UNIVERSITY OF EDUCATION, WINNEBA

COLLEGE OF TECHNOLOGY EDUCATION, KUMASI

ASSESSMENT OF MATERIAL MANAGEMENT ON BUILDING CONSTRUCTION SITES (A CASE STUDY OF STIVO AND CONSAR CONSTRUCTION COMPANIES IN THE KUMASI METROPOLIS)

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AUGUST, 2016

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GLORIA NTIM

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

AUGUST, 2016

DECLARATION

STUDENT'S DECLARATION

I, **GLORIA NTIM**, declare that this Dissertation, with the exception of quotation and reference contained in published works which have all been identified and duly acknowledged, is entirely my own 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 work was supervised in accordance with the guidelines for supervision of Dissertation as laid down by the University of Education, Winneba.

NAME OF SUPERVISOR: **MR. M. K. TSORGALI**

SIGNATURE**:** ……………………………………………

DATE:……………………………………………………

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DEDICATION

This work is dedicated to:

1. My loving kind parents and Mr. Solomon Kwabena Ntim and the late Madam Alice Adwoa Nyarkoah for their prayers
2. I specially dedicate this work to my dear and loving husband, Mr. Augustine Awere Damoah and children; Godwin, Benedicta, Daniela, and Ethlinda for their prayer support.

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ABSTRACT

This study considers an assessment of material management on building construction sites. Materials management is the integrated processes that consist of the people, organization, technology and procedures used to effectively identify, quantify, acquire, inspect, transport, receive, store, and preserve the materials. Basically, the issues of material management are concerned with the planning, identification, procuring, storage, receiving and distribution of materials. The researcher reached the goals of this research through purposive sampling method and a structured questionnaire administered to 26 participants in different construction backgrounds from different selected sites in the Kumasi Metropolis and field observation from January to June, 2016. The responsive rate was about 70% of participants. The Likert scale was used to rank the various factors and analyzed with SPSS and Spreadsheet. Among the challenges involved in materials management on building construction site in Kumasi Metropolis are poor handling of materials, inadequate security structures, delivery of wrong quantity of materials, poor stock control techniques, absence of closed circuit television cameras and improper planning of work. To overcome material management challenges on construction sites, material managers should do the following: Planning and monitoring material schedule on all projects; making it compulsory for the store keepers to record and use inventory of material on daily basis during the construction process, to enable them alert or inform the necessary authority if there is shortage of any material, for prompt ordering; closed circuit television (CCTV) cameras should be installed to increase security on site. The researcher arrived on the conclusion that quality assurance or control processes should be put in place to ensure effective waste management as it improves the schedule and planning of project delivery.

CHAPTER ONE

INTRODUCTION

1.1 Background

The construction industry plays an important role in any economy and its activities are also vital to the achievement of the socio-economic development goals of providing shelter, infrastructure and employment (Anaman & Osei Amponsah, 2007). In Ghana just like many other developing countries the construction industry is playing a vital role to achieve socio-economic development goals, providing shelter, infrastructure, and employment and above all contributing significantly to the GDP of the country (Owusu, 2010).

The concept of management is to ensure efforts to achieve the required level of quality for a product which is well planned and organized from the perspective of a construction company (Agbenyega, 2014). Quality management in construction projects should mean maintaining the quality of construction works at the required standard so as to obtain customer's satisfaction that would bring long term competitiveness and business survival for the companies (Tan & Abdul-Rahman, 2005).

Cost wise all construction works depends on two factors, namely, cost of materials and cost of labour (Ayegba, 2013) and according to Kyomesh (2011), 30 to 70 percent of project cost is consumed by material with about 30 to 40 percent of labour. Attention should mainly be directed to the cost of materials and management of materials (Ayegba, 2013). The term materials refer to all the physical substances that are assembled to create the interior of a building.

Today, most buildings are constructed from a multitude of materials (Chrisman, 2010). Materials management is defined as a coordinating function responsible for planning and controlling materials flow. In detailed view, materials management is a planned procedure that comprises the purchasing delivery (Kasim, 2011). The goal of material management is to ensure that materials are available at their point of use when needed. The material management system attempts to ensure the right quality of materials and that materials are appropriately selected, purchased, delivered and handled on site in a timely manner and at a reasonable cost (Ayegba, 2013).

Materials management is a vital function for improving productivity in construction projects. The management of materials should be considered at all the phases of the construction process and throughout the construction and production periods. This is because poor material management can often affect the overall construction time, quality and budget (Priya, 2014).

1.2 Statement of the Problem

The construction industry makes a vital contribution to the competitiveness and prosperity of the economy. According to Donyavi &Flanagan (2009), a construction project depends upon having the right skills and equipment which are able to deliver the project on time and on budget. It is gathered that current manual materials management practices and control procedures are unsatisfactory as they are labour intensive, inaccurate, and error prone. Most contractors involve the use of sub-standard elements, shoddy jobs through the use of cheap inexperienced labour which most often results in building collapse, abandoned projects and liquidation of contractors. With good construction material management, construction cost can be reduced hence profits can be made and the various bad practices by contractors can be avoided.

Current materials management practices in the construction firms are performed on a fragmented basis with unstructured communication and no clearly established responsibilities between the parties involved. This fragmentation creates gaps in information flow, also lack of information on materials management available to building contractors in Ghana affects the decision making process and lead to mismanagement of materials such as delays in material ordering and receiving, among other problems. The material manager needs to realize that decisions taken at one stage in the process will certainly impact other activities and processes in the supply chain, a problem not realized due to this fragmentation.

The initial phase of this research investigated current material management practices in some selected construction firms in Kumasi Metropolis. The investigation considered the entire range of activities necessary for procuring the needed material, starting with the estimating process and ending with site delivery, distribution and storage logistics. Research outcomes included documenting the problem bottlenecks in the supply chain as well as identifying and classifying the various criteria that influence the decision process for procuring material (Intergraph Corporation, 2012 - *www.intergraph.com*)

1.3 Purpose of the Study

The purpose of the study is to ensure the effective management of materials on building construction sites.

1.4 Specific Objectives

The specific objectives of the study are:

- To examine material management issues on building construction sites.

- To identify the factors that lead to mismanagement of materials on building construction sites.
- To propose measures for effective material management.

1.5 Research Questions

1. What are the issues involved in materials management at construction sites?
2. What factors contribute to mismanagement of materials on building construction sites?
3. What management actions can be taken to prevent mismanagement of materials on building construction sites?

1.6 Significance of the Study

- The study will contribute to literature on factors influencing material management on building construction sites.
- Again it will help improve management of materials on construction sites.
- The study will also serve as a guide for personnel in the building industry, such as Directors of construction companies, project managers and site supervisors to help improve management of materials on building construction sites by making better decisions in order to have quality work done.

1.7 Scope of the Study

The scope of this research is limited to the building industry in Kumasi Metropolis. The focus group will be the directors, project managers, contractors, site supervisors, etc. of Stivo and Consar Construction Companies. This is because they are affected by management issues on construction sites. It entails the following;

classification of materials, importance of materials for a project, purchasing of materials, purchasing departments, purchasing of methods, logistics, co-ordination of materials and other resources, handling of materials, stock and waste control, element of a management, control measures on site, benefits of material management, materials management processes, factors leading to mismanagement of materials, and measures for effective materials management.

CHAPTER TWO

LITERATURE REVIEW

2.0 Overview

This chapter includes the overview, the issues involved in material management at construction sites, definition of the material, management, the factors that contribute to mismanagement of materials on building construction sites and management actions to prevent mismanagement of materials on building construction sites.

2.1 Issues Involved in Material Management at Construction Sites

Basically, the issues of material management are concerned with the planning, identification, procuring, storage, receiving and distribution of materials. The purpose of material management is to assure that the right materials are in the right place and in the right quantities when needed. The responsibility of one department (i.e. material management department) for the flow of materials from the time the materials are ordered, received, and stored until they are used is the basis of material management (Eyad Abed El-Qader, 2006). Priya (2014) states the issues of material management as planning, identification, procuring, storage, receiving and distribution of materials. The issues of materials management are well-defined by Gulghane et al (2015) as the process by which an organization is supplied with the goods and services to achieve its objectives of buying, storage, and movement of materials. According to American Society of Civil Engineers (ASCE,2014), Materials Management is integrated processes that consist of the people, organization, technology and procedures used to effectively identify, quantify, acquire, inspect, transport, receive, store, and preserve the materials. T-Phani et al (2013) pointed out that Materials Management also called Supply Chain Management or Logistics is the field dedicated to the efficiency of procuring, transporting and distributing the supplies needed for an organization's operations.

2.2 Material

The Webster's dictionary defines materials as "the elements, constituents, or substances of which something is composed or can be made." Ballot (1971) defines materials as the physical materials that are purchased and used to produce the final product and does not suggest that materials are the final product. In other words, materials are the parts used to produce the final product. Bailey and Farmer (1982) define materials as the goods purchased from sources out of the organization that are used to produce finished products. Stukhart (1995) defines materials as the items that are used to produce a product and which include raw materials, parts, supplies and equipment items.

Chandler (1978) states that construction materials can be classified into different categories depending on their fabrication and in the way that they can be handled on site. He classifies the materials into five categories. They are:

- **Bulk materials**- these are materials that are delivered in mass and are deposited in a container.
- **Bagged materials**- these are materials delivered in bags for ease of handling and controlled use.
- **Palleted materials**- these are bagged materials that are placed in pallets for delivery.
- **Packaged materials**- Packaged materials are building materials which are usually fragtile and are packed in boxes and cartons.

- **Loose materials-** these are materials that are partially fabricated and that should be handled individually. Table 2.1 presents some examples of commonly used materials in construction and their classification.

Table 2 1: Classification of Materials (Adopted from Chandler, 1978)

Material	Bulk	Bagged	Palleted	Packaged	Loose
Sand	X				
Gravel	X				
Topsoil	X				
Paving Slabs					X
Structural Timber					X
Cement	X	X	X		
Concrete	X				
Pipes				X	X
Tiles				X	
Doors			X		
Electrical Fittings				X	

Stukhart (1995) states that the main categories of materials encountered in a construction project are engineered materials, bulk materials, and fabricated materials.

- Bulk materials- these are materials manufactured to standards and are purchased in quantity. They are bought in standard length or lot quantities. Examples of such materials include pipes, wiring, and cables. They are more difficult to plan because of uncertainty in quantities needed.
- Engineered materials- these materials are specifically fabricated for particular project or are manufactured to an industry specification in a shop away from the site. These materials are used for a particular purpose. This includes materials that require detailed engineering data.
- Fabricated materials- these are materials that are assembled together to form a finished part or a more complicated part. Examples of such materials include steel beams with holes and beam seats.

2.2.1 Importance of Materials for a Project

Problems related to managing the flow of materials can be found in every organization. The 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. Materials account for a big part of products and project costs. The cost represented by materials fluctuates and may comprise between 20-50% of the total project cost and sometimes more. Some studies concluded that materials account for around 50-60% of the project cost (Stukhart, 1995; Bernold and Treseler, 1991). Materials are critical in the operations in every industry since unavailability of materials can stop production. In addition, unavailability of materials when needed can affect productivity, cause delays and possible suspension of activities until the required material is available (Eyad Abed El-Qader 2006).

Unavailability of materials is not the only aspect that can cause problems. Excessive quantities of materials could also create serious problems to managers. Storage of materials can increase the costs of production and the total cost of any project. When there are limited areas available for storage, the managers have to find other alternatives to store the materials until they are needed. Some of these alternatives might require re-handling of materials, which will increase the costs associated with them. Provisions should be taken to handle and store the materials adequately when they are received. Special attention should be given to the flow of materials once they are procured from suppliers (Eyad Abed El-Qader 2006).

It is obvious that materials should be obtained at the lowest cost possible to provide savings to the company (Damodara, 1999). In the late 1970'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 using their resources efficiently and that the decrease in productivity was also attributable to poor management (Stukhart, 1995). Material management has been an issue of concern in the construction industry. 40% of the time lost on site can be attributed to bad management, lack of materials when needed, poor identification of materials and inadequate storage (Baldwin et. al, 1994).

The need for an effective materials planning system becomes mandatory. Some companies have increased the efficiency of their activities in order to remain competitive and secure future work. Many other firms have reduced overheads and undertaken productivity improvement strategies. Considerable improvement and cost savings would seem possible through enhanced materials management. Timely availability of materials and systems are vital to successful construction. Materials management functions are often performed on a fragmented basis with minimal communication and no clearly established responsibilities assigned to the owner, engineer or contractor (Eyad Abed El-Qader, 2006).

Better material management practices could increase efficiency in operations and reduce overall cost. Top management is paying more attention to material management because of material shortages, high interest rates, rising prices of materials, and competition. There is a growing awareness in the construction industry that material management needs to be addressed as a comprehensive integrated management activity (Eyad Abed El-Qader, 2006).

Materials Management is the vital function for improving productivity in construction projects. The management of materials should be considered at all the faces of the construction process and throughout the construction and production period. This is because poor materials management can often affect the overall construction time, quality and budget.

Project managers and building contractors are faced with a huge responsibility of ensuring that materials are used effectively. It is absolutely important for planning and controlling of materials to ensure that the right quality and quantity of materials and installed equipment are appropriately specified in a timely manner, obtained at a reasonable cost, and are available when needed. To achieve this, they implement different policies and strategies.

According to Eyad Abed El-Qader (2006), effective construction materials management is a key to successful projects. Although, other researchers have already done intensive research on this topic of material management, this is not only about what materials is but more about material management issues and for effective utilization of materials on construction sites.

Materials constitute a major cost component for construction industry (Gulghane, 2015). K.V. Patel et al (2011) state emphatically that the total cost of materials may be 60% or more of the total cost incurred in construction projects. Kasim (2011) explained that materials management functions include planning and taking off materials, vendor evaluation and selection, purchasing, expenditure, shipping and material receiving. Almost 60% of the total working capital of any industrial organization consists of material cost.

Materials management is an important element in project planning and control. Materials represent a major expense in construction, so minimizing procurement or purchase costs presents important opportunities for reducing costs (Dabler and Burt, 1996). Poor materials management can also result in large and unavoidable costs during construction. First, if materials are purchased early, capital may be tied up and interest charges incurred on the excess inventory of materials. Even worse, materials may deteriorate during storage or be stolen unless special care is taken. For example, electrical equipment often must be stored in waterproof locations. Second, delays and extra expenses may be incurred if materials required for particular activities are not available (Cavinato, 1984).

Accordingly, ensuring a timely flow of material is an important concern of project managers. Materials management is not just a concern during the monitoring stage in which construction is taking place. Decisions about material procurement may also be required during the initial planning and scheduling stages. For example, activities can be inserted in the project schedule to represent purchasing of major items such as elevators for buildings (Dobler and Burt, 1996).

The availability of materials may greatly influence the schedule in projects with a fast track or very tight time schedule. Sufficient time for obtaining the necessary materials must be allowed. In some cases, more expensive suppliers or shippers may be employed to save time. Materials management is also a problem at the organization level if central purchasing and inventory control is used for standard items. In this case, the various projects undertaken by the organization would present requests to the central purchasing group. In turn, this group would maintain inventories of standard items to reduce the delay in providing material or to obtain lower costs due to bulk purchasing (Cavinato, 1984).

