Jimma University

Jimma Institute of Technology

School of Graduate Studies

Department of Civil and Environmental Engineering

Construction Engineering and Management Stream

Assessment of Material Supply Chain Management Practices in the Building Construction Industry; A case study in Jimma town

By: Yihalem Girum

A Thesis submitted to the School of Graduate Studies of Jimma University Institute of Technology in Partial Fulfillment of the Requirement for the Degree of Master of Science in Construction Engineering and Management

May, 2017

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I declare that I have wholly undertaken the research reported herein under supervision and to the best of my knowledge, it contains no materials previously published except where references have been duly acknowledged.

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ABSTRACT

Construction supply chain is a network of multiple organizations and relationships, which includes the flow of information, the flow of material services or products, and the flow of funds between client, designer, contractor and supplier (Xue, et al., 2007). MSCM is an important element in project management process. Researchers argued that the construction sector is one of the least integrated industries, in order to achieve economic and labor efficiency there needs to be a restructure of the building supply chain. Even though there are challenges to successfully uptake SCM in the construction industry, efficient SCM is still vital to avoid delays through material delivery, wastage and contract time. Ethiopian building contractors currently are suffering from time delays, quality problems and cost overrun in relation to the lack of or very little awareness and poor handling of the MSCP. The research assessed the current MSCM systems practiced in Ethiopian focused on building construction projects i Jimma Town.

A questionnaire survey was used to realize the specific objectives. Fifty questionnaires were distributed to the contracting firms of first, second and third Grade. Thirty three questionnaires were received back and only thirty were found valuable and were analyzed using relative importance index and ranking method.

The study showed that MSC consists of six phases and activities under each phase are viewed as only a series of individual activities, most of the contractors do not have procurement division and a well-organized material purchasing flow structure, contractor/supplier relationship is based on project by project basis without forming long term agreement with competitive pricing as the mostly used criteria for selection. Also different level of buffer stocks and time were advocated to mitigate the uncertainties inherent in the construction setting, the problems that may hinder the smooth application of the MSCP through project phases were identified and most factors that might contribute in integrating the project phases of the MSCP were presented. Finally integrated view towards separate activities of MSC process, establishment of partnership agreement with suppliers, internal coordination between parties involved and development of web based information technology system were recommended.

Key words: Supply Chain, Supply chain Management**,** Construction Material Supply Chain Management

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Acronyms

BPR	Business process redesign
CII	Construction Industry Institute
CSC	Construction supply chain
CSCM	Construction supply chain management
JIT	Just in time
MSCM	Material supply chain management
MSCP	Material Supply chain Process
SC	Supply chain
SCM	Supply chain management
TQM	Total Quality Management

1. INTRODUCTION

1.1 Background of the study

Building construction is one of the major technical sectors in Ethiopia that contributes to the overall national economy of the country. Ethiopia is one of the fastest-growing, non-oil driven economy among African countries. The country has showed a remarkable growth over the past ten years with average annual growth GDP of 10.9% (UNDP, 2014). Recently, the contribution of the industry sector (which is 21.2%) and particularly that of the construction sector to the national economy is given high prominence and is mainly driven by the energetic performance of the construction sub-sector (ECIDP, 2014; UNDP, 2014).

Despite the fact that the construction sector has high importance, several defects are being noted in the sector that require immediate action (ECIDP, 2014; Nega, 2008). Therefore, efforts gear towards enhancing the efficiency of the building construction industry of Ethiopia in terms of improving on construction management techniques is worthwhile and will contribute to better performance of the industry.

There is a growing awareness in the construction industry of the importance of the SCM concept. Unlike the manufacturing and automobile sectors, the construction industry has been slow in employing the concept of Supply chain management and Lean principles due in part to the one-of-a-kind nature of the industry's products. This is a problem in the Ethiopian construction industry too where the knowledge, awareness and the uptake of both principles and practices of SCM is low (Belay M. 2011).

The problem is worsened by the lack of documented evidence of the levels of awareness and the uptake of Lean Principles in the Ethiopian construction industry. This study aimed to address this gap by exploring the potential for integration of principles into the management of supply chains of Ethiopian contractors. Therefore, With regard to this research, the current construction material supply chain management practices being followed in Ethiopian building construction projects were assessed.

1.2 Statement of the problem

Chris T,(1992) defined supply chain 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. Sustainable construction and supply chain management have, in recent years, become two of the most important performance-related issues within the construction industry.

To achieve corporate sustainability within any organization, it is essential that sustainability issues are addressed throughout the organization's whole supply chain, a process referred to as sustainable supply chain management. Actual practice in construction not only fails to address issues of supply chain, but rather follows principles that make supply chain performance worse (Adetunji, et al., 2008)

Timely and with budget completion of a construction project is frequently seen as a major criterion of project success by clients, contractors, consultants and related stakeholders (Luka and Muhammad, 2014; Ibrahim and Nabil, 2013; Abadir, 2011; Chabota et al., 2008). The primary challenge of a project is the handling of constraints to meet the desired goal where one aims to honor the primary constraints of time and budget to produce quality result (ECIDP, 2014; Warszawski, 1996).

Ethiopian building contractors currently are suffering from slippage from schedule or work program, time overrun, cost overrun, quality related problems, low productivity, low profitability, conflicts, ambiguities and disputes in relation to performance-related problems such as delay in material ordering and receiving. And it is clearly a big problem in the Building Construction Industry.

1.3 Research objectives

1.3.1 General objectives

This research assessed supply chain management practices followed in Ethiopian building construction projects focusing on Building construction projects in Jimma Town.

1.3.2 Specific objectives

The specific objectives of this research are:-

i. To assess the level of awareness of supply chain management Ethiopian building contractors have and material purchasing flow structure being followed focusing on Building construction projects in Jimma Town.

ii. To study the Contractor/supplier relationship in Ethiopian building construction projects focusing on Building construction projects in Jimma Town.

iii. To determine the most frequently occurring problems facing contractors in the MSCP through the project phases focusing on Building construction projects in Jimma Town.

iv. To study the key factors that may contribute in integrating the phases of MSCM focusing on Building construction projects in Jimma Town.

v. To recommend ways of integrating MSCM in the Building Construction Industry focusing on Building construction projects in Jimma Town.

1.4 Research questions

The objectives of the paper are addressed in the following research questions;

1. How much awareness of material supply chain management do Ethiopian contractors have? And what material purchasing flow structure are being followed?
2. What is the relationship between contractors and suppliers like in Ethiopian building construction projects?
3. What are the most frequently occurring problems facing Ethiopian building contractors through the MSCP project phases?
4. What are the key factors that may contribute in the integrating the phases of MSCM focusing on Building construction projects in Jimma Town?

1.4 Significance of the study

This study will benefit Contractors across Jimma and over all Ethiopia in such a way that it will shade light on supply chain management application so that they can apply and show demonstrated results such as delivery time reduction, improved financial performance, greater client satisfaction and building trust among suppliers.

Since the study is one of the weak links in the building construction industry, it will show directions so that further doctorial researches can be performed on the basis of the Conclusions drawn.

And also the researcher will benefit from the research since value will be added to the long time curiosity of the researcher since the problem was identified as a major gap in the overall performance of the building construction industry.

1.5 Scope and Delimitation of the study

Supply chain management involves the management of an extended enterprise. Within the context of the construction industry, such as extended enterprise may include many autonomous firms for example contractors, sub-contractors, material and equipment suppliers, engineering design firms and other consulting firms.

The scope of the study is limited only to construction material supply chain management and tries to shade light to the problems in the building construction industry on focus to contractors. And does not include any other sort of supply chain management aside from what is discussed above.

2. LITERATURE REVIEW

2.1. Overview of Supply Chain Management

The construction industry is one of the largest industries in the world. This industry is an aggregation of various trades and professions that have a strong influence on the global economy. The diversity is very evident, particularly in technological societies, in the number and types of residential, commercial, industrial, and heavy construction throughout the world (Hatmoko and Scott, 2010). Whatever the type of construction companies in this sector, they are increasingly confronted with a market that requires the execution of works with a commitment of time and costs. It is, therefore, important to the competitiveness of construction companies, the use of mechanisms to manage all construction activities that lead to the final product (Halpin and Woodhead, 1998).

Management problems in the construction sector generate needs as the application of new prototypes in order to eliminate waste and therefore add value. SCM is an increasingly applied operations paradigm for enhancing overall organizational competitiveness (Gunasekaran and Ngai, 1998). There has, however, been little research to date on the impact of SCM practice on construction site performance, and this opens up an opportunity and provides justification to conduct research on this topic.

SCM is a concept originating from the supply system by which Toyota was seen to coordinate its supplies and manages its suppliers. The basic concept of the SCM includes tools like JIT and logistics management. The current concept of the SCM is somewhat broader but still largely dominated by logistics (Vrijhoef and Koskela, 1999).The concept of Supply Chain Management (SCM) is the "coordination of independent enterprises in order to improve the performance of the whole supply chain." (Lou, et al, 2004). This usually involves a group of companies working collaboratively to satisfy customer needs (Egan, 1997). Contemporary supply chain practices consider the supply chain as an integrated value generating flow rather than only as a set of independent activities (Vrijhoef, 2003). (Christopher, 2000) identified trust, commitment, and willingness to share information among supply chain participants as pre-requisites for efficient supply chains.

SCM deals with the management of materials and information resources across a network of organizations that are involved in the design and the production process. It recognizes the interconnection between materials and information resources within and across the organization boundaries and seeks systematic improvement in the way these resources are structured and controlled (Trucker and Mohammed, 2001). The objective of supply chain management is to be able to have the right products in the right quantities at the right place at the right moment at minimal cost (Vrijhoef et.al., 1999).

2.2. Construction Supply Chain Management

CSC is all the construction process, from the demands by the client, conceptual design, construction and maintenance and organizations, which are involved in the construction process, such as owner, designer, general contractors, subcontractors, suppliers, consultants, etc. CSC is not a chain of construction business with business-to-business relationships but a network of multiple organizations and relationships, which includes the flow of information, the flow of material services or products, and the flow of funds between client, designer, contractor and supplier (Xue, et al., 2007).

The construction industry has been slower to employ the concept of supply chain management which has been embraced in other industries such as manufacturing (Love, et al, 2000). This is due to the short-term supplier-contractor relations that are subject to vulnerability due to the temporary nature of construction projects and the one-of-a- kind nature of the product (Akintoye, et al, 2000). In construction, relationships with third parties have traditionally been managed through adversarial approaches causing detrimental effects on project performance (Palacios, et al, 2013). (Latham, 1994) highlights some of the industry problems such as the sector's reliance on competitive tendering and the adversarial attitudes that commonly exist between contractors and their suppliers. Current and popular thinking in construction however is that the best practices to manage relationships should always foster highly collaborative approaches based on high levels of trust and transparency other than typical opportunistic and adversarial approaches (Cox, et al, 2006). There is a need to move away from adversarial attitudes towards enlightened cooperative relations (Fernie, et al, 2007). Based on the success of other industries, several reports have encouraged this approach in order to overcome a situation of low profitability and poor performance (Koskela, 2000).

Proverbs, et al, (2000) advocates effective SCM through the early involvement of both contractors and subcontractors as a means to effectively reduce overall construction costs. Sobotka, (2000) studied construction material flows and established that in the delivering of the physical flow of materials between elements of the supply chain, only 0.3% to 0.6% of the total time is value being added. Only for the interface between the main contractor and the supplier has an average cost reduction potential of 10% (of material costs) through improved logistical procedures been shown. The waste can be even higher when taking the whole supply chain into consideration.

2.2.1. The Construction Industry

The construction industry in general is highly fragmented with significant negative impacts perceived low productivity, cost and time overruns, conflicts and disputes, and resulting claims and time-consuming litigation. These have been acknowledged as the major causes of performance-related problems facing the industry. The legacy of this high level of fragmentation is that the project delivery process is considered highly inefficient in comparison with other industry sectors (Trucker et al, 2001). The construction industry has numerous problems because of its complicated nature of operation. This industry is comprised of a multitude of occupations, professions and organizations (Milakovich, 1995). They are involved in the different phases of a construction project, which, according to Schultzel and Unruh (1996), include: feasibility, development, finance, concept development and review, estimate, detailed engineering, procurement, construction and start-up.

The client, consultants, contractor and sub-contractors of a construction project all have a role to play in delivering a quality project. Failure of any of the parties will seriously affect the quality of the final project. Moreover, the parties have different objectives which keep them apart. Rowlinson and Walker (1995) point out that the construction industry is also characterized by its non-standardization. Production processes are to some extent different from each other. Hence, no universal standard or specification can be applied to the product, which leads to difficulties in quality assurance.

2.2.2. Material Management in Construction

Efficient management of materials plays a key role in the successful completion of a project. The control of materials is a very important and vital subject for every company and should be handled effectively for successful completion of a project on its intended contractual time. Materials account for a big part of project cost. Some studies concluded that materials account for around 50%-60% of the project cost (Bernold and Treseler, 1991). Different authors define the concept of materials management in different ways. However, all the researchers point out that materials management is extremely important for a project to be successfully completed. The basic idea behind materials management is that the materials and/or equipment needed, in the quantities needed, meeting the standards of quality specified, are obtained at a reasonable cost and are available when needed on the construction site. The process of materials management should integrate purchasing, expediting, and inventory control. A well-managed materials management system can contribute to the cost effectiveness of a project (Perdomo, 2004).

2.2.2.1. Benefits of the Materials Management

An effective material management system can bring many benefits for a company. Previous studies by the CII concluded that labor productivity could be improved by six percent and can produce 4-6% additional savings (Bernold and Treseler, 1991). Among these benefits are reducing the overall costs of materials, better handling of materials, materials will be on site when needed and in quantities required, improvement in labor productivity, improvement in project schedule, better relation with suppliers, reduce of surplus materials, reduce storage of materials on site, labor savings and stock reduction.

2.3. Supply Chain Fundamentals

There are many definitions for the SC and there seems to be a universal agreement on what a supply chain is (Teigen, 1997). Lee et al. (1995) define a SC to be 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. Swaminathan et al. (1996) has a similar definition: a network of autonomous or semi-autonomous business entities collectively responsible for procurement, manufacturing, and distribution activities associated with one or more families of related products. Ganeshan et al. (1995) has yet another analogous definition: SC is a network of facilities and distribution options that performs the functions of procurement of materials, transformation of these materials into intermediate and finished products, and the distribution of these finished products to customers.

2.3.1. Origin of the Supply Chain Management

SCM is a concept that has originated and flourished in the manufacturing industry. The first signs of SCM were perceptible in the JIT delivery system as part of the Toyota Production System (Shingo 1988). This system aimed to regulate supplies to the Toyota motor factory just in the right - small - amount, just on the right time. The main goal was to decrease inventory drastically, and to regulate the suppliers' interaction with the production line more effectively. After its emergence in the Japanese automotive industry as part of a production system, the conceptual evolution of SCM has resulted in an autonomous status of the concept in industrial management theory, and a distinct subject of scientific research, as discussed in literature on SCM (Bechtel and Yayaram 1997, Cooper et al. 1997). Along with original SCM approaches, other management concepts (e.g., value chain, extended enterprise) have been influencing the conceptual evolution towards the present understanding of SCM. In a way, the concept of SCM represents a logical continuation of previous management developments (Van der Veen and Robben 1997). Although largely dominated by logistics, the contemporary concept of SCM encompasses more than just logistics (Cooper et al. 1997). Actually, SCM is combining particular features from concepts including TQM, BPR and JIT (Van der Veen and Robben 1997).

2.3.2. Concept of the Supply Chain Management

The supply chain has been defined 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' (Christopher, 1992).

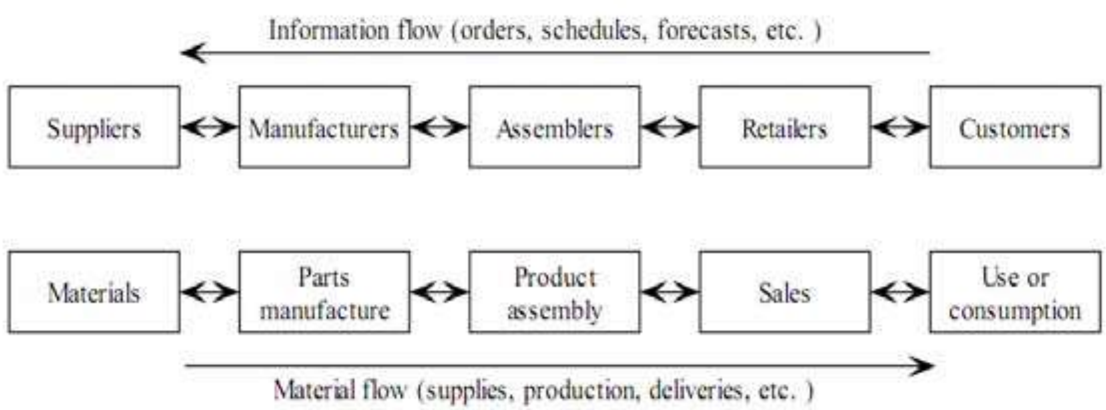


Figure 2.1 Generic Configuration of a Supply Chain in Manufacturing (Christopher, 1992).

Figure 2.1 shows a generic configuration of supply chain in manufacturing, with information flows (such as orders, schedules, forecasts), circulating between customers, retailers, assemblers, manufacturers and suppliers. Material flows (as supplies, production, deliveries, and products of whatever kind) circulate from their manufacturing from raw materials or components, through to their use within the manufactured product. SCM looks across the entire supply chain (Figure 2.1), rather than just at the next entity or level, and aims to increase transparency and alignment of the supply chain's coordination and configuration, regardless of functional or corporate boundaries (Cooper and Ellram 1993). According to Cooper and Ellram (1993), the shift from traditional ways of managing the supply chain towards SCM includes various elements (Table 2.1). The traditional way of managing (Table 2.1) is essentially based on a conversion (or transformation) view on production, whereas SCM is based on a flow view of production. The conversion view suggests that each stage of production is controlled independently, whereas the flow view focuses on the control of the total flow of production (Koskela1992).

Table 2.1: Characteristic differences between traditional ways of managing the supply chain and SCM, (Cooper etal., 1993) cited in (Vrijhoef et al., 1999).

Element	Traditional management	Supply chain management
Inventory management approach	Independent efforts	Joint reduction of channel Inventories
Total cost approach	Minimize firm costs	Channel-wide cost efficiencies
Time horizon	Short term	Long term
Amount of information sharing and monitoring	Limited to needs of current transaction	As required for planning and monitoring processes
Amount of coordination of multiple levels in the channel	Single contact for the transaction between channel pairs	Multiple contacts between levels in firms and levels of channel
Joint planning	Transaction-based	Ongoing
Compatibility of corporate philosophies	Not relevant	Compatibility at least for key relationships
Breadth of supplier base	Large to increase competition and spread risks	Small to increase coordination
Channel leadership	Not needed	Needed for coordination focus
Amount of sharing risks and rewards	Each on its own	Risks and rewards shared over the long term
Speed of operations, information and inventory levels.	Warehouse" orientation (storage, safety stock) interrupted by barriers to flows; localized to channel pairs.	"Distribution center" orientation (inventory velocity) interconnecting flows; JIT, quick response across the channel.

2.4. Construction Supply Chain

Construction is a multi-organization process, which involves owner, designer, contractor supplier, consultant, etc. It is also a multi-stage process, which includes conceptual, design, construction, maintenance, replacement. From this point of view, CSC) is all the construction process, from the demands by the client, conceptual, design, construction and maintenance and organizations, which are involved in the construction process, such as owner, designer, general contractors, subcontractors, suppliers, consultants, etc. CSC is not a chain of construction business with business-to business relationships but a network of multiple organizations and relationships, which includes the flow of information, the flow of materials services or products, and the flow of funds between client, designer, contractor and supplier, as shown in figure 2.2 (Xue, etal., 2007).

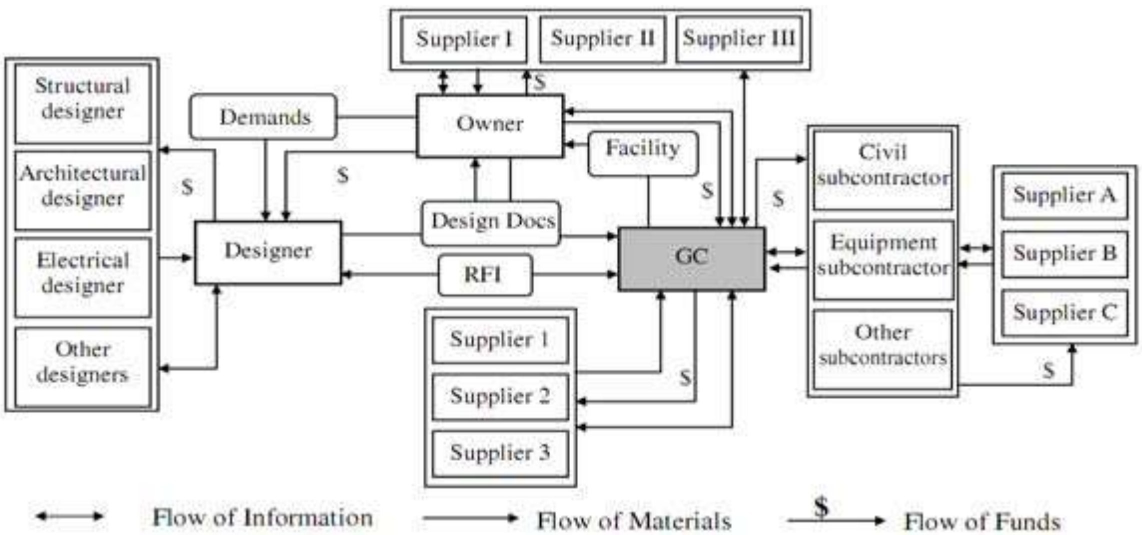


Figure 2.2 General Structure of Construction Supply Chain (Xue, et al., 2007)

2.4.1. Characteristics of Construction Supply Chains

In terms of structure and function, the CSC is characterized by the following elements (Vrijhoef et al., 2000):

• It is a converging supply chain directing all materials to the construction site where the object is assembled from incoming materials. The « construction factory » is set up around the single product, in contrast to manufacturing systems where multiple products pass through the factory, and are distributed to many customers.

