ASSESSMENT OF SUPPLY CHAIN MANAGEMENT IN PUBLIC BUILDING CONSTRUCTION PROJECTS IN ADDIS ABABA

By

Betelhem Kebede

Advisor

Prof. (Dr. Ing.) Abebe Dinku

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May 2017

APPROVED BY THE BOARD OF EXAMINERS

	Name	Signature
ADVISOR	**Prof. (Dr. – Ing.) Abebe Dinku**	_____
EXAMINER (INTERNAL)	**Dr. Abraham Assefa**	_____
EXAMINER (EXTERNAL)	**Engineer Yibeltal Zewedu**	_____
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Declaration

I declare that this thesis entitled "ASSESSMENT OF SUPPLY CHAIN MANAGEMENT IN PUBLIC BUILDING CONSTRUCTION PROJECTS IN ADDIS ABABA" is my original work. This thesis has not been presented for any other university and is not concurrently submitted in candidature of any other degree, and that all sources of material used for the thesis have been duly acknowledged.

Candidate:

Name: Betelhem Kebede

Signature: _____

Place Addis Ababa University

Addis Ababa Institute of Technology

School of Civil and Environmental Engineering

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Abstract

A poor management on construction projects can lead to significant negative impacts with low productivity, cost and time overrun, conflicts and disputes resulting in claims and time consuming litigation. Previous studies pointed out that an efficient management of the construction logistics process can be a way to lift up the construction productivity. Proper management of supply chain would result in lowering costs, short delivery time, low inventory level and improve reliability which would improve the competitive position of organizations.

This research assesses the perception of the construction industry stakeholders on the need and importance of supply chain management on selected public building construction projects, identify and analyze the current practices and challenges in the supply chain management process.

The study subjects are currently active public projects in Addis Ababa which are being administered by the Ministry of Urban Development and Housing. The main tools used for the collection of data included questionnaires and desk study as they are used to identify the various efforts that have been made in the past and to examine the challenges of supply chain management. Frequency analysis and relative importance index (RII) are used to examine the results from the questionnaire and findings are presented in charts and tables.

The findings show that the construction industry stakeholders perceive that supply chain management collaboration has helped in the construction industry as it improves the quality assurance and increases profitability. The study also indicates that the potential factors that are important for supply chain collaboration are improved customer service, increased profitability and improved quality insurance. On the other hand, late and incorrect payments and inaccurate data and engineering drawings not fitting the use are indicated as the major challenges for a successful supply chain network. Furthermore, it was found that most of the stakeholders do not apply the integrated approach to supply chain management.

Table of Contents

List of Figures

List of Tables

Acronyms

BPR	Business Process Redesign
CSCM	Construction Supply Chain Management
EDI	Electro Data Interchange
JIT	Just in Time
SC	Supply Chain
SCM	Supply Chain Management
TQM	Total Quality Management

CHAPTER 1: INTRODUCTION

1.1.Background

Many researchers claim that the construction industry suffers from poor performance although there may be signs of improvement (Egan, 1998; Cox, et al., 2002 ; Vrijhoef, et al., 2000; Love, et al., 2004). Construction companies need new tools and technology in order to improve their supply chain to enhance quality, time, and cost performance. Consequently, the need for supply chain management cannot be emphasized.

In order to accommodate the growing complexity of construction process, various management systems and methods have been developed in academic researches and well applied in industry practices. Among those, supply chain management becomes increasingly popular, especially within the context of broader cooperation, vertical disintegration and the viewpoint of a networked supply chain in the construction industry (Vrijhoef, et al., 1999).

It can be argued that any action towards the rationalization of size, structure, and organization of material consumption, along with proper planning of delivery and storage could increase project efficiency (Czarnigowska, et al., 2005).

Construction contractors are increasingly engaged in supply of material from diverse sources around the world and this process starts with design and engineering pursued at manufacturers' workshop, and ends with a series of journeys from factories to the construction site. Planning such a long supply chain requires examining all the stages involved in terms of time and costs (Wegelius-Lehtonen, et al., 1996)

Late delivery of construction materials and components has been identified as one of the main causes of delay in major industrial construction projects. Therefore, timely delivery of materials is essential to ensure meeting completion date of construction activities (Fallahnejad, 2013).

Public construction projects in Ethiopia are parts of the country's development initiative. It consumes considerable amount of the country's scarce financial resources since the construction industry is the highest recipient of government budget as part of government development program. Previous estimates showed that public construction projects consume an average

annual rate of nearly 58.2% to 60%, of government's capital budget (MoUDHC, 2006; Wubishet, 2004).

However, most public projects are suffering from time and cost overrun. Hitherto, no study has clearly showed which challenges have affected supply chain management that led to time and cost overrun. Hence, this research targets to identify the current practices and challenges that the construction supply chain is facing.

1.2. Statement of the Problem

Performance and innovation in construction are significantly hindered by adversarial relationships and fragmented processes. In order to minimize their own exposure to risk, each party in the supply chain attempts to extract maximum reward for minimum risk that is normally achieved by means of non-legitimate risk transfer - passing risk down to the next level in the supply chain. This way of thinking has resulted in an industry structure with various interfaces, which are points of tension and conflict, which eventually leads to increased cost and reduced efficiency (Cox, et al., 1998). Fragmentation is the lack of integration, coordination and collaboration between the various functions disciplines involved in the life cycle aspects of a project (Baiden, et al., 2006).

Projects involve assembling materials and components designed and produced by a multitude of suppliers, working in a diversity of disciplines and technologies in order to produce a product for particular client. This diversity of product technologies, which has to be reorganized with each new construction project, coupled with discontinuous demand from a large percentage of construction's clients, accounts for the transient nature of the relationships between the demand and supply side of the industry. In addition, with the increasing shift from on-site to off-site production, managing construction projects involves integrating diverse and complex supply systems in which a growing amount of value of the product is added (Saad, et al., 2003).

Construction projects take place where sites are very crowded; this situation is recurrent for projects located in urban areas. In big cities where virtually no storage space exists, a good management of supply chains in order to get materials, people, information, machines, and equipment to the workface in a Lean manner (Just-in-Time) is vitally important to project success (Mossman, 2007).

It has been reported that a 35% reduction in material wastage could be achieved by adopting more efficient logistics practices and the key to achieving it is the development and implementation of a robust construction logistics plan. These plans are an important tool to help the construction sector ensure that the right materials are in the right place at the right time in the right quantity and with the right cost (Material Logistics plan, 2007).

In most public building construction projects in Addis Ababa, certain materials are procured and delivered to the project site for implementation by the public authorities (such as cement and reinforcement bars, etc.). The construction sites are a very intense logistical spot, in which a lot of material that is being managed in a complicated way in order to construct and fulfill requirements. However, there is lack of integration of suppliers and producers as well as stocks and markets which are results of lack of synchronization of the client's requirements with materials and information flows.

Obviously, there is lack of systematic and detailed studies on the construction material logistics and supply chain network systems and this research aims to address this issues.

1.3. Objectives

The research has the following objectives:

1. To assess the perception of the construction industry stakeholders on the need and importance of supply chain management
2. To identify and analyze the current practices and challenges in the supply chain management process
3. To identify the approach of supply chain management used
4. To recommend solutions for the challenges in the supply chain network of Addis Ababa public building projects based on the findings from the study.

1.4. Scope of the Study

Supply chain management challenges and competitive positioning are vast issues to be addressed in this research. However, this research would like to address issues that are critical to supply chain management challenges and their impact on the coming public building projects.

Among numerous projects being carried out in Ethiopia, the study is limited to Addis Ababa city where major public building construction projects are under construction. In addition, as it is difficult to get a formally recorded data of all the currently active public construction projects, the projects selected for this research are those public projects that are being administered by MOUDH.

In addition, it will be focused on the construction stage and particularly on the flow (chain) of stakeholders, clients, consultant, contractors and suppliers and major construction materials such as cement, reinforcement, aggregate, sand, finishing materials, etc.

1.5.Limitations in Data Collection

The process of data collection did not go without some drawbacks. They are described below:

- Low response rate of Suppliers
- The main respondents consist of project managers and contract managers. This is seen as a limitation since the research did not have a broader spectrum of participant to respond to the questionnaire survey. In some cases, only one respondent from a specific role answered. This could also be a source of bias.

1.6.Research Motivation

The motivation for this research mainly comes from seeing that projects are being executed with technical specifications that are not specified in the contract document which also dissatisfies the owner in addition to cost increase and time overrun and conflicts and disputes resulting in claims and time consuming litigation.

In addition to the prevailing situation, it seems hard to find enough literature on the current supply chain practice in Ethiopia. The experience and observation on the above said practices and the requirement for the partial fulfillment of master's program in Construction Technology and Management ignited the motivation.

Hence, the research not only can help increase the understanding of managers and planners on construction logistics activities and their related costs, but also increase their bid competitiveness

and/or improve the chance of success at the construction stage by minimizing the construction logistics cost.

1.7.Structure of the Thesis

Chapter 1 provides a brief introduction and objectives of this study. The importance of construction efficiency and the benefit of improving the construction performance with logistics technology are briefly reviewed. The aim and objectives, scope and limitation of this study as well as the overall structure of the thesis are also outlined in this chapter. Furthermore, it gives an overview of research and lists the research methodology in the supply chain management.

Chapter 2 is a literature review of some relevant important concepts, like SCM, construction SCM, and construction logistics. The definition and application of SCM in both the manufacturing and construction industries are studied. Previous researches on construction logistics are reviewed. The problems and benefits of improvement for construction logistics are also studied.

Chapter 3 covers the research methodology. The methodological approach consists of the overall research strategy; the research design, the analysis of the data and writing of the research paper.

Chapter 4 contains the discussion and analysis part. It contains the findings on the practice, characteristics, current applications and improving methods of SCM & logistics on public buildings and

Chapter 5 presents research conclusions, and recommendations. This will serve as an action guideline to stakeholders in the construction industry.

Figure 1.1shows the outline of the thesis.

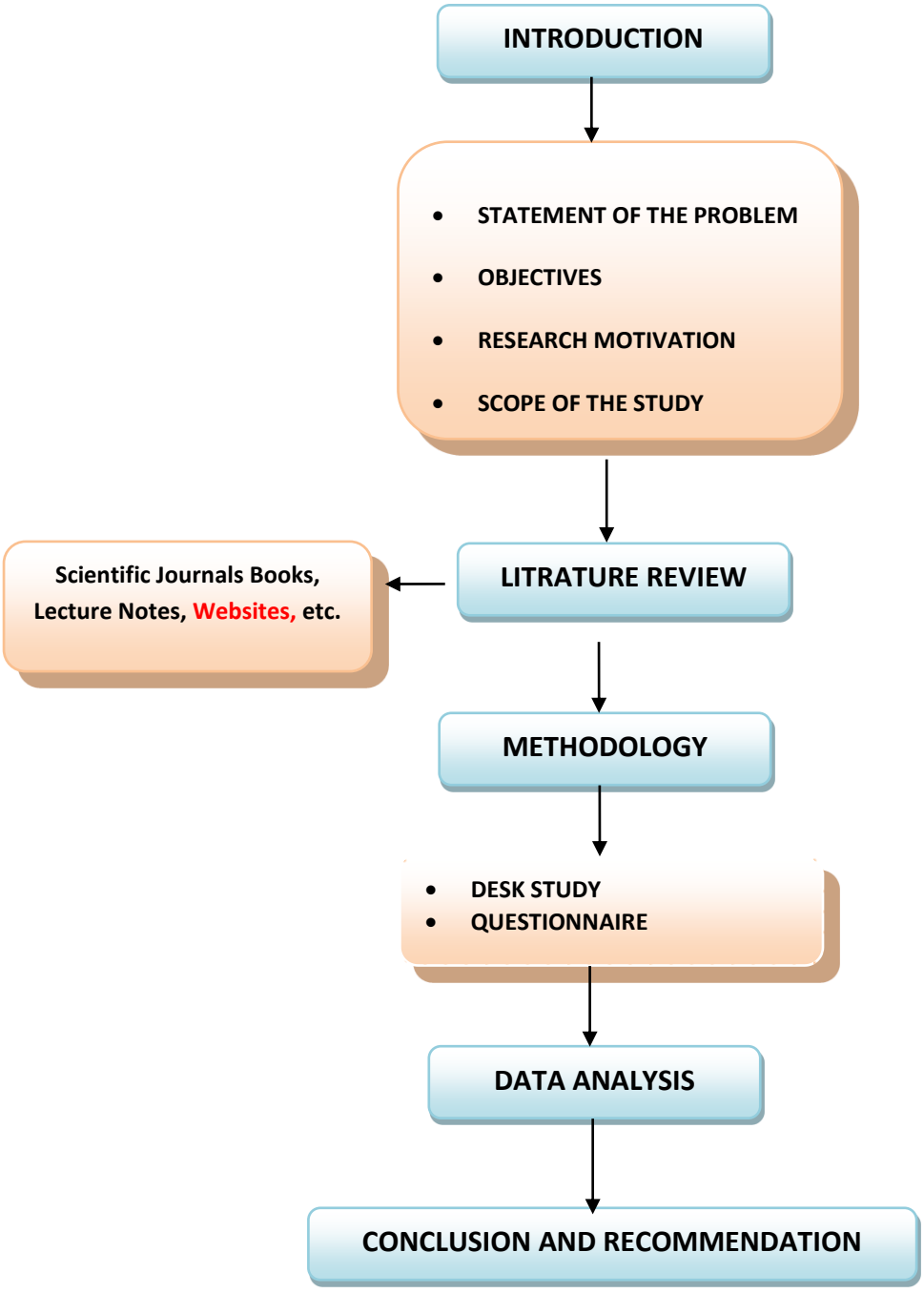

Figure 1.1: Outline of the Thesis

CHAPTER 2: LITERATURE REVIEW

2.1. General

Construction project is a mission, undertaken to create a unique facility, product or service within the specified scope, quality, time, and cost. Cost overrun, poor quality workmanship and delay of construction projects require an in-depth investigation to improve the outputs of the construction industry (Chitkara, 2003).

It is not uncommon to see construction projects failing to achieve their mission of creating facilities within the specified cost and time (Cox, et al., 2002). Hardly, few projects get completed on time and within budget since construction projects are exposed to uncertain environments because of such factors as construction complexity; presence of various interest groups such as the project owners, end users, consultants, contractors, financiers, materials, equipment, project funding; climatic environment; the economic and political environment and statutory regulations.

The successful execution of construction projects, keeping them within estimated cost and the prescribed schedules, primarily depends on the existence of an efficient construction sector capable of sustaining growth and development in order to cope with the requirements of social and economic development and to utilize the latest technology in planning and execution.

Supply Chain Management (SCM) techniques have been successfully used in various industries such as food and manufacturing for decades. The supply chain in these industries encompasses all the activities associated with all processes: from raw materials to completion of the end product. This includes procurement, production scheduling, order processing, inventory management, transport, storage, customer service and all the necessary supporting information systems. It is usually an ongoing process focused upon specific products, which are repeatedly manufactured or purchased (Chritopher, 1992).

Supply chain management consists of a stable group of interacting partners with a mutual interest in improving product quality and process efficiency. SCM strategies, as they are adopted in the manufacturing industries, assume an ongoing process where supplier and customer experience involves frequent transactions for the same or similar products (Harland, 1994). They are seen as a key to maintaining quality and facilitating innovation and measurable improvement. To a large

extent, their success depends upon a long-term shared culture, both within and outside a particular organization.

Construction Supply chain management comprised of the network of organization involved in the different processes and activities which produce the material, components and services that come together to design, procurement and deliver a building. It also consists of different organizations involved in the construction process including client/owner, designer, contractor, subcontractor and suppliers (Cox, et al., 1997).

2.1.1. Emergence of Supply Chain Management

SCM, as a term, first appeared in the early 1980s to describe: 'the range of activities co-ordinated by an organization to procure and manage'. SCM is a concept originating from the supply system used by Toyota to coordinate its supplies and reduce its inventory (Womack, et al., 1990). After its emergence in the Japanese automotive industry as part of a production system, the concept of SCM has been evolved as an industrial management theory and a distinctive subject of scientific research (Bechtel, et al., 1997; Cooper, et al., 1997).

It was indicated that the evolution of SCM theory is driven by rapid changes in global business practice (Harland, 1996). They argued that the worldwide recession of the late 1980s and early 1990s forced companies to re-examine, at a strategic level, the ways in which they aimed to add value and reduce costs throughout their business. Initially, the term referred to an internal focus bounded by a single organization and how that organization sourced and procured supplies, managed their internal inventory and moved goods onto its customers. It was recognized that this understanding was inadequate and that the reality of managing supplies meant that supply chains extended beyond the purchasing organization and into its successive lower tiers - suppliers and their suppliers' suppliers (Christopher, 2005).

