KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY,

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SUPPLY CHAIN MANAGEMENT PRACTICES OF ROAD CONSTRUCTION FIRMS IN GHANA

BY

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DECLARATION

I hereby declare that this submission is my own work towards the award of MSc Construction Management and that, to the best of my knowledge, it contains no material previously published by another person or material which has been accepted for the award of any other degree of the University, except where due acknowledgement has been made in the text.

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DEDICATION

I dedicate this work to the Glory of God, my wife and children and all love ones.

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My heartfelt thanks go to the Most High God, who made it possible for this work to be accomplished. I am also thankful to all those who helped us in diverse ways to make this research work a success, especially Dr. De-Graft Owusu-Manu who supervised the entire work. I thank also all lecturers for their time and support in diverse ways. My final thanks go to my respondents who out of their schedules managed to respond to my questionairres.

ABSTRACT

The road construction sector plays a key role in the developmental agenda of a nation by providing transportation services to the various sectors of the economy. However, the road sector has encountered series of problems in its quest to deliver road infrastructure. Road construction projects have been unduly delayed as a result of poor management of the supply chain system in the sector. The downstream has failed on many occasions to provide the requisite information to the upstream while at the same time the upstream has failed to deliver supplies to construction sites for timely completion of road projects. In this light, this study intends to explore the supply chain management in road construction in in order to enhance project delivery. The study adopted the quantitative approach in its conduct by using survey questionnaire as the main data collection instrument. This yielded a response rate of 74%. The SPSS was used to package the raw data which paved the way for statistical analysis using tools such as the chi square; descriptive statistics comprising of mean, standard deviation and indexes. The findings of the study include approaches for collaboration in the SCM of the road construction sector which consist of strategic purchasing; supply management; long-term relationships; supplier selection; and supplier involvement. Similarly, the study uncovered the benefits of SCM in road construction comprising of information sharing for continuous flow of communication among partners; risk sharing through win-win relationship among parties; resource allocation through corporation; long-term relationship for investing in equipment and efforts to preserve the strategy; better service reliability; lower operation costs; and customer satisfaction and improve overall competitive advantage. Furthermore findings were made in functional areas for SCM implementation in road construction involving client focus; continuous improvement; waste minimization; reliable workflow;

equipment acquisition; and focus on supply chain value analysis and target costing. The key success factors for SCM in road construction were top management support; reliability of supply; integrated information systems to reduce cost and eliminate waste; manpower development; and free flow of information. The study also explored managerial responsibilities of SCM in road construction consisting of planning and control of key operations to move the organization in the right direction; developing work structure indicating how the firm performs its tasks and activities; preparing organizational structure of the individual firm; developing the organizational structure for the supply chain indicating the use of cross-functional teams; and developing product flow facility structure demonstrating the network structure for sourcing. This study has the potential of igniting further studies to deepen the understanding of SCM in road construction. It will also aid practitioners in road construction to deliver projects within the framework of value for money.

Keywords: Supply, Chain, Management, Road, Construction

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CHAPTER ONE

GENERAL INTRODUCTION

1.0 Introduction

This chapter consist of the background to the study; problem statement; research questions; and aim and objectives of the study. It also focuses on the scope of the study; methodology adopted for the study; and the organization of the study.

1.1 Background of the Study

Supply chain management (SCM) is a concept originating from the supply system by which Toyota was seen to coordinate its supplies, and manage its suppliers (Stevenson, 2009). The supply chain has been defined as 'the network of organizations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services in the hands of the ultimate customer (Vrijhoef and Koskela, 2009). In the field of lean production, SCM is closely related to lean supply. The basic concept of SCM includes tools like Just-In-Time delivery (JIT) and logistics management (Deng & Min, 2005). The main goal is to decrease inventory drastically, and to regulate the suppliers' interaction with the production line more effectively.

Companies all over the world are pursuing supply chain as the latest methodology to reduce costs, time lags, waste, also to increase customer or client satisfaction, better utilize assets and build new and large revenues for growth in the competitive, globalizing environment. Indeed, the concept of supply chain management (SCM) is appearing in various industries and is moving into smaller companies (Deveshwar and

Rathee, 2010) and road construction is least to be left out as it is saddled with high inventory levels, network of suppliers and large volumes of material control.

Decisions in supply chain management in construction are made individually and collectively regarding the following areas: inventory to be stocked at each stage of activities, quantity of inventory to be held as raw material, semi-finished, or finished material ascertaining, the optimal inventory levels and re-order point. Location of inventory for effective storage and handling cost must be considered. Also how inventory should be, from one supply chain location to another, thus the most effective mode of transportation. The sum of these decisions will define the capabilities and effectiveness of the supply chain management (Rajib and Alim, 2010).

The goal of this study is to explore the supply chain management in road construction. Starting from SCM in construction, present supply chains in road construction and collaborators, bridge theory and practice gap, provide strategies suitable for timely delivery of supplies and roles of collaborators to SCM in road construction will be observed and recommendation for SCM in road construction in Ghana will be presented.

1.2 Statement of the Problem

According to Vrijhoef and Koskela (2000), construction supply chains remain problematic. The principal reason for this is due to the myopic controls focusing on effects rather than causes (Tran and Tookey, 2012). This problem is deepened further by the fragmented character of construction and its confrontational procurement, contracting and tendering environment. For instance, in a project, separate companies (and sometimes divisions of the same company) will have a tendency to manage their own parts of the process in isolation, without considering the impacts of their

behaviours on other activities in the chain. As a consequence, SCM application in the construction industry may be seriously hindered.

Most supplies at the downstream linkage when failed to deliver on time affects schedule of work on site drastically as well as defected materials and components which are supplied not per specifications. The performance of project planning and control can be improved by enabling each participant to share information with others, construction contractors normally depend on interactions over the telephone or fax machine to communicate with suppliers, subcontractors and designers. Consequently, transactions are often lost or misunderstood (Tserng et al. 2005). Such means of communicating information between contractors and collaborators (suppliers) are ineffective and inconvenient in the road construction sector in Ghana.

Prompt delivery of services and supplies are characterized by prompt honoring of payment of debt by contractors. Failure to do so after receiving pay cheques of payment certificates will therefore reduce credibility with suppliers and service providers to deliver on schedule and thereby will be difficult to plan with prevailing lead time of supplies.

Having looked at the above indication on the role of supply chain management in construction in general, it is important to state that not much empirical research has been carried out on the subject specifically in road construction sector of Ghana. It is against this back drop that this study is being carried out to explore the supply chain management in road construction practicese sector of Ghana.

1.3 Research Questions

This study will be guided by the following questions:

1. What are the existing road construction SCM environment?
2. What are the approaches for collaboration in road SCM?
3. What are the benefits of SCM implementation in road construction?
4. What are the functional areas for SCM implementation in road construction?
5. What are the key success factors for SCM adoption in road construction?
6. What are the managerial responsibilities for key stakeholders in road construction SCM?
7. What are the barriers to successful road construction SCM?

1.4 Aim and Objectives of the Study

1.4.1 Aim of the study

The aim of this study is to explore the existing supply chain management environment with emphasis on the construction industry;

1.4.2 Objectives of the Study

In order to achieve the above aim, the following objectives are set:

1. To identify the approaches for collaboration in the SCM of the road construction sector;
2. To uncover the benefits of supply chain management in the road construction sector The aim of this study is to;
3. To explore the existing road construction supply chain management environment;
4. To discover the functional areas for SCM implementation in road construction;

5. To identify the key success factors for supply chain management in the road construction sector;
6. To ascertain the key managerial responsibilities for road construction supply chain management; and
7. To uncover the barriers to SCM in the road construction sector of Ghana.

1.5 Scope of the Study

The study focused on road contractors in Ashanti Region of Ghana precisely in Kumasi metropolis. Specifically, contractors in A1, B1 and A2, B2 classification by the Ministry of Road and Highways and collaborators (suppliers) were involved in the study. This study focused on road construction projects within the last six years in the metropolis.

1.6 Methodology of the Study

To obtain adequate information on the study, both primary and secondary data was collected. The primary data was collected through carefully structured questionnaires which would be sent to all stakeholders involved in construction's SCM practices in the metropolis. Secondary data will involve the review of literature on the research topic and other related topics from books and journals. Both secondary and primary data will help in the final data analysis of data and information obtained using Microsoft Excel.

1.7 Significance of the Study

The study is aimed at increasing the understanding of SCM in road construction. It is believed that it will bridge the gap between SCM theory and practice. This study is significant by the highlighting the existing practices of SCM in the road construction sector of Ghana. Additionally, this study will serve as a source and repository of

information for students, researchers who are studying similar areas. In this respect, the study contributes to the understanding of both practitioners and researchers as it is applied in road construction companies in Ghana.

1.8 Organisation of the Study

This study consists of five interrelated chapters. Chapter one deals with the general introduction of the study comprising of the background, problem statement; research questions; aim and objectives among others. Chapter two dwells on review of relatable literature while chapter three dealt with the methodology adopted for the study. Chapter four focused on the analysis of field data collected while the final chapter concentrated on the conclusion and recommendations of the study.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

2.2 Conceptual Explanation of Supply Chain Management (SCM)

According to Christopher (1998) SCM is the management of upstream and downstream relationships to deliver superior customer value at a reduced cost to the supply chain as a whole. Harland (1996); Oliver and Webber (1992) and Houlihan (1984) used the term SCM to connote that internal chain integrates business functions involved in the flow of materials and information from inbound to outbound ends of the business. According to Shukla *et al* (2011), SCM is a network of facilities that produce raw materials, transform them into goods and finally deliver the goods to customers through a distribution system. Supply chain is intended to link all the supply chain agents to jointly cooperate within the firm as a way to maximize productivity in the supply chain and deliver the most benefits to all related parties (Finch 2006).

American Production and Inventory Control Society (APICS, 2004) define the supply chain as the processes from the initial raw materials to final consumption of the finished products linking across supplier-user industries. The supply chain constitutes all functions within and outside an industry, which enable the value chain to make products and provide services to customers (Inman, 1992). Ballou (2007) proffered that SCM integrates supply and demand management within and across companies while Scott and Westbrook (1991) opined that SCM as the chain linking each element of the manufacturing and supply process from raw materials to the end user.

Increased global corporation, vertical disintegration and a concentration on core activities have necessitated firms to link in a networked supply chain **(**Chen & Paulraj, 2004). Analytically, supply chain management (SCM) is a network of materials, information and services processing links with the characteristics of supply, transformation and demand **(**Chen & Paulraj, 2004). In addition, SCM has been used to denote logistics activities, planning, control of materials and information flows internally within a company or externally between companies (Christopher, 1992; Cooper *et al*., 1997b; Fisher, 1997). Within the context of research studies, SCM has been used to describe strategic, interorganizational issues (Cox ,1997; Harland et al., 1999); alternative organizational form , vertical integration (Thorelli, 1986; Hakansson & Snehota, 1995); the relationship a company develops with its suppliers (*see for instance* Helper, 1991; Hines, 1994; Narus & Anderson, 1995); and purchasing and supply perspective (Morgan & Monczka, 1996 and Farmer,1997).

According to Miguel and Brito (2011) Supply Chain Management is a collaborative relationship among members of different levels of the supply chain with emphasis on common and agreed practices performed jointly by two or more organizations. Min and Mentzer (2004) perceived SCM as a second order concept encompassing agreed vision and goals, information sharing, risk and reward sharing, cooperation, agreed supply chain leadership, long-term relationship and process integration. In terms of SCM constructs, Chen and Paulraj (2004) advocated five main constructs comprising of information sharing, long-term relationship, risk and reward sharing, cooperation, and processes integration. Information sharing involves continuous flow of communication among partners at both formal and informal levels to foster planning and control within the chain (Chen & Paulraj, 2004; Cooper *et al*., 1997 and Mentzer *et al*., 2001). Long-term relationship means that collaborators of supply chain are

committed to the relationship by investing in equipment and efforts to preserve the strategy (Cooper & Ellram, 1993; Dyer & Singh, 1998; Dwyer, Schurr *et al*., 1987; Ganesan, 1994) while Risk and reward sharing is based on a win-win relationship (nonpower), where organizations share investments on assets, project costs and profits and losses (Chen & Paulraj, 2004; Cooper & Ellram, 1993 and Mentzer *et al*., 2001). Cooperation implies all organizations allocate complementary resources to develop and implement strategic projects or processes and to resolve conflicts (Chen & Paulraj, 2004; Cooper *et al*., 1997; Mentzer *et al*., 2001). Lastly, process integration borders on organizations working together to ensure a continuous and efficient flow of materials and resources (Chen & Paulraj, 2004; Cooper *et al*., 1997; Mentzer *et al*., 2001).