• It is, apart from rare exceptions, a temporary supply chain producing one-of construction projects through repeated reconfiguration of project organizations. As a result, the construction supply chain is typified by instability, fragmentation, and especially by the separation between the design and the construction of the built object.

• It is a typical make-to-order supply chain, with every project creating a new product or prototype. There is little repetition, again with minor exceptions. The process can be very similar, however, for projects of a particular kind.

2.5. Construction Supply Chain Management

Agapiou et al (1998) noted that no studies have defined what SCM is in the construction Process is. However, based on the understanding of SCM, CSCM can be defined as: the integration of key construction business processes, from the demands of client, design to construction, and key members of construction supply chain, including client/owner, designer, contractor, subcontractor and supplier. CSCM focuses on how firms utilize their suppliers' processes, technology and capability to enhance competitive advantage. It is a management philosophy that extends traditional intra-enterprise activities by bringing trading partners together with the common goal of optimization and efficiency. CSCM emphasizes on long-term win-win, cooperative relationships between stakeholders in systemic perspective. Its ultimate goal is to improve construction performance and add client value at less cost (Xue, et al., 2007).

Trucker et al. (2001) define the CSCM as the strategic management of information flow, tasks and process, involving various networks of organizations and linkages (upstream and downstream), throughout a project life cycle. The upstream activities within construction in relation to the position of a main contractor, consists of the activities and tasks leading to the preparation of the production on site involving construction clients and design teams. The downstream consists of activities and tasks in the delivery of construction product involving construction suppliers, subcontractors, and specialist contractor interrelating with the main contractor.

2.5.1. Areas of Focus, and Roles of Supply Chain Management in Construction

Vrijhoef & Koskela (2000) identified four major roles of or level of implementation of SCM, dependent on whether the focus is on the supply chain, the construction site, or both. One or several

SC participants could lead each level of implementation. The roles or level of implementation are not mutually exclusive, but are often used jointly.

i. The focus may be on the impacts of the supply chain on site activities. The goal is to reduce costs and duration of site activities. In this case, the primary consideration is to ensure dependable material and labor flows to the site to avoid disruption to the workflow. This may be achieved by simply focusing on the relationship between the site and direct suppliers. The contractor, whose main interest is in site activities, is in the best position to adopt this focus.

ii. The focus may be on the supply chain itself, with the goal of reducing costs, especially those relating to logistics, lead-time and inventory. Material and component suppliers may also adopt this focus.

iii. The focus may be on transferring activities from the site to earlier stages of the supply chain. This rationale may simply be to avoid the basically inferior conditions on site, or to achieve wider concurrency between activities, which is not possible with site construction with its many technical dependencies. The goal is again to reduce the total costs and duration. Suppliers or contractors may initiate this focus.

iv. The focus may be on the integrated management and improvement of the supply chain and the site production. Thus, site production is subsumed into SCM. Clients, suppliers or contractors may initiate this focus. The focus here is on the supply chain of a main contractor.

2.6. Material Supply Chain Process

Perdomo (2004) developed a conceptual framework for the MSCP. The framework was based on various discussions and interviews with office and site personnel from the electrical contracting industry in Northern Virginia, Southwest Virginia, Tennessee, Maryland and Carolina. From the information acquired from the interviews, five distinct phases that comprise the MSCP were identified which are: 1-Bidding Phase, 2-Sourcing Phase, 3- Materials Procurement, 4-Costruction Phase, 5- Post Construction Phase. The following subsections will briefly discuss the five phases.

Bidding Phase: the materials management process starts from the time that the contractor receives the drawings and specifications. The materials takeoff and identification process is the first step in this phase and involves identifying the materials needed as well as any special requirements or special materials to be used in the project.

Sourcing Phase: This phase includes the selection of reputable suppliers and manufacturers. The selection of suppliers is critical and the contractor needs to verify that the supplier is capable of delivering the right material (i.e. type, quality and quantity) when needed (i.e. at dates specified).

Material Procurement Phase: this phase includes material requisition and expediting and it is considered very critical to the success of a material management process. The person in charge of procuring materials or the purchasing department, in the case of a large company, needs to ensure that the correct materials in the correct quantities are delivered. This person also needs to verify the release dates at which the material is needed and to clearly specify those delivery dates and the location of delivery to the supplier.

Construction Phase: material delivery usually occurs during the construction phase. Material is generally requested for delivery to the jobsite. In some instances material delivery to the jobsite may not be feasible due to storage or access limitations. In this case, the material is delivered to other locations such as the contractor's warehouse, a prefabrication shop or another subcontractor storage area. Material requisition problems greatly affect the construction stage and failure to manage this phase effectively could result in project disruption and possible delays due to late deliveries, stock outs due to small quantities bought, material delivered to the wrong locations, material backordered and effects in overall costs. The requisition process for miscellaneous material starts in the construction phase and is focused on how much material to buy, when to buy this material, where to deliver this material, when to deliver, which supplier to buy from, where to store on site.

Post-Construction Phase: after installation of the materials on the structure, the contractor has to manage any surplus material. The surplus is handled differently depending on the type of material and also whether or not the contractor has a warehouse. If the company has a warehouse, the surplus material is stored in the warehouse for use in future projects. Other companies return surplus material to the supplier for reimbursement.

Furthermore, Abdul Rahman and Al-Dirisy (1993) developed a framework that shows the activities involved in the management of materials on construction site. The following is a description of the activities:

1. Preparation of material purchase- this involves the description, quantity and quality of the materials to be used, order and delivery dates and the location.

2. Order of materials- the preparation of a purchase order that describes the quantity, quality, dimensions and location of delivery.
3. Transportation- this covers the loading and transit, handling and off-loading of materials.
4. Delivery- site management should check the material delivery order against the purchase order. Damages during the transit have to be spotted upon the arrival of materials.
5. Site material management- a record of the performance of the material vendor, providing information on the materials needed and which manages the warehouse and distribution of the materials.
6. Comparison and evaluation- this activity involves comparing materials receipt against orders and records on materials usage.
7. Materials handling- the duty of the foreman to oversee workmanship, overall handling materials and protection of the completed structure.
8. Work implementation and monitoring- this include supervision of the work, the use of proper instrument and check against wastage.
9. Work completed and acceptance- examination of the completed works, inspection and request for remedial work. Once a task is completed and satisfactorily accepted by the client, an evaluation should be made to assess wastage/surplus and stock. Proper overview of wastage and surplus materials to other project sites which require the material should be given of great focus.

2.7. Problems of the Construction Supply Chains

Much research work and real test cases analyses have assessed that construction is ineffective and many problems can be observed. Analysis of these problems has shown that a major part of them are supply chain problems, originating at the interfaces of different parties or functions, as represented in Figure 2.3, among which (Vrijhoef et al., 2001):

• Client/design interface: difficulties in finding out client's wishes, changes of client's wishes, long procedures to discuss changes,

• Design/engineering interface: incorrect documents, design changes, extended wait for architect's approval or design changes,

• Engineering/purchasing & preparation interface: inaccurate data, engineering drawings not fitting the use,

• Purchasing & preparation/suppliers interface and purchase & preparation/subcontractors interface: inaccurate data, information needs not met, adversarial bargaining and other changes.

It can be noticed from this list that communication problems (either described in terms of "data", or more generally in terms of information handled during the exchanges) form an important part of the problems faced in construction supply chains. The current practice of supply chain management rightly suggests controlling the supply chain as an integrated value-generating flow, rather than only as a series of individual activities.

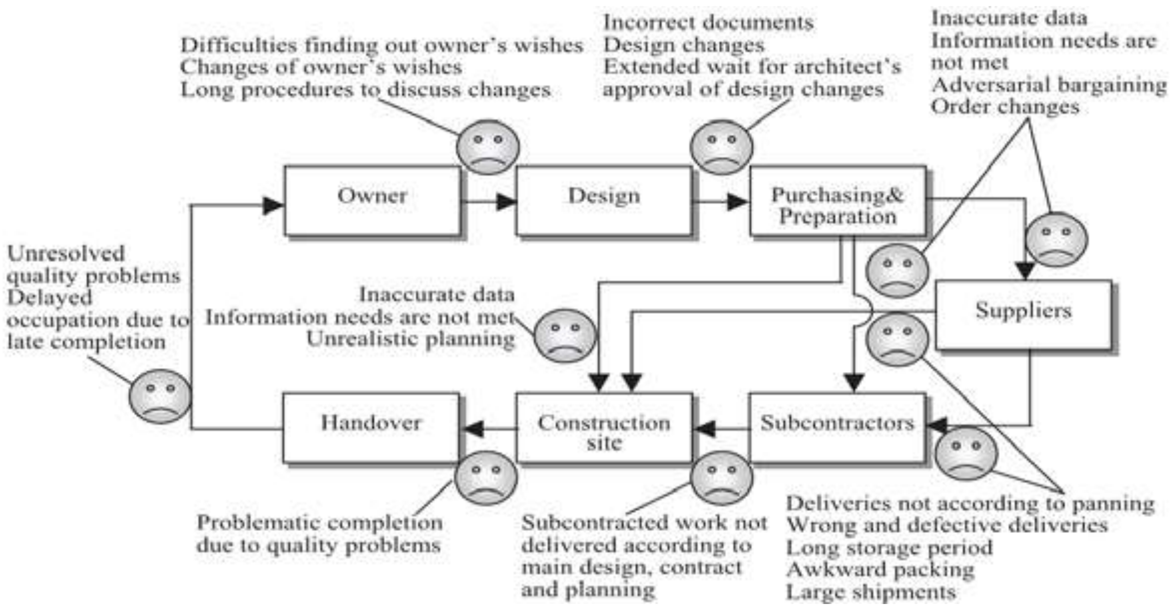


Figure 2.3 Problems in Construction Supply Chain (Vrijhoef et al., 2001)

2.8. Traditional Construction Supply Chain

Traditionally, as compared to the basic definition of SCM, project management in construction follows an activity-centered approach that concentrates on monitoring project participants' activities against a construction schedule (Howell 1999). Since the underlying motivation of this approach is to improve efficiency in value-adding activities where physical conversions occur (Koskela 1992), passive communications from downstream (customer side) to upstream (supplier side) have been prevailing in the industry. However, due to the long information lead-time and the lack of coordination, the initiated communication often fails to have the required information in a timely manner.

To make matters even worse, the communication itself may not be initiated because of the large number of project participants in a construction project: it is an overwhelming task for project managers to cover numerous project members and their suppliers. These types of disturbances in information flows generate turbulences in material flows, which are one of the highly ranked causes of delay in a construction project. Furthermore, project information exchange between designers and contractors has mainly based on paper documents (Luiten et al, 1998). These documents come in the form of architectural and engineering drawings, specification and bills of quantities and materials. This practice is far from being satisfactory, which research showing that about two-thirds of the construction problems are caused by inadequate communication and exchange of information and data (Cornick, 1990).

The most significant characteristic of this process is the project organization which has been described as a "temporary multiple organization" (Cherns and Bryant, 1983). Such an organization is usually project-focused, with a short-term perspective, emphasizing competitive bidding as the main tool in contractors, subcontractors and supplier evaluation. Consequently, customer-supplier relationships in construction are generally of the arm's length type rather than being partnerships. Cox and Thompson (1997) concluded that competitive tendering assures that sub-contracting is procured to the lowest-price supplier with little or no guarantee (or even incentive) to future work. To overcome industry fragmentation, a number of integration approaches and strategies, and their successful applications in manufacturing and other industries have been recommended (Mohamed, 1997).

These include design-and-construct, design-for construction, concurrent engineering, lean construction, business process reengineering, and a variety of others. Unfortunately, these approaches have proved inadequate to cope with the increasing complexity of construction projects, without the support of information technology (Mokhtar and Bedard, 1995). Also, most of these approaches have tried to focus on elements linked to time, quality and/or cost, but research of Kagioglou et al, (1998) noted that 85% of commonly associated problems are process related, and not product related. Except for the most trivial projects, the delivery process for a constructed facility consists of several phases and a multitude of professionals from various disciplines working together to advance the project (Fischer et al, 1998).

2.9. Supplier/Contractor Arrangements

Unavailability of materials when needed can greatly affect the productivity of the workforce, thus causing delays to activities, increasing the cost of the project and possibly delaying the completion of the project. The contractor should search for arrangements that will ensure availability of materials when they are needed.

The construction industry has been characterized by adversarial relationships between the parties involved. The relationship of a contractor with his suppliers is critical for the successful completion of any construction project. Availability of materials is essential for the timely completion of activities and for the productivity of the labor force. If materials are not available when they are needed, a variety of problems might arise. Leenders, et. al., (2002) offer a classification of supplier based on the quality of the service that the supplier offers to the customer. The classifications that they present are unacceptable suppliers, acceptable suppliers, good suppliers, preferred suppliers, and exceptional suppliers. A description of each category follows.

- Unacceptable suppliers- these suppliers are not able to meet the operational needs of the customer and are not able to provide materials when they are needed. In addition, they don't offer means to satisfy the strategic needs of their customers.
- Acceptable suppliers- these suppliers meet the current operational needs of the customer, however, the services that they provide can easily be matched by any other supplier.
- Good suppliers- these suppliers are a step above acceptable suppliers in the fact that they can provide the materials needed, but in addition they can also provide some value added services.
- Preferred suppliers- these suppliers offer a system that integrates the buying/selling functions in an electronic format. This integration eliminates duplication and allows to process transactions faster. These suppliers meet both the operational needs of the company as well as their strategic needs.
- Exceptional suppliers- these suppliers are able to recognize and anticipate the needs of their customers and are able to satisfy those needs. Because of the value they provide to their customers, they are valued. They allow customers to experiment with different scenarios and approaches, because of their efficiency, which results in minimization of risk for their customers.

2.10. Construction Supply Chain Integration

In view of the above, there has been a growing recognition that it is important to integrate the various disciplines/participants in a construction project; this includes aspects of integrating all the members of the supply chain.

2.10.1. Information and Communication System

There is a growing awareness of the value of information and communications technology to bring together the major parties in the construction process and share project as well as industry information in a meaningful way (Tucker et al, 2001). Thus, the coordination of information flows is a key component in achieving tight integration in order to optimize the chain-wide performance. As a way of coordinating information flows, the idea of real-time information sharing has been studied extensively in the manufacturing industry. It specifically emphasizes instantaneous multilateral information sharing within a supply chain in order to reduce uncertainties associated with operations and demand forecast (Cooper et al. 1997).

2.11. Barriers that Obstruct integration of Construction Supply Chain

There are several barriers that obstruct coordination and integration of the CSC process (Xue, et al., 2007).

• Attitude-related issues: such as narrow-minded "win-lose" attitude and short term focus, arrogant attitude, exclusion of the subcontractors and suppliers from the early involvement phases, lack of praise of good performance and lack of understanding of the subcontractors and suppliers problems

• Quality of information-related issues: such as poor information quality from general contractor and less transparency coupled with inadequate information exchanges and limited communications.

• Financial/cost-related issues: these are related to competitive tendering based on price (with inadequate focus on life-cycle costs and ultimate value), which has developed adversarial relationships among clients, general contractors, subcontractors and suppliers that result in serious problems with regards to payments.

• Programming/time related issues: such as false expectation on part of the general contractor, unrealistic and uncertain lead time of materials.

2.12. Overview of the Ethiopian Construction Industry

The Building Construction industry is one of greatest sector that contributes a lot to the current rapid economic growth of Ethiopia. According to the Ethiopian Construction Industry Development Policy published on December/ 2014 the construction sector is growing yearly at an average of 12.43% and contributes 5.3 percent of to the overall Gross Domestic Product. In the policy it is mentioned that the construction industry in Ethiopia involves the government, private companies, consultants, contractors, financial institutions, construction input suppliers, the owners and users of construction end Products, Construction Infrastructure Providing Companies, Construction Licensing and monitoring Bodies and other relevant bodies acting in the industry.

Even though the construction sector is playing a crucial role in solving the country's economic and social problems, it is subjected to a variety of challenges and problems. It has been described that there exists an imbalance between construction services and inputs. The main role players such as contractors and consultants are limited in capacity, insufficient in number and luck business ethics to meet the needs of fast growing industry.

The construction industry is also lacking efficient and responsive supply chain management which is taken as the main reason for the industry to be unproductive. A well-integrated supply chain is not put in place to avail construction inputs produced by the local manufactures or the imported ones at the right time, at the right amount, at the right quality and with the reasonable price. Neither locally manufactured construction inputs nor imported material are available at the right condition demanded by the industry. There is shortage of both manufactured and locally available construction inputs such as stone, sand and selected soil materials when compared to the demanded amount, resulting in rigorous price increase (Gelana A., 2016).

The other main problem mentioned in the policy document is the lack of integration and coordination among the key role players in the industry. As a result of this some government projects face poor feasibility and incomplete design. Procedures are not put in place to test and approve the reasonability of project price, quality of design and the control of project schedule. Even though objectives are set and strategies are designed to tackle the problems so far identified in the policy, there are significant challenges prevailing in the industry.

The problems relating to poor performance and widespread underperformance in the Ethiopian construction industry are well documented and can be clearly observed on completed and ongoing construction activities. Though there are qualified owners that are leading their construction projects well, most of the larger indigenous Ethiopian contractors are owned by proprietors who have little or no formal knowledge of the construction, project or organizational management. Such owners do not see the need to employ personnel with the technical know-how to manage their firms towards sustainable growth.

Management of firms' resources is undertaken haphazardly with little or no knowledge of current developments. This does not promote growth in the construction industry (Vulik, 2004). Kpamma, (2009) argues that a significant proportion of time and effort is spent on waste activities.

In spite of the massive focus on SCM, little attention has been paid to relationships upstream from the construction site, i.e. between contractors and their and material suppliers. This may suggest a lack of clear understanding of the type of relationships associated with SCM. In order to improve the efficiency and effectiveness of construction supply chains, a fundamental change in the management of relationships between clients, contractors and sub-contractors is required (Salem S.,2012).

There is a gap in the knowledge and application of the extent of the use of supply chain management in the Ethiopian construction industry. Hence resulting in performance-related problems such as delay in material ordering and receiving, low productivity, cost and time overrun, conflict and disputes (Belay M. 2011).

Although various partnering arrangements among the construction supply chain actors have been sought, practical ways to achieve integration among processes and firms was not well discussed. Taking a holistic and systemic view of the construction supply chain requires a strategic approach which may, in fact, requires more extensive implementation effort. This is not easy within a single organization, let alone across a diverse and disperse group of trading partners of the kind so typical of the construction industry. The construction literatures seem to agree upon "supply chain integration" being the core task of SCM in construction.

Furthermore, integration is seen as the key means to improve construction performance although definite and practical ways of achieved in an industry characterized by fragmented and adversarial relationships hasn't been well indicated. In conclusion the Ethiopian construction industry is considered to be an engine in the nation's economy and it has many important links to the rest of the economy. Construction is arguably the least integrated of all major industrial sectors, characterized by adversarial and disjointed relationships. (Gelana A., 2016).

The complex and fragmented nature of construction supply chain have significant negative impacts on the construction process of projects. Impacts such as low productivity, cost and time overrun, conflicts and disputes, quality deviations, luck of trust and others frequently happen in the Ethiopian construction industry. (Belay M. 2011).

According to Gelana A. (2016) the application of CSCM to the Ethiopian construction industry has immense benefits to the construction organizations in developing the real sense of integration and collaboration. It can help in maximizing opportunities to add value while minimizing total cost of project through the integration of processes, organizations and information follows. This application requires significant shift of the mindset of stakeholders towards collaboration, team work and mutual benefits.

Thus, this paper has tried to address this gap by providing evidence for the objectives set in the Ethiopian construction industry specific to Contractors with Building construction projects in Jimma Town.

3. METHODOLOGY

This chapter describes the methodology that was used in this research. The adopted methodology to accomplish this study uses the following techniques: review of literature related to construction supply chain management, information about the research design, questionnaire design, research population, sample size and statistical data analysis, formulation of narrative and graphical representation of the material supply chain process, evaluation of the material supply chain process, conclusion and recommendations.

3.1. Study area

The study area is focused on contractors basically involved in the building construction industry in the western part of Ethiopia around Jimma town which is located at 346km from Addis Ababa.

3.2. Research strategy

The type of research adopted for this research was quantitative research. The purpose for adopting it is due to the subjective nature of quantitative approach to research.

3.3 Research design

The first phase of the research thesis proposal included identifying and defining the problems, establishing the objectives of the study and developing the research plan. The second phase included an exhausted summary of the comprehensive literature review. The third phase included a field survey which was conducted from the viewpoint of contracting companies specifically in the building construction industry. The fourth phase focused on the careful selection of variables and questionnaire design. The fifth phase was dissemination of the questionnaire. Fifty questionnaires were distributed to the research population but only Thirty three 66.0% were received back. The sixth phase was data analysis and discussion. Simple percentage and relative importance index method was used to perform the required analysis. The final phase included the conclusion and recommendations.