SCM and other similar terms, such as network sourcing, value chain management and value stream management have become the subject of increasing interest after the 1990s (Christopher, 1998; Hines, 1994; Lamming, et al., 1996; Saunders, 1995). SCM has been labeled as the single most wide-ranging approach when considering how organizations utilize their suppliers' processes, technology and capability to enhance competitive advantage (Houlihan, 1985; Cooper, 1993; DTI, 1995). The interest in SCM is growing due to the ever-increasing market

competition and declining incidence of vertical integration as a result of which efficiency and innovation can no longer be solely an internal management function (Lummus, et al., 1998).

SCM, as an area of study, is a recent phenomenon and yet is clearly related to logistics. It is a common notion that logistics involves the movement of physical goods from one location to another. As long ago as the construction of the great pyramids, man was concerned with how to move materials to a construction site. Human migration from Europe to the Americas is another example of significant logistical challenges. The term logistics was originally first used in the military environment. The study of logistics received much attention from the armed forces during both World Wars. The Second World War necessitated greater movement of troops and supplies than any other period in history; logistics proved a crucial factor in its outcome and indeed the success or failure of many military conflicts. After the war, logistical concepts were given more attention in the business world as described in figure 2.1 (Christopher, 2005).

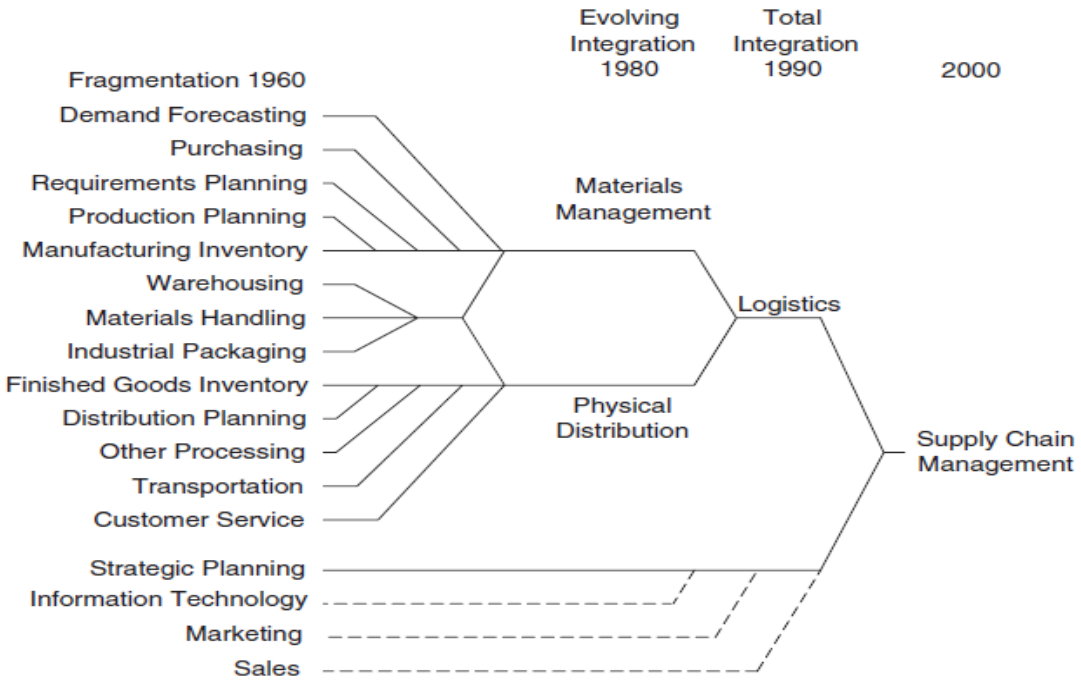

Figure 2.1: Logistics evolution to SCM

The terms ‘SCM’ and ‘logistics’ are often confused and viewed as overlapping, depending on the definition used by an organization. There is confusion and disagreement among general business practitioners and operations professionals regarding the terms logistics and SCM (Lummus, et

al., 2001). Various formal definitions have been offered for both terms. With the increased interest in SCM, several authors have discussed the differences between this newer term (SCM) and logistics. It was stated that an understanding of SCM is not appreciably different from the understanding of integrated logistics management (Cooper, et al., 1997). However, logistics can be thought of as a planning orientation and framework that seeks to create a single plan for the flow of product and information through a business. SCM builds upon this framework and seeks to achieve linkage and co-ordination between the processes of other entities in the pipeline, that is suppliers and customers and client's organization (Christopher, 2005).

2.1.2. Definition of Supply Chain Management

Supply chain management is defined by different practitioners and researchers depending on the background where they come from. Generally, the following definitions can be used as a working definition of supply chain and supply chain management.

Supply chain is defined as the sequence of events that cover a product's entire life cycle, from the conception to consumption (Blanchard, 2010). These days companies are not only competing as autonomous entities instead they entered into an era of competing among different supply chains, leading them to work as a team in the formed network of business relationship (Lambert, et al., 2000).

Various definitions of a supply chain have been offered in the past as the concept has gained popularity. Many definitions describe SCM as the chain linking each element of the manufacturing and supply process from raw materials to end users, encompassing several organizational boundaries. This is well summarized as:

'The management of upstream and downstream relationships with suppliers and customers to deliver superior customer value at less cost to the supply chain as a whole.' (Chritopher, 1992)

Many authors have emphasized the need for clearly defined conceptual frameworks of SCM (Cooper, et al., 1997; Saunders, 1998; Babbar, et al., 1998; New, 1995). Another scholar defined SCM as the process of strategically managing the movement and storage (if necessary) of materials, parts and finished products from suppliers, through the manufacturing process and onto customers or end-users, as well as the associated information flows (Yeo, et al., 2002). A

simple definition provided in the Handbook of Supply Chain Management is that SCM is about the design, maintenance and operation of supply chain processes for the satisfaction of end-users' needs (Ayers, 2006). However, the most widely used definition is:

"The supply chain encompasses all activities associated with the flow and transformation of goods from raw materials stage (extraction), through to the end user, as well as the associated information flows. Materials and information flow both up and down the supply chain. Supply chain management (SCM) is the integration of these activities through improved supply chain relationships, to achieve a sustainable competitive advantage. (Handfield, et al., 1999)".

In summary, key words in typical definitions of SCM include: network, integrative, channel, upstream, downstream linkages, ultimate user and value. These definitions link SCM with the integration of systems and processes within and between organizations, including the upstream suppliers and downstream customers and involving methods of reducing waste and adding value across the entire process. It also emphasizes the importance of effective linkages among the activities in the value chain (Porter, 1985):

2.1.3. Concept of Supply Chain Management

A supply chain is 'the network of organization that are involved through upstream and downstream linkages, in the different processes and activities that produce value in the form of products services in the hands of the ultimate consumer' (Chritopher, 1992). Moreover, Christopher defines the objective of SCM in a relative manner as delivering superior value at less cost.

In order to reflect the fact that there will normally be multiple suppliers, and suppliers to those suppliers, as well as multiple customers, and customers' customers, to be included in the total system, Christopher argues that the word 'chain' should be replaced by 'network' (Christopher, 2005). He also argues that since the chain should be driven by the market, not by the suppliers, the phrase SCM should be termed demand chain management.

It can be argued that SCM is not just another name for logistics. SCM goes further and includes elements that are not typically included in a definition of logistics, such as information systems as well as the integration and coordination of planning and control activities. As logistics primarily deals with the flows to, in and out of companies, with an intra-organizational

perspective, SCM is a development that deals with the inter-organizational view of logistics alongside the intra-organizational perspective.

The concept of SCM is based on the notion that supply chains rather than single business units are competing with each other (Geir et al. 2006). In part, the concept of SCM represents a logical continuation of previous management development principles such as Total Quality Management (TQM), Business Process Reengineering (BPR) and Just in Time (JIT). Some argue that SCM is combining the particular features of these three techniques (Van der Veen J., 1997).

A four-stage supply chain classification is described by (Harland, 1996), outlining four main uses for the term SCM.

- The internal supply chain integrates business functions involved in the flow of materials and information from the inbound to outbound ends of the business.
- The management of a dyadic, or two-party, relationship with immediate suppliers.
- The management of a chain of businesses including a supplier, a supplier's supplier, a customer and a customer's customer and so on.
- The management of a network of interconnected businesses involved in the ultimate provision of product and service packages required by end customers.

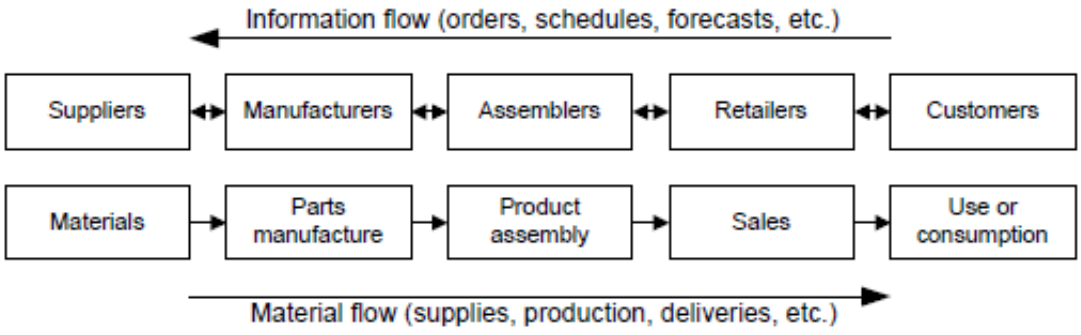

Figure 2.2: Generic configuration of a supply chain in manufacturing

SCM looks across the entire supply chain as described in Figure 2.2, 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, et al.,

1993). According to some authors, the shift from traditional ways of managing the supply chain towards SCM includes various elements as shown in Table 2.1 (Cooper, et al., 1993).

There is a difference between the concept of supply chain management and the traditional concept of logistics. Logistics typically refers to activities that occur within the boundaries of a single organization and supply chains refer to networks of companies that work together and coordinate their actions to deliver a product to market. Also traditional logistics focuses its attention on activities such as procurement, distribution, maintenance, and inventory management. Supply chain management acknowledges all of traditional logistics and also includes activities such as marketing, new product development, finance, and customer service (Vrijhoef, et al., 1999).

Table 2.1 Traditional ways of managing the supply chain and SCM

Element	**Traditional Management**	**Supply Chain Management**
Inventory management approach	Independent efforts	Joint reduction of channel inventories
Total cost approach	Minimizes firm's costs	Channel wide cost efficiencies
Time horizon	Short term	Long term
Amount of information sharing and monitoring	Limited needs of current transaction	As required for planning and monitoring processes
Amount of coordination of multiple levels in the channel	Single contact for 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 suppliers base	Large to increase completion 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 level	'Ware house' 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

In summary, the literature has identified that SCM entails something more than logistics management. It concerns different levels of analysis – chain and network – and involves the exchange of assets, information and knowledge between companies that are interlinked in the provision of goods or services. This process ranges from inception to final consumption and includes the management of inter-organizational relationships that are developed between these companies.

Owing to the unique characteristics of the construction industry, it has been argued that management techniques and principles, such as SCM, applied to other product producing industries, such as the manufacturing industry, often need to be modified before they are applied to the construction industry; otherwise their effectiveness is very limited.

2.1.4. Integration of Supply Chain Management Processes

Increasingly, supply chain management is being recognized as the management of key business processes across the network of organizations that comprise the supply chain. While many have recognized the benefits of a process approach to managing the business and the supply chain, most are vague about what processes are to be considered, what sub-processes and activities are contained in each process, and how the processes interact with each other and with the traditional functional silos.

The Global Supply Chain Forum identified eight key processes that make up the core of supply chain management (Cooper, et al., 1997):

- Customer Relationship Management: the structure for how the relationship with the customer is developed and maintained.
- Customer Service Management: the single source of customer information, such as product availability, shipping dates and order status.
- Demand Management: includes forecasting demand and synchronizing it with production, procurement, and distribution.
- Order Fulfillment: integration of the firm's manufacturing, logistics and marketing plans.
- Manufacturing Flow Management: deals with making the products and establishing the manufacturing flexibility needed to serve the target markets.

- Procurement (Supplier Relationship Management): defines how a company interacts with its suppliers.
- Product Development and Commercialization; developing new products quickly and getting them to the marketplace in an efficient manner is a major component of corporate success.
- Returns: identifying productivity improvement opportunities and breakthrough projects.

The eight key business processes run the length of the supply chain and cut across firms and functional silos within each firm (Figure 2.3). Functional silos include Marketing, Research and Development, Finance, Production, Purchasing and Logistics. Activities in these processes reside inside a functional silo, but an entire process will not be contained within one function.

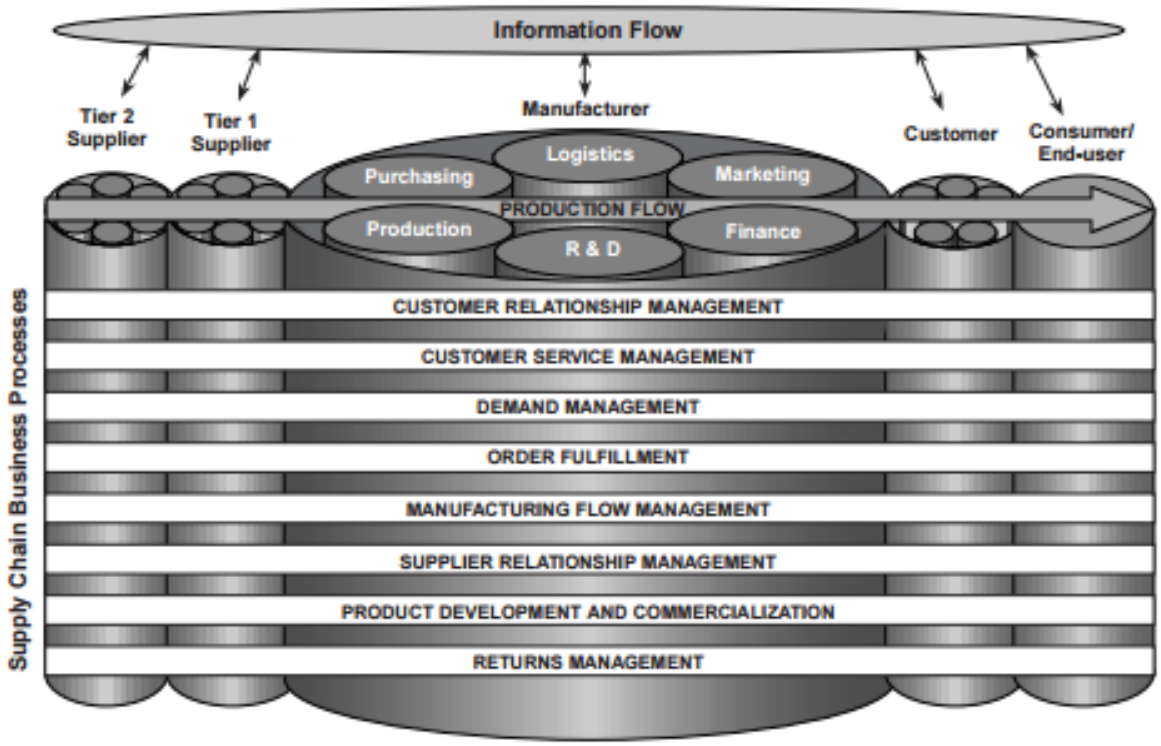

Figure 2.3 Integrating and managing business processes across the supply chain

While management of all firms in each supply chain should consider these eight processes, the relative importance of each process and the specific activities included may vary. The sub processes and activities described are designed from the perspective of a manufacturing company sitting near the middle of the supply chain (Figure 2.3).

2.1.5. Objectives and Benefits of SCM

The objective of supply chain management is to satisfy the requirement of the end customer (Chiderhouse, et al., 2000). As the essence of supply chain management is a pull system and starts from the customer, the role and involvement level would lead in the end to the satisfaction of the customers.

These days, customers are demanding enough due to the level of the awareness created. They expect for lower prices, better quality, shorter lead times on deliveries and increased reliability (Verwaal, et al., 2004)

Generally, an effective and coordinated supply chain management enables companies to lower inventory level, delivery lead times and costs. It also enables them to provide goods and services in a good and reliable quality. As integration and coordination among the member of the supply chain is strategically seen to serve the end consumer better, they would be in a position to proactively strive for changes and innovation where at the end of the day, both would be involved in a position to secure a customer satisfaction.