This organizational material management problem is analogous to inventory control in any organization facing continuing demand for particular items. Materials ordering problems lend themselves particularly well to computer based systems to ensure the consistency and completeness of the purchasing process. In the manufacturing realm, the use of automated materials requirements planning systems is common. In these systems, the master production schedule, inventory records and product component lists are merged to determine what items must be ordered, when they should be ordered, and how much of each item should be ordered in each time period. The heart of these calculations is simple arithmetic: the projected demand for each material item in each period is subtracted from the available inventory. When the inventory becomes too low, a new order is recommended. For items that are non-standard or not kept in inventory, the calculation is even simpler since no inventory must be considered. With a materials requirement system, much of the detailed record keeping is automated and project managers are alerted to purchasing requirements (Stukhart, 1995).

Waste of construction materials on site refers to the difference between materials delivered to construction site and those that are actually used for the construction work (Onabule, 1991). Hence from Onabule's (1991) specification it can be affirmed that construction waste are those materials supplied to site for construction and are not being used in the actual construction constituents. This supports Seeley's (1997) views that not all materials delivered to construction sites are used for the purpose for which they are ordered. Furthermore, Formoso et al, (1999) defined waste as "any losses produced by activities that generate direct or indirect cost but do not add any value to the product". Rational management of material to avoid waste is an important consideration for reducing construction cost and construction duration. Therefore, there is a need for efficient material management in order to control productivity and cost in construction projects. Hence the overall objectives of any on-site management activity should be directed to provide full-guard on construction materials and to perform efficient usage of such materials (Mohammed and Anumba, 2006).

The construction industry is the most significant industry in the economy and the successful measure with completion within time, budget, accordance with specification and satisfaction of stakeholders (Nguyen et al, 2004). Construction is the process of physically erecting the project and putting construction equipment, materials, supplies, supervision, and management necessary to accomplish the work (Clough et al, 2000). Construction projects are complex, with many organizations involved such as clients or owners, architects, engineers, contractors, suppliers and vendors. This includes the heterogeneous and often complex process of producing unique, large and immovable products with a supply of the resources (money, equipment, material, and labour).

The improper handling and management of materials on construction sites has the potential to severely hamper project performance (Ogunlana et al, 1996). The result of improper handling and managing materials on site during construction process will influence the total project cost, time and the quality (Che Wan Putra et al, 1999). The costs of materials management may range from 30-80% of the total construction costs depending on the type of construction (Muchlhausen, 1991). However, Kini (1999) accounted 50-60% of the total cost of construction projects is for construction materials and equipment. According to Stukhart (1995) materials are a major component on any project with value 50-60%. Therefore, there is a need for efficient materials management in construction projects. This is because poor materials management will affect the overall construction time, quality and budget. Therefore, an effective materials management system is required in order to avoid problems, such as delays in a construction project.

Delays in materials supply have been found to be a major cause of time overrun (Dey, 2000). Many factors accelerate the delay of project duration; however poor materials management can have a major effect on site activities. Ogunlana et a (1996) suggested that the main reasons for project delays on housing projects in Thailand were incomplete drawings, material management problems, organization deficiencies, shortage of construction materials, and inefficiencies in site workers. Dey (2000) also suggested that delays in materials supply was a major cause of time overrun. Thus, it would seem that materials delays are a major cause of delays in construction projects. There is also a need for an integrated material handling process from the design stage to the usage of Materials-This could happen, with a good management system with the implementation of ICT in managing materials. Hence, a good materials management environment enables proper materials handling on construction sites.

2.2.2 Procurement

The term procurement encompasses a wide range of activities that include purchasing of equipment, materials, labour and services required for construction and implementation of a project (Barrie and Paulson, 2002). The objective of procurement in materials management is to provide quality materials at the right time and place, and at an agreed budget. Payne et al. (2006) stated that procurement is about organizing the purchasing of materials and issuing delivery schedules to suppliers and following-up, to make sure that suppliers deliver on time. A failure in the purchasing process or in overseeing and organizing the buying functions as listed by Canter (2003) could result in:

I. Over-ordering of materials (wastage problems)

II. Over-payments for materials (inadequate administration procedures)

III. Loss of benefits (lack of skilled negotiating procedures)

IV. Lack of knowledge (when and where the best service/source might be available at any particular time).

Material Purchase

Purchasing has a direct impact on profitability and individual job profits. Purchasing needed raw material, supplies and equipment is a vital area for cost reduction since it involves the spending of large sums. Frank (1980) explained that circumstances of misuse and water of resources in the form of material can be extensive and include:

a. buying the wrong article
b. Buying too much
c. Buying too little
d. Buying uneconomically
e. Losing material in transit, in storage and in use
f. Materials stolen or proffered
g. Spoilage and damage to material before use
h. Scrap and spoiling during use
i. Buying or making out of balance

According to Lamer (2007), purchasing is one of the basics functions common to all type of business enterprise. These functions are basic because no business can operate without them and are administered or managed by coordinating and integrating those six functions:

I. Creation, the idea of design function
II. Finance - the capital acquisition records function
III. Personnel - the human resources and labour relation function

IV. Purchasing - the buying of required equipment, material, and services

V. Conversion - the changing of material to economic goods

VI. Distribution - the selling or marketing of goods produced

The good of the purchasing department then should be to avoid cheap purchase but to look for optimum purchases. Sometimes good material can be purchased at lower unit cost through large – order size purchases.

Purchasing Departments

In a large organization the purchasing group may include purchasing analyst, traffic expert expedites as well as management. Lamer, (2007) stated that the purchasing department has the responsibility and authority outside production for the purchasing function.

- **Purchasing Methods**

1. Purchase Accounting. Purchase accounting is a method used to make sure that:

a) Only goods authorized are purchased

b) Only goods and material purchased and received are paid for

c) Payment is made in accordance with agreed and or on contractual terms.

Forms: - Forms used in purchase accounting include purchase orders, receipts of material form invoices and statements.

Entry is by the supplying firm and includes terms of purchase, such as cash discounts for pre-empt payment of statements.

- **Purchasing research**

Purchasing research is a technique that systematically searches for the analytics and quantity of need material at the best price as well as analysing eventually uses of such material and expensive method of use. Study of the following may include the materials used in construction price, work study, and assessment of material cost (Lamer, 2007).

Type of Purchase

According to Bajeh, (2010), the following are the types of purchase;

1. Batch purchase
2. Schedule purchase
3. Sale supplier agreement

- **Purchasing Procedures and Documentation**

The process is started with purchase requisition, the authorization of the firm through an approved official to buy the needed materials. Quality, quantity, and date needed are specified on a requisition form, which must be signed by an authorized person (Lamer, 2007). The requisition form should also be numbered for accounting control in the case of materials that are needed periodically, a repeating requisition form may be established, where goods are ordered regularly according to a predetermined schedule. A section to include purchase order number and address should be included in the form's design for best control (Lamer, 2007).

- **Ordering**

Selection of suppliers in purchasing depends on several factors, namely

a. Quality of materials
b. Price of goods and materials
c. Availability of materials in bulk and small quantities
d. Service offered by supplier
e. Payments terms offered by supplier
f. Reliability of supplier

Supplier offering case discounts for prompt payment may be cheaper overall than companies without discounts, even if the basic goods cost more. Quotation request froms are often used determine supplier's prices for goods. Quotation is compared and the supplier offering the best advantages to the buyer is chosen (Lamer, 2007).

The next step is preparation of purchase order. Since the purchase order serves as a legal contract, therefore, the Factor to be included are: Name and number of firm, name and address of supplier, name and address of buyer, date of order, description of goods, quantity of materials, production, delivery destination, delivery date, terms of payment, cost of transportation, discount and signature of purchasing officer. Form design and flow should be planned for simplicity for handling, avoiding unnecessary and costly duplication. Purchase orders or contracts often list conditions and terms to protect buyer (Pheng and Chuan, 2001).

- **Purchasing Records**

One key area in reducing purchasing cost is that of record keeping. The following trade lists should be maintained for rapid construction.

i. Supplier's name and address, including what goods are supplied by each
ii. Prices of goods last purchased in each area
iii. Purchase made, listing items, prices and suppliers
iv. Date of purchase

The following records give status purchase to process ensuring time and cost control:

i. File of contracts outstanding by deadline date
ii. Receiving book, detailing deliveries
iii. Invoice book, detailing invoices proceed
iv. Codes for use on requisition, quotation requests and purchase order to indicate department and material for accounting use.
v. Order register for purchase to progress but not yet received.
vi. Department breakdown of purchasing costs.

2.2.3 Logistics

Logistics is a concept that emphasizes movement and it encompasses planning, implementing, and controlling the flow and storage of all goods from raw materials to the finished product to meet customer requirements (Stukhart, 1995). Raw materials for construction are usually varied, bulky and heavy and required proper handling in the supplying process. Consequently, the construction industry requires active movement of materials from the suppliers to the production area in both the factory and the worksite (Pheng and Chuan, 2001).

The primary focus of the logistics concept in construction projects is to improve coordination and communication between project participations during the design and construction phases, particularly in the materials flow control process (Agapiou et al, 1998). They also mentioned that problems arise in the materials flow control process which include delays of materials supply due to some materials purchased just before they are required and waste of materials during storage, handling and transporting when procured in large quantities without complying with the production needs on site. The previous research suggested that, the routing of materials is one of the main causes which affect cost and time during construction projects (Varghese andO'Connor1995).

Hence, the factors that should be taken into consideration during the logistics process for effective materials management include:

a. Optimum forecasting of materials movement.
b. Planning of access and routing of materials within a construction site.

- **Material Logistics Planning (MLP)**

Material logistics planning is a practice designed to assist construction projects in proceeding smoothly whilst achieving programme certainty and cost predictability on complex building projects. Material logistics planning relates to the proactive management of the types and quantities of materials to be used, including supply routes, handling, storage, security, use and reuse, recycling and disposal of excess materials. As projects get larger, supply chains increase in complexity and planning controls get tougher so that logistics becomes progressively more important.

The use of logistics as a complementary approach to construction management is becoming more popular and logistics is now a key feature of pre-construction planning; not just on large complex schemes, but also in the planning and delivery of mainstream housing and fit-out contracts. MLPs are tools to formalize and implement the logistic planning process.

MLPs are tools to manage all materials from project conception through to demobilization and completion. The MLP covers key aspects such as:

1. The setting of objectives and key performance indicators for efficient material use;
2. Training;
3. Minimization of materials through attention to:
   i. material specifications;
   ii. delivery of materials;
   iii. storage of materials;
   iv. handling of materials;
   v. use of materials;
   vi. disposal of materials; and
4. Identifying lessons to be learned and best practice.

Poor material management is commonly linked to the inaccurate or surplus ordering of materials, damage to materials, inadequate storage, and rework due to errors, poor workmanship, defective site processes, and inefficient use of materials (Ala-Risku and Karkkainen, 2005). Ordering materials that are not used on the project due to loss, wastage or being surplus to requirements has a cost which is often overlooked as it is built into the total project price and paid for by the client. This includes the cost of purchase and delivery, storage and handling, disposal, treatment or return to supplier, and labour to manage the unused materials. Implementation of a comprehensive MLP will lead to economic, efficiency and sustainability benefits (Ala-Risku and Karkkainen, 2005).

- **Key Stages of a MLP within the Construction Process**

The key stages of material logistics planning are shown in relation to the construction process

I. Identified responsible persons and their roles
II. Implement a training and communication plan
III. Determine material types and quantities from the detailed design
IV. Plan for material receipt and storage
V. Implement procedures to manage sub-contractors
VI. Site mobilization and construction
VII. Project completion and demobilization

Logistic planning should be initiated at the project outset to achieve the greatest material savings. Ideally the client should develop and maintain a clear strategy for best practice logistics planning based on their corporate goals and policies. The logistics strategy will define the approach to formulation of the MLP (Ala-Risku and Karkkainen, 2005). However, the development of a project specific MLP is often a designated, or implied, responsibility of the main contractor, whereas it should be used during the design stage to minimize material wastage through eliminating bespoke designs; for example, reducing the proportion of unique window sizes.

Once the design of the project has been agreed, the material types and quantities should be built into the MLP together with a programme specifying the project phase for which they are required. It is important to identify and understand how materials will be procured, delivered, stored and handled onsite and incorporate these procedures into the MLP so that they can be communicated to all relevant parties. The MLP will be implemented during site mobilization and is a live document that changes as the project develops (Ala-Risku and Karkkainen, 2005).

Site practices should be monitored for their conformance to the MLP. The plan should also be reviewed on a regular basis and updated as improvements or design changes are identified. The main causes of material wastage during the construction phase are:

a. Off-cuts of materials such as tiles and plasterboard;
b. inaccurate or surplus ordering of materials;
c. damage to materials e.g. through inappropriate handling, inadequate storage;
d. rework due to errors, poor workmanship or defective site processes; and
e. Inefficient use of materials e.g. use of temporary materials such as hoardings.

- **Importance of Good Practice in Material Logistics Planning**

Logistics principles are not difficult in themselves, but putting them into practice takes commitment, effort and attention to detail, with an emphasis on manageability. There is a strong business case for implementing MLPs in construction projects using the good practice guidance laid out in this document. The MLP may assist in delivering financial, efficiency and sustainability benefits.

1. **Financial Benefit**

Ordering materials that are not used on the project due to loss, wastage or being surplus to requirements has a cost which is often overlooked as it is built into the project price and paid for by the client. The total cost of poor material logistics includes the cost of:

a. purchase and delivery;

b. storage and handling;

c. disposal, treatment or return to supplier; and

d. labour to manage the materials.

2. **Labour Efficiency**

The efficiency of the labour force on-site contributes to the project costs, duration and quality, as well as the client's perception of the construction organization. Implementing efficient material logistic practices will reduce the number of times materials are handled and prevent skilled craftsmen being taken away from the core tasks to handle materials. Onsite personnel performance will increase by having the materials required for a task on hand, at the right time and in the right quantities.

3. **Legislative and Policy Drivers**

There is an increasing thrust of public policy (including waste strategy reviews, planning requirements, and industry targets) to achieve greater material resource efficiency. While there is currently no regulatory obligation to implement a formalized plan to minimize the purchase and use of materials that will result in waste, the following initiatives provide a clear indication of the direction in which policy is moving (Ammer, 1974).

4. **Environmental Benefits**

Improving project environmental performance helps clients and contractors demonstrate their commitment to reducing their impact on the environment.

- **Co-ordination of Material and Other Resources**

The money proposed for any activity in the bill of quantity should be spent judiciously. The people responsible for doing any task must be seen to do it otherwise responsibility will be invaded by the people concerned (Ammer, 1974). Control is also necessary to ensure that performance cost and time target are achieved. Concerning problems of inadequate material management, if an organization lacks efficient material management for the following problems may be occur.

i. Increase in material wastage men and machine may be idle waiting for materials.
ii. Men and machine may be idle waiting for materials
iii. Delay in completion of the project.
iv. Possibility of fraud, theft or loss
v. Extensive claims may arise from shortage of materials
vi. Contract sum may increase

- **Handling**

Effective material handling can be defined as using the right method in providing the right amount of the right material, at the right place, time, sequence, position, condition, and cost. This involves handling, storing, and controlling of the construction materials. Therefore, materials handling provides movement to ensure that materials are located and that a systematic approach is required in designing the system (Chan, 2002). Handling of materials is the flow component that provides for their movement and placement. The importance of appropriate handling of materials is highlighted by the fact that they are expensive and engage critical decisions. Due to the frequency of handling materials there are quality considerations when designing a materials handling system. The selection of the material handling equipment is an important function as it can enhance the production process, provide effective utilization of manpower, increase production and improve system flexibility (Chan, 2002).