Figure 3.1 below shows the research methodology flowchart, which leads to achieve the research objectives.

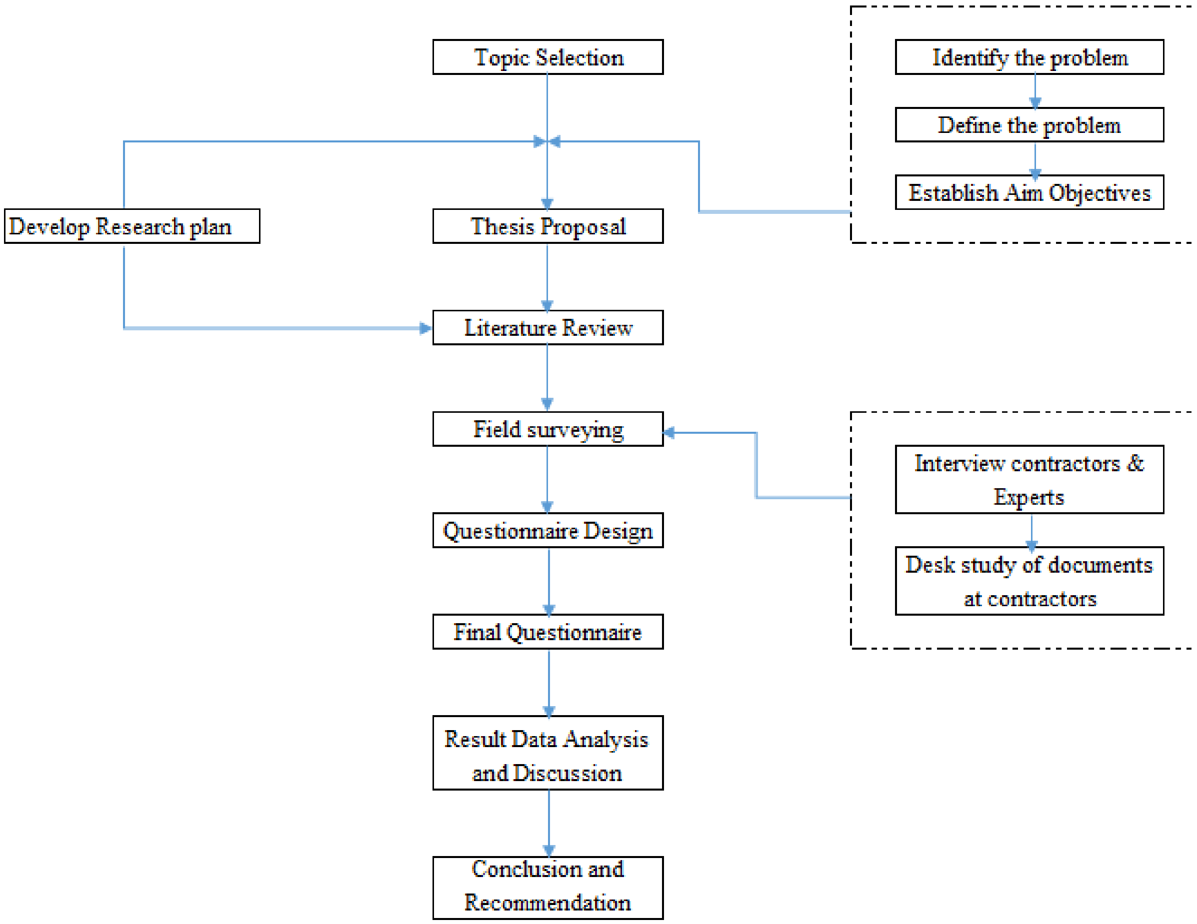


Fig 3.1 Research methodology flow chart

3.4 Questionnaire design and content

Following the comprehensive literature search that was exhaustively conducted related to the construction supply chain management and interview experts who have experience with the subject at different levels and the researcher's personal experience, all the information that could help in achieving the study objectives were collected, reviewed and formalized to be suitable for the study so that a representative questionnaire was developed with closed questions.

The questionnaire was designed in English and was attached also in Appendix 1. Unnecessary personal data, complex and duplicated questions were avoided. The questionnaire was provided with a covering letter which explained the purpose of the study, the way of responding, the aim of the research and the confidentiality of the information in order to encourage high response. The questionnaire design composed of five sections to accomplish the aim of the research, as follows:-

1. The first section contained information about Companies Profiles. It contains eight questions aiming at providing general information about the contracting companies like, company establishment year, company specialized sector, average number of employees within the last five years, total amount of executed projects within the last five years.
2. The second section contained Current Practices of Material Supply Chain Process and the important activities that form it. It contains the phases that form the material supply chain process and each phase contains set of activities. Here the organizational structure followed by contractors will also be determined.
3. The third section was about the Contractor / Supplier Relationship. It contains two subsections aiming at studying the contractor/ supplier relationship. The first subsection contains nine criteria aiming at studying the concerns of the contractors in selecting the suppliers. Here contractor's course of actions aims at studying the likely course of action that contractors will adopt in case suppliers do not deliver materials on time and/ or deliver materials do not comply with the project specifications. The second subsection was about Contractor action for probable delay in relation to delivery of materials to the project site.
5. The fourth section was about identification of the most frequently occuring problems encountering the Contractors through the Material Supply Chain Process. It contains the problems that may encounter the contractors during the application of the material supply chain process. This section aims at determining the most occurred problems facing the contractors through each phase of the material supply chain process in order to address solutions to these problems.
6. The fifth section was about the key factors contributing in construction supply chain integration. It contains twelve questions that aiming at determining the key factors that may contribute in integrating the project phases of the material supply chain process.

3.5 Research Population

On the basis of the data obtained from Jimma Town Housing & Urban development office, the Target population for this research were set to be 100 Ethiopian Contracting companies with building projects available around Jimma Town. These firms comprised of contractors of Grade one, two and three.

3.6 Sample size Determination

Sampling can be defined as the process of selecting representative units of a population for the study in research investigation. The objective of the sampling is to provide a practical means of enabling the data collection and processing the components of the research to be carried out with ensuring that the sample provides a good representation of the population. A sample is a small proportion of a population selected for observation and analysis. Due to the knowledge of the complete information about the research population, systematic sampling technique was used to determine the sample size.

Systematic sampling is a statistical method involving the selection of elements from an ordered sampling frame. The most common form of systematic sampling is an equiprobability method. In this approach, progression through the list is treated circularly, with a return to the top once the end of the list is passed (Wikipedia, http://en.Wikipedia.org/wiki/systematic_sampling). The sampling starts by selecting an element from the list at random and then every kth element in the frame is selected, where k, the sampling interval (sometimes known as the skip): this is calculated as:-

$$k = \frac{N}{n} \quad \text{.......................................Eqn. 1}$$

where n is the sample size, and N is the population size.

Using this procedure each element in the population has a known and equal probability of selection. Systematic sampling is to be applied only if the given population is logically homogeneous, because systematic sample units are uniformly distributed over the population. The researcher must ensure that the chosen sampling interval does not hide a pattern. Any pattern would threaten randomness. The size of the sample (n) was decided from the population (N) by means of selecting N/nth building construction contractor. That is the second one of every consecutive two contractors resulting in a sample size of 50 contractors. The sample consisted of building construction contractor's experts both at head office and project site levels in Jimma Town.

The percent of valid respondents to No. of distributed questionnaires is shown in Table 3.1. The researcher distributed 50 questionnaires by hand. As shown in Table 3.1, the response rate for the questionnaire survey was 66.0%. The percent of valid respondents to the number of distributed questionnaires was 60.0%.

Table 3.1: Classification of Sample Size

Number of population	Number of sample	Number of distributed questionnaires	No of respondents	Number of valid respondents	Percent of valid respondents to No. of distributed questionnaires
100	50	50	33	30	60.0

3.7 Study Variables

The dependent variables of the study are:-

- Supply chain management practices

The in dependent variables of the study are:-

i. Sub items under Current practices of material supply chain process through
   1. Bidding phase
   2. Sourcing phase
   3. Material procurement phase
   4. Construction phase
   5. Assessment conduction phase
   6. Post construction phase

ii. Sub items under Contractor/Supplier relationship

iii. Sub items under contractor action for probable delay caused by suppliers late delivery

iv. Sub items under identification of the most occurred problems encountered by contractors

v. Sub items under key factors contributing in construction supply chain integration

3.8 Data Measurement

For assessing the questionnaire factors, the respondents were required to rate these factors on a 5-point Likert scale for degree of usage and Importance degree. In addition degree of occurrence was also considered:-

Where "1" represents Never and "5" represents always and also

Where "1" represents the Little Importance and "5" represents the Very Important.

Usage degree meaning the degree of application on ground at the respondent's respective projects and Importance degree meaning opinion of the respondents on the importance of the item under the different phases of the processes ideally.

3.9 Reliability of the Research

The reliability of an instrument is the degree of consistency which measures the attribute; it is supposed to be measuring. The less variation an instrument produces in repeated measurements of an attribute, the higher its reliability. Reliability can be equated with the stability, consistency, or dependability of a measuring tool. The test is repeated to the same sample of people on two occasions and then compares the scores obtained by computing a reliability coefficient.

It is difficult to return the scouting sample of the questionnaire that is used to measure the questionnaire validity to the same respondents due to the different work conditions to this sample. Therefore, Cronbach's Coefficient Alpha was applied in order to measure the consistency of the questionnaire.

3.9.1. Cronbach's Coefficient Alpha

This method was used to measure the reliability of the questionnaire between each field and the mean of the whole fields of the questionnaire. The normal range of Cronbach's coefficient alpha values vary between 0.0 and + 1.0, and the higher values reflects a higher degree of internal consistency. As shown in Table 3.2, the Cronbach's coefficient alpha was calculated for the second field of the Current Practices of Material Supply Chain Process, the fourth field of The Identification of the Most Occurred Problems Encountering the Contractors through the Material Supply Chain Process and the fifth filed of The Key Factors Contributing in Integrating the Material Supply Chain Process. The results were in the range from 0.769 to 0.843. This range is considered high; and therefore the result ensures the reliability of the questionnaire. To determine the cronbach's coefficient alpha was determined based on the following formula:-

$$\frac{k}{k-1}\left(\frac{\sum_{i\neq j}^{k} cov(x_i, x_j)}{var(x_0)}\right) = \frac{k}{k-1}\left(1 - \frac{\sum_{j=1}^{k} var(x_j)}{var(x_0)}\right)$$ …………………………….……….Eqn. 2

Table 3.2: Cronbach's coefficient alpha

No.	Section	Cronbach's coefficient alpha
1	Current practices of Material supply chain process	0.808
2	Identification of the most frequently occurring problems encountering the contractors through the material supply chain process	0.822
3	key factors contributing in construction supply chain integration	0.812
	All sections	**0.814**

Hence, the researcher proved that the questionnaire was valid and reliable.

3.10. Data Analysis

The questionnaire analysis was done by using the simple percentage and relative importance index method. To determine the relative ranking of the factors, these scores were then transformed to importance indices based on the following formula:

$$\textbf{Relative Importance Index} = \frac{\sum w}{AN} = \frac{5n_5 + 4n_4 + 3n_3 + 2n_2 + 1n_1}{5N} \quad \text{..........................Eqn. 3}$$

Where w is the weighting given to each factor by the respondent, ranging from 1 to 5. The relative importance index ranges from 0 to 1 (Tam and Le, 2006). And also Microsoft Excel was used to tabulate and make the analysis easy.

3.11 Results presentation

The results of data analysis were presented in the forms of tables, graphs and charts. And following this further discussion has been compiled.

4. DATA ANALYSIS AND DISCUSSION

Following the arrangement of the gathered data, development of Excel Templates and undertaking of data analysis work, the findings of the questionnaires were presented and discussed in this chapter accordingly.

4.1. General Background and Information

This section presents the general background information of the respondents.

4.1.1. Company Establishment Year

As Table 4.1 shows 33.33% of the contracting firms have been established before or on 1995GC, 26.67% of the companies have been established during the period 1996-2000GC and 40.0% of them were established after 2001GC.

Table 4.1: Contracting Companies Establishment Year

Company Establishment year	Frequency	Percentage	No. of years since establishment
1995GC or before	10	33.33	22 years & above
1996-2000GC	8	26.67	17-21 years
After 2001GC	12	40	16 years & below
Total	**30**	**100**	

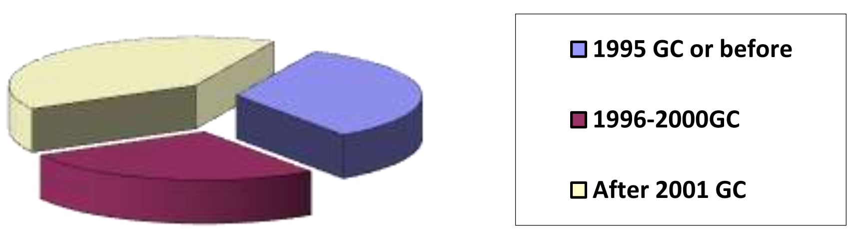


Figure 4.1 Contracting Companies Establishment year

4.1.2. Company Specialized Sector

As it is shown on Table 4.2 30.00% of the respondents are Grade one General Contractors and Specialized in building construction works. 33.33% of the respondents are Grade two General Contractors Specialized in building construction works. 6.00% of the respondents are Grade three General Contractors and Specialized in building construction works.

Table 4.2: Company Specialized Sector

Company Specialized Sector		General Sector			Building Sector		
		GC1	GC2	GC3	BC1	BC2	BC3
General Contractors specialized in Building construction works	Frequency	9	10	6	-	-	-
	Percentage	30.00%	33.33%	20.00%	-	-	-
Building Contractors	Frequency	-	-	-	2	3	-
	Percentage	-	-	-	6.67%	10.00%	-

4.1.3. Respondents position at the Contracting Firms

Table 4.3 illustrates the respondent's position in the contracting companies. Accordingly 53.33% of the respondents are project managers, 23.33% of the respondents are site engineers and project engineers, 16.67 % of the respondents are office engineering heads, 3.335% of the respondents are Procurement division head and 3.335% of the respondents are operation department head of a contracting firm.

Table 4.3: Respondents position in the Company

Respondents position in the company/project	Frequency	Percentage
Project Manager	16	53.33
Site and Project Engineer	7	23.33
Office Engineering head	5	16.67
Others	2	6.67
Total	**30**	**100**

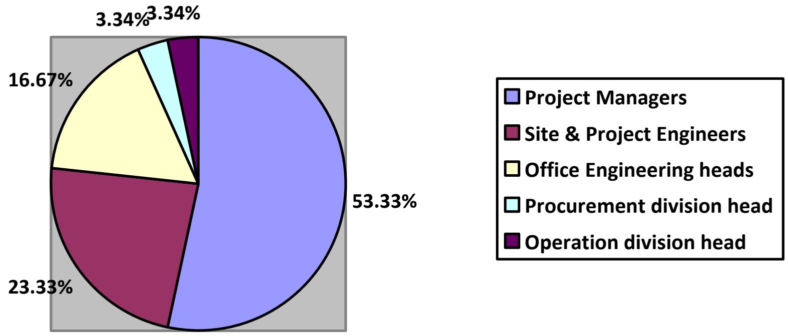


Figure 4.2:- Respondents position in the contracting firms

4.1.4. Average Number of Employees within the Last Five Years

Table 4.4 shows that 36.67% of the respondents have less than 80 employees within the last five years, 43.33% of them have 81-149 employees while 20.00% have an average number more than 150 employees.

Table 4.4: Average Number of Employees within the Last Five Years

Average Number of Employees	Frequency	Percentage
Less than 80 employees	11	36.67
81-149 employees	13	43.33
150 employees and more	6	20.00
Total	**30**	**100**

4.1.5. Number of Executed Projects within the Last Five Years

As shown on Table 4.5 46.67% of the contractors executed less than 10 projects during the last five years and (30%) of them executed from 11-20 projects. The results also show that (16.67%) executed from 21-30 projects.

Table 4.5: Number of Executed Projects within the Last Five Years

Average Number of executed projects	Frequency	Percentage
10 projects and below	16	53.33
11-20 projects	9	30.00
21-30 projects	5	16.67
Total	**30**	**100**

4.1.6. The Person or Section in Charge of Materials Procurement

Table 4.6 shows that the company director is the person in charge of the materials procurement in 30.0% of the contracting companies while the project manager is in charge of material procurement in 40.00% of the companies. 30.00% of the contracting companies have procurement sections responsible for the materials procurement. The results reveal that most of the respondents does not have procurement section for material procurement.

Table 4.6: Person or Section in Charge of the Material Procurement

The Person or section in charge of the material procurement is	Frequency	Percent
Company Director	9	30.00
Project Manager	12	40.00
Site Engineer	-	-
Procurement section	9	30.00
Others	-	-
Total	**30**	**100**

4.2. Current Practices of Material Supply Chain Process and the Important Factors that Form it

This section contains six phases of the materials supply chain process which are: the bidding phase, the sourcing phase, the procurement phase, the construction phase, the post construction phase and the assessment and evaluation phase. The respondents were given a group of questions in each phase to achieve the preset objectives. The rating of these questions consists of two main scales. The first one is the usage degree that aims at studying the current practices of the material supply chain in the local construction industry and the second one is the importance degree which aims at paving the ground for developing the construction materials supply chain process. The respondents were asked to mark each question as always, often, sometimes, seldom and never for the usage degree scale and very important, important, quite important, some important and little important for the importance degree scale.

The sub items under the various phases of materials supply chain process used in this study are derived mainly from the material supply chain process that was developed by Perdomo (2004).

4.2.1. Bidding Phase (Estimating, Preparation, Submission and Winning)

This section contains 12 items that form bidding phase of the MSCP. The respondents were asked about their usage degree for these items and the importance degree from their point of view. Table 4.7 presents the results.

Table 4.7: Bidding Process Phase (Estimating, Preparation, Submission and Winning)

Item No	Material Supply Chain process	Usage Degree			Importance Degree		
		Mean	Relative Index	Rank	Mean	Relative Index	Rank
Phase1:Bidding phase(estimate, Preparation & submission)							
1.1	Identifying the needed material for each item once you receive the project`s drawings and specification.	4.70	0.940	3	4.77	0.953	3
1.2	Estimating the quantity of the needed materials per each item (quantity take off)	4.57	0.913	4	4.63	0.927	5
1.3	Defining any special requirement and/or special materials to be used in the project.	4.33	0.867	6	4.17	0.833	8
1.4	Classifying the materials that are off-the-shelf and the major materials that needed to be prefabricated.	4.17	0.833	8	4.13	0.827	9
1.5	Identifying the local available materials or locally manufactured materials and the materials that are needed to be imported	4.10	0.820	9	4.07	0.813	10

1.6	Using software packages or computer application such as Microsoft Excel for preparing the estimate	4.90	0.980	2	4.67	0.933	4
1.7	Involving the project manager or construction team in the estimation process in order to prepare a realistic estimate	4.27	0.853	7	4.40	0.880	7
1.8	Establishing prices database for the materials from the previous implemented projects in order to be used for preparing the estimate for the future projects	3.70	0.740	11	3.93	0.787	11
1.9	Depending on the prices of suppliers and manufacturers on preparing the project estimate	3.90	0.780	10	3.87	0.773	12
1.10	Verifying the prices used in the estimate prior to submitting the bid	4.97	0.993	1	4.97	0.993	1
1.11	Scheduling a meeting that includes the project manager and the construction team to re-estimate the project quantities once you win the bid	3.47	0.693	12	4.93	0.987	2
1.12	Generating a preliminary material requisition schedule, specifying material types, quantity needed, dates, when the material should be delivered and any additional information needed for clarification	4.37	0.873	5	4.47	0.893	6
	Total	**4.288**	**0.857**		**4.418**	**0.883**	

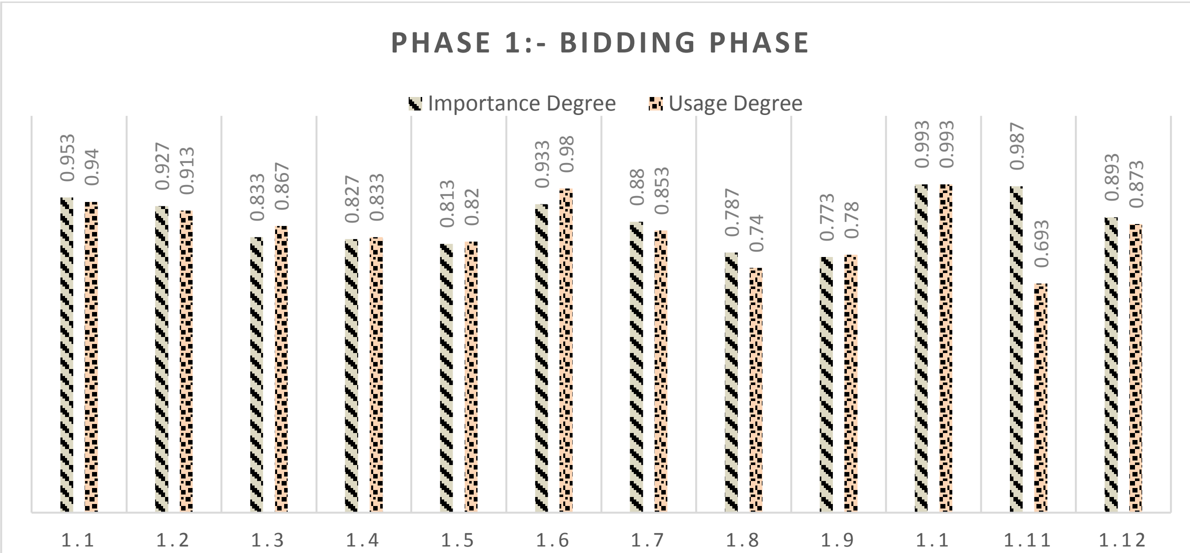


Fig 4.3. Bidding phase RII comparison

The findings of the responses on item 1.1 shows that they are very much aware of the importance of identifying the needed material of each item of the Bill of Quantities (BOQ).