2.2. Supply Chain Management in Construction

It is not uncommon to hear that the construction industry is different to other industries and must find other solutions and concepts for improving performance and efficiency. It is customary to view that there are certain peculiarities of construction, like one-of-a kind products, temporary organization, and site production, preventing the attainment of flows as efficient as in manufacturing (Koskela, 1992). As an example the principal construction company that manages a construction project mostly executes only a small part of the “product” by its own personnel and its own production facilities. The great part, approximately 75 percent and more, of the product’s value is built with help from suppliers and subcontractors (Dubois, et al., 2002). It is often believed that advances in construction are related to the elimination of these peculiarities, like site production by means of industrialization or one-of-a-kind products by means of pre-engineering.

The idea of construction SCM emerged as a result of the actual circumstance of the construction industry. Many researchers consider that the construction industry nowadays is highly fragmented and this could lead to significant negative impacts, low productivity, cost and time overruns conflicts and disputes, resulting in claims and time-consuming litigation (Latham, 1994; Egan, 1998). To overcome industry fragmentation, there has been a growing recognition that it is important to integrate the various disciplines/participants in a construction project, and this includes aspects of integrating all the members of the supply chain (Anumba, et al., 2002)

The need for significant improvements in the project performance and in profits gradually emerged also in construction (O'Brien, et al., 2000; Bankvall, et al., 2010) suggesting changing methods in managing the supply chain (Agapiou, 1998). However, SCM initiatives have not made the breakthrough in construction industry yet, as the attempts to replicate the benefits obtained by supply chains in other industries still testify a lack of effectiveness and a partial and slow implementation (Akintoye, et al., 2000; Love, et al., 2004; Lo¨nngren, et al., 2010). Practitioners have in fact realized partial/fragmented application, focusing on different areas/objectives depending on specific circumstances: sometimes they focused on the supply chain, other times on the construction site, others again on both of them (Vrijhoef, et al., 2000).

There is a view that collaborative relationships that go unmanaged result in rising costs to clients and that SCM is the means through which improvements in value and reductions in costs can be achieved.

The SCM concept has the potential, through information and communication technologies, to overcome some of the fragmentation problems. It has a critical role to play in improving the overall performance of construction, but its application remains at a very early stage of development (Saad, et al., 2002). However, the industry is becoming increasingly aware of the necessity to change the current working practices and the attitudes they represent (Pearson, 1999; Pryke, 2009).

In terms of structure and function, the construction supply chain (CSCM) 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.
- Construction supply chain management is more concerned with the coordination of discrete quantities of materials (and associated specialized engineering services) are delivered to specific construction projects. Construction supply chain (CSC) embodies all construction processes, which starts at the initial demands by the client/owner, to design and construction, maintenance, replacement and eventual demolition of the projects. It also consists of different organizations involved in the construction process, including client/owner, designer, contractor, subcontractor, and suppliers.
- Most construction projects today struggle with the same problems that have faced the industry such as no centralized source of information and resource management, multiple parties involved on each project - resulting in constantly changing people and companies on each job-site, multiple projects occurring simultaneously - resulting in redundant and costly duplication of processes and activities; and multiple Customers - even different departments within the same organization can result in different rules being enforced on each project - resulting in higher management and administrative costs.

To balance improvements in costs and product quality with adequate delivery times, many companies, particularly in the manufacturing industry, have found it necessary to integrate areas of activity such as engineering, purchasing, operations and logistics – in other words, internal integration (Chritopher, 1992). Companies have since been forced to become even more competitive and extend this integration beyond their boundaries – external integration – giving rise to the concept of SCM (Christopher, 2005). SCM aims at improving both efficiency and effectiveness by extending traditional functional and intra-organizational activities (Tan, et al., 1998). Members of the SC can attain sustainable competitive advantages by developing much

closer relationships with all other members, thus allowing for significant reductions in time expenditure and costs and increases in quality, provided, although, that there is proper management of the SC and the customer needs are adequately served. Successful SCM is crucial to strengthening the competitive edge of companies in competitive environments (Kumar, et al., 2006).

The customer–contractor relationship is regarded as the main relationship in the CSC, linking the entities involved in a project together into one SC (Love, et al., 2004). This relationship is central to construction supply chain management and, as a consequence, the relationships change from one CSC to another as customers change (Saad, et al., 2002; Fernie, et al., 2007). However, it is also important to pay attention to relationships upstream of the construction site, i.e. between contractors and their sub-contractors and suppliers (Dainty, et al., 2001; Humphreys, et al., 2003; Bankvall, et al., 2010). It is also argued that a change in the management of relationships among customers, contractors, sub-contractors and suppliers is compulsory to improve the effectiveness and efficiency of CSC (Fearne, et al., 2006).

SCM application has particularly found obstacles in construction sector as a consequence of its particular context of "temporary multiple organization" (Cheng, et al., 2010) and because of the difficulties in managing networks of a large number of different companies, supplying materials, components and multiple services and with adversarial relationships (Briscoe, et al., 2001; Saad, et al., 2003). It was stated that the existing manufacturing research in SCM, although useful, cannot be directly applied to a construction environment; because of the transient nature of production in construction projects (O'Brien, 1995). Although effective SCM is a key element in reducing construction costs, it is noted that very few studies have defined what SCM means within the construction process (Davis, 2008; Atkin, et al., 1995; Crespin-Mazet, et al., 2007). For this reason, CSCM is defined as:

"It is the coordination and the integration of key construction business both processes and members involved in CSC, extending traditional intra-enterprise activities in a management philosophy by bringing together partners who have the common goals of optimization and efficiency so establishing long-term, win/win, and cooperative relationships between stakeholders in a systemic perspective."

The CSC is not a real chain 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 (Xue, et al., 2007). Construction is a multi-organization process, which involves client/owner, designer, contractor, supplier, consultant, and so on. It is also a multi-stage process, which includes conceptual activities, design, construction, maintenance, replacement, and decommission. At first it was proposed an alternative SCM networked structure, to substitute the traditional vertical one, in order to support partnering (Xue, et al., 2007; Karim, et al., 1995). This proposal seems to better fit the peculiarities of construction SC and align with the context of our discussion as presented in Figure 2.4.

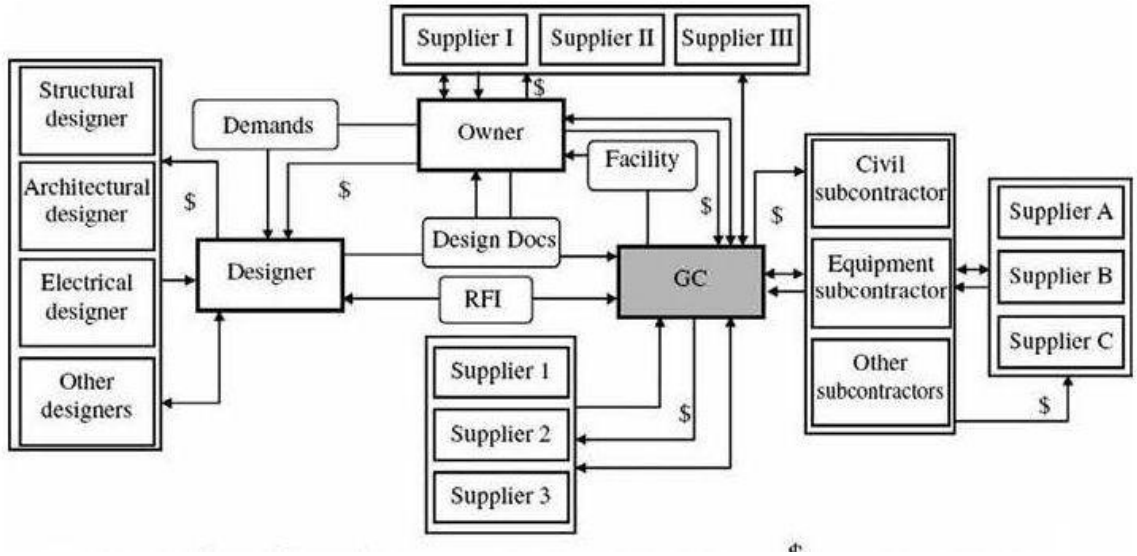

Figure 2.4 Construction supply network

2.3. SCM in Construction and Manufacturing Industry

The construction site is effectively a factory that temporarily creates a prototype product (Cox, et al., 1998). The same as for the development of SCM in the manufacturing industry, the problems existing in the manufacturing industry also emerge during the application of construction SCM. These problems include (Palaneeswaran, et al., 2003):

- Adversarial relationships between clients and contractors;
- Inadequate recognition of the sharing of risks and benefits;

- Fragmented approaches; narrow minded "win/lose" attitudes and short-term focus;
- Power domination and frequent contractual non-commitments resulting in
- Adverse performance track records with poor quality, conflicts, disputes and claims;
- Prime focus on bid prices (with inadequate focus on life-cycle costs and ultimate value);
- Less transparency coupled with inadequate information exchanges and limited communications;
- Minimal or no direct interactions that foster sustainable long-term relationships.

Despite facing similar problems, there are some differences between CSC and SC in the manufacturing industry. Several researchers have investigated the differences and opportunities of using manufacturing SC concepts in construction (Table 2.2) (Vaidyanathan, et al., 2003; Green, et al., 2005; London, et al., 2001).

Table 2.2 The differences between Manufacturing SCs and Construction SCs

Characteristics	**Manufacturing SCs**	**Construction SCs**
Structure	Highly consolidated	Highly fragmented
	High Barriers to entry	Low barriers to entry
	Fixed locations	Transient location
	High Interdependency	Low interdependency
	Predominantly global markets	Predominantly local market
Information flow	Highly integrated	Recreated several times between trades
	Highly shared	Lack of sharing across firms
	Fast	Slow
	SCM tools: factory planning and scheduling, procurement, SC planning	Lack of IT tools to support SC (not real data and work flow integration)
Collaboration	Long term relationship, shared benefits, incentives	Adversarial practices
Production demand	Very uncertain(seasonality, completion, innovation, etc)	Less uncertain (the amount of material is known somewhat in advance
Production variability	Highly automated environment (machines robots), standardization production routes are define lower variability	Labor variability and productivity , tools, open environment (weather), lack of standardization and tolerance management, space

Characteristics	Manufacturing SCs	Construction SCs
		availability, material and trade flows are complex – higher variability
buffering	Inventory models (safety inventory, etc.)	No models – inventory on site to reduce risks, use of floats (scheduling)
Capacity planning	Aggregate planning optimization models	Interdependent planning, infinite capacity assumptions, reactive approach (respond to unexpected situations, for example overtime)

The differences between CSC with SC in the manufacturing industry make the SCM technology which was useful in the manufacturing industry difficult to be applied directly in the construction domain. More efforts have to be made to derive suitable and effective methods to improve the application of SCM in construction practice.

Despite the positive results achieved by the manufacturing industries, the construction industry has been slower to implement SCM practices (Vrijhoef, et al., 2000; Akintoye, et al., 2000). Indeed, the characteristics of the CSC conflict with the implementation of long-standing and efficient supplier–subcontractor– contractor relationships, which are the cornerstone for the adoption of SCM practices (Kornelius, et al., 1998). Actually, some argue that if the construction industry is to successfully replicate the SCM practices of the manufacturing sector, this will call for "careful translation" (Skitmore, et al., 2009).

2.4. Approaches of Supply Chain Management in Construction

Construction industry is characterized by its own distinctive features, which can heavily affect SCM application. They can be summarized as follows:

- Production systems: Construction is a typical project production industry operating within an environment of considerable complexity and uncertainty (Fearne, et al., 2006).
- Customer influence: Customers wields great influence on the final product in relation to its physical aspects and to the value of logistic parameters (Kornelius, et al., 1998; Pesa¨maa, et al., 2009)

- Fragmentation: It refers to market fragmentation, as well process fragmentation (Baiden, et al., 2006)
- Number and type of stakeholders: The main subjects include: owners, designers, contractors and suppliers. However, a typical network involves multiple organizations and relationships, including the flow of information, the flow of materials, services and products, and the flow of funds between client, designer, contractor and supplier (Xue, et al., 2007).
- Buyer-supplier relationship: This is mostly of transactional nature, strained by conflict and mistrust (Lu, et al., 2007; Miller, et al., 2002). Moreover, it is widely known, especially among public sector clients, that in construction a tender price is the most significant parameter used for a bid evaluation. This focus on price is the main reason for project delivery problems (Hatush, et al., 1998; Hartmann, et al., 2010)
- Temporary configuration: Production at a temporary site by a temporary organization (Cheng, et al., 2010; Love, et al., 2002) leads to relationships focused on the short-term thinking, with actors attempting to leverage what they can out of the existing contract, resulting in an environment where opportunism reigns (Cox, et al., 1997; Kamann, et al., 2006).
- Change inertia: Construction organizations tend to be conservative referring to the need to change, because of the risks associated with the procurement of projects (Cheng, 2001; Love, et al., 2002; Kumaraswamy, 2005).

The characteristics discussed above have an impact on the management of supply chains. As described in the figure 2.5 below, four major roles of SCM in construction can be recognized, dependent on whether the focus is on the supply chain, the construction site, or both (ITcon, 2007. They are:

- 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.

- 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.
- 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.
- 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.

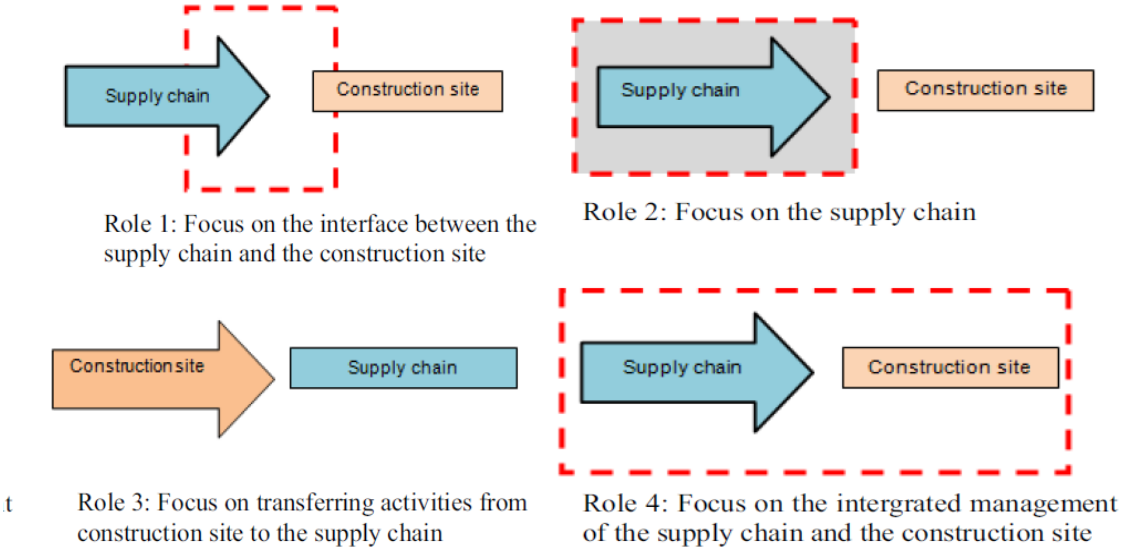

Figure 2.5 The four roles of supply chain management in construction

Effective supply chain management requires simultaneous improvements in both customer service levels and the internal operating efficiencies of the companies in the supply chain. Customer service at its most basic level means consistently high order fill rates, high on-time delivery rates, and a very low rate of products returned by customers for whatever reason. Internal efficiency for organizations in a supply chain means that these organizations get an attractive rate of return on their investments in inventory and other assets and those they find ways to lower their operating and sales expenses.

There is a basic pattern to the practice of supply chain management. Each supply chain has its own unique set of market demands and operating challenges and yet the issues remain essentially the same in every case. Companies in any supply chain must make decisions individually and collectively regarding their actions in five areas (Johnston, H.R., and Vitale, M.R. 1988):

1) **Production**—What products does the market want? How much of which products should be produced and by when? This activity includes the creation of master production schedules that take into account plant capacities, workload balancing, quality control, and equipment maintenance.
2) **Inventory**—What inventory should be stocked at each stage in a supply chain? How much inventory should be held as raw materials, semi-finished, or finished goods? The primary purpose of inventory is to act as a buffer against uncertainty in the supply chain. However, holding inventory can be expensive, so what are the optimal inventory levels and reorder points?
3) **Location**—Where should facilities for production and inventory storage be located? Where are the most cost efficient locations for production and for storage of inventory? Should existing facilities be used or new ones built? Once these decisions are made they determine the possible paths available for product to flow through for delivery to the final consumer.
4) **Transportation**—How should inventory be moved from one supply chain location to another? Air freight and truck delivery are generally fast and reliable but they are expensive. Shipping by sea or rail is much less expensive but usually involves longer transit times and more uncertainty. This uncertainty must be compensated for by stocking higher levels of inventory. When is it better to use which mode of transportation?
5) **Information**—How much data should be collected and how much information should be shared? Timely and accurate information holds the promise of better coordination and better decision making. With good information, people can make effective decisions about what to produce and how much, about where to locate inventory and how best to transport it.

