

## **The Impact of Supply Chain Management Practice on the Jordanian Construction Projects Performance**

**By**

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### **Abstract**

The objective of this study is to investigate the impact of supply chain management practices on the Jordanian construction projects performance. A questionnaire survey was the main method of data collection for this study. 120 questionnaires were distributed to first and second grade contractors; 106 completed questionnaires were received. The data was analyzed by SPSS software; descriptive analysis and regression model were presented. The results revealed that the supply chain management practices have a positive impact on construction project performance. However, its impact on cost and time is variable more than customer satisfaction. In addition, the result showed that the most practices affecting the construction project are enhancing the trust and reliability between all parties followed by developing the flow of materials, manpower, information and cash flow in the project. The study recommends the general contractors to enhance their relations with clients, subcontractors and suppliers that will be positively reflected on the decision making process. Also, the general contractors are advised to develop the materials, labor, equipments and information flow in order to reduce delay and cost, and ensure customer satisfaction.

**Keywords:** Construction, Supply Chain management, Customer Satisfaction, Project Performance, and Contractors.

### **Introduction**

Construction industry is considered as one of the oldest and most important, dynamic, and responsive industries (Mahamid, 2016). It plays an essential role in the economic development (Khan, 2008). In addition to producing structure to add quality and productivity to the life (Dlamini, 2012), the construction industry creates more job opportunities. It also enhances the trade of materials, equipments and tools which generates the economic bloom of the country.

The goal of managers in the construction industry is to execute the projects with a high level of performance. The performance is measured by customers, the owner and contractor's satisfaction as well as the completion of the project within its

budget and time. There are many factors affecting the performance of the project such as the nature of the project, skills and knowledge of project parties, communication between parties, the availability of the materials and money, and management approach (Zavadskas et al,2014).

Construction industry involves complex and overlapping relationships between owners, contractors, sub-contractors and a supplier. It is a complex network of supply the materials, information, cash flow, equipment and labor. Hatmoko and Scott, (2010) identify the five types of flow in the construction projects:

- **Material flow:** the flow of materials affects the whole process of the project. Material management involves planning to determine required materials, purchasing with determined specification, control of inventory and distribution, handling and transfer. This process starts when suppliers receive orders from contractors to deliver the required materials to the site at the determined time as described by Patel and Vyas (2011). Any problems in this process such as not a timely order, or unorganized storage that usually causes a misuse of the time and effort of labor, lack of space for storage and supply of non-required materials leading to loss of time and effort and increase the budget, that can result in a delay of the project execution, increase cost and decrease labor productivity as explained by Gulghane and Khandve (2015).
- **Cash-flow:** after completion each process, the subcontractor demands that the main contractor pay the bills, and the main contractor demands that the owner pay the bills. Any delay in payment may lead to a dispute, thus, delay the project and increase the costs.
- **Labor flow:** labor has a significant role in the success of the project.

Assaf and Al-hejji, (2006) explains that low productivity, lack of skillfulness, labor shortages and weak motivation are the factors that affect a timely completion of the project.

- **Equipment flow:** Every process in a construction requires specific equipments. Therefore, any problem with the equipments such as insufficient number of equipment due to the high cost of some equipment, their breakdown, slow mobilization, low efficiency and accident in the project (Aziz, 2013) can alter the deadlines for the project completion.
- **Information flow:** The parties shall share all the information related to the project such as drawing, specifications, order and condition, and any alterations suggested in time since late communication may lead to a delay in decision making and also cause a controversy between the parties (Rahman et al, 2014).

These flows are defined as supply chain. In general, most of construction projects suffer from many problems such as delay, cost and poor quality which are related to supply chain management as indicated by Aneesa et al, 2015. Papadopoulos et al, (2016) showed that the supply chain management (SCM) can apply in the

construction industry and help achieve the best performance. It can establish good relationships between parties. Mamter et al, (2014) detected that the SCM proved its effectiveness in improving performance, achieving benefits for the contractor, minimizing waste of materials and labor, and reduction inventory level. Therefore, SCM is beneficial to the contractors.

Winjaet al, (2016) stated that SCM guarantees the efficiency of the materials, labor, finance, information and other flows in projects. It also improves communication, increases productivity, the number of the benefits and margin profit which influence the overall realization of construction project.

### **Significance of the Study**

Papadopoulos et al, (2016) showed that applying SCM in construction industry can provide many benefits such as increasing productivity, reduction in waste of time, materials and labor. Also, SCM lowers the cost overrun, decreases inventory level and increases the value of customer. This can prosper the construction industry in Jordan by raising the level of productivity and providing additional benefits to contractors, sub contractors, clients and suppliers.

In addition, this research will provide the background of the firms that are interested in applying SCM in their projects. It also will discuss the usefulness of SCM in this field, taking into consideration the rapid changes in construction sector in Jordan and a need to a new management approach to carry out these changes.

Based on Jordanian Construction Contractors Association (2017) 95% of Jordanian construction projects are lagging behind their schedule. In Jordan, the construction sector suffers from many problems due to owners, contractors or consultants' issues which cause the cost overrun and poor quality as indicated by Sweis et al (2008). The most significant problem is the project management problems which cause the delay in process, cost overrun and poor level of communication between parties as indicated by Assbeihat, 2005. Hence, this research will study the approach of SCM in a Jordanian construction project performance.

### **Research Aims and Objectives**

The overall aim of this research is to investigate the impact of supply chain management practices on Jordanian construction project performance. This aim can be translated into specific objectives, addressed by each research question as shown in table 1:

**Table 1: The Research Objectives**

What is the impact of SCM on the time of a construction project?	To reduce delay in project by improving the flows of materials, information, cash flow, labor and equipment; reducing the time will cause a speedy movement between two activities in chain.
What is the impact of SCM on budget of construction project?	When delay is reduced the cost will be lowered. Reduction of inventory time and using just in time method, will lead to the decrease of waste process and therefore, the cost will be saved. In addition, reducing the physical distance between any two activities helps in saving the cost.
What is the impact of SCM on the improvement of the customer satisfaction?	The SCM focuses on relationships between the parties and keeps them in timely and continuous communication. As a result, the making decision process will be improved by increasing the scope of corporation.
Which is the most SCM practice affecting the performance of the construction project?	To recommend contracting companies to focus on it to develop and enhance the performance.