The findings of the responses on item 1.2 shows that contractors have a good experience on timely estimation of materials for each item of work.

The findings of the responses on item 1.3 shows that they have relatively moderate understanding about special materials. Many contracts require special materials or material with high quality to be used in the project and usually the cost of these materials is expensive. If a contractor does not study the project's specifications carefully, he will prepare bad estimate and will suffer loss after completion of the project.

The responses on item 1.4 shows that they have relatively moderate understanding about the importance and usage of classification of off the shelf and prefabrication materials. Contracts sometimes contain materials that are not off-the shelf and need to be manufactured only for a specific project. The manufacturing of these materials are usually costly and take time.

In regards to item 1.6, as it is expected, most of the respondents use Microsoft excel for preparing the estimate because it makes the estimation process more accurate, easier and faster. Still the contractors can develop other programs that suit their needs.

Responses to item 1.7 shows that the project estimate should not be prepared only by the office engineers only but also the project manager and the field personnel should be involved in preparing the estimate; this will lead to preparation of more realistic and good estimate due to their knowledge and experience in the construction works.

The result of the responses for item 1.8 reveals that despite that the prices of the construction materials fluctuates, many contractors still does not use the prices database of materials from the previous project to prepare the estimate.

The results of the responses for item 1.9 indicates that the respondents favor depending on the prices of the suppliers and manufacturers on preparing the estimate over using the material prices database of the previous implemented project.

Responses for item 1.10, as it is expected, all the respondents verified the prices used in the estimate prior to submitting the bid.

The results of the responses for item 1.11 revealed that the re-estimate of the project quantities is important especially when the project drawings are not clear and there is a high possibility for changes due to design deficiency. But it is not widely used by the contractors when it comes to actual conditions.

The result of the responses for item 1.8 reveals that there exist a moderate cooperation between the project team and procurement section. The project team and procurement section or the person in charge of procurement should cooperate to generate a preliminary material requisition schedule in which the material types, quantity needed, dates when the material should be delivered and any other information are specified.

The results show that bidding phase of the material supply chain process adopted in the local construction industry agrees with materials takeoff and identification process is the first step in the Bidding Phase that involves identifying the materials needed as well as any special requirement or special materials to be used in the project. Most of the companies use computer applications such as Excel for preparing the estimate because this will make the estimating process easier and faster and the contracting companies verified the estimates several times prior to submitting the bid. Also it showed that in some projects project managers are involved in the estimating phase because this could lead to the preparation of more realistic estimate due to the project's manager's experience. After successfully winning the bid for a particular project, companies schedule a kick-off meeting that includes the superintendent, the project manager and all the foremen in which they generate a material requisition schedule specifying materials types, quantity needed, dates when the materials should be delivered and any additional information needed for clarifications.

4.2.2. Sourcing (Vendor Selection) Phase

This section contains 7 items that form the sourcing phase of the MSCP. Table 4.8 presents the results.

Table 4.8: Sourcing (Vendor Selection) Process

Item No	Material Supply Chain process	Usage Degree			Importance Degree		
		Mean	Relative Index	Rank	Mean	Relative Index	Rank
Phase2: Sourcing(vendor Selection)							
2.1	Pre-qualify the suppliers and manufactures and keeping a list of reputable suppliers and manufactures	3.90	0.780	6	4.23	0.847	5
2.2	Verifying that the supplier is capable of delivering the right materials (type, quality and quantity)when needed (i.e. at dates specified)	4.77	0.953	2	4.87	0.973	1
2.3	Purchasing the materials from suppliers that you worked with on previous projects	4.63	0.927	4	4.67	0.933	4
2.4	Requesting the quotation from different suppliers in order to get reasonable good prices	4.83	0.967	1	4.83	0.967	2
2.5	selecting the winner supplier based on lowest prices	4.26	0.853	5	4.17	0.833	6

2.6	Considering suppliers with higher prices but that will provide better services or that have a record to supply the right materials in the quantities needed at the times specified	3.27	0.653	7	3.97	0.793	7
2.7	Negotiating the prices directly with the suppliers	4.67	0.933	3	4.77	0.953	3
	Total	**4.35**	**0.867**		**4.50**	**0.899**	

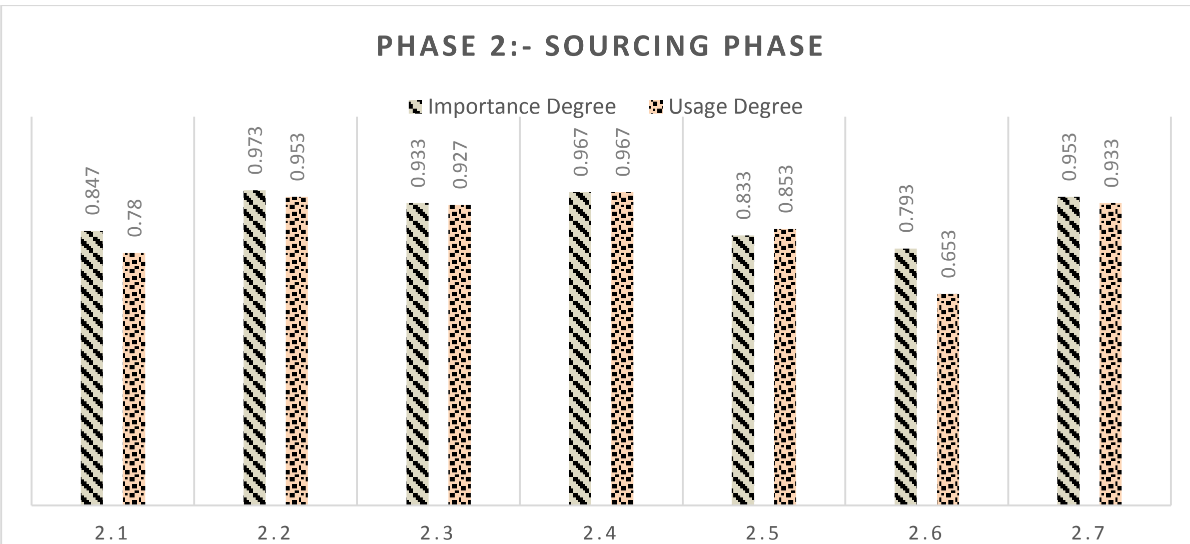


Fig 4.4. Sourcing phase RII comparison

The result of the responses to item 2.1 indicates that the contractors realize the importance of awarding contracts to reputable suppliers. Contractors have to pre-qualify the suppliers and to keep a list of the reputable suppliers so they can obtain quotations from these suppliers to prepare the estimate. Therefore, if a bid is awarded to any one of these suppliers, contractors can guarantee to certain degree that right materials will be delivered on the right quantities and in the right time.

The result of the responses to item 2.2 indicates that contractors are fully aware that unavailability of materials when needed or/ and delay deliveries of materials can greatly affect the productivity of the workforce, thus causing delays to activities, increasing the cost of the project and possibly delaying of the completion of the project. Contractors should make sure that the selected suppliers or manufactures are capable of delivering the right materials in the right time prior to awarding the contract.

The result of the responses to item 2.3 indicates that contractors sometimes purchase materials from suppliers that they worked with on previous projects. When a contractor purchasing materials from suppliers whom he worked with on previous projects a good relationship might be established between the contractor and suppliers and in turn all the project parties get benefit from such relationship. The contactor may be offered good prices and the suppliers get the jobs from this contractor on a continuous basis. This will enhance the integration concept between the contractor and, the suppliers.

The result of the responses to item 2.4 indicates that the most common way in which the contractors select suppliers is by competitive bidding and the respondents consider it the most important tool for the same. The researcher believes that because of the competitive nature of the bidding, the contractor needs to obtain materials at the lowest cost possible. Usually, the contractors request bids from suppliers to get the lowest prices possible for their products. Awarding the contract to the lowest price may create adversarial relation with the suppliers during the course of project implementation.

The result of the responses to item 2.5 indicates many respondents select the suppliers based on the lowest prices and consider it important method for selecting the suppliers. As stated in the previous item selecting suppliers based on lowest prices may create adversarial relationships because the suppliers get the job at a lower price than what they originally were expecting; therefore they are making less profit. Because of this loss in profit, the suppliers might not be totally devoted to this particular contract and some problems might be arising.

The result of the responses to item 2.6 indicates The results show that the respondents gave medium degree for the importance and usage. This means that although many contractors award the contract to the lowest prices, they believe that it is important to consider suppliers with higher prices who provide better services or that have a record to supply the right materials in the quantities needed at the times specified. The researcher believes that contractors should not consider only the cost of the materials to select suppliers but should also consider other factors also such as quality, delivery time, and availability of the materials.

The result of the responses to item 2.7 shows that the second common used method and also the second important method for selecting suppliers is by negotiation. This may be due to the fact that construction material suppliers for each type of material are limited and the contractors know the suppliers who offer best prices. Finally contractors select suppliers whom they worked with in previous project.

4.2.3. Material Procurement Phase

This section contains 9 items that form the procurement phase of the MSCP. The respondents were asked about their usage degree for these items and the importance degree from their point of view. Table 4.9 presents the results.

Table 4.9: Material Procurement Process

No	Material Supply Chain process	Usage Degree			Importance Degree		
		Mean	Relative Index	Rank	Mean	Relative Index	Rank
	Phase 3: Material procurement						
3.1	Obtaining a copy the material requisition schedule, Specifying material types, quantity needed ,dates, when the material should be delivered that prepared by site personnel (such schedule prepared by the site staff on the construction phase)	4.83	0.967	1	4.97	0.993	1
3.2	Verifying the availability of requested materials in your stocks before requesting any materials from suppliers	2.47	0.493	7	4.87	0.973	2
3.3	Requesting a representative material sample from the supplier or manufacture and approving it by the Engineer prior to materials delivery	4.77	0.953	2	4.73	0.947	4

3.4	Issuing purchase order to the winner supplier(Setting an agreement)in order to organize the relationship between the contractor and the supplier	4.50	0.900	3	4.70	0.940	5
3.5	Requesting materials directly by the field personnel	2.07	0.413	9	2.40	0.480	9
3.6	Ordering 100% of the estimated items quantities at once	4.40	0.880	4	3.03	0.607	8
3.7	Ordering the estimated item quantities as per the work progress on the site	2.43	0.487	8	4.77	0.953	3
3.8	Specifying to the suppliers the release dates at which the material is needed supplier and the exact location of materials delivery to avoid materials re-handling	4.20	0.840	6	4.63	0.927	6
3.9	Following up the status of the ordered materials to make sure that the delivered materials comply with the specification, in the quantities needed and within the time frame specified	4.27	0.853	5	4.57	0.913	7
	Total	**3.77**	**0.754**		**4.30**	**0.859**	

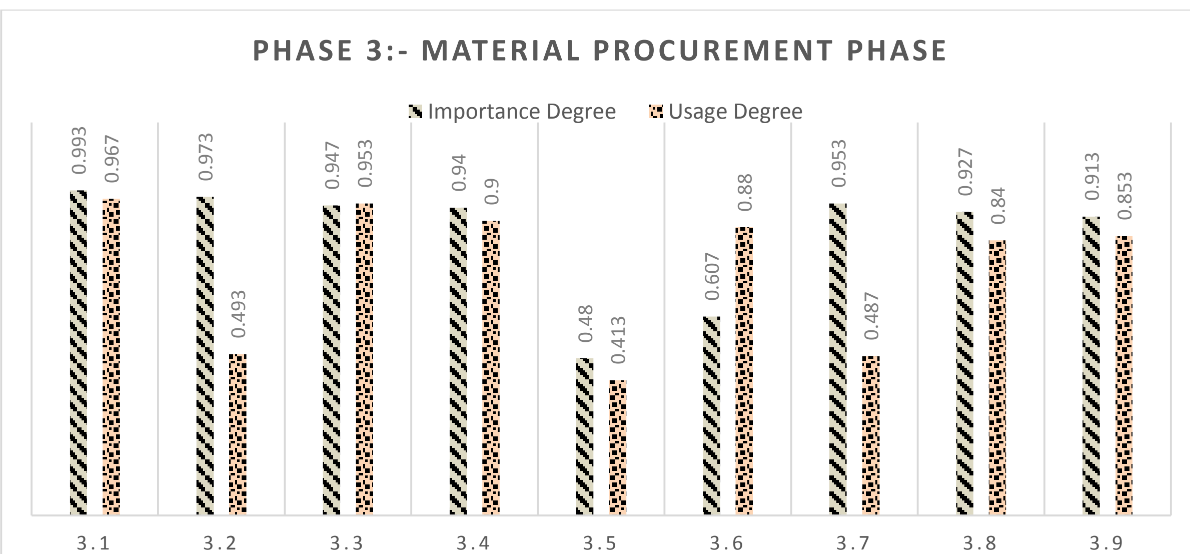


Fig 4.5. Material procurement phase RII comparison

The result of the responses to item 3.1 shows that contractors obtain a copy of the material requisition schedule. The objective of obtaining a copy of the requisition schedule is organizing the purchasing process of materials and issuing delivery schedules to the suppliers. Such schedule should classify the long lead items, local available materials, off the shelf materials and the materials that need to be manufactured.

The result of the responses to item 3.2 shows that the respondents have the awareness but lacks the applicability of verifying the availability of requested materials in their stock prior to requisition. The procurement section or the person in charge of procurement should check with the person in charge of the warehouse the availability of the requested materials before procuring them to avoid wastage and stock problems.

The result of the responses to item 3.3 shows that shows that the majority of the contractors requesting material sample and/ or specifications to be approved by the Engineer prior to the material delivery. This indicates that they are fully aware of the importance of this step.

The result of the responses to item 3.4 reveals that the contractors realize the importance of the purchase order. The researcher believes that the purchase order represents the contract between the contractor and the supplier. It shows the quantity to be delivered, the specifications, and the time to be on the site and other conditions.

The result of the responses to item 3.5 reveals indicates that few number of contractors purchase materials directly by the field staff.

The result of the responses to item 3.6 shows that most of the contractors purchase the estimated quantities at once. Purchasing all the project materials at once will lead to stockpiling the materials on the project site or the warehouse. In either case the stocked materials will be exposed to damage by the weather conditions, theft, losses, and tie down the capital. However and as stated in the literature there are many advantages of purchasing 100% of the estimated quantities at once such as insuring against delay in delivery, allow for possible increase in demand, price discount, insuring against scarcity.

The result of the responses to item 3.7 demonstrates that the contractors does not prefer to order the required quantities as per the work progress.

The result of the responses to item 3.8 reveals that most of the contractors do not specify exact date of materials delivery. The procurement section or the person in the charge of the procurement should specify to the suppliers the exact date that the materials should be on the site. Furthermore, the procurement department should specify the location on which the materials should be delivered at in order to avoid materials re-handling and the associated cost and time overrun.

The result of the responses to item 3.9 reveals that most of the contractors do not follow up the status of the ordered materials. The procurement section or the person in charge of procurement should coordinate with the construction team on the site and the suppliers to make sure that the right materials are delivered to the site within the time specified.

4.2.4. Construction Phase

This section contains 8 items that form the construction phase of the MSCP. The respondents were asked about their usage degree for these items and the importance degree from their point of view. Table 4.10 presents the results.

Table 4.10: Construction Process Phase

No	Material Supply Chain process	Usage Degree			Importance Degree		
		Mean	Relative Index	Rank	Mean	Relative Index	Rank
	Phase 4 : Construction						
4.1	Determining the quantities of the needed materials per each item	4.23	0.847	5	4.43	0.887	5
4.2	Determining dates in which the materials per each item are needed to be available	3.87	0.773	8	4.27	0.853	8
4.3	Determine the exact materials delivery location per each item	4.07	0.813	7	4.37	0.873	6
4.4	generating a material requisition form in which the material description, quantities needed ,dates when the materials are needed and the delivery locations	4.17	0.833	6	4.3	0.86	7

4.5	verifying the material received against the quantity ordered	4.9	0.98	1	4.77	0.953	2
4.6	Inspecting the delivered materials to make sure that it meets the specifications	4.8	0.96	2	4.97	0.993	1
4.7	Recording any problem in the delivered materials	4.27	0.853	4	4.63	0.927	3
4.8	keeping stock record of the supplied materials ,remaining balance and the installed materials	4.67	0.933	3	4.47	0.893	4
	Total	**4.37**	**0.87**		**4.526**	**0.905**	

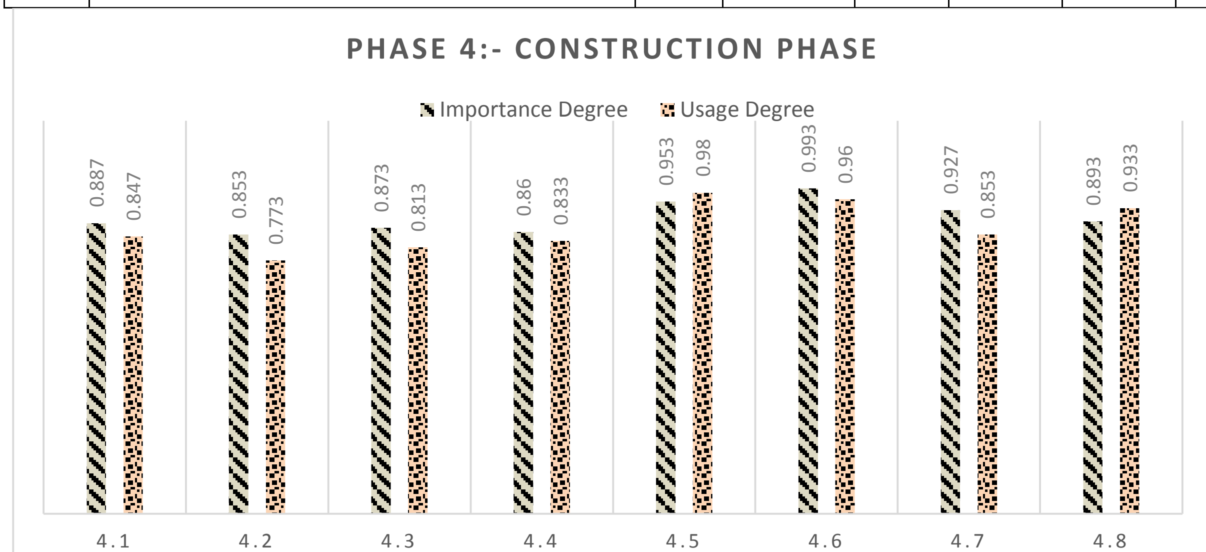


Fig 4.6. Construction phase RII comparison

The result of the responses to item 4.1 reveals that once the works start, the construction team on site can determine the needed materials per each item more accurately.

The result of the responses to item 4.2 reveals that most of the contractors does not determine the exact dates that materials per each item are to be available on site. The construction team should determine the optimum date that the materials should be available on the site. Ordering the materials earlier than what are planned for will lead to materials overstock, while ordering materials later than what are planned for will lead to delay of the project completion and cost overrun.

The result of the responses to item 4.3 reveals that most of the contractors does not determine the exact location of material delivery. The contractors realize that specifying the exact location for materials delivery will avoid materials re-handling which in turn saving time and cost.

The result of the responses to item 4.4 reveals that once a contractor finished the above mentioned item, it generates a material requisition form. Such form may contain materials description, the local materials, the materials needed to imported, the off-shelf materials and the materials needed to be fabricated, the quantities needed, the dates that should be available on the site and the delivery location.

The result of the responses to item 4.5 reveals that contractors always verify received vs. requested materials upon delivery. The construction team should make a comparison between the ordered quantities and the received quantities. If there is a deviation, the construction team or the one who responsible for receipting the materials should inform the procurement section or the person in charge of procurement to follow up with the suppliers.

The results for the responses for item 4.6 indicates that the contractors are fully aware of the importance of inspecting the quality of the delivered materials against the required specifications.

The result of the responses to item 4.7 reveals that most contractor's sometimes keep record of problem faced on the course of material delivery. The construction team should inspect the materials delivered and to record any problem if any.

The result of the responses to item 4.8 reveals that most of the respondents keep stock record of the supplied materials, remaining balance and installed materials. This item will help contractors to make control over the supplied materials, installed and the remaining balance.

4.2.5. Evaluation Phase

The respondents were asked about their usage and importance degree for conducting a comprehensive assessment for the material supply chain process through the project phases. Table 4.11 presents the results.