The sum of these decisions will define the capabilities and effectiveness of a company's supply chain. The things a company can do and the ways that it can compete in its markets are all very

much dependent on the effectiveness of its supply chain. If a company's strategy is to serve a mass market and compete on the basis of price, it had better have a supply chain that is optimized for low cost. If a company's strategy is to serve a market segment and compete on the basis of customer service and convenience, it had better have a supply chain optimized for responsiveness. Who a company is and what it can do is shaped by its supply chain and by the markets it serves.

2.5. Challenges of the Construction Supply Chains

There are substantial difficulties in applying SCM in the construction industry (Saad, et al., 2002). Factors such as short-termism, lack of trust and adversarial relationships, the transient nature of construction projects and the considerable number of infrequent clients were highlighted as the main problems associated with the implementation of SCM in construction. This section will address the main challenges associated with adopting SCM in the construction industry.

Customer focus, SCM may well help improve the construction industry with its poor relationships, fragmented processes and lack of internal and external customer focus. However, there remain a number of critical issues within the construction industry that need to be considered and rectified. A long list of problems could be itemized, including lack of trust and commitment, co-ordination problems and training problems, all of which are already well documented by reports (Latham, 1994; Egan, 1998). Consequently, scope for implementing SCM within construction could be limited (Saad, et al., 2003).

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, among which the following are few of them (Vrijhoef R., 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,
- Suppliers/subcontractors interface and suppliers/site interface: deliveries not in conformance with planning, wrong and defective deliveries, long storage period, awkward packing, large shipments,
- Subcontractors/site interface: subcontracted work not delivered according to main design, contract and planning,
- Site/completion of building interface: problematic completion due to quality problems,
- Completion of building/occupation interface: unresolved quality problems, delayed occupation due to late completion,

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. Here, the term "supply chain" refers to the stages through which construction materials factually proceed before having become a permanent part of the building or other facility. It covers thus both permanent supply chains, which exist independently of any particular project, and temporary supply chains, configured for a particular project.

2.6. Construction Materials Management on Construction Projects

Materials management in construction projects is a key function that significantly contributes to the success of a project. The management of materials in construction projects is made challenging by materials shortages, delays in supply, price fluctuations, damage and wastage, and lack of storage space. Materials management is a vital function for improving productivity in construction projects.

The management of materials should consider at all the phases of the construction process and throughout the construction and production periods. This is because poor materials management can often affect the overall construction time, quality and budget. The importance for planning and controlling of materials to ensure that the right quality and quantity of materials and installed equipment are appropriately specified in a timely manner, obtained at a reasonable cost, and are available when needed. Many construction projects apply manual methods, not only for the tracking of materials, but also for materials management as a whole and this involves paper-based techniques and is problematic with many human errors (Narimah Kasim, 2013).

Table 2.3 Sources and causes of construction site material management problems

	Factor
Design	Changes made to the design while construction is in progress
	Lack of attention paid to standard sizes available on the market
	Designer's unfamiliarity with alternative products
	Complexity of detailing in the drawings
	Incomplete contract documents at commencement of project
	Selection of low quality products
Operational	Errors by tradespersons or laborers
	Damage to work done caused by subsequent trades
	Use of incorrect material, thus requiring replacements
	Required quantity unclear due to improper planning
	Delays in passing of information to the contractor on types and sizes of products to be used
Material Handling	Damages during transportation
	Inappropriate storage leading to damage or deterioration
	Material supplied in loss form
	Use of materials which are close to working place
	Unfriendly attitudes of project team and laborers
Procurement	Ordering errors
	Lack of possibilities to order small quantities
	Purchase products that do not comply with specification

Managing and Minimizing Wastage of materials on construction projects Construction Material wastage has been recognized as a major problem in the construction industry that has important implications both for the efficiency industry and for the environmental impact of construction projects. Moreover, waste measurement plays an important role in the management of production systems since it is an effective way to assess their performance, allowing areas of potential improvement to be pointed out (Carlos Torres Formoso, 2002).

Table 2.4 Methods for Materials managing and Minimization

No.	Methods of material management
1.	Purchasing raw materials that are just sufficient
2.	Good coordination between store and construction personnel to avoid over ordering
3.	Adoption of proper site management techniques
4.	Training of construction personnel
5.	Accurate and good specifications of materials to avoid wrong ordering
6.	Checking materials supplied or right quantities and volumes
7.	Employment of skilled laborers
8.	Minimizing design changes
9.	Change of attitude of workers towards the handling of materials
10.	Accurate measurements of materials during batching
11.	Access to latest information about types of materials on the market
12.	Vigilance of supervisors
13.	Careful handling of tools and equipment on site
14.	Good construction management practice
15.	Adherence to standardization

2.7. Construction Supply Management in Different Countries of the World

2.7.1. Construction Supply Chain Management in Malaysia

Malaysian construction supply chain management involves the management of activities in the chain to ensure best value for the customer and to achieve a sustainable competitive advantage. With the increment of competition and technology it allows many firms transform to supply

chain management as a central part of strategic competence, which is believed would be able to create competitive advantage (Othman .A.A and Abd. Rahman, 2010).

In practice, SCM is applied to prevent issues about abandoned projects and delays. This issues will cause the customer lose the project and project management that are not consistent with plans made before the start of construction is called a real plan only after the contractor gets the Letter of Acceptance. Besides that, practicing the SCM in construction site can be achieved an integrated supply chain for building and facility standards.

2.7.2. Construction Supply Chain Management in Portugal

In Portugal, a framework was developed to automate the tendering, ordering, delivery, invoicing and payment processes of prefabricated house systems, equipment and services in its supply chain, whose members have different levels regarding information and communication technologies (Jardim-Gonclaves et al, 2000). This framework, together with an EDI communication infrastructure based on an inter-organizational workflow system, enables a better coordination between the supply chain partners, from the client, through to the contractor and suppliers. The developed tool coordinates the business and management information flows among participants in the various stages of the process of building prefabricated houses..

The construction industry is an important driving force behind many national economies. The present economic crisis has presented Portuguese construction companies with an opportunity to closely examine SCM practices and consider them as a means of becoming more competitive. Larger-sized companies, which normally take on the role of contractors and are capable of influencing and structuring the CSC, are the target of the survey conducted in different researches.

Results show, with respect to construction SCM issues, that:

- A high percentage of contractors have a SCM strategy and, interestingly, all internationalized contractors also have a SCM strategy in place;
- The level of awareness of construction SCM is low;
- The overall perception of the construction SCM integration level is positive and increases with the size of contractor; and

- The performance assessment transparency increases with the size of contractor.

2.7.3. Supply Chain Management in the UK Construction Industry

There is growing interest among major clients and contractors in the UK construction industry in developing collaborative relationships. So far these efforts have not been very successful, although, "the search for more collaborative relationships has become a contemporary theme in the industry" (Cox, et al., 1997). SCM is considered as having replaced partnering as the latest buzzword of the UK construction industry (Pearson, 1999). He reports that a few major clients and contractors use SCM.

They are also involving suppliers in projects at an early stage, and managing them more effectively, for example, organizing structured development programs for them. Hence, contractors can reduce projects' contingency budgets; and suppliers are able to respond and adapt to the contractor's short- and long-term plans.

In a study, contractors' opinions were surveyed because of their pivotal role in the construction supply chain (Akintoye, et al., 2000). The study reveals that contractors are more oriented towards clients rather than their product suppliers in the supply chain. Contractors seem to have more arrangements with clients than with suppliers and a higher proportion of the relationships with clients are contractual. Due to the aggressive business mentality of the industry and the non-trusting climate, contractors have the tendencies to pay more attention to clients who provide their workload (Akintoye, et al., 2000). Finally, the survey highlights that problems in implementing successful SCM within the UK construction industry are at present associated with an inappropriate traditional business culture and the unique individual features of the organizational structure.

There are a number of problems within UK construction that might arguably be addressed through the use of SCM (Mortledge, et al., 2006). These are:

- Fragmentation
- Adversarial relationships
- Project uniqueness
- Separation of design and production

- Competitive tendering.

There is a now a substantial literature which acknowledges that a major part of the formula for the successful reform of the UK construction industry is the greater involvement of contractors at an early stage in the decision to build. Two UK Government sponsored reports, addressing barriers to efficiency, seek major reform in UK procurement methods and give the potential of supply chain management (SCM) particular relevance at this time (Egan, 1998; Latham, 1994),.

2.7.4. Supply Chain Management in the North America Construction Industry

Since 1999, Virtual Construction Group, Arup Computing and Arup Project Management have been investigating, analyzing and developing new systems that can enhance quality, quantity and speed of project information needed to perform construction tasks (Hudgins and Chang, 2000).

Ove Arup and Partners developed a Web-based Project Extranet Site (a website that allows controlled access to partners, vendors and suppliers or an authorized set of customers - normally to a subset of the information accessible from an organization's intranet) to be used as a communication and document-handling tool for their global operations. The Site streamlines the movement of information between all organizations involved on the project, wherever they may be, enhancing productivity and achieving cost savings through increased access, organization and exchange of project information. Over 20 different project sites, within the Arup Partnership, have successfully adopted the Project Extranet Site (Hudgins and Chang, 2000).

In Canada, a Web-based communications framework was developed to operate as a document information center for project participants (Hammad and Alkass, 2000). This framework, entitled the Construction Project Document Information (CPDI) Center, offers a search facility as an integral part of other services such as document storage, retrieval, and general project information. It is also adaptable to any project organization or delivery method, and works for a single-site project as well as geographically dispersed projects.

2.7.5. Supply Chain Management in the Ethiopia Construction Industry

SCM exists in the form of a chain at a high level of abstraction and it is the networks of relationships that provide us with the detail and analysis that we need to fully understand the

operation of the supply chains. Yet the mission statement associated with the recognition of the importance of supply chains and their management is significant. The management of those relationships, using a supply chain approach (in another words escaping from the management of those firms in direct contractual relationships with the other firm) improves knowledge for academe and practice, thus contributing to the management of projects in construction.

According to the overall challenges of supply chain management, one can say that the practices of supply chain management Ethiopian construction industry are almost poor.

To use the term 'Supply Chain Management' in the context of the current Ethiopia construction industry suggests that it is possible to adopt those practices, which have proved to be successful elsewhere, without significantly adapting them to reflect the particular nature of the industry and its culture (Mugher Cement Enterprise, 2010).

On the other hand, the numbers of construction companies are increasing at an alarming rate and some of the entrants are international companies having huge capital as well as long years of technical and managerial experiences in the industry. The supply chain management practices categorized under different issues shows that the level of the practices is at their lower level. The impacts of different variables on the competitive position of construction industry are highly significant.

It is important to see the Ethiopian industry competitive forces using the (Porter, 1985)'s five competitive forces model (Mugher Cement Enterprise, 2010).

- Rivalry between established firms – few years ago there were few firms and could sell easily what they could produce. This time the number of cement factories has reached to about 11 and some others will resume operations very soon. Though rivalry is not now seemingly stiff as such, it is expected to come sooner at some other time.
- New entrants - though the industry is capital intensive, there are major reasons that the industry may attract capable multinational companies. Government is promoting investors to enter into the construction industry due to the fact that it is becoming a bottleneck for its own infrastructural sector requirements. Economies of scale are very high as it is heterogeneous product that is produced in an integrated process. Due to this

and high profit margin that the existing few companies are enjoying, it is a fertile ground to attract capable entrepreneurs.

- Bargaining power of customers – there is a high demand and supply gap in the market. The former supersedes the latter by far.
- Bargaining power of the suppliers – the main raw materials like lime stone, gypsum and pumice are found in the local market and most of the cement factories own the mining fields. However, spare parts, components, fuel, packing materials and main utilities are mostly owned by few or at times with sole suppliers where most of the time the suppliers do have a strong bargaining powers.
- Threat for substitute products – Material such as cement does not have perfect substitute.

Consequently, to use the term 'supply chain management in construction' is at the very least curious, and probably simply inaccurate if it is used in the manufacturing context. Perhaps supply networks in construction are a more accurate phrase, suggesting a less permanent or secure relationship. SCM is conceptually ambiguous and there are problems in transferring this manufacturing-orientated management approach across to a construction industry which has characteristics that do not ideally lend themselves to SCM. This should not be a barrier to exploring the strengths of some aspects of SCM available to construction, an industry or multi-industry sector trying desperately to recast itself in a new non-adversarial, problems-solving, innovative and collaborative role.

In summary, this chapter presented the findings from a literature review on the concepts and application of SCM and logistics in the construction industry. A supply chain consists of a series of activities and organizations to help materials move from the initial suppliers to final customers. In contrast, logistics is about the time-related position of resources. Many individual logistics systems will form a complete supply chain management network when they act together. Based on the studies of previous research, it is found that the literature only covers a subset of issues in the construction supply chain.to the best of understanding of the researchers, few studies have been conducted to discover the whole supply chain.

Furthermore, although there are many problems during the construction logistics process, the benefits of an efficient supply chain process are identified by many researchers. An early and accurate scheduling of materials, planned to a time schedule and keyed to the master plan for site

storage is highly desirable for the success of a construction project (Enshassi, 1996). It is also found that there is lack of methods to evaluate the benefits or efficiency of the supply chain network as many factors prevent the construction industry from effectively addressing supply chain problems. This led to the motivation for this research.

In order to find the measurement method, an analysis of a general construction supply chain management process for public construction projects will be carried out in the next chapter. The benefits, challenges and the different approaches of applying supply chain management to public construction projects under MoUDH are presented and analyzed in Chapter 4.

CHAPTER 3: METHODOLOGY OF THE RESEARCH

3.1 Research Design

This research can be categorized as descriptive and quantitative type. It is quantitative as it identifies the factors affecting the supply chain collaboration, the challenges and measures taken for resolving the problems of SCM.

3.2 Research Instruments

The research instruments employed in the study mostly are closed questioner survey. Questioner survey is the most preferred choice in logistics and supply chain survey research (Kotzab, 2005). Although, questionnaires have its own inherent limitations, they are particularly relevant in the research of supply chains because it can help collect better information about the realities of supply chains and develop better and more complete theories (Eisenhardt, 1989; Yin, 2003).

To unfold the meanings of peoples' responses in an appropriate and more understandable way, themes are identified and categorized based the objectives of the thesis. The following themes are used:

- Par I - General Information,
- Part II - Perception of construction stakeholders on the benefits of SCM,
- Part III - Current practices and challenges in SCM,
- Part IV - Approach of supply chain management
- Part V - Solutions for the challenges in the supply chain network.

The potential suppliers for the study were identified after the response from the public bodies and contractors were received.

Likert's-scale is important to know respondents' feelings or attitudes about something. The respondents must indicate how closely their feelings match with the question or statement on a rating scale. The study employs a five Likert's - scale ordinal measures (from 1 to 5) as shown in the following sections.

The scales are:

1- Unimportant/ Negligible/ Not at all
2- Less important/ Low/ little
3- Somewhat important/ Moderate/ average
4- Important/ High/ Greatly
5- Very important/ very high/ A lot

The questionnaires are prepared in such a way that detailed information can be gathered in a systematically prepared matrix table.

3.3 Study Subjects

The relevant public projects in Addis Ababa for the study consisted of mainly those projects which are being administered by MoUDH. As supply chain management is a new conceptual framework and applied at the upper level of management, the respondents are identified as; project managers, contract managers, resident engineers and supply managers.

3.4 Data Analysis and Techniques

Descriptive statistics method was used to analyze the responses in numbers. Percentages are easier to interpret and in this analysis, they are implemented to express the findings as a proportion of the whole. The findings are presented in the form of tables and charts to help understand easily.

