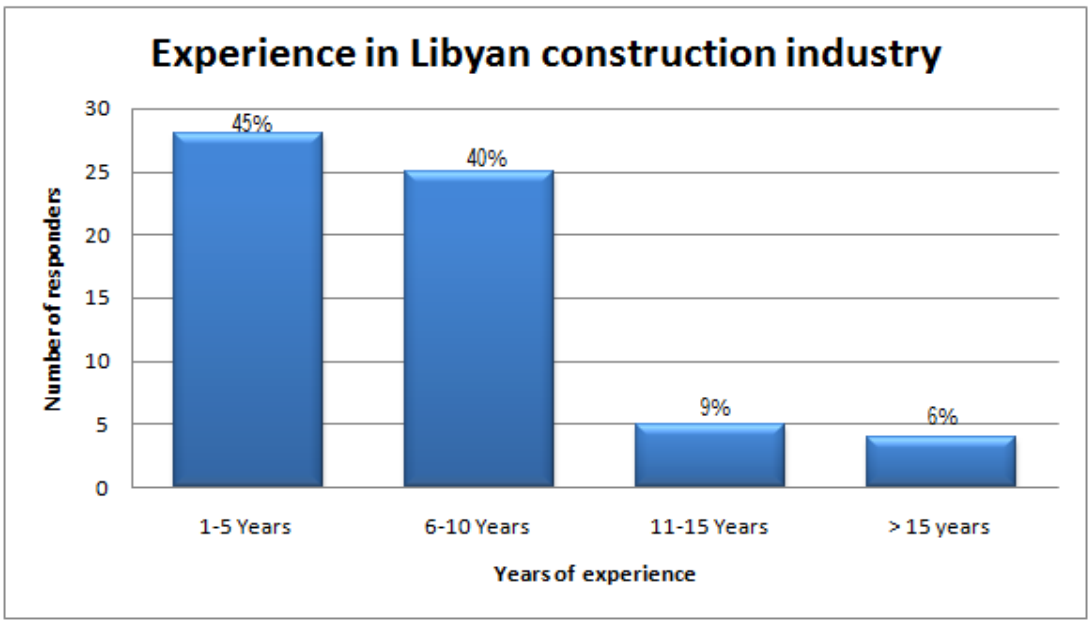



Figure 9: Respondents years of experience in LCI

### 4.3.4 Number of Annual Projects Undertaken by an Organization

The respondents were asked about the yearly number of the project conducted by their companies and results shown that 52% of the respondents' firms undertaking 1-4 projects, followed by 35% of the companies achieving 5-8 projects, then 12% achieving 9-12 projects annually. And Only 1% of the participated companies were dealing with more than 12 project over a year as it is seen in Figure 10.

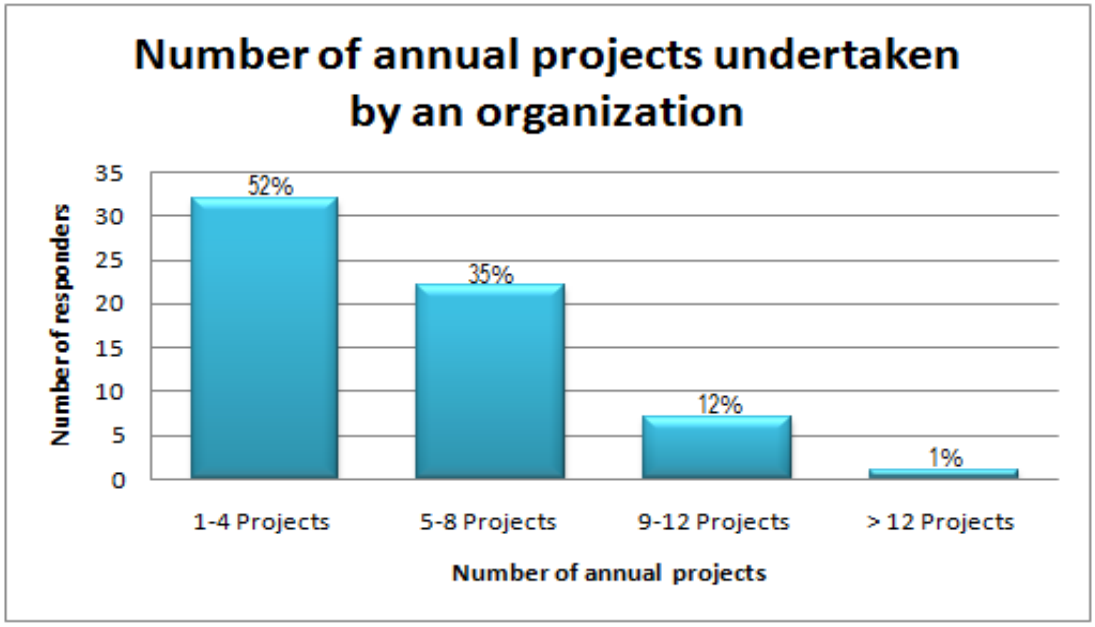



Figure 10: Annual number of projects undertaken by an organization

### 4.3.5 Partnership Agreement with a Supplier

In order to improve the survey accuracy related to the relationship with a supplier, the respondents were asked if their companies have any partnership agreement with their supplies or not. As it is illustrated in Figure 11, the vast majority of the respondents' firms were established partnership agreement with 78%, while 20% of the participators organization have not such an agreement and only 2% of participators were not sure about it.

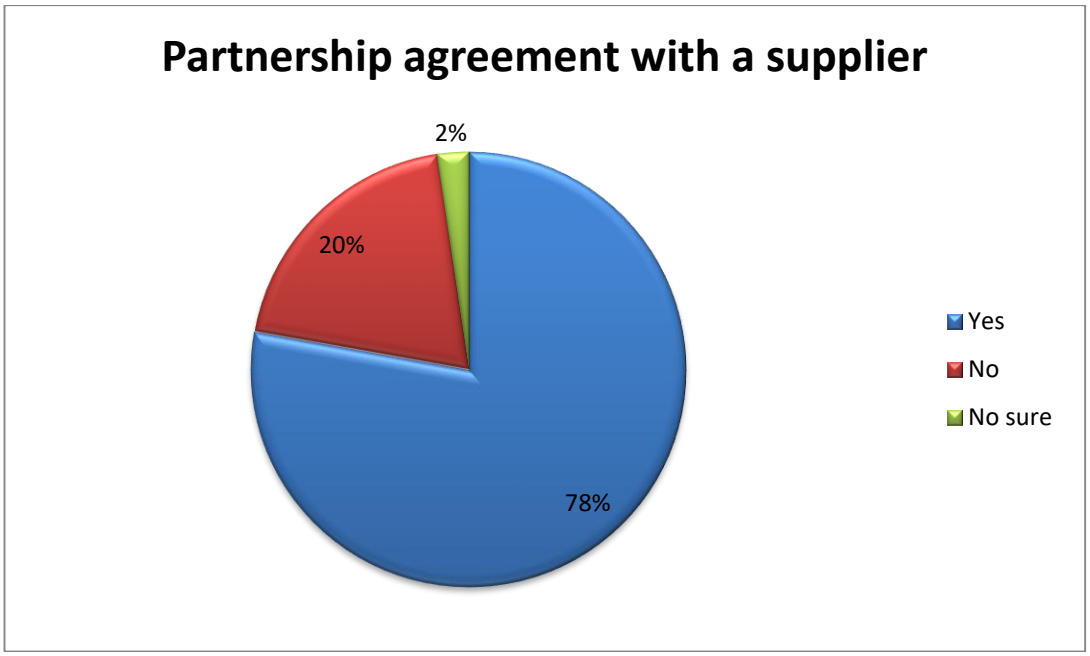


Figure 11: Partnership agreement with a supplier

### 4.3.6 The Favorite Relationship with a Supplier

The responders were asked about their opinions regarding to the relationship with their suppliers, 68% of the responders were preferred to establish a long term relationship with their providers, whereas only 32% of the participators were tend to have a one-off relationship with their suppliers as it shown in Figure 12.

