KWAME NKRUMAH UNIVERSITY OF SCIENCE AND

TECHNOLOGY, KUMASI, GHANA

Assessment of Material Management on Construction Project Sites: A case study of a Proposed Warehouse, Productions Halls and Offices Complex.

by

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A Thesis submitted to the Department of Construction Technology and Management,

College of Art and Built Environment

in partial fulfilment of the requirements for the degree of

MASTER OF SCIENCE

SEPTEMBER, 2018

DECLARATION

I hereby declare that this submission is my own work towards the MSc Project Management and that, to the best of my knowledge, it contains no material previously published by another person, nor material which has been accepted for the award of any other degree of the University, except where due acknowledgement has been made in the text.

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ABSTRACT

Construction projects involves so many activities and processes which involves material resource management. Material resource management is a stage of the project process where decisions are made on what, when, where and how to acquire the necessary material resources needed for the project. The process runs through acquisition to waste control. However, this is also the stage where most players do not accord so much importance. The aim of this study was to assess material management on construction project sites. A questionnaire survey administered to a purposive sample of 12 persons who handles materials for their various companies finding out about the management process they use, and obtaining their perception on the causes of ineffective material management toward 34 causes that were extracted from extensive literature review. Finally, the impact of material management activities on project performance was also acquired through this questionnaire. The study found 5 different material management processes that were followed. The top 3 most common causes of ineffective material management identified were not determining what and when materials needed, poor communication leading to mistakes and errors, and undefined scope. The findings also indicated that most material management activities had an impact of time. This research show that a lot attention needs to be given to the planning and scheduling of material management with proper communication systems put in place during that period.

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ACKNOWLEDGEMENT

My first gratitude goes to the Almighty God for not only the opportunity, but also the guidance and wisdom to go through this programme.

I am grateful to my supervisor Mr. James Cofie Danku. I also owe a great deal of appreciation Mr. Stephen Akunyumu for their precious contribution and guidance.

I am most grateful to my parents, Mr. and Mrs. Nortey and my entire family who have gone a very long way to support me in diverse way.

DEDICATION

To God Almighty and my parents, Mr. and Mrs. Nortey

CHAPTER ONE

INTRODUCTION TO THE STUDY

1.1 Background of Study

Materials resources management has been defined in so many ways and forms by different scholars and researchers. Simply material management can be described as the process by which an organization gets its provision of the goods and services that it needs to achieve its objectives. Material management is essentially focused on the planning, identification, procurement, storing, receiving, and distribution of materials (Gulghane & Khandve, 2015). One of the key bases of managing materials is to ensure that, correct materials are where they are supposed to be, in their right measures and the right time when needed and most importantly acquired at the right price. Material resource management which is classified under physical resources by the Project Management Body of Knowledge (PMBOK) is one of the important resources in construction next to human resource management. According to Bell & Sturkhart 1987 (as cited in Jerutokeitany et al, 2014) effective management of materials can lead to a reduction in cost, resulting in significant savings. A potential 6% saving on total cost through effective material management is achievable (Jerutokeitany et al., 2014). Material resource management is not only associated with construction; it is mutual to all kinds of organizations. It is essential because organizations cannot function or carry on without it (Tezera, 2017). Some studies have shown, managing material resource has a direct relation with the success of organizations. An example is a study Keitany undertook, it showed that material management is a tool, which to enhance performance

in achieving customer service requirement while increasing profitability by reducing cost and utilising resources available to the maximum (Tezera, 2017).

The construction industry is very vast and is bifurcated into many areas such as building, bridges, roads and highways, railways, tunnels, dams and bandharas, etc (Patil, 2016). Every project is unique and every decision related to control on expenses is unique too. Proper and organized material resource management process is therefore vital to the success of construction projects. There has been evolutions and changes with respect to the growing complications and twists in construction projects but materials still make up a major cost component for the construction industry. This makes construction materials influential in construction projects. More than 60% of the total cost incurred in construction projects is the cost of materials (Raja et al, 2017). With such large investments it requires considerable planning and control so to minimize wastage which invariably affects the performance of the organization (Gulghane & Khandve, 2015). There is a high level of uncertainty of materials management due its dependence over various other factors and it being interconnected to other processes and stages in construction projects. Lack of clear responsibilities linking parties and the makeup of construction projects being a fragmented basis with unstructured communication intensifies the challenge of executing effective management of material (Ahmed, 2017). Donyavi and Flanagan (2009) observed that, delivery at the wrong time which interrupts the work schedule, double handling of materials because of inadequate materials, failure to order on time which delays the projects, wrong materials or error in direction of materials requiring re-work, stealing of materials from delivery into production and over ordering are some of the familiar problems linked with material management on

construction site (Arijeloye & Akinradewo, 2016). Some of these then brings up the concern of material waste which can be considered as a serious issue in construction.

1.2 Statement of Problem

Majority of construction workers and some site supervisors have a couldn't-care-less-attitude towards materials on the construction site. Most believe that "where you work is where you eat" meaning benefits from your work place should not only be your salary but making use of materials for personal gain when you need it and this leads to stealing. Others also have the pre-notion that wasting materials in the delivery of construction works is normal, believing that the companies have money and when it is finished stores will be restocked and supply will be made available as soon as possible. These attitudes of managers, supervisors and workers in the delivery of construction works have led projects not to attain value for money. As already known there is a substantial reduction in the whole quantum of the cost of materials and hence profitability because efficient and effective materials functions add up to the improvement of performance.

Due to lack of adequate storage space on site, about 90% of all materials of the main contractor and all subcontractors have been stored at other location. This makes storage, distributions and safety of certain materials an issue of concern. The most likely issues to affect material management is delay, theft and wastage, hence this research aims to assess how materials are being managed on projects sites despite the conditions on site.

1.3 Aim of Study

This study aims to assess material management on construction project sites.

1.4 Project Under Study

The project which is the focus of this study is the F 4000 project located at North Industrial Area, Accra commissioned by Promasidor Ghana Limited. It contains a warehouse, production halls and offices. The project is being led by Fuler Architects Limited in association with CAAD & CAD consult, Unique Josap Engineering and Yopak consult Limited.

1.5 Project Objectives

The specific objectives of the study are:

1. To identify material management process used on construction project sites.
2. To identify causes of ineffectiveness in materials management on construction sites.
3. To assess the impact material management activities has on project performance.

1.6 Research Questions

1. What material management processes are being used and why?
2. Are there any motivating factors determining the process or processes being used?
3. What are the causes of ineffective material management on construction projects sites?

1.7 Significance of Study

The outcome of this research work will first help understand how Ghanaian construction players understand what material management is. Furthermore, aspects of material management practices in construction have been identified and recorded before. This research work intends to focus more on what mainly transpires on the project sites in relation material management as to what goes on off site, it will seek to identify behaviourally features of site participants on construction materials usage and handling from delivery all the way to waste management.

The outcome of this study is expected to aid the change in behaviour among construction participants on site. This can in the future help improve the overall management of materials on construction project sites which in turn can go on to impact on the total cost materials purchased for a project.

1.8 Scope of the work

The study is centred on the construction industry in Ghana. It however focuses on the case of a Proposed Warehouse, Productions Halls and Offices Complex. The Special attention is on what transpires on the site.

1.9 Organization of Study

The approach to do this work was a thorough literature search and study, field survey through the administration of a questionnaire and analyses of the results.