Several disciplines have contributed massively to the evolution of SCM; key among them are purchasing and supply, logistics and transportation, marketing, organizational behaviour, network, strategic management, management information systems and operations management(Chen & Paulraj, 2004). SCM approaches and initiatives undertaken by companies, and mostly investigated by researchers include strategic purchasing, supply management, logistics integration, supply network coordination, communication, long-term relationships, supplier selection, supplier certification, supplier involvement, trust and commitment (Chen & Paulraj, 2004). In adopting the concept of SCM in organizations and for that matter construction firms, supply chain orientation must precede the infusion of SCM into organizations. Supply chain orientation which are behaviours that members of organizations must adopt for SCM infusion into the organization include trust, commitment, common vision and goals or top management support (Miguel & Brito, 2011 and Min & Mentzer 2004). Similarly, Miguel and Brito (2011) adapted the work of Chen and Paulraj

(2004) and proposed three key dimensions for effective SCM in organizations including construction firms. These dimensions include, supply network structure, characterized by strong linkages between members, low levels of vertical integration, non-power based relationships; long-term relationships, managed with effective communication, cross-functional teams, early supplier involvement in crucial projects, planning processes; and logistics integration.

The positive impacts constructs of SCM on operational performance of construction firms are enormous. These comprises of process improvement, inventories and lead time reduction; reduction of uncertainty in the supply chain; better planning and control processes; and cost and time reduction and quality and flexibility improvements (Cooper *et al*., 1997; Cooper & Ellram, 1993; Bechtel & Jayaram, 1997; Mentzer *et al*., 2001; Lee *et al*., 1997; Jarillo, 1988). However, Harland *et al.* (2006) opined that the concept of SCM is still an emerging discipline and there is no consensus about its definition and constructs throughout extant literature (Burgess *et al*., 2006; Mentzer *et al*., 2001; Gibson *et al*., 2005). In dealing with the diversity of conceptual explanations of SCM, Croom (2005) held the view that it is prudent to concentrate on the core processes and functions relating to the management of supply chains such as fulfillment, operations planning and procurement. This is to provide enough scope for the analysis of important initiatives of organizations regarding SCM.

Gunasekaran and McGaughey (2003) believed the scope of SCM is beyond material management, partnership and information technology by encompassing total quality management areas notably management commitment, organizational structure, training and behavioural issues. Some of the definitions of supply chain management provided by Shukla *et al*. (2011) provided in Table 2.1 below.

Table 2.1: Conceptual explanations of SCM

Authors	Definition of SCM	Key ideas
Scott and Brook, (1991)	The chain linking each element of the manufacturing and supply process from raw materials to the end user, encompassing several organizational boundaries	Highlights the significance of coordination among constituent members.
Ellaram, (1991)	The integration of the processes, systems, and organizations that control the movement of goods from the supplier to a satisfied customer without waste.	Highlights the necessity of integration among the organizations, physical \movement and the waste reduction principal of JIT.
Lee and Billington, (1992)	Networks of manufacturing and distribution sites that procure raw materials, transform them into intermediate and finished products, and distribute them to customers.	Attempts to show conventional functions of supply chain.
Christopher, (1992,1998)	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.	Signifies the importance of relationships, customer focus and cost reduction.
Ellrarn and Cooper, (1993)	An integrating philosophy to manage the total flow of a distribution channel from supplier to ultimate customer.	Identifies the importance of integration within supply chain.
Berry *et al.* (1994)	SCM aims at building trust, exchanging information on market needs, developing new products, and reducing the supplier base to particular original equipment manufacturer so as to release management resources for developing meaningful, long term relationship.	Highlights the importance of supplier relationships in achieving supply chain objectives.
Cox *et al.* (1995)	The functions within and outside a company that enable value chain to make and provide products to the customer.	Attempts to identify strategic partners within supply chain.
Saunders, (1997)	Supply Chain is the total chain of exchange from original source of raw material, through various firms involved in extracting and processing raw materials, manufacturing, assembling, distributing, and retailing to end customers.	Network of firms interacting to deliver product or service to the end customer, linking flows from raw material supply to final delivery.
Patricia *et al.* (1996)	The physical network that begins with the supplier and ends with the customer.	Traces all the organizations with within a supply chain including all tiers of suppliers and distribution.
Monczka and Morgan	Integrated SCM is about going from the external customer and then managing	Highlights the necessity of flat organizational

(1997)	all the processes that are needed to provide the customer with value in a horizontal way.	structure and customer focus.
Tan *et al.* (1998)	It is management philosophy that extends traditional intra-enterprise activities by bringing trading partners together with the common goal of optimization and efficiency.	Focuses on how firms utilize their suppliers' processes, technology and capability to enhance competitive advantage.
Houlihan and Houlihan, (1999)	The integration of various functional areas within an organization to enhance the flow of goods from immediate strategic suppliers through manufacturing and distribution chain to the end user.	Considers strategically important suppliers and integration among constituent members

Source: Shukla *et al*. (2011)

Koskela *et al*. (2002) portray SCM views as transformation and production which is conceptualized as a conversion of inputs to outputs. The principles by which production is managed suggest, for example, disintegrating the total transformation hierarchically into smaller transformations, called tasks, and minimizing the cost of each task independently of the others. The conventional pattern of production has been based on this transformation view, as well as the doctrine of operations management. However, this basis of production is an idealization, and in complex production settings the associated idealization error becomes unacceptably large. The transformation view is instrumental in determining which tasks are needed in production. Production managed in the conventional manner therefore tends to become inefficient and ineffective. The production as flow view is embodied in lean production; a term coined to characterize Toyota's manufacturing practices. In the flow view, the basic thrust is to eliminate waste from flow processes. Thus, such principles as lead time reduction, variability reduction, and simplification are promoted. Hopp and Spearman (2000) demonstrated by means of queuing theory that the various insights that have been used as heuristics in the framework of JIT can be mathematically proven.

The significance of improved construction supply chain performance in order to improve the stakeholders' achievement of both short-term business objectives and long-term competitive advantage cannot be underestimated (Egan, 1998). Lean construction has to be developed and modified to fit the project-based context (Hook & Stehn, 2008). According to Eriksson (2010), the various best practices of lean supply chain can be grouped into six core elements as follows: waste reduction, process focus on production planning and control, end customer focus, continuous improvements, cooperative relationships and systems perspective, demand management. Supply chain management include a wide range of services notably operational analysis and design materials handling; distribution strategy; operational improvements, distribution management; computer systems; warehouse design project management; operational commissioning; computer simulation; and technical seminars (Zigiaris, 2000).

2.2 Evolution of Supply Chain Management

Shukal *et al*. (2011) in their work provided excellent work on the evolution of SCM noting that industrial activities such as material requirements planning (MRP) in the 1970s provide inventories on manufacturing cost, quality, product development, and delivery lead-time. The attractiveness of the concept of supply chain management emanated from many directions including the quality revolution (Dale *et al*., 1994). Materials management and logistics management which are key components of the construction industry have also necessitated supply chain management (SCM) (Carter & Price, 1993). Increasing interest in industrial markets and networks (Ford, 1990 and Jarillo, 1993); the desire to focus on operations (Porter, 1987; Snow *et a*l., 1992), and the influences of studies concentrating on industry are all strong underpinning for SCM (Womack *et al*., 1991 and Lamming, 1993).

Supply chains have existed ever since businesses have been organized to bring products and services to customers, the idea of their competitive advantage, and consequently supply chain management (SCM) (Chen & Paulraj, 2004). It is believed SCM originated along the lines of physical distribution and transport (Croom *et al*., 2000) which is hinged on the theory of industrial dynamics (Forrester, 1961). Regarding theories and practice, SCM is believed to have traced its source to total cost approach to distribution and logistics (Heckert & Miner, 1940 and Lewis, 1956). The concept of supply chain management was introduced by consultants in the 1980s (Oliver & Webber, 1992). Since its introduction, SCM has gained tremendous attention in many spheres of human endeavor including construction (La Londe, 1998).

The evolution eras of SCM coined by Shukla *et al*.(2011) include creation era in which the term SCM was introduced by an American consultant in 1980; the second era was the integration era which saw the introduction of key terms notably development of electronic data interchange (EDI) and enterprise resource planning (ERP) systems. The next era was Globalization which witnessed the infusion of SCM into organizations in global dimension; while specialization era with emphasis on outsourced manufacturing and distribution brought antecedents such as the abandonment of vertical integration by companies; sale of non-core operations, and outsourcing of those functions to other companies. The phase two of the specialization era was when supply chain management was considered as a service. This era began in the 1980s with SCM operations notably the inception of transportation brokerages, warehouse management, and non-asset based carriers which have matured beyond transportation and logistics into aspects of supply planning, collaboration, execution and performance management. The final era was

supply chain management in which the introduction of the World Wide Web which is meant to increase creativity, information sharing, and collaboration among users in performing their respective businesses.

2.3 Overview of Supply Chain Management in the construction industry

The application of SCM in the construction industry has been tried with varied degree of success **(**Tiwari *et al*., 2014). The application of SCM concepts to construction sector require the supply chain managers to break the traditional SCM shells of manufacturing industry and make the supply chain project-centric rather than organization-centric. According to Hatmoko and Scott (2010), construction supply chain management is a system of suppliers, contractors, clients and their agents working together in coordination to install and utilise information in order to produce, deliver materials, plant, temporary works, equipment and labour and/or other resources for construction projects. Construction supply chain management in most studies focused on reduction of costs (especially logistical costs), lead-time and inventory in the supply chain (Tran and Tookey, 2012); while others concentrated on material and labour flows to the site to avoid disturbances in the workflow (Vrijhoef & Koskela, 1999).

The adoption of SCM in construction was necessitated by the successes it chalked in other industrial sectors when researchers and professionals related to construction adapted supply chain management (SCM) philosophy in order to make construction industry more effective and more efficient in the 1990s. Specifically, the supply chain management philosophy adoption in construction was inspired by manufacturing supply chain management (MSCM) in spite of the marked differences between the two philosophies (Tran and Tookey, 2012). Khalfan *et al.* (2004) believed that the adoption of SCM philosophy in construction has the potential of solving the mounting

problems identified by Ofori (2000) namely win-lose arrangements; a focus on negative issues; uncertainty within construction process; a minimal exchange of information and knowledge; price competition due to buying of supplies of each item from many companies; and the environment of fear, dishonesty, and frustration.

The construction supply chain commences with the determination of the requirements of the project owner which are communicated downstream (Longfellow, 2009). The determination of the requirements of the project owner necessitates the flow of information, material and money which subsequently determines the quality of the level of construction supply chain management (Benton & McHenry, 2010).The identifiable aspects of information flow in construction supply chain management include the information sharing support technology, information content, and information quality which have attracted the attention of construction organizations within the framework of information technology(IT) (Benton, 2007).

According to Tiwari *et al.* (2014) construction supply chain involves the purchase of materials; leasing or buying equipment and contracting with subcontractors to produce a finished project. The construction supply chain is regarded as an operational and strategic cycle that encompasses labor, materials, equipment, subcontracting, and a finished project (Trent, 2005). The three main elements linking supply chain in construction are technology, safety, and communications (Tiwari *et al.*, 2014). Among these elements, technology and safety are crucial to the reduction of construction cost (Trent, 2005). The adoption of appropriate technology on the field of construction operations decreases the amount of time required to perform tasks and administrative duties while safe working environment inures into less or no fines; decreased workers' compensation pay and claims; and a prestigious image in the community of operation (Akintoye *et al*., 2000).

According to Benton and McHenry (2010) construction supply chain involves entities such as the project owner, architect and engineers, prime contractor, subcontractors, and suppliers. These entities require interrelationship among them to function effectively for project delivery. In a heavy construction project supply chain, the participants in the chain include project owner, the design engineer, the prime contractor, the subcontractors, the suppliers of materials and equipment, and the banks (Benton, 2007).