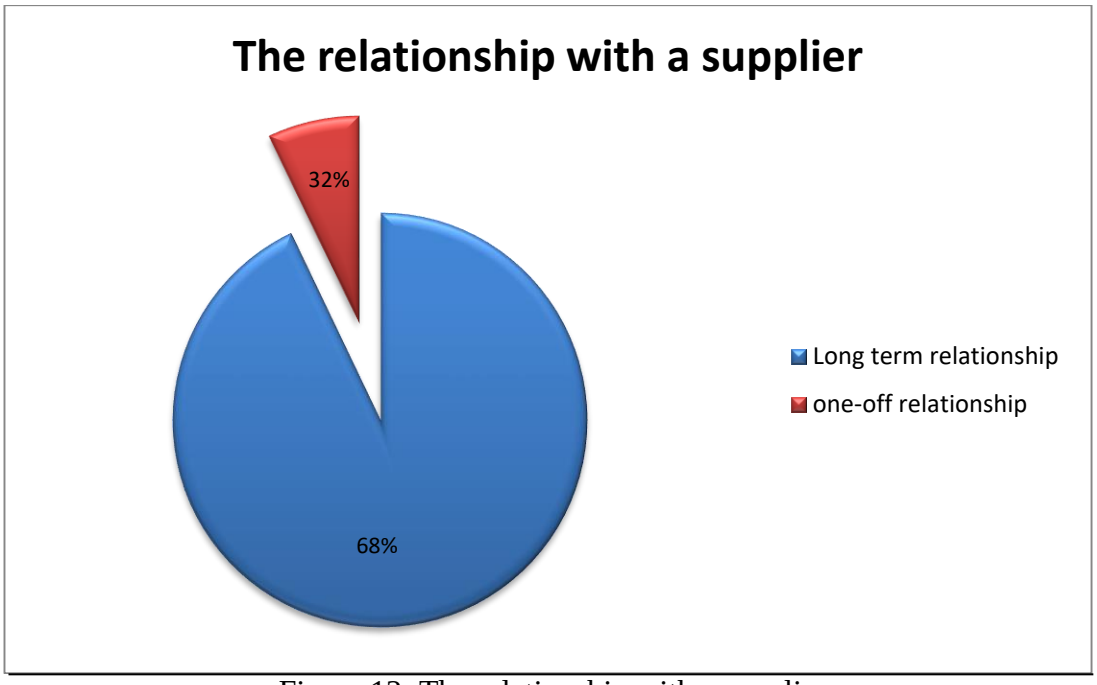


Figure 12: The relationship with a supplier

### 4.3.7 The Dependence of a Supplier Selection

In order to evaluate the importance of the factors affecting suppliers' selection, a question related to the system of selection suppliers for the responders' companies were sit. The majority of responders with 47% were believed that the price is the most important factor when choosing a supplier. The recommendation was chosen after that with 29% followed by experience of supplier with 19%, and only 5% from participators were selected the market reputation as it is shown in Figure 13.

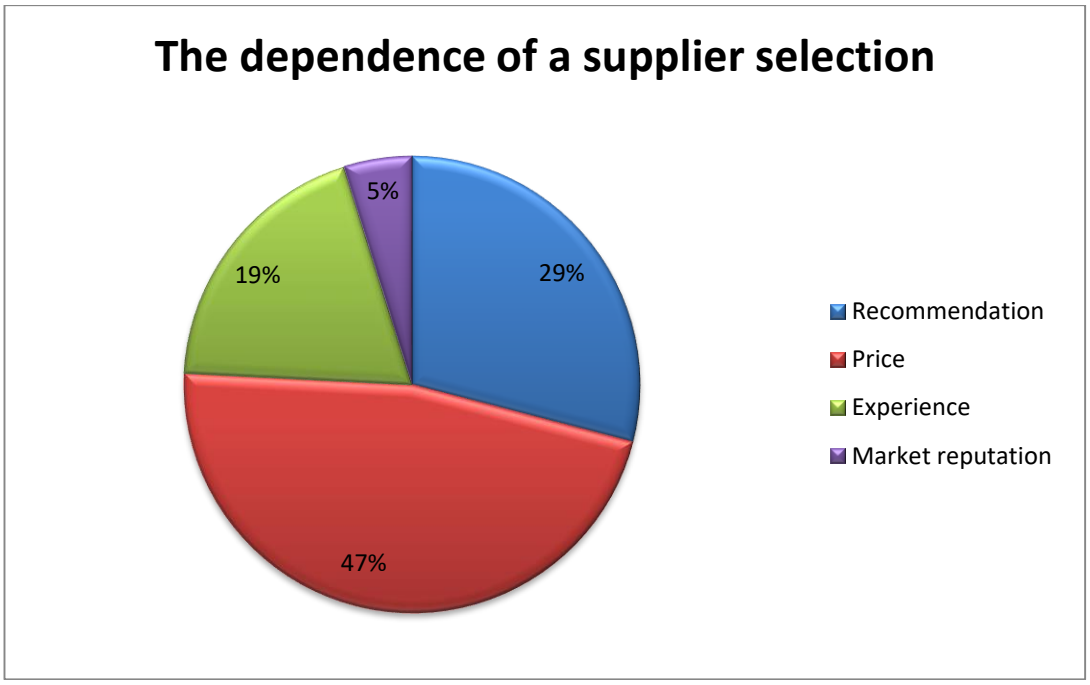


Figure 13: The dependence of a supplier selection

## 4.4 Factor Analysis and Reliability Test (Cronbach α)

For ensuring the reliability of the questionnaire factors, Cronbach's alpha is being used to check the internal consistency of these factors. This reliability coefficient (α) has been determined for each of the categories aforementioned. The loading factors had a minimum value of 0.548 and a maximum of 0.868, indicating that some factors have high and low acceptable levels of reliability. The efficiency of CSCM organization and the relationship among CSCM parties (suppliers, contractors, and client) have scored the highest reliability coefficient (α) with values 0.788 and 0.780 respectively. Meanwhile, trust and reliable delivery date have achieved the highest factor loading of 0.868 and 0.803 respectively. Furthermore, Inventory and production planning have achieved the highest factor loading of 0.856 and 0.621 respectively. Table 7 provide the results of Factor Analysis and Cronbach test of the factors affecting the CSCM implementation in construction projects. Table 7

provides the results of factor analysis and Cronbach test of the factors affecting the CSCM implementation in construction projects.