This research work is made up of five chapters, the details are in brief as follows:

Chapter 1

This chapter contains the general introduction of the research. It briefly discusses what material management is and also what material management means in the construction industry. It explains the purpose of the study, its objectives, the significance of the work and the scope of study.

Chapter 2

Gives a review of the various literature used for this study. Material management and the processes under it, is discussed in detail. Also causes of ineffective management of materials is also reviewed in this chapter.

Chapter 3

This chapter deals with the approach used to conduct this research to enable achieve the set objectives. It looks at the research design, determination of sample size, data collection and the techniques adopted for data collection. Also discusses questionnaire development and how the questionnaires were administered.

Chapter 4

Data presentation and analysis of the study. This looks into the causes of ineffective material management from the data collected and the impact it is having on the project

Chapter 5

Presents the findings of the data analysed. Discusses the conclusion of the research and the limitations of the study

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The Oxford living dictionary defines materials as “the matter from which a thing is or can be made” or “things needed for an activity”. Materials as defined by Robert Ballot are the physical things that are acquired for the creation of the end product and its doesn’t imply that materials are the end product. This simply means materials should be considered as the items or things used to create or complete the final product. Manteau (2007) explains that materials can be identified as the items that a product is obtained from and these include natural resources, equipment items, parts and also supplies.

Materials Management thus can be defined as that function of business that is responsible for the Coordination of planning, sourcing, purchasing, moving, storing and controlling materials in an optimum manner so as to provide service to the customer, at a pre-decided level at a minimum cost (“Principles of material management,” n.d.). Materials management is an important function in order to improve productivity in construction projects. It is vital that all materials from design to the construction stage of a project are managed well, as improper management greatly affects the entire performance of the project in terms of cost, quality, time and overall productivity of the project (Arijeloye & Akinradewo, 2016). According to Walker (2015) as cited in Ahmed (2017) unlike the former days the construction industry today has evolved and become multifaceted due to advancements in technology, unpredictable economic conditions, globalization and so on. This has had an impact of the various management process used through the various faces of construction. An example as cited by Jerutokeitany et al.,

(2014) is that in the earlier years, materials management was treated as a cost centre, since purchasing departments were spending money on materials while store was holding huge inventory of materials blocking money and space. The normal old methods are no longer capable of satisfying the demands of today's environment.

2.2 Management of Materials in Construction Projects

An important factor greatly affecting the performance of projects on construction sites is the improper management of materials during site activities. Material is the number one component in any construction related project. It is therefore key that management of materials in construction related projects are done appropriately else it would bring about a major variance in cost (Gulghane & Khandve, 2015). Construction materials being identified to be an integral portion in the construction project's cost, should be achieved at a rational cost and be available for use when desired. An analysis of project cost for certain civil engineering projects indicated that materials and plant components can be up to 70 % of the project cost, but this was dependent upon the type of project. Whilst housing projects and that of commercial buildings show a material cost of 45 % - 50 % of the project cost (Donyavi & Flanagan, 2009). Due to the levels of growth in projects and its complexities, it becomes more difficult to manage materials, often requiring the use of appropriate tools and processes to certify amongst other things that materials are delivered on time, stock levels are well managed, construction schedule is not compromised and that wastage is brought to the barest minimum (Kasim, 2008a). Chandler (2001) indicated that construction materials can be classified into different

categories depending on their fabrication and in the way that they can be handled on site. This classification was into five categories and they are explained as follows:

- Bulk material: All materials which are ordered and are supplied in relation to its weight and are also deposited in containers.
- Bagged materials: All materials supplied in containers of material flexible in nature, such as paper, plastic, or leather, that is used for carrying or storing items for easy handling and controlling.
- Palleted material: These are packaged materials that are put in pallets for supply or delivery.
- Packaged material: These are materials that are put into a box or special wrapping to avert damage during transportation and deterioration when they are stored.
- Loose materials: Materials that can be moved, carried, combined, redesigned, lined up, or partially fabricated and that need to be handled individually (Arijeloye & Akinradewo, 2016)

Table 2.1 Classification of Materials

Materials	Bulk	Bulk	Palleted	Packaged	Loose
Paving Slabs	/				
Cement	/				
Tiles	/				
Pipes					/
Structural Timber					/
Gravel	/	/	/		
Concrete	/				
Doors				/	/
Electrical Fittings				/	
Sand			/		
Top Soil				/	

Source: (Adopted from Chandler, 2001)

Stukhart informs that the main categories of materials encountered during construction projects are engineered materials, bulk materials and fabricated materials.

- Engineered materials- these materials are specifically fabricated for a 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.
- 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

2.3 Importance and Benefits of Materials Management on Project Sites

The successful management of materials both before and when delivered to site is fundamental to the success of any development. The instances where this is made difficult it can have a negative impact on the progress of work (Spillane et al, 2010). Problems associated with the movement of materials can be identified in every m organization. This makes the control of materials a very central and significant issue for an organization. The unavailability of materials can halt production of activities until the needed materials are made available. An excess quantity of materials can also be a serious problem to managers. Storing of excess materials can cause a rise in the cost of production and also the entire cost of project. When places for storage are inadequate, site managers have to find other options and may need re-handling of materials which can affect schedule and can increase the cost related to them (Manteau, 2007). Previous studies by the Construction Industry Institute (CII) concluded that 4-6 % of added saving can be produced if labour productivity could be bettered by 6% through effective material management (Sawalhi & Kass, 2014) . Among the benefits were:

- Better relations with suppliers
- Better handling of materials
- Materials will be on site when needed and in the quantities required
- Improvements in labour productivity
- Improvements in project schedule
- Quality control
- Better field material control
- Reducing the overall costs of materials

- Reduce of materials surplus
- Reduce storage of materials on site
- Labour savings
- Stock reduction
- Purchase savings
- Better cash flow management
- Reduction in duplicated orders

Sustainable materials management can have so many advantages. A United States Environmental Protection Agency report in 2013 indicated that these benefits can be grouped into: Environmental benefits, Economic benefits and Performance benefits(Arijeloye & Akinradewo, 2016).

Environmental Benefits: This includes the conservation of natural resources, reduction of energy consumption, conservation of landfill space and reduction of environmental impacts across the life cycle by decreasing the demand for virgin products

Economic Benefit: It includes reduction in disposal costs and may reduce material hauling costs which leads to reducing overall project costs, reduction in purchasing costs since non-virgin materials are often less expensive than virgin resources, make contractors to be more competitive with their bids at reduced costs and it creates employment opportunities and economic activities in the reuse and recycling industries

Performance Benefits: This includes reclamation of materials, salvaged, and reused can perform as well as or better than virgin products in many applications, reduction in 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 labour productivity, improvements in project schedule, quality control, better field material control, better relations with suppliers, reduction in materials surplus, reduce storage of materials on site, labour savings, stock reduction, purchase savings and better cash flow management (Arijeloye & Akinradewo, 2016).

A study conducted by Stukhart and Bell on twenty heavy construction sites noted that in one of the projects, a 6% drop in craft labour cost took place due to the enhanced availability of materials required on site. On a different project, an 8% savings was attained due to reduced delay of materials estimated. A contrast of two projects with and without a materials management systems revealed a change in productivity from 1.92 man-hours per unit without a system to 1.14 man-hours per unit with a new system (Arijeloye & Akinradewo, 2016).