## **Supply Chain Management Practices in Construction**

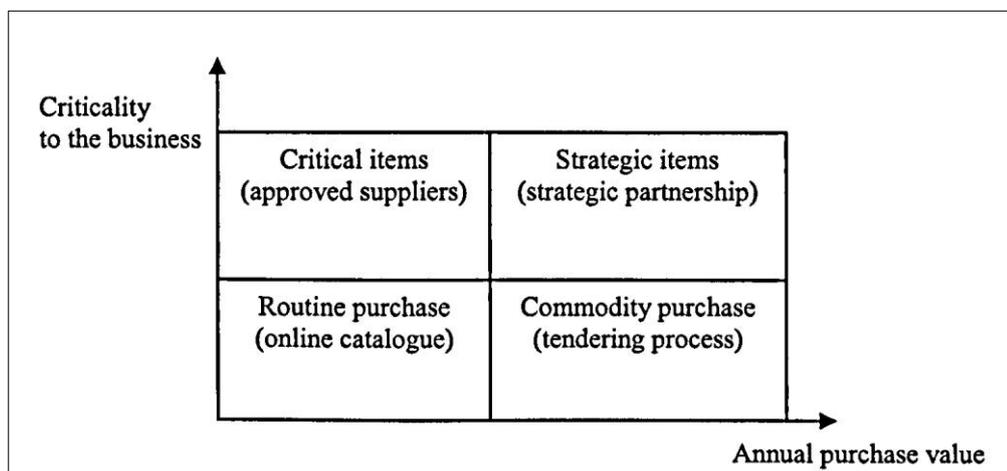
### **Purchasing in Construction**

Logistic is a very important process in SCM because it is an integration of materials handling and packing, transport, inventory and information. Therefore, any problems in any stage of the process will affect the whole project. That is why the firms should manage this process effectively (Islam et al, 2013).

Tuomela et al (2015) stated that there are many factors controlling the purchasing process. First, it is a buyer-supplier relationship. The construction projects maybe faced discontinuity, exclusivity, and complexity which have implications on the relationship between the buyer and the supplier. Second, there is a supply risk. The business world is volatile and unpredictable. Hence, a lot of interruptions and changes in prices and sources may occur. Third, there is a coordination and integration between project parties which is necessary in order to share knowledge. Coordination depends on skills, culture, and routine and team work of the parties. Finally, there is a learning-knowledge sharing during which several obstacles such as lack of motivation, incentives and trust might occur.

The four categories of products are routine purchases, commodities, critical items, and strategic items. Figure 1 shows the purchase categorization and how it is classified based on a hierarchy of importance to ensure the suitable time and

effort of purchasing. The categorization was made based on analysis of how critical the items are in the organization and what the annual value of purchasing is. Routine purchase is not critical to organizations with low annual purchase value. Strategic items are of a high critical and high annual value as indicated by Ruston et al (2010).



**Figure 1: Purchase categorization and appropriate buying process (adopted from Rushton et al, 2000)**

The purchasing process starts with the client's need. Then the quantity and specifications are determined and after that qualified sources do the search. Proposal acquisition and analysis are followed by the evaluation of the proposals and suppliers selection. After that, an order and routine selection processes are done. The final stage is a performance evaluation as indicated by Bildsten (2016).

### **Logistic In Construction**

Relationship between SCM and logistic in construction will be discussed. Persson and Virum (1996) indicated that the logistic term was first used in a military environment. According to Council of logistic management, the logistic is the part of a supply chain involving the planning, implementation, control of the flow in an effective and efficient manner. Also, it monitors implies the monitoring of the storage of the goods, services and information from origin point to consumption point to meet the customer's needs.

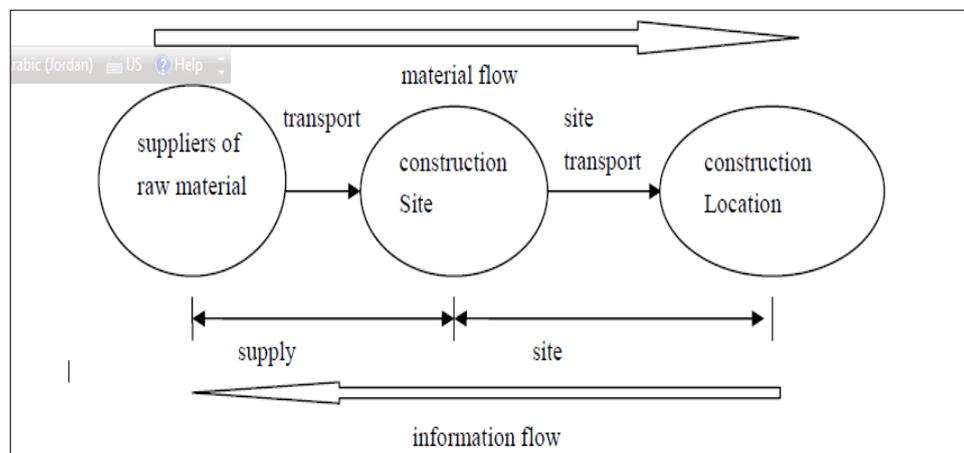
Logistic is defined as the process involving a labor supply, materials supply, storage, processing, handling, information and finance flow and equipment supply between a supplier and a customer. It also includes loading, purchasing, allocation and packing (Duiyong et al, 2014). Almohsen and Ruwanpura (2011) defined the construction logistic as a management of materials, tools, equipment flows from origin point to the consumption point. They stated that quantity; cost of materials and

tools represent a large proportion of project budget so these should be managed in the best way.

Evidently, the logistic plays a significant role in CSC because it is related to the flow of materials, information and labor. Therefore this process should be managed absolutely in an effective way to improve the performance of project and increase productivity (Almohsen and Ruwanpura, 2011). Certainly, there are two approaches in construction logistic: the first one focuses on the logistic in project environment which aims to improve the performance by the effective scheduling and handling of the materials, and the second approach which considers multiple echelons to enhance more interaction between a client and a supplier (Vidalakis et al, 2011).