The importance of appropriate handling of materials is highlighted by the fact that there are expensive and engages critical decisions. The materials handling equipment selection is an important function in the design of a material handling system in order to enhance the production process, provide effective utilization of manpower, increase production, and improve system flexibility (Chan, 2002). In addition, materials scheduling is also an essential part of handling material on site, which has several benefits (Che Wan Putra et al., 1999) such as:

i. Showing the quantities involved in each particular operation;
ii. Providing a key to the distribution of materials on site; and
iii. Demonstrating useful way of checking quantities required by sub-contractor, etc.

Materials must be delivered to site undamaged and without any wastage. Most common problems associated with materials supply is inadequate unloading and handling facilities, which attribute a high proportion of wastage (Canter, 2003). Therefore, handling with safety during movement of materials at site, will reduce the percentage of materials wastage and finally foster significant improvement in productivity.

- **Stock and Waste Control**

The European Construction Institute's Total Productivity Management report (ECI, 1994) states that "materials delivery to site is a critical, productivity-related aspect which demands the introduction of a carefully developed system of monitoring and control as early as possible". Delivery of the bulk of the construction materials requires proper management of the stock control. Stock control is a technique to ensure all items such as raw materials, processed materials, and components for assembly, consumables stores, general stores, maintenance materials and spares work in progress and finished products are available when require. (Prabu & Baker, 2006).

According to Teo and Loosemore (2001), Construction activity can generate an enormous amount of waste and materials waste has been recopied as a major problem in the construction industry (Formoso et al, 2002). It is also mentioned that construction materials waste, in the USA contributes approximately 29%. In the UK, it contributes more than 50% and in Australia it contributes 20-30%. The cause of waste in construction projects indicates that waste can arise at any stage of the construction process from inception, right through the design, construction and operation of the built facility (Faniran & Caban, 1998). Therefore, waste can be reduced through the careful consideration of the need for minimization and better reuse of materials in both the design and construction phases. Material storage on site requires close attention in order to avoid waste, loss and any damage of materials which would affect the operations on the construction project (Chan, 2002).

Problems often arise during materials supply because of improper storage and protection facilities (Canter, 2003). Previous studies have identified that building materials often require a large storage capacity which is rarely available on site (Agapiou et al, 1998). However, Stukhart (1995) suggested that there are a few considerations to be taken into account in the planning of the storage space such as timing of the initial buy, and historical information and experience. Materials management on site should seek to reduce loss of profit due to theft, damage and wastage, as well as running out of stock. Therefore, the requirements of storing space should be taken into consideration from the initial stage of the construction process (Chan, 2002).

- **Elements of a Waste Management Plan**

Project planning is very important because it allows the opportunity to define a problem, assess possible solutions, proceed to implement the final option and make provision for evaluation at the end. It is unthinkable to commence a construction project without going through this process. For the same reason, waste management on construction sites should be planned before construction activities begin (in order to avoid dealing with waste as a problem).

A waste management plan does not have to be complicated; in fact, it need not even be a long document. It simply needs to be concise, comprehensive and practical for easy interpretation and implementation on site. A good waste management plan will contain the following components:

a. Goals;
b. Waste audit;
c. Waste disposal options;
d. Waste handling requirements;
e. Transportation requirements;
f. Economic assessment.

- **Materials Wastage and Security Control on Site**

Control is applied to the following areas.

1. Materials quality: Inspection of materials prior to construction can eliminate faulty materials that would waste processing labour and other materials if unchecked.

2. Materials standard should be specified to aid to the inspection process.
3. Materials handling efficiency including equipment and methods that will not change materials in storage or interplant practices
4. Employee training to maximize efficient construction.
5. Study packing to protect incoming materials and outgoing materials.

When determining the amount of waste and methods to control it the following statistics should be established.

1) Weight and / or volume of wastes.
2) Sources of wastes
3) Value of waste.
4) Later use of waste, if any.

Therefore, with the trend of materials cost using at a faster than other resources the control of waste is vitally important, both on and off site. Buttler (1983) in the Element of Administration for building students stressed that waste can reduce by the following:

1) Ensure that materials are delivered as required so that site storage time is cut to a minimum and this requires careful phasing of deliveries between site and supplier.
2) Ensure that materials delivered are those specified for that particular job.
3) Ensure that workman are not only producing excessive amount of "off event"
4) Make sure that the storage is located near the site.
5) Make sure that stored materials are not deteriorated.
6) Collect waste and use to prevent more cutting.

- **Security Control of Materials**

Security is the protection of business property including information, both in the plant or site and intransit. Costs are reduced through the use of security by a reduction of materials, suppliers that are proffered or stolen. Additionally, insurance costs may be reduced when adequate security pensions are made.

- **Material Control**

Chandler (2008) explained that the degree of control on the inflow of materials and accompanying paper work will depend upon the size of the contract and the staff assigned to oversee this work. He stressed further that control on site must be exercised in respect of waste deterioration, misuse careful check should be made to ensure correction of orders and that materials delivery can be properly stretch and unnecessarily handling avoided.

Control measures on site should include:

1. Delivery: schedule of timing and contractual responsibility in delivery orders should be agreed with supplier. Order should be checked on arrival at site by competent storekeeper.
2. Security and storage: practical site security with fencing where necessary and a watched gateman, site store with lock.
3. Internal Transportation: This should be done in a way to avoid double handling.
4. Adequate supervision: should ensure that materials are not dropped, spoiled or discarded unnecessarily during operation.

5. Accounting: Records should be kept of all transactions – receipts, suppliers, waste, and transfers to other sites and so on.

- **Stock Control Technique**

Compton (2009) states that "stock control" is the means by which materials of the correct quality and quantity is made available as and when required with due regard to economy in storage and ordering cost, purchase prices and provision in terms of money. Higgins (2006) explained that careful stock control assures the user that materials and supplies are not being wasted or stolen and can reduce costs of such goods and their storage. He said further that another fact of the technique controls purchase of goods inventories from the times they are supplied until incorporated by the contractors. Both areas of stock control include the following basic steps.

a) Goods receiving and receiving the receipt.
b) Storage of goods in goods conductor.
c) Control recording incoming and outgoing construction materials as well as the supply on hand. Also control of incoming and issuing of construction materials as well as inventories of stock on hand and reserve stock records of issuing materials and the of inventory turnover.

- **Reason for Holding Stock**

The cost of goods for inventory burden cost is high usually 25-35 percent of the values of goods (Higgins, 2006). This figure includes the cost of the physical storage facilities. Handling, distribution taxes insurance and deterioration. Deterioration account for well over half of the cost, and therefore they are especially suitable targets for cost reduction procedures.

Storage should be kept to the minimum required, and reasons for holding stock include the following:

a) Delivery cannot be exactly matched with day by day usage.
b) Quantity discounts or projected inflation cause price increase on materials purchased large enough to offset storage costs.
c) Fear of widely fluctuating market for goods.
d) Fear of short run inflation on some materials constantly used.
e) Some items appreciate in value during the time of storage e.g. block.

- **Control**

Stock control requires the following steps.

1. Establishing a base inventory of goods now held, as well as a method for adding to or subtracting from the inventory, will eliminate costly annual stock taking.
2. Decisions must be made as to the amount of supplier's goods to be held, taking business conditions and quantity needed into account along storage cost factors.
3. Co-ordination of purchase and delivery schedules by departmental head and the purchasing department.

The following are the stock control;

a. ABC Analysis: this is a useful technique for stock control materials. Here, goods are broken down into one of three classifications of value of goods consumed. A small percentage of items stocked will account for a large percentage of total value, and storage cost control can be more precisely applied to these items with the saving of large areas of cost with little effort.

b. Material Utilization Control: the efficient use of construction materials to reduce waste thus lowering costs. According to Higgins (2006), primary methods of materials utilization include efficient materials selection, efficient handling and use, standardized materials practices, and administrative controls.

c. Efficient Material Selection: includes choosing the lowest cost material of an adequate quality for construction purpose after considering the availability of needed grades, sizes, quality, etc.

d. Efficient Handling and Use: can be facilitated through proper management of computers firm with correctly designed and maintained fools and equipment.

The following objectives were enjoyed in an organization employing plant to handle materials for construction operation on site.

To achieve the objectives of material management without hampering other objectives

a. To improve the quantity and standard of work carried out and to offer better services to the client where possible.

b. To strive continually period of the project. And selection of particular equipment for handling materials both to and of site depends on the following factors.

c. Cost of plant hire or own

d. Management of plant

e. Type of construction site

f. The operation to be performed.

g. Degrees of standardization of flexibility desire in machine.

- **Storage of Materials**

According to Mezue (1992) material storage can be defined as merely keeping material(s) in safe place until it is required or requested for use in a manufacturing process. Manufacturing process also includes construction process. To obtain good material storage, a system whereby material are systematically organized by administratively keeping them safely and providing for the best means of flowing in and out of them is adopted. Storage of materials is the direct responsibility of site management and has a strong influence on material.

Chandler (1978) advanced that attitude taken to newly delivered materials and components will be carried through their subsequent handling and usage. A careless regard for the value and utility of the materials on part of the management could lead to a progressive deterioration in the operatives' regard for the materials. The system adopted for the storage of materials will therefore depend wholly on the co-operation of the site team. He stressed further that areas on site allocated for the storage of materials should be determined after considering the under listed questions:

1. Will construction take place in that area?
2. Is the storage for a long or short term relative to the contract time?
3. Can delivery transit vehicles safely and easily reach the areas?
4. Can on-site movement storage area to point of use be safely and economically carried out?
5. Are the materials as near their point of use as practically possible?
6. Are the materials stored at the security area?
7. Will the storage area create problems in routine site transport and personnel?

The answers to each of these questions will vary from materials to materials. Good storage facilities must be maintained by construction industries for effective construction work cost and cost control. Materials must be stocked in places where they can be easily obtained for use.

- **Storage of Materials**

Popularity storage is a stock control technique that places the most frequently used and/or the most easily moved materials, suppliers or goods nearest the point issue. Priorities and storage positions are assigned to good to the following order.

i. Most often issue most easily moved items.
ii. Out of date items.
iii. Excess stock items.
iv. Out of reason items.

- **Physical Storage Facilities**

In arranging storage areas, the following factors should be considered.

1. Central versus networks system: choice of one large storage place or a network of smaller storage areas is the first consideration. If only one operation is served or if multiple operations are located near one another, a central storage place is the most economical. If branch operations are located near one another, a central storage place is the most economical. If branch operations are spread over a wide geographical area, however branch areas may be proffered to allow storage near the point of use (Ng, et al., 2007).

2. Transportation loading and unloading materials should design to most efficiently handle the type of transportation used, as should access facilities such as roads or rail access features.
3. Safety areas should be designed for storage of fragile or dangerous materials.
4. Open areas such as outdoor yards may be used for low cost storage for durable materials or goods not harmed by weather.

- **Goods Receiving**

In goods receiving, incoming materials and suppliers are checked against purchase order for quantity and conditions and shipment is recorded, purchasing departments and inspection division are notified. A multiple copy form called a good received register may be used for this purpose.

2.2.4 Benefits of Material Management

The benefit of effective material management within the construction industry has been widely acknowledged. Many writers have sought to detail the effects that site layout have on both materials and their waste (Formoso, et al., 2002 Oglesby et al., 1989; Li and Li, 2001; Tommelein, et al., 1991). Material wastage amounts to a daily reduction in productivity of up to 40% (Thomas et al., 2005); therefore, effective management of waste is an essential factor in materials management.

In addition, the surrounding environment has a significant impact on the management of materials and the associated level of accidents that occur, with a third of accidents on-site attributable to poor material management (Perttula et al., 2003). The constraints identified are many (Perttula et al., 2003), but the more significant constraint identified is the surrounding environment and its sporadic and dynamic nature.

Many studies have stated the significant importance to both material and waste management to that of the site layout. Those writing on waste (Thomas et al., 2005; Sanad et al., 2008; Formoso et al., 2002) highlight the significance of the on-site layout and many attribute it to one of the leading factors of waste on building sites today. However, in contrast to confined construction sites, many of the researchers highlight that it is the larger, spatially rich sites that pose the biggest problems due to the long distances for which materials must be transported, coupled with the additional burden of monitoring materials. There is an abundance of literature on the management of materials on-site (Ala-Risku and Karkkainan, 2005; Enshassi, 1996; Ng et al., 2007; Navon and Berkovich, 2006), particularly where space is plentiful (Choo and Tommelein, 1999; Tommelein and Zouein, 1993), yet many fail to acknowledge the importance and the benefits of effective material management where space is a finite resource, requiring extensive management and the resulting benefits available to all. Many fail to take the aspect of confined sites into consideration when looking at material wastage, under such headings as;

- Lack of adequate storage space
- Lack of adequate room for the effective handling of materials
- Damage occurring due to poor material management, and
- Lack of adequate room to account for materials (e.g. materials becoming ‘buried’ on site)

The effective management of such aspects as delivery, off-loading, storage, handling, on-site transportation and on-site utilization of materials is essential to the overall success of any development (Thomas et al., 2005), however this is even more accurate in the case of an urban construction site (Li et al., 2005; Poon et al., 2004), where spatial restrictions are evident.

Various authors have covered on-site logistics management illustrating the benefits when implemented (Poppendeick, 2000; Caron et al., 1998; Proverbs et al., 1999). The majority of researches that focus on sites with little or no spatial restrictions, only hint at some of the potential issues that may arise (Chudley and Greeno, 2006a, 2006b; Ahuja et al., 1994). Due to spatial restrictions, effective logistics management should result in more proactive and productive utilization of materials on confined construction sites.

When materials are not delivered to site as per the project programme, it results in delay in construction projects (Assaf and Al-Hejji, 2006). Therefore, where increased logistical management is required, as is the case in urban inner city environments, effective logistical management and supply chain management is essential in the overall material management process. The benefits of effective material management are well documented, resulting in significant monetary savings and schedule compression where implemented (Agapiou et al., 1998; Poon et al., 2004). During such difficult economic conditions, the need to acquire new contracts under difficult tendering practices further illustrates the benefits of effective material management, particularly in confined site environments.

If the findings of this research are acknowledged and implemented, there are significant savings attainable based on the following. In the majority of construction projects, materials amount to between 50-60% of the total contract cost, (Song, et al., 2006) effective management of this resource can lead to a reduction in costs, resulting in a significant saving. A potential 6% saving on total cost through effective materials management is achievable (Bell and Stukhart, 1987), yet the construction industry invests only 0.15% in materials management and control (Navon and Berkovich, 2006). In addition, poor material management contributes to over a third of accidents on-site; a reduction would further lead to monetary savings to a project (Perttula et al., 2003). Based on the possible savings that are achievable, the potential for more competitive tendering and increased profit margins are evident and become increasingly beneficial in the current economic climate.