Against the various benefits, the cost 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 (Sawalhi & Kass, 2014). Better practises of materials management bring a surge in effectiveness of operations and cut down the whole cost. The higher level of management is giving greater interest to management of materials due to shortages of materials, rates of interests rising, competition and prices of materials rising. The consciousness in the construction sector about the need of materials management to be tackled as a comprehensive integrated activity is increasing (Manteau, 2007).

2.4 Materials Management Process and Practices

Managing materials is made up of a sequence of processes that require being linked together and synchronized properly to ensure that materials are always available when needed and in the right quantities (Ahmed, 2017). These processes may vary per the industry or organization it is being used, but these processes no matter what they are must be integrated, coordinated and synchronized properly because it is this process the makeup material management. This strongly indicates that material management is made up of components, components which is normally referred to as the processes which make managing of materials what it is. The components of material management can be identified as follows (Patel and Vyas, 2011)

- Material estimation, budgeting, planning and programming
- Scheduling, purchasing and procurement
- Receiving and inspection
- Inventory control, storage and warehousing
- Waste management

Patel and Vyas (2011) indicated very simply that these processes start from needs generated from site with this information sent to store department and materials are ordered from the store, indents are then generated. Vendor selection is then carried out for the least value and best item. Materials are received at the store department and inspection is carried out and finally issued to the appropriate department (Fig 2.1 below).

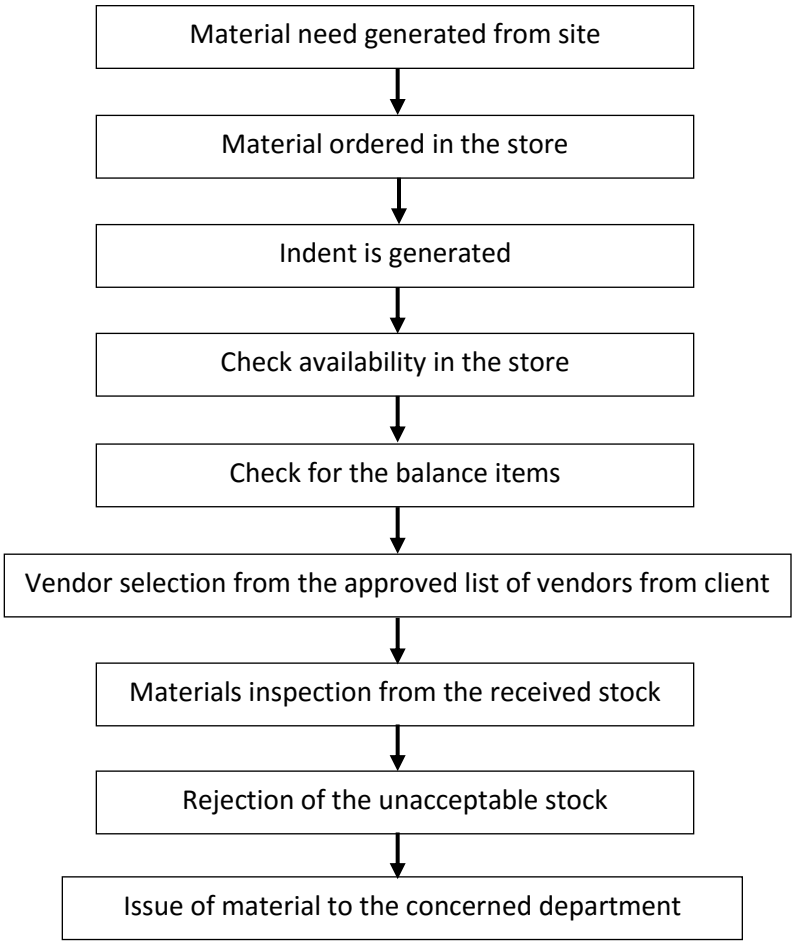

Figure 2.1 Material Management Process

Source: Patel and Vyas (2011)

Jusoh & Kasim, (2017a) in a study identified seven key processes which are; Project planning, Material take-off, Suppliers' enquiry , Purchasing, Material control, Warehousing and Material take-off. Gulghane and Khandve (2015) categorised material management into five processes and many writers seem to follow the same if not very similar way of categorizing material management processes. These are the processes usually followed and used on construction sites, planning, procurement, handling, logistics and stock and waste control.

Dakhli and Lafhaj (2018) discuss the use of techniques which could be adopted to optimise functions. Some of the techniques identified are the “pull planning”, “Just-in-time” and “Kitting”. Other literatures also identify techniques such as Economic order quantity (EOQ) and warehousing management as part of materials management.

2.4.1 Planning Materials Resource

Material management includes the process of planning to get the materials. It is the beginning point for the whole material management process. Planning sets the procurement process and the other subsequent material functions rolling.Material planning is a scientific way of determining the requirements starting with raw materials, consumables, spare parts and all other materials that are required to meet the given production plan for a certain period(“Production and Material Management,” n.d.). Planning is a core, important process for every project no matter the sector it is in. Material planning which is a vital part of material management is closely linked with project planning and control set up (Patil & Sarode, 2017). The Bill of Quantity (BOQ) prepared by clients is the most commonly used basis for planning things out for a project (Patel & Vyas, 2011). According to Kasim et al., (2005) and Stukhart (1995) stated that suitable materials planning needs to be undertaken concurrently with engineering, construction and other project plans. There was also a mention that material planning provides direction to all following activities and its effect on the project plan can be great. The Project Management Body of Knowledge (PMBOK) defines Plan Resource Management as the process of defining how to estimate, acquire, manage and use team and physical resources. Material management can be found under physical resources, we

can say a plan material is the process of defining how to estimate, acquire and manage material resources. As construction projects are getting bigger and more complicated planning is getting more efficient (Donyavi & Flanagan, 2009).

2.4.2 Procurement (Purchase)

Procurement means acquisition. It can generally be defined as the process of purchasing goods and services. It can also be described briefly as the process by which materials are procured and managed and how the results may vary. It involves purchase planning, standards determination, specification development, supplier research, value analysis, price negotiation, making the purchase and contract administration and monitoring. Procurement is also about organizing the purchasing of materials and issuing delivery schedules to suppliers and following up to make sure that suppliers deliver on time (Arijeloye & Akinradewo, 2016). Typically, the word “purchasing” is not used interchangeably with the word “Procurement”, since procurement typically includes Expediting, Supplier Quality, and Traffic and Logistics (T&L) in addition to Purchasing.Due to the major effect materials have on every aspect of construction projects, companies without effective or proper material procurement systems incur additional but avoidable costs (Bandyopadhyay & Dimilia, 2002). It is indicated that a failure in the purchasing process or in the guidance and organizing of the buying functions could result in the following

- Over-ordering of materials (wastage problems);
- Over-payments for materials (inadequate administration procedures);
- Loss of benefits (lack of skilled negotiating procedures);

- Lack of knowledge (when and where the best service/source might be available at any particular time) (Kasim et al., 2005)

2.4.3 Handling and Storage

Materials handling as explained by Haynes is "Material handling embraces the basic operations in connection with the movement of bulk, packaged, and individual products in a semi-solid or solid state by means of gravity manually or power actuated equipment and within the limits of individual producing, fabricating, processing or service establishment." Simply we can define material handling as the function dealing with the preparation, placing and positioning of materials to facilitate their movement or storage. Handling of materials does not enrich or make the product/material any better than it was before but it adds to the cost of the final product and hence can cost the client more. Handling must be kept at a minimum, but for this to happen a proper material handling system has to be put in place. The major objective of such system design is to reduce production cost through efficient handling

Material storage can be considered as the provision of enough space, protection and control of building materials and components held on site during the construction process. Types of physical storage system on site vary according to the space availability and company practices (Patel & Vyas, 2011). For better management of materials on site a good and systematic storage of materials has to be put in place. Mincks and Johnson (2011) state that warehousing relates to materials storage and it is important because the duration between ordering and receiving materials is uncertain. Therefore, there is a

necessity that delivered materials need to be stored within the site area (Jusoh & Kasim, 2017b).