According to Larson and Halldorsson (2004), there are four perspectives on the relationship between logistics and SCM. These are relabeling, traditionalist, inter-sectionist and unionist. In relabeling logistic becomes as SCM, in traditionalist SCM is a small part of logistic, in an inter-sectionist the SCM and logistic are separated but there is an overlap between them and in a unionist logistic is a part of SCM.

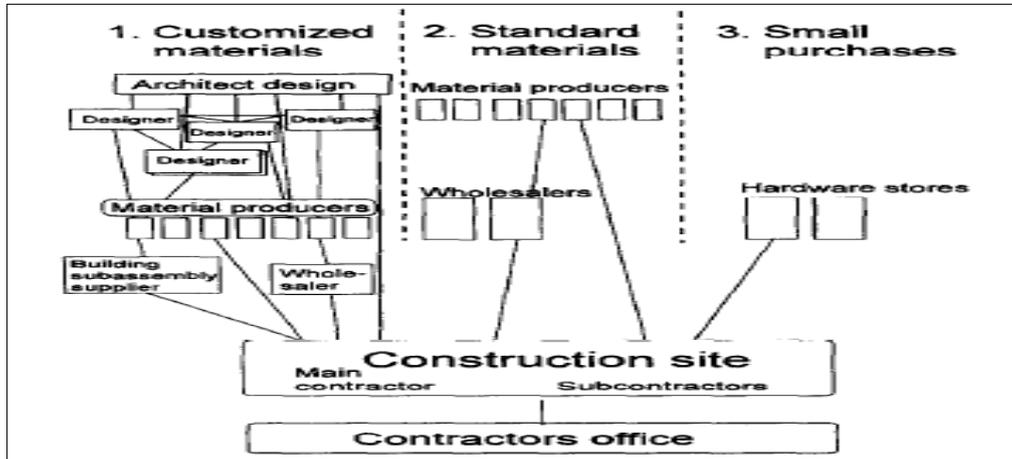
In the logistic process in construction project; Figur.2 shows that material flow starts when ordering and flows from the suppliers to the construction site, information starts from construction site to the suppliers.



**Figure 2: logistic process in construction project (adapted by Islam et al, 2013).**

Papaprokopiou (2010) classified the logistics as tasks in construction to supply logistic and site logistic. Supply logistic involves all activities in the process of production such as storage, transport and supply materials, equipment and manpower. Site logistics refers to the planning, organization, management, controlling and directing of physical flows.

Hatamoc (2010) classified the delivery process of materials into three types based on types of materials: customized materials, standard materials and small purchases. Customized materials are design to order while standard materials and small



**Figure 3: the delivery process of materials (adopted from Hatmoco, 2008)**

In the delivery of materials shown in figure 3, standard materials, the flow of materials is very important because of the difficulty in handling and storing. In customized materials, the flow of information is also very important as lack of required information may cause disruption of the project.

### **Inventory Management in Construction**

As defined in a business dictionary, inventory is a stock of goods or other items owned by a firm and held for sale or processing before sale. Muller (2011) stated that the reason of inventories is to control unpredictability, lower ordering cost, fluctuations in demand, price protection, unreliability of supply, and quantity discounts. Mohopadkar and Patil, (2017) classified the items in inventory as raw materials which are basic materials of a product. The other parts of products are manufactured from the raw materials by the company. The work in progress leads to the finishing goods and the product it ready to be supplied.

The right management of inventory is very essential in order to achieve the purpose of inventories. Inventory management is the process of planning, purchasing, storing, transfer and supplying the right quality and quantity in right time and at right place as indicated by Kasim et al (2012). Aravinth and Indhu,(2016), stated that the materials play a significant role in a success of project because the cost of materials constitute 60% of project cost so the proper materials management is very important to avoid the delay in enterprise and waste of labor work hour.

There are many factors affecting the inventory management such as minimum stock level which the stock should not allow to decrease, and maximum stock level which the inventory should not excess. Lead time is the time between the date of order and the date of delivery and the re-order level when the stock falls as

indicated by Aravinth and Indhu (2016). They also observed that the inventory management is responsible to complete the project on time and on budget.

The main objective of inventory management is to reduce the cost of keeping inventory. The costs comprised in inventory are purchase cost, order cost, holding cost and unavailable cost:

1. Purchase cost: according to Han (2009), purchase cost is a cost of materials purchase from external source including the freight and transportation.

2. Holding cost: Durlinger (2012) divided the holding cost into:

2.1. Cost of capital: The value of the stored materials and the value of the stores are not continuous recycled investment. At the same time it reduces the value of available cash equivalent to the value of stock, which reduces the size of the return of investment of that money depending on the company's finance.

2.2. Cost of storage and handling: This cost includes the rent of warehouses if leased or the value of the depreciation of the buildings of the stores if they are owned by the establishment. It also includes the cost of labor supervising the storage and the cost of lighting and handling and expenses of maintaining the stock of heating or cooling and other expenses paid for this purpose. In addition, the expenses of insurance premiums on the stores and inventory are also included in this cost, depending on a company or inventory weather.

2.3. Cost of risk: The stock may suffer damage due to the length of the storage period or from poor storage. The stock may become obsolete, making it useless or greatly devalued. This cost is high in some stock types, such as foodstuff or products associated with rapid technological development; cost of risk depends on cycle of the product life.

2.4. Ordering cost: Durlinger, 2012 divided the order cost into: Cost of Order: When a delivery order is made, the client pays the price not only for the goods and delivery. In fact, the price includes the cost of employment that work for several hours or days to define specifications, bid, and study, etc. It may also include transportation costs, insurance costs and inspection costs.

3. Unavailable cost occurs when the required materials are not available on time or when the time of the need to some materials is difficult to estimate (Han, 2009).