Table 4.11: Assessment Phase Result

No	Assessment phase result	Usage Degree			Importance Degree		
		Mean	**Relative Index**	**Rank**	**Mean**	**Relative Index**	**Rank**
	Phase 5: Construction Supply chain management Assessment						
5.1	Conducting comprehensive assessment for the material supply chain process through the mentioned phases to avoid the mistakes and develop this process in the future projects	3.47	0.693		4.53	0.907	

The result indicates that although many contractors do not evaluate materials supply chain process through the mentioned five phases at the end of the project, they believe that such evaluation is a very important step to improve the material supply chain process in the future projects. As a matter of fact, there are many decisions emerged out of the five mentioned phases of the materials supply chain process that contactors should take. Therefore, such evaluation will create knowledge for the contractors that could be used to improve their decisions making in the future projects.

4.2.6. Post Construction Phase (Surplus Materials)

Reducing the surplus materials to the minimum is one of the fundamental concepts of the supply chain management in the construction industry that related to the quantity attribute. This section contains five scenarios for dealing with surplus materials at the end of the project. The respondents were asked to select the scenario/s that they encountered and the percentage of occurrence. Percentage of occurrence means the rough estimate of the respondents out of a 100% of cumulative effect of ways of dealing with surplus materials. That is response or weight given for each item, percentage given for each item to bring the cumulative sum a 100%. Table 4.12 presents the results.

Table 4.12: Post Construction Phase (Surplus Materials)

Item No	Material Supply Chain process	% of Occurrence	Ranks
6.1	Storing the surplus materials to be used in the future projects	42.08	1
6.2	Returning back the surplus materials to the suppliers without penalty	6.84	4
6.3	Returning back the surplus materials to the suppliers with penalty	3.68	5
6.4	Selling the surplus materials to the other contractors	32.6	2
6.5	Scraping the surplus materials	14.8	3
	Total	**100**	

Table 4.12 shows that 42.08% of the surplus materials are stored to be used in the future projects. Such materials may be subject to deterioration, damage, loss, theft and more importantly it will tie down the capital of the contractors. Thus, contractors should prepare good materials take off in order to avoid the material surplus. 32.6% of the surplus materials are sold to other contractors. 14.8% of the surplus materials are scraped. 6.84% of the surplus materials are returned to the suppliers without penalty.

These results indicate that the suppliers are very flexible and the contractors may keep some kind of good relationships with them. Keeping good relationships with the suppliers is very important for achieving integration between them. And also 3.68% of the surplus materials are returned to the suppliers with penalty.

The results of this research along show that there are surplus materials at the end of the construction projects and the contractors need to develop a plan for managing it in proper way.

4.2.7. Information Related to the Current Practices of the Construction Supply Chain Management

Table 4.13: Information Related to the Current Practices of the CSCM Results

Item		Frequency	Percentage
1. Do you have a section in your company for material procurement?	Yes	9	30.00
	No	21	70.00
2. Do you have a person in your company responsible for material procurement?	Yes	9	30.00
	No	21	70.00
3. Do you have a warehouse or yard for storing materials?	Yes	24	80.00
	No	6	20.00
4. Do you use special forms for material management?	Yes	18	60.00
	No	12	40.00

This findings indicates that the majority of the contracting companies does not have a procurement section or division in their firm. They do not have a person in charge of procurement while the materials are procured by the company directors in most of the contracting companies.

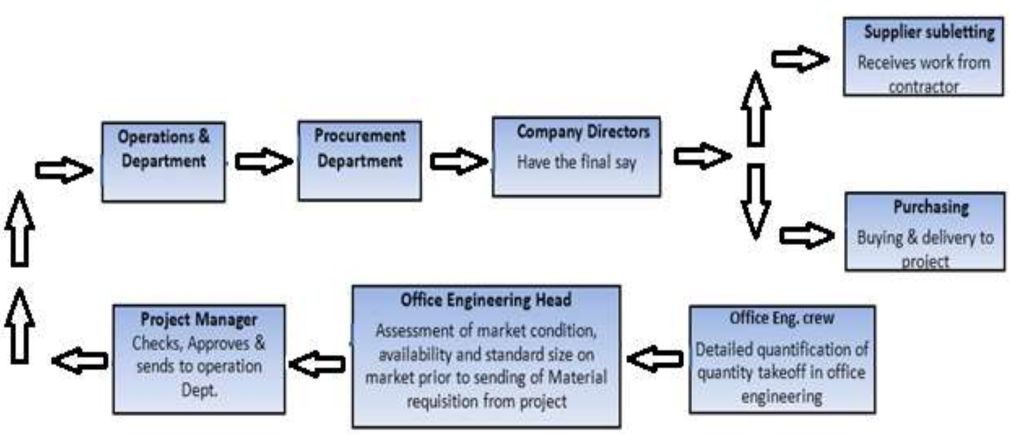
Type of organizational structure followed	Frequency	Percentage
	21	70.00
	9	30.00

Table 4.14:- Information related to organizational structures followed

The results of the respondents also demonstrated that 30.0% of the contracting companies uses the well-organized purchasing flow structure as shown above where as 70.0% of the respondents follow simple purchasing flow structure for material supply chain as shown above.

4.2.8. Methods Used for Ordering Materials from the Suppliers

This subsection contains five methods that contractor may use to order the materials from the suppliers. The respondents were asked to rank these methods as per their use. Table 4.15 presents the results

Table 4.15: Ranking of the Methods of Ordering Materials from the Suppliers

Item No	Methods of Material ordering	Percentage	Ranks
1	E-mail	66.67	1
2	Fax	53.33	3
3	Telephone	60.00	2
4	Personal Meeting	33.33	4
5	Others (SMS Text)	3.33	5
	Total		

Table 4.15 indicates that the most important tool that the contractors adopt to order the materials from the suppliers is the E-mail. This may be due to it provides a good tool for sharing information such as text, full color graphics and photos, audio and video between the project participants and make them to act as one team which in turn achieving the principle of the integration through the supply chain process. Since most of the suppliers operate from their head offices and will submit samples and catalogues for materials prior to supply of materials, E-mail was selected as the most important one.

The results also reveal that that the least preferable tool is the SMS texting. This may due to the fact that the document sent is not signed and confidential for the suppliers to act up on it.

4.3 Contractor / Supplier Relationship

The relationship of a contractor with his suppliers is critical for the successful accomplishment of any construction project. This section aims at studying the contractor / supplier relationships. It is divided into two subsections. The first subsection shows the criteria that the contractors adopt to select the suppliers. The second subsection shows the likely or preferred course of action that contractors use when the supplier deliver materials late or deliver materials do not meet the required specifications.

4.3.1. Criteria for Selection the Suppliers

In this subsection the respondents were given nine criteria and they were requested to rank it in accordance with their concerns to select the suppliers. Table 4.16 presents the results

Table 4.16: Ranking the Criteria to Select the Supplier

Criteria	Percentages	Rank
Availability	46.56	4
Good Quality	61.22	3
Competitive pricing -Cost	75.44	1
Reliable Delivery	62.33	2
Flexibility in accommodating contractor`s changes/request	29.89	6
Financial facilities	35.67	5
Sign long term agreement/enter in to partnership	28.56	7
Personal Relationship	22.33	8
Mutual interests	10.33	9

Table 4.16 reveals that the contractor / supplier relationship are based mainly on project by project basis. Most of the contractors believe that the reliable delivery, good quality and availability are very important criteria for selecting the suppliers as these criteria were selected respectively. Such criteria are considered the main attributes of the construction supply chain management.

The results also reveal that competitive pricing is the most important criteria to select suppliers. This is may be due to the fact that the contractors believe that they can get lowest prices by competitive bidding. However, using competitive bidding to select the suppliers will make the suppliers to reduce their profit to the minimum in order to win the contract. This in turn may create adversarial relationships between them during the course of project implementation and consequently affect the project's success.

The results also show that the contractors do not depend on the personal relation and mutual interest in selecting the suppliers as these two criteria were least ranked respectively.

4.3.2. Action Taken Against Late Deliveries and Not Complying With the Required Specifications

The basic principle behind the material supply chain management is to have the right products in the right quantities at the right place at the right moment at minimal cost. If a supplier does not deliver materials needed on time or deliver materials that do not meet the quality specified, then the work progress on site will be disrupt and the project completion may delayed. What will be the behavior of the contractors or the most likely course of actions that they will take against the suppliers who deliver the materials late or not comply with the quality specified? In this sub-section the respondents were provided five likely courses of actions that they may take in case a supplier is in default and they are requested to rank these actions in accordance to their use and preferences. Table 4.17 presents the results.

Table 4.17: Preferred Course of Action Taken against Late Deliveries and/ or not complying with the Required Specifications

Likely Course of Action	Percentages	Rank
Learn from the lesson and taking the necessary actions and procedures next times	66.67	2
Send a letter of complaint to supplier to improve the bargaining position of the contractor if there is a need for conflict resolution	83.33	1
Reprimand the supplier and then let the matter rest	26.67	5
Simply give-and-take to avoid any sour relationship	60.00	3
Impose penalty charges on the supplier	33.33	4

Table 4.17 reveals that "sending a letter of a complaint to the suppliers" is the first likely course of action that the respondents will take against late deliveries or delivering materials not complies with the required specifications. An official letter that will be a good document to such problem

and puts the contractor in a better bargaining position if there will be a need for dispute resolution at later stage.

Learn from the lesson and take preventive measures was ranked second. Contractors adopt preventive measures in relation to late deliveries. Some contractors take into account in the material delivery schedule the possibility of such delayed activities in order to mitigate their impact on the project activities. The materials are then requested for earlier than required.

"Simply give and take to avoid any sour relationship" is the third likely course of action that the respondents will take against the supplier who defaults. Defaulted suppliers may not fully realize the impact of late deliveries or delivering materials do not meet the quality specified on the project success and on the future relationship with the contractors as well. Therefore some contractors may prefer to discuss the problem with the supplier first hoping that the defaulted actions not to be repeated and to keep good relationship with the suppliers.

Imposing penalty charges on the defaulted suppliers was ranked fourth. This course of action depends on the terms and agreement of the contract between the two parties. If the terms and conditions of the contract give the contractor the right to withhold payments against later deliveries or delivering materials don’t meet the specifications, then the contractor will not hesitate to exercise this right. Hitting the suppliers in their pockets will make them to avoid any defaults in the future.

4.3.3. Buffer Stock

Despite the fact that the supply chain management philosophy is built on the principle that materials are not stockpiled and due to varied conditions of the construction setting, a minimum level of buffer stocks (inventory) should be attained to lessen any potential delay in delivering materials on the site or not delivering the right materials. Here the respondents were given buffer stock levels and they were requested to use their experience to determine the minimum level or the preferred level of buffer stocks needed for the locally available materials and materials need to be imported on the stable and unstable conditions. Normal or stable conditions for local materials represents the market condition where there is a stable market, order and get just in time deliveries without queuing, receive upon payment and agreement conditions, including right away purchase what so ever. Whereas normal condition for imported materials represent the market condition where delivery as per the shipment schedule and quantities. Unstable conditions for local materials represents the market condition where raw materials are short and scarce, materials are highly demanded and distributed on small quantities and inadequate productions. Whereas unstable conditions for imported materials represents the market condition where inflation and increment in foreign currency exchange rates occurs, shipments are delayed, coastal port complications and on land dry port customs process elongations. For imported materials material ordering is done after selecting the supplier, receiving samples and catalogues, Negotiating on the price, finalizing the LC and related bank processes and payments as per the terms set on the term of reference. Hence ordering period refers the actual final go ahead given to time of delivery to project site. Table 4.18 presents the results.

Table 4.18: Preferred (Minimum) Level of Buffer Stocks to Safeguard against Uncertainties

No	Preferred (Minimum) Level of Buffer Stocks to Safeguard Against Uncertainties	Local materials		Materials needed to be Imported	
		Normal Conditions (%)	Unstable conditions (%)	Normal Conditions (%)	Unstable conditions (%)
1	Enough for an operation to carry on for 1 to 2 days	20	0	0	0
2	Enough for an operation to carry on for3 to 5 days	36	0	0	0
3	Enough for an operation to carry on for 1 week	19	12	0	0
4	Enough for an operation to carry on for 2 week	13	26	8	0
5	Enough for an operation to carry on for 1 month	12	50	90	4
6	Enough for an operation to carry on for the whole project	0	12	2	96
7	Other Suggestions	0	0	0	0
	Total	**100**	**100**	**100**	**100**

4.3.3.1 Local Materials with Normal Conditions

Table 4.18 shows that 20.0% of the respondents favor keeping buffer stocks on site enough for an operation for 1 to 2 days to safeguard against the uncertainties inherent in the construction industry. 36.0% favor keeping buffer stocks on site enough for an operation for 3 to 5 days. 19.0% and 13.0% of them advocate a buffer level that is enough for an operation to continue for one week and two weeks respectively. Another group 12% of the respondents prefers to keep stocks enough for operation one month. The survey findings illustrate different buffer stocks levels for a jobsite.

4.3.3.2 Local Materials with Unstable Conditions

Table 4.18 shows 12.0% of the respondents favor keeping buffer stock on site enough for an operation to carry on for one week to safeguard against uncertainties inherent in the construction projects and in unstable conditions, 26.0% prefer to keep stocks enough for operation two weeks. 50.0% of the respondents believe that the minimum buffer stocks should be enough an operation to carry on for one month. 12.0% of the respondents prefer to keep the buffer stocks for the whole of the project.

4.3.3.3 Imported Materials with Normal Conditions

Table 4.18 shows that the majority of the respondents 90.0% prefer to keep the level of the buffer stock enough for an operation to carry on for 1 month. 8.0% advocate a buffer level that is enough for an operation to continue for two weeks. Only 2.0% of them favor keeping the buffer stock to keep operation continue for whole of the project.

4.3.3.4 Imported Materials with Unstable Conditions

Table 4.18 shows that most of the respondents 96.0% prefer to keep the level of the buffer stock enough for an operation to carry on for the whole the project. Only 4.0% of them favor keeping the buffer stock to keep operation continue for one month.

4.3.4 Buffer Time

Ordering materials very late may cause disruption to work progress on site and delay the project and ordering materials too early may lead to build-up unnecessary inventories or stocks. Ala-Risku & Karkainen (2006) stated that "for pro-active delivery we have added an extra parameter to the task schedule- the project buffer time. The project buffer time is used to ensure that the materials arrive early enough for the tasks that are moving into the workable backlog. Here the respondents were given buffer time level and they were requested to use their experience to determine the minimum level or the preferred level of buffer time needed for ordering the local materials and the imported materials on the stable and unstable conditions. Table 4.19 presents the results.

Table 4.19: Preferred (minimum) Level of Buffer Time to Safeguard against Uncertainties

No	**Preferred (Minimum) Level of Buffer Time to Safeguard Against Uncertainties**	**Local materials**		**Materials needed to be Imported**	
		Normal Conditions (%)	**Unstable conditions (%)**	**Normal Conditions (%)**	**Unstable conditions (%)**
1	Same day	6	4	0	0
2	1 to 2 day in advance	40	0	0	0
3	3 to5 days in advance	30	2	0	0
4	1 week in advance	16	14	6	0
5	2 weeks in advance	8	32	6	0
6	3 weeks in advance	0	28	0	0
7	1 month in advance	0	14	72	0
8	2 months in advance	0	6	12	8
9	3 months in advance	0	0	4	92
10	Other Suggestions	0	0	0	0
	Total	**100**	**100**	**100**	**100**

4.3.4.1 Local Materials with Normal Conditions

Table 4.19 shows that 40.0% of the respondents favor ordering materials from 1 to 2 days in advance before the tasks is commenced to safeguard against uncertainties inherent in the construction industry. 30.0% of them prefer to order materials from 3 to 5 days in advance. 16.0% of them advocate ordering materials one week in advance before the task is commenced. 8.0% of them advocate ordering materials two weeks in advance before the task is commenced. Only 6.0% of the respondents order the materials on the same day of the of the task commencement. The results indicate that different levels of buffer time preferred by the contractors.

4.3.4.2 Local Materials with Unstable Conditions

Table 4.19 shows that 14.0% of the respondents favor ordering materials one week in advance before the tasks is commenced to safeguard against uncertainties inherent in the construction industry. 32.0% and 28.0% of them prefer to order materials 2 weeks and 3 weeks in advance respectively. 14.0% and 6.0% advocate ordering materials one month and two months in advance respectively before the task is commenced. The results also indicate that different levels of buffer time preferred by the contractors.

4.3.4.3 Materials need to be imported in Stable Conditions

Table 4.19 shows that 72.0% of the respondents prefer to order materials 1 month in advance before the start of the task. 12.0% of them advocate that the materials should be ordered 2 months in advance prior to commence of the related task. Only 4.0% favor ordering materials 3 months in advance. 6.0% of the respondents prefer to order the materials before 1 week in advance and also 6.0% of them prefer ordering materials 2 weeks in advance of starting the related activity.

The buffer time that advocated by those two groups of respondents are short and they could mean that buffer time for importing the materials from neighbored countries.

4.3.4.4 Materials need to be imported With Unstable Conditions

Table 4.19 shows that 8.0% of the respondents prefer to order materials 2 months in advance before the start of the task. The majority of the respondents 92.0% prefer ordering materials 3 months in advance before starting the task.

4.4. Problems Encountering Contractors through the Material Supply Chain Process

Understanding the existing problems is an absolute necessity for resolving them effectively. Many problems may be encountering the contractors during the phases of the material supply chain process that hamper achieving the main objectives of the supply chain management. This section aims to determine the most occurred problems encountering the contractors during the material supply chain process through the five phases which are: the bidding phase, the sourcing phase, the procurement phase, the construction phase, the post construction phase. The section also aims at studying the root causes of these problems and then developing possible solutions for them in order to make the application of MSCP goes smoothly without interruption.

4.4.1. Bidding Phase

The respondents were given 4 problems that may face contractors in the bidding phase and they were asked to mark each question as always, often, sometimes, seldom and never. Table 4.20 presents the results

Table 4.20: Problems Encountering Contractors during the Bidding Phase

No	Problems	Degree of Occurrence		
		Mean	**Relative Index**	**Rank**
	Phase 1: Bidding Phase-Material takeoff and Identification			
1.2	Lack of communication between the parties involved	3.67	0.733	1
1.5	Ambiguities between plans and specifications	3.43	0.687	2
1.3	Incomplete drawings and details are missing	3.3	0.66	3
1.1	Not a good definition of what is wanted from the owner and suppliers	3.27	0.653	4
1.4	Using specifications different from those commonly used	2.6	0.52	5
	Total	**3.25**	**0.650**	

During the bidding phase contractors may need more information and / or clarifications from the parties involved in order to prepare reasonable and good estimate.

The results indicate that tender documents are not well prepared by the consultants. Ambiguities in the tender documents and incomplete drawings and details may not enable contractors to prepare good estimate.

Furthermore, differences between plans and specifications will lead to many problems and disputes between the involved parties during the construction phase which may consequently lead to disruption of project activities on site. Ambiguities should be solved in advance otherwise it will interrupt the works during the construction phase.

4.4.2. Sourcing (Vendor Selection) Phase

The respondents were given 3 problems that may face contractors in the sourcing phase and they were asked to mark each question as always, often, sometimes, seldom and never. Table 4.21 presents the results.

Table 4.21: Problems Encountering Contractors during the Sourcing (Vendor Selection) Phase

No	Problems	Degree of Occurrence		
		Mean	**Relative Index**	**Rank**
	Phase 2: Sourcing (Vendor Selection)			
2.1	Having too many suppliers and do not have information about them	2.50	0.500	3
2.2	Incomplete proposals (Suppliers did not include all the documents with the proposal)	3.20	0.640	1
2.3	Time spent investigating non-qualified supplier	2.87	0.573	2
	Total	**2.86**	**0.571**	

The root cause behind incomplete proposal by suppliers may be due to the bad communication represented in incomplete or bad formulation of the "invitation to bid" documents that prepared by the contracting companies.

4.4.3. Material Procurement

The respondents were given 7 problems that may face contractors in the procurement phase and they were asked to mark each question as always, often, sometimes, seldom and never. Table 4.22 presents the results.

Table 4.22: Problems Encountering Contractors during Material Procurement Phase

Item No	Problems	Degree of Occurrence		
		Mean	**Relative Index**	**Rank**
	Phase 3: Material procurement			
3.1	Unavailability of required material	3.50	0.700	2
3.2	Late submittal of materials by the contractor to be approved by the Engineer(Materials are not submitted as per the material approval schedule)	3.13	0.627	5
3.3	Incorrect of submittal by the suppliers	3.33	0.667	4
3.4	Late approval of submittal by the suppliers	3.37	0.673	3
3.5	Poor communication between the parties involved	3.93	0.787	1
3.6	The contractor sets delivery dates that are impossible to meet by the suppliers)	3.03	0.607	6
3.7	The contractor does not communicates exactly what is wanted to suppliers	2.57	0.513	7
	Total	**3.27**	**0.65**	

The procurement section or the person in charge of procurement needs, for example, to ensure that the correct materials in correct quantities are ordered. The researcher believes that poor communication may be due to the absence of effective tools and mechanisms of sharing information between the involved parties.

Therefore, the procurement section or the person in charge of the procurement should have an access to contract data, project scheduling as well as means to communicate delivery instruction to the personnel on site in order to perform his tasks. Also developing internet-based communication system will enable the procurement section or the person in charge of the procurement to place orders and systemically follow up the status of the ordered materials in order to make sure that the materials arrive to the job site in the quantities and date specified.

Unavailability of the materials when needed can greatly affect the productivity of the workforce, thus causing delays to activities, increasing the cost of the project and possibly delaying the completion of the project. This problem could be detected in the construction phase whilst the origin of it could be happened in the sourcing phase as the contractors may select the supplier based on the lowest prices only without considering other factors.