Previous studies by the Construction Industry Institute (CII) concluded that labor productivity could be improved by six percent and can produce 4-6% additional savings (Bernold and Treseler, 1991). Among these benefits are:

- Reducing the overall costs of materials
- Better handling of materials
- Reduction in duplicated orders
- Materials will be on site when needed and in the quantities required
- Improvements in labor productivity
- Improvements in project schedule
- Quality control
- Better field material control
- Better relations with suppliers
- Reduce of materials surplus
- Reduce storage of materials on site
- Labor savings
- Stock reduction
- Purchase savings
- Better cash flow management

From a study of twenty heavy construction sites, the following benefits from the introduction of materials management systems were noted (Stukhart and Bell, 1987):

- In one project, a 6% reduction in craft labor costs occurred due to the improved availability of materials as needed on site. On other projects, an 8% savings due to reduced delay for materials estimated.
- A comparison of two projects with and without a materials management system revealed a change in productivity from1.92 man-hours per unit without a system to 1.14 man-hours per unit with a new system. Again, much of this difference can be attributed to the timely availability of materials.
- Warehouse costs were found to decrease 50% on one project with the introduction of improved inventory management, representing a savings of $ 92,000. Interest charges for inventory also declined, with one project reporting a cash flow savings of $ 85,000 from improved materials management.

Against these various benefits, the costs of acquiring and maintaining a materials management system has to be compared. However, management studies suggest that investment in such systems can be quite beneficial.

2.3 What is Material Management?

Different researchers provide different definitions for material management. Therefore, different definitions can be found in different references. Ballot (1971) defines material management as the process of planning, acquiring, storing, moving, and controlling materials to effectively use facilities, personnel, resources and capital. Tersine and Campbell (1977) define material management as the process to provide the right materials at the right place at the right time in order to maintain a desired level of production at minimum cost. The purpose of material management is to control the flow of materials effectively. Beekman-Love (1978) states that a material management structure should be organized in such a way that it allows for integral planning and coordination of the flow of materials, in order to use the resources in an optimal way and to minimize costs. Material is a vital commodity for improving productivity in construction projects.

Ammer (1980) defines material management as the process in which a company acquires the materials that it needs to achieve their objectives. This process usually begins with the requisition of materials from the supplier until the material is used or incorporated into a product. Bailey and Farmer (1982) define material management as a concept concerned with the management of materials until the materials have been used and converted into the final product. Activities include cooperation with designers, purchasing, receiving, storage, quality control, inventory control, and material control. Gossom (1983) indicates that a material management system should have standard procedures for planning, expediting, transportation, receipt, and storage to ensure an efficient system for materials control.

Cavinato (1984) states that material management involves the control of the flow of goods in a firm. It is the combination of purchasing with production, distribution, marketing and finance.

Arnold (1991) states that material management is a function responsible for planning and controlling of materials flow. He adds that a materials manager should maximize the use of resources of the company.

Materials management is an important function in order to improve productivity in construction projects. According to Bell and Stukhart (1986) materials management functions include "material requirement planning and material take off, vendor evaluation and selection, purchasing, expenditure, shipping, material receiving, warehousing and inventory, and material distribution". This is concerned with the planning and controlling process to ensure that the right quality and quantity of materials and installed equipment are appropriately specified in a timely manner, obtained at reasonable cost and are available when needed.

2.3.1 Materials Management Processes

Materials management processes involve the planning, procurement, handling, stock and waste control, and logistics surrounding materials on construction projects. A good materials management environment enables proper materials handling on construction sites. In order to better understand materials management the following processes are discussed: planning, procurement, logistics, handling, stock and waste control.

- **Planning**

The process of planning construction methods has been defined as "understanding what has to be built, then establishing the right method, in the most economical way to meet the client's requirements" (Illingworth, 1993). This is a detailed scheme for achieving an objective for certain work tasks. In the case of materials, there is a need for an appropriate planning, which must be done concurrently with engineering, construction, and other project plans (Stukhart, 1995). Stukhart (1995) also mentioned, thus, material planning will provide guides for all the subsequent activities and can have a great impact on the project plan. The materials planning process covers setting up and maintaining the records of each part used in each plant to determine target inventory levels, and delivery frequency (Payne et al, 1996). As a result, an excellent management of the materials record will help the flow of materials at the site in order to avoid several problems such as materials out of stock and materials that have not been delivered.

Stukhart (1995) mentioned that material planning would provide guides to all the subsequent activities and that this could have a great impact on the project plan. The materials planning process covers the set up and maintenance of records and determines the target inventory levels, and delivery frequency (Payne et al, 2006). Planning of access and routing of materials within a construction site has an important implication for the development of an effective materials management strategy (Faniran and Clean, 1998 Olusegun et al 1998) particularly in terms of increasing productivity and profit, and facilitating the timely completion of construction projects (Wong and Norman, 1997). The objective of efficient materials planning is, to increase productivity and profit of the company, and facilitate the completion of construction projects (Wong and Norman, 1997). Thus, better planning of raw materials on site can help to eliminate project delays and reduces activity times, resulting in better service.

- **Material Schedule**

Chandler (2008) said schedule is a list in a diagrammatic presentation indicating requirement of resources. An aid used in the ordering of material is schedule. Materials gratuity will be required to be taken off from the drawing and must show:

a) Quantity required to be fixed.

b) Waste allowed in the estimate.

c) The gratuity to be ordered.

d) Date of delivery.

e) Cost inclusions in the estimate.

The schedule is usually produced by Quantity surveyor or by a material scheduler etc. By systematic analysis to bills of quantity and contract drawing with specification, schedule is the pre-requisite for the programming of the materials delivery and material usage planning on the site. Material should never be ordered directly from the contract bills, which are only intended as a guide to the contractor pricing the contract. The estimate will produce schedule of material for the buyer. The estimator will produce figure for material to be delivered in bulk and those materials that should be imported. The date of delivery guaranteed by the suppliers against each item can be compared with the builders plan requirements. In those circumstances changes in the specification will often enable the builder to order under material that be available within the required period for delivery and thereby avoid unnecessary delay in the future.

- **Ordering Planning**

Materials may be ordered for by the architect or the contractor. The supplier dominated by the architect is called dominated supply. Whoever is making the order should give fullest information as regard delivery debt, the hour during which the material will be accepted on site and other general terms and conditions such as liability for damage use, method of packing, size and weight of the load that can be handled on site. Materials that are on long term delivery should be placed on other as soon as the contract is signed so that material will arrive at the award time.

- **Storage Planning**

Before the material ordered arrives, adequate preparation should be pounded for storage. Good storage enhances proper management of materials aid it minimizes concerned. The rate at which materials are being used and the working order should provide a guide as to the quantity of materials to be ordered.

- **Transportation Planning**

An efficient transportation of construction materials from storage to point of use reduces project cost. Therefore, proper transportation planning system should be planned, the route and the best suited for the conveyance of each material should be used for it. Although materials must be tied to the transporting plan to prevent breakage (Lamer, 2007).

2.4 Factors that Lead to Mismanagement of Materials on Building Construction Sites

Spillane *et al.,* (2011) postulate that the top five issues in the management of materials on a confined construction site was established using the severity index (SI) ranking. Therefore, the top five issues identified are:

1. Contractor's material spatial requirements exceed the available space
2. Difficult to coordinate the storage of materials in line with the programme
3. Location of the site entrance makes delivery of materials particularly difficult
4. Difficult to store materials on site due to the lack of space
5. Difficult to coordinate the storage requirements of the various sub-contractors

Each of these top five factors in the management of materials on a confined construction site are addressed and scrutinized further, paying particular attention to existing literature to compound the points noted.

2.4.1 Contractor's Material Spatial Requirements Exceed the Available Space

Spatial requirement requires thorough attention due to the likelihood of this issue occurring, considering that construction materials make up an average of 40% to 50% of a total project cost (Vainio, 1999; Vrijhoef and Koskela, 2000). With the increase in the utilization of sub-contractors and third parties to the average construction project (Langford and Male, 2001; Holt, et al., 2003), the amount of on-site management and co-ordination is set to increase dramatically (Winch, 2009, 2010).

With the increase in contractor involvement coupled with the continued compression of many of today's project schedules (Chang et al., 2005; Nepal, 2006), the need for on-site management to successfully accept delivery and accommodate the numerous material requirements of these subcontractors grows in complexity with the number of contractors on-site. In order to provide for and aid in the movement of required material, the space required must be documented, managed and allocated accordingly. Scenarios where the spatial requirements for material on-site exceed the availability of space on site require proactive management to be introduced to mitigate the resulting effect. Where such instances are mitigated, there is a propensity for reduced accidents (Spillane et al., 2011), increased productivity (Thomas et al., 1989) and ultimately, a greater possibility of achieving project success. In order to alleviate the issue, the vast majority of authors agree that the most advantageous strategy to adopt is one of proactive mitigation through early contractor involvement

(Proverbs and Holt, 2000; Trigunarsyah, 2003; Khalfan, et al., 2004; Song, et al., 2009) coupled with continuous communication among the parties (Emmitt and Gorse, 2003), both horizontally and vertically, on and off-site with the various internal stakeholders associated with the project.

2.4.2 Difficult to Coordinate the Storage of Materials in Line with the Programme

Interestingly, Thomas et al., (2005) identifies storage as the first step in materials management and failure to accommodate materials results in poor productivity and waste (Thomas et al., 1989). The effect of unsuitable storage locations is also an issue in poor labour productivity (Enshassi, et al., 2007), thereby indicating that not only is the presence of adequate storage space essential, but correctly located storage is also a factor in the overall on-site productivity. The negative effect of inadequate/inappropriate material storage is an issue with various trades on-site, such as masonry productivity (Sanders and Thomas 1991). The mismanagement of material storage is a leading factor in spatial congestion and results in reduced levels of productivity on construction projects (Thomas, and Riley, (2006). Therefore effective measures must be taken to counteract such instances on-site.

Ensuring an adequate stockpile of materials on-site is essential in the management of production (Horman and Thomas, 2005). Where there is a lack of storage space, this inventory may become compromised, resulting in further negative results in productivity and materials management. Effective site and space utilization is fundamental to the management of materials (Chau et al., 2004). Where space is limited, additional management of the available space is essential to accommodate the various material requirements of a project.

On reviewing a number of the interviews and the literature (Yang and Mahdjoubi, 1999; Yang, et al., 2003; Mohamed and Anumba, 2006; Soltani and Fernando, 2004), a number of authors identify the experience of the management in the successful allocation of material and its associated storage on-site. This is based on intuition and experience gained through knowledge obtained in the industry. The knowledge gained is tacit and takes years to develop through experience and interaction in the industry. Koskela (1999) aptly concludes by outlining that projects are very often constructed in 'sub-optimal conditions'. In addition, congestion was highlighted as being 'one facet of a wider phenomenon' where extensive management is necessary to accommodate such working conditions on site.

2.4.3 Location of the Site Entrance Makes Delivery of Materials Particularly Difficult

The third material management issue is the difficulty in the transportation of materials, particularly in relation to the location of the site entrance. This happens predominantly in the vicinity of the site entrance. This is mainly attributable to bottleneck effects, where multiple deliveries can result in increased management intervention to alleviate any issue that may arise. This may be classified and detailed under the title of material flow, an important topic in the management of materials on-site. In a study conducted on material management, material flow management was classified as the second most critical factor in project management's level of satisfaction in construction logistics (Jang et al., 2003).

Inadequate working conditions can ultimately lead to increased material handling, resulting in possible injury to personnel (Mitropoulos et al., 2005a). Mitropoulos et al., (2005b) also outlines that the "unpredictability generates hazardous situations" results in "chaos and confusion". Furthermore, the benefit of an effective site layout and thus, the location and number of site entrances, contributes to the flow of materials. The provision of adequate spatial considerations has been considered by a number of authors (Elbeltagi et al., 2004). This is highlighted further where adequate planning is required to avoid excessive movement of materials on-site, thereby, reducing the probability of double handling materials in adverse conditions. Through effective identification and location of site entrances, the possibility of increased handling of materials is mitigated. Thomas and Riley (2006) concludes that interruptions to the normal flow of materials will cause serious degradations to performance and labour productivity. From the aforementioned it is evident that improper location of the site entrance, resulting in inadequate room for the effective handling of materials, is a significant issue in materials management in confined site environments.

The site layout is directly connected to the management of materials (Elbeltagi and Hegazy, 2003; Tam, et al., 2002; Sadeghpour, et al., 2002), and where such management is implemented, monetary savings are attainable (Osman and Georgy, 2005). One of the primary functions of an adequate designed site layout is to aid in the movement of materials, unto and around site, as is necessary in the completion of the various tasks (Elbeltagi et al., 2004). The supply of materials is fraught with difficulties, not only onto site, but also in getting materials to site (Agapiou et al., 1998). With many urban confined site environments, the location of the site entrance or the site itself can be an issue. The role of logistics management and supply chain management are essential in the management of materials and the location of the site entrance, both prior to arriving on-site and during the delivery and unloading process.

To conclude, the ability to design and accommodate adequate logistics management plans, site layout plans and materials management plans are all essential in the management of the transportation of materials both unto and around site (Yang et al., 2003). Where such site layout plans are not implemented, the movement of materials on-site is significantly restricted, resulting in increased manual handling, double handling, waste, lost productivity, increased health and safety risks and inevitably, at the extreme, project failure (Mawdesley et al., 2002).

2.4.4 Difficult to Store Materials on-Site Due to the Lack of Space

The fourth issue identified by the quantitative analysis was the difficulty with storing materials on-site due to the lack of space. One of the main reasons for a lack of storage space on-site is over-crowding or congestion of the workspace, which is directly correlated to poor project productivity (Thomas and Riley, 2006). An overcrowded construction site may lead to double handling of materials, again, reducing productivity and increasing damage to materials (Horman and Thomas, 2005) along with increased health and safety concerns (Huang and Hinze, 2003). Inadequate management of materials through over allocation also has been identified as impeding progress, workflow and overall productivity, due to overcrowding the limited work space available (Horman and Thomas, 2005) while also exasperating the issue of security of materials (Berg and Hinze, 2005). Planning is essential to overcome this issue and management of the critical space. Planning has been noted as being fundamental to site management, including spatial management (Winch and North, 2006) and reducing congestion on-site (Winch and North, 2006).

On confined sites, material waste may increase, resulting in significant increases in cost (Poon, et al., 2004b) and additional project costs (Bell and Stukhart, 1987). It is estimated that on average, 1 to 10% of materials entering site, leave site as waste, due to improper management (Bossink and Brouwers, 1996). This shows the need for effective material management on-site. Formoso et al. (2002) considers the estimate conservative as they report that the range of material waste falls between 2-15%. Formoso et al. (2002) also highlight that the total building waste in urban areas could be as much as 30% in confined construction sites.

Lack of space is an inherent difficulty acknowledged throughout the industry, when constructing a development in an urban environment (Singer, 2002; Tindiwensi, 2000; Navon and Berkovich, 2006). In counteracting this issue, it has been noted that the strategies implemented can often prove problematic and cumbersome when trying to monitor and control a rigid project programme (Navon and Berkovich, 2006; Vrijhoef and Koskela, 1999; Lummus et al., 2001). As a result, the effective management of materials within a confined urban site cannot be over-emphasised and must be acknowledged and implemented throughout any project, but in particular, a spatially restricted development.