The management makes great effort in managing warehouses to reduce the cost and delay. The best method that proved its effectiveness in inventory management is Just in Time (JIT) technique. Pheng and Shang, 2011, stated that the first time JIT term was used in manufacturing sector by Taiichi Ohno in Toyota Company. They defined the JIT as the tools, techniques and principals that help the company to reduce the lead time, to deliver and produce product in small quantities and to satisfy the customer. JIT was defined as a long term strategy to reduce the waste in the firm as indicated by Gyampah and Gargeya, 2001.

Ballard and Howell, 1995 compare the JIT application in manufacturing and construction industry. They claimed that the application of JIT in construction is

harder than in manufacturing because the environment of the construction is more complex. In addition, they explained that the strategy of JIT in construction is aiming to reduce physical buffers i.e. time or materials between processes. Boris, 2001 described the process of JIT as allocation of the resources depending on minimum overtime work and monitoring to add recourse when it is required.

Ali and Beheiry, 2015 stated the JIT aims to zero inventory. The strategy of JIT is to control the delivery timing of the materials, to reduce inventory quantities and reduce the time spent on rectifying the defect and inspection to improve productivity and quality. The supplier is responsible for JIT application.

### **Stakeholders Management**

Yang et al (2009) defined the stakeholders as individuals or organizations that are negatively or positively affected by the project and play a role in achieving the objectives of the project. Chan et al (2004) said stakeholders have a key role in the success of the project. Mulla et al (2015) stated that there are four main stakeholders involved in CSCM: main contractor, sub-contractor, client and supplier.

- Client: According to Lindah and Ryd (2006), clients are individuals and organizations that agree to start building the projects for their own use or for the use of others. They are defined as the initiators of projects; they finance the project; they are responsible to decide the procurement system, decide on the contractors, to ensure the needs of the final user and to meet the laws and regulations. Also they are responsible to motivate and support the contractors.

Chan et al (2004), the client has a key role in the success of the project depending on the characteristics, type, and the experience of the client. Level of experience is very important to the choice of a procurement system and meeting the requirements. Kulatunga et al (2011) stated that the types of clients depend on primary or secondary constructors and the level of their experience. The type of client affects the decision making process and project management which reflects on the project performance.

Masterman and Gameson stated (1994) stated that primary clients such as property developers are those who own main business and primary income derives from constructing buildings. Secondary clients are clients whose expenditure on constructing buildings is a small percentage of their total turnover, and they need the buildings to run a specific business activity, such as manufacturing. Based on the level of experience clients are classified as inexperienced and experienced. Inexperienced clients do not have any relevant experience in construction projects. Experienced clients have relevant experience in construction project either in-house or externally.

- Main contractors: Alzahrani and Emsley (2012) concluded that the success of the project depends on main contractors. This, the selection of main

contractors is crucial as they are responsible for the budget, time, and quality of the project.

Based on health and safety executive, (2015) the client is in charge of determining the main contractor. There are many other responsibilities such as selecting the sub-contractor and suppliers, ensuring the specification of materials and work, ensuring the safety and keeping in touch with all parties in all construction stages.

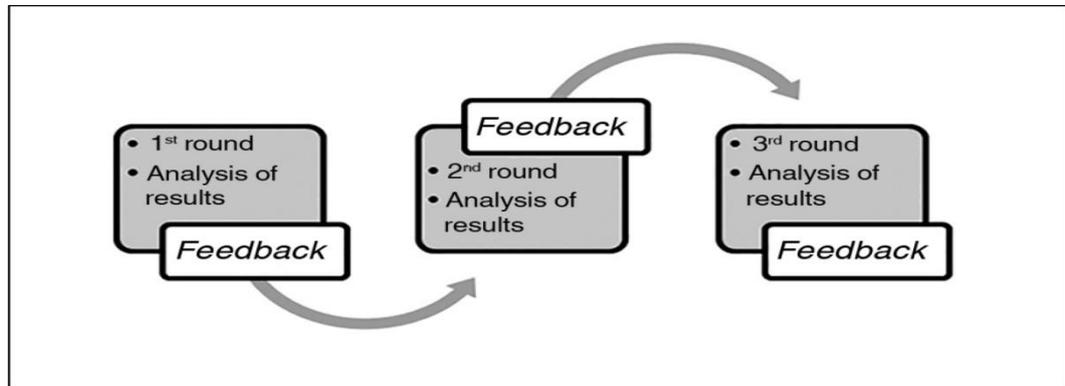
- Sub-contractors: in construction projects about 80–90% is performed by subcontractors. The main contractor may be unable to perform specialized tasks, so the main contractor uses subcontractors who have greater ability and skill in implementing it. If the number of sub-contractors increases the complexity of the project will increase. The main contractor should manage and organize the sub-contractors, so the relationship between the two parties must be complementary and cooperative as indicated by Choudhry et al (2012). Akintan and Morledge (2012) explains that the good relationships will increase teamwork and trust between all parties.
- Suppliers: Collin dictionary defines the suppliers as the person or companies that supply the materials, equipments, tool and services to customers. Samarasinghe et al (2012) asserted that the cost of construction materials constitutes 50% of the total cost of the project. The delivery of materials on determined time, quality, quantities, and specification will save money and time and reduce the inventory level. Hence, the suppliers play a significant role in project performance.

All the stakeholders play a significant role in a project performance and success. So the good relationships between the parties will increase trust and teamwork which will result in the advanced performance of the project.

The PMI(2004) defined the stockholders management as the process of identification, analysis and planning of action to influence and communicate with stockholders. According to Olander and Landin (2008), the aim of stockholders management is to successfully implement the project and avoid disputes and conflicts between project stakeholders. There are many techniques to carry out the stakeholder management discussed in this Delphi method research.

Delphi method was firstly utilized by Dalkey and Helmer in 1953. It is an organized communication between a stockholders to predict the future through organized collaborative action to propose appropriate solutions to a particular problem without a meeting. Delphi method is used to determine the possible alternatives of the programs and to explore information or assumptions leading to different judgments.

Orndoff, (2005) suggested that the Delphi method should be used in construction industry by using questionnaire as shown in figure 4. Each round includes the same questions and different set of groups. Chinyio and Olomolaiye (2010) explained that the success or failure of the project strongly is linked with management and communication of stakeholders.