The lack of effective interrelationship among these entities poses severe risks to the construction process notably internal financial problems; working capital problems; slow payment from project owner; inferior plans and specifications; inadequate technical capabilities; insufficient information technology; lack of communication between supply chain partners; productivity inefficiencies; work quality problems; work method problems; delivery reliability problems; bulk materials quality problems (Benton & McHenry, 2010). The complex nature of construction supply chain has made its management to be characterized by adversarial short-term relationships driven by the competitive bidding process (Trent, 2005). Supply chain management in construction is dependent on efficient resource coordination and teamwork (Benton, 2007). Similarly, within the SCM relationship management in construction, the contractor is responsible for coordinating and motivating the supply chain to deliver a high-quality project under budget and on time (Trent, 2005). In pursuing a vigorous supply chain management relationship in the construction subsector, the contractor must adhere to five main principles comprising of competing by adding supply chain value and eliminating waste; establishing long-term relationships with subcontractors and suppliers; focus on supply chain value analysis and target costing; development of continuous improvement throughout the supply

chain; and promotion of upstream and downstream information technology(Benton & McHenry, 2010).

It is also important to note that for a construction firm to keep its head above water in the face of mounting global competition, it is necessary to maintain strong relationships with subcontractors and suppliers (Benton, 2007). A good relationship among collaborators will help the construction organization to secure highly qualified subcontractors and materials that will ensure value for money (Benton & McHenry, 2010). Similarly, a strong relationship between a construction organization and subcontractors and suppliers will aid the construction organization to be considered as the most valuable customer for supply in order to ensure the survivability of the construction organizations (Longfellow, 2009). Trent (2002) perceived supply chain relationship management within the framework of counterproductive (lose-lose), competitive (win-lose), cooperative (win-win), and collaborative (win-win) relationships. It is worthy to note that good supply chain relationship management maximizes profits by reducing delays in delivery of materials, equipment, and services to the project site (Benton & McHenry, 2010).

According to Department for Business, Innovation and Skills of UK (2013) players in the construction industry supply chain management are categorized as Tier 1, Tier 2 and Tier 3 in which main contractors with a direct commercial relationship with a client are termed Tier 1. Sub-contractors and suppliers with a direct contract with the Tier 1 main contractor are termed Tier 2. Sub-contractors and suppliers working for sub-contractors are termed Tier 3. Tier 3 sub-contractors also employ suppliers and sub-contractors, so in many cases there will be a fourth or even fifth tier involved in construction delivery. Yan (2012) have also introduced lean construction supply chain management model to Engineering Project and Construction (EPC). This is aimed at

applying lean thinking as well as relevant lean technologies to solve the major problems of EPC project management and improve the overall competence of our Construction supply chain (Tiwari *et al.*, 2014).

2.4 Elements of SCM in Construction

2.4.1 Waste Minimization

Waste reduction is the most important element of construction (Green, 1999). A central aspect of waste reduction is keeping the construction site well organized, clean and tidy (Salem *et al*., 2006). Workers should therefore be encouraged to clean the job site once an activity has been completed (Salem *et al*., 2006). A related aspect, crucial for waste reduction in lean construction, is efficient transportation and stockholding of material, often termed just-in-time (JIT) delivery, (Mao and Zhang, 2008). From a JIT perspective inventories are not valuable and should be regarded as waste (Salem *et al.*, 2006). Through JIT, contractors strive to receive smaller batches of material to the site when they need it in order to reduce stockholding and double-handling of material (Mao and Zhang, 2008). In the perspectives of waste management, lean performances are important to generate flexibility in order to control organization waste; the focus is to reduce waste; not costs, (APICS, 2004). Anything that delays or impedes supply chain's flow must be analyzed as a potential non-value added activity. Some of the lean performances initiatives can be taken such as engaging and energizing people and supply chain partners to work together and individually to eliminate wasteful processes and excess inventory across the chain. This elimination of waste should have a significant by-product, a reduction in cost for the supply chain.

2.4.2 Process Flow

Approaching production management through a focus on processes and flow of processes is another core element of construction. The last planner system is a key aspect that enhances efficient production planning and control (Jorgensen and Emmitt, 2008). Last planners are the people accountable for the completion of individual operational assignments (Salem *et al*., 2006). Each planner prepares weekly work plans to control the workflow, and if assignments are not completed on time, they must determine the root cause and develop an action plan to prevent future failures **(**Kamaru, 2012**)**. It is important that each individual takes immediate action regarding their own work i.e. self-control to prevent defects at the source, hindering them to flow through the process (Ballard *et al*., 2003; Salem *et al*., 2006).

Better process flow involves identifying and eliminating non-value-adding activities in design, production, supply chain and dealing with customers. The goal of Lean is to maximize process flow and flexibility **(**Kamaru, 2012**)**. Lean deployment methodology has evolved over the last few decades into a highly capable, well-defined multi-step approach that can be applied to administrative processes as effectively as production processes. Some of the advantages of better process flow include: structured methodology for waste identification and elimination in any process, organization wide training and involving employees at all levels, focused and rapid process improvement and cost reduction structured project management approach. This helps communicate customer defined value to all levels of organization and strong analytical tools to map the process and identify root-causes (Kent and Attri, nd).

Material flow has been identified by Tiwari *et al*. (2014) in their systematic review to be an integral part of the construction supply chain process. The review among other

things revealed that the smooth flow of material across the construction supply chain is considered as a major factor in successful execution of construction projects.

With the continued development of confined urban centres and the increasing high cost of materials, any marginal savings made on-site would translate into significant monetary savings at project completion. Such savings would give developers a distinct competitive advantage in this challenging economic climate. As on-site management professionals successfully identify, acknowledge and counteract the numerous issues illustrated, the successful management of materials on a confined urban construction site becomes attainable.

It is also important to improve coordination in construction supply chain and flow of information among various business entities. An e-business model to support supply chain activities in construction has been developed by researchers to support business cordination (Eddie *et al.*, 2001). The authors have advocated that proposed e-business model not only will be of benefit to those organizations which operate in the construction supply chain, but also may be fit for other types of business-to-business e-commerce when cooperation between business partners is necessary to improve organizational performance and gain a competitive advantage (Tiwari *et al*., 2014). With the advent of information technology, it is possible to achieve the supply chain management for construction by seamlessly connecting all components in the construction chain with real-time information.

2.4.3 Customer/Client Focus

Another element of supply chain is customer focus. It is very significant maximizing the value of construction (Jorgensen and Emmitt, 2008; Mao and Zhang, 2008). Contractors and suppliers must understand the needs of the customer so that they can supply the customer with what he/she needs, not what he/she asks for (Styhre *et al*.,

2004). Customer satisfaction is dependent on the end product and the process during which it is created, that is service quality (Maloney, 2002). In order to increase end customer focus, it is important to adopt principles already in the design stage (Freire & Alarcon, 2002). Early involvement of contractors and integration of design and construction in concurrent engineering are an important aspect in construction (Green and May, 2005; Mao and Zhang, 2008; Jorgensen and Emmitt, 2009).

In organizational terms improving customer focus requires firms to integrate market intelligence with design and product development much more closely, so that customer requirements are channeled directly to managers at key decision points. To achieve this traditional functional divisions based on development, design, production and marketing, may need to be eroded with decision making devolved as much as possible. Identifying user requirements and adding value to increase 'satisfaction' pre-suppose that customers know what they want and their needs can be captured and translated into realizable products. The objective of a system would be to ensure that firms are much better able to respond to customer requirements during the conceptualization phases of a project and accelerate decisions during its realization phases. This has traditionally proved especially difficult in the construction industry (Ahmed and Kangari 1995), although some attempts have also been made to develop tools for capturing customer requirements more effectively. Anumba *et al*. (1996) argue that more effective ways of processing clients' requirements and designing quality into the product can be developed using new techniques such as 'quality function deployment' (QFD) and 'design function deployment' (DFD).

2.4.4 Continuous Improvement

A long-term perspective on continuous improvements (called Kaizen in the Toyota Production System) is equally important in construction (Green and May, 2005; Salem *et al*., 2006) in order to reduce waste and increase the efficiency of the construction process over time. Long-term contracts are an important aspect, reducing the traditional short-term focus on cost reduction (Green and May, 2005) and promote lasting improvements. By working together on a series of projects the transfer of knowledge and experiences among supply chain actors and from one project to another is facilitated. For almost three decades now, leading companies have been implementing effective processes in order to plan and execute strategy, to prioritize market and plant improvement opportunities, and to monitor results. Much of Western manufacturing has "gone Lean", using the tools of lean manufacturing and Six Sigma to drive continuous improvement - reduce defects, cut set up times and order quantities, slash lead times, increase productivity, reduce obsolescence, and cut costs. The widespread adoption of continuous improvement through manufacturing and 6 Sigma, and of sales and operations planning, have been the outstanding events in manufacturing in the last twenty years (Salem *et al*., 2006).

2.4.5 Partnering

Cooperative relationships among the supply chain actors often referred to as partnering are an important element of supply chain (Green and May, 2005; Jorgensen and Emmitt, 2008), facilitating the integration of different actors' competences and efforts in joint problem-solving. Since traditional procurement and governance forms are often criticized for producing waste, long lead times, and adversarial relationships, they need to be changed into a contracting approach. Since subcontracting can account for most of the project value and because project activities are totally

interrelated, a harmonization between main contractors and subcontractors is important for partnering and for construction (Miller *et al*., 2002).

Companies must learn to create reliable partnerships with their suppliers in order to be able to reduce on costs. Meurer (n.d) argues that organizations should focus on only reducing supply chain costs through direct raw materials but also through effective partnerships with suppliers. Organizations that practice adversarial type of relationships with all their suppliers may not be able to achieve a lot in cost reduction even if they require suppliers to reduce their prices on a yearly basis.

According to Tiwari *et al*. (2014), 'partnering' in the construction supply chain implies:

- Long-term relationship among supply chain members, which was due to trust and open communication;
- Processes are in place to incentivize for good performance as part of the supply chain;
- Appropriate strategies are in place for main contractors to use local suppliers, subcontractors, and work force;
- There is a commitment of client to provide long term work (work continuity) for enhancing supply chain integration;
- Strong commitment of clients and main contractors to invest in training and development of their supply chain organizations;
- Early payments of services provided is observed;
- Involvement of downstream suppliers and subcontractors at the beginning to understand the buildability and interface issues, is not very common;
- Learning is taken from one project to the new projects;

- Support is provided from main contractors to their supply chain partners if any one of them; are in troubled water either financially or skill shortage-wise, etc.; and
- All supply chain participants are practicing the partnering ethos both in the office as well as on construction and development site.

2.4.6 Reliable Workflow

Another core element of supply chain is to adopt a systems perspective (Jorgensen and Emmitt, 2009), which is required in order to increase the overall efficiency of supply chain and avoid sub-optimizations (Green and May, 2005; Jorgensen and Emmitt, 2008). A reliable workflow in the system as a whole is more critical than individual activity speed or cost (Miller *et al.*, 2002). An important aspect of this is to consider the whole buying process and make coherent procurement decisions that support or complement one another (Eriksson and Pesamaa, 2007). Smith and Fingar (2004) argued that in modern times there are enterprise applications that have made the flow of work in organizations more reliable. Applications such as Enterprise resource planning (ERP) have been very instrumental in the integration of various departments in the organization thus making it possible to achieve reliable workflow. Smith and Fingar further indicated that today, workflow is far more than an aid to manage documents and forms routing since it has become a systems development platform in its own right and a way to develop new business applications.

2.4.7 Demand Management

In terms of demand management, it is very important that how well firms manage the demand signal, demand collaboration, sales and operation planning and inventory management is also reflected in how a supply chain system is viewed as a system (Phelps, 2004). Seeking a Web-based solution that provides high levels of scalability,

economy, usability, availability, synergy and functionality is important for organizations wanting to migrate. It is important to ensure that the solution chosen should be able to support a real-time response that is designed to enable an enterprise to dynamically forecast against a number of variables, such as supply, customer orders, inventory, and financial objectives. Demand management enables an automated bionetwork of the supply chain that simultaneously maps demand forecasting against factors like supply restrictions, customer commitments, inventory counts, financial predictions, as well as patterns of behavior that can affect demand at any given time (Aberdeen Group, 2010).