Table 7: Results of Factor Loading and Cronbach coefficient affecting the CSCM implementation in construction industry

| Categorize | Factors | Factor Loading | Cronbach (α) |
|---|---|---|---|
| **The relationship among CSCM parties (suppliers, contractors, client)** | Reliable delivery date | 0.803 | 0.780 |
| | Accurate order fulfillment | 0.762 | |
| | Flexibility | 0.735 | |
| | Fast order cycle time | 0.645 | |
| | Quality of materials | 0.643 | |
| | Quality of service | 0.637 | |
| | More frequent meetings | 0.585 | |
| | Free flow of information | 0.565 | |
| | Top management support | 0.557 | |
| | Trust | 0.868 | |
| **SCM dependence on organizational relationships** | Long term and stable relationships | 0.840 | 0.715 |
| | Open exchange of data and information | 0.730 | |
| | Earlier involvement | 0.729 | |
| | Greater trust in relationships | 0.806 | |
| **The efficiency of CSCM organization** | Inventory | 0. 856 | 0.788 |
| | Transportation | 0.564 | |
| | Lead Time | 0.592 | |
| | Purchasing | 0.548 | |
| | Production Planning | 0.621 | |
| | Storage | 0.611 | |
| **Developing CSCM collaboration** | Improved customer service | 0.790 | 0.709 |
| | Overall supply chain reduction | 0.722 | |
| | Increased profitability | 0.703 | |
| | Reducing bureaucracy/ paperwork | 0.628 | |
| | Cost reductions within your organization | 0.561 | |
| | Benefits to the client | 0.581 | |

| | | | |
|---|---|---|---|
| | Benefits to your supplier | 0.539 | |
| **Barriers to CSCM integration** | Lack of top management commitment. | 0.567 | 0.741 |
| | Fragmentation of construction supply chain | 0. 856 | |
| | Poor understanding of SCM concept | 0.803 | |
| | Inappropriate organization structure to support system | 0.737 | |
| | Unrealistic program times | 0.715 | |
| | Low commitment of partners | 0. 609 | |
| | Strategic benefits unclear | 0. 660 | |
| | Lack of appropriate information technology | 0. 562 | |

While for the factors affecting construction performance within CSCM, trust between project partners, time predictability, and magnitude and frequency of contractual claims have achieved the highest factor loading of 0.807, 0.784, and 0.723 respectively. Additionally, all categories have scored an acceptable reliability coefficient (α) values with 0.825for reducing adversarial relationships in construction projectand0.794, 0.740, 0.707forimprove reliability between project partners, improve information sharing and adding value to the overall construction project respectively. Tables 8 illustrates the results of the factors affecting CSCM performance.

Table 8: Results of Factor Loading and Cronbach coefficient for factors affecting CSCM performance

| Categorize | Factors | Factor Loading | Cronbach(α) |
|---|---|---|---|
| **Reducing adversarial relationships in construction project** | Time predictability | 0.784 | 0.825 |
| | Cost predictability | 0.681 | |
| | Occupational health and safety | 0.762 | |
| | Site productivity | 0.571 | |
| **Adding value to the overall construction project** | Increased client satisfaction | 0.629 | 0.707 |
| | Reduce supply chain costs | 0.511 | |
| | Reduce working capital | 0.616 | |
| | Reduce direct labor and material | 0.547 | |
| | Transform fixed costs to variable costs | 0.517 | |
| **Improve information sharing in the construction process** | Effectiveness of communication systems | 0.621 | 0.740 |
| | Magnitude and frequency of contractual claims | 0.764 | |
| | Magnitude and frequency of contractual dispute | 0.723 | |
| | Reduction of paperwork and request for information documents | 0.541 | |
| **Improve reliability between project partners** | Trust between project partners | 0.807 | 0.794 |
| | Top management commitment | 0.550 | |
| | Frequency of arbitrations and law suits | 0.625 | |

Concerning the factor loading, some of the factors within relationship among CSCM parties' factors and SCM dependence on organizational relationships were deleted because of the presence of cross loading and failed some factors to meet the

threshold of factor loading which is 0.50. These factors as following: delivery at specified time, handling of complaints, added value, reduction of the number of suppliers and customers, clearer negotiation of common objectives, sharing learning and innovation, improved quality assurance and failure to share project information.

## 4.5 Relative Importance Index (RII) with Mean Scores and Standard Deviations (SD)

### 4.5.1 Relationship Among CSCM Parties

As is stated previously, to determine whether a factor can be considered as significant, the RII value should be calculated to rank the factors according to their importance. The statistical mean score has been calculated for each factor by examined their frequencies selection on SPSS software. The calculated RII value, SD and mean scores for each factor are provided in Table 9.

As it is clearly seen the trust between CSCM members has ranked 1st with (RII= 0.847) as the most significant factor affecting the successful supply chain relationship, whereas the quality of materials provided by suppliers has ranked as the 2nd significant factor with a value of RII equal 0.767.

### 4.5.2 SCM Dependence on Organizational Relationships

After conducting the analysis of RII for SCM dependence to determine the critical factors SCM based on, it results that the long term and stable relationships has the most significant with (RII=0.755) makes it ranked as 1st factor before creating trust and earlier involvement which are ranked 2nd and 3rd with RII of 0.738 and 0.734 respectively.

### 4.5.3 Efficiency of CSCM Organization

Regarding to functions affecting the efficiency of SCM in construction organization, the inventory of materials and equipment has considered to ranked 1st by an obtained

RII value of 0.742 followed by storage and transportation with RII up to 0.730 and 0.683 respectively.

### 4.5.4 Developing CSCM Collaboration

In the objectives of developing CSCM collaboration increased profitability of construction industry is ranked 1st with RII accessed 0.784 while cost reductions within an organization come in the 2nd order by RII value of 0.667. Which indicates the importance of the financial resources within CSCM collaboration.

### 4.5.5 Barriers to CSCM Integration

The poor understanding of SCM concept has been ranked 1st as the most significant barriers to adopting SCM in construction process with RII up to 0.813, followed by the lack of top management commitment and appropriate information technology with RII 0.794 ranked 2nd and 0.738 ranked 3th respectively. Whereas, unrealistic program times comes at the end of the listed barriers of CSCM integration with 0.705 value of RII.

Table 9: Ranking of factors affecting SCM implementation using Mean, Standard Deviation, and RII

| Categorize | Factors | Mean | Std. Deviation | RII | Ranking |
|---|---|---|---|---|---|
| **The relationship among CSCM parties (suppliers, contractors, client)** | Reliable delivery date | 3.10 | 0.928 | 0.614 | 8 |
| | Accurate order fulfillment | 3.29 | 0.967 | 0.755 | 7 |
| | Flexibility | 3.37 | 0.792 | 0.670 | 5 |
| | Fast order cycle time | 3.67 | 1.140 | 0.732 | 4 |
| | Quality of materials | 3.84 | 0.787 | 0.767 | 2 |
| | Quality of service | 3.35 | 0.936 | 0.667 | 6 |
| | More frequent meetings | 2.59 | 0.941 | 0.508 | 10 |