**Figure 4: Diagram of Delphi Technique process (Pereira and Alvim, 2015)**

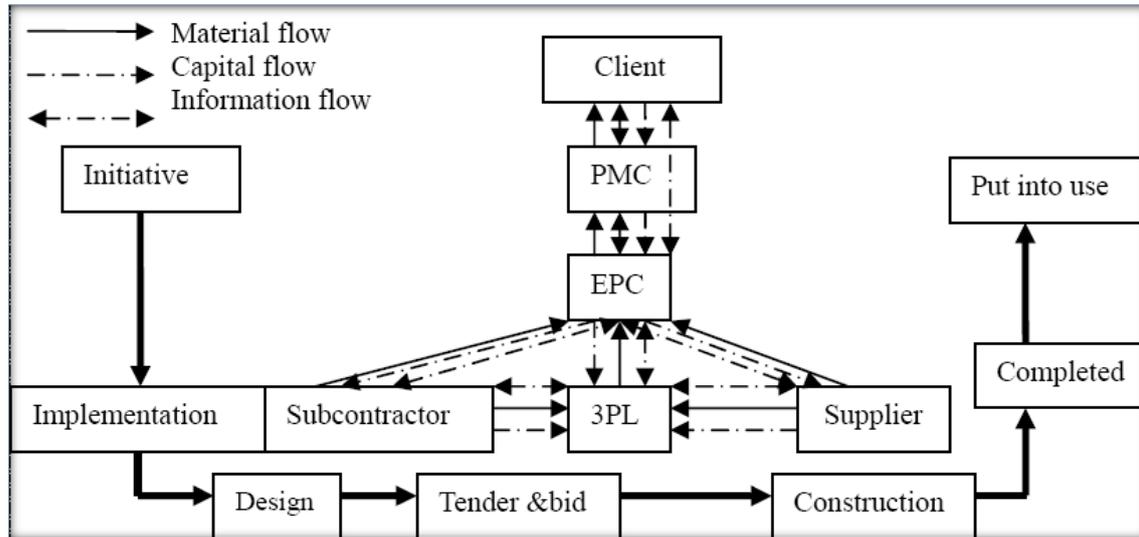
The relationships between stockholders affect the information flow in supply chain. The construction industry is different from manufacturing industry. The nature of the construction project is temporary, unique and complex due to one-off design solution and one-off location. Thus, the information management is very important which ensures that the parties communicate at all times in order develop a healthy decision making process as lack of communication and information exchange might lead to a disruption of the project, according to Hore, 2006.

Gyampoh et al, (2003) stated that the information management is handling construction information in communication, storage and exchange information and decision making which affect the success of the project and decision making. Mak (2001) explained that the contractors can use information technology (IT) to man power saving, make efficient achievements and to improve communication which can positively impact the decision making.

#### **The Role of General Contractor in CSCM**

In construction projects, there is a challenge for contractor and client to deliver the project successfully due to complexity in design and the involvement of stakeholders. The main contractor plays a significant role in the success of the project, especially when being in execution phase (Alzahrani and Emsley, 2012).

There are many responsibilities of a general contractor in CSC such as: integrating the resource of suppliers and subcontractors to make full use of it and enhancing the relationships between project management, contractors and/or clients to ensure the whole operational efficiency of the supply chain. The general contractor in the construction supply chain should establish long-term and stable partnerships with upstream and downstream enterprises to better play the core competitiveness. Figure 2.5 is the construction supply chain model based on the general contractor (Shusheng and Min, 2006).



**Figure 5: Construction Supply Chain Model Based on the General Contractor**

From the above figure 5, the role of contractor in CSCM is the improvement of the logistics evaluation system, construction of a close partnership with upstream and downstream enterprises and establishment of an information platform to enhance communication as indicated by Shusheng and Min (2006).

#### **Supply Chains Performance in the Construction Projects**

Performance is the evolution of the productivity of workers, organization and system to accomplish specific goals (Ankrah and Proverbs, 2015). There are many factors affecting the performance such as poor manpower, lack of communication, problems with equipment, and financial problems (Enshassi et al, 2009) as the construction industry is complex and involves a large number of contractors, sub-contractors, stakeholder, clients and suppliers (Helen t al, 2015). The performance indicators in the construction are time, cost and quality. Quality is defined according to the customer's satisfaction (Enshassi et al, 2009). The best performance is achieved when the project is completed within determined time, on its budget and complements to the customer's satisfaction.

The first indicator is the time. In construction projects time is money. The effective management of time is vital to avoid the risk of delay (Chin and Hamid, 2015). The time of project can be affected by many factors such as the productivity of equipment, labor, managers and engineers, contract termination, cost, task completion, consequential damages, management approach, contractor's productivity. Also, a decision making of stakeholders and owners payment can cause the changes as indicated by Varghese and Varghese(2015).

The second is the cost which can be defined as the budgeted expenditure. The client agrees to pay for creating a new project. It is a significant indicator to measure

the success and performance of the project because it not only measures the profitability; it also measures the productivity and performance. Poor cost performance can be described as inability of the project to be completed within estimated budget (Rahman et al, 2013). Besides, poor management, errors in project formulation and estimation, lack of experience, delay and changes in the project can cause the cost overrun.

The third indicator is a quality. In this research the quality will be described as the customer satisfaction. Omoruyi and Mafini (2016) defined the customer satisfaction as making the customer happy and meeting all their needs within desired specification, time and quality. It is very important in order to develop the construction process, customer loyalty. In addition, it strengthens the relationship between a customer and a company. Company must evaluate the customer satisfaction to learn how to satisfy their customer (Kärnä, 2004). Customer satisfaction can be achieved by acquiring the knowledge of the customer's need, by raising the customer awareness of the organization quality management, by identifying the customer expectations as explained by Harrington et al(2012).

Omoruyi and Mafini, (2016) examined the impact of SCM on customer satisfaction in South Africa using a survey sent to 200 owners and managers. The survey revealed that there is a significant and positive relationship between SCM and customer satisfaction. Lagat et al(2016) studied the effects of SCM in customer satisfaction and loyalty using a survey with 1208 procurement officers and managers. The results showed that the SCM affects positively the customer satisfaction and customer loyalty, too. Because of the SCM practice, the relationships with suppliers and partners and increase in information sharing have been improved.

