UNIVERSITY OF EDUCATION, WINNEBA

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THE ROLE OF SUPPLY CHAIN MANAGEMENT IN MINIMISING CONSTRUCTION MATERIALS WASTE: PERSPECTIVES OF CONSTRUCTION COMPANIES IN GREATER ACCRA REGION

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EMMANUEL KWASHIE DEGBLOR

(7141190022)

A Dissertation in the Department of WOOD AND CONSTRUCTION TECHNOLOGY EDUCATION, Faculty of TECHNICAL EDUCATION, submitted to the school of Graduate Studies, University of Education, Winneba in partial fulfillment of the requirements for the award of Master of Technology Education in (Construction Technology) degree.

AUGUST, 2016

DECLARATION

STUDENT'S DECLARATION

I, **EMMANUEL KWASHIE DEGBLOR**, declare that this dissertation, with the exception of quotations and references contained in published works which have all been identified and acknowledged, is entirely my original work, and it has not been submitted, either in part or whole for another degree elsewhere.

SIGNATURE:……..

DATE:……..

SUPERVISOR'S DECLARATION

I hereby declare that the preparation and presentation of this thesis was supervised in accordance with the guidelines and supervision laid down by the University of Education Winneba.

NAME OF SUPERVISOR: **DR. NONGIBA ALKANAM KHENI**

SIGNATURE:……..

DATE:……..

ACKNOWLEDGEMENT

I wish to render my profound thanks to the Almighty God for giving me the strength, wisdom and guidance to successfully undertake and complete this study.

I wish to express my sincere thanks and gratitude to Dr. Nongiba Alkanam Kheni, of the University of Education, College of Technology Education Kumasi, Wood and Construction Technology Department, my supervisor who spent his precious time reading through this script and making the necessary corrections and giving the best suggestion and solutions. Dr. I am very grateful to you, thanks for the fatherly role you played.

My indebtedness also goes to Miss Esther Aboagye Boateng and Joseph Owusu Nyarko who took pains amidst their entire heavy schedules to type this work nicely for me.

My invaluable thanks go to Mr. Seth Gbeku who also guided and provided me with very valuable information and suggestions. Mr. Clement Lomotey Kwarblah, Principal of A.T.T.C my mentor and teacher cannot be overlooked.

I further want to thank all my lecturers and all those names that have not been acknowledged but assisted me in diverse ways to make this work a complete one. Once again I say thank you all and may the almighty God Bless you all.

DEDICATION

This dissertation is profoundly dedicated to my dear wife Mrs. Mireille Akpe Adjoa Degblor for her encouragement and support throughout the duration of the course. My children and God children Davidson, Paul, Agnes and Michael are a contributing factor and influence to my successful completion.

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ABSTRACT

Supply chain management has been widely practiced in the manufacturing industry, but the construction industry as a relatively newcomer in the discipline. Construction projects are realized through a multitude of teams that supply essential services of one or another. Supply Chain Management (SCM) will thus have many benefits to construction stakeholders. The aim of this study was to explore supply chain management as a tool to minimising material waste in construction projects. The key specific objectives included: to identify practices associated with effective supply chain management that could minimize material waste in construction projects in the Greater Accra Region: to identify the barriers to the adoption of SCM practices that could minimize material waste in construction projects in the Greater Accra Region; and to make recommendations for minimizing materials waste through effective SCM in the Greater Accra Region. Quantitative research approach was used for the study involving the development and administration of survey questionnaires to a randomly selected stratified sample of 97 construction managers in the Greater Accra Region. The findings of the study suggest that effective SCM practices that could minimize material waste included: supply chain management practices focused on quality and performance, improving the existing transportation system to enhance the free flow of goods and materials for construction works, analysis of the risk of potential loss regarding financial, physical and social loss to the firm, analysis of the availability of suppliers when developing supply chain management practices, tendering, design and procurement practices are factored into designing supply chain management system in the firm. The adoption of effective supply chain management system included the contribution to environmental protection, waste reduction across the supply chain management system, reducing environmental risks, benefits in cost reduction associated with the adoption of supply chain management practices, organizational image improvement and meeting

market expectations. The barriers to effective supply chain management practices are: lack of adequate financial and human resources, lack of top management commitment, ineffective internal communication within firms, inappropriate organizational structure and lack of markets for recyclable materials. The study recommended that the management of the construction firms should seek financial assistance from merchant banks to expand their financial and human resources competencies. This can improve the effective supply chain management systems of the firm.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Supply chain management (SCM) originated in the manufacturing industry in the 1990's alongside Just In Time (JIT) delivery system implemented in Toyota Vrijhoef and Koskela, (2005), with the main aim of reducing inventories and regulating suppliers interaction with the production lines. Nevertheless, since its birth SCM has evolved into a full range of disciplines that involves closer customer supplier relationships. Handfield and Nichols (1999), defined SCM as: "The supply chain encompasses all activities associated with the flow and transformation of goods from raw materials (including extraction), through the end user, as well as information flows. Materials and information flow both up and down the supply chain: In other words SCM can be defined as the integration of suppliers and customers into the decision-making processes, focusing on the planning, implementation and control of the logistics operations to pull materials through the supply chain (Kannan and Tan, 2005).

However, there are some implications for customer firms that decide to work with their supply chain: understanding of the pressures they are experiencing as well as their capabilities, understanding of their supplier's activities and capabilities, and evaluation of whether or not they have the power over their suppliers (Hall, 2000). The power matrix is a model that compares Buyer power versus Supplier power to assess the dominance situation. There is no such thing as a typical construction supply chain because of the variety of buildings, sizes, technologies and products that can be used (Akintoye et al., 2000). Within a construction supply chain there are several supply chains, each one with different properties and circumstances. The main types

of suppliers can be classified into materials, labour, equipment or machinery and professional services (Cox and Ireland, 2012).

The role of contractors is usually the "integration" of all the actors mentioned. To understand construction supply chains there are two main factors, 1) the behaviour of construction firms within markets and 2) the behaviour of individual supply chains (operational aspects) (O'Brian et al., 2002). The construction industry market can be described as fragmented and highly adversarial (Boardman, 2004) because of the conflicting nature of demand-supply (Cox and Ireland, 2012). It is characterised by traditional trading and non-cooperative relationships which result in a non-trusting climate and aggressive business mentality (Vrijhoef and Koskela, 2005), generating more focus on the clients than on the suppliers (Akintoye et al., 2000).About the operational aspects, the construction industry has a large amount of suppliers, mostly SMEs with less than 20 employees (Courtney, 1999). In some cases, the customer selects the contractor andsome of the suppliers (Akintoye et al., 2000). In addition, lack of communication which generates large amounts of waste (Vrijhoef and Koskela, 2005).

The supply chain processes influence the quantities and types of resources acquired and select the source of key products and suppliers; these activities are directly connected with the degree of negative impacts on the environment and indirectly connected with economic and social growth within a community (Morton et al., 2002). In other words, SCM is related with any attempt of improving the environmental performance of the purchased products/services or the suppliers that provide them (Bowen et al., 2001a).The main aims of SCM are to identify benefits, costs and risks associated with environmental performance to minimise waste (Hanfield et al., 2005). A typical starting point in considering the inclusion of the

supply chain is by implementing ISO 14001, which recommends the inclusion of policies to ensure the suppliers are aware of their environmental practices and liabilities (Rao, 2005).

Sarkis (2003) detailed the components of a supply chain and its environmental impacts. Environmental impacts and responsibilities within the supply chain can be classified as follows: direct impacts, depending entirely on the organisation and refers mainly to the construction of the building; shared impacts between the organisation and its suppliers; and indirect impacts that depend entirely on the suppliers activities (Hall, 2000). Nonetheless, when a company decides to purchase goods or products from a particular supplier, it inherently accepts the waste stream generated by its decision as well as the liability implications (Hanfield et al., 2005). Therefore, the present study will investigate the effective supply chain management as a tool to minimising material waste in the construction industry of Ghana.

1.2 Statement of the Problem

Problems related to ineffective supply chain management of construction materials can be found in every organization and construction firms in the Greater Accra region is no exception. The researcher observed that construction firms in the Greater Accra Region of Ghana do not manage their supply chain effectively and that eventually resulted in the generation of waste in the construction industry. This problem has eventually caused liquidation and collapse of many firms in the Greater Accra Region. For example, in the late 1990's, construction companies experienced an increase in costs and a decrease in productivity. Owners of these companies thought that these increases in cost were due to inflation and economic problems. Further research concluded that these companies were not managing their supply chain

effectively and that the decrease in productivity was also attributable to poor management and utilization of construction materials. However, efficient management of materials plays a key role in the successful completion of a project. The control of materials is a very important and vital subject for every company and should be handled effectively for the successful completion of a project.

The aforementioned arguments underscore the importance of effectively managing supply chain in the construction industry with the aim of minimising material waste. Clearly, there remains a gap in literature in this direction, particularly in the construction industry of developing countries like Ghana. The aim of the present research is to fill such a gap in the literature pertaining to the Ghanaian construction industry.

1.3 Aim and Objectives of the Study

The aim of the study is to explore supply chain management as a tool to minimising material waste in construction projects. The specific objectives of the study are as follows:

- to identify practices associated with effective supply chain management that could minimize material waste in construction projects in the Greater Accra Region.
- to identify drivers to adoption of SCM practices that could minimize material waste in the Greater Accra Region.
- to identify the barriers to the adoption of SCM practices that could minimize material waste in construction projects in the Greater Accra Region.

1.4 Research Questions

The following research questions will be used for the study.

- What are the practices associated with effective supply chain management that could minimize material waste in construction projects in the Greater Accra Region?
- What are the drivers to adoption of SCM practices that could minimize material waste in the Greater Accra Region.
- What are the barriers to the adoption of SCM practices that could effectively address materials waste in construction projects in the Greater Accra Region?

1.5 Significance of the Study

The study would help Construction firms with regard to creating awareness about effective supply chain management practices that could minimize waste. Moreover, minimising waste increases the profitability of the construction firm. Also, the study outcome would help the stakeholders to develop policies and practices that could minimize material wastage. Furthermore, the recommendations from the study could also help construction firms adopt the best practices and standards at the construction sites and enforce contractors to take keen interest in training their employees on material handling and management.

1.6 Scope of the Study

The study is focused on construction professional working on projects in the Greater Accra Region. This study is geographically limited in scope to the Greater Accra Region of Ghana. However, the study is conceptually, theoretically and empirically limited in scope to effective supply chain management practices and its

benefits in minimising waste in the construction firms, ascertaining and maintaining the flow and supply of materials, waste minimization management, supply chain management in the construction industry.

1.7 Organization of the Dissertation

This dissertation consists of five chapters. Chapter one deals with the background to the study, the statement of the problem, research questions and objectives of the study, significance of study and organization of the dissertation. In chapter two, the researcher presents review of related literature while chapter three deals with the research methodology used in the study. Other aspects of chapter three describe the research design, the population sample and sampling procedures, data gathering instruments and data collection procedures of the study, and methods of data analysis. Chapter four describes the research results and the discussion of the main results. Chapter five presents the summary of the findings, conclusions and recommendations and suggestions for further research.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter presents reviewed literature regarding theoretical, empirical and conceptual frameworks of supply chain management and minimisation of waste in the construction industry.

2.1 Overview of the Construction Industry

2.1.1 The Global Construction Industry

The construction industry includes all companies primarily engaged in construction such as general contractors, heavy construction (airports, highways, and utility systems), and construction by specialist trades. Also included are companies that engage in the preparation of sites for new construction and in subdividing land for building sites. Construction work may include new work, additions, alterations, or maintenance and repairs. Construction work is often described by either type, residential (home building) or non-residential (commercial and government buildings and infrastructure projects), or by funding source, public or private (Conway *et al.,* 2005).

The construction sector represents, for many countries, a core economic activity. It not only provides the infrastructure for all other industries, but also constitutes one of the largest single sectors in the economy on its own. Closely linked with public works, governments have relied on the construction sector as a strategically important industry for creating employment and sustaining growth. For the developing economies, the construction sector carries particular importance

because of its link to the development of basic infrastructure, training of local personnel, transfer of technologies, and improved access to information channels (International Investment and Services Directorate, 2009).