The sample for this study is relatively small. As a result, the analysis had combined all groups of respondents (clients, consultants, contractors) in order to obtain significant results. The study used relative importance index (RII) method to ordinals arranges variables in terms of importance and agreement and it is calculated as follows (Aibinu and Jagboro, 2002).

$$RII = \frac{\sum_{i=1}^{N} f_i * w_i}{N * A}$$

Where:

N = Total number of respondents

w_i = the variable expressing the frequency of the i^{th} response.

f_i= frequency or count of variables

A= the maximum scale

The results are analyzed from fifty four (54) questionnaires using MS Excel 2007 and SPSS and the analysis and results are presented in form of graph and tables as shown in Chapter 4. The results are prepared to present the information about the sample size, response rate and contracting companies' characteristics in Ethiopia especially in Addis Ababa. It also includes the ranking of factors affecting the perception of construction stakeholders on the benefits of SCM and the current practices and challenges in SCM based on their relative mean ranks, in addition to the different approaches of SCM and the solutions for the challenges in the supply chain network.

CHAPTER 4: RESULTS, ANALYSIS AND DISCUSSIONS

4.1 General Respondents' Characteristics

Out of the 34 questionnaires distributed to clients, contactors and consultants, 23 responses are received with 67.65% return rate in this study. The following chart shows distribution of the respondents, i.e. Contactors (43 %), Consultants (35 %) and Client (22 %). Furthermore, the potential suppliers were identified after collecting responses' from the public bodies, contractors and consultants. And twenty questionnaires are distributed to supplier, among which only eight of them were retuned.

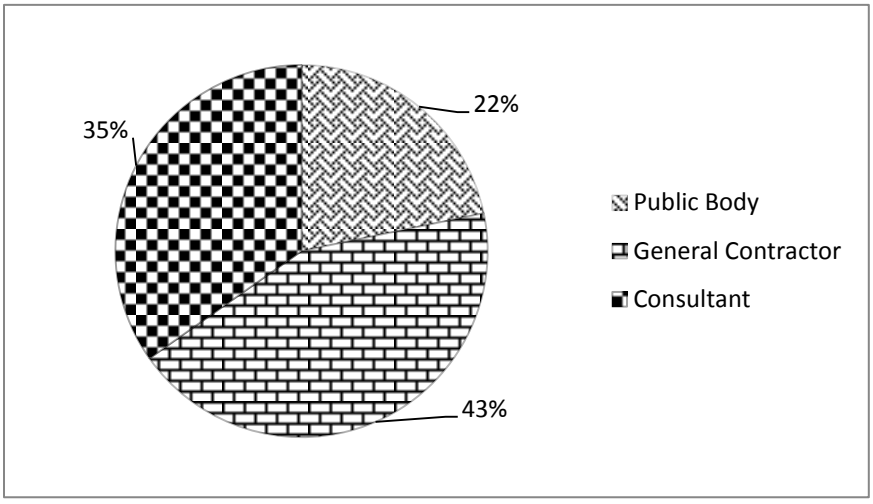

Figure 4.1 Classification of questionnaires general response rate

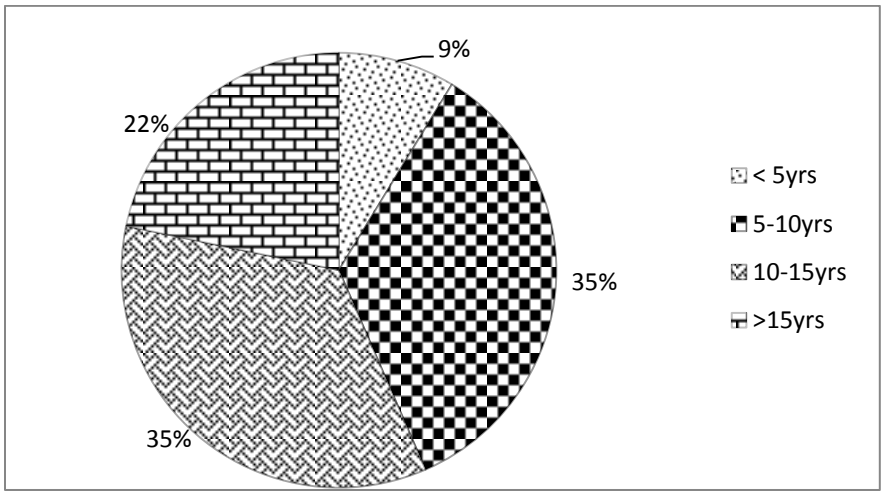

Figure 4.2 Respondent's experience on the construction industry

Figure 4.2 shows the years of experience for the surveyed respondents in the construction industry Addis Ababa. In the chart below which shows the characteristics of the respondents; about 39% of the respondents have 5-10 years of experience, 39% have 10-15 years, 22% have an experience above 15 years and the rest 9% have an experience less than 5 years.

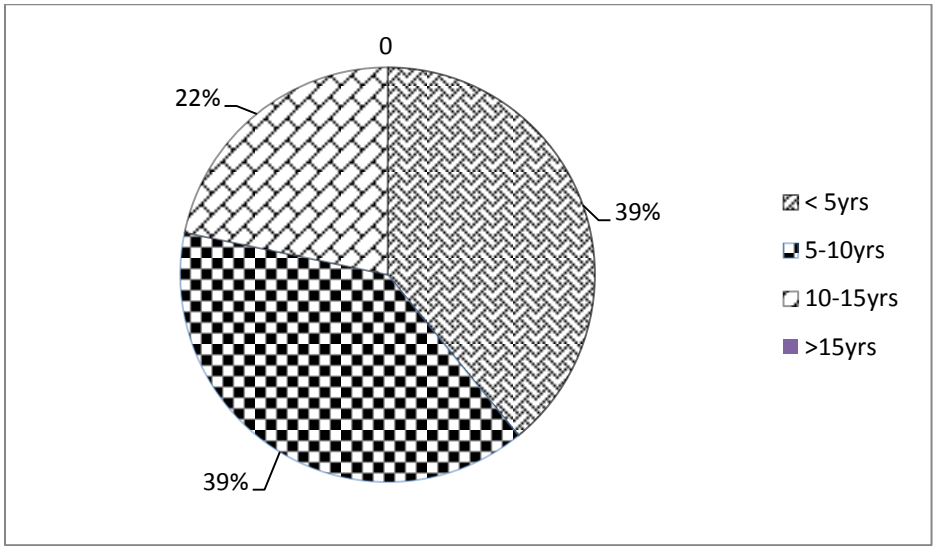

Figure 4.3 Respondent's experience in current firm

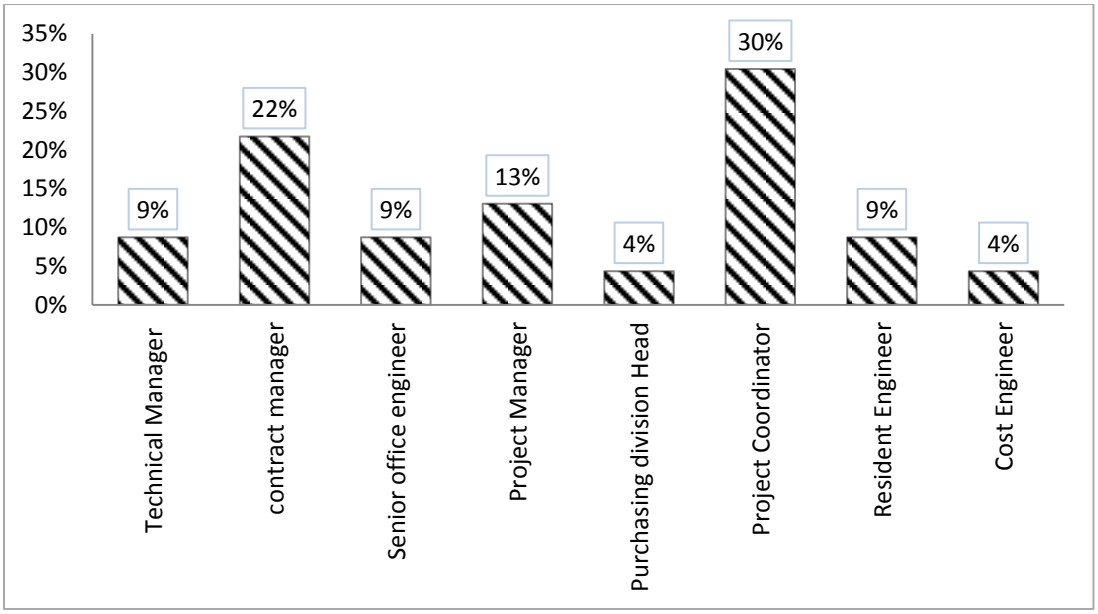

Figure 4.4 Respondents' current roles / positions

The chart above shows that a large percentage of respondents are project coordinators, and contract managers.

4.2Perception of construction stakeholders on the benefits of SCM

As described in the table below, the top most factors which are important to the supply chain collaboration for public bodies, contractors and consultants include:

i. Improved quality assurance
ii. Increased profitability
iii. Improved customer service
iv. Cost reductions within the organization
v. Benefits to the client

It can be seen in table 4.1, the five factors that are essential for supply chain collaboration for suppliers include;

i. Improved customer service
ii. Achievement of company goals and objectives
iii. Increased profitability
iv. Improved quality assurance
v. Increased market competitiveness

Evidently, improved quality assurance, improved customer service and increased profitability are perceived to be common factors for the supply chain collaboration of organizations.

Table 4.1RII analysis on the importance of supply chain management collaboration

			Public body, Contractor and Consultant response					Suppliers' response				
Factors	**Likert Scale**	**w_i**	**frequency (f_i)**	$f_i * w_i$	$\sum_{i=1}^{23} f_i * w_i$	**RII**	**Rank**	**frequency (fi)**	$f_i * w_i$	$\sum_{i=1}^{8} f_i * w_i$	**RII**	**Rank**
Improved customer service	Unimportant	1	0	0				0	0			
	Less important	2	0	0				0	0			
	Somewhat important	3	2	6				0	0			
	Important	4	9	36				0	0			
	Very important	5	12	60	102	89%	2	8	40	40	35%	1
Overall supply chain reduction	Unimportant	1	2	2				1	1			
	Less important	2	1	2				0	0			
	Somewhat important	3	8	24				3	9			
	Important	4	4	16				1	4			
	Very important	5	8	40	84	73%	9	3	15	29	25%	10
Increased profitability	Unimportant	1	0	0				0	0			
	Less important	2	0	0				0	0			
	Somewhat important	3	1	3				0	0			
	Important	4	11	44				2	8			
	Very important	5	11	55	102	89%	2	6	30	38	33%	3
Reducing bureaucracy/ paperwork	Unimportant	1	1	1				0	0			
	Less important	2	1	2				0	0			
	Somewhat important	3	6	18				2	6			
	Important	4	5	20				5	20			
	Very important	5	10	50	91	79%	6	1	5	31	27%	9
Increased market competitiveness	Unimportant	1	0	0				0	0			
	Less important	2	2	4				0	0			
	Somewhat important	3	6	18				0	0			
	Important	4	6	24				5	20			
	Very important	5	9	45	91	79%	6	3	15	35	30%	5

			Public body, Contractor and Consultant response					Suppliers' response				
Factors	**Likert Scale**	**w_i**	**frequency (f_i)**	$f_i * w_i$	$\sum_{i=1}^{23} f_i * w_i$	**RII**	**Rank**	**frequency (fi)**	$f_i * w_i$	$\sum_{i=1}^{8} f_i * w_i$	**RII**	**Rank**
Cost reductions within your organization	Unimportant	1	0	0				0	0			
	Less important	2	0	0				0	0			
	Somewhat important	3	7	21				0	0			
	Important	4	7	28				6	24			
	Very important	5	9	45	94	82%	4	2	10	34	30%	6
Benefits to the client	Unimportant	1	0	0				0	0			
	Less important	2	0	0				0	0			
	Somewhat important	3	8	24				3	9			
	Important	4	5	20				1	4			
	Very important	5	10	50	94	82%	4	4	20	33	29%	7
Benefits to your supplier	Unimportant	1	0	0				0	0			
	Less important	2	3	6				0	0			
	Somewhat important	3	10	30				3	9			
	Important	4	4	16				2	8			
	Very important	5	6	30	82	71%	10	3	15	32	28%	8
Improved quality assurance	Unimportant	1	0	0				0	0			
	Less important	2	0	0				0	0			
	Somewhat important	3	0	0				0	0			
	Important	4	10	40				2	8			
	Very important	5	13	65	105	91%	1	6	30	38	33%	3
achievement of company goals and objectives	Unimportant	1	0	0				0	0			
	Less important	2	0	0				0	0			
	Somewhat important	3	9	27				0	0			
	Important	4	6	24				1	4			
	Very important	5	8	40	91	79%	6	7	35	39	34%	2

The analysis shown in the table below describe that at public projects, the main reasons given for a successful supply chain relationship between organizations and supplier are linked to the following peak potential factors:

i. Trust
ii. Reliability of supply
iii. Mutual interest
iv. Creating standardization of processes
v. Closer links between demand/ supply

Meanwhile suppliers' response result as shown in the table below, the five factors are:

i. Reliability of supply
ii. Closer links between demand/ supply
iii. Creating standardization of processes
iv. Trust
v. Manpower development

Trust, creating standardization processes and closer links between demand and supply are the common reasons that the public bodies, contractors, consultants and suppliers believe have an effect on successful supply chain relationship between organizations.

Table 4.2 RII Analysis on Factors affecting a successful SC relationship with suppliers

			Public body, Contractor and Consultant response					Suppliers' response				
Factors	**Likert Scale**	**w_i**	**frequency (f_i)**	$f_i * w_i$	$\sum_{i=1}^{23} f_i * w_i$	**RII**	**Rank**	**frequency (fi)**	$f_i * w_i$	$\sum_{i=1}^{8} f_i * w_i$	**RII**	**Rank**
Reliability of supply	Negligible	1	0	0	98	85%	2	0	0	35	30%	1
	Low	2	0	0				1	2			
	Moderate	3	1	3				0	0			
	High	4	15	60				2	8			
	Very high	5	7	35				5	25			
Top management support	Negligible	1	0	0	86	75%	8	2	2	26	23%	7
	Low	2	1	2				0	0			
	Moderate	3	9	27				2	6			
	High	4	8	32				2	8			
	Very high	5	5	25				2	10			
Trust	Negligible	1	0	0	102	89%	1	0	0	30	26%	4
	Low	2	2	4				1	2			
	Moderate	3	0	0				2	6			
	High	4	7	28				3	12			
	Very high	5	14	70				2	10			
Mutual interest	Negligible	1	0	0	94	82%	3	1	1	24	21%	8
	Low	2	0	0				1	2			
	Moderate	3	5	15				4	12			
	High	4	11	44				1	4			
	Very high	5	7	35				1	5			
Manpower development	Negligible	1	0	0	93	81%	4	0	0	27	23%	5
	Low	2	0	0				2	4			
	Moderate	3	5	15				2	6			
	High	4	12	48				3	12			
	Very high	5	6	30				1	5			
Closer links	Negligible	1	0	0	89	77%	6	0	0	32	28%	2

			Public body, Contractor and Consultant response					Suppliers' response				
Factors	**Likert Scale**	**w_i**	**frequency (f_i)**	$f_i * w_i$	$\sum_{i=1}^{23} f_i * w_i$	**RII**	**Rank**	**frequency (fi)**	$f_i * w_i$	$\sum_{i=1}^{8} f_i * w_i$	**RII**	**Rank**
between demand/ supply	Low	2	0	0				1	2			
	Moderate	3	8	24				0	0			
	High	4	10	40				5	20			
	Very high	5	5	25				2	10			
Free flow of information	Negligible	1	0	0				1	1			
	Low	2	0	0				0	0			
	Moderate	3	9	27	88	77%	7	6	18	24	21%	8
	High	4	9	36				0	0			
	Very high	5	5	25				1	5			
More frequent meetings	Negligible	1	1	1				0	0			
	Low	2	5	10				4	8			
	Moderate	3	14	42	66	57%	11	3	9	21	18%	11
	High	4	2	8				1	4			
	Very high	5	1	5				0	0			
Simplify the whole construction process	Negligible	1	0	0				0	0			
	Low	2	2	4				4	8			
	Moderate	3	8	24	85	74%	9	1	3	24	21%	8
	High	4	8	32				2	8			
	Very high	5	5	25				1	5			
Creating standardization of processes	Negligible	1	0	0				0	0			
	Low	2	1	2				1	2			
	Moderate	3	7	21	91	79%	5	1	3	32	28%	2
	High	4	7	28				3	12			
	Very high	5	8	40				3	15			
Simplify bid process	Negligible	1	0	0				0	0			
	Low	2	4	8				2	4			
	Moderate	3	5	15	81	70%	10	1	3	27	23%	5
	High	4	12	48				5	20			
	Very high	5	2	10				0	0			

4.3Current practices and challenges in SCM

On the table below, the analysis show that at public projects, the main grounds given for unsuccessful supply chain relationship between organizations and clients are linked to the following top most factors:

i. Cash flow problems due to late and reduced payments
ii. Design/engineering interface - incorrect documents, design changes, extended wait for architect's approval or design changes
iii. Difficulties in finding out client's desires, changes of client's requirements, long procedures to discuss changes
iv. Inaccurate data, engineering drawings not fitting the use
v. Deliveries not in conformance with planning, wrong and defective deliveries, long storage period, awkward packing, large shipments

From suppliers' point of view, the main reasons given for a successful supply chain relationship between organizations and supplier are linked to the following uttermost potential factors:

A. Cash flow problems due to late and reduced payments
B. Inaccurate data, engineering drawings not fitting the use
C. Design/engineering interface - incorrect documents, design changes, extended wait for architect's approval or design changes
D. Difficulties in finding out client's desires, changes of client's requirements, long procedures to discuss changes
E. Inaccurate data, information needs not met, adversarial bargaining and other changes

There are substantial difficulties in applying SCM in the construction industry, factors such as cash flow problems due to late and reduced payments, difficulties in finding out client's desires, changes of client's requirements, long procedures to discuss changes, inaccurate data, and engineering drawings not fitting the use and incorrect documents, design changes, extended wait for architect's approval or design changes are highlighted as the common problems associated with the implementation of successful supply chain management.