Shoghari and Abdallah, (2016) discussed the impact of SCM on customer satisfaction in Lebanon. Having analyzed the case study, they found out that the effective application of SCM in organization will improve the profit and trust and consequently advance the customer service together with the customer satisfaction.

Many researchers studied the impact of SCM on project performance. Almost everyone proclaimed that the SCM has a positive impact on a project performance. Albaloushi et al, (2008) studied the SCM approach in project. The survey was distributed and analyzed by SPSS. The findings prove that the SCM affects the project performance by reducing inventory level and by improving collaboration and trust. Moreover, they explained the factors that have an effect on performance of SC are support of upper management, SC technical background and customer's need. Also, they stated that the raising awareness leads to best SCM implementation in future.

Hatmoko and Scott (2010) studied the impact of SCM in a project performance. Preliminary investigations were made by visiting two projects during six months. Also, main survey was distributed and modal was simulated. The results

showed that the delay in project is about 22% of project duration and delay can be reduced about 45% by using subcontractor. They also discovered that the flow of materials plays a significant role in a project, followed by labor, information, and equipment flow.

Meng (2012) studied the impact of relationship on project performance. The questionnaire was distributed in UK construction industry. SC relationship was described by ten key indicators: trust, gain pain, communication, no-blame culture, continuous improvement, risk allocation, problem solving, joint working and performance measurement. He claims that the better relationship will improve the performance whereas bad relationships will cause a delay in decision making, and cost overrun.

Magalhaes et al, (2012) studied the impact of delays in CSC. They observed the construction site during six months to obtain the impact of SCM in delays, and learnt that the biggest cause of a delay is construction site followed by work flow and the delay by the subcontractor. Mamter et al (2014) discovered that the SCM improved its effectiveness in Malaysian construction site by saving money and time. It also increased the trust between the stakeholders and decreased the waste of materials and labor.

Sindhu et al, (2014) examined the effect of inventory management on a project performance. The survey was administered and data analyzed by SPSS. The results revealed that the contractor should be involved in material management. Moreover, it proved that the inventory management plays a significant role in a project performance and helps to complete the project in estimated time and quality.

Wibowo and Sholeh, (2015) studied the SC performance measured by a survey in one case, and another performance was measured by Supply Chain Operations References (SCOR). The result showed that the SC performance has medium score and a contractor, a supplier, SC strategy and labor skill lead to a success of project. Olaniyi et al, (2015) examined the SCM practices in construction procurement. The outcome showed that the most important three factors are the information sharing followed by management leadership followed by relationship development.

Subramani and Tamizhanan, (2016) discussed the SCM approach from literature and focus on logistic issue. The survey and case study used in this research revealed that the research focusing on logistic approach in construction project showed that main contractors play greatest role in SCM, in purchasing process, and SCM develops the logistic process and all SC activities.

Shusheng and Min studied the role of a main contractor in SC in all process: logistic, information sharing, and risk management. A main contractor can improve

the relationship between suppliers and subcontractors and be responsible for CSCM integration and collaboration. Also, SCM can reduce project duration and save cost.

This research investigate the impact of SCM on project performance, in Jordan there are a lack of similar research and construction industry need to new management approach to enhance the performance, especially the Jordanian construction project suffer from delay, cost overrun.

## Data Analysis and Discussion

### Descriptive Analysis of SCM Practice

A questionnaire was designed and arbitrated with experience and academic personnel. 120 questionnaires were distributed to the first and second grade of Jordanian contractors with approximately 88.33% response rate. However, validity and reliability tests for the questionnaire were conducted. Minimum and maximum values mean, and standard deviation for each practice will be calculated. Practices will be ranked according to the importance index.

Relative importance index is calculated by equation 4.1 as indicated by Somiah (2015).

$$RII = \frac{\sum W}{A*N} \dots\dots\dots 4.1$$

where:

W: weighting given to each statement by the respondents and ranges from 1 to 5

A: Higher response integer (5)

N: Total number of respondents.

### Simple Linear Regression Analysis

There are many factors affecting the project performance such as weather, change of order, client and subcontractor, but in this analysis the research studies only the impact of supply chain management on performance.

In this research ordinary least square method (OLS) was used. According to Campbell and Campbell(2008), regression is a statistical tool to determine the linear relationship between two or more variables. Regression shows the relationship between

one independent variable (X) and a dependent variable (Y), as in the formula below:

$$Y = B_0 + B_1X_1 + B_2X_2 + B_3X_3 + \dots\dots\dots + B_nX_n \quad (3.3)$$

Where  $B_0$  is a constant and express about the intercept point,  $B_1$  is the slope and describes the magnitude and direction of equation, X expresses the independent variable, and Y expresses the dependent variable. When  $B_1$  does not equal to zero, the equation will conclude that there is a significant relationship between the independent

and dependent variables. the regression coefficient ( $R^2$ ) describes how much the values fit the data and adjusted R Square will be used to describe which dependent variables are more affected by SCM practices. P-value will be calculated to reject or accept the null hypothesis, if p-value <0.005 the null hypothesis will be rejected.

The aggregation of data was calculated before conducting the regression analysis. The aggregation of data is a calculation of the sum of each question which is answered by each respondent from the total sum. Total sum is a sum of the number of questions multiplied by the answer scale; this process will help in regression analysis.

### Descriptive Analysis of SCM Practice

The results are shown in Tables 2, minimum and maximum values, mean, and standard deviation for each practice are listed. Practices are ranked according to the relative importance index as shown in 2 as well.

This section displays the descriptive statistics of the study variables, which include means, standard deviations, levels of importance and ranks; all will be explained below.

The mean and standard deviation values for each dimension and each variable in the model of the study were found to understand the attitude of respondents toward a particular dimension or a particular variable.

The mean is a measure of the central tendency that draws a general picture of the answers given by the respondents for each question, dimension, and variable (Sekaran and Bougie, 2013). The standard deviation is a measure of dispersion, which offers an index of the spread or variability in the data (Sekaran and Bougie, 2013).