Construction services, in a large number of countries, are primarily supplied through the establishment of service suppliers at or near the site for the work by local or regional operators. On-site establishment is normally confined to the duration of the particular project, while regional or local presence may be ensured on a permanent basis to service or promote several projects. Joint ventures between foreign and domestic firms are quite common - often out of necessity for financing of projects; transfers of technology and know-how; and assistance in meeting local laws, regulations, and practices (International Investment and Services Directorate, 2009).

In many countries, construction services may be carried out by general contractors who complete all the work for the proprietor of the project, or by specialized sub-contractors who undertake parts of the work. Analysis by the World Trade Organization Secretariat indicates that most countries have a small number of large firms, a moderate number of medium-sized firms, and a large number of small firms who specialize in certain fields or who operate in small geographical areas (International Investment and Services Directorate, 2009).

2.1.2 The International Supply of Construction Services

The global construction industry is the single largest industry in the world. In 2004 the total value of the global construction industry exceeded four trillion dollars (Gary, 2004). Of even greater importance, 25% of the world's workforce worked directly for the construction industry or an entity supporting construction. Construction work is a tool to stimulate economies and project foreign policy.

From 2003 to 2004, the global construction industry grew by 6.6% (Conway *et al.,* 2005). In 2003 the largest global construction firms were *Vinci* of France ($12 Billion (B) domestic/$8B international revenue), and *Skanska* of Sweden ($3B domestic/$14B international) (Conway *et al.,* 2005). The largest international construction market is Europe. The second largest international construction market is Asia/Australia with China being the single fastest growing market. Transportation is the largest sector in the international construction market (27.5%), followed by general building (25.4%) and petroleum infrastructure (18.7%) (Conway *et al.,* 2005). According to the World Trade Organization Secretariat, the international supply of construction services involves large movements of workers at all levels of skill. Although statistics regarding the movement of workers related to the industry are not readily available, analysts believe that large portion of the movement of workers into the industrialized countries and the Middle East from Asia, Latin America and other developing regions are construction-related (International Investment and Services Directorate, 2009).

Because of the type of work involved, the majority of construction services are either supplied by the commercial presence of a foreign company or through the presence of natural persons. The cross border supply of construction services is assumed to be practically non-existent as a result of technical infeasibility (i.e., construction services cannot be supplied without the movement of service providers). However, some services (such as land surveying and blue-print designing) may become increasingly traded over telecommunications infrastructures. As electronic commerce develops there may be some changes in

the way that construction services are supplied (International Investment and Services Directorate, 2009).

2.1.3 The Ghanaian Construction Industry

The construction industry in Ghana, as in other parts of the world, is huge and a crucial segment in economic development. No matter what one does, there is construction, as it cuts across all sectors. Being among the top drivers of the Ghanaian economy, including agriculture, manufacturing and mining, its importance cannot be over emphasized, especially as the country is one of the most active economically in West Africa. From a low point in the1970s and 1980s the share of construction in the GDP has moved up from 4.5% in 1975 to 8.5% by the turn of the century and has been doing about the same levels since. The sector grew by 10% in 2008 but registered a negative growth rate of 1% in 2009 due to the global economic recession (Gyadu-Asiedu, 2009). The key stakeholders in the construction industry in Ghana are clients, professional consultants and contractors (Gyadu-Asiedu, 2009).

In Ghana four main clients are distinguishable: the Government (being the major client), Real Estate Developers, Investors and Owner-Occupiers. Between 2000 and 2008 the government of Ghana identified construction as a priority sector for foreign and private investment as part of its vision to promote the private sector as the engine of growth. According World Bank (2003) as provided by Anvuur and Kumaraswamy (2006), an approximate annual value of public procurement for goods, works and consultant services amounts to US$600 million. This represents about 10% of the country's GDP. This amount forms part of the bulk of the expenditure of all government agencies, namely, the Ministries, the Assemblies, Departments, Institutions and other agencies. The government as a client is represented by the

Ministry of Road and Transport (for road works) and the Ministry of Water Resources, Works and Housing in giving out projects. The Real Estate developers are also the other group of clients who undertake large investment in building. Usually, these take loans and undertake speculative buildings for sale. Their performance is usually influenced by the lending situations in the country.

Professional consultants who are regularly engaged by the government and other clients are Architects, Quantity Surveyors (QS), Geodetic Engineers (GE), Structural Engineers (St.E), Electrical Engineers (EE) and Services Engineers (SE). Geodetic Engineers are often called when it is about roads construction. All these professionals are regulated by their professional institution (Gyadu-Asiedu, 2009). Contractors in Ghana are grouped into eight categories (A, B, C, S, D, K, E and G) according to the type of works they undertake. These are (i) Roads, Airports, and Related Structures (A); (ii) Bridges, Culverts and other Structures (B); (iii) Labour based road works (C); (iv) Steel bridges and structures: construction rehabilitation and maintenance (S); (v) General building works (D); (vi) General civil works (K); (vii) Electrical works (E); and (viii) Plumbing works (G). In each category, they are grouped into 4, 3, 2 and 1 financial classes in increasing order (Vulink, 2004). In addition, Dansoh (2005) notes a combined category of AB for road contractors. According to Dansoh (2005) Class 4 contractors can tender for contracts up to $75,000; class 3 up to $200,000; class 2 up to $500,000. Class 1 takes contracts of all amounts. Categories E and G contractors act as main contractors when the work is of a specialized nature.

The industry is dominated by large number of small- and medium-sized firms. This is mainly because such firms are able to register with as little equipment as possible. Mostly, they are sole proprietors, (few cases of partnerships), and are

characterized by high attrition rate. This is because they are highly influenced by the boom and slum nature of the industry in Ghana. They are the least organized and because they lack the resources to employ and retain very skilful labour, their performance is usually below expectation and they have often been accused of producing shoddy works. Because there are often more jobs within their financial class than those above their limits, and because they form the largest group, their performance impacts greatly on the performance of the industry. Because of this, the classification by the Ministry has been criticized as being too general and obsolete with the registration criteria, list of contractors and monetary thresholds not regularly updated (Eyiah and Cook, 2003; World Bank, 2003). The two upper classes (D1 and D2) are more organized and hence more stable, taking on both bigger and smaller works. However, these firms (especially the D2 firms) do not always employ the very qualified workers. The Ghana-based foreign contractors are able to do this and hence perform better. Vulink (2004) notes that because of the poor performance of Ghanaian local contractors most of the nation's major projects are usually awarded to foreign contractors. Assibey-Mensah (2008) attributes this to the "non-businesslike culture" with which indigenous firms operate in Ghana.

2.2 Supply Chain Management

Supply Chain Management concept originated and flourished in the manufacturing industry. The first signs of SCM were perceptible in the Just In Time (JIT) delivery system as part of the Toyota Production System (Shingo 1988). This system aimed to regulate supplies to the Toyota motor factory just in the right - small - amount, just on the right time. The main goal was to decrease inventory drastically, and to regulate the suppliers' interaction with the production

line more effectively. After its emergence in the Japanese automotive industry as part of a production system, the conceptual evolution of SCM has resulted in an autonomous status of the concept in industrial management theory, and a distinct subject of scientific research, as discussed in literature on SCM (e.g., Bechtel and Cooper and Ellram, 1993). Along with original SCM approaches, other management concepts (e.g., value chain, extended enterprise) have been influencing the conceptual evolution towards the present understanding of SCM. In a way, the concept of SCM represents a logical continuation of previous management developments (Van der Veen and Robben 1997). Although largely dominated by logistics, the contemporary concept of SCM encompasses more than just logistics (Cooper and Ellram, 1993). Actually, SCM is combining particular features from concepts including Total Quality Management (TQM), Business Process Redesign (BPR) and JIT (Van der Veen and Robben 1997).

The supply chain has been defined as 'the network of organizations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services in the hands of the ultimate customer' (Christopher 2012).

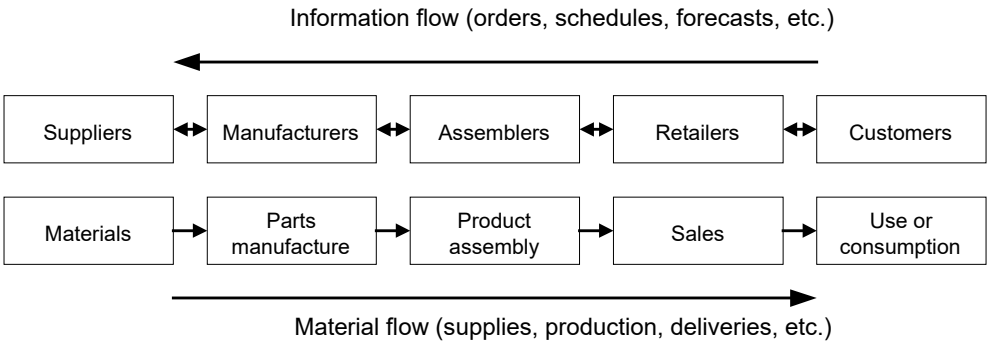


Figure 2.1: Generic configuration of a supply chain in manufacturing

Source: Christopher 2012

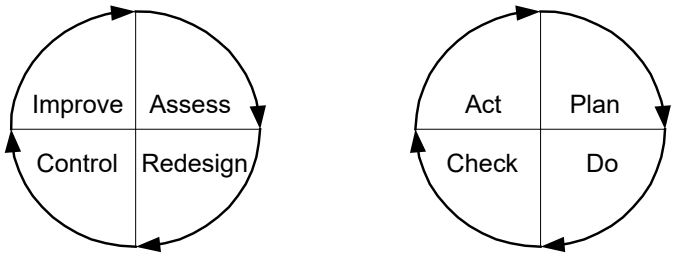
Supply chain management looks across the entire supply chain (Figure 2.1), rather than just at the next entity or level, and aims to increase transparency and alignment of the supply chain's coordination and configuration, regardless of functional or corporate boundaries (Cooper and Ellram, 1993). According to some authors (e.g., Cooper and Ellram, 1993), the shift from traditional ways of managing the supply chain towards SCM includes various elements (Table 1). The traditional way of managing (Table 1) is essentially based on a conversion (or transformation) view on production, whereas SCM is based on a flow view of production. The conversion view suggests that each stage of production is controlled independently, whereas the flow view focuses on the control of the total flow of production (Koskela 1992).

In the literature on SCM, many supply chain methods have been proposed. Most methods address logistical issues of the supply chain, e.g., quality rates, inventory, lead-time and production cost. The methods of pipeline mapping (Scott and Westbrook 1991), supply chain modelling (Davis 1993) and logistics performance measurement (Lehtonen 1995) analyze stock levels across the supply chain. The **LOGI method** (Luhtala et al. 1994, Jahnukainen et al. 1995) studies time buffers and controllability problems of the delivery process. Supply chain costing (La Londe and Pohlen 1996) focuses on cost buildup along the supply chain. Integral methods like value stream mapping (Hines and Rich 1997, Jones et al. 1997) and process performance measurement (De Toni and Tonchia 1996) offer a "toolbox" to analyze various issues including lead time and quality defects.

Table 2.1: Characteristic differences between traditional ways of managing the supply chain and SCM (Cooper and Ellram, 1993)

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

Besides assessing and improving the supply chain, other elements are essential to the methodology of SCM. A generic methodology of SCM can be deduced combining and generalizing the commonalities of different SCM methods. In a way, the SCM methodology bears resemblance to the Deming Cycle (Figure 2). Generically, the methodology of SCM consists of four main elements: (1) Supply chain assessment, (2) Supply chain redesign, (3) Supply chain control, and (4) Continuous supply chain improvement.



Generic SCM Methodology **Deming Cycle**

Figure 2.2: Generic SCM methodology compared to the Deming Cycle

Source: Cooper and Ellram (1993)

The first step is to assess the current process across the supply chain in order to detect actual waste and problems. The issue here is to find the causality between the waste and problems, and locate their root causes. Once the causality is understood, and having found out about the root causes, the next step is to redesign the supply chain in order to introduce structural resolution of the problems. This includes redistribution of roles, tasks and responsibilities among the actors in the supply chain, and a review of procedures.

The next step is to control the supply chain according to its new configuration. An important part of the control is the installation of a monitoring mechanism to continuously assess how the supply chain operates. This includes systems to measure and estimate waste across the supply chain process, and feedback systems to discuss and evaluate underlying problems. The objective is to continuously identify new opportunities, and find new initiatives to develop the supply chain. In fact, this continuous improvement implies the ongoing evaluation of the supply chain process, and the recurring deployment of the previous three steps: assessment, redesign and control (Figure 3).