| | | | | | |
|---|---|---|---|---|---|
| | Free flow of information | 3.78 | 0.880 | 0.660 | 3 |
| | Top management support | 2.95 | 1.052 | 0.593 | 9 |
| | Trust | 4.24 | 0.946 | 0.847 | 1 |
| **SCM dependence on organizational relationships** | Long term and stable relationships | 3.78 | 0.991 | 0.755 | 1 |
| | Open exchange of data and information | 3.57 | 0.837 | 0.715 | 4 |
| | Earlier involvement | 3.67 | 0.916 | 0.734 | 3 |
| | Greater trust in relationships | 3.69 | 0.964 | 0.738 | 2 |
| **The efficiency of CSCM organization** | Inventory | 3.71 | 1.325 | 0.742 | 1 |
| | Transportation | 3.41 | 1.381 | 0.683 | 3 |
| | Lead Time | 3.38 | 1.084 | 0.677 | 4 |
| | Purchasing | 3.17 | 1.171 | 0.636 | 5 |
| | Production Planning | 2.70 | 1.148 | 0.543 | 6 |
| | Storage | 3.65 | 1.180 | 0.730 | 2 |
| **Developing CSCM collaboration** | Improved customer service | 3.30 | 0.998 | 0.661 | 3 |
| | Overall supply chain reduction | 2.94 | 1.091 | 0.591 | 4 |
| | Increased profitability | 3.92 | 0.981 | 0.784 | 1 |
| | Reducing bureaucracy/ paperwork | 2.49 | 1.078 | 0.503 | 6 |
| | Cost reductions within your organization | 3.33 | 0.948 | 0.667 | 2 |
| | Benefits to the client | 2.86 | 1.105 | 0.574 | 5 |
| | Benefits to your supplier | 2.48 | 1.122 | 0.501 | 7 |
| **Barriers to CSCM integration** | Lack of top management commitment | 3.97 | 0.861 | 0.794 | 2 |
| | Fragmentation of construction supply chain | 3.89 | 0.774 | 0.778 | 4 |
| | Poor understanding of SCM concept | 4.06 | 0.588 | 0.813 | 1 |
| | Inappropriate organization structure to support system | 3.91 | 0.710 | 0.782 | 3 |

| | | | | | |
|---|---|---|---|---|---|
| **Barriers to CSCM integration** | Unrealistic program times | 3.52 | 0.992 | 0.705 | 8 |
| | Low commitment of partners | 3.58 | 0.989 | 0.717 | 7 |
| | Strategic benefits unclear | 3.66 | 0.821 | 0.732 | 6 |
| | Lack of appropriate information technology | 3.69 | 0.924 | 0.738 | 5 |

### 4.5.6 Factors Affecting CSCM Performance

In order to improve the performance of construction industry several factors should be considered such as reducing the adversarial relationships, improving information sharing, maximizing project value and Improving reliability between project partners. As it is illustrated in Table 10, the time predictability of project has significant effects on reducing the adversarial relationships in construction processes with RII accessed 0.813, while the most significant factor contributes to increase the project value is transform fixed costs to variable costs with 0.805 value of RII. The Effectiveness of communication systems with RII up to 0.789 has considered to be a critical factor when it comes to improving information sharing in the construction process, however, the top management commitment is evaluated as the most supportive factor to improve reliability between project partners by RII value equal to 0.766.

Table 10: Ranking of factors affecting CSCM performance using Mean, Standard Deviation, and RII

| Categorize | Factors | Mean | Std. Deviation | RII | Ranking |
|---|---|---|---|---|---|
| **Reducing adversarial relationships in construction project** | Time predictability | 4.06 | 0.892 | 0.813 | 1 |
| | Cost predictability | 3.61 | 0.989 | 0.722 | 3 |
| | Occupational health and safety | 3.51 | 0.821 | 0.703 | 4 |
| | Site productivity | 3.76 | 0.924 | 0.752 | 2 |
| **Adding value to the overall construction project** | Increased client satisfaction | 3.14 | 1.111 | 0.630 | 4 |
| | Reduce supply chain costs | 3.28 | 1.431 | 0.657 | 3 |
| | Reduce working capital | 2.90 | 1.187 | 0.582 | 5 |
| | Reduce direct labor and material | 3.84 | 0.919 | 0.768 | 2 |
| | Transform fixed costs to variable costs | 4.03 | 0.718 | 0.805 | 1 |
| **Improve information sharing in the construction process** | Effectiveness of communication systems | 3.95 | 0.869 | 0.789 | 1 |
| | Magnitude and frequency of contractual claims | 3.37 | 1.348 | 0.675 | 4 |
| | Magnitude and frequency of contractual dispute | 3.59 | 1.213 | 0.718 | 3 |
| | Reduction of paperwork and request for information documents | 3.63 | 1.005 | 0.726 | 2 |
| **Improve reliability between project partners** | Trust between project partners | 3.14 | 0.988 | 0.630 | 2 |
| | Top management commitment | 3.83 | 0.976 | 0.766 | 1 |
| | Frequency of arbitrations and law suits | 3.07 | 0.995 | 0.616 | 3 |

## 4.6 Pearson Correlation and Significance Test Analyses

In order to determine if there is a significant relationship among the four (4) significant factors indicated CSCM performance, the Pearson's Correlation analysis was applied using SPSS. In addition, the four hypothesis were sit and tested by applied aforementioned approaches explained in chapter three. If p-value less than or even equal to 0.05, therefore, there is a significant relationship between the tested variables. The result from correlation analysis is illustrated in Table 11.

Table 11: Pearson Correlation Analysis for the top four significant performance factors

| Variables | | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| Time predictability | **Correlation**<br>ρ-value | **1.000** | | | |
| Transform fixed costs to variable cost | **Correlation**<br>ρ-value | **0.421***<br>0.001 | **1.000** | | |
| Effectiveness of communication systems | **Correlation**<br>ρ-value | **0.568***<br>0.001 | **0.342***<br>0.001 | **1.000** | |
| Top management commitment | **Correlation**<br>ρ-value | **0.590***<br>0.001 | **0.462***<br>0.001 | **0.489***<br>0.001 | **1.000** |

* Correlation is significant at the 0.01 level (2-tailed).

What can be conclude from the above, is that there are significant relationships between all the four indicators since all the ρ-value interaction sout comes are 0.001 which is several time less than 0.05.

## 4.7 Hypotheses Testing

As it is mentioned previously, t-teat method was applied to examine the four hypotheses related to effects of the significant four factors resulted from RII test on CSCM performance. Each hypothesis was tested by defining $H_0$and H1 as follows:

$H_0$ = Null hypothesis.

$H_1$ = Alternative hypothesis.

The first hypothesis test if there is a significant correlation between reducing the adversarial relationships in construction process and predicting project time and cost. The hypothesis as follows:

$H_0$: Predict the project time and cost does have significant interaction with reduce the adversarial relationships in construction process.

$H_1$: Predict the project time and cost does not have significant interaction with reduce the adversarial relationships in construction process.

The t-test results from the first hypothesis are given in Table 12. As it is obtained a significance (2-tailed) of 0.03, which is less than 0.05, thus, this means $H_0$ has to be rejected and concluding that there is no significant interaction between the two factors.

The second hypothesis test if there is a significant correlation between adding value to project and transform fixed costs to variable costs. The hypothesis as follows:

$H_0$: Transform fixed costs to variable costs does have significant interaction with adding value to the project.

$H_1$: Transform fixed costs to variable costs does not have significant interaction with adding value to the project.

The t-test results from the second hypothesis are provided in Table 13. As it is obtained a significance (2-tailed) of 0.118, which is more than 0.05, thus, this means that $H_0$ cannot be rejected and concluding that there is significant interaction between the two factors.

The third hypothesis test if there is a significant correlation between improve information sharing in the construction process and effectiveness of communication systems. The hypothesis as follows:

$H_0$: The effectiveness of communication systems does have significant interaction with improving information sharing in the construction process.