2.5 Success Factors of Performance in Construction SCM

The drivers of performs as outlined by the Department for Business, Innovation and Skills of UK (2013) are demonstrated in Table 2.2 below.

Table 2.2: Drivers of construction SCM performance

SCM Performance Driver	Explanation
1. Financial arrangements	Prompt payment builds trust and encourages flexibility in the supply chain.
2. Selection of the Supply Chain	Supply chain selection involves balancing competition and cooperation as means of developing best value solutions on behalf of clients.
3. Design management	Design management has a crucial role in enabling improved project performance, by ensuring that design is complete and buildable, by unlocking supplier contributions to design development and through effective change management.
4. Construction site management	Effectiveness of site management has a high impact on project performance as most of the integration and coordination of the supply chain is undertaken by the site team.
5. Price determination	Work has to be priced realistically to drive effective project performance. The challenge for suppliers is whether the 'realistic price' meets the affordability constraints of the client.
6. Supply chain integration	Greater integration of the supply chain is an effective means of reducing cost and eliminating waste.

Also Tan (2001) identified the drivers of SCM in the construction industry to include change in the corporate cultures; trust and communication among parties involved; information/knowledge sharing; suppliers evaluation for supplier development process; and sharing common goals of waste elimination and increased efficiency. According to Vrijhoef and Koskela (2000), the roles of construction supply chain management include focusing on the interface between the supply chain and the construction site; concentration on the supply chain; transfer of activities from the construction site to the supply chain; and integrating the supply chain with the construction site. Similarly, Vrijhoef and Koskela (2000) demonstrated that these roles of construction supply chain management are also the practical initiatives required to implement SCM in construction and to reduce cost.

In construction supply chain management, purchasing price has been identified as the dominant determinant of supplier selection (Wegelius *et al*., 1996). SaKirkilahti (1993) found that subcontractors are predominantly selected on the basis of price. In Tiwari *et al*. (2014) the success factors of supply chain management in construction were noted as follows:

- education process;
- cultural change;
- an understanding that all parties will benefit /profit;
- open and shared approach to the dissection of the 'associated benefits' of improved supply chain performance;
- an attitude of 'if you're in, you win' with regard to enhanced approach to supply chain participation;
- pre-planning and visibility opportunities provided by a visible client forward workload well into the future that is shared by the supply chain 'family';

- where possible freeze expectations but include change where necessary through joint agreement through the use of contingency plans;
- regarding the sub-contractor as being part of the supply chain (key to the value add process);
- sharing a full picture of the project;
- sharing the values that are required by the supply chain;
- inviting input where the sub-contractor can add value; and
- vision for future.

2.6 Management Components of SCM

According to Lambert and Cooper (2000) the management component of SCM should comprise of planning and control of key operations to move the organization in the right direction; the work structure indicating how the firm performs its tasks and activities; organizational structure of the individual firm and the supply chain including the use of cross-functional teams; and product flow facility structure which refers to the network structure for sourcing, manufacturing, and distributing across the supply chain.

2.7 Benefits of SCM in Construction

The application of SCM in firms will enable them to achieve lower operation costs, better service reliability, decrease inventory level, reduce order cycle time, lower the number of back orders, improve customer satisfaction and improve overall competitive advantage (Talib and Hamid, 2014; Bowersox *et al*., 2010) . Several studies have indicated that the application of SCM in the construction industry can result in better coordination, costing and control **(**Tiwari *et al*., 2014). It can also lead to a better understanding of a firm's production costs and capabilities particularly the

ability to manage the resources across projects given changes in schedule and scope. It further affords construction firms several opportunities for improvement as it provides a background for improved production control within each subcontractor and supplier **(**Tiwari *et al*., 2014).

It has been established that construction supply-chain management offers new approaches to reduce the cost and increase the reliability and speed of facility construction. Supply-chain management takes a systems view of the production activities of autonomous production units (subcontractors and suppliers in construction) and seeks global optimization of these activities. The promise of supply-chain management comes from its system perspective on production activities. Such a perspective allows improved understanding of firms' production costs and capabilities (particularly under the uncertain and changing conditions that characterize modern construction sites). Supply-chain management ensures an engineering basis for designing, planning and managing construction projects in a collaborative manner **(**Tiwari *et al*., 2014).

Furthermore, in Tiwari *et al.* (2014), the contributions of SCM to the construction industry were outlined as follows:

- cost and performance modeling of subcontractor and supplier production;
- improved scheduling methods, particularly with regard to the design and placement of buffers against uncertainty and changes;
- improved subcontractor coordination methods by linking site production to resource management; and
- improved accounting and production control systems.

2.8 Supply Chain management in the construction sector

Supply chain collaboration has been beneficially applied to several industries, notably in vehicle manufacture and the retail trade **(**Akintoye *et al*., 2000). The benefits of collaborative, rather than adversarial, working relationships within and beyond the organisation were identified by Ford (1980) while Lummus *et al*. (1998) suggested that SCM was growing in importance due to: increased market competition, the acceptance of a wider focus for evaluating organisational change and its full impact on company fortunes and the declining incidence of vertical integration as a result of which efficiency and innovation can no longer be solely an internal management function. Wider co-operation and consultation are a regarded as a necessity in the new order. Christopher (1992) suggested that a customer service explosion, time compression, the globalisation of industry and organisational integration has given great importance to SCM.

2.9 Successful Factors for Supply chain management in Construction

The emergence of prime contracting and the increasing use of framework agreements in the construction sector potentially provide a more supportive climate for SCM than has traditionally prevailed **(**Tiwari *et al*., 2014). According to Wong and Kanji (1998) construction SCM, when adopted along with partnering and total quality management, can successfully address major problems of the industry and its clients. A wider and clearer view of project partnering and the linkage to total quality management has been proffered by Wong and Fung (1999). Similarly Akintoye *et al*. (2000) identified key success factors for construction supply chain management which consist of trust, reliability of supply; top management support; mutual interest; free flow of information; joint business planning; closer links between demand and supply; integrated information systems; and manpower development. Adding on, Talib and

Hamid (2014) found collaborative partnership; information technology; top management support; and human resource to be major critical success factors for SCM implementation in organizations.

2.9 Supply Chain Management Strategies

Supply chain management strategies include two or more firms in a supply chain entering into a long term agreement; the development of mutual trust and commitment to the relationship; the integration of logistics events involving the sharing of demand and supply data; the potential for a change in the locus of control of the logistics process" (La Londe & Masters, 1994). Manufacturers are able to develop alternative conceptual solutions, select the best components and technologies, and assist in design assessment by involving suppliers early in the design stage, (Burt & Soukup, 1985). Similarly Brammer *et al*. (2011) identified the strategies for SCM as establishing code of conduct to ensure that expectations are met throughout the supply chain process; certification using screening device in the selection and development of suppliers; selection which is the primary process of reducing supply risks; and monitoring and auditing to ensure compliance with expectations. In their strategic model for implementing sustainable SCM, Brammer *et al*.(2011) demonstrated key activities necessary for every level of the strategies. These activities are outlined in Table 2.3 below.

Table 2.3: Supply chain management strategies

Strategy	Activity	Process
1. Creating meaningful expectation	Environmental scanning in partnership with stakeholders	Develop code of conduct
2. Confirming suppliers and agreeing upon targets	Measurement and development of KPIs for consultation	Supplier selection
3. Measuring supply chain performance	a. Supplier development: investments, training, incentives and changes in practices. b. Industry and community engagement	Monitoring and auditing
4. Evaluate and improve	Capture data	Supplier evaluation and learning

Source: Adapted from Brammer *et al*., (2011)

2.10 Barriers to supply chain management in the construction sector

The successful implementation of SCM requires that implementers surmount challenges. The identification of these challenges will help managers of companies adopt antidotes for them. Key among these challenges are lack of common purpose; multiple and hidden goals; power imbalances; culture and procedures; conflict over autonomy and accountability; over-dependence and a continuing lack of openness and opportunistic behaviour (Cox & Townsend, 1998). Barriers to SCM are categorized as inter-firm rivalry and managerial complexity (Fawcett *et al*., 2008). Inter-firm rivalry barriers of SCM include internal and external turf wars, poor SCM planning, lack of vision of SCM, lack of trust, executive commitment and poor SCM understanding while Managerial complexity includes misaligned SC processes, structures and major differences in SCPs' business culture (Fawcett *et al*., 2008).

Brammer *et al*. (2011) outlined barriers to effective SCM implementation demonstrated in Table 2.4 below.

Table 2.4: Barriers to SCM

Area	Barriers
1. Expectation	• Un-negotiated expectations lack legitimacy with local stakeholders. • Expectations codified in codes of conduct tend to remain relatively static and are thus unresponsive to new issues or changes in stakeholder expectations. • Codes and their underlying rationale are seldom communicated effectively to supply chain partners, rendering them ineffective. • Implementation of culturally unsophisticated codes can lead to unforeseen negative consequences (for firms or society).
2. Selection	• Selection tends to favour those with developed capabilities over those without such capabilities; suppliers with developed capabilities are not always available. • Suppliers often lack the know-how to implement sustainable practices. • Certification imposes considerable costs on supply chain partners.
3. Inspection	• Monitoring and auditing approaches undermine trust and commitment in buyer–supplier relationships. • Intensive monitoring can incentivize unethical practices that hide issues from supply chain partners.
4. Rejection	• Lack of security of contract undermines suppliers' willingness to invest in alternative (more sustainable) practices. • De-selection of suppliers' leads to a restriction of firms' supply base to the point where, in some circumstances, sourcing sustainably is impossible. • Suppliers often lack the resources to implement new approaches, and countervailing pressures (for example, the need for timely deliveries) tend to undermine the conditions necessary for compliance among partners.

In another vein Khalfan *et al*. (2004) proffered that the fragmentation of project delivery system, lack of trust, and adversarial contractual relationship are barriers against SCM implementation in construction. Akintoye *et al*. (2000) also identified the key barriers to SCM as nature of construction project teams (each of them could be referred as 'temporary multiple organisation' which disappears after a project is completed, culture at the workplace, lack of commitment from senior managers, lack

of trust, inappropriate support structure, and lack of knowledge about supply chain management philosophy in general. Adding on, Barratt (2004) noted implementation problems of SCM some of which include difficulty in collaboration; over-reliance on technology for implementation; failure to differentiate between whom to collaborate with; and lack of trust between trading partners.

People are resistant to changes on their working place even if the management is dedicated enough efforts in training programs and explaining the values of the new practice. Especially when workers veterans encounter the new challenge of changing their way of working and when they need to be convinced in the benefits of the new technique. Many negative attitudes can be turned into a great resistance (Mefford, 2009). A hard time is the decision to let go some of the employees who cannot accept the adoption of change and wouldn't support the implementation efforts.

Employees' skills, knowledge and experience necessary for working specific tasks throughout the company can be scarce and difficult to copy and hence provide a platform for sustainable competitive advantage. So subsequent problems with staff retention have a major impact on operating performance and "getting into a bidding war"(Lewis, 2000). These skills have a market value for the particular company and if externally visible to other competitors in the same field a risk of staff leaving to leverage this value appears. When key members of staff are being headhunted by other larger organizations willing to offer substantial benefits, to retain these staff becomes time consuming, expensive and can have a major impact on morale in single status firms. Traditionally companies have been developing multiple sources of supply using lowest price as a major deciding criteria. They seem to have overlooked the inbuilt inefficiencies and higher costs in such a system due to sub-optimization and low volume per supplier. Managing costs for multiple suppliers is also very high.

Some of the best companies in the world, based on the experience of Japanese companies are now gradually shifting to single supplier. However, again there is a disadvantage of such a set up (Admides *et al*., 2008).

In case of contingencies at the suppliers end, most or all of the supply of material may get disrupted. So it is better to have a key supplier and one or two secondary suppliers. Successful companies have developed long term relationships with the key suppliers, to the extent of helping some of them even get the Deming Award for quality improvement. A long term strategic relationship helps companies to keep the sourcing costs low and synchronize the production planning process to reduce the variability in the sourcing chain. Since commodity prices fluctuate and increase due to inflation, companies entering into long term supply contracts as part of strategic relationships, are able to ensure supply of raw materials and relatively lower and stable rates (Kate *et al*., 2005).