Table 4.3 RII Analysis on Factors affecting of successful SC relationship with clients

			Public body, Contractor and Consultant response					Suppliers' response				
Factors	**Likert Scale**	**w_i**	**frequency (f_i)**	$f_i * w_i$	$\sum_{i=1}^{23} f_i * w_i$	**RII**	**Rank**	**frequency (fi)**	$f_i * w_i$	$\sum_{i=1}^{8} f_i * w_i$	RII	Rank
Cash flow problems due to late and reduced payments	Negligible	1	0	0	94	82%	1	0	0	37	32%	1
	Low	2	0	0				0	0			
	Moderate	3	4	12				1	3			
	High	4	13	52				1	4			
	Very high	5	6	30				6	30			
Bidding process	Negligible	1	0	0	73	63%	9	Not Applicable				
	Low	2	5	10								
	Moderate	3	10	30								
	High	4	7	28								
	Very high	5	1	5								
Retention	Negligible	1	1	1	64	56%	12	Not Applicable				
	Low	2	8	16								
	Moderate	3	9	27								
	High	4	5	20								
	Very high	5	0	0								
Difficulties in finding out client's desires, changes of client's requirements, long procedures to discuss changes	Negligible	1	0	0	87	76%	3	0	0	31	27%	4
	Low	2	1	2				1	2			
	Moderate	3	8	24				2	6			
	High	4	9	36				2	8			
	Very high	5	5	25				3	15			

			Public body, Contractor and Consultant response					Suppliers' response				
Factors	**Likert Scale**	**w_i**	**frequency (f_i)**	$f_i * w_i$	$\sum_{i=1}^{23} f_i * w_i$	**RII**	**Rank**	**frequency (fi)**	$f_i * w_i$	$\sum_{i=1}^{8} f_i * w_i$	RII	Rank
Threat for substitute products	Negligible	1	1	1	75	65%	8	0	0	27	23%	8
	Low	2	1	2				2	4			
	Moderate	3	15	45				2	6			
	High	4	3	12				3	12			
	Very high	5	3	15				1	5			
Design/engineering interface - incorrect documents, design changes, extended wait for architect's approval or design changes	Negligible	1	0	0	91	79%	2	0	0	32	28%	3
	Low	2	1	2				1	2			
	Moderate	3	5	15				1	3			
	High	4	11	44				3	12			
	Very high	5	6	30				3	15			
Inaccurate data, engineering drawings not fitting the use	Negligible	1	0	0	83	72%	4	0	0	33	29%	2
	Low	2	3	6				0	0			
	Moderate	3	5	15				2	6			
	High	4	13	52				3	12			
	Very high	5	2	10				3	15			
Subcontracted work not delivered according to main design, contract and planning	Negligible	1	0	0	72	63%	10	0	0	27	23%	8
	Low	2	5	10				1	2			
	Moderate	3	11	33				3	9			
	High	4	6	24				4	16			
	Very high	5	1	5				0	0			

			Public body, Contractor and Consultant response					Suppliers' response				
Factors	**Likert Scale**	**w_i**	**frequency (f_i)**	$f_i * w_i$	$\sum_{i=1}^{23} f_i * w_i$	**RII**	**Rank**	**frequency (fi)**	$f_i * w_i$	$\sum_{i=1}^{8} f_i * w_i$	RII	Rank
Deliveries not in conformance with planning, wrong and defective deliveries, long storage period, awkward packing, large shipments	Negligible	1	0	0	83	72%	4	0	0	26	23%	10
	Low	2	1	2				1	2			
	Moderate	3	10	30				5	15			
	High	4	9	36				1	4			
	Very high	5	3	15				1	5			
Problematic completion due to quality problems	Negligible	1	0	0	80	70%	6	0	0	30	26%	6
	Low	2	1	2				1	2			
	Moderate	3	16	48				3	9			
	High	4	0	0				1	4			
	Very high	5	6	30				3	15			
Unresolved quality problems, delayed occupation due to late completion	Negligible	1	0	0	79	69%	7	0	0	28	24%	7
	Low	2	5	10				1	2			
	Moderate	3	6	18				4	12			
	High	4	9	36				1	4			
	Very high	5	3	15				2	10			
Inaccurate data, information needs not met, adversarial bargaining and other changes	Negligible	1	0	0	72	63%	10	0	0	31	27%	4
	Low	2	7	14				1	2			
	Moderate	3	8	24				1	3			
	High	4	6	24				4	16			
	Very high	5	2	10				2	10			

From the functions listed in the table 4.5 the extent in which the factors affect the efficiency of supply chain: Purchasing of materials has been the most efficient function that affected the efficiency of SC. Not having a lead time for ordering of material, the transportation of materials to the project site and the Inventory level of material at the project site affected the efficiency of the supply chain in the respective order as shown in the following table.

Whereas, for suppliers, purchasing of materials is an efficient function among the functions that are listed. Not having enough stocks in the inventory affects he efficiency of SC. And also having a lead time for ordering of material and the transportation of materials to the project site affects the effectiveness of SC for suppliers.

The procedures the respondents are using for the delivery of material, from the alternatives proposed: building up inventory or Just-in-Time delivery, both ways are equally utilized at the construction site as shown in the Table 4.6.

Table 4.4 RII Analysis on functions affecting efficiency of supply chain

			Public body, Contractor and Consultant response					Suppliers' response				
Functions	**Likert Scale**	**w_i**	**frequency (f_i)**	$f_i * w_i$	$\sum_{i=1}^{23} f_i * w_i$	**RII**	**Rank**	**frequency (fi)**	$f_i * w_i$	$\sum_{i=1}^{8} f_i * w_i$	**RII**	**Rank**
Inventory	Negligible	1	1	1	81	70%	4	0	0	31	27%	2
	Low	2	2	4				1	2			
	Moderate	3	6	18				1	3			
	High	4	12	48				4	16			
	Very high	5	2	10				2	10			
Transportation	Negligible	1	1	1	84	73%	2	0	0	27	23%	4
	Low	2	2	4				1	2			
	Moderate	3	8	24				3	9			
	High	4	5	20				4	16			
	Very high	5	7	35				0	0			
Lead Time	Negligible	1	0	0	83	72%	3	0	0	30	26%	3
	Low	2	6	12				0	0			
	Moderate	3	2	6				5	15			
	High	4	10	40				0	0			
	Very high	5	5	25				3	15			
Purchasing	Negligible	1	0	0	89	77%	1	0	0	33	29%	1
	Low	2	3	6				0	0			
	Moderate	3	4	12				1	3			
	High	4	9	36				5	20			
	Very high	5	7	35				2	10			

Table 4.5 RII Analysis on method of delivery of materials

			Public body, Contractor and Consultant response					Suppliers' response				
	Likert Scale	**w_i**	**frequency (f_i)**	$f_i * w_i$	$\sum_{i=1}^{23} f_i * w_i$	**RII**	**Rank**	**frequency (fi)**	$f_i * w_i$	$\sum_{i=1}^{23} f_i * w_i$	**RII**	**Rank**
Based on inventory levels	Never	1	1	1	83	72%	2	0	0	30	26%	2
	Rarely	2	1	2				1	2			
	Seldom	3	10	30				1	3			
	Frequently	4	5	20				5	20			
	Always	5	6	30				1	5			
Just exactly as the materials are needed	Never	1	1	1	85	74%	1	0	0	34	30%	1
	Rarely	2	0	0				0	0			
	Seldom	3	9	27				1	3			
	Frequently	4	8	32				4	16			
	Always	5	5	25				3	15			

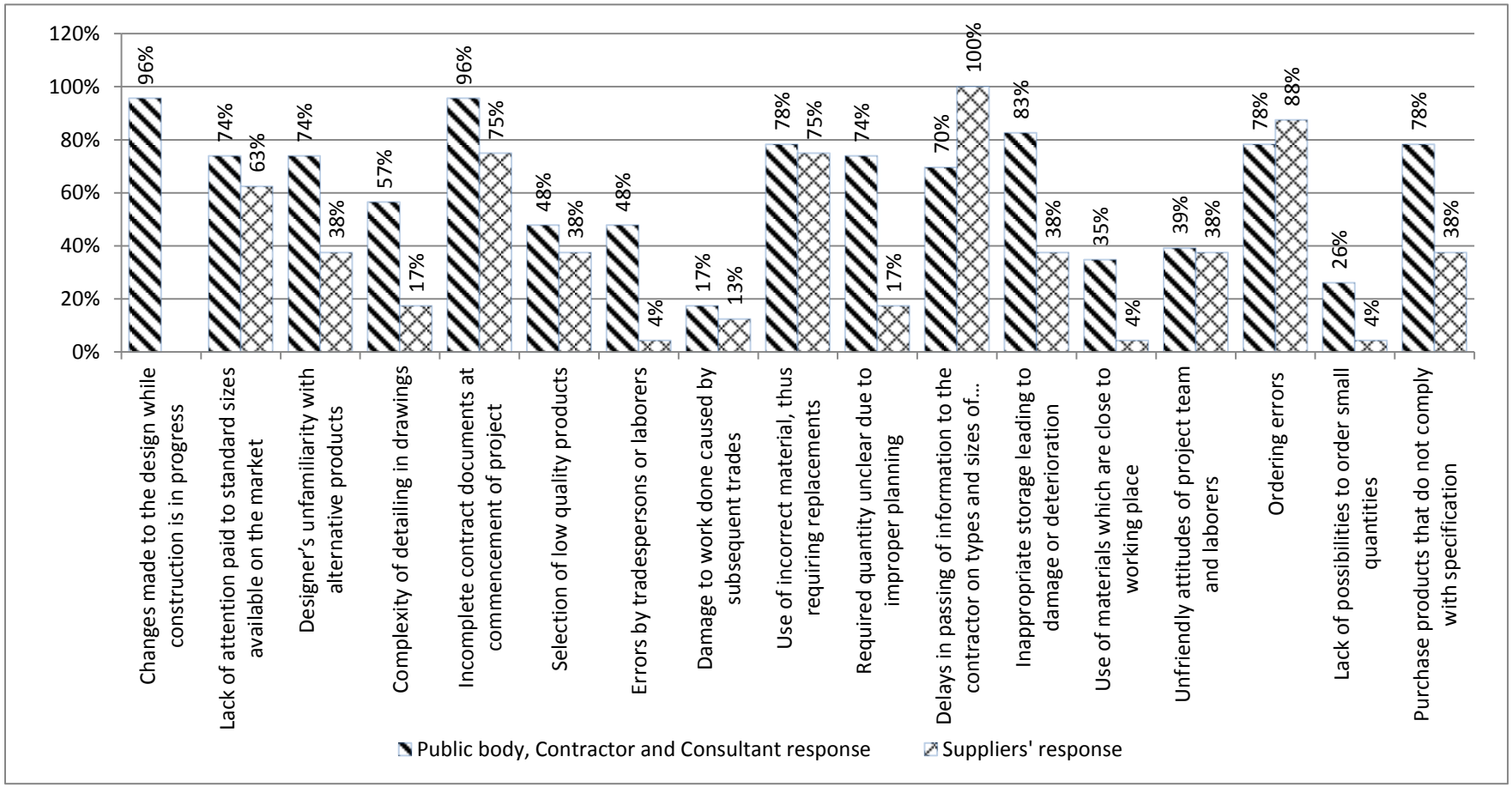

Figure 4.5 Frequency of challenges encountered in material delivery

Figure 4.5 gives the repartition of the different challenges which come across in material delivery. The figure below shows that at public construction projects, the main reasons given for problems on material delivery are mainly linked to changes made to the design while construction is in progress as well as incomplete contract documents at commencement of project.

While, the analysis from the suppliers reveals that the factors that affect material delivery are delay in passing information to the contractor on type and size of products to be used and ordering errors.

Other challenges include inappropriate storage leading to damage or deterioration, purchasing products that do not comply with specification and using of incorrect material, thus requiring replacements.

Among the measures the respondents are taking in case of lack of materials on the projects; it can be seen from the chart below that preparing for other works (91.30%) is the major action taken by public bodies, contractors and consultants. Whereas, suppliers usually wait or take a break until the problems related to delivery of material are solved. The second option the use is to move people to other project sites.

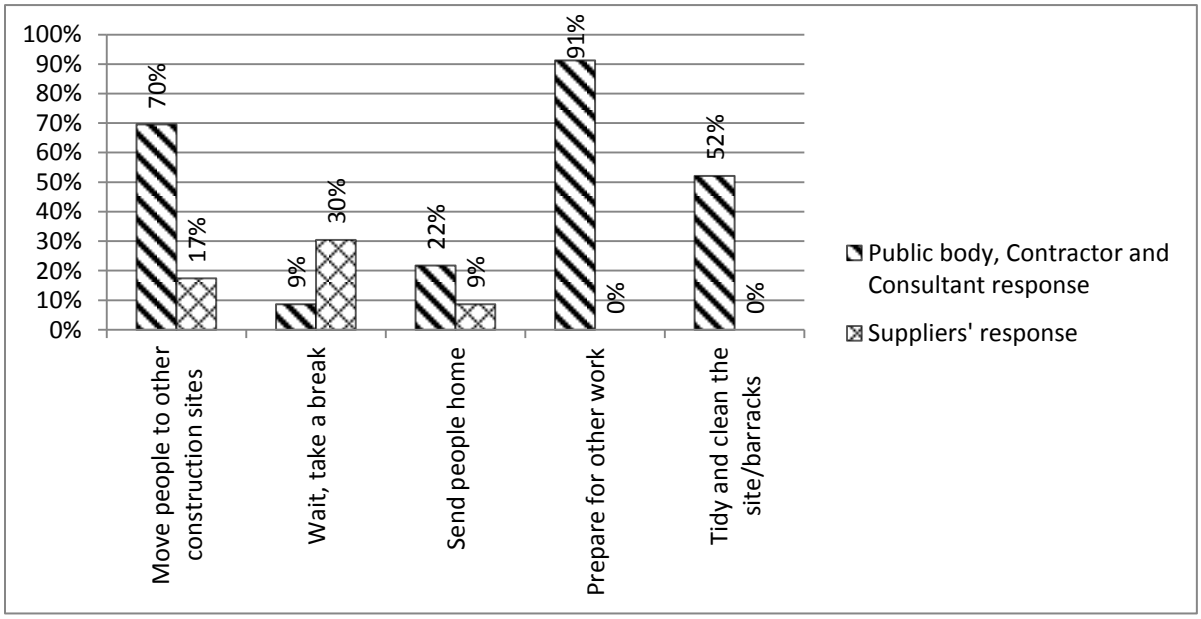

Figure 4.6 Frequency of measures taken in the case of lack of materials

4.4Approach of supply chain management

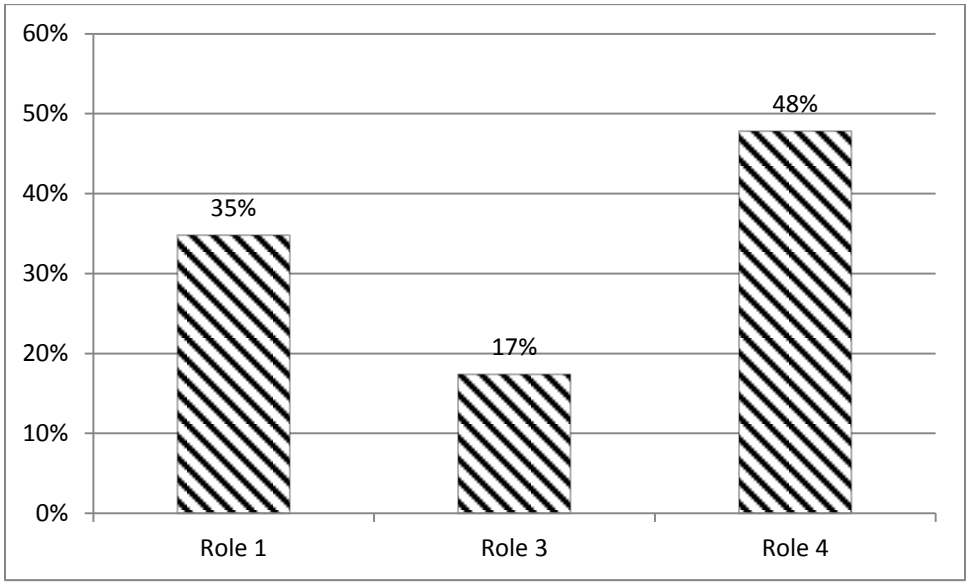

Figure 4.7 Frequency of Approaches to SCM

Form the above chart, it can be seen that more than 50% of the respondents do not prefer the integrated approach to supply chain management. Even if its idea is to structure the site work as successive realizations of autonomous sequences; Role number 4 in which the focus is on the integrated management and improvement of the supply chain and the site production where site production is subsumed into SCM, the goal is to replace construction's usual temporary chains with permanent supply chains.