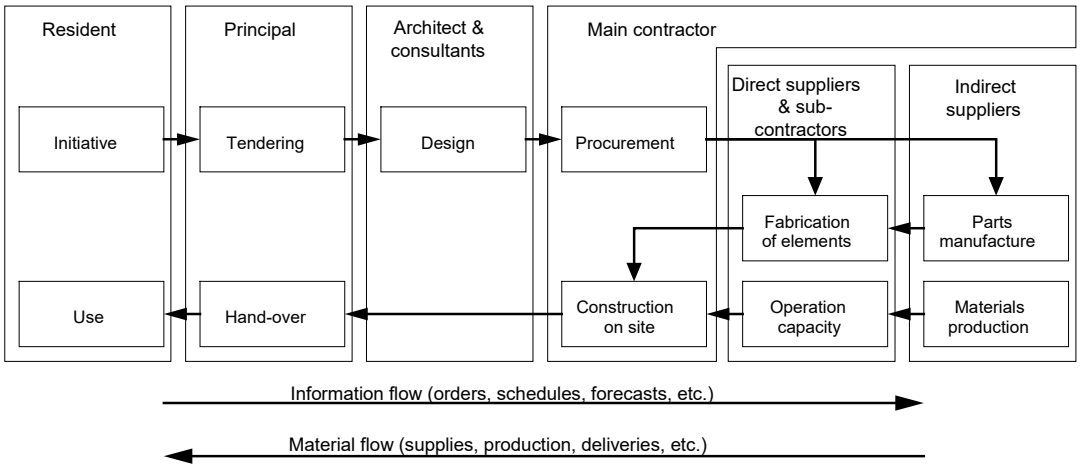


Figure 2.3: Generic configuration of a traditional supply chain in residential building

Source: Cooper and Ellram (1993)

2.2.1 Classification of SCM Practices

There are many ways of classifying SCM. For example, Theyel (2001) explains three types of environmental relationships, setting environmental requirements, sharing information and collaboration for improving products or processes. Bowen *et al.* (2001b) present a different classification: greening the supply process (that includes the incorporation of environmental practices into supplier's management), product-based green supply (that includes changes in the product supplied) and advanced green supply that introduces more proactive measures into the customer-supplier relationships such as the inclusion of environmental goals in supplier selection. Zhu and Sarkis (2004) identifies four types of SCM, Internal Environmental Management, External SCM practices, Investment recovery and Eco-design.

Finally, Srivastava (2007) and Bowen et al. (2001a) identify just two categories, product based and process-based. The following description of SCM practices are based on the last-mentioned classification, and within every category the

practices are the most common identified in the literature and are listed according to the level of complexity and resources needed to implement them. It is important to mention that these practices do not exclude each other and several practices can be performed together.

Product-based practices are those related with modifications to the product purchased or its by-products. One of the most common requirements is packaging reduction or modification, which refers to actions such as reducing the amount of packaging material, elimination of hazardous materials, facilitate dismantling or recycling (Envirowise, 2001). Another product-based practice is the implementation of recycling schemes, which involves the collaboration between supplier and customer for the collection, sorting and transportation when the recycling happens on a different link of the supply chain. Eco-design refers to the designing of products with certain environmental considerations (Srivastava, 2007). The main practices aim to material reduction, materials recovery (e.g. to facilitate dismantling or recycling), waste minimization or hazardous materials removal (Zhu and Sarkis, 2006). And finally, life cycle assessment (LCA), which can be considered as the most complex product-based practice because it requires knowledge about all the stages of a product. It is a technique used to track all materials and energy flows of a product associated with any activity over its entire life-cycle from raw material extraction, manufacturing, and use to ultimate disposal, it is also known as "cradle to grave" assessment (Vigon, 1994; Starkley, 2000).

On the other hand, process-based practices are those related with modifications to the supplier's management practices. One of the most common is the requirement of an environmental policy in order to improve the environmental performance. Nevertheless, an environmental policy has to be more than just a written

exercise, it needs to reflect the realities of the wider environmental context in which the company operates (Sheldon & Yoxon, 2006). Another common practice is the completion of questionnaires to demonstrate to the customer commitment and performance. Some issues addressed are: regulatory compliance, environmental effects and measures, existing procedures and general commitment (Lamming & Hampson, 1996). Environmental criteria for supplier selection refer to the inclusion of environmental attributes or requirements in order to be approved as a supplier. Site Waste Management Plans is a process performed by customer and supplier involving the collection, transportation, incineration, composting or disposal of goods traded between the two parties involved (Srivastava, 2007). A plan of this type should detail the amount and type of waste generated and how it will be reused, recycled or disposed (DEFRA, 2007). Reverse Logistics plans can be considered similar to a site waste management plan.

However, it is about the collection, sorting and transportation of used materials specifically for remanufacturing. It needs the coordination between the return rate of materials and the actual demand (Srivastava, 2007), so to be effective it requires the close collaboration between the customer and the supplier. One more process-based practice is the implementation of environmental audits by the customer or by a third party on behalf of the customer. It consists on a systematic, periodic and documented evaluation of environmental performance of facility operations and practices (Glasson *et al.*, 2005). Finally, the requirement to design, implement and certify an EMS in order to maintain the relationship with a specific client was done. There are mainly two standards used in the industry, the development of EMAS in 1993 and the release of the ISO 14000 series in 1996 (Morrow and Rondinelli, 2002). A recent addition is the British Standard 8555 (Project Acorn) that breaks down the

ISO 14001 or EMAS implementation into six stages, each stage with official recognition (DEFRA, 2005; Gascoigne, 2002).

Nevertheless, collaboration can occur in any of the practices mentioned before and it refers to any kind of support provided by a big customer to its supply chain. It can be financial, training or provision of information (Lamming and Hampson, 1996). As an example some big contractors with the support of CIRIA have worked in recent years towards the implementation of EMS with their tier 1 suppliers (ENDS Report, 2001).

2.3 Drivers and Barriers to Implement SCM Practices

The classification of drivers is based on a survey carried out by Rao (2005), in which two main factors were identified as the most significant, sustainability motivators and economic motivators. In addition, additional research has commented on the influence of external pressures and the purchasing process itself (Hall, 2000; Morton *et al.*, 2002). Sustainability motivators refer to the improvement in management practices to prevent significant environmental impacts as well as develop new environmental solutions (Rondinelli & Vastag, 2000). Economic Motivators refer to the reduction in energy use, raw materials, increase market share or any strategy that could be translated into financial capital (Morrow &Rondinelli, 2002). External pressures refer to any external force capable to initiate these types of practices and finally the motivation of improving the purchasing process itself.

Usually the barriers for SCM do not appear as isolated issues. Hence, the analysis on this section will be for groups of barriers that are linked because of their nature. The first group is formed by lack of resources, short term planning and lack of markets for recyclable materials. These are linked because they all deal with

availability of resources (financial or human) for SCM. Lack of resources is probably the most important barrier identified because the resources needed have to compete with other company's priorities (Stoesser, 1997). In addition, the costs and efforts involved in the design, development, documentation, implementation and certification of an EMS usually discourage smaller companies in which financial resources are restricted (Rondinelli & Vastag, 2000). Furthermore, costs have to be incurred on the short term whilst the benefits can take years and often can be difficult to associate with the measures taken (Freimann & Walther, 2001). Finally, lack of markets for recyclable materials can become a barrier for companies trying to implement product-based strategies (Rao, 2005).

The second group is formed by top management commitment, middle management commitment, inappropriate organisational structure and internal communication because they all deal with the internal aspects of a company. Top and middle management commitment are related and have to do with the company's capacity towards a successful SCM. Top management particularly on SMEs, differs from the management behaviours found on large publicly owned businesses because they respond to different stakeholders and have different experiences and capabilities (Emiliani, 2000). Top-management commitment needs to understand the value, efforts and support required to implement SCM strategies successfully (Lippmann, 1999). On the other hand, middle management commitment, knowledge and awareness towards legislation and environmental impacts are a crucial step towards the successful implementation of SCM strategies (Bowen *et al.*, 2001a). Another barrier identified is the internal communication within a company. Organizations need to communicate effectively their environmental goals to their own personnel as well as their stakeholders and make clear how these goals relate with their regular

functions (Lippmann, 1999). Lack of appropriate organisational structures and widespread ignorance of supply chain philosophy are also barriers identified for the implementation of SCM (Akintoye *et al.*, 2000).

Another group is formed by lack of knowledge, lack of information and lack of support to implement such measures. These barriers deal with the expertise needed on issues such as environmental impacts, sustainability and supply chain processes. For SMEs, lack of knowledge about environmental impacts or underestimation of the environmental impacts is usual, one reason is that legal thresholds are usually bigger (Hillary, 2000). Lack of technical knowledge and skills on SMEs are also common. Usually these types of companies have less information and expertise available to them for dealing with environmental requirements from customers (Hillary, 2000; Ofori *et al.*, 2002). In the absence of other capabilities (such as quality control, inventory control management or pollution prevention) the concepts of continual improvement, lean production practices as well as avoiding the focus on "end of pipe technology" are more difficult to understand and achieve (Darnall & Edwards, 2006). Finally, the lack of government legal enforcement (Shen et al., 2002) or compliance with different types of legislation (local, national or even international legislation depending on the size) can be considered as a barrier to SMEs' adoption of SCM (Hillary, 2000).

2.4 The Role of Supply Chain Management in Materials Waste Management

During the construction process, construction managers have to deal with different factors that can negatively affect the performance of the production process, and producing different types of wastes. Wastes can include mistakes, rework, working out of sequence, redundant activity and movement, delayed or premature inputs and products or services that do not meet customer needs

(CIRIA, 1998). Waste in construction has been defined in different ways by different studies. According to the new production philosophy, waste should be understood as any inefficiency that results in the use of equipment, materials, labour, or capital in larger quantities than those considered as necessary in the production of a building. Waste includes both the incidence of material losses and the execution of unnecessary work, which generate additional costs but do not add value to the product (Polat & Ballard, 2004). Waste should be defined as any losses produced by activities that generate direct or indirect costs, but do not add any value to the product from the point of view of the client (Alwi *et al.,* 2002; Formoso *et al.*, 1999). According to Polat and Ballard (2004), a simple way to define waste is "that which can be eliminated without reducing customer value". It can be activities, resources, rules, etc. Macomber and Howell (2004), add that, the common sense understanding of waste is anything of no value. More precisely, waste is the expenditure of effort or the using-up of resources without producing value. After categorizing waste to seven types by Ohno (1994), Womack and Jones (1996) defined waste as any activity that absorbs resources and does not have any value adding. Waste in construction can be classified into three main types; waste of materials, waste of time and waste of machinery (Al-Moghany, 2006; Ekanayake and Ofori, 2000). However, this research focuses on materials waste.

Construction material wastes refer to materials from construction sites that are unusable for the purpose of construction and have to be discarded for whatever reason (Yahya & Boussabaine, 2006). According to Ekanayake and Ofori (2000), construction material waste is defined as any material apart from earth materials, which needs to be transported elsewhere from the construction site or used on the site itself other than the intended specific purpose of the project due to damage, excess or non-use or which

cannot be used due to non-compliance with the specifications, or which is a by-product of the construction process.

Bossink and Brouwers (1996) conducted a research in The Netherlands that was concerned with the measurement and prevention of construction waste with regard to meeting sustainability requirements stated by Dutch environmental policies. Waste from seven materials was monitored in five house-building projects between April 1993 and June 1994. During the study, all material waste was sorted and weighed. The amount of direct waste by weight ranged between 1 and 10% in weight of the purchased amount of materials. Further, it was concluded that an average 9% (by weight) of the total purchased construction materials end up as site waste in the Netherlands.

According to Datta (2000), about 20-25% of materials are wasted on construction sites in Tanzania, Zambia, Zimbabwe and Botswana. Fatta et al., (2003) also stated that in Greece, each 1000m^2 of building activity entail the generation of 50m^3 of waste. Ayarkwa and Adinyira (n.d.) reports of a wide variation in wastage rates of between 5% and 27% of total materials purchased for construction projects in Ghana.

2.4.1 Causes of Materials Waste

Many factors contribute to construction waste generation on site. Waste may occur due to one or a combination of many causes. According to Poon *et al.* (2001), research in Hong Kong indicates there are many contributory factors to the generation of waste; these include both human and mechanical activities. Table 2.2 is a summary of the major causes of materials waste in Hong- Kong.