Furthermore, Akintoye *et al*. (2000) in an empirical study uncovered key challenges serving as barrier to successful implementation of SCM in the construction industry. These barriers include lack of top management commitment; poor understanding of the concept; inappropriate organisation structure to support system; low commitment of partners; unclear strategic benefits; and lack of appropriate information technology.

2.11 Suggestions for Addressing the Barriers of Construction SCM

Some of the suggestions by Fawcett *et al*. (2008) for addressing the barriers of SCM implementation include information transparency; collaborative planning; IT architecture/internet; formal performance tracking; adopt strategies SCM vision; attention to human factors; supplier certification/reduction; and target segmented customers and shared investment/benefits. Christopher & Peck, 2005 suggested good

management and control of internal processes together with more open information flows within and between organisations to address the SCM conundrum especially in construction.

CHAPTER THREE

RESEARCH METHODOLOGY AND METHODS

3.1 INTRODUCTION

This chapter discussed the methods adopted in the conduct of this study. It focused on key methodological issues comprising research strategy, design and process. Other aspects of the research method which this chapter considered included sources of data; sampling and sample size determination; questionnaire design; instrument administration; and data preparation and statistical tool for analysis.

3.2 RESEARCH STRATEGY, DESIGN AND PROCESS

It is important to consider the orientation of the researcher in the conduct of the research study (Bryman 2004). The research strategy is concerned about the procedure for attacking the research questions. The research strategy deals with how the research objectives are questioned. The choice of research strategies is dependent on the aim of the study, and the availability of information to the researcher (Naoum, 2002). This study adopted the quantitative approach in its conduct. The quantitative approach is appropriate as this study seeks to ascertain the opinions of respondents.

Research design deals with the procedure for data collection. It stipulates all the methods required for the collection of data in order to draw empirical conclusion at the end of the study in a logical manner in relation to the research questions (Bryman, 2004). This study followed survey design in its conduct by using pre-coded questionnaires to elicit data from respondents. The survey design was adopted to enable the generalization of findings. This has the potential of wide application of

research findings in the road construction and other related sectors of the construction industry within the perspective of supply chain management in Ghana.

The research process addresses the sampling techniques adopted; instruments for data collection; the research process sheds light on the methods employed and how these adopted methods were used in the collection of data in order to address the aims objectives and research questions of the study.

3.3 DATA COLLECTION

3.3.1 Sources of Data

The design of questionnaire was hinged on the information derived from desk survey. Through the desk survey relevant information were gleaned from various locations with much emphasis on studies that have not been conducted within the scope of this study.

3.3.2 Sampling and Sample Size Determination

Sampling is the process of selecting respondents to participate in a research or an activity. The study took into consideration the nature and background of respondents especially their location and other important factors including research problem, aim and objectives, design and practical implications of the research.

This study adopted the purposive sampling in the selection of respondents. Purposive sampling is considered to be judgmental in which a deliberate effort is taken to select respondents based their typical areas or groups (Kerlinger, 1986; Rea and Parker, 1997; Struwig *et al*., 2001). Similarly, Krathwohl (1998), perceived purposive sampling as an intentional act of seeking respondents likely to yield new instances or greater understanding of a dimension. In the same light, Pasha (1979) noted that

purposive sampling is an appropriate method under conditions in which the researcher select a sample on the basis of their knowledge of the population, its elements, and the nature of the research aims.

The study population consisted of nineteen (19) A1B1 and A2B2 road contractors; five (5) quarry site managers; five(5) quarry production managers; and five marketing (5) marketing managers stone quarries. In the case of suppliers to road contractors, two (2) managing directors; four (4) sales managers; two (2) sales managers; and two (2) store keepers. Hence the survey population was 42.

3.3.4 Questionnaire Design

The questions were worded taking into consideration the background of respondents in order to make the response easy. Issues of appeal and ease of reading, were the key consideration in designing the questionnaire. The questionnaires were mainly pre-coded questions which enable respondents to tick their preferred options from relevant options that which were based on measurement scale. In designing the questionnaire, enough information was provided regarding the purpose and the use of the study in order to fulfill ethical considerations regarding the conduct of research of this nature. Enough instructions which were simple and concise were provided to guide respondents in the selection of their choices for each question.

The questionnaire which fitted on to a four page A4 sheets comprises of the first question which dwelt on the experience of respondents as far as supply in the road construction sector is concerned. The second and third questions explored the existing supply environment in the road construction sector. The fourth question contains nine variables within the framework of supply chain management approaches for road construction. Questions five, six, seven, eight and nine dwell on notable issues of

benefits of supply chain management in road construction; functional areas for supply chain management in road construction; Success factors for SCM implementation in road construction; Managerial Responsibilities for construction supply chain implementation; and Barriers to SCM in road construction respectively. The five point likert scale was used to measure the responses such as not frequent to very frequent; not beneficial to very beneficial; not important to very important; not effective to very effective; and not severe to very severe.

3.4 INSTRUMENT ADMINISTRATION

The researcher personally administered the questionnaire to respondents. Some of the questionnaires were retrieved on the spot while the rest were collected later. The administration of questionnaires took five weeks commencing on the first week of July, 2014 and ending on the first week of August, 2014. In all 42 questionnaires were administered while 31 were retrieved which gave a response rate of 74%.

3.5 DATA PREPARATION AND STATISTICAL TOOL FOR ANALYSIS

The raw data was first edited and sorted before they were entered in to the SPSS for analysis to begin. Descriptive statistical tools were mainly used to analyse the data which was ordinal data in nature. The selection of the analytical tool was dependent upon a thorough review of available analytical and statistical tools.

CHAPTER FOUR

DATA ANALYSIS AND DISCUSSION

4.0 Introduction

This chapter discussed the results of the analysis. The first section discussed the respondents' information presented in figures. Statistical tools used for the analysis were descriptive statistics (mean and standard deviation), non-parametric chi-square testing and frequency analysis with percentages. Results were presented in figures and tables.

4.1 Respondents information

Respondents information demonstrate the number of years respondents have been involved in construction related activities and activities undertaken. Figure 4.1 demonstrated high percentage of respondents who have been involved in road construction related activities between 10-20 years representing 52 percent. The number of respondents who have worked less than 10 years represent 42 percent, 3 percent have worked between 20-30 years and 3 percent have worked over 30 years.

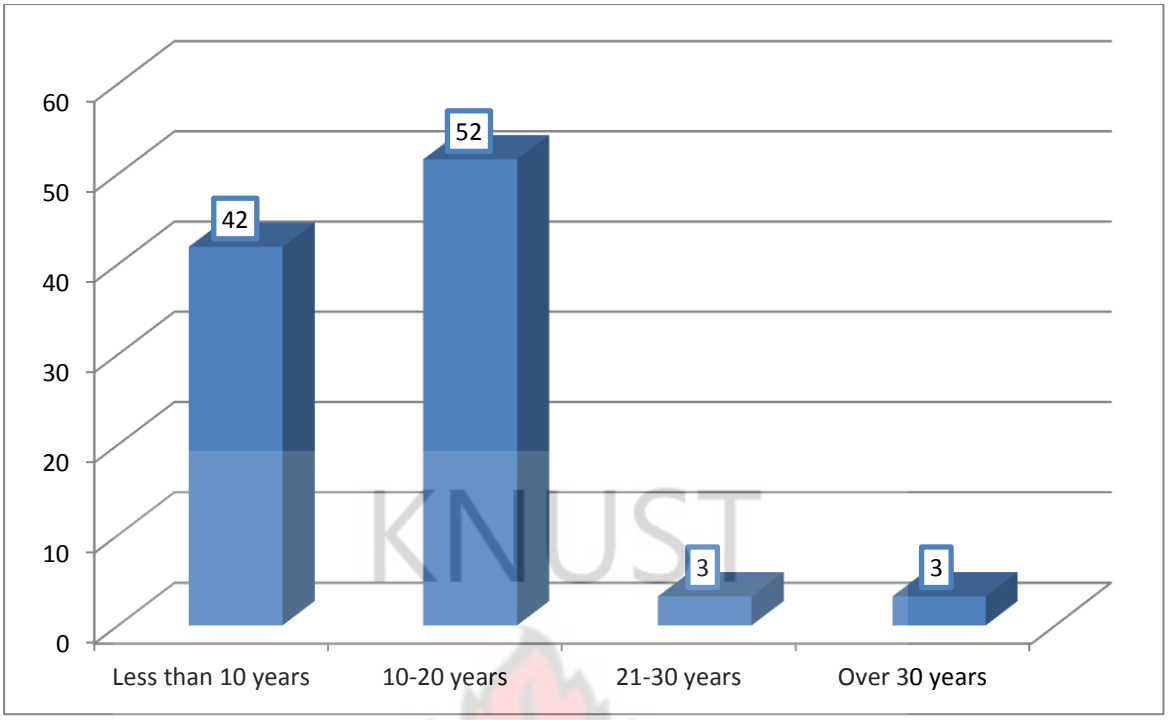

Figure 4.1: Number of years involved in road construction related activities

Source: Field Study, 2014

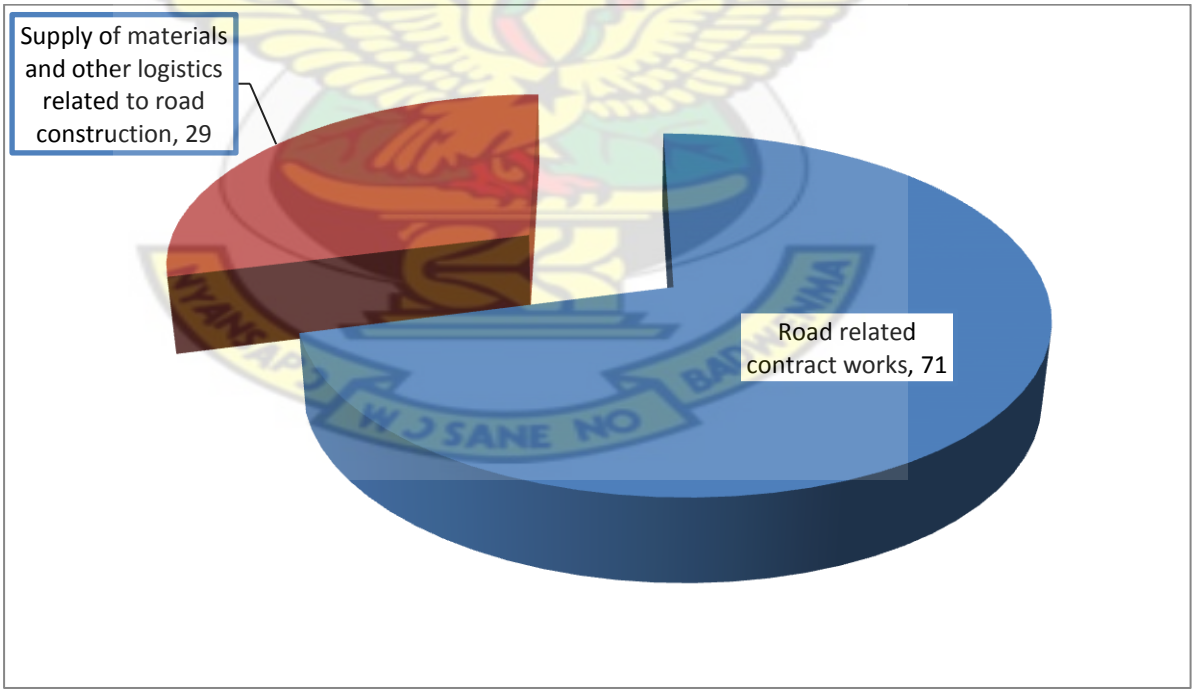

Figure 4.2: Type of Construction activities

Source: Field Study, 2014

4.2 Importance of SCM implementation in road construction

Figure 4.3 denotes respondents' measure on how important was the implementation of supply chain management in road construction. It was observed from the figure that, about 52 percent of the respondents said implementation of supply chain management in road construction was very important. Most of the respondents at least rated implementation of supply chain management as important (thus important representing about 39 percent and very important representing about 52 percent, together make up about 91 percent). It was observed that few percentages of the respondents rated implementation as moderately important and not important representing 6.5 percent and 3.2 percent respectively. In general, implementation of supply chain management in road construction was measured to be at least important.