The improper handling and storing of materials often result in costly injuries and damages to materials. Training, Education and applying general safety principles and efficient material handling systems – such as proper work practices can help reduce workplace accidents involving the moving, handling and storing of materials.

2.4.4 Logistics

Logistics, most often associated with transport, is a comprehensive business planning framework for the management of materials, service, information and capital flow (WRAP, 2007). Logistics is a concept that emphasises movement and it may incorporate planning, implementing and controlling the movement and storage of all goods from raw materials to finished goods to meet customer's conditions (Kasim et al, 2005). Three basic models of logistic systems are to be observed in building companies:

- informal, where co-ordination of logistic tasks of separate departments and fields of activity is enforced within the existing organisational structure of the company,
- semiformal, where a logistics manager takes the responsibility for the coordination of logistic processes of the company, but is not in charge of the departments, where these processes are conducted,
- Formal, where a separate department takes over all the logistic processes of the company.

The particular model of logistics is selected according to the current organisation structure of the company, its targets and management strategy(Sobotka et al., 2005).

2.4.5 Stock (Inventory) and Waste Control

All projects experience a certain amount of surplus and waste of materials after construction. Surplus and waste materials come up at various stages in the life cycle of a construction project, from the initiation all the way through design, construction and operation of the building facility (Patil & Sarode, 2017). Many factors contribute to the generation of material waste. These factors have been grouped by Ekanayke and Ofori (2000) under four categories (1) design; (2) procurement; (3) Handling of equipment; and (4) operation (Al-Hajj & Hamani, 2011). According to a United States Environmental Protection Agency 2007 publication, engaging of waste management coordinators; training workers, subcontractors and suppliers; and implementation of waste management plans are but a few ways by which material waste can be controlled.

Praba (1986) indicated that stock control is classified as the modus operandi worked out to deal with, and ensure all items are there when required. Raw materials, processed materials, components for assembly, consumable stores, general stores, maintenance materials and spares can all be included in stock control (Arijeloye & Akinradewo, 2016). In industry inventory means ‘stock of goods’. Inventory can be defined as an idle resource having an economic value awaiting conversion, consumption or resale. To the finance manager, inventory means the value of raw materials, consumable, spares, work-in-progress, finished goods and scrap in which a company’s funds have been invested. In plain language, he considers inventory as locked up capital. On the other end of the line

are the various departments that use the stock, so for both sides to be happy, the inventory has to be controlled (Arunprakash & Nandhini, 2013). Inventory control refers to the management of these idle resources which have economic value tomorrow. Inventory should neither be excessive or inadequate. If inventories are kept at high levels, higher storage cost would be incurred. A lower levels of inventories may result in underutilization of capacity and lower sales (Flores et al., 1992). The main concern of controlling inventory is minimizing the total cost of inventory. The three main factors in inventory control decision making process are: The cost of holding the stock (e.g., based on the interest rate). The cost of placing an order (e.g., for raw material stocks) or the set-up cost of production. The cost of shortage, i.e., (what is lost if the stock is insufficient to meet all demand) ("Principles of material management," n.d.)

2.4.6 Just-In-Time (JIT) method

Just in Time is a technique credited to Taichi Ohno and his fellow workers at Toyota. Ohno's fundamental purpose was to change production's directives from estimates of demand to actual demand (Ballard & Howell, 1997). The Just in time philosophies aims to eliminate inventory, eliminate waste, smooth the flow of materials as well as improve productivity. Material vendors play very important roles in the successful implementation of JIT. Late delivery of materials can lead to delays which can negatively affect the entire project schedule. (Ocheoha & Moselhi, 2013). JIT when implemented properly, especially in manufacturing organizations can lead to big improvements in their return on investment quality. Some have suggested that a more appropriate name would be "Just on Time" since it highlights more that production

should create items that arrive when needed and neither earlier or later ("Principles of material management," n.d.) . For a successful implementation of JIT, the following is required:

(1) a relatively precise forecast study of the needs in terms of production;

(2) a reliable transportation and delivery network, and

(3) a strict management of the demands(Dakhli & Lafhaj, 2018).

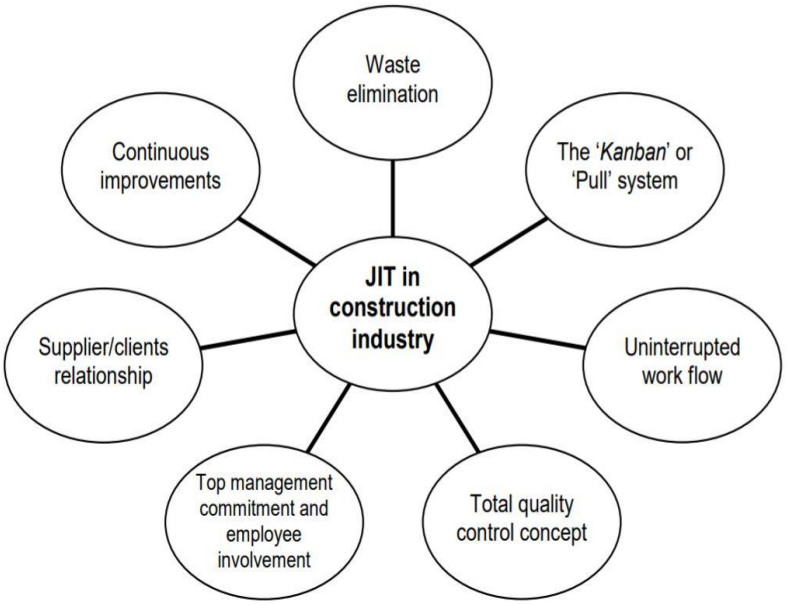

Figure 2.2 JIT Framework:(Low and Chan, 1997).

Source: Pheng & Shang (2011)

2.4.7 Warehouse Management

The term warehouse is mostly linked to storage. Sayeed (2013) explains that warehouse is a storage facility that receives goods and products for the eventual distribution to consumers or other businesses. Managing materials in a warehouse involves receiving

the materials; providing storing facilities; redistribution of the materials, as per requirement; maintaining its infrastructure; ensuring safety and security; and recording and reporting (Sayeed, 2013). Warehouse management as further explained by Sayeed, (2013) is concerned with ensuring that all activities involved in warehousing are carried out efficiently and effectively by those working in the warehouse. Not all warehouses are the same. Hardly any are. There are significant differences across warehousing operations in the various segments of the supply chain: manufacturing, wholesaling and retailing. But there are also similarities, especially at a macro level(Zebra Technologies, 2015). Current research has dealt with many warehouse design and operations issues with aim to cut down order fulfilment cost and advance system performance (Blomqvist, 2010). A research by Blomqvist, (2010) concluded that focus should be given to operational management of warehousing system, where the different process in the warehouse are considered jointly to achieve general warehousing objectives. If effectively and efficiently organized and managed warehouses should be able deliver safe custody of materials, clear monitoring and accountability, distribution of the right goods at the right time whenever required in the right condition to all user departments and also maximum profitability with the minimum investment through ordering cost and carrying of materials(Sayeed, 2013).