$H_1$: The effectiveness of communication systems does not have significant interaction with improving information sharing in the construction process.

The t-test results from the third hypothesis are provided in Table 14. As it is obtained a significance (2-tailed) of 0.368, which is greater than 0.05, hence, this means that $H_0$ cannot be rejected and concluding that there is significant interaction between the two factors.

The fourth hypothesis test if there is a significant correlation between improve reliability between project partners and top management commitment. The hypothesis as follows:

$H_0$: Top management commitment does have significant interaction with improving reliability between project partners.

$H_1$: Top management commitment does not have significant interaction with improving reliability between project partners.

The t-test results from the fourth hypothesis are provided in Table 15. As it is obtained a significance (2-tailed) of 0.316, which is greater than 0.05, consequently, this means that $H_0$ cannot be rejected and concluding that there is significant interaction between the two factors.

Table 12: t-test results for "adversarial relationships in construction process" and" predicting project time and cost"

**Paired Samples Test**

| | Paired Differences | | | | | t | df | Sig. (2-tailed) |
|---|---|---|---|---|---|---|---|---|
| | | | | 95% Confidence Interval of the Difference | | | | |
| | Mean | Std.Deviation | Std. Error Mean | Lower | Upper | | | |
| Pair: Factor 1 Factor 2 | .460 | 1.1644 | .207 | .046 | .874 | 2.22 | 61 | .030 |

Table 13: t-test results for "adding value to project" and "transform fixed costs to variable costs"

**Paired Samples Test**

| | Paired Differences | | | | | t | df | Sig. (2-tailed) |
|---|---|---|---|---|---|---|---|---|
| | | | | 95% Confidence Interval of the Difference | | | | |
| | Mean | Std.Deviation | Std. Error Mean | Lower | Upper | | | |
| Pair: Factor 1 Factor 2 | .206 | 1.034 | .130 | -.054 | .467 | 1.58 | 61 | .118 |

Table 14: t-test results for "improve information sharing in the construction process" and "effectiveness of communication systems"

**Paired Samples Test**

| | Paired Differences | | | | | t | df | Sig. (2-tailed) |
|---|---|---|---|---|---|---|---|---|
| | | | | 95% Confidence Interval of the Difference | | | | |
| | Mean | Std.Deviation | Std. Error Mean | Lower | Upper | | | |
| Pair: Factor 1 Factor 2 | 0.133 | 1.261 | .497 | -.158 | 0.425 | .902 | 61 | 0.368 |

Table 15: t-test results for "improve reliability between project partners" and "top management commitment"

**Paired Samples Test**

| | Paired Differences | | | | | t | df | Sig. (2-tailed) |
|---|---|---|---|---|---|---|---|---|
| | | | | 95% Confidence Interval of the Difference | | | | |
| | Mean | Std.Deviation | Std. Error Mean | Lower | Upper | | | |
| Pair: Factor 1 Factor 2 | .159 | 1.247 | .571 | -.155 | .473 | 1.01 | 61 | .316 |

# Chapter 5

# DISCUSSION

## 5.1 Introduction

This chapter provides a detailed discussion of the research findings in comparison with the previous studies and addressed the significant outcomes regarding to the factors affecting CSCM application. In addition, a conceptual framework for SCM implementation in LCI is presented at the end of this chapter.

## 5.2 Relationship Between CSCM Parties

The most important factor for successful relationship between supply chain members identified by the Libyan contractor companies is trust followed by quality of materials provided by suppliers and then free flow of information between CSC members. The trust and free flow of information sharing were among the top five factors identified by PE Consulting (1997) and it is similar to Akintoye et al. (2000) results. Moreover, as Schultz and Unruh (1996) have concluded to improve the information and materials flows among the firms' stakeholders it is crucial to implant reliability and mutual trust between project parties.

Regarding to the SCM dependence, the long term and stable relationship among CSC parties were identified as a critical factor, as Jiang et al. (2011) concluded especially when considering large and continuously projects. The importance of stable relationship between CSC members can be interpreted as the difficulty of finding the

alternative member with appropriate characteristic in terms of supply chain processes.

## 5.3 Efficiency of CSCM Organization

Unlike the traditional management procedures, SCM tends to gather the fragmented activities to improve the effectively of construction process organization. In this area the inventory, storage and transportation has ranked as the most significant function, whereas production planning has identified as the lowest affecting factor. These results contrast with those concluded by Akintoye et al. (2000) which revealed that production planning is more paramount for both contractors and materials' suppliers.

## 5.4 Developing CSCM Collaboration

The evaluation of the most important collaboration objectives has resulted that increased profitability and cost reductions within an organization are among the significant objectives for construction firms in developing supply chain relationships with either clients, these results are quite different from what Akintoye et al. (2000) have stated, who have concluded that benefits to the client and benefits to supplier are the most important aims in developing the collaboration within CSC process.

## 5.5 Barriers to CSCM Integration

After conducting the RII analysis to determine the most significant barrier to CSCM integration, it has been concluded that the poor understanding of SCM concept, lack of top management commitment and inappropriate organization structure are the most significant barriers to CSCM integration respectively. These outcomes are relatively corresponding with the results obtained by Karataş (2009). However, the recorded results obtained in this research are somehow contradictory with what Serpell and Heredia (2004) concluded in their survey, which has concluded that

fragmentation of construction project is the most significant barrier to control the supply chain processes in construction industry.