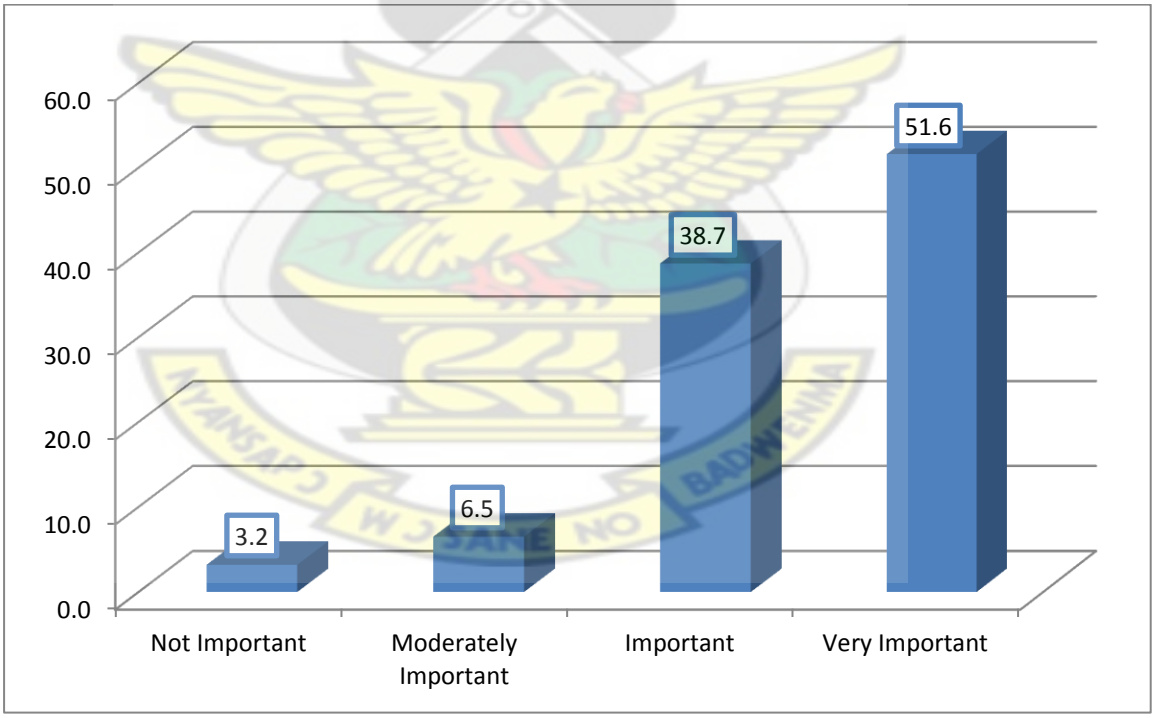

Figure 4.3: Importance of the implementation of SCM

Source: Field Study, 2014

4.3 Supply Chain Management Approaches in road Construction

To identify the supply chain approaches frequently used in road construction, descriptive statistics was performed on the empirical variables to determine how respondents scaled each variable. Chi-square statistics was run to measure the significant of scaling. Table 4.1 presented results of the descriptive statistics with emphasis on mean, standard deviation.

Table 4.1 presented the means, standard deviations, chi-square with it significant level of the supply chain management approaches variables in road construction. The highest mean value of supply chain management approach was communication with low standard deviation, thus demonstrating the significance of communication in road construction SCM. There was not significant deviation of the scaled data from the mean. There were three variables with mean value within 3.5 to 3.9. These approaches were long-term relationships, supplier selection and supply management. The rest of the approaches have mean values below 3.5 but greater than 3.0.

There was significant difference among the categories of each variable. The direction was observed to be in the positive, where most respondents rated the variables as frequent and very frequent with few respondents rating it as moderate, less and not frequent. The only variable which showed no significant difference among ratings was long-term relationships.

As has been observed in table 4.1, the most frequently used supply chain management collaboration in road construction was observed to be communication as shown in table 4.2 with relative index of 81 percent. The second frequently used approaches was long-term relationships with index of 76 percent, followed by supplier selection with index of 76 percent, then supply management with index of 73 percent.

To summarise, it is clear from the results that supply chain management approaches in road construction entails communication, long-term relationship; supplier selection; and supply management. This result is in consonance with the works of Tan (2001); Vrihhoef and Koskela (2000) who considered these issues earlier.

Table 4.1: Supply chain management approaches in road construction

	N	Mean	Std. Deviation	Chi-Square	df	Asymp. Sig.
Strategic purchasing	31	3.45	0.995	13.677[a]	4	0.008
Supply management	31	3.65	0.709	17.903[b]	3	0.000
Logistics integration	31	3.32	0.832	11.968[b]	3	0.007
Supply network coordination	31	3.45	1.028	11.419[a]	4	0.022
Communication	31	4.03	0.983	7.581[b]	3	0.056
Long-term relationships	31	3.81	0.98	5.774[b]	3	0.123
Supplier selection	31	3.81	0.749	22.806[b]	3	0.000
Supplier certification	31	3.29	0.973	15.935[a]	4	0.003
Supplier involvement	31	3.35	1.082	12.710[a]	4	0.013

Table 4.2: Supply Chain Management Approaches in Road Construction

	N	Mean	Sum	RII	Ranking
Communication	31	4.0	125	81	1
Long-term relationships	31	3.8	118	76	2
Supplier selection	31	3.8	118	76	3
Supply management	31	3.7	113	73	4
Strategic purchasing	31	3.5	107	69	5
Supply network coordination	31	3.5	107	69	6
Supplier involvement	31	3.4	104	67	7
Logistics integration	31	3.3	103	66	8
Supplier certification	31	3.3	102	66	9

Source: Field Study, 2014

4.3 Benefit of Supply Chain Management in Road Construction

With reference to Table 4.3 and 4.4 below, respondents were further asked to scale from 1-5 where 1 denoted not beneficial and 5 denoted very beneficial, on how beneficial the implementation of supply chain management in road construction. Thirteen variables were used to measure implementation benefits.

The mean values of benefits of supply chain management in road construction were all high which could be approximated to 4 showing beneficial. Variables with mean value of 4 were long-term relationship for investing in equipment and efforts to preserve the strategy, process integration, achieve lower operational costs, better service reliability, improve customer satisfaction and improve overall competitive advantage and it provides an engineering basis for designing, planning and managing construction projects in a collaborative manner with mean values ranging from 4.0-4.2. The other variables have mean value ranging from 3.5-3.9.

The variables; achieve lower operation costs, lower the number of back orders, better service reliability and decrease inventory level had no significant difference among categories of each variable. Respondents rated these variables from moderately beneficial to very beneficial as shown in the appendix.

The relative importance index revealed six variables which were highly significant beneficial of supply chain management implementation with indexes ranking from 80-84 percent. These variables were presented in order of beneficial (ranking) as indicated in Table 4.4; it provides an engineering basis for designing, planning and managing construction projects in a collaborative manner with index of 84 percent, long-term relationship for investing in equipment and efforts to preserve the strategy and better service reliability with index of 83 percent each, achieve lower operation costs and improve customer satisfaction and improve overall competitive advantage

with 81 percent each and the sixth ranking was process integration with index of 80 percent.

Drawing on from the above, this study uncovered the benefits of supply chain management in the road construction sector as providing the engineering basis for designing, planning and managing construction projects in a collaborative manner. Other benefits the study has discovered include long-term relationship for investing in equipment and efforts to preserve the strategy; better service reliability; achieving lower operational costs; improve customer satisfaction and improve overall competitive advantage; and process integration. Juxtaposing these benefit of SCM in road construction as identified by the study with the earlier works of Talib and Hamid (2014); Bowersox *et al*. (2014); and Tiwari *et al*. (2014) reveal an agreement between the benefits of SCM espoused by these authors and the SCM benefits identified by this study.

Table 4.3: Benefits of Supply Chain management in road construction

	N	Mean	Std. Deviation	Chi-Square	df	Asymp. Sig.
Information sharing for continuous flow of communication among partners	31	3.94	0.814	10.935[a]	3	0.012
Risk and reward sharing based on a win-win relationship	31	3.61	0.715	20.226[a]	3	0.000
Cooperation to allocate resources to develop and implement strategic projects or processes and to resolve conflicts	31	3.87	0.718	20.484[a]	3	0.000
Agreed supply chain leadership	31	3.74	0.631	29.516[a]	3	0.000
Long-term relationship for investing in equipment and efforts to preserve the strategy	31	4.13	0.806	13.258[a]	3	0.004
Process integration	31	4.00	0.632	10.903[b]	2	0.004

Achieve lower operation costs	31	4.06	0.772	1.226[b]	2	0.542
Better service reliability	31	4.13	0.718	3.935[b]	2	0.140
Decrease inventory level	31	3.55	0.995	5.516[a]	3	0.138
Reduce order cycle time	31	3.55	0.81	12.226[a]	3	0.007
Lower the number of back orders	31	3.68	0.979	3.452[a]	3	0.327
Improve customer satisfaction and improve overall competitive advantage	31	4.06	0.814	18.419[a]	3	0.000
It provides an engineering basis for designing, planning and managing construction projects in a collaborative manner	31	4.19	0.833	12.742[a]	3	0.005

Source: Field Study, 2014

Table 4.4: Benefit of Supply Chain Management in Road Construction

	N	Mean	Sum	RII	Ranking
It provides an engineering basis for designing, planning and managing construction projects in a collaborative manner	31	4.2	130	84	1
Long-term relationship for investing in equipment and efforts to preserve the strategy	31	4.1	128	83	2
Better service reliability	31	4.1	128	83	3
Achieve lower operation costs	31	4.1	126	81	4
Improve customer satisfaction and improve overall competitive advantage	31	4.1	126	81	5
Process integration	31	4.0	124	80	6
Information sharing for continuous flow of communication among partners	31	3.9	122	79	7
Cooperation to allocate resources to develop and implement strategic projects or processes and to resolve conflicts	31	3.9	120	77	8
Agreed supply chain leadership	31	3.7	116	75	9
Lower the number of back orders	31	3.7	114	74	10
Risk and reward sharing based on a win-win relationship	31	3.6	112	72	11
Decrease inventory level	31	3.6	110	71	12
Reduce order cycle time	31	3.6	110	71	13

Source: Field Study, 2014

4.3 Functional Areas for SCM implementation in road construction

In assessing the supply chain management environment in road construction, respondents were asked to again scale the importance of the functional areas for supply chain management in road construction. Table 4.5 shows the descriptive statistics of the results and table 4.6 showed the rankings of the variables in order of importance.

The mean value for six variables ranged from 4.1-4.3 showing that averagely, the respondents rated these variables as important. These variables as shown in Table 4.5 were; client focus, material and labour flows to the site to avoid disturbances in the workflow, continuous improvement, partnering, waste minimization and process and reliable workflow. The standard deviation for each was relatively low to conclude that the means were representative. There was significant difference among the scaling of the categories of the variables except material and labour flows to the site to avoid disturbances in the workflow and equipment acquisition. Most respondents responded to the variables as important and very important with few responding as moderately important.

Table 4.6 presented how respondents ranked the importance of functional areas. Respondents ranked client focus as the most functional area for supply chain management among the functional areas with index of 86 percent showing very important. The second ranked was material and labour flows to the site to avoid disturbances in the workflow with index of 85 percent, then continuous improvement with index of 85 percent, partnering with index 83 percent, waste minimization and process and reliable workflow with index 82 percent each. These functional areas were ranked as very important. The rest of the functional areas were ranked as important with indexes ranging from 75-79 percent.

The functional areas of supply chain management are important for successful road construction SCM. This study clearly identified client focus; material and labour flows to site to avoid disturbances in workflow; continuous improvement; partnering; waste minimization; and process and reliable workflow. Existing works of Green and May (2005); Salem *et al*.(2006); Miller et al. (2002); Tiwari *et al*.(2014); Jorgensen and Emitt (2008); Eriksson and Pesamaa (2007) have also considered these functional areas of SCM. The functional areas identified by this study are in consonance with the works of earlier authors such as Tiwari et al. (2014) *inter alia*.