Table 2.2: Causes of Construction Site Waste

	Causes of Building Waste on Site	**Examples**
SITE MANAGEMENT PRACTICES	Lack of a quality management system aimed at waste minimization	lack of waste management plan
	Untidy construction sites	waste materials are not segregated from useful materials
	Poor handling	breakage, damage, losses
	Over-sized foundations and other elements	over design leads to excess excavation and cut-offs
	Inadequate protection to finished work	finished concrete staircases are not protected by boarding
	Limited visibility on site resulting in damage	inadequate lighting in covered storage area
	Poor storage	pallet is not used to protect cement bags from contamination by ground water
	Poor workmanship	poor workmanship of formwork
	Waste generation inherited with traditional construction method	e.g. timber formwork, wet trade
DELIVERY OF PRODUCTS	Over-ordering	over ordering of concrete becomes waste
	Method of packaging	inadequate protection to the materials
	Method of transport	materials drop from forklift
	Inadequate data regarding time and method of delivery	lack of records concerning materials delivery

(Source: Poon *et al.,* 2001)

Bossink and Brouwers (1996), in their study in The Netherlands indicated the main sources and causes of construction waste as shown in Table 2.3.

Table 2.3: Sources and Causes of Construction Materials Waste

SOURCE	CAUSE
Design	Error in contract documents
Design	Contract documents incomplete at commencement of construction
Design	Changes to design
Design	Choices about specifications of products
Design	Choices of low quality to sizes of used products
Design	Designer is not familiar with possibilities of different products
Design	Lack of influence of contractors and lack of knowledge about construction
Procurement	Ordering error, over ordering, under ordering, and so on
Procurement	Lake of possibilities to order small quantities
Procurement	Use of products that do not fit
Materials handling	Damage during transportation to site/on site
Materials handling	Inappropriate storage leading to damage or deterioration
Materials handling	Unpacked supply
Materials handling	Throwaway packaging
Operation	Error by tradesmen or operatives
Operation	Equipment malfunction
Operation	Inclement weather
Operation	accidents
Operation	Damage caused by subsequent trades
Operation	Use of incorrect material, requiring replacement
Operation	Method to lay the foundation
Operation	Required quantity of product unknown due to imperfect planning
Operation	Information about types and sizes of products that will be used arrived too late on the construction site
Residual	Conversion waste from cutting uneconomical shapes
Residual	Off cuts from cutting material to length
Residual	Over mixing of materials for wet trades due to a lack of knowledge of requirements
Residual	Waste from application process
Residual	Packaging
Other	Criminal waste due to damage or theft
Other	Lack of onsite materials control and waste management plans

(Source: Bossink and Brouwers, 1996)

Similarly in Singapore, Ekanayake and Ofori (2000) organized the sources of construction waste under four categories: (1) design; (2) operational; (3) material handling; (4) procurement as shown in Table 2.4.

Table 2.4: Sources of Construction Materials Waste

Design	Operational	Material handling	Procurement
Lack of attention paid to dimensional coordination of products	Errors by tradesmen or operatives	Damages during transportation	Ordering errors (eg., ordering significantly more or less)
Changes made to the design while construction is in progress	Accidents due to negligence	Inappropriate storage leading to damage or deterioration	Lack of possibilities to order small quantities
Designers inexperience in method and sequence of construction	Damage to work done caused by subsequent trades	Materials supplied in loose form	Purchased products that do not comply with specification
Lack of attention paid to standard sizes available on the market	Use of incorrect material, thus requiring replacement	Use of whatever material close to working place	
Designers unfamiliarity with alternative products	Required quantity unclear due to improper planning	Unfriendly attitudes of project team and operatives	
Complexity of detailing in the drawings	Delays in passing information to the contractor on types and sizes of products to be used		
Errors in contract documents	Equipment malfunctioning		
Incomplete contract documents at commencement of project	Inclement weather		
Selection of low quality products			

(Source: Ekanayake and Ofori, 2000)

According to Alwi *et al.* (2002), the most significant causes of waste during the construction process in a comparative study of Indonesia and Australia construction projects are summarized in Table 2.5.

Table 2.5: Causes of Construction Materials Waste in Indonesia and Australia

Indonesia	Australia
Design changes	Design changes
Lack of trades‟ skill	Poor design
Slow in making decisions	Poor quality site documentation
Poor coordination among project participants	Slow drawing revision and distribution
Poor planning and scheduling	Unclear site drawing supplied
Delay of material delivery to site	Unclear specifications
Inappropriate construction methods	Weather

(Source: Alwi *et al.,* 2002).

Other studies (Arnold 1998; Formoso *et al.,* 1999; 2002; Polat and Ballard 2004) trace materials waste to sources including: overproduction, substitution, waiting time, transportation, processing, inventories, movement and production of defective products. Many of the root causes and sources of materials in the aforementioned studies can be traced to supply chain issues such as, but not limited to; poor supplier relationship management, poor customer relationship and poor flow of information. Arguably, effective SCM can lead to prevention or reduction in levels of materials waste on most projects as observed in many of the aforementioned studies.

2.5 Supply Chain management and Construction waste Minimisation in Ghana

Ayarkwa and Adinyira (n.d) studied the perceptions of contractors and consultants on the major causes of materials wastage on construction sites in Ghana. The results are shown in Figures 2.4 and 2.5 respectively.

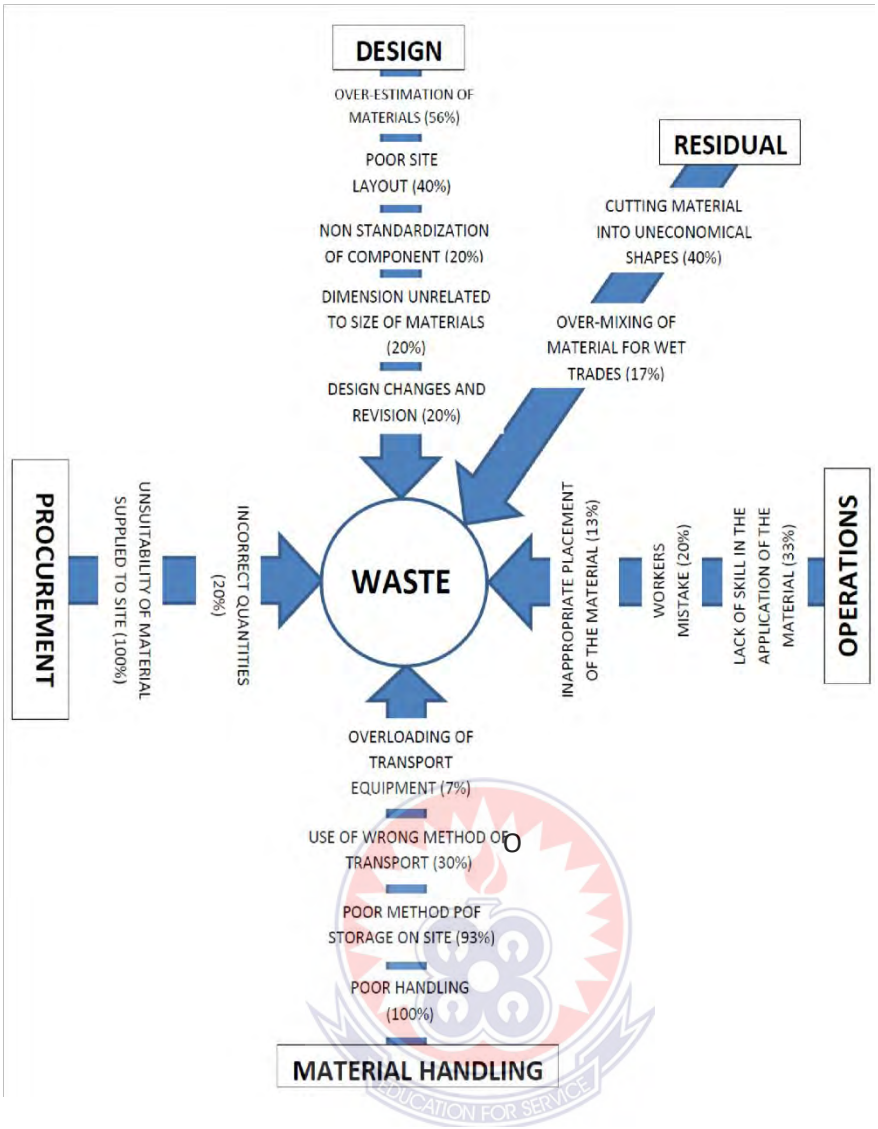
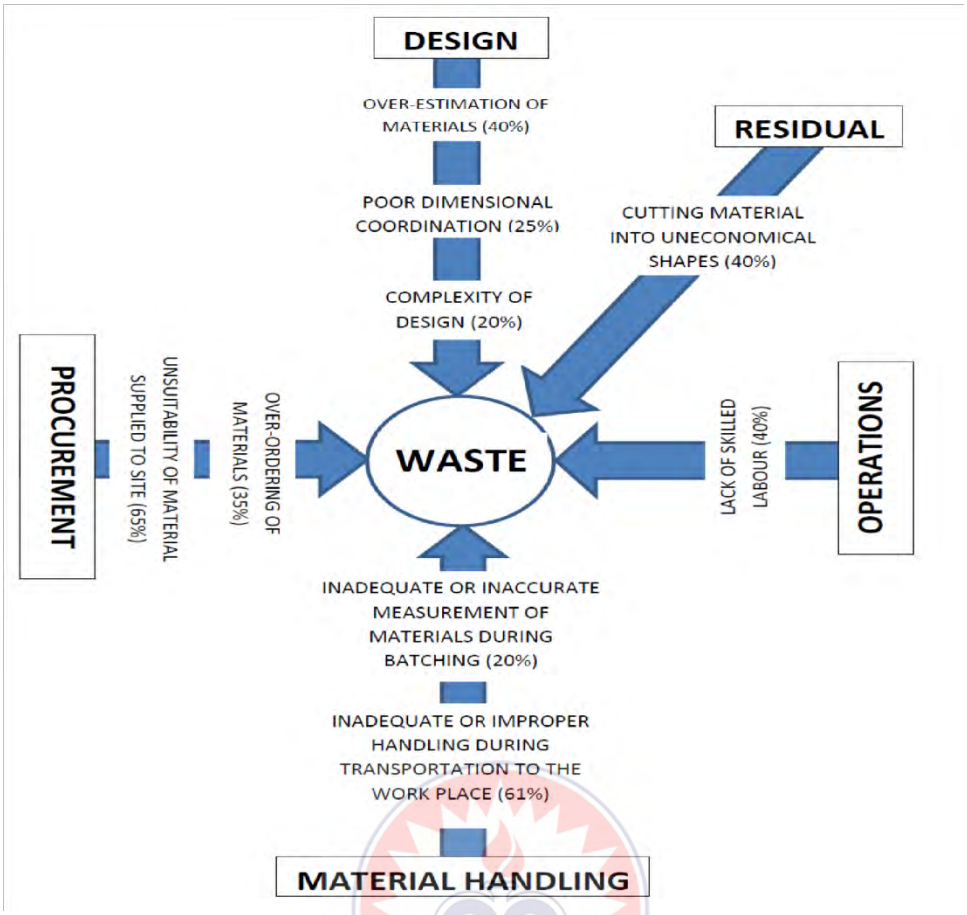


Figure 2.4: Contractors' perception of the main causes of material waste in construction in Ghana

(Source: Ayarkwa and Adinyira, n.d.)



(Source: Ayarkwa and Adinyira, n.d.)

Figure 2.5: Consultants' perception of the main causes of material waste in construction in Ghana

According to Ayarkwa and Adinyira (n.d.), in order to reduce the amount of waste generated in construction, the main causes of waste generation must be identified. The study asked respondents to identify the main causes of material waste in their construction operations. The frequencies of the causes were calculated following a classification proposed by Bossink and Brouwers (1996). The main causes of material waste and their percentage frequencies are presented in Figures 2.4 and 2.5 respectively.

Waste occurs at every stage in the construction life cycle. All contractors and 65% of consultants considered the ordering of unsuitable materials for a project (in terms of quality, type and dimensions) to result in material waste. This situation may arise from wrong information flow, deliberate choice of low quality materials in order to reduce cost, or wrong/ inadequate specification by project consultant.