2.5 Causes of Ineffective material management

Effective management of construction materials used on site is a process vital to the achievements of a construction project (Gulghane & Khandve, 2015). Ineffectiveness of the management of materials stems from various factors and conditions. A variety of

researchers' have conducted investigations to know more about the issues affecting the effective management of materials on construction site. Some of these were:

An investigation into some these factors by Kulkarni et al., (2017) showed that transportation problems, seasonal problems, delay of materials due to rejection from quality control team were some of the factors affecting all types of construction firms. Other factors indicated were improper handling, hike in material prices, communication problems and lack of material management. It was summarised as such:

Large firms:

- Delay due to rejection of materials from quality control team;
- Transportation problems;
- Seasonal problems;

Medium firms:

- Delay due to rejection of materials from quality control team;
- Transportation problems;
- Seasonal problems;
- Labour strikes;
- Improper handling of materials;

Small firms:

- Delay due to rejection of materials from quality control team;
- Transportation problems;
- Seasonal problems;
- Labour strikes;

- Communication problems;
- Hike in material prices;
- Lack of material management;
- Improper material handling (Kulkarni et al., 2017)

Another study by Gulghane & Khandve(2015) identified procurement systems, poor handling procedures, overstocked materials because of improper planning, damaged materials due to logistics, handling or in application, , waiting of the materials to arrive in location due to improper tracking systems, material changes in buying/purchasing situation starting from the prepared cost estimation, bulk construction material, the shortages and changes of construction materials quantity required, , stealing and loss of construction materials, work repairing, delay in updating/posting storage system on site, inaccurate measurement of work location on construction projects, material off-take, inaccurate estimation of shipment quantity of materials, uneconomic order quantity of materials, inadequate tools/equipment needed on site, , choosing the wrong materials for construction, the increasing storage cost of materials, the poor buying ability of managers, delay of payment for materials, and the poor policy in purchasing the materials, material shipment, loss of materials because of improper supervision, increasing transportation cost of materials, frequent moving of materials due to improper site layout, material over usage in location of project, inflation, materials inefficiency on site, poor shipping time

as some the things the influence effective material management.

In another study conducted by Jusoh & Kasim(2017b), 47 influential factors were identified to affect the efficiency/effectiveness of material management. The identified

factors were then categorized into 8 specific groups according to their respective themes, the 8 groups were: site condition, planning and handling on site, management, material, transportation, supplier or manufacturer default, contractual and governmental interferences(Jusoh & Kasim, 2017a). Below is a simplified summary of the study.

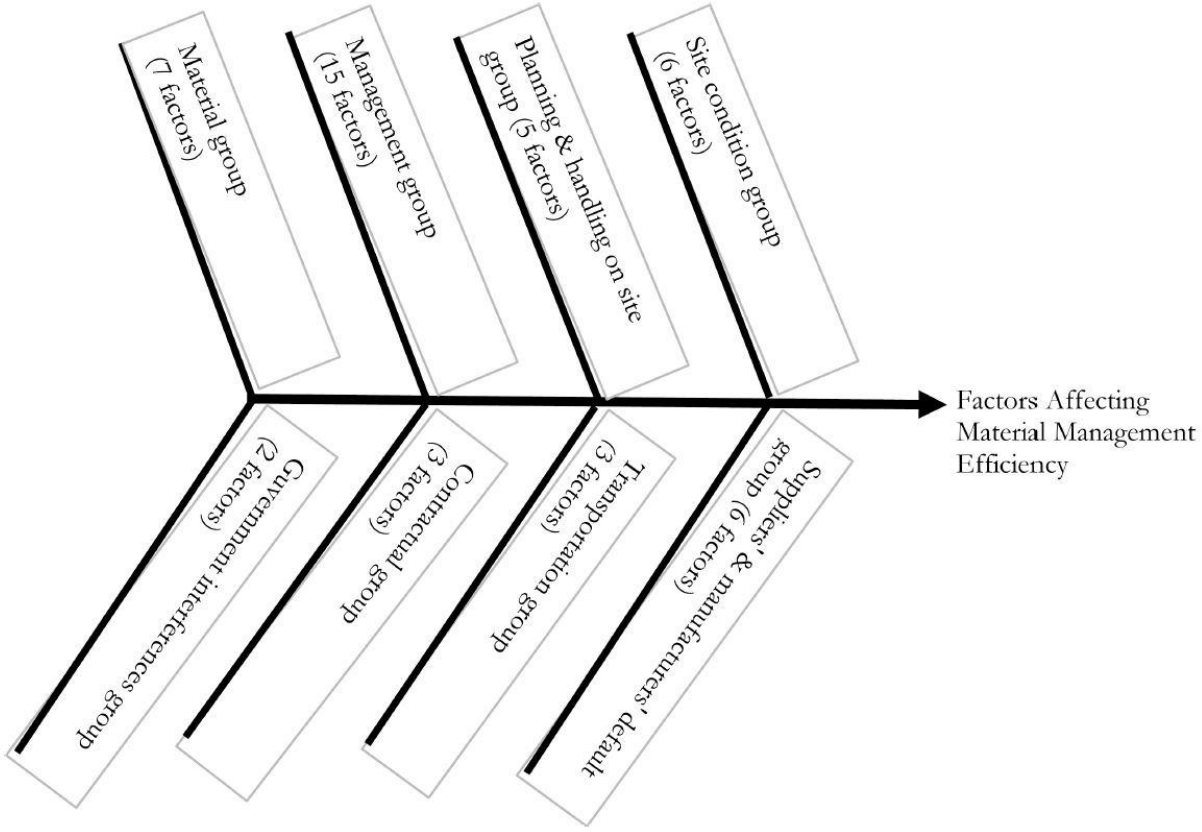

Figure 2.3 Diagram of group factors affecting materials management efficiency
Source: Jusoh & Kasim (2017b)

Below is a simplified summary of the study of factors the influence efficiency of material management by Jusoh & Kasim(2017a).

Table 1.2 Efficiency of material management

Site Conditions group - Lack of materials storage, restricted - Equipment movement at site, - Unsuitable site storage, - Improper storing methods, - Congestion of site, - Materials stored far from working area.	**Planning and handling on site group** - Inadequate of planning, - Poor material handling, - Inefficient equipment for unloading, - Lack of protection during unloading - Unsystematic flow of materials.
Management group - Improper material usage, - Ordering errors, - Shortage of fund, - Excessive paperwork, - Delay in materials procurement, - Communication breakdown, - Poor coordination, - Waste due to negligence, - Lacking in qualified staffs, - Inefficient communication in construction sites, - Unsystematic documentation, - Delay in forwarding information on sizes of materials to be used, - Taking off error, - Lack of materials control and lack of supervision.	**Materials group** - Poor quality of materials, - Materials price fluctuation, - Damages of materials, - Shortage of materials in market, - Materials supplied without pallet, - Fluctuating demand of materials - Improperly marked of materials. **Suppliers and manufacturers' default group** - Delay in materials delivery by suppliers, - Supplier's errors, - Delay in manufacturing, - Lack of competent suppliers, - Work stoppages at factories - Monopoly control by particular supplier.
Transportation group - Poor delivery of materials to site, - On-site transportation difficulties - Damage during transportation.	**Contractual group** - Wrong materials from specification, - Changes of materials specification during construction and - Ambiguous materials specification
Governmental interference group - Delay in custom clearance for imported materials - lack of policy in procuring materials	

Source : Jusoh & Kasim(2017a).