2.4.5 Difficult to Coordinate the Storage Requirements of the Various Sub-Contractors

The final factor identified as significant is the difficulty to coordinate the storage requirements of the various subcontractors. The co-ordination and movement of materials both onto and around site can be a cumbersome and time consuming task but one which is of paramount importance to site management (Soltani and Fernando, 2004). In cases where space is a limited factor, this task becomes infinitely more difficult and requires extensive management interface in the co-ordination of the material storage requirements of the various sub-contractors (Winch and North, 2006). The co-ordination of materials on-site has been classified under a number of sub-sections, as follows (Thomas et al., 1989):

- Organization and storage of materials,
- Housekeeping of materials and their waste,
- Planning of material deliveries,
- Material availability on-site,
- Material handling and distribution on-site.

The effective coordination and movement of materials is fundamental to the success of any project (Kini, 1999), particularly under then headings outlined previously. Where such steps are acknowledged and managed accordingly, increased savings are attainable, with some cases reporting saving of up to six percent in labour costs due to optimised schedules and improved productivity as a direct result of effective materials management (Bell and Stukhart, 1987).

The coordination of materials and other resources has been documented by numerous authors (Thomas et al., 2005; Nepal et al., 2006; Lu et al., 2007), illustrating that effective co-ordination of the various resources is essential to avoid waste or non-value adding activities in the industry (Formoso et al., 2002). Effective co-ordination of resources is essential in the management of the various resources on-site. To further this point, material waste is not always the result of poor co-ordination on-site. In some instances, waste occurs due to design faults and errors occurring during the design stage of a development (Enshassi, 1996; Love and Li, 1999). In the majority, waste on-site has been identified as being caused by poor co-ordination and communication in the management of materials which results in considerable additional cost in both monetary and schedule terms (Thomas et al., 2005).

Koskela (1999) shows that almost 40% of the total cost of materials on-site is made up of purchasing and controlling the movement of materials on-site. Where this task is made more efficient, there are significant savings available (Koskela, 1999). Project co-ordination, including material co-ordination was highlighted as one of the key issues in projects failing to meet the predetermined project programme (Muholland and Christian, 1999). Through acknowledging the requirement to facilitate effective material co-ordination with the other various tasks and resources on-site, such programme slippages could be mitigated or eliminated as the project progresses.

Coordination and communication are often taken collectively due to each generally occurring in unison. Where both facets are taken jointly, the cause of delay and disruption between resources and stakeholders is vastly reduced (Assaf and Al-Hejji, 2006). In addition, co-ordination is fundamental in the management of the allocation of stakeholders to resources - an integral part of the management of the movement and allocation of materials on site (Koskela, 1999). Therefore, the co-ordination of materials is an essential facet in the management of materials on-site, but where spatial limitations occur, this point is significantly more evident (Thomas et al., 1989).

According (Narimah, 2011), the following are the factors affecting materials management;

1. Sourcing of materials and requisition
2. Demand estimation
3. Transportation
4. Receiving and verification of materials on site
5. Storage of materials on site

6. Issuing of materials for use
7. Procurement or indent for materials
8. Quality inspection and control
9. Maintenance
10. Time
11. Materials handling
12. Stock and waste control
13. Financial ability
14. Possession of qualified staff
15. Possession of qualified subcontractors
16. Possession of qualified of required equipment
17. Competence of estimators
18. Availability of equipment
19. Duration of the project
20. Type of project
21. Type of materials
22. Level of awareness

2.5 Measures for Effective Material Management

According Narimah (2008), and also Intergraph.com 2012 the following are the measures for effective materials management practices on construction project;

2.5.1 Business Benefits

An effective materials management system has the capability to integrate the entire material and supply chain work processes. Project teams will have online access to information during all project phases – from engineering through the complete supply chain to onsite management. The business benefits of effective materials management include significant cost savings and increased procurement efficiency.

Effective materials management governs the material- and quantity-related activities by providing:

- Efficient corporate and project specification management
- Definition and quantification of material in the manner best suited to the individual project
- Procurement and material tracking through delivery
- Scheduling and forecasting
- Engineering integration with customers and subcontractors
- Timely construction planning down to the work package level

2.5.2 Managing Reference Data at One Place

With an effective materials management system, all partners in the building project supply chain can manage all reference data in one location. This has several benefits, including:

- Definition of key technical material attributes for bulk materials or itemized equipment to be used downstream
- Provides a common foundation for defining all bulk materials, which eliminates redundancy by creating and managing attribute-driven bulk commodities and specifications at a corporate standard or enterprise level
- Provides internal revision control, reducing the man-hours required to make revisions
- Delivers substantial benefits from materials standardization

- Up to 79% reduction on traditional paper-based project piping specification costs
- Up to 70% reduction on manual 3D load file costs
- Up to 13% reduction on change and revision management

2.5.3 Engineering and Procurement Integration

The integration of engineering and procurement data presents the most recent status of any material item being used within the project. The benefits of this capability include:

- Ability to turn dynamic engineering data into stable procurement data
- Unlimited comparisons of different quantification statuses
- Management of change is automated and current requirements will be clearly communicated to supply chain managers
- Reduces risk of over/under procurement
- Rule-driven processes automatically create material requisitions according to company-specific operating procedures
- Increases efficiency in the process by the automation of the work
- Continuous tracking of material requirements against material acquisitions, which allows for proactive management of potential surpluses and shortages

2.5.4 Supply Chain Management

An effective materials management system enables users to seamlessly integrate interchanges with commodity suppliers, subcontractors, manufacturers, fabricators, and freight forwarders. The ability to manage the supply chain has several benefits:

- Complete supplier management allows access to historical information on supplier performance on previous projects
- Performance measurement criteria will help to aid/advise for further selection
- Allows effective, efficient management of materials milestones, which adds value by automatic notification of missed or delayed critical events
- Provides timely information and flexible event tracking, increasing project efficiency and savings
- Centralized storage of all data involved in the inquiry process: supplier information, attached documentation, and requisition-based data
- Allows buyers the option of picking and choosing items during the bid evaluation process or optimizing the selection of suppliers for requisition line items to minimize project costs
- Knowledge of material shipments well in advance of release from the suppliers allows for better planning and allocation of resources (labor and equipment)
- Right material at the right place at the right time reduces site delays

2.5.5 Site Management

It is critical to balance onsite personnel with material availability so that material can be assigned to site inventories in the shortest possible time. Site management is a key component of effective materials management with several benefits, including:

- Total material visibility from shipments through issue of material to be installed into the final works
- Multiple warehouse status capabilities – physical and virtual

- Ability to track material movement between the warehouses with audit trails
- Fabrication tracking of the fabricated spools
- Work package planning with priorities by sequence or date
- Ability to forecast material availability – looking ahead by 30, 60, or 90 days
- Complete history of material issues down to the isometric/spool level, which gives material traceability

2.5.6 Procurement Efficiency

Smart Plant Materials enables improvement in procurement efficiencies through the following:

- Single data input and Smart Plant Enterprise integration
- Downstream processes/groups are not required to re-input data for their purposes
- Copy and paste through Microsoft Office files is no longer required
- Less time spent organizing with more time spent on strategizing and negotiating
- Rule-driven processes allow Smart Plant Materials to gather the requirements and generate inquiries, which allows buyers to be more effective
- Common system and processes for all projects
- As personnel move from project, they do not have to learn how a particular project is being run as reporting will be consistent across all projects
- Better planning and less "panic" buying
- With better quality and quantity of information available earlier, decisions can be proactive instead of reactive

2.5.7 Lower Risks, Lower Costs

Smart Plant Materials helps to lower project costs and improve risk management through the following:

- Improved audit performance with reduced data entry points
- Inadequate performance impacts project schedules while the project team responds to findings
- Having easier access to key audit data makes it easier to track performance and to recover from required modifications
- Minimizes shortages and surpluses
- Tight integration of engineering and procurement facilitates the elimination of surplus materials
- Elimination of shortages reduces risks and construction costs ROS-driven milestone planning and control
- Allows for a construction-driven schedule for early planning of engineering and procurement material activities
- Material delivery and arrival control
- Gives the project a complete view of movement and availability to support desired work fronts Integration of all EPC materials data in one system
- Allows for total project material reporting and control without having to gather data from different disciplines
- Construction work-front planning and forecasting
- Rule-driven processes allow Smart Plant Materials to gather construction work package requirements and assess material situation throughout the supply chain with appropriate feedback into the EP process

2.5.8 Other Benefits

Smart Plant Materials customers have reported other business benefits, including:

- Standardized work processes for engineering, procurement, and construction
- Standardization reduces costs in engineering, procurement, and construction
- Downstream integration compresses project schedules
- Assessment of historical project data improves quality of new bids and compresses bid time
- Improved organizational efficiency
- Enhanced integration and functionality over in-house legacy systems
- This helps to break down silos further and facilitates faster response to change
- Ability to see full EPC material work processes at a glance
- Seamless integration with design and engineering
- Integration with the extended supply net
- Real-time information
- Improved reporting from a single integrated system
- Timely placing of orders for materials
- Ensure quality assurance/control processes are in place
- Logistics for tracking & transportation of materials to site
- Receiving and inspecting materials on site
- Storage & issuing of materials to construction location
- Complete quality records of materials
- Established material management system to be used
- Documentation
- Record receipt of goods upon delivery
- Monitoring of materials distributed

- Assigning of material codes
- Construction activities and schedule of materials
- Proper materials handling
- Make the store safe from theft and vandalism
- Materials return to be submitted weekly
- Determine the daily allocation of materials on site
- Education/training/enlightenment of staff in charge of materials management
- Special security agents
- Usage of qualified construction professionals

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Overview

The chapter discusses how the research was conducted and the methods used in data collection. The methods include the following: - design, population, sampling techniques and sample size, data collection techniques, questionnaires, interview schedule and observation check list.

3.2 Study Area

The area of the study is Ashanti Region. It is further narrowed down to two selected construction firms in Kumasi Metropolis (Stivo and Consar Construction Companies Limited).

3.2.1 Kumasi Metropolitan Assembly

The Kumasi Metropolis is centrally located in the Ashanti region of Ghana. Its unique central position makes it accessible from all corners of the country. It is the second largest city in the country and the administrative capital of Ashanti. It is a fast growing metropolis with an estimated population of more than two million people and an annual growth rate of about 5.4 percent. The metropolis is about 254 kilometres; its physical structure is basically circular with a central located commercial area (KMA Annually Report, 2015).

Figure 3.1: Map of Kumasi Metropolis (KMA Annual Report, 2015).

3.3 Research Design

The study adopted the concurrent mixed study design (Quantitative and Qualitative). Quantitative research investigates facts and tries to establish relationships between these facts. While qualitative research is a subjective assessment of a situation or problem, and takes the form of an opinion, view, perception or attitude towards objects. A combination of quantitative and qualitative approach was selected because it takes advantage of the strengths in the two approaches while limiting the weaknesses. Quantitative study of human phenomena can only give frequencies of occurrences of certain observable manifestations of the phenomena without explaining why they occur. Therefore, it is important to also adopt a qualitative research paradigm to compensate for the limitations of using quantitative approach for a study.

3.4 Population of the Study

A research population refers to a well-defined collection of individuals with similar or binding characteristics or traits (Castillo, 2009). Hence to collect data from all the members of a population is considered impractical (Aaker 2010; Bryman & Bell, 2011). To solve this problem, the choice was to narrow down the population of this study to fifty (50) professionals who have been working for the past five years up to now according to Ashanti Regional Engineer as at 2015 (oral communication). Even if there is enough time and financial means to do so, the odds are that the respondents will not provide sufficient data, particularly with a large population such as the all construction firms in Kumasi. In fact, it will in many cases result in a less accurate study, because of the difficulty to maintain control over the data collection (Aaker, 2010).

The population consists of professionals in the construction industry i.e. quantity surveyors, project managers, foremen, contractors, site supervisors, security personnel and storekeepers in selected construction firms within Kumasi Metropolitan Assembly.

3.5 Sampling Technique and Sample Size

The sample size is basically a subset of the entire population. It is representative of the population from which it is drawn and can be used to conduct research study to derive findings that apply to the population (Castillo, 2009). Purposive sampling approach was adopted in determining the choice of respondents after the used of Kish, (1965) method or formula for the study to determine sample size. To determine the minimum sample size to recruit for the study, method or formula described by Kish (1965) was used in estimating the minimum sample size.

$$n = \frac{K}{1 + \frac{K}{N}}$$

Where: n = Sample Size

N= Population Size

$K = S^2/V^2$

S = Maximum standard deviation in the population element (total error = 0.1 at a confidence level of 95%)

S = P (1-P) = 0.5(1-0.5) = 0.25

V = Standard error of sampling distribution = 0.05

P = the population elements.

Therefore, in determining the minimum sample size of some selected construction firm in Kumasi Metropolis, N = 50

But $K = S^2/V^2$

K = 0.0625 / O.0025

K = 25

= K/ (1+K/N)

= 25 / (1+25 / 50)

= 16.67 ≃ 17

The minimum sample size calculated for the study is seventeen (17). However, twenty-nine (29) respondents were targeted to ensure a high participation in the study and to resolve cases of respondents who might drop out from the study. After three weeks' survey of construction firms and sites, the researcher was able to identify the population that would assist in assessing material management.

3.6 Data Collection Techniques

Data collection techniques involved questionnaires, interviews and observations.

3.6.1 Questionnaire

The questionnaire was designed to collect data from project managers, quantity surveyors, foremen and contractors of selected construction firms in Kumasi Metropolis. These experts were selected based on their roles in construction as far as management of materials are concerned. These questionnaires were developed to enable respondents select the response from options. The questionnaire prepared reflected on the following issues:

- Demographic data of respondent.
- Causes of material waste on site.
- Measures for effective material management.
- Benefits of material management planning.

3.6.2 Interview Guide

Structured interviews were conducted with interviewees. The interview was designed to gather specific information from site supervisors, security personnel and store keepers. The interviews conducted were based on causes of mismanagement of materials and effective measures to minimize them.

3.6.3 Visits and Observation

Visits and observations were made to Consar Limited Site at Pakoso in Kumasi and Stivo Company Limited at KNUST Campus. The purpose was to observe the delivery, storage and usage of building materials. And also to find out whether

Closed Circuit Television (CCTV) cameras were available for monitoring construction activities.

3.7 Data Presentation and Analysis

Data was presented using tabulation, graphical methods and analysis of frequencies. The quantitative data was analyzed by descriptive means. On the other hand, qualitative data analysis and presentation, involved a narrative analysis of the data to enrich the study with real and vivid information as given by respondents. The data collected through questionnaires was edited, coded and entered into computer. The data fed into computer was then analyzed using the Statistical Programme for Social Scientists (SPSS) version 21.0 and spreadsheet (Excel of Microsoft Office).

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the results and discussions of the various methods used to collect data for the study in chapter three. The results or the outcomes reflect the issues of material management and the discussions explained the meaning of the issues that came out of the various methods.

4.2 Results and Discussion of Questionnaire

This section presents background information or demographic profile of the 20 respondents in the construction profession, such as project managers, foremen, contractors, quantity surveyors who hold various positions in their respective organizations with various academic qualifications and quite a lot of years of experience in managing construction projects.

Characteristics of Respondents

Table 4.1 shows the demographics of respondents used for the study. Below is a detailed analysis of the data presented in the table.