Bossink and Brouwers (1996) and Polat and Ballard (2004), realized that the choice of low quality products and products that do not fit are two main causes of material waste. All contractors and 61% of consultants were of the opinion that poor handling of materials results in material waste. This may occur during transportation to the workplace, within the store, or during application. Poor handling may result from lack of knowledge on proper handling of sensitive material or lack of skill in job performance on the part of site workers. Poor storage method was also considered by 93% of contractors to cause material waste. Poor storage can result in breakage or damage to materials, especially fragile ones like ceramic tiles and glass.

Overestimation, over-ordering, and poor site layout were also considered by significant percentages of contractors and consultants to result in material waste. Overestimation leads to over-ordering of materials which will bring more materials than necessary for a job. Improper site layout resulting from improper planning, which affects the flow or sequence of activities on site, creates problems with transportation of materials and movement of site workers, and results in poor handling and resultant damage to materials. Lack of standardization of component dimension, dimensions unrelated to sizes of materials or poor dimensional coordination, which are design issues, may result in cutting, shaping, sawing etc., causing material waste in construction.

Most of the causes of construction materials waste identified by Ayarkwah and Adinyira (n.d) confirm the findings of similar other studies (Gara *et al.,* 2001; Bossink and Brouwers, 2006, Gavilan and Bernold, 2004; Craven *et al.,* 2014; Polat and Ballard, 2004). Twenty percent of contractors indicated that workers' mistakes cause material waste on site. Forty percent (40%) of consultants also think lack of skilled labour causes material waste. In a study of dominant causes of waste generation in Egyptian construction Garas *et al.* (2001) is reported to have found that untrained labourers make mistakes frequently. The results again showed that the reduction of construction waste is not only a responsibility of the construction company. The client and the designer can make environmentally-friendly choices in the programme of demands and the design. Sources of material waste have been traced to the design, procurement, material handling, operation and residual activities. Also worth noting is that effective SCM has the potential to address some causes of materials wastes thereby substantially reducing levels of materials waste on construction sites and consequently resulting cost savings to both contractor and clients of the construction industry.

2.6 The Importance of Minimising Construction waste through Effective Supply chain Management

Construction and demolition projects pose unique challenges in the area of waste minimization (Hoe, 2006; Milward, 2005). Since each project is different, generating its own unique combination of wastes, the contractor must be flexible and creative in finding ways to reduce, reuse, or recycle the various types of wastes (Hoe, 2006). According to Hoe (2006), managing construction and demolition waste can constitute a significant cost to the business. Some wastes require careful and perhaps

expensive handling techniques during the construction process. A company can thus benefit in a number of ways from reducing the amount of waste it needs to dispose of. The consideration of waste minimization can generate advantages such as financial and environmental benefits (Al-Moghany, 2006; Poon and Jailon, 2002).

2.6.1 Financial Benefits

Waste minimization can provide financial benefits, and in some cases can even save cost and time. The financial benefits can be appreciated over a short term or long-term period. But overall, cost benefits can be appreciated throughout the whole building process by carrying out an analysis of the life cycle costs. Financial benefits include:

- Reduced transportation costs for waste materials (less transportation because of less material wasted). This includes transportation to and from the site and disposal.
- Reduced disposal costs of waste materials.
- Reduced purchase quantity and price of raw materials by waste minimization.
- Reduced purchase price of new materials when considering reuse and recycling

  (depending on materials).
- Increased returns can be achieved by selling waste materials to be reused and recycled.

Long term benefits through optimizing the building life concept, by avoiding expenses from demolition and construction of new buildings (Al-Moghany, 2006; Poon and Jailon, 2002). Use of recycled materials has reduced waste storage costs and minimized the dereliction of land (Al-Moghany, 2006; Lnyang, 2003). Sometimes,

reuse and recycling may not always be financially viable, hence other considerations should be considered such as environmental benefits (Al-Moghany, 2006).

2.6.2 Environmental Benefits

Waste minimization can provide environmental benefits, which are important to be considered due to the alarming situation of materials waste on construction sites (Al-Moghany, 2006; Poon and Jailon, 2002). These environmental benefits are:

- Reduced quantity of waste generated.
- Efficient use of waste generated.
- Reduced environmental effects as a result of disposal, e.g. noise, pollution.
- Reduced transportation of waste to be disposed of (hence less noise, vehicle emission pollution, and energy used).

2.7 Conceptual Framework of the Study

2.7.1 Main concepts of SCM

Green et al. (1996) define SCM as follows:

> *"The way in which innovation in supply chain management and industrial purchasing may be considered in the context of the environment"*

SCM is a broader term than sustainable procurement (Bowen *et al.*, 2001a). However, this concept is also related with SCM practices and can be defined as:

> *"The process whereby organisations meet their needs for goods, services, works and utilities in a way that achieves value for money on a whole-life basis in terms of generating benefits not only to the organisation, but also to society and the economy, while minimising damage to the environment"(Purchasing and Supply Agency, 2006).*

The supply chain processes influence the quantities and types of resources acquired and select the sources of key products and suppliers; these activities are directly connected with the degree of negative impacts on the environment and indirectly connected with economic and social growth within a community (Morton et al., 2002). In other words, SCM is related with any attempt of improving the environmental performance of the purchased products/services or the suppliers that provide them (Bowen *et al.*, 2001a).The main aims of SCM are to identify benefits, costs and risks associated with environmental performance (Hanfield *et al.*, 2005). A typical starting point in considering the inclusion of the supply chain is by implementing ISO 14001, which recommends the inclusion of policies to ensure the suppliers are aware of their environmental practices and liabilities (Rao, 2005). However, given that clients must obtain value for money invested and most contractors must obtain profit for risks undertaken in construction projects, it can be argued that client satisfaction, cost (financial), quality, safety and environmental dimensions of project performance are necessary outcomes of effective SCM practices aimed at reducing materials wastes in construction projects as can be seen from the author's conceptual framework in Figure 2.6.

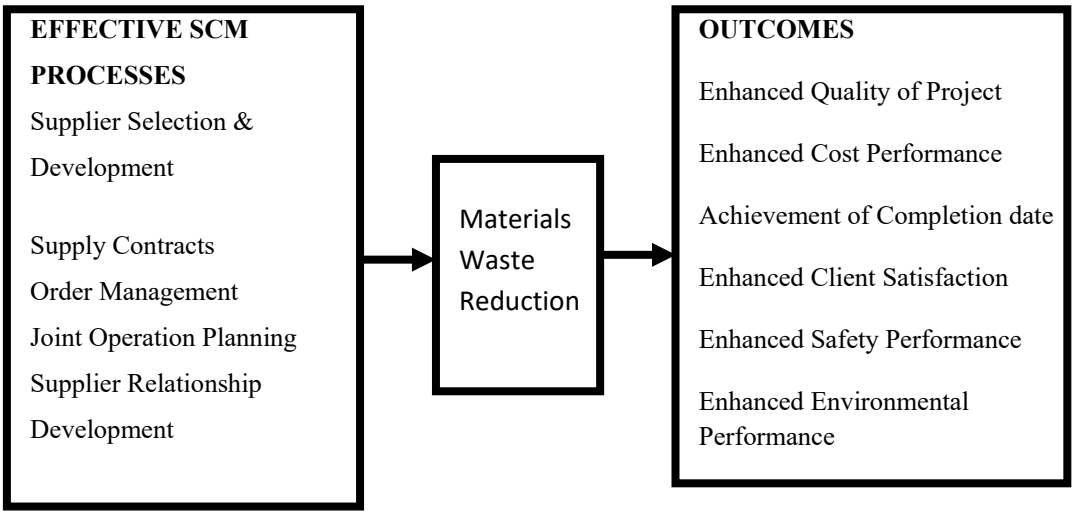


Figure 2.6: Author's Conceptual framework

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

The chapter presents the methods used to achieve the research objectives and to answer the research questions posed in chapter one. The chapter is organized into six main sections comprising introduction, research design, population of the study, sampling and sample size determination, data collection and analysis of data.

3.2 Research Design

This study adopted the case study design. The researcher used the case study method because among the various research designs, case study is frequently regarded as using both quantitative and qualitative research and a combination of both approaches (Bryman, 2004). Research methods can be placed into two basic categories: quantitative or qualitative. This research used both qualitative and quantitative research approach. Qualitative research gathers information that is not in numerical form. For example, diary accounts, open-ended questionnaires, unstructured interviews and unstructured observations. The researcher used open ended questions because they help the researcher to gather factual information from respondents. Qualitative data is typically descriptive data and as such is harder to analyze than quantitative data. Qualitative research is useful for studies at the individual level, and to find out, in depth, the ways in which people think or feel (e.g. case studies). The researcher used both qualitative and quantitative research approach for the study. The researcher used both qualitative and quantitative approach because quantitative approach helped to gather information that could be easily analysed using statistical means while qualitative information can be easily evaluated using thematic

analysis. The questionnaires for the study were adequate, however, with closed ended questions, the response from respondents was limited however, and this was overcome by additional open ended questions. Open ended questions helped to provide more clarification from respondents.

3.3 Population

According to the Ministry of Works and Housing Department, there are 132 registered building construction companies in the Greater Accra Region. Therefore, the population for the study is one hundred and thirty two (132). The population of the study was made up of managers of the Building construction companies in the Greater Accra Region.

3.4 Sampling Procedures and Sample Size

The ever increasing need for a representative statistical sample in empirical research has created the demand for an effective method of determining sample size. To address the existing gap, Krejcie & Morgan (1970) came up with a table for determining sample size for a given population for easy reference. According to the Krejcie & Morgan (1970), table of determining sample size, a population of 132 requires a sample size of 97. The sample size was adjusted for non response rate of 30% (Enshassi et al., 2010). In view of this, a sample size of one hundred and twenty-six (126) managers of building construction firms were chosen for the study. Stratified random sampling methods were adopted for the study. Stratified random sampling method were adopted to select managers of the construction companies since the intention was to gain an insight into the effective supply chain management and minimizing of waste in the construction industry.

3.5 Data Collection Instrument

The main instrument that was used to collect information for the study was questionnaire. The questionnaire was structured to consist of closed ended and open ended type of questions in order to elicit feedback from the respondents. The questionnaire consisted of four sections. Section 1 contained the demographic information of the respondents including the respondents gender, age and educational qualifications. Section 2 assessed effective supply chain management practises that could minimise material waste in the construction industry in Ghana. Section 3 investigated the barriers and expectations about the economic impacts for implementing SCM practices in the construction industry in Ghana and section 4 identified the importance of minimising construction waste through effective supply chain management. These were the main areas around which data gathered from respondents were analyzed. Likert type scale was used as categories mainly ranging from strongly disagree, disagree, neutral, agree to strongly agree. Care was taken in order not to be biased but to come out with objective interpretations of what were questioned. The researcher used the likert type scale because the scale had variables that could help the respondents provide responses suitable for the study.

3.5.1 Pilot Testing

A pilot questionnaire was given to 10 people (6 Building contractors, Project Managers, Site Supervisors and 4 Labourers) to answer to correct errors which could take the form of repetition of questions and typographical mistakes and the avoidance of double questions. The pilot testing took place at Trassaco Construction Company in Accra. The results from the pilot testing showed that the questionnaire wer accurate and grammatically good for distribution.

3.5.2 Data Collection Procedure

Primary data were collected through a field survey of Building contractors, Project Managers, Site Supervisors and Labourers in the Trassaco Construction Company in Accra. Data were collected through the use of a designed questionnaire administered to participants in their construction sites. Questionnaires were filled out by participants and the researcher had to go for the questionnaires on the same day.

3.6 Data Analysis

Raw data obtained from a study is useless unless it is transformed into information for the purpose of decision making (Emery & Couper, 2003). The data analysis involved reducing the raw data into a manageable size, developing summaries and applying statistical inferences. Consequently, the following steps were taken to analyze the data for the study. The data were edited to detect and correct, possible errors and omissions that were likely to occur, to ensure consistency across respondents.

The questionnaire data were then coded to enable the respondents to be grouped into limited number of categories. The SPSS version 18 was used to analyse data. The results were would be presented in tabular form, graphical and narrative forms. In analyzing the quantitative data, descriptive statistical tools such as percentages, mean and standard deviation were be used.

CHAPTER FOUR

PRESENTATION OF RESULTS, ANALYSIS AND DISCUSSION

4.0 Introduction

The chapter presents the analysis and discussion of results of the field survey. A total of one hundred and twenty six (126) questionnaires were administered and nine-nine (99) were completed and returned to the researcher. Three of the questionnaires were not properly completed and as such were not analysed. Ninety-six questionnaires (96) were analysed representing a response rate of 76%. The sections that follow present the analysis and discussion of results of the study in relation to the study's aim and objectives.