Although this problem may be discovered in the procurement phase, its origin may be at earlier phase of the material supply chain management. The main cause of such problem may be the absence of clause or agreement between the owner and the contractor on the approval period of the submittal.

To solve this problem, once a contractor sign a contract, he should, among other issues, make an agreement with the owner on the approval period for submittal if there no related clause in the project general conditions. During the construction phase, contractor has to follow up the status of material submittal approval.

Despite that this problem may be detected on the procurement phase, the base of this problem occurred in the sourcing phase.

To overcome this problem contractors should pre-qualify the suppliers, obtain quotations from reputable suppliers and whom they worked with on previous projects as per the conclusion that have been drawn out of this research. Also contractors could send a letter of a complaint to the suppliers who are in default.

4.4.4. Construction Phase

The respondents were given 9 problems that may face contractors in the construction phase, that is during the course of construction process and they were asked to mark each question as always, often, sometimes, seldom and never. And the responses given by the contractors for each item or activity under the construction phase was gathered, screened and analyzed prior to presentation under Table 4.23.

Table 4.23: Problems Encountering Contractors during Construction Phase

Item No	Problems	Degree of Occurrence		
		Mean	**Relative Index**	**Rank**
	Phase 4: construction			
4.1	Late Deliveries(Materials do not arrive as scheduled)	4.23	0.847	1
4.2	The Delivered materials do not comply with the required specifications	3.30	0.660	2
4.3	Re-handling of materials – Materials have to be moved from one place to another before being installed	2.53	0.507	5
4.4	Storage of materials – storage area are limited or far away from the working area	2.47	0.493	6
4.5	Loss of materials	2.27	0.453	8
4.6	Theft	2.20	0.440	9
4.7	Damaging –Materials are damaged while handling or by other conditions	2.73	0.547	4
4.8	Poor communication between the parties involved	3.23	0.647	3
4.9	Receiving, Handling and storage of the unused materials	2.40	0.480	7
	Total	**2.82**	**0.568**	

Although these problems uncovered in the construction phase of the supply chain but their base may be in the sourcing phase.

Because of the low price, the supplier might not totally devote to the project. Furthermore, contractors may do not pre-qualify the suppliers and did not make sure that the supplier is capable to deliver the required quantities in the right time. No contract between the supplier and the contractor in procurement phase is another cause that may make late deliveries and delivering materials that do not comply with the project specifications. Bad planning by contractors during the construction phase may also cause late deliveries.

To solve the problems of late deliveries and delivering materials do not comply with the required specifications, the contractors have to do the following:

In the sourcing phase, they should pre-qualify the suppliers and should make sure that they are capable of delivering the right material in the right quantities in the time specified. They should not select the supplier based on the lowest prices but should consider the supplier with higher prices but who provide better services.

In the procurement phase, contractors have to set out agreement with the suppliers showing the duties and responsibilities of each party. There should be a clause of penalty charges in case the supplier make late deliveries or deliver materials that do not meet the required specifications.

In the construction phase, contractors may keep buffer stocks on site enough for an operation for certain days to safeguard against the uncertainties inherent in the construction industry.

"Poor communication between the parties involved the main cause of this problem may be the absence of effective tools and mechanisms of sharing information between the involved parties. To overcome this problem, there should be a system for exchanging information and sharing date among the project participants. Such system allows a contractor to identify what material is available, materials not delivered as ordered or if the order is delayed and where the materials are stored on site.

4.4.5. Post-Construction (Surplus materials) Phase

The respondents were given 4 problems that may face contractors in the post construction phase and they were asked to mark each question as always, often, sometimes, seldom and never. Table 4.24 presents the results.

Table 4.24: Problems Encountering Contractors during Post-Construction Phase

Item No	Problems	Degree of Occurrence		
		Mean	**Relative Index**	**Rank**
	Phase 5: Post –Construction			
5.1	No storage for the surplus materials	2.00	0.400	3
5.2	No possibility that the surplus materials to be return to the supplier	2.37	0.473	2
5.3	Charging penalties by the suppliers for the returned materials	1.90	0.380	4
5.4	Salvage losses for the surplus materials	2.47	0.493	1
	Total	**2.19**	**0.437**	

The results reveal that most of the contractors could not return the surplus materials to the suppliers without charging penalties. Also the contractors have warehouses where they can store the surplus materials at. Two conclusions could be drawn out of this section.

First, poor communication among the parties involved is the common problem occurred in each phase of the MSCP. Therefore, there should be a system such as web-based system to manage the information properly among the concerned parties. SCM crosses organizational boundaries, organizing information and process flows, sending signal to operations and evaluating results. There is a heavy reliance in information management to coordinate the chain. As a result, information management becomes the heart of CSCM".

Second, most problems are caused in another (i.e. earlier) stage other than where they are found. This conclusion agrees with one of the findings of the three case studies conducted by Vrijhoef and Koskela (1999) which was the root causes of the problems were rarely found in the activity where they are encountered, but rather in a previous activity executed by a prior actor.

4.5. Key Factors Contributing in Integrating Construction Supply Chain

Integration among the key members of the project participants: owner, main contractor, subcontractors and suppliers and also integration of the project phases will contribute in making the MSCP through the project phases described in section 4.3 goes smoothly. The aim of this section is to study the key factors that could contribute in integrating the project phase of the MSCP. The section consists of twelve factors derived from reviewing the literature related subject. The respondents were asked to mark each factor as very important, important, quite important, some important and little important. Table 4.25 presents the results.

Table 4.25: Factors which may contribute to Successful Integration of the Construction Supply Chain Process

Item No	Factors	Degree of Importance		
		Mean	Relative Index	Rank
4	Understanding the client needs and objectives by the contractor, subcontractors and suppliers and committing for these needs and objectives	4.83	0.967	1
8	Establishing a protocol for dealing effectively with disputes and problems that may arise between the project participant during the course of project implementation	4.77	0.953	2
11	Establishing a system between the project participants for communication and share project information in timely and accurate manner	4.57	0.913	3
12	Using Web Based system for information access and exchange between the project participants that include memos, request for information, transmittal, site instruction, etc.	4.33	0.867	4
7	The participation of the designers should not end at the design phase but continues during construction phase	4.23	0.847	5
5	Executing the project activities by the contractors own sources (Not sourcing all the project to subcontractors)	4.07	0.813	6
10	Aligning the system and procedures of your own company with that of the client, suppliers and subcontractors	3.83	0.767	7

6	Negotiating contracts with the suppliers and subcontractors rather than using competitive tendering	3.47	0.693	8
3	Entering a partnership relationship with suppliers and subcontractors based on commitment over extended time period, mutual information sharing, trust, openness, dedication to common goals	3.37	0.673	9
9	Conducting workshop for suppliers and subcontractors to discuss the quality, innovation, health and safety issues	3.17	0.633	10
2	Using design construct arrangement between the contractor and the client	2.83	0.567	11
1	The design team should be expanded such that to includes contractors, subcontractors and materials suppliers	2.67	0.533	12
	Total	**3.845**	**0.769**	

Understanding the client's needs and objectives is related to the prevailing culture among contractors, suppliers and subcontractors which is that all of them want to get the maximum benefit from the project regardless the other parties' benefits.

Communication and information sharing are key components in achieving tight integration between the project participants and project phases. MSCP depends mainly on accurate and timely generation and transfer of information.

The result shows that some of the contractors still don't aware of the importance of using the web-site system for information sharing among the project participants.

The respondents gave this factor high degree since this factor integrates the design phase with the construction phase. During the project implementation many problems may arise because of ambiguities in the project documents. Despite that such problem existed in bidding phase; it is always detected in the construction phase. If the problem is not solved immediately once it is uncovered, the works on the site will be stopped and the project will be delayed accordingly.

5. CONCLUSION & RECOMMENDATION

5.1. Conclusion

After conducting the research the following were concluded in accordance to the specific objectives:-

• MSCP comprises six phases which are bidding phase, sourcing phase, procurement phase, construction phase and evaluation phase each phase with a set of activities that are viewed as only a series of individual activities.

• The purchasing flow structure followed in most of the contracting companies is simple and procurement division and a person in charge of the division are not available in majority of the contracting companies.

• Studying contractor/supplier relationship it has been found that the contractor/supplier relationship is based on project by project basis.

• Most of the contractors do not form long term agreement or partnership with the suppliers. Competitive pricing is the most important criteria adopted for selection of the suppliers and it is primarily based on the lowest price.

• Minimum level of the buffer stocks should be kept to ensure that the work progress is not delayed by the supplier's failure to provide the right materials at the right time. Furthermore, contractors advocate that materials should be ordered in advance by certain days before the related tasks start to safeguard against failure of supplier to deliver the materials on the specified time.

• Different level of buffer times shall be maintained for the locally available materials and the imported materials on the stable and unstable conditions.

The most occurred problems encountering the contractors were determined to be:-

Bidding Phase

- Lack of communication between the parties involved with a RII of 0.733.
- Ambiguities between plans and specifications with a RII of 0.687.
- Incomplete drawings and details are missing with a RII of 0.653.

Sourcing Phase

- ❖ Incomplete proposals (Suppliers did not include all the documents with the proposal) with a RII of 0.640.

Material Procurement Phase

- ✓ Poor communication between the parties involved with a RII of 0.787.
- ✓ Unavailability of required material with a RII of 0.700.
- ✓ Late approval of submittal by the Supervisor Engineer with a RII of 0.673.
- ✓ Incorrect of submittals by the suppliers with a RII of 0.667.

Construction Phase

- Late deliveries (Materials do not arrive as scheduled) with a RII of 0.847.
- The delivered materials do not comply with the required specifications with a RIIof 0.660.
- Poor communication between the parties involved with a relative importance index of 0.647.

It has been noticed that most of the problems were caused in an earlier stage of the MSCP other than where they are detected.

• It also has been found that the most factors that contribute in integrating the project phases of the MSCP are:-

- ➢ Understanding the client needs and objectives by the contractor, subcontractors and suppliers and committing for these needs and objectives with a RII of 0.967.
- ➢ Establishing a protocol for dealing effectively with disputes and problems that may arise between the project participants with a RII of 0.953.
- ➢ Establishing a system between the project participants for communication and share project information in timely and accurate manner with a RII of 0.913.
- ➢ Using Web based system for information access and exchange between the project participants with a RII of 0.867.
- ➢ The participation of the designers should not end at the design phase but continues during construction phase with a RII of 0.847.

5.2. Recommendations

The following recommendations are based on the conclusions drawn from the survey results and the literature outcomes.

Contracting companies are recommended to:-

- ✓ Deal with the activities that form the MSC process as integrated ones rather than a series of separated activities.
- ✓ Establish a procurement division in their firms and strengthen their material handling flow structure well.
- ✓ Set up partnership agreement with the suppliers based on a win-win relationship other than the competitive bidding.
- ✓ Achieve internal coordination and achieve seamless integration of organizational functions.
- ✓ Commit to good faith, fair dealings with other partners and to work in a cooperative environment.
- ✓ Develop a web based information technology system for information sharing among the project participants.

The University and contractors union are recommended to conduct training courses and workshops to:-

1. Increase the awareness of the value of information and communication technology to bring together the major parties in the construction process
2. Increase the awareness of mutual benefits of applying the supply chain management among the project participants
3. Change cultural issues that resist change and are invited to adopt new strategic management/ planning.

The following are suggested research areas for future studies:-

- Research to study the impact of information technology on Ethiopian construction industry
- Research to study the factors that hinder the application of the SCM
- Research to study the supply chain management from the client perspective

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APPENDIX 1:-THE QUESTIONNAIRE *(In English)*

Jimma University

Institute of Technology

School of Graduate studies

Department of civil Engineering

Construction Engineering & Management stream

Dear Contractors,

Reference: - Dissertation- Msc Construction Engineering & Management

I am currently undertaking a Master of Science Degree in Construction Engineering & Management at Jimma University. In fulfillment of this dissertation I am required to research a topic area and produce a dissertation. The topic I have chosen is "Assessment of material supply chain management practices in the local building construction industry".

Through this questionnaire, I am investigating the following:-

1. The current practices of material supply chain process through the project phases in the local construction industry and the organizational structure followed by companies for material supply chain or material procurement
2. The supplier/contractor relationship
3. The most serious problems encountered the contractors through the project phases
4. The key factors that may contribute for the successful integration of the construction supply chain through the project phases and

The information provided will be used only for the above mentioned objectives, and will be treated with strict confidence and individual firms will not be identified. The results of the study will be provided to you for the benefit.

Researcher	**Supervisor**
Yihalem Girum	Asst. Prof. Elmer C. Agon
________________________	________________________

Assessment of Material Supply chain management practices in the building Construction industry; a case study in Jimma Town, Questionnaire.

Section one; - company profile

Please respond to the following questions by either ticking the appropriate box or by writing your answer in the space provided.

1.1 company establishment year:-----------------------------------

1.2 company specialized sector and classification

- building sector ☐ BC1 ☐ BC2 ☐ BC3
- General sector ☐ GC1 ☐ GC2 ☐ GC3

1.3 Respondent position in the company/project

☐ Project manager ☐ Project engineer ☐ Office engineering head

☐ Other, please specify---

1.4 Average number of employees within the last five years----------------------------------

1.5 Number of executed projects within the last five years

☐ 10 and below ☐ 11-20 ☐ 21-30 ☐ 31-40 ☐ 41-50 ☐ More than 50

1.6. Total amount of executed projects within the last five years

☐ 1.5 And less ☐ 1.6-3 ☐ 3.1-4.5 ☐ 4.6-6 ☐ 6.1-7.5 ☐ More than 7

1.7. The person or section in charge of the material procurement is:-

☐ Company Director ☐ Project Manager ☐ Site Engineer ☐ Procurement section ☐ Other, please specify--

Section Two - Current practices of material supply Chain process

2.1 Below is material supply chain process through the various phases of project. Please choose your practice to each statement and then express your opinion on how important each one on the material supply chain process is. Please tick the appropriate cell.

Phase 1:- Bidding phase (estimate, Preparation & submission)

Phase 2:- Sourcing (vendor Selection)

Phase 3:- Material procurement

Phase 4:- Construction

Phase 5:- Construction Supply chain management Assessment

item No	Material Supply Chain process	Usage Degree					Importance Degree				
		Always	often	Some times	Seldom	Never	Very Important	Important	Quite Important	Some Important	Little Important
Phase1:Bidding phase(estimate, Preparation & submission)											
1.1	Identifying the needed material for each item once you receive the project`s drawings and specification.										
1.2	Estimating the quantity of the needed materials per each item (quantity take off)										
1.3	Defining any special requirement and/or special materials to be used in the project.										
1.4	Classifying the materials that are off-the-shelf and the major materials that needed to be prefabricated.										
1.5	Identifying the local available materials or locally manufactured materials and the materials that are needed to be imported										
1.6	Using software packages or computer application such as Microsoft Excel for preparing the estimate										
1.7	Involving the project manager or construction team in the estimation process in order to prepare a realistic estimate										
1.8	Establishing prices database for the materials from the previous implemented projects in order to be used for preparing the estimate for the future projects										
1.9	Depending on the prices of suppliers and manufacturers on preparing the project estimate										
1.10	Verifying the prices used in the estimate prior to submitting the bid										
1.11	Scheduling a meeting that includes the project manager and the construction team to re-estimate the project quantities once you win the bid										
1.12	Generating a preliminary material requisition schedule, specifying material types, quantity needed, dates, when the material should be delivered and any additional information needed for clarification										

item No	Material Supply Chain process	Usage Degree					Importance Degree				
		Always	often	Some times	Seldom	Never	Very Important	Important	Quite Important	Some Important	Little Important
Phase2: Sourcing(vendor Selection)											
2.1	Pre-qualify the suppliers and manufactures and keeping a list of reputable suppliers and manufactures										
2.2	Verifying that the supplier is capable of delivering the right materials (type, quality and quantity)when needed (i.e. at dates specified)										
2.3	Purchasing the materials from suppliers that you worked with on previous projects										
2.4	Requesting the quotation from different suppliers in order to get reasonable good prices										
2.5	selecting the winner supplier based on lowest prices										
2.6	Considering suppliers with higher prices but that will provide better services or that have a record to supply the right materials in the quantities needed at the times specified										
2.7	Negotiating the prices directly with the suppliers										
	Phase 3: Material procurement										
3.1	Obtaining a copy the material requisition schedule, Specifying material types, quantity needed ,dates, when the material should be delivered that prepared by site personnel (such schedule prepared by the site staff on the construction phase)										
3.2	Verifying the availability of requested materials in your stocks before requesting any materials from suppliers										
3.3	Requesting a representative material sample from the supplier or manufacture and approving it by the Engineer prior to materials delivery										
3.4	Issuing purchase order to the winner supplier(Setting an agreement)in order to organize the relationship between the contractor and the supplier										
3.5	Requesting materials directly by the field personnel										
3.6	Ordering 100% of the estimated items quantities at once										

3.7	Ordering the estimated item quantities as per the work progress on the site										
3.8	Specifying to the suppliers the release dates at which the material is needed supplier and the exact location of materials delivery to avoid materials re-handling										
3.9	Following up the status of the ordered materials to make sure that the delivered materials comply with the specification, in the quantities needed and within the time frame specified										

item No	Material Supply Chain process	Usage Degree					Importance Degree				
		Always	often	Some times	Seldom	Never	Very Important	Important	Quite Important	Some Important	Little Important
	Phase 4 : Construction										
4.1	Determining the quantities of the needed materials per each item										
4.2	Determining dates in which the materials per each item are needed to be available										
4.3	Determine the exact materials delivery location per each item										
4.4	generating a material requisition form in which the material description, quantities needed ,dates when the materials are needed and the delivery locations										
4.5	verifying the material received against the quantity ordered										
4.6	Inspecting the delivered materials to make sure that it meets the specifications										
4.7	Recording any problem in the delivered materials										
4.8	keeping a track record of the supplied materials ,remaining balance and the installed materials										
	Phase 5: Construction Supply chain management Assessment										
5.1	Conducting comprehensive assessment for the material supply chain process through the mentioned phases to avoid the mistakes and develop this process in the future projects										

2.2 Following are five scenarios for dealing with surplus materials. Please select the scenarios that you encountered during project implementation and then write the% of occurrence.

Item No	Material Supply Chain process	Selected Scenario/s	% Of occurrence
	Phase 6: Post Construction		
6.1	Storing the surplus materials to be used in the future projects		
6.2	Returning back the surplus materials to the suppliers without penalty		
6.3	Returning back the surplus materials to the suppliers with penalty		
6.4	Selling the surplus materials to the other contractors		
6.5	Scraping the surplus materials		
	Total		**100%**

2.3 Please answer the following questions by ticking (Yes/No)

	Yes	No
1. Do you have a section in your company for material procurement?	☐	☐
2. Do you have a person in your company responsible for material procurement?	☐	☐
3. Do you have a warehouse or yard for storing materials?	☐	☐
4. Do you use special forms for material management?	☐	☐

5. Please sketch the material purchasing flow structure or material procurement cycle of your organization here under.

Your company's flow structure for material supply chain

2.4. Would you please indicate, in priority order, which of the following method you choose to place your material orders. Please indicate which method is first; which method is second, which method is third so forth.

No	Method	Rank
1	E-mail	
2	Fax	
3	Telephone	
4	Personal Meeting	
5	Others	

Section Three- Contractor /Supplier Relationship

3.1 Would you please indicate, in priority order, which of the following criteria you will take to select the supplier. Please indicate which criteria is first, which criteria is second, which criteria is third and so forth.

No	Criteria	Rank
1	Availability	
2	Good Quality	
3	Competitive pricing -Cost	
4	Reliable Delivery	
5	Flexibility in accommodating contractor`s changes/request	
6	Financial facilities	
7	Sign long term agreement/enter in to partnership	
8	Personal Relationship	
9	Mutual interests	

3.2 Would you please indicate, in priority order, which of the following course of action you will take in case the supplier makes late delivery to the materials or not comply with the requested specifications? Please indicate which course of action is taken first. Which is second, which is third and so forth?