Table 4.1: Demographic characteristics of respondents (Education and Working Experience)

Variables	Frequency	Percentage (%)
Level of education		
CTC I,II,III	8	40.0
HND	5	25.0
BSc	4	20.0
MSc	3	15.0
Total	**20**	**100**
Years of working experience		
Less than 1 year	3	15.0
1 – 5 years	7	35.0
6 – 10 years	6	30.0
More than 10 years	4	20.0
Total	**20**	**100**

Level of Education

From table 4.1, eight (8) respondents representing 40% possessed CTC I, II, or III certificates. Five (5) respondents representing 25% had HND with four (4) respondents representing 20% possessing BSc. The remaining three (3) respondents representing 15% possessed MSc. This implies that the respondents used for the study possessed the required qualification and as such provided the needed data for the studies.

Working Experience

With regard to employees' work experience, seven (7) respondents representing 35% had 1-5 years of working experience; six (6) respondents representing 30% had 6-10 years working experience whereas four (4) respondents representing 20% had more than 10 years of experience. The remaining three (3) respondents representing 15% had less than one year working experience. This indicates that most of the respondents had at least a year experience to actively monitor the causes of material wastage on various construction sites.

Demographic of Respondents on Number of Projects Executed

Figure 4.1 shows the demographics of respondents used for the study. Below is a detailed analysis of the data presented in the pie chart.

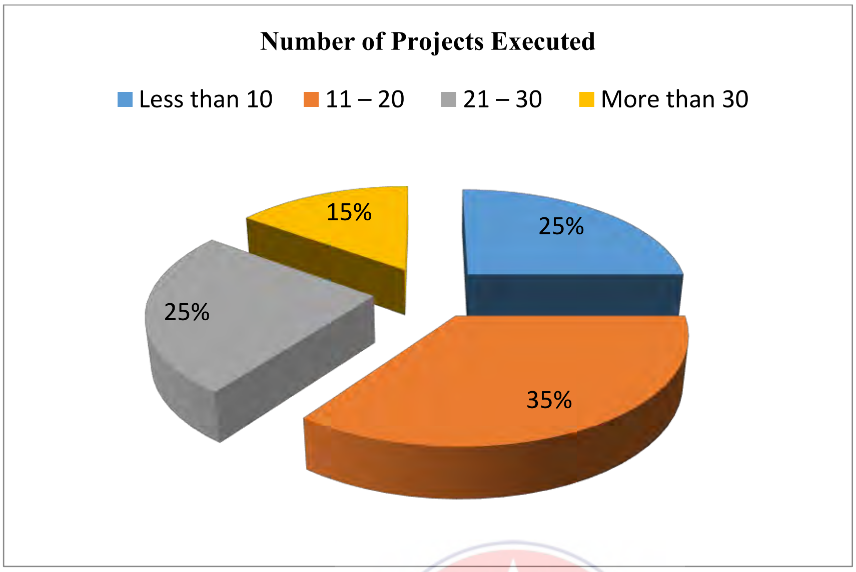

Figure 4.2: Number of Projects executed

Source: Field Survey, 2016

Number of Projects Executed

From Figure 4.1, out of 20 respondents, seven (7) respondents representing 35% had undertaken 11-20 projects; five (5) respondents each representing 25% had undertaken 21-30 projects and less than 10 projects with the remaining three (3) respondents representing 15% undertaking more than 30 projects.

Demographic of respondents on Construction Experts

Figure 4.2 shows the demographics of respondents used for the study. Below is a detailed analysis of the data presented in the pie chart.

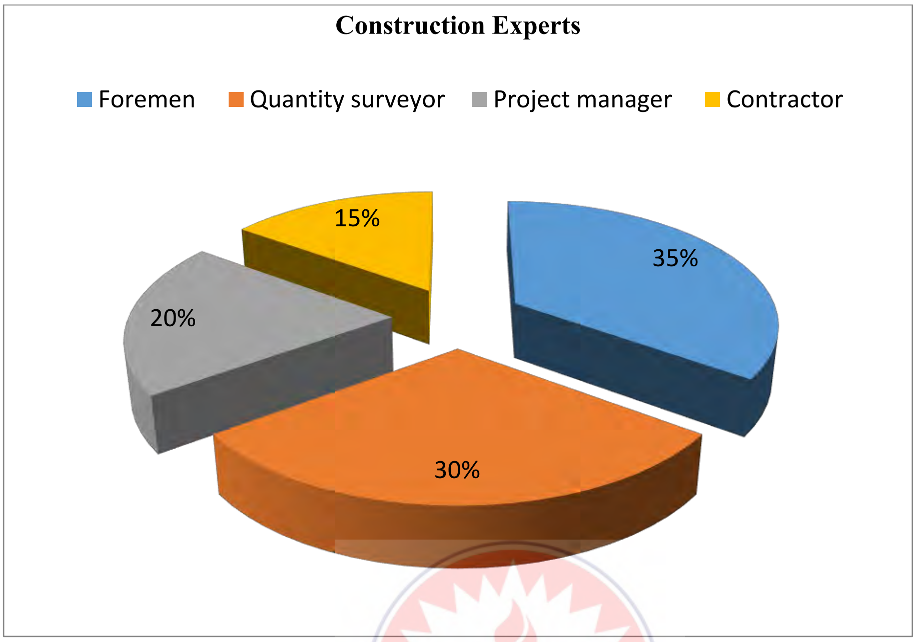

Figure 4.2: Construction Experts
Source: Field Survey, 2016

Construction Experts

Again from Figure 4.2, out of 20 respondents even (7) respondents representing 35% were foremen; six (6) respondents representing 30% were Quantity Surveyors, with four (4) respondents representing 20% being Project Managers. The remaining three (3) respondents representing 13% were contractors. This shows that most of the respondents used for the study were Quantity surveyors.

4.2.1 Results of questionnaire of Quantity Surveyors

Quantity surveyors were among the construction experts selected for this study. Their views on causes of material waste at the construction sites were examined and presented in Table 4.2. The sampled Quantity surveyors were asked in this section to rank the factors contributing to the wastage of resources on construction sites on a Likert scale of 1 to 5 where one (1) =never; two (2) =seldom; three (3) =Sometimes; four (4) =Mostly; and five (5) =always.

Table 4.2: Quantity surveyors' opinion of causes of material wastage on site

Causes	Mean	SD	Rank
Over ordering of materials	4.56	.690	1st
Insufficient ordering of materials	4.42	.378	2nd
Inadequate quantity surveys	4.20	.787	3rd
Ordering materials that do not fulfill project requirements	4.00	.790	4th
In adequate Stock and waste control	3.85	.458	5th
Competence of estimators	3.71	1.254	6th
Possession of unqualified equipment.	3.62	.699	7th

Source: Field Survey, 2016

From Table 4.2, over ordering of materials was ranked 1st with mean of 4.56 and standard deviation of 0.690; insufficient ordering of materials was ranked 2nd with mean of 4.42 and standard deviation 0.378. Inadequate quantity survey was ranked 3rd with mean of 4.20 and standard deviation of 0.787. Ordering materials that do not fulfill project requirements was ranked 4th with mean of 4.00 and standard deviation of 0.790. Moreover, inadequate stock and waste control was ranked 5th by respondents with mean score of 3.85 and standard deviation of 0.458. Respondents however believed the competence of estimators was also a factor when it comes to managing wastage of resources ranking it at 6th with mean of 3.71 and standard deviation of 1.254. The least ranked of the causes was possession of unqualified or required equipment with mean score of 3.62 and standard deviation of 0.699. The responses of the Quantity Surveyors buttress the view of Narimah (2011) who outlined several causes of materials wastage in the construction industry. Such causes in his opinion included incompetent or inadequate estimators or surveyors, demand estimation or ordering of materials that do not fulfil project requirements, stock and waste control, possession of unqualified of required equipment, possession of qualified staff, over ordering of materials as well as insufficient ordering of materials. Muholland and Christian (1999) highlighted factors including material co-ordination as an important factor in material wastage. Through acknowledging the requirement to facilitate effective material co-ordination with the other various tasks and resources on-site, such programme slippages could be mitigated or eliminated as the project progresses (Muholland and Christian, 1999).

4.2.2 Results of Questionnaire from Site Foremen

Site foremen were also among the construction experts considered for the study. The researcher therefore examined them to find out the causes of material waste at construction site (Table 4.3).

Table 4.3: Opinion of Site Foremen on Causes of Material Waste on Site

Causes	Mean	SD	Rank
Workers mistakes	4.76	.816	1
Deficient stockpiling	4.60	.516	2
Mishandling of materials	4.55	.408	3
Conversion waste from cutting uneconomical shape	4.23	.753	4
Overcrowded workplace	3.88	.894	5
Difficulty to transport materials around site	3.75	1.169	6
Transporting material from long distance	3.50	.887	7

SD = standard deviation

Source: Field Survey, 2016

The views of site foremen who are responsible for organizing construction on site were also taken concerning the causes of material waste on site. Table 4.3 gives the representation of responses from the site foremen. Respondents ranked attributed material wastage to the mistakes of workers ranking it 1st with mean score of 4.76 and standard deviation 0.816. Deficient stockpiling was ranked 2nd with mean score of 4.60 and standard deviation of 0.516 with mishandling being ranked 3rd with mean score of 4.55 and standard deviation 0.408. Respondents however believed conversion waste from cutting uneconomical shape also contributes to materials waste and ranked it 4th with mean score of 4.23 and standard deviation 0.753. Overcrowding at the workplace, difficulty in transporting materials around site and transporting materials from long distances were ranked 5th, 6th and 7th respectively. The mean scores were 3.88, 3.75 and 3.50 with standard deviations 0.894, 1.169 and 0.887 respectively.

With respect to the reviewed literature, Thomas et al., (2006) posited that the mismanagement of material storage is a leading factor in spatial congestion and results in reduced levels of productivity on construction project. According to Thomas and Riley (2006), an overcrowded construction site may lead to double handling of materials, again, reducing productivity and increasing damage to materials along with increased health and safety concerns (Huang and Hinze, 2003). As Enshassi et al, (2007) puts it the effect of unsuitable storage locations is also an issue in poor Labour productivity. Moreover, Jang et al., (2003) in their study of material management classified material flow management as the second most critical factor in project management's level of satisfaction in construction logistics. This implies that difficulty in transporting materials around construction site ultimately causes material wastage. This is buttressed by Thomas et al., (2006) who concluded that interruptions to the normal flow of materials will cause serious degradations to performance and labour productivity. The researcher aside these causes of waste management supported by the literature also found out that, workers' mistakes, transport of materials from long distance and conversion of waste from cutting uneconomical shapes were some of the causes of material wastage on construction sites.

4.2.3 Results of Questionnaire from Project Managers

Project managers were very influential in the construction industry. Their involvement in projects building in the construction industry cannot be over emphasized. They were therefore selected for the study. The project managers were quizzed on causes of material wastage at sites. Their response is presented in Table 4.4.

Table 4.4: Perception of project managers on causes of material waste on site

Causes	Mean	SD	Rank
Imperfect planning of construction	4.80	.577	1st
Inexperience personnel	4.60	.500	2nd
Procurement of materials	4.52	.957	3rd
Design changes and revisions	4.50	.887	4th
Error in information about type and size of materials on design documents	4.40	.560	5th
Financial ability	4.25	.773	6th
Duration of the project	4.00	.665	7th
Equipment malfunctioning	3.85	1.250	8th
Type of project	3.75	.978	9th
Possession of qualified subcontractors	3.65	.957	10th
Labour force	3.55	.555	11th

Source: Field Survey, 2016

Table 4.4 indicates the presentation of responses from Project Managers on the causes of materials waste on construction sites. Respondents believed that material waste on construction sites was primarily caused by imperfect planning of construction ranking it first with mean score of 4.80 and standard deviation 0.577. Respondents however attributed high prevalence of material waste to inexperienced personnel on construction sites ranking it 2nd with mean score of 4.60 and standard deviation of 0.500. Procurement of materials was ranked 3rd with mean score of 4.52 and standard deviation 0.957. Moreover, design changes and revisions was ranked 4th with mean of 4.50 and standard deviation 0.887. Error in information about type and size of materials on design documents was ranked 5th with mean score of 4.40 and standard deviation 0.560. Project Managers believed labour force was the least cause of materials waste ranking it 11th with mean score of 3.55 and standard deviation 0.555. Financial ability, duration of project, equipment malfunctioning, type of project and possession of qualified subcontractors were ranked 6th (mean=4.25, SD=0.773), 7th (mean=4.00, SD=0.665), 8th (mean=3.85, SD=1.250), 9th (mean=3.75, SD=0.978) and 10th (Mean=3.65, SD=0.957) respectively. Narimah (2011) outlined financial ability, type of project, duration of project, Procurement or indent for materials, Possession of qualified subcontractors as the major causes of material wastage in his study. This study also drew conclusions on the fact that material wastage could be attributed to the following factors; imperfect planning of construction, inexperience personnel, design changes and revisions, error in information about type and size of materials on design documents, equipment malfunctioning and labour force.

4.3.4 Results of Questionnaire from Contractors

Table 4.5 shows the presentation of Contractors' responses on the causes of materials waste on construction sites.

Table 4.5: Perception of Contractors on causes of material waste on site

Causes	Mean	SD	Rank
Lack of waste management plan	4.87	.865	1st
Lack of adequate storage space	4.67	.772	2nd
Inadequate Quality inspection and control	4.55	.957	3rd
Sourcing of materials and requisition	4.50	1.155	4th
Lack of site materials control	4.32	.670	5th
Stocking and pilfering	4.00	.784	6th
Weather condition	3.95	.357	7th
Batching of materials	3.80	1.130	8th
Demand estimation	3.50	.888	9th
Transportation	3.45	.758	10th

Source: Field Survey, 2016

Contractors believed that the primary cause of material wastage on construction sites was lack of waste management plan with mean score of 4.87 and standard deviation 0.865. Contractors however attributed high prevalence of material wastage to lack of adequate storage space on construction sites ranking it 2nd with mean score of 4.67 and standard deviation of 0.772. Inadequate quality inspection and control was ranked 3rd with mean score of 4.55 and standard deviation 0.957. Moreover, sourcing of materials and requisition was ranked 4th with mean of 4.50 and standard deviation 1.155. Lack of site materials control was ranked 5th with mean score of 4.32 and standard deviation 0.670. Stocking and pilfering as well as weather conditions were ranked 6th and 7th with mean scores of 4.00 and 3.95 and standard deviation 0.784 and 0.357 respectively. Batching of materials, demand estimation, and transportation were ranked 8th (mean=3.80, SD=1.130), 9th (mean=3.50, SD=0.88), and 10th (mean=3.45, SD=0.758) respectively. These findings agree with the findings of Narimah (2011) who found out that the major factors that contribute to material wastage on construction sites are transportation, Storage of materials on site, quality inspection and control and demand estimation. The researcher also uncovered lack of waste management plan, stocking and pilfering, whether conditions and batching of materials as other causes of construction site material wastage.

Measures for effective Material Management

Table 4.6 shows respondents (Project Managers, Quantity Surveyors, Foremen and Contractors) responses on the measures that could be put in place to maintain an effective material management.