4.1 Demographic Information of the Respondents

This section contains tables that depict the demographic characteristics of the respondents including the respondent's gender, age range, and educational qualification of the respondents, working experience and availability of supply chain systems in the firm.

Table 4.1 shows that 88.5% of the respondents were males while 11.5% were females. This means that males dominated the construction industry. Majority of the respondents (89%) representing 85 were male while 11.5% representing 11 were female.

Table 4.1: Gender of the Respondents

Gender of the Respondents	Frequency	Percent
Male	85	88.5
Female	11	11.5
Total	96	100.0

Source: Field survey (2016)

Table 4.2 indicates that 47.9% of the respondents were between the age range 26-35 years, 33.3% of the respondents were between the age range 36-45 years while 18.8% were between the age range 46-55 years.

Table 4.2: Age range of the respondents

Age range of the respondents	Frequency	Percent
26-35 years	46	47.9
36-45 years	32	33.3
46-55 years	18	18.8
Total	96	100.0

Source: Field survey (2016)

Table 4.3 indicates that 45.8% of the respondents possessed Higher National Diploma as their highest qualification, 32.3% possessed SSSCE certificates, 15.6% possessed Bachelor's degrees while 6.2% held Master's degrees.

Table 4.3: Educational Qualification of the Respondents

Educational Qualification of Respondents	Frequency	Percent
Senior High School Certificate	31	32.3
Higher National Diploma	44	45.8
Bachelor's degree	15	15.6
Master's degree	6	6.2
Total	96	100.0

Source: Field survey (2016)

Table 4.4 shows that 25% of the respondents have worked in the construction industry for 5-10 years and 10-15 years respectively, 22.9% have worked in the industry for 1-5 years and 15-20 years respectively while 4.2% have worked in the construction industry for more than 20 years now.

Table 4.4: Working experience of the Respondents

Working experience of the Respondents	Frequency	Percent
1-5 years	22	22.9
5-10 years	24	25.0
10-15 years	24	25.0
15-20 years	22	22.9
20 years and above	4	4.2
Total	96	100.0

Source: Field survey (2016)

Table 4.5 depicts that 53.1% of the respondents affirmed that their construction firms have supply chain management system in place, 42.7% said that their firms do not have supply chain management system in place while 4.2% said that the supply chain management system is in progress in their firms. The construction sector represents, for many countries, a core economic activity. It not only provides the infrastructure for all other industries, but also constitutes one of the largest single sectors in the economy on its own. Closely linked with public works, governments have relied on the construction sector as a strategically important industry for creating employment and sustaining growth. For the developing economies, the construction sector carries particular importance because of its link to the development of basic infrastructure, training of local personnel, transfer of technologies, and improved access to information channels (International Investment and Services Directorate, 2009).

Construction services, in a large number of countries, are primarily supplied through the establishment of service suppliers at or near the site for the work by local or regional operators. On-site establishment is normally confined to the duration of the particular project, while regional or local presence may be ensured on a permanent basis to service or promote several projects. Joint ventures between foreign and domestic firms are quite common - often out of necessity for financing of projects; transfers of technology and know-how; and assistance in meeting local laws, regulations, and practices (International Investment and Services Directorate, 2009).

Table 4.5: Availability of Supply Chain Management System

Availability of Supply Chain Management System	Frequency	Percent
Yes	51	53.1
No	41	42.7
In progress	4	4.2
Total	96	100.0

Source: Field survey (2016)

4.2 Effective Supply Chain Management Practices that could Minimise Material Waste in the Construction Industry in Ghana

Table 4.6 shows the effective supply chain management practices in the construction firm.

Table 4.6: Effective supply chain management practices

SCM Practices	1 Freq. (%)	2 Freq. (%)	3 Freq. (%)	4 Freq. (%)	5 Freq. (%)	Total Freq. (%)
Focus on quality and performance	6 (6.2%)	11 (11.5%)	4 (4.2%)	64 (66.7%)	11 (11.5%)	96 (100%)
Enhancing transportation system	11 (11.5%)	4 (4.2%)	6 (6.2%)	60 (62.5%)	15 (15.6%)	96 (100%)
Risk of potential loss (Financial, physical and social)	8 (8.3%)	6 (6.2%)	9 (9.4%)	65 (67.7%)	8 (8.3%)	96 (100%)
Availability of suppliers	5 (5.2%)	5 (5.2%)	7 (7.3%)	73 (76%)	6 (6.2%)	96 (100%)
Initiative, tendering, design and procurement	-	-	9 (9.4%)	49 (51%)	38 (39.6%)	96 (100%)
Just-In-Time delivery (JIT) and logistics management.	-	-	-	65 (67.7%)	31 (32.3%)	96 (100%)
Pipeline mapping, Supply chain modelling and logistics performance measurement	-	-	10 (10.4%)	52 (54.2%)	34 (35.4%)	96 (100%)
Analysing stock levels across the supply chain	-	-	20 (20.8%)	49 (51%)	27 (28.1%)	96 (100%)
Supply chain costing and value stream mapping	-	-	13 (13.5%)	71(74%)	12 (12.5%)	96 (100%)
Waste management planning	5 (5.2%)	7 (7.3%)	5 (5.2%)	74 (77.1%)	5 (5.2%)	96 (100%)

1- Strongly disagree, 2- Disagree, 3- Uncertain, 4- Agree, 5- Strongly agree

Source: Field survey (2016)

Focus on quality and performance

Table 4.6 shows that 78.2% of the respondents agreed that supply chain management practices in the construction firm focused on quality and performance, 17.7% of the respondents disagreed while 4.2% were neutral.

Transport/Distance

The study indicates that 78.1% of the respondents agreed that supply chain management practices of the construction firm were geared towards improving the existing transportation system to enhance the free flow of goods and materials for construction works, 15.7% of the respondents disagreed while 6.2% were neutral. Bossink and Brouwers (1996) and Polat and Ballard (2004), realized that the choice of low quality products and products that do not fit are two main causes of material waste. All contractors and 61% of consultants were of the opinion that poor handling of materials results in material waste. This may occur during transportation to the workplace, within the store, or during application.

Poor handling may result from lack of knowledge on proper handling of sensitive material or lack of skill in job performance on the part of site workers. Poor storage method was also considered by 93% of contractors to cause material waste. Poor storage can result in breakage or damage to materials, especially fragile ones like ceramic tiles and glass. Overestimation, over-ordering, and poor site layout were also considered by significant percentages of contractors and consultants to result in material waste. Overestimation leads to over-ordering of materials which will bring more materials than necessary for a job. Improper site layout resulting from improper planning, which affects the flow or sequence of activities on site, creates problems with transportation of materials and movement of site workers, and results in poor handling and resultant damage to materials.

Risk of potential loss (Financial, physical and social)

The study further indicates that 76% of the respondents agreed that the supply chain management practices focused on risk of potential loss regarding financial, physical and social loss to the firm, 14.5% of the respondents disagreed while 9.4% were neutral. Waste minimization can provide financial benefits, and in some cases can even save cost and time. The financial benefits can be appreciated over a short term or long-term period. But overall, cost benefits can be appreciated throughout the whole building process by carrying out an analysis of the life cycle costs. Financial benefits include:

- Reduced transportation costs for waste materials (less transportation because of less material wasted). This includes transportation to and from the site and disposal.
- Reduced disposal costs of waste materials.
- Reduced purchase quantity and price of raw materials by waste minimization.
- Reduced purchase price of new materials when considering reuse and recycling

  (depending on materials).
- Increased returns can be achieved by selling waste materials to be reused and recycled.

Long term benefits through optimizing the building life concept, by avoiding expenses from demolition and construction of new buildings (Al-Moghany, 2006; Poon and Jailon, 2002). Use of recycled materials has reduced waste storage costs and minimized the dereliction of land (Al-Moghany, 2006; Lnyang, 2003). Sometimes,

reuse and recycling may not always be financially viable, hence other considerations should be considered such as environmental benefits (Al-Moghany, 2006).

Availability of suppliers

The study revealed that 82.2% of the respondents agreed that firms focused on the availability of suppliers when developing supply chain management practices, 10.4% of the respondents disagreed while 7.3% were neutral.

Initiative, tendering, design and procurement

The study shows that 90.6% of the respondents agreed that initiative, tendering, design and procurement practices are factored into when designing supply chain management system in the firms while 9.4% were neutral. Waste occurs at every stage in the construction life cycle. All contractors and 65% of consultants considered the ordering of unsuitable materials for a project (in terms of quality, type and dimensions) to result in material waste. This situation may arise from wrong information flow, deliberate choice of low quality materials in order to reduce cost, or wrong/ inadequate specification by project consultant. Lack of standardization of component dimension, dimensions unrelated to sizes of materials or poor dimensional coordination, which are design issues, may result in cutting, shaping, sawing etc., causing material waste in construction.

Just-In-Time delivery (JIT) and logistics management

The study shows that 100% of the respondents agreed that firms focused on Just-In-Time delivery (JIT) and logistics management when practicing supply chain management system.

Pipeline mapping, Supply chain modelling and logistics performance measurement

The study depicts that 89.6% of the respondents agreed that construction firms focused on Pipeline mapping, Supply chain modelling and logistics performance measurement when practicing supply chain management system while 10.4% of the respondents were neutral.

Analysing stock levels across the supply chain

The study holds it that 79.1% of the respondents agreed that analysing stock levels across the supply chain management system are practices firms focused on when developing supply chain management system while 20.8% were neutral.

Supply chain costing and value stream mapping

The study shows that 86.5% of the respondents agreed that firms focused on supply chain costing and value stream mapping practices when developing supply chain management system while 13.5% of the respondents were neutral.

Waste management planning

The study shows that 82.3% of the respondents agreed that waste management planning practises are considered when devising supply chain management system in firms, 12.5% of the respondents disagreed while 5.2% were neutral. Construction and demolition projects pose unique challenges in the area of waste minimization (Hoe, 2006; Milward, 2005). Since each project is different, generating its own unique combination of wastes, the contractor must be flexible and creative in finding ways to reduce, reuse, or recycle the various types of wastes (Hoe, 2006). According to Hoe (2006), managing construction and demolition waste can constitute a significant cost

to the business. Some wastes require careful and perhaps expensive handling techniques during the construction process. A company can thus benefit in a number of ways from reducing the amount of waste it needs to dispose of. The consideration of waste minimization can generate advantages such as financial and environmental benefits (Al-Moghany, 2006; Poon and Jailon, 2002).

4.3 Drivers to Adoption of Effective Supply Chain Management by Construction Firms

Table 4.7 indicates the drivers to adoption of effective supply chain management by the construction firms.

Table 4.7: Drivers to adoption of effective supply chain management

Drivers to adoption of effective supply chain management	1	2	3 Freq. (%)	4 Freq. (%)	5 Freq. (%)	Total Freq. (%)
Contribute to environmental protection	-	-	10 (10.4%)	76 (79.2%)	10 (10.4%)	96 (100%)
Reduces waste	-	-	11 (11.5%)	61 (63.5%)	24 (25%)	96 (100%)
Reduction of environmental risks	-	-	9 (9.4%)	80 (83.3%)	7 (7.3%)	96 (100%)
Cost benefits	-	-	14 (14.6%)	53 (55.2%)	29 (30.2%)	96 (100%)
Image improvement	-	-	10 (10.4%)	59 (61.5%)	27 (28.1%)	96 (100%)

1-Very unimportant, 2-Unimportant, 3-Neutral, 4-Important, 5-Very important

Source: Field survey (2016)

Contribute to environmental protection

The study indicates that 89.6% of the respondents affirmed that supply chain management system contribution to environmental protection is an important factor that drives to adoption of effective supply chain management by the construction firms while 10.4% were neutral.

The supply chain processes influence the quantities and types of resources acquired and select the source of key products and suppliers; these activities are directly connected with the degree of negative impacts on the environment and indirectly connected with economic and social growth within a community (Morton et al., 2002). In other words, SCM is related with any attempt of improving the environmental performance of the purchased products/services or the suppliers that provide them (Bowen *et al.*, 2001a).The main aims of SCM are to identify benefits, costs and risks associated with environmental performance (Hanfield *et al.*, 2005). A typical starting point in considering the inclusion of the supply chain is by implementing ISO 14001, which recommends the inclusion of policies to ensure the suppliers are aware of their environmental practices and liabilities (Rao, 2005). However, given that clients must obtain value for money invested and most contractors must obtain profit for risks undertaken in construction projects, it can be argued that client satisfaction, cost (financial), quality, safety and environmental dimensions of project performance are necessary outcomes of effective SCM practices aimed at reducing materials wastes in construction projects.