No	Likely Course of Action	Rank
1	Learn from the lesson and taking the necessary actions and procedures next times	
2	Send a letter of complaint to supplier to improve the bargaining position of the contractor if there is a need for conflict resolution	
3	Reprimand the supplier and then let the matter rest	
4	Simply ``give-and-take to avoid any sour relationship	
5	Impose penalty charges on the supplier	

3.3 Contractor action for probable delay that is caused by Suppliers late delivery of materials to the project site.

3.3.1 Please indicate the preferred (minimum) level of buffer stocks for the local materials and the materials needed to be imported to safe against varied conditions and material late delivery by the suppliers the normal conditions and unstable conditions

No	Preferred (Minimum) Level of Buffer Stocks to Safeguard Against Uncertainties	Local materials		Materials needed to be Imported	
		Normal Conditions	**Unstable conditions**	**Normal Conditions**	**Unstable conditions**
1	Enough for an operation to carry on for 1 to 2 days				
2	Enough for an operation to carry on for3 to 5 days				
3	Enough for an operation to carry on for 1 week				
4	Enough for an operation to carry on for 2 week				
5	Enough for an operation to carry on for 1 month				
6	Wait for the supplier to deliver the materials in full without no buffer stock				
7	Other Suggestions				

*__Buffer Stock:__ is minimum level of stocks to ensure that work progress is not delayed by the supplier failure to provide the right stocks at the right time

3.3.2 Please indicate the preferred (minimum) level of buffer time for the local materials and the materials needed to be imported to safe against varied conditions and material late delivery by the suppliers the normal conditions and unstable conditions

No	Preferred (Minimum) Level of Buffer Time to Safeguard Against Uncertainties	Local materials		Materials needed to be Imported	
		Normal Conditions	**Unstable conditions**	**Normal Conditions**	**Unstable conditions**
1	Same day				
2	1 to 2 day in advance				
3	3 to5 days in advance				
4	1 week in advance				
5	2 weeks in advance				
6	3 weeks in advance				
7	1 month in advance				
8	2 months in advance				
9	3 months in advance				
10	Other Suggestions				

*__Buffer Time:__ is used to ensure that the materials arrive early enough for the tasks that moving into the operation

Section Four –Identification of the most Occurred problems encountering the Contractors Through the material Supply Chain Process

Use your experience to determine the degree of occurrence of the following problems by ticking the appropriate cell

item No	Problems in the Material supply chain process	Degree of Occurrence				
		Always	often	Some times	Seldom	Never
	Phase 1: Bidding Phase-Material takeoff and Identification					
1.1	Not a good definition of what is wanted from the owner and suppliers					
1.2	Lack of communication between the parties involved					
1.3	Incomplete drawings and details are missing					
1.4	Using specifications different from those commonly used					
1.5	Ambiguities between plans and specifications					
	Phase 2: Sourcing (Vendor Selection)					
2.1	Having too many suppliers and do not have information about them					
2.2	Incomplete proposals (Suppliers did not include all the documents with the proposal)					
2.3	Time spent investigating non-qualified supplier					
	Phase 3: Material procurement					
3.1	Unavailability of required material					
3.2	Late submittal of materials by the contractor to be approved by the Engineer(Materials are not submitted as per the material approval schedule)					
3.3	Incorrect of submittal by the suppliers					
3.4	Late approval of submittal by the suppliers					
3.5	Poor communication between the parties involved					
3.6	The contractor sets delivery dates that are impossible to meet by the suppliers)					
3.7	The contractor does not communicates exactly what is wanted to suppliers					

Item No	Problems in the Material supply chain process	Degree of Occurrence				
		Always	often	Some times	Seldom	Never
	Phase 4: construction					
4.1	Late Deliveries(Materials do not arrive as scheduled)					
4.2	The Delivered materials do not comply with the required specifications					
4.3	Re-handling of materials – Materials have to be moved from one place to another before being installed					
4.4	Storage of materials – storage area are limited or far away from the working area					
4.5	Loss of materials					
4.6	Theft					
4.7	Damaging –Materials are damaged while handling or by other conditions					
4.8	Poor communication between the parties involved					
4.9	Receiving, Handling and storage of the unused materials					
	Phase 5: Post –Construction					
5.1	No storage for the surplus materials					
5.2	No possibility that the surplus materials to be return to the supplier					
5.3	Charging penalties by the suppliers for the returned materials					
5.4	Salvage losses for the surplus materials					

Section five –key Factors Contributing in Construction Supply Chain Integration

Introduction:-Construction is characterized by adversarial practices and disjointed relationship. Projects are treated as a series of sequential and predominantly separate operations where the individual players have very little stake to the long term-term success of the resulting building and no commitment to it. All parties to the contract should work together as unified team, rather than as a disparate collection of separate organizations.
Below are numbers of factors which can have an impact on successful integration of the construction supply chain. From your experience, please express your opinion on how important each factor cab be on construction supply chain integration

Item No	Factors that can be important in integration of construction supply chain	Degree of Importance: Very Important	Important	Quite Important	Some Important	Little Important
1	The design team should be expanded such that to includes contractors, subcontractors and materials suppliers					
2	Using design construct arrangement between the contractor and the client					
3	Entering a partnership relationship with suppliers and subcontractors based on commitment over extended time period, mutual information sharing, trust, openness, dedication to common goals					
4	Understanding the client needs and objectives by the contractor, subcontractors and suppliers and committing for these needs and objectives					
5	Executing the project activities by the contractors own sources (Not sourcing all the project to subcontractors)					
6	Negotiating contracts with the suppliers and subcontractors rather than using competitive tendering					
7	The participation of the designers should not end at the design phase but continues during construction phase					
8	Establishing a protocol for dealing effectively with disputes and problems that may arise between the project participant during the course of project implementation					
9	Conducting workshop for suppliers and subcontractors to discuss the quality, innovation, health and safety issues					
10	Aligning the system and procedures of your own company with that of the client, suppliers and subcontractors					
11	Establishing a system between the project participants for communication and share project information in timely and accurate manner					
12	Using Web Based system for information access and exchange between the project participants that include memos, request for information, transmittal, site instruction, etc.					

APPENDIX 2:- Microsoft Excel Analysis Results

Section Two - Current practices of material supply Chain process

Item No	Material Supply Chain process	Usage Degree											
		Mean	***5***	***4***	***3***	***2***	***1***		***A***	***N***	***AN***	***RII***	***Rank***
Phase1:Bidding phase(estimate, Preparation & submission)													
1.1	Identifying the needed material for each item once you receive the project`s drawings and specification.	4.70	23	5	2	0	0	141	5	30	150	0.940	3
1.2	Estimating the quantity of the needed materials per each item (quantity take off)	4.57	21	5	4	0	0	137	5	30	150	0.913	4
1.3	Defining any special requirement and/or special materials to be used in the project.	4.33	10	20	0	0	0	130	5	30	150	0.867	6
1.4	Classifying the materials that are off-the-shelf and the major materials that needed to be prefabricated.	4.17	8	19	3	0	0	125	5	30	150	0.833	8
1.5	Identifying the local available materials or locally manufactured materials and the materials that are needed to be imported	4.10	9	17	2	2	0	123	5	30	150	0.820	9
1.6	Using software packages or computer application such as Microsoft Excel for preparing the estimate	4.90	27	3	0	0	0	147	5	30	150	0.980	2
1.7	Involving the project manager or construction team in the estimation process in order to prepare a realistic estimate	4.27	9	20	1	0	0	128	5	30	150	0.853	7
1.8	Establishing prices database for the materials from the previous implemented projects in order to be used for preparing the estimate for the future projects	3.70	7	10	10	3	0	111	5	30	150	0.740	11
1.9	Depending on the prices of suppliers and manufacturers on preparing the project estimate	3.90	8	12	9	1	0	117	5	30	150	0.780	10
1.10	Verifying the prices used in the estimate prior to submitting the bid	4.97	29	1	0	0	0	149	5	30	150	0.993	1
1.11	Scheduling a meeting that includes the project manager and the construction team to re-estimate the project quantities once you win the bid	3.47	5	11	8	5	1	104	5	30	150	0.693	12
1.12	Generating a preliminary material requisition schedule, specifying material types, quantity needed, dates, when the material should be delivered and any additional information needed for clarification	4.37	11	19	0	0	0	131	5	30	150	0.873	5
	Phase2: Sourcing(vendor Selection)												
2.1	Pre-qualify the suppliers and manufactures and keeping a list of reputable suppliers and manufactures	3.90	11	9	7	2	1	117	5	30	150	0.780	6
2.2	delivering the right materials (type, quality and quantity)when needed (i.e. at dates specified)	4.77	23	7	0	0	0	143	5	30	150	0.953	2
2.3	Purchasing the materials from suppliers that you worked with on previous projects	4.63	20	9	1	0	0	139	5	30	150	0.927	4
2.4	suppliers in order to get reasonable good prices	4.83	25	5	0	0	0	145	5	30	150	0.967	1
2.5	selecting the winner supplier based on lowest prices	4.27	16	6	8	0	0	128	5	30	150	0.853	5
2.6	Considering suppliers with higher prices but that will provide better services or that have a record to supply the right materials in the quantities needed at the times specified	3.27	8	5	7	7	3	98	5	30	150	0.653	7
2.7	Negotiating the prices directly with the suppliers	4.67	21	8	1	0	0	140	5	30	150	0.933	3

Item No	Material Supply Chain process	Usage Degree											
		Mean	*5*	*4*	*3*	*2*	*1*	[illegible]	*A*	*N*	*AN*	*RII*	*Rank*
Phase 3: Material procurement													
3.1	Obtaining a copy the material requisition schedule, Specifying material types, quantity needed ,dates, when the material should be delivered that prepared by site personnel (such schedule prepared by the site staff on the construction phase)	4.83	26	3	1	0	0	145	5	30	150	0.967	1
3.2	Verifying the availability of requested materials in your stocks before requesting any materials from suppliers	2.47	4	3	6	7	10	74	5	30	150	0.493	7
3.3	Requesting a representative material sample from the supplier or manufacture and approving it by the Engineer prior to materials delivery	4.77	24	5	1	0	0	143	5	30	150	0.953	2
3.4	Issuing purchase order to the winner supplier(Setting an agreement)in order to organize the relationship between the contractor and the supplier	4.50	19	7	4	0	0	135	5	30	150	0.900	3
3.5	Requesting materials directly by the field personnel	2.07	0	0	9	14	7	62	5	30	150	0.413	9
3.6	Ordering 100% of the estimated items quantities at once	4.40	17	8	5	0	0	132	5	30	150	0.880	4
3.7	Ordering the estimated item quantities as per the work progress on the site	2.43	0	4	11	9	6	73	5	30	150	0.487	8
3.8	Specifying to the suppliers the release dates at which the material is needed supplier and the exact location of materials delivery to avoid materials re-handling	4.20	15	7	7	1	0	126	5	30	150	0.840	6
3.9	Following up the status of the ordered materials to make sure that the delivered materials comply with the specification, in the quantities needed and within the time frame specified	4.27	14	10	6	0	0	128	5	30	150	0.853	5
Phase 4 : Construction													
4.1	Determining the quantities of the needed materials per each item	4.23	16	8	3	3	0	127	5	30	150	0.847	5
4.2	Determining dates in which the materials per each item are needed to be available	3.87	13	9	2	3	3	116	5	30	150	0.773	8
4.3	Determine the exact materials delivery location per each item	4.07	16	6	4	2	2	122	5	30	150	0.813	7
4.4	generating a material requisition form in which the material description, quantities needed ,dates when the materials are needed and the delivery locations	4.17	19	4	2	3	2	125	5	30	150	0.833	6
4.5	verifying the material received against the quantity ordered	4.90	27	3	0	0	0	147	5	30	150	0.980	1
4.6	Inspecting the delivered materials to make sure that it meets the specifications	4.80	24	6	0	0	0	144	5	30	150	0.960	2
4.7	materialsRecording any problem in the delivered	4.27	18	7	2	1	2	128	5	30	150	0.853	4
4.8	materialsmaterials ,remaining balance and the installed	4.67	22	6	2	0	0	140	5	30	150	0.933	3
Phase 5: Construction Supply chain management Assessment													
5.1	Conducting comprehensive assessment for the material supply chain process through the mentioned phases to avoid the mistakes and develop this process in the future projects	3.47	8	9	5	5	3	104	5	30	150	0.693	

Item No	Material Supply Chain process	Important Degree											
		Mean —	*5*	*4*	*3*	*2*	*1*	=1 = =5	*A*	*N*	*AN*	*RII*	*Rank*
Phase1:Bidding phase(estimate, Preparation & submission)													
1.1	Identifying the needed material for each item once you receive the project`s drawings and specification.	4.77	23	7	0	0	0	143	5	30	150	0.953	3
1.2	Estimating the quantity of the needed materials per each item (quantity take off)	4.63	19	11	0	0	0	139	5	30	150	0.927	5
1.3	Defining any special requirement and/or special materials to be used in the project.	4.17	13	9	8	0	0	125	5	30	150	0.833	8
1.4	Classifying the materials that are off-the-shelf and the major materials that needed to be prefabricated.	4.13	11	12	7	0	0	124	5	30	150	0.827	9
1.5	Identifying the local available materials or locally manufactured materials and the materials that are needed to be imported	4.07	8	16	6	0	0	122	5	30	150	0.813	10
1.6	Using software packages or computer application such as Microsoft Excel for preparing the estimate	4.67	20	10	0	0	0	140	5	30	150	0.933	4
1.7	Involving the project manager or construction team in the estimation process in order to prepare a realistic estimate	4.40	13	16	1	0	0	132	5	30	150	0.880	7
1.8	Establishing prices database for the materials from the previous implemented projects in order to be used for preparing the estimate for the future projects	3.93	8	12	10	0	0	118	5	30	150	0.787	11
1.9	Depending on the prices of suppliers and manufacturers on preparing the project estimate	3.87	8	11	10	1	0	116	5	30	150	0.773	12
1.10	Verifying the prices used in the estimate prior to submitting the bid	4.97	29	1	0	0	0	149	5	30	150	0.993	1
1.11	Scheduling a meeting that includes the project manager and the construction team to re-estimate the project quantities once you win the bid	4.93	28	2	0	0	0	148	5	30	150	0.987	2
1.12	Generating a preliminary material requisition schedule, specifying material types, quantity needed, dates, when the material should be delivered and any additional information needed for clarification	4.47	14	16	0	0	0	134	5	30	150	0.893	6
Phase2: Sourcing(vendor Selection)													
2.1	Pre-qualify the suppliers and manufactures and keeping a list of reputable suppliers and manufactures	4.23	13	11	6	0	0	127	5	30	150	0.847	5
2.2	Verifying that the supplier is capable of delivering the right materials (type, quality and quantity)when needed (i.e. at dates specified)	4.87	26	4	0	0	0	146	5	30	150	0.973	1
2.3	Purchasing the materials from suppliers that you worked with on previous projects	4.67	21	8	1	0	0	140	5	30	150	0.933	4
2.4	Requesting the quotation from different suppliers in order to get reasonable good prices	4.83	26	3	1	0	0	145	5	30	150	0.967	2
2.5	selecting the winner supplier based on lowest prices	4.17	16	6	5	3	0	125	5	30	150	0.833	6
2.6	Considering suppliers with higher prices but that will provide better services or that have a record to supply the right materials in the quantities needed at the times specified	3.97	10	9	11	0	0	119	5	30	150	0.793	7
2.7	Negotiating the prices directly with the suppliers	4.77	23	7	0	0	0	143	5	30	150	0.953	3

Item No	Material Supply Chain process	Important Degree											
		Mean	***5***	***4***	***3***	***2***	***1***		***A***	***N***	***AN***	***RII***	***Rank***
Phase 3: Material procurement													
3.1	Obtaining a copy the material requisition schedule, Specifying material types, quantity needed ,dates, when the material should be delivered that prepared by site personnel (such schedule prepared by the site staff on the construction phase)	4.97	29	1	0	0	0	149	5	30	150	0.993	1
3.2	Verifying the availability of requested materials in your stocks before requesting any materials from suppliers	4.87	26	4	0	0	0	146	5	30	150	0.973	2
3.3	Requesting a representative material sample from the supplier or manufacture and approving it by the Engineer prior to materials delivery	4.73	23	6	1	0	0	142	5	30	150	0.947	4
3.4	Issuing purchase order to the winner supplier(Setting an agreement)in order to organize the relationship between the contractor and the supplier	4.70	24	3	3	0	0	141	5	30	150	0.940	5
3.5	Requesting materials directly by the field personnel	2.40	0	0	16	10	4	72	5	30	150	0.480	9
3.6	once Ordering 100% of the estimated items quantities at	3.03	2	8	9	11	0	91	5	30	150	0.607	8
3.7	Ordering the estimated item quantities as per the work progress on the site	4.77	25	3	2	0	0	143	5	30	150	0.953	3
3.8	Specifying to the suppliers the release dates at which the material is needed supplier and the exact location of materials delivery to avoid materials re-handling	4.63	22	5	3	0	0	139	5	30	150	0.927	6
3.9	Following up the status of the ordered materials to make sure that the delivered materials comply with the specification, in the quantities needed and within the time frame specified	4.57	20	7	3	0	0	137	5	30	150	0.913	7
Phase 4 : Construction													
4.1	Determining the quantities of the needed materials per each item	4.43	17	9	4	0	0	133	5	30	150	0.887	5
4.2	Determining dates in which the materials per each item are needed to be available	4.27	14	10	6	0	0	128	5	30	150	0.853	8
4.3	Determine the exact materials delivery location per each item	4.37	19	6	4	0	0	131	5	30	150	0.873	6
4.4	generating a material requisition form in which the material description, quantities needed ,dates when the materials are needed and the delivery locations	4.30	19	6	2	2	0	129	5	30	150	0.860	7
4.5	ordered verifying the material received against the quantity	4.77	23	7	0	0	0	143	5	30	150	0.953	2
4.6	Inspecting the delivered materials to make sure that it meets the specifications	4.97	29	1	0	0	0	149	5	30	150	0.993	1
4.7	Recording any problem in the delivered materials	4.63	21	7	2	0	0	139	5	30	150	0.927	3
4.8	keeping a track record of the supplied materials ,remaining balance and the installed materials	4.47	17	10	3	0	0	134	5	30	150	0.893	4
Phase 5: Construction Supply chain management Assessment													
5.1	Conducting comprehensive assessment for the material supply chain process through the mentioned phases to avoid the mistakes and develop this process in the future projects	4.53	18	10	2	0	0	136	5	30	150	0.907	

Section Four –Identification of the most Occurred problems encountering the Contractors Through the material Supply Chain Process

Item No	Material Supply Chain process	Usage Degree											
		Mean —	*5*	*4*	*3*	*2*	*1*		*A*	*N*	*AN*	*RII*	*Rank*
Phase 1: Bidding Phase-Material takeoff and Identification													
1.1	Not a good definition of what is wanted from the owner and suppliers	3.27	7	4	9	10	0	98	5	30	150	0.653	4
1.2	Lack of communication between the parties involved	3.67	6	8	16	0	0	110	5	30	150	0.733	1
1.3	Incomplete drawings and details are missing	3.30	2	8	17	3	0	99	5	30	150	0.660	3
1.4	Using specifications different from those commonly used	2.60	4	6	4	6	10	78	5	30	150	0.520	5
1.5	Ambiguities between plans and specifications	3.43	5	7	14	4	0	103	5	30	150	0.687	2
Phase 2: Sourcing (Vendor Selection)													
2.1	Having too many suppliers and do not have information about them	2.50	2	4	9	7	8	75	5	30	150	0.500	3
2.2	Incomplete proposals (Suppliers did not include all the documents with the proposal)	3.20	6	5	8	11	0	96	5	30	150	0.640	1
2.3	Time spent investigating non-qualified supplier	2.87	3	4	9	14	0	86	5	30	150	0.573	2
Phase 3: Material procurement													
3.1	Unavailability of required material	3.50	5	9	12	4	0	105	5	30	150	0.700	2
3.2	Late submittal of materials by the contractor to be approved by the Engineer(Materials are not submitted as per the material approval schedule)	3.13	3	5	15	7	0	94	5	30	150	0.627	5
3.3	Incorrect of submittal by the suppliers	3.33	2	12	11	4	1	100	5	30	150	0.667	4
3.4	Late approval of submittal by the suppliers	3.37	4	8	13	5	0	101	5	30	150	0.673	3
3.5	Poor communication between the parties involved	3.93	9	10	11	0	0	118	5	30	150	0.787	1
3.6	The contractor sets delivery dates that are impossible to meet by the suppliers)	3.03	3	4	14	9	0	91	5	30	150	0.607	6
3.7	The contractor does not communicates exactly what is wanted to suppliers	2.57	0	5	12	8	5	77	5	30	150	0.513	7
Phase 4: construction													
4.1	Late Deliveries(Materials do not arrive as scheduled)	4.23	14	11	3	2	0	127	5	30	150	0.847	1
4.2	The Delivered materials do not comply with the required specifications	3.30	6	8	9	3	4	99	5	30	150	0.660	2
4.3	Re-handling of materials – Materials have to be moved from one place to another before being installed	2.53	2	3	7	15	3	76	5	30	150	0.507	5
4.4	Storage of materials – storage area are limited or far away from the working area	2.47	4	3	5	9	9	74	5	30	150	0.493	6
4.5	Loss of materials	2.27	0	3	9	11	7	68	5	30	150	0.453	8
4.6	Theft	2.20	0	4	6	12	8	66	5	30	150	0.440	9
4.7	Damaging –Materials are damaged while handling or by other conditions	2.73	2	5	6	17	0	82	5	30	150	0.547	4
4.8	Poor communication between the parties involved	3.23	5	6	10	9	0	97	5	30	150	0.647	3
4.9	Receiving, Handling and storage of the unused materials	2.40	0	4	9	12	5	72	5	30	150	0.480	7
Phase 5: Post –Construction													
5.1	No storage for the surplus materials	2.00	0	2	3	18	7	60	5	30	150	0.400	3
5.2	No possibility that the surplus materials to be return to the supplier	2.37	0	4	8	13	5	71	5	30	150	0.473	2
5.3	Charging penalties by the suppliers for the returned materials	1.90	0	0	8	11	11	57	5	30	150	0.380	4
5.4	Salvage losses for the surplus materials	2.47	0	5	9	11	5	74	5	30	150	0.493	1