Table 4.6: Results of Questionnaire on Measures for effective material management

Measures for effective material management	Mean scoring of respondents PM	QS	FM	CON	Avg mean	Rank
Timely placing of orders for materials	4.83	4.64	4.55	4.00	4.505	2nd
Ensure quality assurance/control processes are in place	4.67	4.83	4.55	4.32	4.593	1st
Logistics for tracking & transportation of materials to site	4.50	3.45	4.01	3.55	3.878	16th
Receiving and inspecting materials on site	4.00	4.33	3.78	4.60	4.178	5th
Storage & issuing of materials to construction location	3.83	4.56	4.00	3.55	3.985	12th
Complete quality records of materials	4.00	3.88	3.85	4.00	3.925	15th
Established material management system to be used	4.50	3.83	3.70	4.55	4.145	8th
Documentation	3.83	4.00	4.65	4.20	4.170	6th
Record receipt of goods upon delivery	4.17	4.05	4.45	4.25	4.230	4th
Monitoring of materials distributed	4.33	4.25	4.50	3.56	4.160	7th
Assigning of material codes	4.00	4.00	4.02	3.80	3.955	13th
Construction activities and schedule of materials	4.50	3.74	4.10	4.00	4.085	9th
Proper materials handling	4.60	3.00	3.90	4.30	3.950	14th
Make the store safe from theft and vandalism	4.50	4.30	3.40	4.10	4.075	10th
Materials return to be submitted weekly	4.33	3.60	4.00	4.32	4.062	11th
Determine the daily allocation of materials on site	4.33	3.50	4.65	4.55	4.257	3rd

PM = project manager, QS = quantity surveyor, FM = foremen, CON = contractors

Source: Field Survey, 2016

Respondents believed that to maintain an effective material management, quality assurance must be put in place with respondents ranking it first with mean score of 4.593. Timely placing of orders for materials was ranked 2nd on the strategies with a mean score of 4.505. Respondents however entreated site managers to determine the daily allocation of materials on site ranking it 3rd with mean score of 4.257. Recording receipt of goods upon delivery, receiving and inspecting materials on site as well as documentation were ranked 4th, 5th and 6th respectively. These measures had mean scores of 4.230, 4.178 and 4.170 respectively. The least ranked of the measures to maintain an efficient waste management was storage and issuing of materials to construction location, assigning of material codes, proper handling of materials handling, completing records of materials and putting in place logistics for tracking & transportation of materials to site. The aforementioned measures were ranked 12th, 13th, 14th, 15th and 16th respectively with mean scores of 3.985, 3.955, 3.950, 3.925 and 3.878 respectively. Narimah (2008) posited that to effectively ensure the management of material wastage on construction sites, reference data should be managed at one place and there should be a centralized storage of all data involved in the inquiry; supplier information, attached documentation and requisition-based data. Narimah (2008) also stressed on the impact of determining allocation of materials on site, materials monitoring as well as storage and issuing materials to construction location.

Benefits of Material Management

The benefits of material management to any construction firm are enormous. Table 4.7 presents an overview of respondents' view on the benefits of material management planning to the construction firm.

Table 4 7: Benefits of material management planning

	Percentage scoring of respondents (%)				
	SA or A	**SD or D**	**M**	**SD**	**Rank**
Improvements in project schedule	60.0	40.0	4.87	.408	1st
Reduce cost of materials	60.0	40.0	4.73	.983	2nd
Purchase saving	75.0	25.0	4.67	.516	3rd
Providing adequate storage of materials on site	55.0	45.0	4.43	.516	4th
The effective design site layout so as to aid in the management of materials on site	50.0	50.0	4.33	.816	5th
Project will be constructed on time or early than expected	74.0	26.0	4.20	.894	6th
Reduction in duplicated orders	80.0	20.0	4.17	.753	7th
The installation of materials hoists on site to aid in the movement of materials	60.0	40.0	4.00	.894	8th
Improvements in labor productivity	84.0	16.0	3.83	.753	9th

Source: Field Survey, 2016

More than half of the respondents (60%) strongly agreed or agreed that material management planning ensures improvement in project schedule with the remaining 40% strongly disagreeing or disagreeing to this assertion. The mean score was 4.87 and standard deviation 0.408. Cost reduction on materials was ranked 2nd with 60% of respondents strongly agreeing or agreeing to this notion on a mean score of 4.73 and standard deviation 0.983. About 3/4th of respondents (75%) strongly agreed or agreed that material management planning ensures purchase saving ranking it 3rd on a mean score of 4.67 and standard deviation 0.516. Provision of adequate storage of materials on site was ranked 4th with just a little over half of respondents (55%) strongly agreeing or agreeing to this notion. The mean score was 4.43 and standard deviation 0.816. Almost all respondents strongly agreed or agreed that material management planning ensures that the project will be constructed on time or earlier than expected (74%), reduction in duplicated orders (80%), installation of materials hoists on site to aid in the movement of materials (60%) and improvement in Labour productivity (84%). The mean scores were 4.20, 4.17, 4.00 and 3.83 respectively with standard deviation 0.894, 0.753, 0.894 and 0.753. Again Narimah (2008) buttresses these findings positing that Smart Plant policies provides the following benefits on the construction site: reduction in costs in engineering, procurement, and construction, compressing of project schedules, improvement in quality of new bids and compresses bid time, improvement in organizational efficiency, enhancement in integration and functionality over in-house legacy systems, timely placing of orders for materials and ensuring quality assurance/control processes.

4.3 Results and Discussion of Interviews

Interview was one of the data collection instruments used in soliciting for data for analysis. Site supervisors, Security Personnel and Storekeepers were the professionals the researcher interviewed.

4.3.1 Results of Interviews from Site Supervisors

From the interview made with site supervisors, most of the construction firms really understand material management processes, control measures like adequate security and storage of materials, good supervision, preparation of schedule for delivery of materials and keeping of records for all transactions are undertaken to measure material management on site. Again construction team meets very often especially when the security report of any unusual situation. Schedule is prepared to conform to that of the project owner so as to complete the work on time. Addition to these, poor handling of materials, poor stock control techniques and inadequate security account for mismanagement of materials (Field Survey, 2016)

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4.3.2 Results of Interviews from Security Personnel

According to the security personnel the construction firms protect their sites by using closed-board hoarding; wodin temporary modern structures and metal containers are used as storage facilities which are checked regularly. However, CCTV cameras are not found on the sites. Again, all materials are marked for easy identification and those which need to be locked up in stores are done. Apart from these any theft or suspicious behavior is reported to site manager immediately. Costs are reduced through the use of security control measures by a reduction of materials which are stolen (Field Survey, 2016).

4.3.3 Results of Interviews from Storekeepers

From the views of storekeepers, the selected construction firms have inventory system for recording materials in-flow and out-flow in record books. The quality of materials is checked and counted; damaged materials or wrong delivery is returned to the supplier. Again the building materials are stored on site either in site, store or outside in case of material shortage, the site manager reports to the suppliers. According to the storekeepers interviewed, they record materials issued, followed up and make sure the rest are retrieved. Workers are also advised on better material management (Field Survey, 2016).

4.4 Results and Discussions of Observation

The data collected through questionnaires was supplemented with the findings of the interviews and observation.

4.4.1 Results of Observation from Consar Limited Construction in (Kumasi)

It was observed at the Consar Construction Firm site at Pakoso that, the bulk purchasing of materials is used in the procurement of the building materials. Records are kept as to the quantity of materials received at a particular point in time. It was realized that most of the materials which were supposed to be kept indoors were left outside in the site due to lack of space giving way for theft on some occasions. CCTV cameras were also not found in the sites to provide extra security to the materials. Again, it was observed that location of the site entrance makes delivery of materials particularly difficult Field Visit, 2016).

Fig. 4.3: Pakoso Community Day Senior High School showing building materials which were kept outside.

Fig. 4.4: Pakoso Community Day Senior High School (Initial stage of construction)

Fig. 4.5: Construction site at Pakoso where construction work was in progress.

4.4.2 Observation at Stivo Company Limited Construction Site at KNUST Campus

It was observed at Stivo Company Ltd Construction Site at KNUST Campus that working schedule was available and workers were sometimes idling due to delay in procurement of building materials. This disturbs the schedule which has been prepared. Adequate security at the site is tight and especially around storage facilities that help to keep materials. However, closed circuit television (CCTV) cameras were not available at the site. It was also observed that some building materials which could be used in construction were ignored. This leads to wastage of materials on the site (Field Visit, 2016).

Fig. 4.6: Construction Site at KNUST Campus where these building materials were packed for future use.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Introduction

This chapter presents the summary of findings of the study, conclusion (achievement of objectives) and recommendations.

5.2 Summary of Findings

The following are the summary of findings:

- The study revealed that error in information about type and size of materials on design document has led to excessive ordering of materials, and hence wastage.
- The study discovered that, most of the building construction firms in the Kumasi Metropolis are large sized firms; however they do not have all the necessary experts and equipment to implement effective measures for material management on sites.
- Among the challenges involved in materials management on building construction site in Kumasi metropolis are:
    - poor handling of materials inadequate security structures,
    - lack of storage spacing,
    - delivery of wrong quantity of materials,
    - poor stock control techniques,
    - improve planning of work
    - Absence of closed circuit television cameras improper planning of work.
- The study further showed that, most of the construction companies do not make use of techniques like proper work schedule free-flow of information

from the managerial level to the workers, proper storage of materials on site leading to poor management of materials on site.

- The study also revealed that, the workers' mistakes about wrong use of materials and overcrowded workplace has caused to wastage of materials on site.
- The study however revealed that lack of proper logistics for tracking and transporting materials to site on right time has caused mishandling and waste of materials.

5.3 Conclusion

The concept of material wastage even though was addressed in this study needs to be given regular attention by construction firms as it plays an important role in the delivery of construction projects in the country. With results obtained from the descriptive analysis of the data that was gathered, the researcher arrived at the conclusion that over ordering of materials, worker's mistakes, imperfect planning of construction and lack of waste management plan were the major causes of material wastage on construction sites. That notwithstanding, quality assurance/control processes should be put in place to ensure effective waste management as it improves the schedule of project delivery.

5.4 Recommendations of the Study

To address the findings, the following recommendations are made:

- There should be free flow of information from the managerial level to every department of the construction firm in order to make decisions implemented at the right time, at the right place to prevent over or insufficient ordering of materials.

- Construction firms should try as much as they can either to employ or hire necessary effective experts or equipment that will help to curb the wastage of materials during construction of projects.
- To overcome materials management challenges on construction sites, material managers should work to do the following;
  - Plan and monitor material schedule on all projects.
  - Make it compulsory for the store keepers to record and use inventory of material on daily basis during the construction process, to enable them alert or inform the necessary authority if there is shortage of any material, for prompt ordering.
  - As much as possible material managers should make adequate pre-construction survey on materials before commencement of any construction project.
  - Closed circuit television (CCTV) cameras should be installed to increase the securities on site, especially the stores to reduce theft.
  - Material managers or experts should advise the project managers to raise proper structure with adequate storage space to keep materials on safe places.
- Planning and scheduling in construction should be prepared and followed strictly with all assumptions on the projects, which must be carried out at the planning stage in order to improve material management on site.
- The recommendations pointed out that, the formation of strategies for effective material management; in-service training and good supervision should assist the workers to reduce mistakes on the project site.

- Logistics for tracking and transporting materials to site should be provided; planning of access and routing of material within construction site.

5.5 Suggestions for Further Studies

It is the hope of the researcher that this research will be conducted on a large sample with an extended period of time to enable construction firms accrue the benefits of putting place effective waste management procedures.

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APPENDIX A

QUESTIONNAIRE FOR CONTRUCTORS ON BUILDING CONSTRUCTION SITES

Dear respondent;

I am carrying out a study on "*An assessment of Material Management on building construction sites (some selected construction firms in Kumasi metropolis)*". Please note that this study is not an investigation into any activities of your project as an entity. The study is purely academic and any responses obtained will be treated with confidentiality and anonymity. Kindly respond truthfully. Thank you in advance for your time.

SECTION A: CONTRUCTORS GENERAL INFORMATION

Please, thick your respond in the box

1. Name of the organization (optional)

    ____

2. Number of Employees

0 – 9 employees [ ] 10 – 99 employees [ ] 100 – 299 employees [ ]

3. Respondent Highest Level of Education.

MSc [ ] BSc [ ] HND [ ] (CTC I, II, and III) [ ]

Others …………………………..

4. Years of experience.

Less than 1 year [ ] 1- 5years [ ] 6-10 years [ ] More than 10 years [ ]

5 Number of projects executed in the last five years.

Less than 10 [ ] 11 – 20 [ ] 21- 30 [ ] More than 30 [ ]

SECTION B: MATERIALS MANAGEMENT ISSUES IN CONSTRUCTION SITES

6. Rank the following stages of materials logistic planning, one (1) = **Never**; two (2) =**Seldom**; three (3) =**Sometimes**; four (4) = **Mostly**; and five (5) = **Always**.

S/N	Stages	Responses				
		5	4	3	2	1
1	Identified responsible persons and their roles					
2	Implement a training and communication plan					
3	Determine material types and quantities from the detailed design					
4	Plan for material receipt and storage					
5	Implement procedures to manage sub-contractors					
6	Site mobilization and construction					
7	Project completion and demobilization					

SECTION C: FACTORS THAT LEAD TO MISMANAGEMENT OF MATERIALS ON BUILDING CONSTRUCTION SITES.

7. Please rank the following factors in order of their relevance as factors affecting materials

Management. Where one (1) = **Very Low Effective**; two (2) = **Low Effective**; three (3) =**Medium Effective**; four (4) = **High Effective**; and five (5) = **Very high Effective**.

S/N	Factors	Responses				
		5	4	3	2	1
1	Sourcing of materials and requisition					
2	Demand estimation					
3	Transportation					
4	Receiving and verification of materials on site					
5	Storage of materials on site					
6	Issuing of materials for use					
7	Quality inspection and control					
8	Materials Handling					
9	Types of materials					
10	other					

SECTION D: CAUSES OF MATERIAL WASTAGE ON SITE

9. Please rank the following factors in order of their relevance as causes of materials wastage on site.5- Strongly Agree, 4-Agree, 3-Partially Agree, 2-Disagree, 1-Strongly disagree.