Reduction of waste

The study shows that 88.5% of the respondents said that effective supply chain management is important in reducing waste while 11.5% were neutral. According to Hoe (2006), managing construction and demolition waste can constitute a significant cost to the business. Some wastes require careful and perhaps expensive handling techniques during the construction process. A company can thus benefit in a number of ways from reducing the amount of waste it needs to dispose of. The consideration of waste minimization can generate advantages such as financial and environmental benefits (Al-Moghany, 2006; Poon and Jailon, 2002).

Reduction of environmental risks

The study revealed that 90.6% of the respondents said that supply chain management practices is important in reducing environmental risks while 9.4% of the respondents were neutral. Waste minimization can provide environmental benefits, which are important to be considered due to the alarming situation of materials waste on construction sites (Al-Moghany, 2006; Poon and Jailon, 2002). These environmental benefits are:

- Reduced quantity of waste generated.
- Efficient use of waste generated.
- Reduced environmental effects as a result of disposal, e.g. noise, pollution.
- Reduced transportation of waste to be disposed of (hence less noise, vehicle emission pollution, and energy used).

Cost benefits

The study shows that 85.4% of the respondents said that cost benefits are important drivers to the adoption of supply chain management practices while 14.6% were neutral. Waste minimization can provide financial benefits, and in some cases can even save cost and time. The financial benefits can be appreciated over a short term or long-term period. But overall, cost benefits can be appreciated throughout the whole building process by carrying out an analysis of the life cycle costs. Financial benefits include:

- Reduced transportation costs for waste materials (less transportation because of less material wasted). This includes transportation to and from the site and disposal.
- Reduced disposal costs of waste materials.

- Reduced purchase quantity and price of raw materials by waste minimization.
- Reduced purchase price of new materials when considering reuse and recycling

  (depending on materials).
- Increased returns can be achieved by selling waste materials to be reused and recycled.

Long term benefits through optimizing the building life concept, by avoiding expenses from demolition and construction of new buildings (Al-Moghany, 2006; Poon and Jailon, 2002). Use of recycled materials has reduced waste storage costs and minimized the dereliction of land (Al-Moghany, 2006; Lnyang, 2003). Sometimes, reuse and recycling may not always be financially viable, hence other considerations should be considered such as environmental benefits (Al-Moghany, 2006).

Image improvement

The study shows that 89.6% of the respondents affirmed that organizational image improvement is an important driver to consider when planning supply chain management practices while 10.4% were neutral.

4.4 Barriers to Implementing Effective SCM Practices in the Construction Industry in Ghana

Table 4.8 assessed the barriers and expectations about the economic impacts for implementing supply chain management practices in the construction industry in Ghana.

Table 4.8: Respondents' opinions about barriers to effective SCM

The Barriers and expectations	1 Freq. (%)	2 Freq. (%)	3 Freq. (%)	4 Freq. (%)	5 Freq. (%)	Total Freq. (%)
Lack of top management commitment	4 (4.2%)	6 (6.2%)	6 (6.2%)	69 (71.9%)	11 (11.5%)	96 (100%)
Lack of resources (financial/human)	-	-	-	55 (57.3%)	41 (42.7%)	96 (100%)
Lack of middle management level commitment	5 (5.2%)	6 (6.2%)	6 (6.2%)	52 (54.2%)	27 (28.1%)	96 (100%)
Lack of internal communication	3 (3.1%)	4 (4.2%)	5 (5.2%)	61 (63.5%)	23 (24%)	96 (100%)
Inappropriate organisational structure	6 (6.2%)	5 (5.2%)	5 (5.2%)	71 (74%)	9 (9.4%)	96 (100%)
Lack of support or tailor made guidance	-	-	11 (11.5%)	54 (56.2%)	31 (32.3%)	96 (100%)
Lack of information (no information sharing between customers/suppliers)	-	-	10 (10.4%)	71 (74%)	15 (15.6%)	96 (100%)
Lack of knowledge about the environmental impacts of the company	-	-	11 (11.5%)	65 (67.7%)	20 (20.8%)	96 (100%)
Lack of enabling legal environment	-	-	7 (7.3%)	58 (60.4%)	31 (32.3%)	96 (100%)
Lack of markets for recyclable materials	-	-	7 (7.3%)	45 (46.9%)	44 (45.9%)	96 (100%)

1- Strongly disagree, 2- Disagree, 3- Uncertain, 4- Agree, 5- Strongly agree.

Source: Field survey, (2016)

The study revealed that 100% of the respondents agreed that lack of financial and human resources is a barrier to effective supply chain management practices. The study shows that 83.4% of the respondents agreed that lack of top management commitment is a barrier that affects the implementation of supply chain management practices, 10.4% of the respondents disagreed while 6.2% were neutral. The study revealed that 82.3% of the respondents agreed that lack of middle management level commitment affects the implementation of supply chain management systems in the construction firms, 11.4% of the respondents disagreed while 6.2% were neutral. The study hold that 87.5% of the respondents agreed that lack of internal communication

affects the implementation of supply chain management strategies, 7.3% of the respondents disagreed while 5.2% were neutral.

The study shows that 83.4% of the respondents agreed that inappropriate organizational structure affects the implementation of supply chain management systems, 11.4% of the respondents disagreed while 5.2% were neutral. The study shows that 88.5% of the respondents agreed that lack of support or tailor made guidance affects supply chain management systems in the firm while 11.5% were neutral. The study revealed that 89.6% of the respondents agreed that lack of information between customers and suppliers affects the implementation of supply chain management systems while 10.4% were neutral. The study shows that 88.5% of the respondents agreed that lack of knowledge about the environmental impacts of the company affects the implementation of supply chain management systems while 11.5% were neutral. The study results hold it that 92.7% of the respondents agreed that lack of enabling legal environment affects the implementation of supply chain management systems while 7.3% of the respondents were neutral. The study shows that 92.7% of the respondents agreed that lack of markets for recyclable materials affects the implementation of effective supply chain management systems while 7.3% were neutral.

The first group is formed by lack of resources, short term planning and lack of markets for recyclable materials. These are linked because they all deal with availability of resources (financial or human) for SCM. Lack of resources is probably the most important barrier identified because the sources needed have to compete with other company's priorities (Stoesser, 1997). In addition, the costs and efforts involved in the design, development, documentation, implementation and certification of an EMS usually discourage smaller companies in which financial resources are restricted

(Rondinelli & Vastag, 2000). Furthermore, costs have to be incurred on the short term whilst the benefits can take years and often can be difficult to associate with the measures taken (Freimann & Walther, 2001). Finally, lack of markets for recyclable materials can become a barrier for companies trying to implement product-based strategies (Rao, 2005).

The second group is formed by top management commitment, middle management commitment, inappropriate organisational structure and internal communication because they all deal with the internal aspects of a company. Top and middle management commitment are related and have to do with the company's capacity towards a successful SCM. Top management particularly on SMEs, differs from the management behaviours found on large publicly owned businesses because they respond to different stakeholders and have different experiences and capabilities (Emiliani, 2000). Top-management commitment needs to understand the value, efforts and support required to implement SCM strategies successfully (Lippmann, 1999). On the other hand, middle management commitment, knowledge and awareness towards legislation and environmental impacts are a crucial step towards the successful implementation of SCM strategies (Bowen *et al.*, 2001a). Another barrier identified is the internal communication within a company. Organizations need to communicate effectively their environmental goals to their own personnel as well as their stakeholders and make clear how these goals relate with their regular functions (Lippmann, 1999). Lack of appropriate organisational structures and widespread ignorance of supply chain philosophy are also barriers identified for the implementation of SCM (Akintoye *et al.*, 2000).

Another group is formed by lack of knowledge, lack of information and lack of support to implement such measures. These barriers deal with the expertise needed

on issues such as environmental impacts, sustainability and supply chain processes. For SMEs, lack of knowledge about environmental impacts or underestimation of the environmental impacts is usual, one reason is that legal thresholds are usually bigger (Hillary, 2000). Lack of technical knowledge and skills on SMEs are also common. Usually these types of companies have less information and expertise available to them for dealing with environmental requirements from customers (Hillary, 2000; Ofori *et al.*, 2002). In the absence of other capabilities (such as quality control, inventory control management or pollution prevention) the concepts of continual improvement, lean production practices as well as avoiding the focus on "end of pipe technology" are more difficult to understand and achieve (Darnall & Edwards, 2006). Finally, the lack of government legal enforcement (Shen & Tam, 2002) or compliance with different types of legislation (local, national or even international legislation depending on the size) can be considered as a barrier to SMEs' adoption of SCM (Hillary, 2000).

4.5 The Impact of Supply Chain Practices on Waste Reduction

Table 4.9 shows the impact of supply chain practices on waste reduction in construction firms.

Table 4.9: The impact of supply chain practices on waste reduction

The impact of supply chain practices on waste reduction	1 Freq. (%)	2 Freq. (%)	3 Freq. (%)	4 Freq. (%)	5 Freq. (%)	Total Freq. (%)
Supply chain management enhance waste reduction	3 (3.1%)	3 (3.1%)	2 (2.1%)	40 (41.7%)	48 (50%)	96 (100%)
Supply chain management reduces raw materials mining or fabrication	-	-	7 (7.3%)	65 (67.7%)	24 (25%)	96 (100%)
Employing unskilled labourer affects reduction of waste	-	-	6 (6.2%)	65 (67.7%)	25 (26%)	96 (100%)
Overdesign generate waste	-	-	10 (10.4%)	68 (70.8%)	18 (18.8%)	96 (100%)
Inadequate storage facilities promotes waste generation	-	-	11 (11.5%)	42 (43.8%)	43 (44.8%)	96 (100%)
Improper handling of equipment affects waste generation	-	-	8 (8.3%)	44 (45.8%)	44 (45.8%)	96 (100%)
Health and safety hazards affect waste reduction	-	-	9 (9.4%)	57 (59.4%)	30 (31.2%)	96 (100%)
Effective transportation system affects waste reduction	-	-	6 (6.2%)	71 (74%)	19 (19.8%)	96 (100%)
Misunderstanding of the blueprint promotes waste generation	-	-	10 (10.4%)	58 (60.4%)	28 (29.2%)	96 (100%)

1- Strongly disagree, 2- Disagree, 3- Uncertain, 4- Agree, 5- Strongly agree.

Source: Field survey (2016)

The study results indicate that 91.7% of the respondents agreed that supply chain management enhances waste reduction, 6.2% of the respondents disagreed while 2.1% were neutral. The study shows that 92.7% of the respondents agreed that supply chain management reduces raw materials mining or fabrication while 7.3% were neutral. Moreover, 93.7% of the respondents agreed that employing unskilled labourer affects reduction of waste while 6.2% of the respondents were neutral. The study depicts that 89.6% of the respondents agreed that overdesign of construction blueprints generates waste while 10.4% were neutral. The study shows that 88.6% of the respondents agreed that inadequate storage facilities promotes waste generation

while 11.5% were neutral. The study shows that 91.6% of the respondents agreed that improper handling of equipment affects waste generation while 8.3% were neutral. The study revealed that 90.6% of the respondents agreed that health and safety hazards affect waste reduction while 9.4% were neutral. The study indicates that 93.8% of the respondents agreed that effective transportation system affects waste reduction while 6.2% were neutral. The study indicates that 89.6% of the respondents agreed that misunderstanding of the blueprint promotes waste generation while 10.4% were neutral.

During the construction process, construction managers have to deal with different factors that can negatively affect the performance of the production process, and producing different types of wastes. Wastes can include mistakes, rework, working out of sequence, redundant activity and movement, delayed or premature inputs and products or services that do not meet customer needs (Construction Industry Board, 1998). Waste in construction has been defined in different ways by different studies.