Table 4.5: Functional areas for supply chain management in road construction : Descriptive Statistics

	N	Mean	Std. Deviation	Chi-Square	df	Asymp. Sig.
Reduction of costs (especially logistical costs)	31	3.97	0.752	26.935[a]	3	0.000
Lead-time and inventory in the supply chain	31	3.87	0.67	27.452[a]	3	0.000
Material and labour flows to the site to avoid disturbances in the workflow	31	4.23	0.762	2.774[b]	2	0.250
Equipment Acquisition	31	3.9	0.7	5.097[b]	2	0.078
Subcontracting	31	3.77	0.884	9.645[a]	3	0.022
Focus on supply chain value analysis and target costing	31	3.84	0.735	26.419[a]	3	0.000
Waste Minimization	31	4.1	0.831	16.613[a]	3	0.001
Process and Reliable Workflow	31	4.1	0.746	18.935[a]	3	0.000
Client Focus	31	4.29	0.643	8.581[b]	2	0.014
Continuous Improvement	31	4.23	0.762	17.903[a]	3	0.000
Partnering	31	4.16	0.735	20.484[a]	3	0.000
Demand Management	31	3.84	0.934	21.419[c]	4	0.000

Source: Field Study, 2014

Table 4.6: Functional areas for supply chain management in road construction

	N	Mean	Sum	RII	Ranking
Client Focus	31	4.3	133	86	1
Material and labour flows to the site to avoid disturbances in the workflow	31	4.2	131	85	2
Continuous Improvement	31	4.2	131	85	3
Partnering	31	4.2	129	83	4
Waste Minimization	31	4.1	127	82	5
Process and Reliable Workflow	31	4.1	127	82	6
Reduction of costs (especially logistical costs)	31	4.0	123	79	7
Equipment Acquisition	31	3.9	121	78	8
Lead-time and inventory in the supply chain	31	3.9	120	77	9
Focus on supply chain value analysis and target costing	31	3.8	119	77	10
Demand Management	31	3.8	119	77	11
Subcontracting	31	3.8	117	75	12

Source: Field Study, 2014

4.4 Success factors for supply chain management in road construction

How effective were the factors for successful supply chain integration in road construction and how important are managerial responsibilities for supply chain management in road construction? These were the questions asked to measure the effects of collaborators in road construction's supply chain management.

The mean value observed to be high with the following variables; integrated information systems to reduce cost and eliminate waste, top management support, reliability of supply and manpower development. Their mean values ranged from 4.1-4.2. The results showed significant difference among ratings of the categories, where most of the respondents rated the variables at the positive direction with few respondents rating at the negative direction. The variable that showed no significant difference was efficient resource coordination and teamwork with mean value of 3.9. Majority of the respondents rated efficient resource coordination and teamwork as

follows; very effective 6 representing 19 percent, effective 16 representing 52 percent and moderately effective 9 representing 29 percent. Table 4.8 presented how the respondents rated the effect of success factors on supply chain management in road construction.

The first success factor ranked was integrated information systems to reduce cost and eliminate waste and followed by top management support with index of 83 percent for each. The third ranking was Reliability of supply and forth was Manpower development with index of 81 percent each. These four success factors were scaled as very effective and the rest of the variables were scaled as effective. The results showed that the success factor were significantly effective as shown in Table 4.8.

Drawing on from the above presentation of results, the findings of this study as far as success factors for SCM in road construction is concerned include integrated information systems to reduce cost and eliminate waste; top management support; reliability of supply; manpower development; and prompt payment to build trust and encourage flexibility in the supply chain among collaborators. These findings are in consonance with the earlier finding of authors such as Akintoye et al. (2000); Tiwari et al. (2014); Wong and Kanji (1998); and Wong and Fung (1999).

Table 4.7: Success factors for supply chain management in road construction: Descriptive Statistics

	N	Mean	Std. Deviation	Chi-Square	df	Asymp. Sig.
Efficient resource coordination and teamwork	31	3.9	0.7	5.097[a]	2	0.078
Top management support	31	4.13	0.67	29.516[b]	3	0.000
Mutual interest	31	3.81	0.703	30.806[b]	3	0.000
Free flow of information	31	3.94	0.727	3.355[a]	2	0.187
Joint business planning	31	3.74	0.93	9.645[b]	3	0.022
Closer links between demand/ supply	31	3.74	0.93	26.258[c]	4	0.000
Reliability of supply	31	4.06	0.854	9.645[b]	3	0.022
Integrated information systems to reduce cost and eliminate waste	31	4.16	0.688	26.677[b]	3	0.000
Prompt payment to build trust and encourage flexibility in the supply chain among collaborators	31	3.97	0.875	8.097[b]	3	0.044
Ensuring that design is complete and buildable	31	3.84	0.934	21.419[c]	4	0.000
Effectiveness of site management through integration and coordination of supply chain	31	3.81	0.91	10.161[b]	3	0.017
Pricing realistically to drive project performance	31	3.94	0.727	20.226[b]	3	0.000
Information technology	31	3.65	0.839	9.903[b]	3	0.019
Manpower development	31	4.06	0.727	21.258[b]	3	0.000

Table 4.8: Relative Importance Index: Success Factors for Supply Chain Management in Road Construction

	N	Mean	Sum	RII	Ranking
Integrated information systems to reduce cost and eliminate waste	31	4.2	129	83	1
Top management support	31	4.1	128	83	2
Reliability of supply	31	4.1	126	81	3
Manpower development	31	4.1	126	81	4
Prompt payment to build trust and encourage flexibility in the supply chain among collaborators	31	4.0	123	79	5
Free flow of information	31	3.9	122	79	6
Pricing realistically to drive project performance	31	3.9	122	79	7
Efficient resource coordination and teamwork	31	3.9	121	78	8
Ensuring that design is complete and buildable	31	3.8	119	77	9
Mutual interest	31	3.8	118	76	10
Effectiveness of site management through integration and coordination of supply chain	31	3.8	118	76	11
Joint business planning	31	3.7	116	75	12
Closer links between demand/ supply	31	3.7	116	75	13
Information technology	31	3.7	113	73	14

Source: Field Study, 2014

4.5 Managerial responsibilities in road construction SCM

All the variables had high mean values with significant difference. This indicated that all the variables were significantly important. The highest mean value was planning and control of key operations to move the organization in the right direction with mean value of 4.3. the frequency showed that 18 respondents rated it as very important representing 58 percent of the respondents. Develop product flow facility structure demonstrating the network structure for sourcing rated with mean value of 4.1, develop work structure indicating how the firm performs its tasks and activities and prepare organizational structure of the individual firm with mean value of 4.03 each.

The management responsibilities for construction supply chain were ranked by respondents as highly significant. Respondents were asked to scale each of the

managerial responsibilities as to how important they were for supply chain management in road construction. It was observed that all the managerial responsibilities were very important for supply chain management. The most important managerial responsibility was Planning and control of key operations to move the organization in the right direction with index of 86 percent. The second ranked managerial responsibility was develop product flow facility structure demonstrating the network structure for sourcing with index of 82 percent, then develop work structure indicating how the firm performs its tasks and activities was ranked third with index of 81 percent. The forth ranked managerial responsibility important for supply chain management was prepare organizational structure of the individual firm with index of 81 percent and lastly, develop the organizational structure for the supply chain indicating the use of cross-functional teams with index of 79 percent.

Table 4.9: Managerial Responsibilities for construction supply chain

	N	Mean	Std. Deviation	Chi-Square	df	Asymp. Sig.
Planning and control of key operations to move the organization in the right direction	31	4.32	0.945	19.710[a]	3	0.000
Develop work structure indicating how the firm performs its tasks and activities	31	4.03	0.795	13.258[a]	3	0.004
Prepare organizational structure of the individual firm	31	4.03	0.657	31.839[a]	3	0.000
Develop the organizational structure for the supply chain indicating the use of cross-functional teams	31	3.94	0.68	27.194[a]	3	0.000
Develop product flow facility structure demonstrating the network structure for sourcing	31	4.1	0.87	12.484[a]	3	0.006

Source: Field Study, 2014

Table 4.10: Management responsibilities for construction supply chain

	N	Mean	Sum	RII	Ranking
Planning and control of key operations to move the organization in the right direction	31	4.3	134	86	1
Develop product flow facility structure demonstrating the network structure for sourcing	31	4.1	127	82	2
Develop work structure indicating how the firm performs its tasks and activities	31	4.0	125	81	3
Prepare organizational structure of the individual firm	31	4.0	125	81	4
Develop the organizational structure for the supply chain indicating the use of cross-functional teams	31	3.9	122	79	5

Source: Field Study, 2014

4.5 Barriers of Road Construction Supply Chain Management

In an attempt to uncover the barriers of road construction, respondents were asked to scale twenty barriers on how severe each was to supply chain management in road construction from 1-5, where 1 denoted "not severe" and 5 denoted "very severe". The barriers to supply chain management in road construction showed high mean values as observed in table 4.11. Seven variables were scaled with mean ranging from 4.0-4.3. The variable with the highest mean value was lack of top management commitment. It showed significant severity as observed by the chi-square column in table 4.11 and the frequency in the appendix. Other variables with high mean values were; slow payment from project owner, working capital problems, internal financial problems, inadequate technical capabilities, insufficient information technology and supplier reluctance to change. Internal financial problems and insufficient information technology showed no significant difference among the scaling. It was observed that scaling was between moderately severe to very severe for both variables.

Table 4.12 denoted the ranking of severity of barriers to supply chain management in road construction management. It was observed that all the barriers were severe to supply chain management in road construction. The worst among them was lack of top management commitment with index of 85 percent. The first seven barriers were scaled as very severe, showing indexes ranging from80-85 percent. This index indicated very severe barriers to supply chain management in road construction. These barriers were; slow payment from project owner ranked second with index of 84 percent, followed by working capital problems with index of 83 percent, then internal financial problems with index of 82 percent, inadequate technical capabilities, insufficient information technology and supplier reluctance to change with indexes 80 percent each.

The barriers of SCM in road construction found by this study include Lack of top management commitment; Slow payment from project owner; Working capital problems; Internal financial problems; Inadequate technical capabilities; Insufficient information technology; Supplier reluctance to change; Lack of organization encouragement; and Lack of government support system. Existing works which also found these barriers to SCM include Cox and Townsend (1998); Fawcett et al. (2008); Khalfan et al. (2004); and Akintoye et al. (2000). It can be concluded that the barriers of SCM identified by the earlier works of these authors are in agreement with the findings of this study.

Table 4.11: Barriers to supply chain management in road construction

	N	Mean	Std. Deviation	Chi-Square	df	Asymp. Sig.
Internal financial problems	31	4.1	0.7	5.097[a]	2	0.078
Working capital problems	31	4.16	0.86	14.548[b]	3	0.002
Slow payment from project owner	31	4.19	0.833	12.742[b]	3	0.005
Inferior plans and specifications	31	3.94	0.854	11.452[b]	3	0.010
Inadequate technical capabilities	31	4.00	0.894	14.806[b]	3	0.002
Insufficient information technology	31	4.00	0.856	.258[a]	2	0.879
Lack of communication between supply chain partners	31	3.84	0.735	17.903[b]	3	0.000
Productivity inefficiencies	31	3.68	0.599	31.323[b]	3	0.000
Work quality problems	31	3.65	0.709	17.903[b]	3	0.000
Work method problems	31	3.77	0.956	4.484[b]	3	0.214
Delivery reliability problems	31	3.94	0.854	11.452[b]	3	0.010
Bulk materials quality problems	31	3.94	0.964	6.290[b]	3	0.098
Lack of IT implementation	31	3.77	0.884	7.323[b]	3	0.062
Resistance to technology advancement adoption	31	3.90	0.908	10.677[b]	3	0.014
Lack of organization encouragement	31	3.97	0.752	17.387[b]	3	0.001
Poor quality of human resources	31	3.65	0.877	8.097[b]	3	0.044
Market competition and uncertainty	31	3.77	0.717	18.935[b]	3	0.000
Lack of government support system	31	3.97	0.752	17.387[b]	3	0.001
Lack of top management commitment	31	4.26	0.893	15.323[b]	3	0.002
Supplier reluctance to change	31	4.00	0.73	20.484[b]	3	0.000

Source: Field Study, 2014

Table 4.12: Relative Importance Index: Barriers to supply chain management in road construction

	N	Mean	Sum	RII	Ranking
Lack of top management commitment	31	4.3	132	85	1
Slow payment from project owner	31	4.2	130	84	2
Working capital problems	31	4.2	129	83	3
Internal financial problems	31	4.1	127	82	4
Inadequate technical capabilities	31	4.0	124	80	5
Insufficient information technology	31	4.0	124	80	6
Supplier reluctance to change	31	4.0	124	80	7
Lack of organization encouragement	31	4.0	123	79	8
Lack of government support system	31	4.0	123	79	9
Inferior plans and specifications	31	3.9	122	79	10
Delivery reliability problems	31	3.9	122	79	11
Bulk materials quality problems	31	3.9	122	79	12
Resistance to technology advancement adoption	31	3.9	121	78	13
Lack of communication between supply chain partners	31	3.8	119	77	14
Work method problems	31	3.8	117	75	15
Lack of IT implementation	31	3.8	117	75	16
Market competition and uncertainty	31	3.8	117	75	17
Productivity inefficiencies	31	3.7	114	74	18
Work quality problems	31	3.7	113	73	19
Poor quality of human resources	31	3.7	113	73	20

Source: Field Study, 2014

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.0 Introduction

This study was motivated by the inadequate use of SCM in the road construction sector. This is the concluding chapter of the study on SCM in the road sector consisting of five main interrelated chapters. This last chapter consist of review of research objectives; recommendation; suggestions for future studies; and conclusions.