S/N	Causes of material wastage on site	Responses				
		5	4	3	2	1
1	Weather condition					
2	Batching of materials					
3	Placing of materials					
4	Stocking and pilfering					
5	Handling of materials					
6	Lack of site materials control					
7	Lack of waste management plan					
8	Lack of adequate storage space					
10	Lack of adequate room for account for materials and materials becoming‘buried’ on site					
11	Increased security risks due to the lack of adequate space to safely facilitate thestorage of materials					
12	other					

SECTION E: MEASURES FOR EFFECTIVE MATERIAL MANAGEMENT ON BUILDING CONSTRUCTION SITES

Rank the following factors as important measures to be put in place to ensure effective materials management in construction sites.5 = **Very important, 4 = important, 3 = moderately important, 2 = slightly important, 1 = not important.**

S/N	Measures for effective Materials management	Responses				
		5	4	3	2	1
1	Timely placing of orders for materials					
2	Ensure quality assurance/control processes are in place					
3	Logistics for tracking & transportation of materials to site					
4	Receiving and inspecting materials on site					
5	Storage & issuing of materials to construction location					
6	Complete quality records of materials					
7	Established material management system to be used					
8	Documentation					
9	Record receipt of goods upon delivery					
10	Monitoring of materials distributed					
11	Assigning of material codes					
12	Construction activities and schedule of materials					
13	Proper materials handling					
14	Make the store safe from theft and vandalism					
15	Materials return to be submitted weekly					
16	Determine the daily allocation of materials on site					

SECTION F: IMPORTANCE AND BENEFIT OF MATERIAL MANAGEMENT PLANNING

Rank the following factors in order of their relevance as importance and benefits of material management planning.5- Strongly Agree, 4-Agree, 3-Partially Agree, 2-Disagree, 1-Strongly disagree

S/N	Importance and Benefit of material management planning	Responses				
		5	4	3	2	1
1	Reduce cost of materials					
2	Improvements in labor productivity					
3	Project will be constructed on time or early than expected					
4	Purchase saving					
5	Providing adequate storage of materials on site					
6	Reduction in duplicated orders					
7	Improvements in project schedule					
8	The effective design site layout so as to aid in the management of materials onsite					
9	The installation of materials hoists on site to aid in the movement of materials					

APPENDIX B

QUESTIONNAIRE FOR FOREMAN ON BUILDING CONSTRUCTION SITES

Dear respondent;

I am carrying out a study on "*An assessment of Material Management on building construction sites (some selected construction firms in Kumasi metropolis)*". Please note that this study is not an investigation into any activities of your project as an entity. The study is purely academic and any responses obtained will be treated with confidentiality.

Kindly respond truthfully. Thank you in advance for your time.

SECTION A: FOREMAN'S GENERAL INFORMATION

Please thick in box provided.

1. Name of the organization (optional) ________________________________

2. Number of Employees

0 – 9 employees [ ] 10 – 99 employees [ ] 100 – 299 employees [ ]

3. Respondent Highest Level of Education.

MSc [ ] BSc [ ] HND [ ] (CTC I, II, and III) [ ]

Others ……………………

4. Years of experience.

Less than 1 year [ ] 1- 5years [ ] 6-10 years [ ] More than 10 years [ ]

5 Number of projects executed in the last five years.

Less than 10 [ ] 11 – 20 [ ] 21- 30 [ ] More than 30 [ ]

SECTION B: MATERIALS MANAGEMENT ISSUES IN CONSTRUCTION SITES

6. Rank the following components of materials management where 5 = **Very important, 4 = important, 3 = moderately important, 2 = slightly important, 1 = not important.**

S/N	Components of Materials Management	Responses				
		5	4	3	2	1
1	Inventory control, storage and warehousing					
2	Material handling and transport					
3	Waste management					
4	Others					

SECTION C: FACTORS THAT LEAD TO MISMANAGEMENT OF MATERIALS ON BUILDING CONSTRUCTION SITES.

7. Please rank the following factors in order of their relevance as factors affecting materials
management. Where 5-Strongly Agree, 4-Agree, 3- partially Agree, 2-Disagree and 1-Strongly Disagree

S/N	Factors	Responses				
		5	4	3	2	1
1	Maintenance					
2	Time					
3	Availability of equipment					
4	other					

SECTION D: CAUSES OF MATERIAL WASTAGE ON SITE

9. Please rank the following factors in order of their relevance as causes of materials wastage on site. 5- extremely high, 4-very high, 3-high 2-low, 1-very low.

S/N	Causes of material wastage on site	Responses				
		5	4	3	2	1
1	Distance					
2	Damage of materials due to deficient stockpiling and handling of materials					
3	Workers mistakes					
4	Conversion waste from cutting uneconomical shape					
5	Difficult to transport materials around site					
6	Workplace becoming overcrowded					
7	Others					

SECTION E: MEASURES FOR EFFECTIVE MATERIAL MANAGEMENT ON BUILDING CONSTRUCTION SITES

Rank the following factors as important measures to be put in place to ensure effective materials management in construction sites

5 = **Very important, 4 = important, 3 = moderately important, 2 = slightly important, 1 = not important.**

S/N	Measures for effective Materials management	Responses				
		5	4	3	2	1
1	Timely placing of orders for materials					
2	Ensure quality assurance/control processes are in place					
3	Logistics for tracking & transportation of materials to site					
4	Receiving and inspecting materials on site					
5	Storage & issuing of materials to construction location					

6	Complete quality records of materials					
7	Established material management system to be used					
8	Documentation					
9	Record receipt of goods upon delivery					
10	Monitoring of materials distributed					
11	Assigning of material codes					
12	Construction activities and schedule of materials					
13	Proper materials handling					
14	Make the store safe from theft and vandalism					
15	Materials return to be submitted weekly					
16	Determine the daily allocation of materials on site					

SECTION F: IMPORTANCE AND BENEFIT OF MATERIAL MANAGEMENT PLANNING

Rank the following factors in order of their relevance as importance and benefits of material
management planning. 5- Strongly Agree, 4-Agree, 3-Partially Agree, 2-Disagree, 1-Strongly disagree

S/N	Importance and Benefit of material management planning	Responses				
		5	4	3	2	1
1	Reduce cost of materials					
2	Improvements in labor productivity					
3	Project will be constructed on time or early than expected					
4	Purchase saving					
5	Providing adequate storage of materials on site					
6	Reduction in duplicated orders					
7	Improvements in project schedule					
8	The effective design site layout so as to aid in the management of materials on site					
9	The installation of materials hoists on site to aid in the movement of materials					

APPENDIX C

QUESTIONNAIRE FOR PROJECT MANAGERS ON BUILDING CONSTRUCTION SITES

Dear respondent;

I am carrying out a study on "*An assessment of Material Management on building construction sites (some selected construction firms in Kumasi metropolis)*". Please note that this study is not an investigation into any activities of your project as an entity. The study is purely academic and any responses obtained will be treated with confidentiality.

Kindly respond truthfully. Thank you in advance for your time.

SECTION A: PROJECT MANAGERS GENERAL INFORMATION

Please thick in box provided.

1. Name of the organization (optional) ___________________________________

2. Number of Employees

0 – 9 employees [ ] 10 – 99 employees [ ] 100 – 299 employees [ ]

3. Respondent Highest Level of Education.

MSc [ ] BSc [ ] HND [ ] (CTC I, II, and III) [ ]

Others ……………………………

4. Years of experience.

Less than 1 year [ ] 1- 5years [ ] 6-10 years [ ] More than 10 years [ ]

5 Number of projects executed in the last five years.

Less than 10 [ ] 11 – 20 [ ] 21- 30 [ ] More than 30 [ ]

SECTION B: MATERIALS MANAGEMENT ISSUES IN CONSTRUCTION SITES

1. Who is the person in charge of managing construction materials in construction projects?

General Manager [ ] Project Manager [ ] Site Engineer [ ] Store manager [ ] others _____________

2. Who is the person responsible for ordering materials?

[ ] General Manager [ ] site engineer [ ] procurement department [ ] project manager [ ] others _____

3. Which method do you apply in the purchase of material?

Bulk purchase [ ] in pieces [ ] others _________________

4. In making bulk purchases do you take into consideration the nature/type of material?

Yes [ ] No [ ]

5. When does your materials planner start planning for projects?

Before tender [ ] after award of contract [ ] during construction process [ ]

6. Rank the following components of materials management where 5 = **Very important, 4 = important, 3 = moderately important, 2 = slightly important, 1 = not important.**

S/N	Components of Materials Management	Responses				
		5	4	3	2	1
1	Material estimation, budgeting, planning and programming					
2	Scheduling, purchasing and procurement					
7	Others					

7. Rank the following stages of materials logistic planning, where 5 = **Very important, 4 = important, 3 = moderately important, 2 = slightly important, 1 = not important.**

S/N	Stages	Responses				
		5	4	3	2	1
1	Material estimation, budgeting, planning and programming					
2	Scheduling, purchasing and procurement					
7	Others					

SECTION C: FACTORS THAT LEAD TO MISMANAGEMENT OF MATERIALS ON BUILDING CONSTRUCTION SITES.

8. Please rank the following factors in order of their relevance as factors affecting materials

Management. Where 5-Strongly Agree, 4-Agree, 3- partially Agree, 2-Disagree and 1-Strongly Disagree

S/N	Factors	Responses				
		5	4	3	2	1
1	Procurement of materials					
2	Financial ability					
3	Possession of qualified staff					
4	Possession of qualified subcontractors					
5	Duration of the project					
6	Type of project					
7	Level of awareness					
8	other					

SECTION D: CAUSES OF MATERIAL WASTAGE ON SITE

9. Please rank the following factors in order of their relevance as causes of materials wastage on site.5- extremely high, 4-very high, 3-high 2-low, 1-very low

S/N	Causes of material wastage on site	Responses				
		5	4	3	2	1
1	Labour force					
2	Inexperience personnel					
3	Equipment malfunctioning					
4	Lack of information about type and size of materials on design documents					
5	Error in information about type and size of materials on design documents					
6	Design changes and revisions					
7	Imperfect planning of construction					
8	Others					

SECTION E: MEASURES FOR EFFECTIVE MATERIAL MANAGEMENT ON BUILDING CONSTRUCTION SITES

Rank the following factors as important measures to be put in place to ensure effective materials management in construction sites
5 = **Very important, 4 = important, 3 = moderately important, 2 = slightly important, 1 = not important.**

S/N	Measures for effective Materials management	Responses				
		5	4	3	2	1
1	Timely placing of orders for materials					
2	Ensure quality assurance/control processes are in place					
3	Logistics for tracking & transportation of materials to site					
4	Receiving and inspecting materials on site					
5	Storage & issuing of materials to construction location					
6	Complete quality records of materials					
7	Established material management system to be used					
8	Documentation					
9	Record receipt of goods upon delivery					
10	Monitoring of materials distributed					
11	Assigning of material codes					
12	Construction activities and schedule of materials					
13	Proper materials handling					
14	Make the store safe from theft and vandalism					
15	Materials return to be submitted weekly					
16	Determine the daily allocation of materials on site					

SECTION F: IMPORTANCE AND BENEFIT OF MATERIAL MANAGEMENT PLANNING

Rank the following factors in order of their relevance as importance and benefits of material
management planning.5- Strongly Agree, 4-Agree, 3-Partially Agree, 2-Disagree, 1-Strongly disagree

S/N	Importance and Benefit of material management planning	Responses				
		5	4	3	2	1
1	Reduce cost of materials					
2	Improvements in labor productivity					
3	Project will be constructed on time or early than expected					
4	Purchase saving					
5	Providing adequate storage of materials on site					
6	Reduction in duplicated orders					
7	Improvements in project schedule					
8	The effective design site layout so as to aid in the management of materials onsite					
9	The installation of materials hoists on site to aid in the movement of materials					
10	Better relations with suppliers					
11	Better handling of materials					
12	Better field material control					
13	Quality control					
14	Reduce of materials surplus					
15	Better cash flow management					
16	other					

APPENDIX D

QUESTIONNAIRE FOR QUANTITY SURVEYORS ON BUILDING CONSTRUCTION SITES

Dear respondent;

I am carrying out a study on "*An assessment of Material Management on building construction sites (some selected construction firms in Kumasi metropolis)*". Please note that this study is not an investigation into any activities of your project as an entity. The study is purely academic and any responses obtained will be treated with confidentiality and anonymity. Kindly respond truthfully. Thank you in advance for your time.

SECTION A: QUANTITY SURVEYORS GENERAL INFORMATION
Please, thick your respond in the box

1. Name of the organization (optional) ________________________________
2. Number of Employees
0 – 9 employees [ ] 10 – 99 employees [ ] 100 – 299 employees [ ]
3. Respondent Highest Level of Education.
MSc [ ] BSc [ ] HND [ ] (CTC I, II, and III) [ ]
Others ……………………………
4. Years of experience.
Less than 1 year [ ] 1- 5years [ ] 6-10 years [ ] More than 10 years [ ]
5 Number of projects executed in the last five years.
Less than 10 [ ] 11 – 20 [ ] 21- 30 [ ] More than 30 [ ]

SECTION B: MATERIALS MANAGEMENT ISSUES IN CONSTRUCTION SITES

1. Does your firm undertake market survey before ordering for materials?
Yes [ ] No [ ]
2. If Yes, how often?
Weekly [ ] monthly [ ] after every 3 months [ ] after every 6 months [ ] over 6 months [ ]
3. How do you assess materials?
Testing [ ] Selection [ ] Measurement [ ] others ____________________
4. Who is responsible for monitoring handling of materials on sites?
Site engineer [ ] project manager [ ] store manager [ ] others
____
5. Do you consider stock and waste control for effective material management on sites?
Yes [ ] No [ ]

SECTION C: FACTORS THAT LEAD TO MISMANAGEMENT OF MATERIALS ON BUILDING CONSTRUCTION SITES.

6. Please rank the following factors in order of their relevance as factors affecting materials
management. Where one (1) = **Very Low Effective**; two (2) = **Low Effective**; three (3) =**Medium Effective**; four (4) = **High Effective**; and five (5) = **Very high Effective**.

S/N	Factors	Responses				
		5	4	3	2	1
1	Stock and waste control					
2	Possession of qualified of required equipment					
3	Competence of estimators					
4	Competence of estimators					
5	other					

SECTION D: CAUSES OF MATERIAL WASTAGE ON SITE

9. Please rank the following factors in order of their relevance as causes of materials wastage on site. 5one (1) = **Never**; two (2) =**Seldom**; three (3) =**Sometimes**; four (4) = **Mostly**; and five (5) = **Always**.

S/N	Causes of material wastage on site	Responses				
		5	4	3	2	1
1	Ordering of materials that do not fulfil project requirements defined on designdocuments					
2	Over – ordering or under – ordering due to mistakes in quantity surveys					
3	Others					

SECTION E: MEASURES FOR EFFECTIVE MATERIAL MANAGEMENT ON BUILDING CONSTRUCTION SITES

Rank the following factors as important measures to be put in place to ensure effective materials management in construction sites

5 = **Very important, 4 = important, 3 = moderately important, 2 = slightly important, 1 = not important.**

S/N	Measures for effective Materials management	Responses				
		5	4	3	2	1
1	Timely placing of orders for materials					
2	Ensure quality assurance/control processes are in place					
3	Logistics for tracking & transportation of materials to site					
4	Receiving and inspecting materials on site					
5	Storage & issuing of materials to construction location					
6	Complete quality records of materials					

7	Established material management system to be used					
8	Documentation					
9	Record receipt of goods upon delivery					
10	Monitoring of materials distributed					
11	Assigning of material codes					
12	Construction activities and schedule of materials					
13	Proper materials handling					
14	Make the store safe from theft and vandalism					
15	Materials return to be submitted weekly					
16	Determine the daily allocation of materials on site					

SECTION F: IMPORTANCE AND BENEFIT OF MATERIAL MANAGEMENT PLANNING

Rank the following factors in order of their relevance as importance and benefits of material management planning. 5- Strongly Agree, 4-Agree, 3-Partially Agree, 2-Disagree, 1-Strongly disagree

S/N	Importance and Benefit of material management planning	Responses				
		5	4	3	2	1
1	Reduce cost of materials					
2	Improvements in labor productivity					
3	Project will be constructed on time or early than expected					
4	Purchase saving					
5	Providing adequate storage of materials on site					
6	Reduction in duplicated orders					
7	Improvements in project schedule					
8	The effective design site layout so as to aid in the management of materials on site					
9	The installation of materials hoists on site to aid in the movement of materials					