A small standard deviation for a set of values indicates that these values are closely clustered around the mean or located close to it while a large standard deviation indicates the opposite. Thus, a mean with a smaller standard deviation is more reliable than a mean with a larger standard deviation (Mason, et al, 1999).

The Likert scale from 1 to 5 is employed in this study allowed the respondents to indicate their degree of agreement or disagreement with a given statement in the questionnaire. The Likert scale permits the researcher to alter the qualitative data into quantitative data to measure the variables (Rubin and Babbie, 2008).

**Table 2: Importance Indexes of SCM practice.**

Descriptive analysis						
	Minimum	Maximum	Mean	Sta. Deviation	Importance index	Rank (RII)
Utilizing the supply chain management in your project	1	5	3.31	0.877	0.66	9

The need for supply chain management	1	5	3.31	1.027	0.66	10
The benefits that are possible from implementing supply chain management.	1	5	3.18	0.944	0.636	8
Development of purchasing and logistic	2	5	3.37	0.772	0.67	6
Development storage process, apply just in time to reduce the inventory level.	1	5	3.20	0.877	0.64	7
Developing the flow of materials, manpower, information and cash flow in the project is one of the important goals of management.	2	5	3.50	0.759	0.7	2
Improving the communication between parties involved.	1	5	3.46	0.841	0.69	4
Improving the decision making process.	2	5	3.43	0.676	0.687	5
Enhance the relationships between suppliers during project implementation and after the project completion.	2	5	3.45	0.806	0.691	3
Enhancing the trust and reliability between all parties.	2	5	3.59	0.859	0.72	1

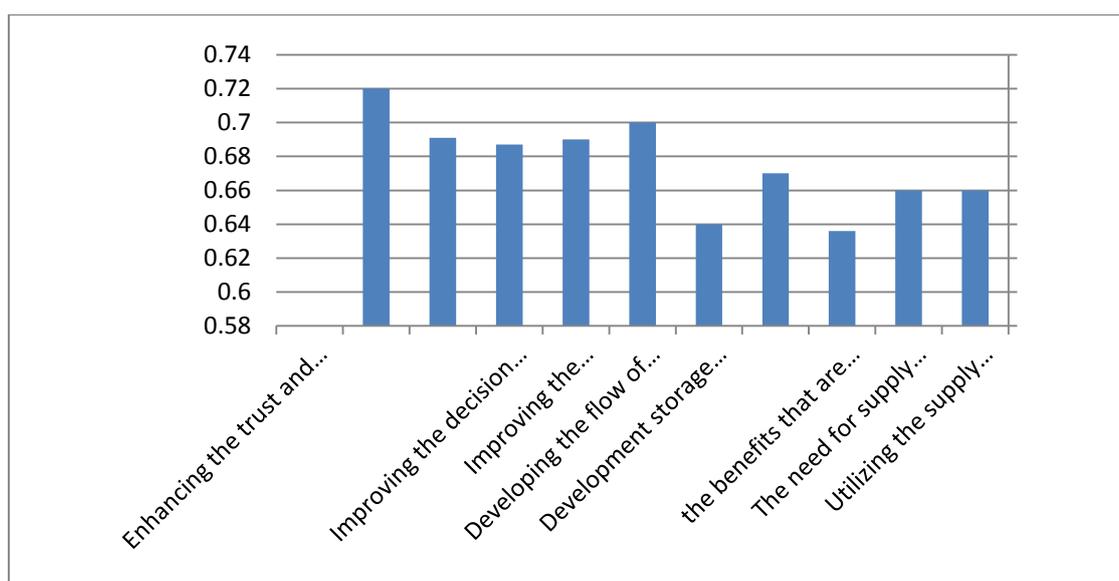


Figure 6: Importance Indexes for SCM Practices

The results in Table 2 are presented graphically in Figure 6 that shows the rank of SCM practices. The highest three practices are:

1. Enhancing the trust and reliability between all parties.
2. Developing the flow of materials, manpower, information and cash flow of the project is one of the important goals of management.
3. Enhancing the relationships between suppliers during project implementation and after the project completion.

As shown above it is clear that contractors believe that the relationship between parties is very important in order to accomplish a successful project. Thus, the strong relationship is built upon trust and reliability that develops better decision making, improves the flow of materials, equipment and information, and decreases the level of dispute.

### Simple Regression Analysis

Regression is a statistical analysis that is used to determine the relationship between two or more variables. The regression is generally used to determine which one of the presented variables (independent variable) is mostly affected by the dependent variables (Draper et al., 1966). In this study the relationship between the SCM practices and project performance is investigated by utilizing a simple regression analysis.

The hypothesis below was studied in order to be tested by regression:

$H_0$  = There is no relationship between the "SCM practices" and "project performance"

$H_1$  = There is a relationship between the "SCM practices" and "project performance"

The sub-hypothesis below was studied in order to be tested by regression:

$H_{11}$  = There is no relationship between the "SCM practices" and "budget of a project"

$H_{12}$  = There is no relationship between the "SCM practices" and "project time"

$H_{13}$  = There is no relationship between the "SCM practices" and "customer satisfaction"

Firstly, the data aggregation was calculated as shown in the following table. For SCM practice, the sum of each respondent's answer was calculated and the total score which is 10 questions multiplied by 5 (the answer scale) which equals to 50. For the first respondents' sum of answer equals to 34. The table shows that the data aggregation of cost and time variable and customer satisfaction variable.

Secondly, the regression analysis was used to estimate the following two models:

$$T\&C = \beta_0 + \beta_1 SCM \dots \dots \dots 1$$

$$CS = \alpha_0 + \alpha_1 SCM \dots \dots \dots 2$$

Where:

T&C: time cost variable

CS: customer satisfactions

SCM: supply chain management

And to test the null hypotheses against the alternative hypotheses for two models:

$$H_0: \beta_1, \alpha_1 = 0$$

$$H_1: \beta_1, \alpha_1 \neq 0$$

The null hypotheses state that there are no relationships between independent variable and the dependent variables and the alternative hypotheses are vice versa.