## 5.6 Factors Affecting CSCM Performance

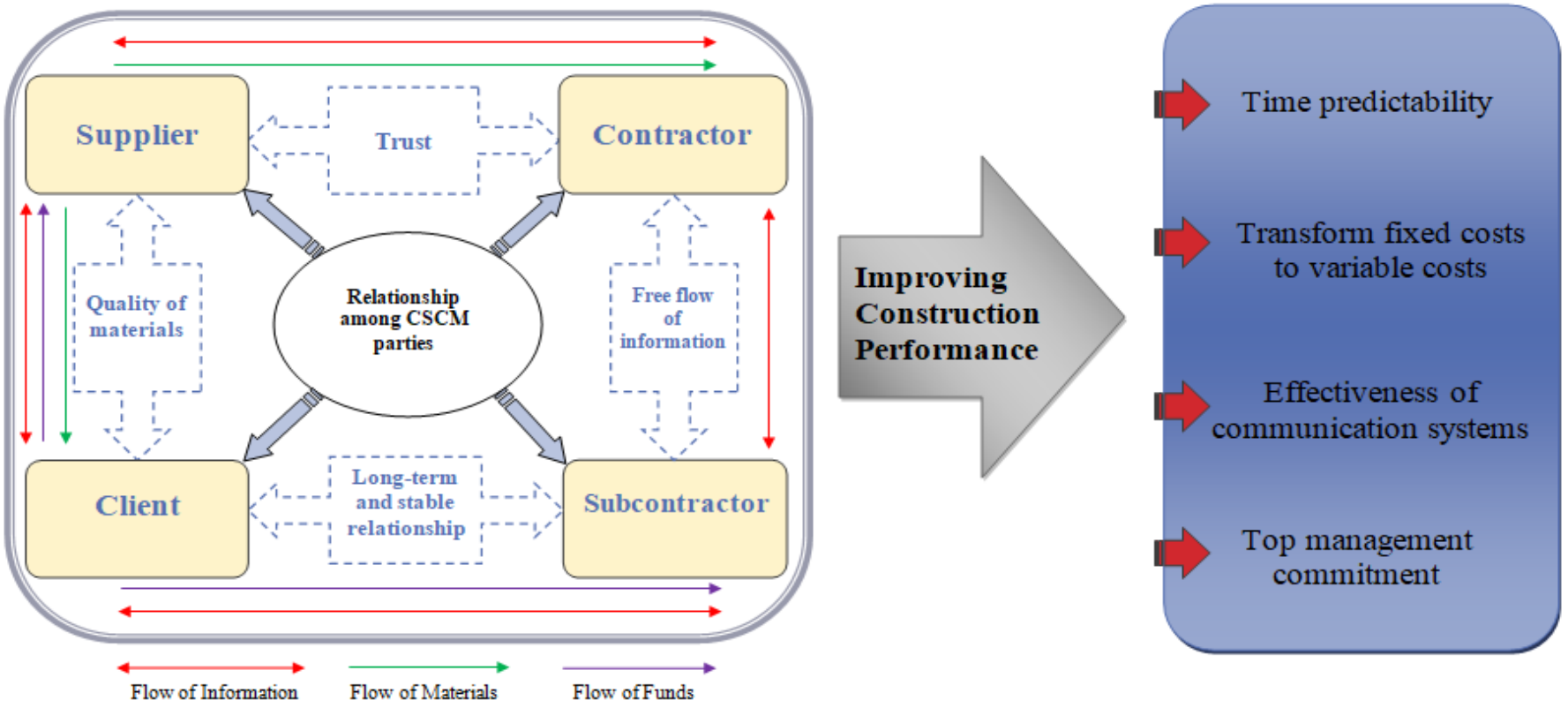
The quality of relationship, reliability and information sharing between construction project parties are among the most significant indicators which determining the degree of CSCM performance (Martella, 2000). The survey in this study have resulted that time predictability and site productivity are among the most influential factors contributing to reduce adversarial relationships in construction industry while transforming fixed costs to variable costs has been evaluated as a significant factor to maximize the project value. These outcomes are slightly different from those which recorded by Emuze (2010), who has stated that increase client and contractors' satisfaction, and reduce working capital cannot only measure the project value but also eliminate the fragmentation in construction projects.

Regarding to improving the information sharing and reliability between project partners, as it was expected the effectiveness of communication systems and top management commitment has been considered among the most critical factors for increasing the CSCM performance. The quality of communication systems and coordination can contribute to facilitate flows of information, materials and cash between CSCM parties which reflecting positively on construction performance.

## 5.7 Conceptual Framework for SCM Implementing in LCI

This section provides a conceptual framework for implementing SCM conception in Libyan construction industry LCI developed by the researcher. This framework model represents the resulted of influential factors which have significant effects to SCM application in LCI. The framework consists of two categories which are the successful relationship between CSCM parties and improvement of construction performance.

The quality of relationship and communication between CSCM members including suppliers, contractors, subcontractors and client considered to be the most important key for developing a successful supply chain within construction projects. Well-established partnership based on mutual trust, free sharing information and partners' building stable and long-term relationships between the CSCM players can contribute effectively to improve the project performance.




**Flow of Information**: involves demands forecasts, order transmission and generating delivery status report.
**Flow of Funds**: involves commercial information, payment schedule, ownership arrangements and consignment details.
**Flow of Materials**: involves physical product flow from the supplier to chain via the contractor and the reverse as well through product return, disposal, and recycling.

Figure 14: Conceptual Framework for SCM Implementing in LCI

**Trust**

- Mutual trust within and between CSCM members reflects on the quality of relationship exist at both interpersonal and inter-organizational level.
- Trust in CSC system should be defined as rely on, believe in and accept vulnerability to the actions of sharing information, supply materials, flows of cash.
- The top management support can play effective role in enhancing the trust and reliability between construction parties which results in increase project productivity and performance.

**Free flow of information**

- Information sharing between CSCM parties should be involved at early stages of the project execution.
- This flow includes materials required, delivered time, order transmission and demands forecasts.

**Quality of materials**

- In order to establishing and maintaining intimate relationship between suppliers and clients which is this case the construction companies it is crucial to ensure the materials' qualities.
- The client should determine the quality level of the required materials and the suppliers should commit to provide these materials with desired quality.

**Long-term and stable relationship**

- Found a long-term and constant relationship among the CSC parties including suppliers, contractor and client can contribute positively to enhance collaboration and coordination between the mentioned members.
- Having a long-term and successful relationship with a specific supplier or contractor can save the time and cost to look for new alternative with appropriate features.
- The long term and worthy relation between construction players can be achieved by mutual trust and commitment which finally leads to increase satisfactions, performance and value of project.

A summary of the most significant factors affecting SCM implementation in LCI is provided as framework in Figure 15.