A case study by Patel & Vyas(2011) using three construction organizations in India, to identify some problems in material management grouped their findings into four phases

of material management processes. They were Material identification, vendor selection, procurement and construction phase. Problems identified were associated with a particular phase in the processes, unveiling problems that usually occur under the various phases. The table below summarizes their finding

Table 2.3 Causes of ineffectiveness in material management

1st Phase: Material Identification	***Challenge***
Challenge	Lack of conformance to requirements
Undefined scope	Unrealistic delivery dates
Lack of communication	Vague stated requirements
Incomplete drawings	Re-handling of material
Lack of conformance to requirements	Storage of materials
Nonstandard specifications	Theft
Incomplete/ ineffective meetings	Damaging
Difference between plans & specifications	**4th Phase Construction Phase**
Not determining when and what materials are needed	Incorrect type of material delivered
2nd Phase Vendor Selection	Incorrect sizes delivered
Time spent in investigating non-qualified suppliers	Incorrect quantities delivered
Incomplete proposals	Keeping track of material
Uncontrollable bid list	Re-handling of material
3rd Phase Procurement Problem	Storage of material
Availability of material	Loss of material
Availability of quantity	Damage
Matching price to competitor's price	No supplier QA
Late deliveries	Poor communication
Late or incorrect submittals	Receiving, handling and storage of unused materials
Poor communication	

Source: Patel & Vyas, (2011)

These causes identified causes material management problems can greatly aid reveal the problems in Ghana's construction sector. We now need to understand further how these threats can really be associated with the industry here in Ghana. To be able to assess material management we will need to learn more of the causes and effects of ineffective management here.

2.6 Impact of Material management

Material management is a key element in project management because of the vital nature of materials on the total cost of projects. It also plays a key role because, the success of every construction project rely on having proper resources (Jusoh & Kasim, 2017a). This therefore has an impact on project performance. Jusoh & Kasim (2017a) further explain that a properly managed material management system can greatly contribute to the performance of a project, and the criteria of project performance can be identified both from a positive and negative perspective. Performance centre on inputs (the effects put in) and outputs (the results of the effort put in) (Oyebamiji, 2018). Effective material management has positive impact on time optimization, cost savings, quality maximization, productivity improvement and waste minimization, ineffective management of materials on the other hand has negative impact on project performance such as time delay, cost overrun, poor quality, loss of productivity and excessive waste generation (Jusoh & Kasim, 2017a).

A study by Oyebamiji (2018) examining the effects of materials management on the performance of manufacturing industry's confirmed that materials management dimensions put together contribute significantly to the firms performance. This study

showed that materials inventory and procurement had little or no impact on performance, while material storage indicated a significant impact on the firms' performance.

In another study by Jusoh & Kasim(2017a) a discussion of material management effect of 5 criteria of project performance was put up. In the sole context of the paper, the criteria were labeled impartial form as follows; productivity, cost, quality, time and waste.

Cost: Cost of projects can be explained as the amount a client has to spend on the project which includes charges of the main contractors, sub-contractors and even consultant fees. Research has shown that construction materials and equipment may constitute more than 70% of the total project cost for a typical construction project (Patel & Vyas, 2011). This is an indication that materials if not managed as it should be would have an impact on the total cost of the entire project.

Quality: Quality can be defined as meeting the legal aesthetic and functional requirements of a project (Mallawaarachchi & Senaratne, 2015). Requirements for a project may be straight forward or complex or they can be in a form of detailed description of what is expected or may be specified in terms of end results wanted. Quality however on some occasions become a problem because it is under stood differently by different people and organizations due to its subjective nature (Jusoh & Kasim, 2017a).

Productivity: According to Dozzi & AbouRizk(1993) many terms are used to describe productivity in the construction industry: performance factor, production rate, unit

person-hour (p-h). Productivity can be defined as the ratio of input over output, which simply means the ratio of the input of an associated resource to real output (Dozzi & AbouRizk, 1993). It is known that construction projects which are not able to utilise resources available to them properly will have a drop in their productivity. Lacks of materials, shortages, re-handling of materials all have a significant impact on labour productivity. An example is the amount of time and effort it takes workers to retrieve materials due to inappropriate storage (Jusoh & Kasim, 2017a). These causes increase in unproductive hours.

Waste: Good practices of materials handling, systematic inventory process, stock control for minimization of over or duplicate ordering are but some of the few strategies for waste minimization (Jusoh & Kasim, 2017a). Reducing waste of materials on construction projects is key to avoid unnecessary waste. Research has revealed that 2.5 % of an entire project cost can be saved by implementing waste minimization practises on site (Begum, et al., 2006).

Table 2.4 Summary of material management effect on performance

No.	Material Management Activities	Criteria of Project Performance				
		Time	Cost	Quality	Productivity	Waste
1	Availability and sufficient materials and equipment	√	√	√	√	
2	Appropriate quality material	√	√	√		
3	Prompt and reasonable time of material procurement	√	√			
4	Efficient inventory system and documentation	√				√
5	Reasonable changes	√				
6	On time delivery	√				
7	Minimizing procurement cost		√			
8	Appropriate site storage				√	√
9	Efficient site layout				√	
10	Easy site access				√	
11	Unconfined working space				√	
12	Efficient material controlling					√
13	Appropriate handling					√

Source: Jusoh & Kasim, 2017a)

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

This chapter examines the research methodology that was used to conduct this research. This section tackles research methods, procedures and data collection instruments. It describes how sample size was selected, data collection and how handling of the data was done. It provides detailed explanations to the methods in the conduct of the study in order to address the research questions appropriately.

Research in common parlance refers to a search for knowledge. One can also say research is a scientific and systematic search for pertinent information on a specific topic (Kothari, 2004). This is what this research seeks to do, systematically search for knowledge on materials management.

3.2 Research Design

Kothari, (2004) states that "the formidable problem that follows the task of defining the research problem is the preparation of the design". A research design constitute decisions regarding what, where, when, how much, by what means concerning an inquiry or research study (Kothari, 2004). In very simple terms Kerlinger (as cited in Kothari et al., 2014) defines research design as a plan, structure and strategy of investigation so conceived as to obtain answers to research problems. This plan is the complete programme of the research (Kothari et al., 2014). A mixed method strategy was adopted for this research work, as this method aids to obtain the objectives of this research. The research methodology chosen for this research is made up intense review

of literature, a structured questionnaire to contractors and subcontractors on the F4000 project, and analysis of the survey.

- Search and Gathering of Literature
- Review of Literature
- Ascertain material management process and causes of Ineffective material management
- Preparation of questionnaire
- Identify targeted response group
- Data collection
    - Distribute the questionnaire
- Analysis of Data

3.3 Data Collection

Data is often thought of as 'the facts' – the things that are known to be true. But the truth is that data are social products (Ahmed, 2017). According to Byrne (as cited in Ahmed, 2017) the records created are not reality itself; rather they are a result of researchers' attempt to observe or measure traces or evidence of phenomena situated within complex systems. The research strongly leans on the legitimacy and dependability of the data collected. Data come in two forms, depending on its closeness to the event recorded. For this research, there was dependence on both primary and secondary data. Primary data which refers to the first-hand information collected directly by the researcher for the use

of his/her study (Kent, 2015). This was done by the use of questionnaires and observations on site. Secondary data unlike the primary data refers to the information that have already been collected, analysed, documented and published by another researcher or institution (Kent, 2015). For this research the secondary data were obtained using related research papers, journals, magazines and books.