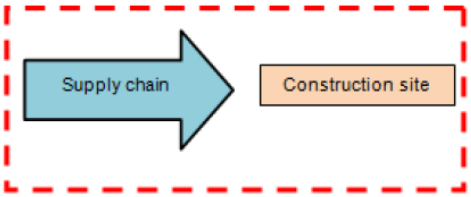

Figure 4.8 Role 4: focus on the integrated management of the SC and the construction site

4.5 Stakeholders proposed solutions for challenges in SC network

The actions respondents usually take to overcome the challenges they faced in the delivery of material are a good coordination between store and construction personnel which helps in avoiding over ordering. They also suggested minimizing design changes and good construction management practice. Furthermore, they suggest that having accurate and good specifications of materials to avoid wrong ordering can have favorable impact on material delivery. Checking materials supplied or right quantities and volumes to improve routines for deliveries are also recommended.

From the suppliers' point of view the actions they usually take to overcome the challenges they faced in delivery of material are checking materials supplied are in right quantities and volumes, Good coordination between store and construction personnel to avoid over ordering. Moreover, taking accurate and good specifications of materials helps them to avoid wrong ordering and measurements of materials during batching.

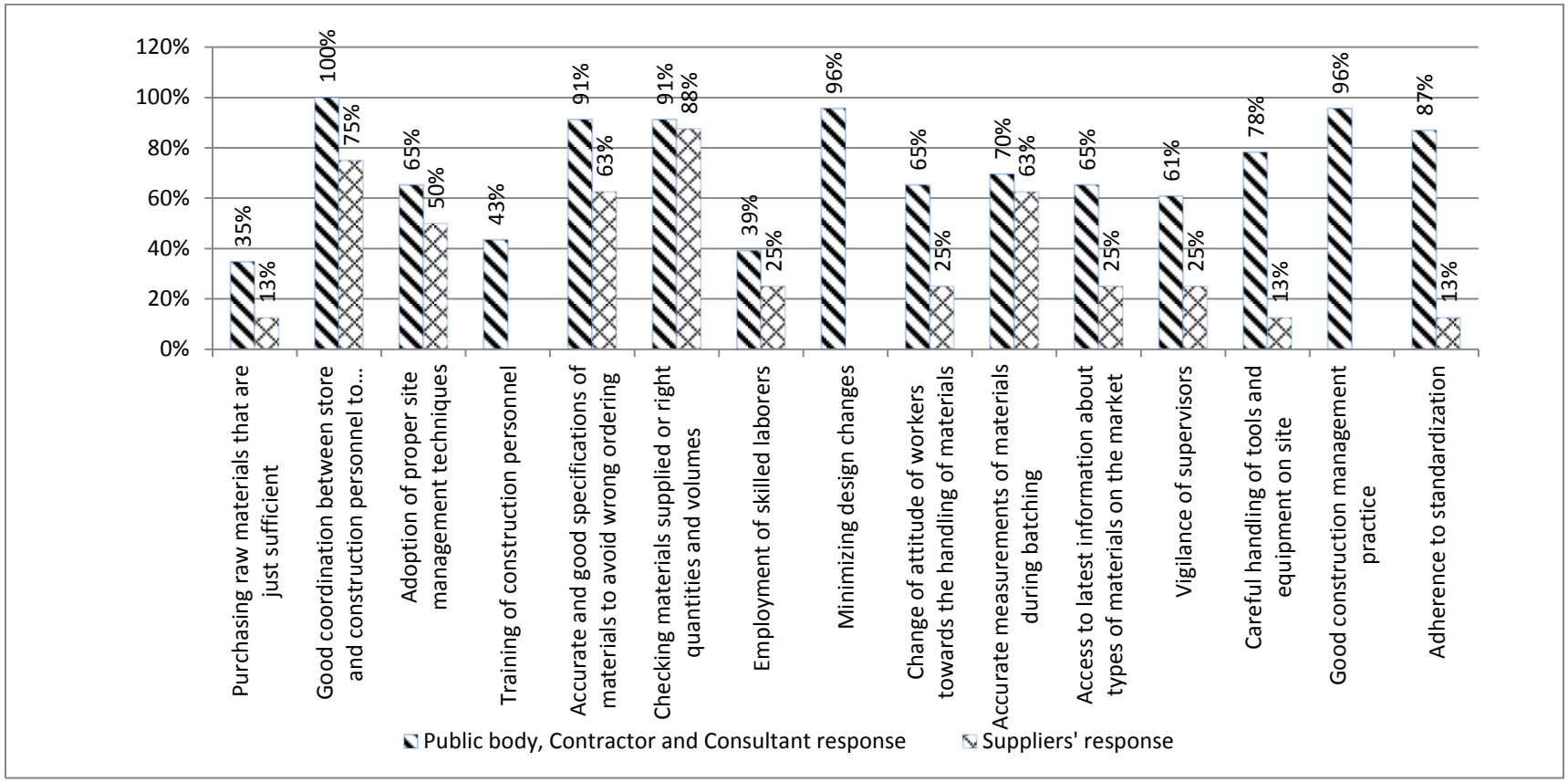

Figure 4.9 Frequency of actions to overcome challenges faced in delivery of materials

The benefits ranked in the top five as shown in the table below which are important to public bodies, contactors and consultants are:

i. Reduced lead-time in production
ii. Forecasting
iii. Resource planning
iv. Increased coordination with suppliers
v. Increased coordination with customers and better quality and quantity of information

The benefits ranked in the top five as shown in the table below which are important to the suppliers are:

i. Resource planning
ii. Reduced lead-time in production
iii. Cost saving
iv. Better operational efficiency
v. Forecasting

It can be noticed from the above lists that reduced lead-time in production, forecasting and resource planning are the common benefits that can be achieved from applying supply chain management in the construction industry.

Table 4.6 RII Analysis on benefits of using SC

			Public body, Contractor and Consultant response					Suppliers' response				
Benefits	**Likert Scale**	**w_i**	**frequency (f_i)**	**$f_i * w_i$**	**$\sum_{i=1}^{23} f_i * w_i$**	**RII**	**Rank**	**frequency (fi)**	**$f_i * w_i$**	**$\sum_{i=1}^{8} f_i * w_i$**	**RII**	**Rank**
Reduced lead-time in production	Not at all	1	0	0	91	79%	1	0	0	32	28%	2
	Little	2	1	2				0	0			
	Average	3	3	9				2	6			
	Greatly	4	15	60				4	16			
	A lot	5	4	20				2	10			
Cost saving	Not at all	1	0	0	85	74%	7	0	0	31	27%	3
	Little	2	1	2				0	0			
	Average	3	7	21				2	6			
	Greatly	4	13	52				5	20			
	A lot	5	2	10				1	5			
Forecasting	Not at all	1	0	0	90	78%	2	0	0	28	24%	5
	Little	2	1	2				0	0			
	Average	3	3	9				4	12			
	Greatly	4	16	64				4	16			
	A lot	5	3	15				0	0			
Resource planning	Not at all	1	0	0	89	77%	3	0	0	36	31%	1
	Little	2	2	4				0	0			
	Average	3	3	9				0	0			
	Greatly	4	14	56				4	16			
	A lot	5	4	20				4	20			
Better operational efficiency	Not at all	1	0	0	76	66%	10	0	0	30	26%	4
	Little	2	3	6				0	0			
	Average	3	10	30				4	12			
	Greatly	4	10	40				2	8			
	A lot	5	0	0				2	10			

			Public body, Contractor and Consultant response					Suppliers' response				
Benefits	**Likert Scale**	**w_i**	**frequency (f_i)**	**$f_i * w_i$**	**$\sum_{i=1}^{23} f_i * w_i$**	**RII**	**Rank**	**frequency (fi)**	**$f_i * w_i$**	**$\sum_{i=1}^{8} f_i * w_i$**	**RII**	**Rank**
Reduced inventory level	Not at all	1	0	0	75	65%	11	0	0	26	23%	10
	Little	2	2	4				2	4			
	Average	3	15	45				3	9			
	Greatly	4	4	16				2	8			
	A lot	5	2	10				1	5			
More accurate costing	Not at all	1	0	0	77	67%	9	0	0	28	24%	5
	Little	2	2	4				2	4			
	Average	3	14	42				1	3			
	Greatly	4	4	16				4	16			
	A lot	5	3	15				1	5			
Increased coordination with suppliers	Not at all	1	0	0	87	76%	4	0	0	25	22%	11
	Little	2	2	4				3	6			
	Average	3	4	12				2	6			
	Greatly	4	14	56				2	8			
	A lot	5	3	15				1	5			
Increased coordination with customers	Not at all	1	0	0	87	76%	4	0	0	25	22%	11
	Little	2	2	4				3	6			
	Average	3	6	18				2	6			
	Greatly	4	10	40				2	8			
	A lot	5	5	25				1	5			
Increased sales	Not at all	1	0	0	70	61%	12	0	0	28	24%	5
	Little	2	6	12				1	2			
	Average	3	11	33				3	9			
	Greatly	4	5	20				3	12			
	A lot	5	1	5				1	5			

			Public body, Contractor and Consultant response					Suppliers' response				
Benefits	**Likert Scale**	**w_i**	**frequency (f_i)**	**$f_i * w_i$**	**$\sum_{i=1}^{23} f_i * w_i$**	**RII**	**Rank**	**frequency (fi)**	**$f_i * w_i$**	**$\sum_{i=1}^{8} f_i * w_i$**	**RII**	**Rank**
Better quality and quantity of information	Not at all	1	0	0	86	75%	6	0	0	28	24%	5
	Little	2	2	4				4	8			
	Average	3	3	9				0	0			
	Greatly	4	17	68				0	0			
	A lot	5	1	5				4	20			
Flexibility	Not at all	1	0	0	83	72%	8	0	0	27	23%	9
	Little	2	2	4				3	6			
	Average	3	6	18				1	3			
	Greatly	4	14	56				2	8			
	A lot	5	1	5				2	10			

As can be seen in the table below, the respondents have suggested that Just In time material delivery system needs to be improved for a better supply chain management. However, JIT is mostly practice by other industries such as the manufacturing and food industry; rather, the inventory management on site needs to be improved.

And improving their relationship with the few suppliers they are currently involved with. They also suggested that the vertical integration of their organization need to be enhanced. Planning strategically and holding safety stock will also enhance the supply chain management better.

For suppliers, the measures that they need to improve in order to manage its supply chain better are include vertical integration, holding safety stock, plan strategically, subcontracting and close partnership with clients.

The current practice of SCM rightly suggest that improving the vertical integration of organizations, planning strategically and holding safety stock will increase the capabilities and effectiveness of a company's supply chain.

Table 4.7 RII Analysis on measures for a better supply management

			Public body, Contractor and Consultant response					Suppliers' response				
Measures	**Likert Scale**	**w_i**	**frequency (f_i)**	$f_i * w_i$	$\sum_{i=1}^{23} f_i * w_i$	**RII**	**Rank**	**frequency (fi)**		$\sum_{i=1}^{8} f_i * w_i$	**RII**	**Rank**
Close partnership with Suppliers	Improve	1	8	8	49	53%	6	1	4	19	21%	4
	Plan Implementing	2	4	8				1	3			
	Satisfied already	3	11	33				6	12			
	Not appropriate	4	0	0				0	0			
Close partnership with customers	Improve	1	7	7	53	58%	4	1	4	19	21%	4
	Plan Implementing	2	2	4				1	3			
	Satisfied already	3	14	42				6	12			
	Not appropriate	4	0	0				0	0			
JIT supply	Improve	1	16	16	32	35%	11	2	8	17	18%	9
	Plan Implementing	2	5	10				0	0			
	Satisfied already	3	2	6				3	6			
	Not appropriate	4	0	0				3	3			
Outsourcing	Improve	1	4	4	51	55%	5	0	0	18	20%	7
	Plan Implementing	2	10	20				5	15			
	Satisfied already	3	9	27				0	0			
	Not appropriate	4	0	0				3	$f_i * w_i$			
Subcontracting	Improve	1	5	5	56	61%	2	0	0	19	21%	4
	Plan Implementing	2	3	6				5	15			
	Satisfied already	3	15	45				1	2			
	Not appropriate	4	0	0				2	2			
Plan strategically	Improve	1	8	8	43	47%	7	2	8	21	23%	3
	Plan Implementing	2	10	20				1	3			

			Public body, Contractor and Consultant response					Suppliers' response				
Measures	**Likert Scale**	**w_i**	**frequency (f_i)**	$f_i * w_i$	$\sum_{i=1}^{23} f_i * w_i$	**RII**	**Rank**	**frequency (fi)**		$\sum_{i=1}^{8} f_i * w_i$	**RII**	**Rank**
	Satisfied already	3	5	15				5	10			
	Not appropriate	4	0	0				0	0			
Vertical integration	Improve	1	10	10	42	46%	9	3	12	25	27%	1
	Plan Implementing	2	7	14				3	9			
	Satisfied already	3	6	18				2	4			
	Not appropriate	4	0	0				0	0			
Few suppliers	Improve	1	16	16	37	40%	10	1	4	18	20%	7
	Plan Implementing	2	3	6				0	0			
	Satisfied already	3	1	3				7	14			
	Not appropriate	4	3	12				0	0			
Many suppliers	Improve	1	7	7	55	60%	3	0	0	17	18%	9
	Plan Implementing	2	6	12				4	12			
	Satisfied already	3	4	12				1	2			
	Not appropriate	4	6	24				3	3			
Holding safety stock	Improve	1	11	11	43	47%	7	3	12	22	24%	2
	Plan Implementing	2	7	14				2	6			
	Satisfied already	3	2	6				1	2			
	Not appropriate	4	3	12				2	2			
Use of external consultants	Improve	1	1	1	68	74%	1	0	0	11	12%	11
	Plan Implementing	2	10	20				1	3			
	Satisfied already	3	1	3				1	2			
	Not appropriate	4	11	44				6	6			

CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusion

1. The findings of the study suggest that the construction industry stakeholder's awareness on the need and importance of supply chain management collaboration has helped in the construction industry as it improves the quality assurance and increases profitability. In addition, it improves the customer service and reduces the cost of organizations. Above all this it increases the benefits to the client.

   For development of a successful supply chain relationship between organization and suppliers, the main reasons that are linked are found to be trust, reliable supply, having a mutual interest, creating standardization of processes and closer links between demand and supply. Furthermore, quality of materials and quality of service have an effect on the chain relation with suppliers.

   The benefit that could be achieved from using Supply chain management include reduced lead-time in production, forecasting, resource planning, increased coordination with suppliers, increased coordination with customers and better quality and quantity of information.
2. The research has 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, among which late and incorrect payments, design/engineering interface and difficulties in finding out client's desires, changes of client's requirements, long procedures to discuss changes are few of them.