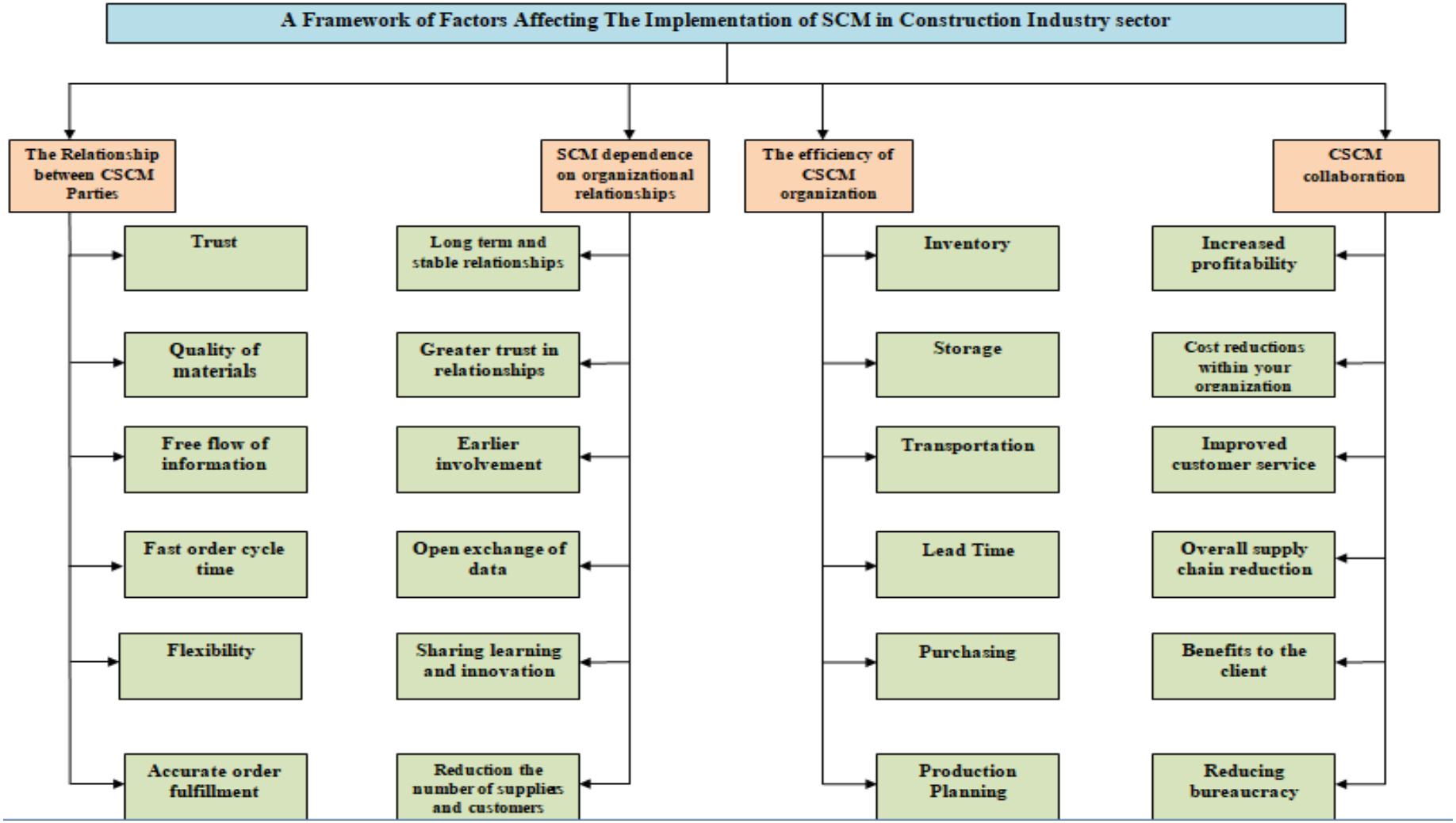



Figure 15: A framework of factors affecting the implementation of SCM in construction industry

# Chapter 6

# CONCLUSION AND RECOMMENDATION

## 6.1 Introduction

The conclusions and obtained knowledge related to adopting SCM in construction industry of Libya are presented in this chapter, which is divided into three parts as follows: the overall findings and conclusions drawn from the questionnaire survey analyses, limitations of the presented research and suggested recommendations for future studies and investigations in this field.

## 6.2 Conclusion

After the completion of this study, the conclusions are given in points as follows:

1. Trust is considered as the most important factors for a successful relationship between CSCM parties followed by the quality of materials provided and then free flow of information comes after that in this category.

2. Regarding to SCM dependence, long term and stable relationships and earlier involvement of project members are evaluated among the effective factors which CSCM process based on.

3. The efficiency of CSCM organization can be improved by enhancing the functions of inventory, storage and transportation in respective importance.

4. In order to develop CSCM collaboration the most important objective in this category is recorded for increasing the profitability followed by reducing the cost within construction organization.

5. Poor understanding of SCM concept is considered as the most significant barrier to CSCM integrating, whereas, lack of top management commitment and inappropriate organization structure come after that respectively. However, unrealistic program times is evaluated as the least important barrier in this category.

6. Related to the factors affecting the project performance, the time predictability and site productivity are chosen as critical factors for reducing adversarial relationships, while the effectiveness of communication systems and top management commitment are considered among the most effective factors to improve the information sharing and reliability between project partners.

## 6.3 Research Limitation

Although the presented CSCM framework in the current study is applicable in any construction projects, this research study is limited to implementation of this conceptual framework in LCI only, since all participated respondents of the questionnaire survey were chosen from researchers and practitioner involved in LCI.

## 6.4 Recommendation

1. In order to improve the performance of construction industry sector in Libya the contractor organizations should give more attention for involving SCM in their projects.

2. To enhance the integration of SCM in construction industry sector and increase the effectiveness and efficiency within supply chain process BIM technology should be adopted.

3. The data collected in this study was obtained from both public and private sectors, more accurate results can be concluded by separating these sectors and focusing on public and huge organizations which have adopted SCM concept in their projects.

4. It would be worthy if a similar study can be conducted and validated in other developing countries, since the variations in different aspects such as culture, locality, political views and economic situation could result in different results.

5. Further research should consider other aspects such as the budget allocations, government policies, strategic planning, as well as facets of the nation's economy.

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# APPENDIX

## Appendix A: Survey Questionnaire

Dear participator:

This survey is part of a research for master degree thesis in civil engineering department with specialization in construction management felid at Eastern Mediterranean University which is located in North Cyprus.

You have been kindly asked to voluntarily participate in the current study titled "Construction Supply Chain Management Implementation in Libyan Construction Industry", which aiming to analyze the effects of supply chain management on the entire relationships of construction projects' parties and its implementation to improve project performance in Libyan construction industry. In addition, a proposed framework for implementing the concepts of SCM in Libyan construction industry will be presented as a result of this study.

This survey is designed to collect information about your knowledge and understanding of SCM implementation in construction industry. As well as your opinions about the factors affecting the implementation of SCM within your organization. I would be very grateful if you could answer all questions as completely and accurately as possible. Be sure that your responses will be kept confidential and used for academic issues only. If you have any questions about this study, please do not hesitate to contact me at (mhdy.90.23@gmail.com) or on (+905338539038-KKTCELL), North Cyprus.

Thank you for your participation.

Researcher: **ALMAHDI M. A. ELFERGHANI**
Supervisor: **ASSOC.PROF.DR. İBRAHİM YİTMEN**

# Construction Supply Chain Management Implementation in Libyan Construction Industry
## Section 1:General Information

*Required

1. **What is your position in your firm?** *
   *Mark only one oval.*

   - ◯ Project Manager
   - ◯ Quality Manager
   - ◯ Purchasing Manager
   - ◯ Contractor
   - ◯ Site engineer
   - ◯ Owner
   - ◯ Other: _____

2. **What is the highest formal qualification you hold?** *
   *Mark only one oval.*

   - ◯ Diploma
   - ◯ First degree (BSc)
   - ◯ Postgraduate degree (MSc, PhD)

3. **How long have you been involved in Libyan construction industry?** *
   *Mark only one oval.*

   - ◯ 1 to 5 Years
   - ◯ 6 to 10 Years
   - ◯ 11 to 15 Years
   - ◯ More than 15 Years

4. **Approximately, number of annual projects undertaken by your organization?** *
   *Mark only one oval.*

   - ◯ 1 to 4 Projects
   - ◯ 5 to 8 Projects
   - ◯ 9 to 12 Projects
   - ◯ More than 12 Projects

5. **Do you have any partnership agreements with any of your suppliers?** *
*Mark only one oval.*

- ◯ Yes
- ◯ No
- ◯ Not sure

6. **What kind of relationship do you prefer to establish with your suppliers?** *
*Mark only one oval.*

- ◯ One-off relationship
- ◯ Long term relationships

7. **Does your organization have any system in place for the selection of suppliers, if yes how does your company select a vendor or supplier based on?** *
*Mark only one oval.*

- ◯ Recommendation
- ◯ Price
- ◯ Experience
- ◯ Market reputation
- ◯ Other: _____