The above equations describe the relationship between independent variable (SCM practices) and dependent variables (time, cost and customer satisfaction) and to know which dependent variables are more affected by SCM practices.

The results of regression analysis of time and cost variable are shown in tables 3 and ANOVA analysis results of R square, p- value and adjusted R show in table 4.

**Table 3: The regression results of time and cost variable**

SUMMARY OUTPUT	
Time and cost are dependent variable and supply chain is the independent variable	
Regression Statistics	
Multiple R (Regression)	0.561230558
R Square (R <sup>2</sup> )	0.314979739
Adjusted R Square (R <sup>2</sup> )	0.308455737
Standard Error (Standard Deviation)	4.010902208
Observations	106

**Table 4: ANOVA Results of cost and time variable**

ANOVA					
	df	SS	MS	F	Significance F
Regression	1	776.6988243	776.6988243	48.28013782	3.21495E-10
Residual	105	1689.170335	16.08733652		
Total	106	2465.869159			
	Coefficients	Standard Error	t Stat	P-value	
Intercept	7.327157247	2.416047976	3.03270354	0.003053924	
S.C	0.490048141	0.070526851	6.948391024	3.21495E-10	
	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%	
Intercept	2.536580419	12.11773408	2.536580419	12.11773408	
S.C	0.350206423	0.629889859	0.350206423	0.629889859	

From ANOVA table the relationship between cost and time and SCM practices are described in the following equation:

$$TC = 7.327157247 + 0.490048141SCMpractices$$

From ANOVA table P-value of intercept equal to 0.003053924 and for slope equal to 3.21495E-10 both reading are smaller than 0.05. So the null hypothesis can be rejected which means that there is a positive relationship between time-cost variable and SCM practices variable.  $R^2$  equals 0.31 that means the model interpreted 0.31 as estimated value of time and cost.

The results of regression analysis of customer satisfaction variable are shown in table 5 and ANOVA analysis result is shown in table 6.

**Table 5: The regression results of customer satisfaction variable**

SUMMARY OUTPUT	
Customer satisfaction as dependent variable and supply chain is independent variable	
Regression Statistics	
Multiple R	0.221555372
R Square	0.049086783
Adjusted R Square	0.040030467
Standard Error	2.955107247
Observations	106

**Table 6: ANOVA Results of customer satisfaction variable**

ANOVA					
	DF	SS	MS	F	Significance F
Regression	1	47.33250399	47.3325	5.420170976	0.021822155

Residual	105	916.9291782	8.732659	
Total	106	964.2616822		
	Coefficients	Standard Error	t Stat	P-value
Intercept	9.72257893	1.780068551	5.461913	3.18276E-07
S.C	0.120974034	0.051961977	2.328126	0.021822155
	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	6.193031819	13.25212604	6.193032	13.25212604
S.C	0.017943032	0.224005036	0.017943	0.224005036

From the regression analysis the following equation is used to describe the relationship between independent variable (SCM practices) and dependent variable (time, cost and customer satisfaction).

$$CS = 9.72257893 + 0.120974034SCM$$

From ANOVA table P-value of intercept equals to 3.18276E-07 and of slope equals to 0.021822155 both reading are smaller than 0.05 so the null hypothesis can be rejected and there is a positive relationship between time-cost variable and SCM practices variable.  $R^2$  equals 0.049086783, which means the model interpreted 0.049086783 as estimated value of customer satisfaction.

Compare the adjusted R Square of time, cost and customer variables in table 7 to determine which variable is mostly affected by SCM practices:

**Table 7: Compare the adjusted R square**

Adjusted R Square of cost and time variable	Adjusted R Square of customer satisfaction
0.308455737	0.040030467

Table 7 evidently depicts that the adjusted R Square of cost and time variable is more than customer satisfaction, so the SCM practices have more effect on the time and cost variable.

### Conclusions

The results showed that the supply chain management can be used as a tool to regulate the cost, time and customer satisfaction. The SCM has many practices, in this research the results show that enhancing trust and reliability between parties help reduce time and cost, satisfy customer, develop information flow and increase the collaboration which is improving the decision making process.

The second practice highly affecting the performance is developing materials, labor, information and cash flows, which is developing and controlling the process in the site and reduce time, cost and waste.

The third practice highly affecting the performance is relationships between parties in order to enhance the trust and reliability. From the results, the lowest impact of practices is purchasing and logistics management and inventory management that may refer to lack of planning of logistic process and poor relationships between suppliers, contractors, sub-contractors and clients.

Because of 95% of Jordanian construction projects lag behind its schedule, the SCM can be used to reduce delays by scaling down the waste of process and materials, by increasing the profit and lowering cost. SCM can also be utilized to satisfy the customer. This will contribute to a better performance of the project by reinforcing the stronger relationships between the parties.

The impact of SCM practices on performance for construction projects in Jordan has been investigated in this study. Main conclusions can be drawn as the following:

1. The most practices of SCM that influence the performance of construction projects in Jordan are enhancing the trust between parties, then the flows of materials, labor, equipments and cash flow which is crucial in developing the decision making and the relationship between parties.
2. There is a positive relation between the SCM practices and construction projects performance in Jordan.
3. SCM practices have a great effect on saving the time and the cost which is described as the basic purpose of the construction project management.
4. SCM practices have a positive effect on customer satisfaction which is a positive and significant index.
5. The time and cost of the project are affected by SCM practices more than the customer satisfaction.

### **Recommendations**

SCM practices were found to highly affect the time and cost of construction projects in Jordan.

1. Increasing the awareness of importance and benefits of the supply chain management through training courses preferably before design stage.
2. Since the most influential supply chain practices are trust and relationships enhancing among the project parties, this research recommends the involvement of all parties, establishing long-term participatory relationships, creating open channels of communication between the parties to share information, sharing of experiences between the parties and improving relationships between general contractors, subcontractors and suppliers.
3. The focus should be made on materials management to improve performance when estimating the specifications and quantities, ordering, logistic,

purchasing and transporting, and also, the finance, labor and equipment flow should be made in order to reduce delays and claims.

4. Apply the Just-in-Time technique to reduce the inventory level to save time and cost.

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