5.1 Review of Research Objectives

The prime aim of this study was to is to explore the supply chain management in road construction in in order to enhance the performance of projects delivery. To achieve this noble aim for the furtherance of effective road construction in Ghana, key objectives were set to guide the conduct of this study. This section if the dissertation presents the objectives of this study and the findings as a result of field survey in the case of each objective below.

Objective 1: To explore the existing supply chain management environment with emphasis on the construction industry

Desk study was one of the tasks carried out in order to achieve this objective. The review of the existing supply chain management environment in the construction industry dwelt on key areas such as conceptual explanation of supply chain management (SCM); evolution of supply chain management; and overview of supply chain management in the construction industry. Other areas include Elements of SCM in Construction which comprised of waste minimization, process flow, customer/client focus, continuous improvement, partnering and demand management.

The studies revealed that in spite of much works on construction supply chain management, they do not focus on road construction. This finding gave the needed impetus to the conduct of this study with much relevance for stakeholders in road construction. The study also revealed that SCM management in road construction is important for enhancing the performance of stakeholders. This was indicated by majority of participants (71%) involved in the study.

Objective 2: To identify the approaches for collaboration in the SCM of the road construction sector

In supply chain management, collaboration among parties is very vital for successful management of projects. This study identified key SCM approaches for collaboration among stakeholders in the road construction. These approaches uncovered include Strategic purchasing; Supply management; Long-term relationships; Supplier selection; and Supplier involvement. Overall, the variables presented in Table 4.1 and 4.2 of chapter four of this study are all deemed as necessary approaches for supply chain management of the road construction since they recorded mean score above 3 and indexes above 0.5. This therefore implies that stakeholders in the road construction sector need to adapt these approaches in the implementation of SCM in the road construction sector of Ghana.

Objective 3: To uncover the benefits of supply chain management in the road construction sector

The main benefits of SCM implementation in the road construction sector include Information sharing for continuous flow of communication among partners; risk sharing through win-win relationship among parties; resource allocation through corporation; Long-term relationship for investing in equipment and efforts to preserve

the strategy; Better service reliability; Achieve lower operation costs; and Improve customer satisfaction and improve overall competitive advantage. Other benefits presented in Table 4.3 and 4.4 of chapter four of this study reordered significant values which made them to be suitably considered as important benefits of SCM implementation in the road construction sector.

Objective 4: To discover the functional areas for SCM implementation in road construction

The functional areas for SCM implementation in the road construction sector discovered by this study consist of Client Focus; Continuous Improvement; Waste Minimization; Process and Reliable Workflow; Demand Management; Equipment Acquisition; and Focus on supply chain value analysis and target costing. In general, all the functional areas for SCM implementation explored in this study are considered to be key to SCM in road construction as a result of the mean score and indexes which they produced being above average in Table 4.5 and 4.6 respectively in chapter four of this study.

Objective 5: To identify the key success factors for supply chain management in the road construction sector

Knowledge of the success factors is important for implementation process. It is in this light that this study considered success factors in its conduct. The study revealed the key success factors for SCM in road construction as follows top management support; reliability of supply; integrated information systems to reduce cost and eliminate waste; manpower development; and free flow of information. Other key success factors demonstrated in Table 4.7 and 4.8 in chapter four of this study are all important for successful implementation of SCM in road construction.

Objective 6: To discover key managerial responsibilities for road construction supply chain management

The supply chain process in road construction has to be efficiently managed in order to achieve the needed result. This study discovered the managerial responsibilities of SCM in road construction as planning and control of key operations to move the organization in the right direction; developing work structure indicating how the firm performs its tasks and activities; preparing organizational structure of the individual firm; developing the organizational structure for the supply chain indicating the use of cross-functional teams; and developing product flow facility structure demonstrating the network structure for sourcing.

Objective 7: To uncover the barriers to SCM in the road construction sector of Ghana

Knowledge of the implementation barriers is critical to any improvement effort in organizations. In the same light, road construction SCM implementation is bound to encounter some barriers as far as success is concerned. This study therefore uncovered such barriers for players in the road construvction sector to take cognizance of in the implementation of SCM. The SCM barriers uncovered by this study include lack of top management commitment; slow payment from project owner; working capital problems; internal financial problems and inadequate technical capabilities. The study clearly demonstrated that all the barriers in Table 4.11 and 4.12 of chapter four of this study are critical to SCM adoption in road construction. It is therefore important to take note of them and put actions in place in order to eliminate them during road construction.

5.2 Recommendations of the Study

Considering the benefits of SCM to road construction sector in the country couple with the strategic role of road networks, it is recommended that key players in the road construction sector implement the SCM during road construction. Government being the major client as far as road construction is concerned should put contractual policies in place to compel road contractors to adhere to the tenets of SCM. It is also recommended that suppliers providing materials to road construction firms are educated on supply chain management practices so that they will understand the processes for easy implementation of SCM in the road construction sector.

5.3 Future Research Agenda

This study in its conduct was limited in some aspects of SCM. It is necessary to further conduct further studies in road construction SCM in order to advance the theory and practice of SCM. In this regard, the following studies are proposed:

- A study to explore the managerial responsibilities of each stakeholder in road construction SCM;
- A study to explore the possibility of applying information and communication technology in road construction SCM; and
- A study to evaluate the effectiveness of the SCM functional areas identified in road construction.

5.4 Conclusion of the Study

The conduct of this study revealed that supply chain management implementation is non-existent in the road construction sector. The knowledge of supply chain management in the road construction sector is useful to contractors in their delivery of projects. This will eliminate problems related to the supply of materials and logistics

to construction sites. The adoption of this study this study will also eliminate the problem of non-compliance in the supply of materials and other construction resources to enhance the quality of inputs and subsequently the final product to be delivered by contractors. The study also sets the tone for conducting further studies in the road construction sector as far as supply chain management is concerned. Practically, when this study is adapted by practitioners, it is believed it will mitigate the delay in road project delivery partly.

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APPENDIX 1: SURVEY QUESTIONNARE

This research is a Postgraduate level research entitled "*Exploring Supply Chain Management in the Road Construction Sector of Ghana.*" The study intends to thoroughly explore the supply chain management environment in road construction sector of Ghana in order to enhance the delivery of projects. **Kindly respond to the questions by ticking (√) the appropriate response.**

1. How long have you been involved in construction related activities?
[ ] less than 10 years
[ ] 10 -20 years
[ ] 20- 30 years
[ ] Over 30 years

2. Which of these construction activities do you undertake?
[ ] Road related contract works
[ ] Supply of materials and other logistics related to road construction

3. How important is the implementation of supply chain management in road construction?

[ ] Not important [ ] Less important [ ] Moderately important [ ] Important [ ] Very important

Supply Chain Management approaches for road construction

4. Which of these supply chain approaches do you frequently use in road construction? ***Use the scale: 1= Not frequent 2= Less frequent 3= Moderately frequent 4= Frequent 5= Very frequent***

Supply chain management approaches in road construction	1	2	3	4	5
1. strategic purchasing					
2. supply management					
3. logistics integration					
4. supply network coordination					
5. communication					

6. long-term relationships					
7. supplier selection					
8. supplier certification					
9. supplier involvement					

Benefits of Supply Chain Management in road Construction

5. How beneficial are the following in the implementation of supply chain management in road construction? ***Use the scale: 1= Not beneficial 2= Less beneficial 3= Moderately beneficial 4= Beneficial 5= Very beneficial***

Benefits of Supply Chain management in road construction	**1**	**2**	**3**	**4**	**5**
1. information sharing for continuous flow of communication among partners					
2. risk and reward sharing based on a win-win relationship					
3. cooperation to allocate resources to develop and implement strategic projects or processes and to resolve conflicts					
4. agreed supply chain leadership					
5. long-term relationship for investing in equipment and efforts to preserve the strategy					
6. process integration					
7. achieve lower operation costs					
8. better service reliability					
9. decrease inventory level					
10. reduce order cycle time					
11. lower the number of back orders					
12. improve customer satisfaction and improve overall competitive advantage					
13. It provides an engineering basis for designing, planning and managing construction projects in a collaborative manner					

Functional Areas for Supply Chain Management in road construction

6. What would you say about the importance of the functional areas for supply chain management in road construction? ***Use the scale: 1= Not important 2= Less important 3= Moderately important 4= Important 5= Very important***

Functional areas for supply chain management in road construction	**1**	**2**	**3**	**4**	**5**
1. reduction of costs (especially logistical costs)					
2. lead-time and inventory in the supply chain					
3. material and labour flows to the site to avoid disturbances in the workflow					
4. Equipment Acquisition					
5. subcontracting					
6. focus on supply chain value analysis and target costing					
7. Waste Minimization					
8. Process and Reliable Workflow					
9. Client Focus					
10. Continuous Improvement					
11. Partnering					
12. Demand Management					

Success factors for SCM implementation in road construction

7. How effective are the following factors for successful supply chain integration in road construction? ***Use the scale: 1= Not effective 2= Less effective 3= Moderately effective 4= Effective 5= Very effective***

Success factors for supply chain management in road construction	**1**	**2**	**3**	**4**	**5**
1. efficient resource coordination and teamwork					
2. top management support					
3. mutual interest					
4. free flow of information					
5. joint business planning					
6. closer links between demand/ supply					
7. reliability of supply					
8. integrated information systems to reduce cost and eliminate waste					
9. Prompt payment to build trust and encourage flexibility in the					

supply chain among collaborators					
10. ensuring that design is complete and buildable					
11. Effectiveness of site management through integration and coordination of supply chain					
12. pricing realistically to drive project performance					
13. information technology					
14. manpower development					

Managerial Responsibilities for construction supply chain implementation

8. How important are the following managerial responsibilities for supply chain management in road construction? ***Use the scale: 1= Not important 2= Less important 3= Moderately important 4= Important 5= Very important***

Managerial Responsibilities for construction supply chain	**1**	**2**	**3**	**4**	**5**
1. planning and control of key operations to move the organization in the right direction					
2. develop work structure indicating how the firm performs its tasks and activities					
3. prepare organizational structure of the individual firm					
4. develop the organizational structure for the supply chain indicating the use of cross-functional teams					
5. develop product flow facility structure demonstrating the network structure for sourcing					

Barriers to SCM in road construction

9. How severe are the following barriers to supply chain management in road construction? ***Use the scale: 1= Not severe 2= Less severe 3= Moderately severe 4= Severe 5= Very severe***

Barriers to supply chain management in road construction	**1**	**2**	**3**	**4**	**5**
1. internal financial problems					
2. working capital problems					
3. slow payment from project owner					
4. inferior plans and specifications					
5. inadequate technical capabilities					
6. insufficient information technology					
7. lack of communication between supply chain partners					
8. productivity inefficiencies					
9. work quality problems					
10. work method problems					
11. delivery reliability problems					
12. bulk materials quality problems					
13. lack of IT implementation					
14. resistance to technology advancement adoption					
15. lack of organization encouragement					
16. poor quality of human resources					
17. market competition and uncertainty					
18. lack of government support system					
19. lack of top management commitment					
20. supplier reluctance to change					