According to the new production philosophy, waste should be understood as any inefficiency that results in the use of equipment, materials, labour, or capital in larger quantities than those considered as necessary in the production of a building. Waste includes both the incidence of material losses and the execution of unnecessary work, which generates additional costs but do not add value to the product (Polat & Ballard, 2004). Waste should be defined as any losses produced by activities that generate direct or indirect costs, but do not add any value to the product from the point of view of the client (Alwi *et al.,* 2002; Formoso *et al.*, 1999). According to Polat and Ballard (2004), a simple way to define waste is "that which can be eliminated without reducing customer value". It can be activities, resources, rules, etc.

Macomber and Howell (2004) add that, the common sense understanding of waste is anything is not value. More precisely, waste is the expenditure of effort or the using-up of resources without producing value. After categorizing waste to seven types by Ohno (1994), Womack and Jones (1996) defined waste as any activity that absorbs resources and does not have any value adding. Waste in construction can be classified into three main types; waste of materials, waste of time and waste of machinery (Al-Moghany, 2006; Ekanayake and Ofori, 2000). However, this research focuses on materials waste.

Other studies (Arnold 1998; Formoso *et al.,* 1999; 2002; Polat and Ballard 2004) trace materials waste to sources including; overproduction, substitution,, waiting time, transportation, processing, inventories, movement and production of defective products. Many of the root causes and sources of materials in the aforementioned studies can be traced to supply chain issues such as but not limited to; poor supplier relationship management, poor customer relationship and poor flow of information. Arguably, effective SCM can lead to prevention or reduction in levels of materials waste on most projects as observed in many of the aforementioned studies.

4.6 Recommendations for Minimizing Materials waste Through Effective SCM

Table 4.10 depicts the recommendations for minimizing materials waste through effective supply chain management practices.

Table 4.10: Recommendations for minimizing materials waste through effective SCM

Recommendations	1 Freq. (%)	2 Freq. (%)	3 Freq. (%)	4 Freq. (%)	5 Freq. (%)	Total Freq. (%)
Effective procurement management	-	-	-	57 (59.4%)	39 (40.6%)	96 (100%)
Selection of quality materials	-	-	-	57 (59.4%)	39 (40.6%)	96 (100%)
Effective transportation system	-	-	-	48 (50%)	48 (50%)	96 (100%)
Recycling of construction material waste	-	-	-	63 (65.6%)	33 (34.4%)	96 (100%)
Adequate storage facilities	-	-	5 (5.2%)	85 (88.5%)	6 (6.2%)	96 (100%)
Adequate designs	-	-	-	55 (57.3%)	41 (42.7%)	96 (100%)
Use of right skilled labour	-	-	5 (5.2%)	54 (56.2%)	37 (38.5%)	96 (100%)
Effective transportation	-	-	6 (6.2%)	73 (76%)	17 (17.7%)	96 (100%)
Correct batching or measuring of materials			7 (7.3%)	61 (63.5%)	28 (29.2%)	96 (100%)

1- Strongly disagree, 2- Disagree, 3- Uncertain, 4- Agree, 5- Strongly agree.

Source: Field survey (2016)

The study results indicate that 100% of the respondents agreed that supply chain management system promotes effective procurement management. The study shows that 100% of the respondents agreed that effective supply chain management improves the selection of quality materials. The study results depicts that 100% of the respondents agreed that supply chain management system enhances effective transportation system. Moreover, 100% of the respondents agreed that supply chain

management system improves the recycling of construction material waste. The study shows that 94.7% of the respondents agreed that providing adequate storage facilities enhances the supply chain management system of the firm while 5.2% were neutral. The study shows that 100% of the respondents agreed the providing adequate designs improves the supply chain management systems of the firm. Furthermore, 100% of the respondents agreed that effective supervision enhances supply chain management system. The study shows that 94.7% of the respondents agreed that the use of right skilled labour improves supply chain management system. The study revealed that 93.7% of the respondents agreed that effective transportation system enhances supply chain management practices in the firm. The study shows that 92.7% of the respondents agreed that correct batching or measuring of materials can improve the effectiveness of the supply chain management system while 7.3% were neutral.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter contains the summary, conclusions and recommendations for further research.

5.2 Summary of Key Findings of the Study

- **Effective supply chain management practices that could minimise material waste in the construction industry in Ghana.**

The findings of the study suggest practices associated with effective supply chain management that minimize materials waste included: ensuring quality standards are being adhered to, implementation of measures aimed at controlling the risk of potential loss, improving transportation system in order to enhance the flow of materials, and pipeline mapping, supply chain modelling and logistics performance measurement.

- **Drivers to adoption of effective supply chain management that minimizes materials waste**

The findings of the study indicate that supply chain management system contribution to environmental protection is an important factor that drives the adoption of effective supply chain management by the construction firms. The study shows that effective supply chain management is important in reducing waste. The study revealed that the implementation of supply chain management practices ensures the reduction of environmental risks. Other drivers to adoption of supply chain management practices included: benefits associated with adoption of supply chain management practices, organizational image improvement and meeting market expectations.

- **Barriers of adoption of SCM that minimises materials waste.**

The study revealed that the barriers to effective implementation of supply chain management practices that minimise materials waste include; lack of inadequate financial and human resources lack of top management commitment to implementation of supply chain management practices, ineffective internal communication mechanisms, inappropriate organizational structure, lack of enabling legal environment, and insufficient markets for recyclable materials.

- **Recommendations for minimizing materials waste through effective SCM**

The study results indicates that effective procurement management enhances supply chain management system, moreover, the selection of quality materials and effective transportation system improves supply chain management systems. Furthermore, the recycling of construction material waste improves SCM system. Also, providing adequate storage facilities enhances the supply chain management system of the firm, providing adequate designs improves the supply chain management systems of the firm. Furthermore, effective supervision enhances supply chain management system, the use of right skilled labour improves supply chain management system, effective transportation system enhances supply chain management practices in the firm and correct batching or measuring of materials can improve the effectiveness of the supply chain management system.

5.3 Conclusion

The study has identified key Supply Chain Management (SCM) practices that have potential to reduce materials waste and the key drivers to the adoption of SCM practices. Also, key barriers to the implementation of effective SCM practices were identified. The study's findings have implications for policy making on construction firms. In regard therefore, management of construction companies need to adopt innovative measures aimed at implementing effective SCM aimed at reducing materials wastage in construction firms.

5.4 Recommendations

Based on the conclusions of the study, the following recommendations were highlighted:

- The management of the construction firms should seek financial assistance from banks to expand their financial and human resources competencies. This can improve the effective supply chain management systems of the firm.
- The top and middle level management of the construction firms should show a high level of commitment to the implementation of effective supply chain management practices. This would improve the free flow of construction materials supply.
- There is the need for management of the construction firms to intensify the internal communication system of the firm. Improvement in effective communication system of the firm would enhance the supply chain management system. This will also improve the dissemination of information between customers and suppliers and strengthen the supply chain management system.

- There is the need to reduce construction waste generation by promoting the recycling of construction waste. The availability of recycled waste materials will reduce the cost of materials across the procurement and the supply chain management system.
- The management of the firm should employ competent and skilled labourers to work effectively and professionally to minimise the generation of construction wastes.
- There is the need to provide adequate storage facilities to keep construction materials safe and promote the proper handling of equipment.
- The management of the construction firms should organise periodic in-service training programmes for the workforce of the firms to improve their professional expertise regarding the effective supply chain management and procurement management skills.

5.5 Suggestions for Further Research

Based on the recommendations of the study, the researcher suggested that a similar study should be conducted to investigate the impact of organizing in-service training for the workforce of the construction firms.

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APPENDIX 1

QUESTIONNAIRE FOR THE RESPONDENTS

The researcher is a Post graduate student of University of Education Winneba, Kumasi Campus conducting a piece of research on effective supply chain management as a tool to minimising material waste in the construction industry of Ghana. I respectively request that you form part of this research by completing the attached questionnaire. Anonymity and non-traceability are assured. It is my fervent hope that you participate in the study. May I thank you for your valuable cooperation.

EMMANUEL KWASHIE DEGBLOR

The sections 1: Demographic Information of the Respondents

Please tick [√] in the box where appropriate

1. What is your Gender? Please tick [√]

[ ] Male

[ ] Female

2. What is the age category you belong? Please tick [√]

[ ] Below 25 years

[ ] 26-35 years

[ ] 36-45 years

[ ] 46-55 years

[ ] 56-65 years

[ ] More than 66 years

3. What is your highest level of educational qualification?

[ ] Senior High School Certificate

[ ] Higher National Diploma (HND)

[ ] Bachelor's degree

[ ] Master's degree

[ ] PhD

Other (please state)……

4. How long have you been a manager of your construction firm?

[ ] 1-5 years

[ ] 5-10 years

[ ] 10-15 years

[ ] 15-20 years

[ ] 20 years and above

5. Is there currently a Supply Chain Management System in place? Please tick [√] in the box where appropriate

[ ] Yes

[ ] No

[ ] In progress

SECTION 2: Effective supply chain management practises that could minimise material waste in the construction industry in Ghana. Please tick [√] in the box where appropriate.

6. To what extent do you agree on the following practices associated with effective supply chain management? Please rate using a scale of 1-5 where 1 represents strongly disagree, 2 represent disagree, 3 represents uncertain, 4 represents agree, 5 represents strongly agree.

SCM Practice	**1**	**2**	**3**	**4**	**5**
Focus on quality and performance.					
Transport/Distance.					
Risk of potential loss (Financial, physical and social)					
Availability of suppliers					
Environmental performance					
Initiative, tendering, design and procurement					
Just-In-Time delivery (JIT) and logistics management.					
Pipeline mapping, Supply chain modelling and logistics performance measurement.					
Analysing stock levels across the supply chain.					
Supply chain costingand value stream mapping					
Packaging reduction or modifications					
Recycling					
Eco-design					
Life cycle assessment					
Waste management planning					

Section 3: Drivers to adoption of effective supply chain management by construction firms in the Greater Accra Region

7. How important are the following drivers for your company to pursue effective supply chain management strategies? Please tick [√] in the box where appropriate

1-Very Important, 2-Unimportant, 3-Neutral, 4-Important, 5-Very Important

		Rating				
		1	2	3	4	5
I	**Sustainability issues**					
	Contribute to environmental protection					
	Reduction of waste					
	Reduction of environmental risks					
II	**Economic issues**					
	Cost benefits					
	Avoid fines					
	Image improvement					
	Meet market expectations					

Section 4: The barriers and expectations about the economic impacts for implementing SCM practices in the construction industry in Ghana.

8. What are your perceptions about the main barriers of your suppliers to implementing these strategies? Please tick [√] in the box where appropriate

1-Strongly disagree, 2-Disagree, 3-Neutral, 4-Agree, 5-Strongly agree

	Rating				
	1	2	3	4	5
Lack of resources (financial/human)					
Lack of top management commitment					
Lack of mid level commitment					
Lack of internal communication					
Inappropriate organisational structure					
Lack of support or tailor made guidance					
Lack of information (no information sharing between customers/suppliers)					
Lack of knowledge about the environmental impacts of the company					
Lack of government legal enforcement					
Lack of markets for recyclable materials					
Short term planning over long term planning					

Section 5: The impact of supply chain practices on waste reduction

9. To what extent do you agree on the impact of the following supply chain practices on waste reduction on construction sites? Please rate using a scale of 1-5 where 1 represents strongly disagree, 2 represent disagree, 3 represents uncertain, 4 represents agree, 5 represents strongly agree. Please tick as appropriate.

	1	2	3	4	5
Waste reduction					
Raw materials mining or fabrication					
Unskilled labourer					
Overdesign					
Inadequate storage facilities					
Improper handling					
Health and safety hazards					
Transportation system					
Misunderstanding of the blueprint					
Vibration/light/heat					
Economic (e.g. employment, expenditure and income effects, effects on the development potential of the area)					
Social (e.g. population and demographic structure, accommodation and housing)					

Section 5: Recommendations for minimizing materials waste through effective SCM

10. To what extent do you recommend the use of the following supply chain management practices to minimise waste in construction industry? Please rate using a scale of 1-5 where 1 represents strongly disagree, 2 represent disagree, 3 represents uncertain, 4 represents agree, 5 represents strongly agree. Please tick as appropriate.

Recommendations	***1***	***2***	***3***	***4***	***5***
Effective procurement management					
Selection of quality materials					
Effective transportation system					
Recycling of construction material waste					
Adequate storage facilities					
Prevention of double handling					
Adequate designs					
Effective supervision					
Use of right skilled labour					
Effective transportation					
Correct batching or measuring of materials					

Thank you very much for completing this questionnaire