## Section 2: The Organization Relationships Section 2.1: Factors Affecting The Relationship Between CSCM Parties

8. **How important are the following factors when developing a successful supply chain relationship between CSCM parties including supplier, contractor and client?** *
*Mark only one oval per row.*

| | Unimportant | Less Important | Normal | Important | Very important |
|---|---|---|---|---|---|
| Reliable delivery date | ◯ | ◯ | ◯ | ◯ | ◯ |
| Accurate order fulfillment | ◯ | ◯ | ◯ | ◯ | ◯ |
| Delivery at specified time | ◯ | ◯ | ◯ | ◯ | ◯ |
| Flexibility | ◯ | ◯ | ◯ | ◯ | ◯ |
| Fast order cycle time | ◯ | ◯ | ◯ | ◯ | ◯ |
| Handling of complaints | ◯ | ◯ | ◯ | ◯ | ◯ |
| Added value | ◯ | ◯ | ◯ | ◯ | ◯ |
| Quality of materials | ◯ | ◯ | ◯ | ◯ | ◯ |
| Quality of service | ◯ | ◯ | ◯ | ◯ | ◯ |
| Free flow of information | ◯ | ◯ | ◯ | ◯ | ◯ |
| More frequent meetings | ◯ | ◯ | ◯ | ◯ | ◯ |
| Top management support | ◯ | ◯ | ◯ | ◯ | ◯ |
| Trust | ◯ | ◯ | ◯ | ◯ | ◯ |

5. **Do you have any partnership agreements with any of your suppliers?** *
*Mark only one oval.*

- ◯ Yes
- ◯ No
- ◯ Not sure

6. **What kind of relationship do you prefer to establish with your suppliers?** *
*Mark only one oval.*

- ◯ One-off relationship
- ◯ Long term relationships

7. **Does your organization have any system in place for the selection of suppliers, if yes how does your company select a vendor or supplier based on?** *
*Mark only one oval.*

- ◯ Recommendation
- ◯ Price
- ◯ Experience
- ◯ Market reputation
- ◯ Other: _____

## Section 2: The Organization Relationships Section 2.1: Factors Affecting The Relationship Between CSCM Parties

8. **How important are the following factors when developing a successful supply chain relationship between CSCM parties including supplier, contractor and client?** *
*Mark only one oval per row.*

| | Unimportant | Less Important | Normal | Important | Very important |
|---|---|---|---|---|---|
| Reliable delivery date | ◯ | ◯ | ◯ | ◯ | ◯ |
| Accurate order fulfillment | ◯ | ◯ | ◯ | ◯ | ◯ |
| Delivery at specified time | ◯ | ◯ | ◯ | ◯ | ◯ |
| Flexibility | ◯ | ◯ | ◯ | ◯ | ◯ |
| Fast order cycle time | ◯ | ◯ | ◯ | ◯ | ◯ |
| Handling of complaints | ◯ | ◯ | ◯ | ◯ | ◯ |
| Added value | ◯ | ◯ | ◯ | ◯ | ◯ |
| Quality of materials | ◯ | ◯ | ◯ | ◯ | ◯ |
| Quality of service | ◯ | ◯ | ◯ | ◯ | ◯ |
| Free flow of information | ◯ | ◯ | ◯ | ◯ | ◯ |
| More frequent meetings | ◯ | ◯ | ◯ | ◯ | ◯ |
| Top management support | ◯ | ◯ | ◯ | ◯ | ◯ |
| Trust | ◯ | ◯ | ◯ | ◯ | ◯ |

## Section 2.2: Factors Affecting SCM Dependence on Organizational Relationships

9. **How important are the following factors regarding to SCM dependence on intra- and inter-organizational relationships?** *

*Mark only one oval per row.*

| | Unimportant | Less important | Normal | Important | Very important |
|---|---|---|---|---|---|
| Long term and stable relationships | | | | | |
| Reduction of the number of suppliers and customers | | | | | |
| Open exchange of data and information | | | | | |
| Earlier involvement | | | | | |
| Clearer negotiation of common objectives | | | | | |
| Sharing learning and innovation | | | | | |
| Greater trust in relationships | | | | | |

## Section 3: The efficiency, Collaboration And Barriers Within CSCM. 3.1: Factors Affecting Efficiency of CSCM Organization

10. **To what extent do you consider that the following functions affect your efficiency of supply chain organization?** *

*Mark only one oval per row.*

| | To a very small extent | To a small extent | To a moderate extent | To a great extent | To a very great extent |
|---|---|---|---|---|---|
| Inventory | | | | | |
| Transportation | | | | | |
| Lead Time | | | | | |
| Purchasing | | | | | |
| Production Planning | | | | | |
| Storage | | | | | |

## Section 3.2: Factors Affecting Collaboration Development Within CSCM

11. **To what extent do you consider that the following objectives are important for your organization when considering developing a supply chain collaboration?** *

*Mark only one oval per row.*

| | To a very small extent | To a small extent | To a moderate extent | To a great extent | To a very great extent |
|---|---|---|---|---|---|
| Improved customer service | | | | | |
| Overall supply chain reduction | | | | | |
| Increased profitability | | | | | |
| Reducing bureaucracy/ paperwork | | | | | |
| Cost reductions within your organization | | | | | |
| Benefits to the client | | | | | |
| Benefits to your supplier | | | | | |
| Improved quality assurance | | | | | |

## Section 3.3: Barriers to CSCM Integration

12. **To what extent do you agree with the under listed relationship barriers to construction supply chain process ?** *

*Mark only one oval per row.*

| | To a very small extent | To a small extent | To a moderate extent | To a great extent | To a very great extent |
|---|---|---|---|---|---|
| Lack of top management commitment | | | | | |
| Fragmentation of construction supply chain | | | | | |
| Failure to share project information | | | | | |
| Poor understanding of SCM concept | | | | | |
| Inappropriate organization structure to support system | | | | | |
| Unrealistic program times | | | | | |
| Low commitment of partners | | | | | |
| Strategic benefits unclear | | | | | |
| Lack of appropriate information technology | | | | | |

## Section 4: The Effects of SCM on Construction Performance

13. **Using the under listed key performance indicators, on a scale of 1 (very poor) to 5 (very good) please indicate the effect of proactive supply chain management as a tool to reduce adversarial relationships in construction?** *

*Mark only one oval per row.*

| | Very poor | poor | Moderate | Good | Very good |
|---|---|---|---|---|---|
| Time predictability | | | | | |
| Cost predictability | | | | | |
| Occupational health and safety | | | | | |
| Site productivity | | | | | |

14. **Using the under listed key performance indicators, on a scale of 1 (very poor) to 5 (very good) please indicate the effect of proactive supply chain management as a tool to adding value for the overall project by considering the following factors?** *

*Mark only one oval per row.*

| | Very poor | poor | Moderate | Good | Very good |
|---|---|---|---|---|---|
| Increased client satisfaction | | | | | |
| Reduce supply chain costs | | | | | |
| Reduce working capital | | | | | |
| Reduce direct labor and material | | | | | |
| Transform fixed costs to variable costs | | | | | |

15. **Using the under listed key performance indicators, on a scale of 1 (very poor) to 5 (very good) please indicate the effect of proactive supply chain management as a tool to improve information sharing in the construction process?** *

*Mark only one oval per row.*

| | Very poor | poor | Moderate | Good | Very good |
|---|---|---|---|---|---|
| Effectiveness of communication systems | | | | | |
| Magnitude and frequency of contractual claims | | | | | |
| Magnitude and frequency of contractual dispute | | | | | |
| Reduction of paperwork and request for information documents | | | | | |

16. **Using the under listed key performance indicators, on a scale of 1 (very poor) to 5 (very good) please indicate the effect of proactive supply chain management as a tool to improve reliability between project partners?** *

*Mark only one oval per row.*

| | Very poor | poor | Moderate | Good | Very good |
|---|---|---|---|---|---|
| Trust between project partners | | | | | |
| Top management commitment | | | | | |
| Frequency of arbitration and law suits | | | | | |