3.4 Sample Size Determination

Sampling may be defined as the selection of some part of an aggregate or totality on the basis of which a judgement or interference about the aggregate or totality is made (Kothari, 2004). Samples can only be obtained from the identified population. From the statistical point of view, population refers to the total of items about which information is desired. The population is the aggregate or totality form which some part (sample) is selected. There are two major sampling types namely Probability and non-probability sampling.

The case study approach is being taken for this research with the chosen project being selected as the case for the study. The contractor and subcontractors on this project were considered entirely as the population. Due limited time and resources the non-probability sampling method was adopted for use concerning this research. Under non-probability, purposive sampling technique was applied. Purposive sampling technique is used by researchers to choose samples that are likely to be knowledgeable and informative about the phenomena under study (Sanders, et al., 2007). In view of this the sample size was mainly made up selected workers from the management staff and supervisory staff of the main contractor and all subcontractors on the F 4000 project. In

entirety, due to the case study method being used for this research, the entire work force per category of positions which amounted to twelve (12) was considered for data collections.

3.5 Research Instrument

The survey method was used for this research, with this data was collected at a point in time for this research. Data gathered was through site observations, semi-structured interview and questionnaires. The development of the questionnaires was done from the literature review in connection to the research questions for this study. The questionnaire was the main tool used to gather data from the identified response group. The designed questionnaire was put into four sections. This pattern of the questionnaire helped achieve and obtain the results needed for the set objectives. Section A of the questionnaire contained questions to know the background of the respondent.

3.5 Data Processing and Analysis

Data obtained will be analysed using descriptive statistics such as frequencies of responses, percentages, mean and standard deviation with the help of SPSS. Evaluation of the data was done to reach a valid conclusion and recommendation that will help make applicable decisions.

CHAPTER FOUR

ANALYSIS AND DISCUSSION

4.1 Introduction

This chapter deals with the analysis of data that was gathered from the selected respondents. These analyses were conducted to find out the kind of material management processes being used on construction projects sites, what causing of ineffectiveness in the management of materials and the impact material management is having on project performance. These are the objectives of the study. Information taken from the data collected using the questionnaires was analyzed by using Microsoft Excel and Statistical Package for Social Sciences (SPSS).

4.2 Demography

This part looks into the background information from the respondents of the questionnaires. This information included their area of specialization in the construction industry, current positions they are holding currently, academic qualification, work experience in terms of years and experience in material management if any.

4.2.1 Job Position of Participants

The diagram and table below illustrate the job positions of the people that responded to the questionnaires of this research.

Table 4.1 Job Position of respondents

	FREQUENCY	PERCENTAGE(%)	CUMULATIVE %
Main Contractor	1	10 %	10 %
Sub-Contractors	9	90 %	100 %
TOTAL	10	100 %	

This results points out that 10 participants took this survey out of the total number of distributed questionnaires. Out of the 10 returned questionnaire 1 (10%) was answered by a participant from the main contractor and the other 9 (90%) by subcontractors on site.

4.2.2 Work Experience of Respondents

Table 4.2 Respondents' working experience

	FREQUENCY	PERCENTAGE(%)	CUMULATIVE %
5 – 10 years	4	40 %	40 %
11 – 15 years	4	40 %	80 %
> 15 years	2	20 %	100 %
TOTAL	10	100 %	

As already indicated in the above analysis there were 10 respondents, out of this 10, 4 (40 %) had 5 – 10 years of work experience, another 4 (40 %) of the respondents had 11 – 15 years of work experience and only 2 (20 %) of the respondents had more than 15 years of experience. This shows a certain balance in the level of experience of the respondents of this survey.

4.3 Material Management Process

Section B of the questionnaire was designed to identify the processes used to manage materials on construction sites. This data collected in this section was analyzed using content analysis. Respondents were asked to examine a set of construction management processes labeled P1 to P5 with an option P6 providing space for the respondent to state process they follow if the processes in P1 to P5 does not fall within their type. P1 to P2 contained 8 processes each and P4 had 7 processes. 3 of the respondent ticked P2 as the process they follow. P2 contains the following; Plan and Schedule for materials, activities organization of materials management structure, procurement, delivery of requested materials, storage, issue out materials(usage) and surplus and waste control. Another 3 responded to P4 as the process they followed, and the processes were; Plan for materials, purchasing, receiving of materials on site, Inspection of received stock, stacking and storing, issuing out of materials and inventory control. The others did not follow categorically any of the process stated in P1 to P5 but the process they followed were not too far from some of the listed processes. The tables below show the results of the participants who listed their processes in the space provided under P6.

Table 4.3 Material Management Processes selected by respondents

S/N	Process Type	Frequency	Percentage
P1	Construction Material need generated from site	1	10 %
	Check availability from the company warehouse		
	Check availability from local supplier shops		
	Inform the procurement department		
	Indent is generated (Purchase Order)		
	Vendor is selected from an approved list		
	Conduct inspection from the received stock		
	Update the ware house stock the requested materials are supplied to site		
P2	Plan and Schedule for materials	3	30%
	Monitoring & Controlling of all material activities		
	Organization of material management structure		
	Procurement		
	Delivery of requested materials		
	Storage		
	Issue out materials (Usage)		
	Surplus and Waste control		
P3	Planning	0	0%
	Purchasing		
	Logistics		
	Handling		
	Stock & Waste control		

S/N	Process Type	Frequency	Percentage
P4	Plan for materials	3	30%
	Purchasing		
	Receiving of materials on site		
	Inspection of received stock		
	Stacking and storing		
	Issuing out of materials		
	Inventory control		
P5	Plan and Schedule for materials	0	0 %
	Monitoring & Controlling of all material activities		
	Organization of material management structure		
	Procurement		
	Delivery of requested materials		
	Storage		
	Issue out materials (Usage)		
	Surplus and Waste control		

Source: Field Survey (2018)

There was no real significant difference between the sated processes and the process followed by the other respondents. One basic key activity to note that most of the respondents is planning which comes first. All the respondents aside one checks from company warehouse, all the others seem to go through their own procurement process of some sort. Below are the responds of the others who did not follow any of the provided principles.

Process 1

(a) Plan & Schedule for materials

(b) Procurement

(c) Receive materials on site

(d) Storage and inventory

(e) Site distribution

(f) Waste control.

Process 2

(a) Materials need generated from site

(b) Check availability form company warehouse

(c) Purchase when unavailable

(d) Delivery of requested materials

(e) Storage

(f) Issue out

(g) Surplus and Waste control

Process 3

(a) Define material requirements for project

(b) Vendor Evaluation

(c) Purchase materials

(d) Delivery of materials

(e) Storage and inventory

(f) Site distribution

(g) Waste control

4.4 Ineffective Material Management (Causes)

For Section C, the analyses of what causes ineffectiveness in the management of materials will be done using SPSS to first find the mean of the listed activities. These causes were classified into 3 parts for this project. They were, (A) Material Identification, (B) Procurement phase and (C) Construction phase. The causes were classified based on the frequency of the response by the individuals who answered the questionnaire. The causes that had the highest mean were classified as highly probable causes of ineffective materials management faced on construction project sites.