   The findings show that the problems that are related to materials management are changes made to the design while construction is in progress as well as incomplete contract documents at commencement of project. Further challenges include inappropriate storage leading to damage or deterioration, Purchase products that do not comply with specification and Use of incorrect material, thus requiring replacements.
3. A focus mainly on activities and the need for coordination of sequential interdependence between them may prevent development of appropriate SCM models and efficient supply chain practices in construction. Unlike certain other industrial contexts, construction

supply chains are not mainly subject to sequential but also to pooled and reciprocal interdependencies, and to interdependence owing to the need for synchronizing a range of supply chains to construction site. Hence, it is preferred that the focus to be on the integrated management and improvement of the supply chain and the site production; site production is subsumed into SCM.

4. The results show that the actions that are usually taken to avoid the problems with material deliveries are good coordination between store and construction personnel helps in avoiding over ordering. It is also suggested minimizing design changes and good construction management practice. Moreover, they suggest that having accurate and good specifications of materials can have favorable impact on material delivery.

   The measures practiced to manage its supply chain better include improving the Just In time material delivery system at project sites, refining the relationship with the few suppliers which are currently involved with and the vertical integration of organization, planning strategically and holding safety stalk will also enhance the supply chain management better.

A successful project requires careful planning, organization and control throughout the project to achieve the correct result for the client. For the contractor, good planning, organization and control are essential in order to achieve a timely and satisfactory outcome for the client, and to ensure a financial profit. To ensure the successful implementation of construction projects there should be an effective teamwork between all parties. To ensure proper teamwork on construction sites, managers should be committed to change, workers should be able to work in teams, companies should be more clients focused, firms should be willing to change organizational cultures that do not promote partnering to maximize team building and team members should be empowered in decision-making to make partnerships meaningful.

5.2 Recommendations

Based on the findings of the study and the discussions above and taking into consideration that a continuous improvement will require more fundamental changes than the simple adoption of the recommendations mentioned above, a summary of some general recommendations are offered to support the construction of future public building projects. These are listed below:

1. As it can be seen from the outcomes of the research good coordination between store and construction personnel helps in avoiding over ordering of materials; hence, enhancing the material deliver systems. Public bodies should hire a logistic manager or facilitator to support and sustain the implementation in the management of material and also for the construction activity. The facilitator would have the responsibility to train the key players of the project in material handling and procedures and assists them in developing a schedule.
2. Construction stakeholders are usually concerned with improving supply chain of material. In this way, advancement in logistics management has been proven to be an important ingredient for success. Although reducing costs of logistics can benefit involved parties, it should not direct them to the pitfall of overlooking time management in movement of material. Moreover, time is a readily available measure that can be used as an indication of performance in cost management. Consequently, it is essential to spend efforts on developing cautious time schedule for inventory checking, purchasing transportation of construction material and carry out this plan.
3. Obstacles for SCM are found to be poor level of logistical competence, lack of guidance for creating strategic alliances, strong project focus as well as the attitudes and traditions in the construction industry. SCM is a great opportunity for the construction industry primarily to reduce cost and time, and thus improve profitability. SCM principles seem to have much strength to smoothen and integrate the construction processes. The SC in construction could be divided into two major groups as materials chain and the construction chain, which would help to separate the procurement and management operations. Both chains are linked through a SCM database. This would ensure the smooth flow of information within the different chains and results in increased collaboration within the supply chain partners.

This study has pursued to obtain knowledge concerning the problems related to supply chain management on a very limited scale. There is a lot of room for further explorations and research.

- One interest could be in the incentive structure to get suppliers and contractors involved with construction. Risks and rewards structure are of interest.
- Building in city is very challenging for many construction companies. A study with a broad sample of construction sites can be of interest.
- Studies related to the different working culture in the construction site can be of interest.
- Developing a model or a typical network system how materials are procured and delivered to site could be one area of study
- How to transfer knowledge and lessons learned from one project to another taken into consideration the temporary nature of construction projects.

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Appendixes

Questionnaire

To: _____

Dear Sir/Madam,

My name is BetelhemKebede, a student of MSc in Civil Engineering - Construction Technology and Management at Addis Ababa Institute of Technology (AAiT).

For the fulfillment of graduation, I have chosen a research topic entitled **"Assessment of Supply Chain Management in Public Building Construction Projects in Addis Ababa."**

Global Supply Chain Forum has defined supply chain management as an integration of key business processes from end user through original suppliers that provides products, services and information that add value for customers and other stakeholders.

Therefore, I hereby would like to request you voluntarily take some of you valuable times and assist my research project by filling the attached questionnaire. In the meantime I would like to assure you that the responses you give would remain confidential and anonymous. If you are interested enough to get the copy of the executive summary of this research please put a remark on your return questioner so that I may send you the same. If you do have any questions or concerns about the study please do not hesitate to forward it at the addresses mentioned below.

With my best regards,
BetelhemKebede
Cell phone: 0913 481659
Email: bettykebede1981@gmail.com
Addis Ababa, Ethiopia

Section I- General Information

Q1 – What type of organization do you work in?

- ☐Public Body
- ☐Building contractor
- ☐General contractor
- ☐Consultant
- ☐Supplier
- Other. (Please specify) …….

Q2 – How long have you been working in construction industry projects?

a☐< 5yrs b ☐5-10yrs c ☐10-15yrs d ☐>15yrs

Q3 – Your position in the company (please put √ at the corresponding answer)

a. ☐Owner
b. ☐General Manager
c. ☐Technical Manager
d. ☐Contract Manager
e. ☐project coordinator
f. ☐Project Manager
g. ☐ Purchasing division Head
h. ☐ Customer services Head
i. ☐ Supply Manager
j. ☐ Logistics division head
k. ☐Other, Specify:_____

Q4 – How long have you been working as in your position in construction?

a☐< 5yrs b ☐5-10yrs c ☐10-15yrs d ☐>15yrs

Q5 – About how many public construction projects have your firm been involved in the past five years?

a☐ 1 b ☐2-10 c ☐11-15 d ☐ above 15

Section II – Perception of construction stakeholders on the benefits of SCM

Q6 –How important are the following factors to your organization supply chain collaboration?

Factors	Unimportant 1	Less important 2	Somewhat important 3	Important 4	Very important 5
a. Improved customer service					
b. Overall supply chain reduction					
c. Increased profitability					
d. Reducing bureaucracy/ paperwork					
e. Increased market competitiveness					
f. Cost reductions within your organization					
g. Benefits to the client					
h. Benefits to your supplier					
i. Improved quality assurance					
j. achievement of company goals and objectives					

Q7 – To what extent do the following factors affect the development of a successful supply chain relationship with clients?

Factors	Negligible	Low	Moderate	High	Very high
	1	2	3	4	5
1. Reliability of supply					
2. Top management support					
3. Trust					
4. Mutual interest					
5. Manpower development					
6. Closer links between demand/ supply					
7. Free flow of information					
8. More frequent meetings					
9. Simplify the whole construction process					
10. Creating standardization of processes					
11. Simplify bid process					
12. Others, please specify: _____					

Section III - Current practices and challenges in SCM

Q8 - To what extent do you believe the following factors are a barrier to supply chain integration?

Factors	Negligible	Low	Moderate	High	Very high
	1	2	3	4	5
1. Late and incorrect payments					
2. Bidding process					
3. Retention					
4. Difficulties in finding out client's desires, changes of client's requirements, long procedures to discuss changes					
5. Threat for substitute products					
6. Design/engineering interface - incorrect documents, design changes, extended wait for architect's approval or design changes					
7. Inaccurate data, engineering drawings not fitting the use					
8. Subcontracted work not delivered according to main design, contract and planning,					
9. Deliveries not in conformance with planning, wrong and defective deliveries, long storage period, awkward packing, large shipments					
10. Problematic completion due to quality problems					
11. Unresolved quality problems, delayed occupation due to late completion					
12. Inaccurate data, information needs not met, adversarial bargaining and other changes					
13. Others, please specify: _____					

Q9 - To what extent do you consider that the following functions affect efficiency of supply chain?

Functions	Negligible	Low	Moderate	High	Very high
	1	2	3	4	5
Inventory					
Transportation					
Lead Time					
Purchasing					

Q10 - How are materials replenished at project site?

	Never	Rarely	Seldom	Frequently	Always
	1	2	3	4	5
a. Based on inventory levels					
b. Just exactly as the materials are needed					
c. Others Please Specify:_____					

Q11- Which problems are related to materials management?

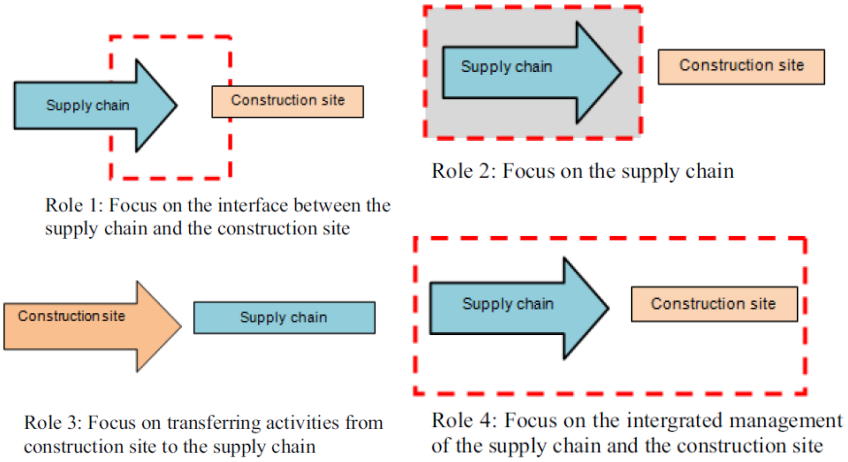
a. ☐ Changes made to the design while construction is in progress
b. ☐ Lack of attention paid to standard sizes available on the market
c. ☐ Designer's unfamiliarity with alternative products
d. ☐ Complexity of detailing in drawings
e. ☐ Incomplete contract documents at commencement of project
f. ☐ Selection of low quality products
g. ☐ Errors by tradespersons or laborers
h. ☐ Damage to work done caused by subsequent trades
i. ☐ Use of incorrect material, thus requiring replacements
j. ☐ Required quantity unclear due to improper planning
k. ☐ Delays in passing of information to the contractor on types and sizes of products to be used
l. ☐ Inappropriate storage leading to damage or deterioration
m. ☐ Use of materials which are close to working place
n. ☐ Unfriendly attitudes of project team and laborers
o. ☐ Ordering errors
p. ☐ Lack of possibilities to order small quantities
q. ☐ Purchase products that do not comply with specification
r. ☐ Other, specify:_____

Q12 - What is actually done in case of lack of materials at the project site?

a. ☐ Move people to other construction sites
b. ☐ Wait, take a break
c. ☐ Send people home
d. ☐ Prepare for other work
e. ☐ Tidy and clean the site/barracks
f. ☐ Others Please Specify:_____

Section IV - Approach of supply chain management

Q13. Construction industry is characterized by its own distinctive features, which can heavily affect SCM application. So, which SCM approach (role) do you think is effective to be applied at project site?



- ☐ **Role 1: The focus on the impacts of the supply chain on 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.
- ☐ **Role 2: The focus 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.
- ☐ **Role 3: The focus 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.
- ☐ **Role 4: The focus on the integrated management and improvement of the supply chain and the site production**. Site production is subsumed into SCM.

Section V - Solutions for the challenges in the supply chain network

Q14- What kinds of actions are usually taken to avoid problems with material deliveries?

a. ☐ Purchasing raw materials that are just sufficient
b. ☐ Good coordination between store and construction personnel to avoid over ordering
c. ☐ Adoption of proper site management techniques
d. ☐ Training of construction personnel
e. ☐ Accurate and good specifications of materials to avoid wrong ordering
f. ☐ Checking materials supplied or right quantities and volumes
g. ☐ Employment of skilled laborers
h. ☐ Minimizing design changes
i. ☐ Change of attitude of workers towards the handling of materials
j. ☐ Accurate measurements of materials during batching
k. ☐ Access to latest information about types of materials on the market
l. ☐ Vigilance of supervisors
m. ☐ Careful handling of tools and equipment on site
n. ☐ Good construction management practice
o. ☐ Adherence to standardization
p. ☐ Others Please Specify:_____

Q15 - How much did you actually benefit from using Supply chain management?

Benefits	Not at all (1)	Little (2)	Average (3)	Greatly (4)	A lot (5)
1. Reduced lead-time in production					
2. Cost saving					
3. Forecasting					
4. Resource planning					
5. Better operational efficiency					
6. Reduced inventory level					
7. More accurate costing					
8. Increased coordination with					
9. Increased coordination with					
10. Increased sales					
11. Better quality and quantity of information					
12. Flexibility					
13. Other (specify):_____					

Q16- Which of the following measures you think that its need to be improved or implemented in order to manage its supply chain better?

Measures	Improve (1)	Start Implementing	Satisfied already (3)	Not appropriate (4)
1. Close partnership with				
2. Close partnership with				
3. JIT supply				
4. Outsourcing				
5. Subcontracting				
6. Plan strategically				
7. Vertical integration				
8. Few suppliers				
9. Many suppliers				
10. Holding safety stock				
11. Use of external consultants				
12. Other (specify): _____				

Q17. I am interested in any other comment you might have concerning supply chain management in public building construction projects. Please use the space below for any of your comment.

_____

_____

_____

ONCE AGAIN I THANK YOU A LOT!!!

Please list the materials you have used for this project and name of your suppliers

(Please don't fill if you are not a contractor or public body)

No.	Type of Material	Suppliers name
1	Cement	
2	Reinforcement	
3	Aluminum	
4	Sanitary fixtures	
5	Electrical Fixtures	
6	Floor Finishes	
7	Paint	
8	Glass	
9	Aggregate	
10	Sand	
11		
12		
13		
14		

ONCE AGAIN I THANK YOU A LOT!!!

Glossary

Aggregate Planning: An operational activity which compiles an aggregate plan for the production process

Buffer: The level of merchandise / goods to be stocked as needed to accommodate regular sales orders, taking into consideration low and peak periods.

Business process reengineering (BPR) - The fundamental rethinking and radical redesign of the business processes to achieve dramatic improvements in critical, contemporary measures of performance, such as cost, quality, service and speed.

Capacity Planning - Assuring that needed resources (e.g., manufacturing capacity, distribution center capacity, transportation vehicles, etc.) will be available at the right time and place to meet logistics and supply chain needs.

Channel Leadership - Members of a supply chain (i.e. suppliers, manufacturers, distributors, retailers, etc.) who work in conjunction with one another to manufacture, distribute, and sell a specific product

Customer Service - Activities between the buyer and seller that enhance or facilitate the sale or use of the seller's products or services.

Electronic Data Interchange (EDI) – The electronic interchange of business information using a standardized format; a process which allows one company to send information to another company electronically rather than with paper. Business entities conducting business electronically are called trading partners.

Goals - statements you make about the future for your business.

Inventory Management - Maintaining accurate and up-to-date records to help identify and prevent shortages and to serve as a database for decisions.

Just-in-time (JIT) - an inventory strategy companies employ to increase efficiency and decrease waste by receiving goods only as they are needed in the production process, thereby reducing inventory costs.

Joint Planning - An orderly, analytical process that consists of a logical set of steps to analyze a mission, select the best course of action, and produce a joint operation plan or order.

Total Quality Management (TQM) - A management philosophy embracing all activities through which the needs and expectations of the CUSTOMER and COMMUNITY, and the objectives of the organization are satisfied in the most efficient and cost effective manner by maximizing the potential of ALL employees in a continuing drive for improvement.

Materials Management - Inbound logistics from suppliers through the production process. The movement and management of materials and products from procurement through production.

Total Cost Approach - the idea that all logistical decisions that provide equal service levels should favor the option that minimizes the total of all logistical costs and not be used on cost reductions in one area alone, such as lower transportation charges.

Objectives - the exact steps your company must take to reach its goals.

Profitability - The ability of a given investment to earn a return from its use.

Quality Assurance - A management method that is defined as "all those planned and systematic actions needed to provide adequate confidence that a product, service or result will satisfy given requirements for quality and be fit for use".

Quality Control - The management function that ensures that the goods or services manufactured or purchased meet the product or service specifications.

Reliability of supply - The ability of a system to perform as designated in an operational environment over time without failures.

SPSS - one of the most popular statistical packages which can perform highly complex data manipulation and analysis with simple instructions. It is designed for both interactive and non-interactive (batch) uses.