Section five –key Factors Contributing in Construction Supply Chain Integration

Item No	Material Supply Chain process	Important Degree											
		Mean	***5***	***4***	***3***	***2***	***1***		***A***	***N***	***AN***	***RII***	***Rank***
1	The design team should be expanded such that to includes contractors, subcontractors and materials suppliers	2.67	0	5	12	11	2	80	5	30	150	0.533	12
2	Using design construct arrangement between the contractor and the client	2.83	3	4	8	15	0	85	5	30	150	0.567	11
3	Entering a partnership relationship with suppliers and subcontractors based on commitment over extended time period, mutual information sharing, trust, openness, dedication to common goals	3.37	6	9	5	10	0	101	5	30	150	0.673	9
4	Understanding the client needs and objectives by the contractor, subcontractors and suppliers and committing for these needs and objectives	4.83	25	5	0	0	0	145	5	30	150	0.967	1
5	Executing the project activities by the contractors own sources (Not sourcing all the project to subcontractors)	4.07	14	7	6	3	0	122	5	30	150	0.813	6
6	Negotiating contracts with the suppliers and subcontractors rather than using competitive tendering	3.47	6	8	10	6	0	104	5	30	150	0.693	8
7	The participation of the designers should not end at the design phase but continues during construction phase	4.23	16	7	5	2	0	127	5	30	150	0.847	5
8	Establishing a protocol for dealing effectively with disputes and problems that may arise between the project participant during the course of project implementation	4.77	24	5	1	0	0	143	5	30	150	0.953	2
9	Conducting workshop for suppliers and subcontractors to discuss the quality, innovation, health and safety issues	3.17	5	11	3	6	5	95	5	30	150	0.633	10
10	Aligning the system and procedures of your own company with that of the client, suppliers and subcontractors	3.83	12	7	7	2	2	115	5	30	150	0.767	7
11	Establishing a system between the project participants for communication and share project information in timely and accurate manner	4.57	21	5	4	0	0	137	5	30	150	0.913	3
12	Using Web Based system for information access and exchange between the project participants that include memos, request for information, transmittal, site instruction, etc.	4.33	14	12	4	0	0	130	5	30	150	0.867	4

APPENDIX 3:- Cronbach's Coefficient Alpha results

Section Two-current practices of material supply Chain process
Phase1:Bidding phase(estimate, Preparation & submission)

Calculating Cronbach's coefficient alpha for a 12 Question questionnaire with Likert score between 1 and 5 based on the 30 person sample

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Total
1	5	5	4	5	5	5	5	5	5	5	5	5	59
2	5	4	4	4	4	5	4	3	4	5	3	4	49
3	5	5	5	4	5	5	5	4	5	5	4	4	56
4	5	5	4	5	4	5	4	5	4	5	4	4	54
5	5	4	4	4	3	5	4	3	5	5	3	4	49
6	5	5	4	4	4	4	4	4	3	5	5	4	51
7	5	5	4	4	5	5	5	3	3	5	4	5	53
8	5	5	4	5	4	5	4	4	4	5	2	4	51
9	5	3	5	4	4	5	5	3	5	5	4	4	52
10	5	5	4	4	4	4	4	5	3	5	3	4	50
11	4	5	4	3	5	5	4	3	4	5	2	5	49
12	5	5	4	4	4	5	5	2	4	4	3	4	49
13	4	4	5	4	3	5	4	4	4	5	4	5	51
14	5	5	4	5	4	5	4	5	5	5	4	4	55
15	5	5	5	4	4	5	4	3	4	5	2	5	51
16	5	5	4	4	5	5	5	3	5	5	3	4	53
17	4	3	4	4	4	4	4	2	3	5	4	5	46
18	5	5	5	4	4	5	4	4	3	5	5	4	53
19	5	5	5	5	5	5	4	3	4	5	3	5	54
20	3	5	4	4	4	5	4	5	5	5	4	5	53
21	5	5	5	4	4	5	4	4	4	5	5	4	54
22	4	3	4	3	5	5	4	4	5	5	2	5	49
23	5	5	5	4	4	5	5	3	4	5	3	5	53
24	5	4	5	4	2	5	4	5	3	5	5	4	51
25	5	5	5	5	4	5	4	4	3	5	4	5	54
26	4	3	4	4	5	5	5	4	4	5	2	4	49
27	5	5	4	5	4	5	4	3	4	5	3	4	51
28	5	4	4	4	4	5	4	5	3	5	4	4	51
29	5	5	4	5	5	5	5	4	3	5	4	4	54
30	3	5	5	3	2	5	3	2	2	5	1	4	40
Total	141	137	131	125	123	147	128	111	117	149	104	131	1544
Var	0.343333	0.512222	0.23222	0.33889	0.623333	0.090000	0.262222	0.876667	0.69000	0.032222	1.11556	0.23222	5.348889

k	12
$\sum Var$	5.348889
Var	11.18222
α	0.769085

Phase 2: Sourcing (Vendor Selection)

Calculating Cronbach's coefficient alpha for a 7 Question questionnaire with Likert score between 1 and 5 based on the 30 person sample

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Total
1	5	5	5	5	5	5	5	35
2	5	5	4	5	3	3	4	29
3	5	5	4	5	5	2	5	31
4	3	5	5	5	5	3	5	31
5	5	5	4	5	5	5	4	33
6	3	4	5	4	4	2	5	27
7	3	5	5	5	5	3	5	31
8	5	5	4	5	3	3	4	29
9	4	5	5	5	4	2	5	30
10	5	5	4	5	5	5	4	33
11	4	4	5	4	4	4	5	30
12	3	5	5	5	3	2	5	28
13	2	5	4	5	5	5	4	30
14	4	4	5	5	4	3	5	30
15	4	5	4	5	4	4	4	30
16	5	4	5	5	5	2	5	31
17	3	5	5	5	4	3	5	30
18	5	5	4	5	3	5	4	31
19	4	4	5	4	5	4	5	31
20	2	5	5	5	5	1	5	28
21	5	5	5	5	5	3	5	33
22	4	5	5	5	5	5	5	34
23	3	4	5	5	3	2	5	27
24	3	5	4	5	3	4	4	28
25	5	5	5	5	5	2	5	32
26	4	5	5	4	5	1	5	29
27	4	5	5	5	3	5	5	32
28	5	5	5	5	5	4	5	34
29	4	5	5	5	5	5	5	34
30	1	4	3	4	3	1	3	19
Total	117	143	139	145	128	98	140	910
Var	1.156667	0.178889	0.298889	0.138889	0.728889	1.795556	0.288889	4.586667

k	7
$\sum Var$	4.586667
Var	8.82222
α	0.76012

Phase 3: Material procurement

Calculating Cronbach's coefficient alpha for a 9 Question questionnaire with Likert score between 1 and 5 based on the 30 person sample

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Total
1	5	5	5	5	3	5	4	5	5	42
2	5	2	4	4	3	5	2	5	5	35
3	5	4	5	5	2	5	3	3	4	36
4	5	2	5	5	1	5	2	4	5	34
5	5	5	5	4	3	5	3	5	4	39
6	4	1	4	5	2	4	3	3	5	31
7	5	1	5	5	1	5	2	4	3	31
8	5	2	5	4	3	5	2	5	4	35
9	5	2	5	5	2	5	3	5	5	37
10	5	3	5	5	3	5	3	4	4	37
11	5	5	5	4	2	5	3	4	4	37
12	5	1	4	5	1	4	2	5	5	32
13	5	1	5	3	3	3	1	3	3	27
14	5	3	5	5	2	3	3	3	5	34
15	5	3	5	5	3	4	3	5	5	38
16	5	1	5	4	2	5	2	5	4	33
17	5	5	5	5	3	4	2	5	3	37
18	5	2	5	5	2	5	4	4	4	36
19	4	1	4	3	1	5	1	5	5	29
20	5	3	5	5	1	3	3	3	3	31
21	5	4	5	5	2	4	4	5	4	38
22	5	2	5	4	2	4	1	5	5	33
23	5	1	5	5	2	5	3	4	5	35
24	5	3	5	5	2	5	2	5	4	36
25	4	1	4	5	3	5	1	5	5	33
26	5	4	5	5	2	3	3	3	3	33
27	5	2	5	3	2	4	4	5	5	35
28	5	1	5	4	1	5	2	4	4	31
29	5	3	5	5	2	4	1	3	5	33
30	3	1	3	3	1	3	1	2	3	20
Total	145	74	143	135	62	132	73	126	128	1018
Var	0.205556	1.915556	0.245556	0.516667	0.528889	0.573333	0.912222	0.826667	0.595556	4.198889

k	9
$\sum Var$	4.198889
Var	16.2622
α	0.83453

Phase 4: construction

Calculating Cronbach's coefficient alpha for a 8 Question questionnaire with Likert score between 1 and 5 based on the 30 person sample

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Total
1	5	5	5	5	5	5	5	5	40
2	4	4	4	5	5	5	5	5	37
3	4	4	5	4	5	4	4	4	34
4	4	4	4	5	5	5	5	5	37
5	5	5	5	5	5	5	5	5	40
6	5	5	3	4	4	4	4	4	33
7	5	4	5	5	5	5	5	5	39
8	5	5	4	5	5	5	4	5	38
9	5	5	5	5	5	5	5	5	40
10	4	4	4	4	4	4	4	4	32
11	5	5	5	5	5	5	5	5	40
12	5	5	5	5	5	5	5	5	40
13	5	3	3	5	5	5	5	5	36
14	4	4	5	4	5	5	5	5	37
15	5	2	5	5	5	5	5	5	37
16	4	4	4	5	5	5	5	5	37
17	5	4	5	3	4	4	4	4	33
18	3	5	3	5	5	5	5	5	36
19	5	5	5	5	5	5	3	5	38
20	2	2	5	2	5	5	5	5	31
21	4	5	4	5	5	5	5	5	38
22	3	3	3	5	5	5	4	5	33
23	5	5	5	5	5	5	3	5	38
24	4	1	2	2	5	4	4	4	26
25	5	5	5	5	5	5	5	3	38
26	5	4	5	5	5	5	5	5	39
27	5	1	1	1	5	4	1	4	22
28	3	5	5	3	5	5	5	5	36
29	2	2	2	2	5	5	2	5	25
30	2	1	1	1	5	5	1	3	19
Total	127	116	122	125	147	144	128	140	1049
Var	0.978889	1.782222	1.528889	1.672222	0.090000	0.160000	1.328889	0.355556	6.917778

k	8
$\sum Var$	6.917778
Var	28.9656
α	0.86991

Section Four –Identification of the most Occurred problems encountering the
Phase 1: Bidding Phase-Material takeoff and Identification

Calculating Cronbach's coefficient alpha for a 5 Question questionnaire with Likert score between 1 and 5 based on the 30 person sample

	Q1	Q2	Q3	Q4	Q5	Total
1	5	5	5	5	5	25
2	4	4	4	4	4	20
3	5	5	5	5	5	25
4	4	4	5	5	5	23
5	3	3	4	4	3	17
6	4	5	5	5	5	24
7	4	5	5	3	5	22
8	3	3	3	2	3	14
9	3	4	4	4	4	19
10	4	4	5	4	4	21
11	3	5	5	3	3	19
12	3	3	3	3	3	15
13	4	4	4	4	4	20
14	3	4	3	4	4	18
15	3	3	3	2	3	14
16	4	5	3	2	4	18
17	3	3	3	1	3	13
18	3	3	3	1	3	13
19	4	4	2	1	4	15
20	3	3	2	3	3	14
21	3	3	2	1	3	12
22	2	3	2	2	2	11
23	3	3	3	2	3	14
24	3	4	3	1	3	14
25	3	3	2	1	2	11
26	3	3	2	1	3	12
27	3	3	2	2	3	13
28	2	3	2	1	2	10
29	3	3	2	1	3	12
30	2	3	2	1	2	10
Total	99	110	98	78	103	488
Var	0.543333	0.622222	1.328889	2.106667	0.845556	5.446667

k	5
$\sum Var$	5.446667
Var	20.39556
α	0.816185

Section Four –Identification of the most Occurred problems encountering the
Phase 1: Bidding Phase-Material takeoff and Identification

Calculating Cronbach's coefficient alpha for a 5 Question questionnaire with Likert score between 1 and 5 based on the 30 person sample

	Q1	Q2	Q3	Q4	Q5	Total
1	5	5	5	5	5	25
2	4	4	4	4	4	20
3	5	5	5	5	5	25
4	4	4	5	5	5	23
5	3	3	4	4	3	17
6	4	5	5	5	5	24
7	4	5	5	3	5	22
8	3	3	3	2	3	14
9	3	4	4	4	4	19
10	4	4	5	4	4	21
11	3	5	5	3	3	19
12	3	3	3	3	3	15
13	4	4	4	4	4	20
14	3	4	3	4	4	18
15	3	3	3	2	3	14
16	4	5	3	2	4	18
17	3	3	3	1	3	13
18	3	3	3	1	3	13
19	4	4	2	1	4	15
20	3	3	2	3	3	14
21	3	3	2	1	3	12
22	2	3	2	2	2	11
23	3	3	3	2	3	14
24	3	4	3	1	3	14
25	3	3	2	1	2	11
26	3	3	2	1	3	12
27	3	3	2	2	3	13
28	2	3	2	1	2	10
29	3	3	2	1	3	12
30	2	3	2	1	2	10
Total	99	110	98	78	103	488
Var	0.543333	0.622222	1.328889	2.106667	0.845556	5.446667

k	5
$\sum Var$	5.446667
Var	20.39556
α	0.816185

Phase 2: Sourcing (Vendor Selection)

Calculating Cronbach's coefficient alpha for a 3 Question questionnaire with Likert score between 1 and 5 based on the 30 person sample

	Q1	Q2	Q3	Total
1	5	5	5	15
2	4	4	4	12
3	3	5	5	13
4	5	5	5	15
5	4	4	4	12
6	3	3	3	9
7	3	3	3	9
8	1	5	2	8
9	3	3	3	9
10	4	5	4	13
11	3	3	3	9
12	1	2	2	5
13	3	3	3	9
14	1	5	2	8
15	4	4	4	12
16	2	2	3	7
17	1	2	2	5
18	2	3	2	7
19	1	2	2	5
20	3	4	3	10
21	2	2	2	6
22	3	4	3	10
23	2	3	2	7
24	1	2	2	5
25	3	3	3	9
26	2	2	2	6
27	2	2	2	6
28	1	2	2	5
29	2	2	2	6
30	1	2	2	5
Total	75	96	86	257
Var	1.450000	1.293333	0.982222	3.725556

k	3
$\sum Var$	3.725556
Var	9.112222
α	0.836721

Phase 3: Material procurement

Calculating Cronbach's coefficient alpha for a 7 Question questionnaire with Likert score between 1 and 5 based on the 30 person sample

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Total
1	5	5	5	5	5	5	4	34
2	5	4	4	4	5	4	3	29
3	5	5	5	5	4	5	4	33
4	4	4	4	4	4	4	4	28
5	5	5	4	5	5	5	3	32
6	4	3	3	4	4	3	4	25
7	5	4	4	5	5	4	4	31
8	4	4	4	4	5	4	3	28
9	3	2	3	4	3	2	2	19
10	4	4	4	4	5	3	2	26
11	3	3	3	3	4	3	3	22
12	4	3	3	3	5	3	3	24
13	3	2	3	2	3	2	2	17
14	3	3	4	4	4	3	3	24
15	4	3	4	4	5	3	3	26
16	3	2	3	3	3	2	1	17
17	3	3	3	3	4	3	2	21
18	4	3	4	3	4	3	3	24
19	3	3	3	3	5	3	3	23
20	2	2	2	2	3	2	2	15
21	3	3	3	3	3	2	1	18
22	4	3	4	3	4	3	3	24
23	4	3	4	3	3	3	3	23
24	2	2	3	3	3	2	1	16
25	3	3	2	2	4	2	2	18
26	3	3	4	3	4	3	3	23
27	3	3	2	3	3	3	2	19
28	2	2	3	2	3	2	1	15
29	3	3	2	3	3	3	2	19
30	2	2	1	2	3	2	1	13
Total	105	94	100	101	118	91	77	686
Var	0.850000	0.782222	0.822222	0.832222	0.662222	0.832222	0.912222	5.693333

k	7
$\sum Var$	5.693333
Var	30.9822
α	0.80228

Phase 4: construction

Calculating Cronbach's coefficient alpha for a 9 Question questionnaire with Likert score between 1 and 5 based on the 30 person sample

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Total
1	5	5	5	5	4	4	5	5	4	42
2	5	4	4	4	3	3	4	4	3	34
3	4	5	5	5	4	4	5	5	4	41
4	5	5	4	5	4	4	3	5	3	38
5	4	4	3	4	3	3	4	4	2	31
6	5	5	3	5	2	2	4	5	4	35
7	5	4	4	4	2	4	4	4	4	35
8	4	4	2	3	3	3	2	4	2	27
9	5	5	2	3	3	3	2	5	3	31
10	4	5	3	1	1	1	4	4	3	26
11	5	4	2	2	2	2	2	3	2	24
12	5	3	2	3	3	1	3	3	2	25
13	5	4	2	1	2	2	2	4	2	24
14	4	3	2	2	2	2	2	3	3	23
15	4	4	3	1	1	1	3	2	3	22
16	5	3	2	3	3	3	2	3	2	26
17	4	3	2	2	2	2	2	2	2	21
18	5	4	3	2	2	2	3	3	3	27
19	3	3	2	1	1	1	2	2	2	17
20	4	3	2	3	3	3	2	3	1	24
21	5	2	3	2	2	2	3	2	3	24
22	4	3	2	2	2	2	2	3	2	22
23	5	1	1	1	1	1	2	2	1	15
24	3	3	2	1	3	2	2	3	2	21
25	4	1	2	1	1	1	2	3	1	16
26	4	2	3	2	2	2	3	2	3	23
27	5	3	2	2	3	2	2	3	2	24
28	2	1	1	1	1	1	2	2	1	12
29	3	2	2	2	2	2	2	2	2	19
30	2	1	1	1	1	1	2	2	1	12
Total	127	99	76	74	68	66	82	97	72	761
Var	0.778889	1.610000	1.048889	1.848889	0.862222	0.960000	0.928889	1.112222	0.840000	9.990000

k	9
$\sum Var$	9.990000
Var	58.4989
α	0.84288

Phase 5: Post –Construction

Calculating Cronbach's coefficient alpha for a 4 Question questionnaire with Likert score between 1 and 5 based on the 30 person sample

	Q1	Q2	Q3	Q4	Total
1	2	4	3	4	13
2	4	3	2	3	12
3	2	3	3	3	11
4	4	4	2	4	14
5	2	2	1	2	7
6	2	2	2	3	9
7	3	2	1	2	8
8	2	4	3	4	13
9	1	2	1	4	8
10	3	2	2	2	9
11	2	3	1	3	9
12	2	2	1	2	7
13	2	4	3	4	13
14	1	2	1	1	5
15	2	2	2	2	8
16	3	3	3	3	12
17	2	2	2	2	8
18	2	3	1	3	9
19	1	1	2	2	6
20	2	2	1	2	7
21	2	3	3	3	11
22	1	1	2	1	5
23	2	2	2	2	8
24	2	2	1	2	7
25	1	1	2	1	5
26	2	3	3	3	11
27	2	3	3	3	11
28	1	1	2	1	5
29	2	2	1	2	7
30	1	1	1	1	4
Total	60	71	57	74	262
Var	0.600000	0.832222	0.623333	0.915556	2.971111

k	4
$\sum Var$	2.971111
Var	7.59556
α	0.81178

Section five- Key Factors Contributing in Construction Supply Chain Integration

Calculating Cronbach's coefficient alpha for a 12 Question questionnaire with Likert score between 1 and 5 based on the 30 person sample

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Total
1	4	5	5	5	5	5	5	5	5	5	5	5	59
2	3	4	5	5	4	4	4	5	4	5	5	4	52
3	4	2	4	5	5	5	5	4	5	3	4	5	51
4	2	3	2	5	4	4	4	5	4	5	5	4	47
5	3	3	5	5	3	3	5	5	4	4	5	5	50
6	2	5	4	4	5	5	5	5	4	4	5	4	52
7	4	2	4	5	3	4	3	5	2	3	4	5	44
8	2	4	5	5	5	4	5	5	5	5	5	5	55
9	3	2	2	5	4	3	5	5	5	5	5	4	48
10	3	5	2	5	4	3	4	5	3	3	5	5	47
11	3	2	5	5	5	5	4	5	4	5	5	4	52
12	2	2	2	5	3	2	4	5	2	4	5	5	41
13	4	3	4	5	5	3	5	5	4	3	5	5	51
14	2	2	5	4	5	4	5	4	5	5	4	3	48
15	3	2	3	5	4	3	5	5	3	4	5	4	46
16	3	4	2	5	5	5	3	5	4	4	3	5	48
17	2	2	4	5	3	2	5	5	1	3	5	5	42
18	4	4	4	5	5	4	3	5	2	5	5	5	51
19	2	3	2	4	5	3	4	4	4	5	4	4	44
20	3	2	2	5	4	4	5	5	4	3	5	4	46
21	2	3	3	5	4	3	5	5	2	4	5	3	44
22	3	2	4	5	5	5	5	5	1	3	5	4	47
23	3	2	4	5	3	2	3	5	4	5	3	5	44
24	2	3	2	4	5	3	5	4	4	5	4	5	46
25	3	2	2	5	2	2	4	5	1	2	5	4	37
26	3	3	3	5	5	4	5	5	2	5	5	5	50
27	2	2	3	5	5	3	5	5	3	4	5	4	46
28	1	3	4	5	2	2	2	5	1	1	5	3	34
29	2	2	3	5	3	3	3	4	2	2	3	4	36
30	1	2	2	4	2	2	2	3	1	1	3	3	26
Total	80	85	101	145	122	104	127	143	95	115	137	130	1384
Var	0.688889	1.005556	1.298889	0.138889	1.062222	1.048889	0.912222	0.245556	1.872222	1.472222	0.512222	0.488889	10.746667

k	12
$\sum Var$	10.746667
Var	42.04889
α	0.812099