4.4.1 Material Identification

From the analysis of the figure above, it indicates that ‘not determining what and when materials are needed’ (with a mean of 4.9) came up as the highest cause of ineffective materials management in this phase. On the other hand, ‘selection of low quality products’ was the lowest as causing ineffectiveness in management of materials in the Material identification phase.

Table 4.4 Causes of ineffective material management in Material Identification phase

	(A) MATERIAL IDENTIFICATION	MEAN SCORE	STANDARD DEVIATION	RANKING
1	Not determining what and when materials needed	4.9000	0.3162	1st
2	Poor communication leading to mistakes and errors	4.6000	0.5164	2nd
3	Undefined Scope	4.5000	0.5271	3rd
4	Difference between plan and Specification	4.5000	0.8498	4th
5	Poor/ wrong specifications	4.5000	0.7071	5th
6	Lack of information in the drawings	4.0000	0.6667	6th
7	Complexity of detailing in the drawings	3.7000	0.675	7th
8	Overlapping of design and construction	3.3000	0.4831	8th
9	Selection of low quality products	2.9000	0.5677	9th

Source: Field Survey (2018)

4.4.2 Discussion

As we have understood through the literature review that to really make your material management process successful and effective, proper planning needs to be undertaken. Though there are many other activities involved in the material identification process, knowing what materials you need, to get your work done and at what point those materials are needed is very crucial to the project on site. For building projects such as factories, and warehouses a large amount of the materials needed are imported, so the type of materials needed and when they are needed has to be made known to enable all other process to follow on time. This springs up the ‘plan and schedule for materials’ process. If this is not done, it can cause unwanted problems for the project, which could affect the project quality and time to name a few. Poor communication ranked second.

Even though it is important to communicate throughout the whole life cycle of the project, it is very vital that proper communication takes place during the planning stages of the project to enable everyone understand and know what is wanted and expected.

4.4.3 Procurement Phase

'Unsuitability of materials delivered to site' showed as the highest-ranking cause of ineffective management in the procurement phase (with a mean of 4.3), while 'availability of materials' ranked as the lowest cause (with a mean of 2.3).

Table 4.5 Causes of ineffectiveness in the Procurement phase

	(B) PROCUREMENT (Orders/Purchase/Delivery/Transportation)	MEAN SCORE	STANDARD DEVIATION	RANKING
1	Unsuitability of materials supplied to site	4.3330	0.5000	1st
2	Poor Communication	4.1250	0.3536	2nd
3	Late or Incorrect submittals of material request	4.1000	0.3162	3rd
4	Damage of materials	4.1000	0.3162	4th
5	Late Deliveries	4.0000	0.6667	5th
6	Ordering errors (e.g., ordering significantly more or less)	3.7778	0.9718	6th
7	Unrealistic delivery dates	3.5000	0.7071	7th
8	Storage of material	3.3000	0.8233	8th
9	Poor handling / Re-handling of materials	3.3000	0.4831	9th
10	Use of wrong method of transport	2.8889	0.3333	10th
11	Availability of material	2.3000	0.6750	11th

Source: Field Survey (2018)

4.4.4 Discussion

With the best of intentions for projects, contractors and subcontractors alike mostly do their best to purchase materials at the best prices possible, but suppliers sometimes fail to deliver exactly what was expected of them. When materials procured and supplied to site turn out to be unsuitable for an intended purpose it can trigger a ripple effect by going on to affect certain aspects of the project, like productivity and quality. Unsuitability of materials can be caused by various things and poor communication happens to be one of such causes. 'Poor Communication' ranked second as cause of ineffectiveness. If there is proper communication (example about the full specifications of materials) the probability of such deliveries can be minimized.

4.4.5 Construction Phase

It is observed that 'petty stealing by workers (theft)' (mean of 4.5) came up the highest ranked cause and 'unnecessary inventories on site leading to waste' turned out to be the lowest ranked cause of ineffectiveness in material management for the construction phase.

Table 4.6 Causes of ineffectiveness Construction phase

	(C) CONSTRUCTION PHASE	MEAN SCORE	STANDARD DEVIATION	RANKING
1	Petty stealing by workers (Theft)	4.5000	0.5271	1st
2	Use of incorrect material, thus requiring replacement	4.4000	0.6992	2nd
3	Incorrect type of materials delivered	4.2000	0.6325	3rd
4	Waste resulting from cutting uneconomical shapes	4.1111	0.7817	4th
5	Damage of materials	4.1000	0.3162	5th
6	Lack of onsite materials control	4.0000	0.0001	6th
7	Errors by tradesmen or operatives	3.8000	0.4216	7th
8	Incorrect quantity delivered	3.7000	0.8233	8th
9	Accidents due to negligence	3.6000	0.6992	9th
10	Method of Storage of materials (On site)	3.5556	0.7265	10th
11	Poor Handling / Re-handling of materials	3.4440	0.7265	11th
12	Monitoring of materials	3.2220	1.5634	12th
13	Attitude of workers and site foremen	3.2000	0.6325	13th
14	Unnecessary inventories on site leading to waste	3.1000	0.7379	14th

Source: Field Survey (2018)

4.4.6 Discussion

In Ghana, construction workers seem to have certain air around them, that materials handed to them for work is theirs and therefore have control over them, others also have the feeling that the companies they work for are rich to replace materials if they turn up short, so taking some of the materials for personal use is not a problem at all. During planning the scope of the whole project did not include the personal projects of workers so materials turning up short due to theft affects the total estimated plan for the projects.

‘Use of incorrect materials thus requiring replacement’ followed closely. This can also occur if there is no proper supervision or control of materials onsite

4.4.7 Overall Causes of ineffectiveness

With all the 3 selected phases put together, as it shows in Table 4.6 below, it indicates that the top 3 causes of ineffective management of materials are ‘not determining what and when materials are needed’ (mean of 4.9) and ‘poor communication’ (mean of 4.6) and ‘Undefined Scope’ (mean of 4.5)

Table 4.7 Overall Causes of ineffectiveness

S/N	CAUSES OF INEFFECTIVENESS	MEAN SCORE	STANDARD DEVIATION	RANKING
1	Not determining what and when materials needed	4.9000	0.3162	1st
2	Poor communication leading to mistakes and errors	4.6000	0.5164	2nd
3	Undefined Scope	4.5000	0.5271	3rd
4	Difference between plan and Specification	4.5000	0.8498	4th
5	Poor/ wrong specifications	4.5000	0.7071	5th
6	Petty stealing by workers (Theft)	4.5000	0.5271	6th
7	Use of incorrect material, thus requiring replacement	4.4000	0.6992	7th
8	Unsuitability of materials supplied to site	4.3330	0.5000	8th
9	Incorrect type of materials delivered	4.2000	0.6325	9th
10	Poor Communication	4.1250	0.3536	10th
11	Waste resulting from cutting uneconomical shapes	4.1111	0.7817	11th
12	Late or Incorrect submittals of material request	4.1000	0.3162	12th
13	Damage of materials	4.1000	0.3162	13th
	CAUSES OF INEFFECTIVENESS	MEAN SCORE	STANDARD DEVIATION	RANKING
14	Damage of materials	4.1000	0.3162	14th
15	Late Deliveries	4.0000	0.6667	15th
16	Lack of information in the drawings	4.0000	0.6667	16th
17	Lack of onsite materials control	4.0000	0	17th
18	Errors by tradesmen or operatives	3.8000	0.4216	18th
19	Ordering errors (e.g., ordering significantly more or less)	3.7778	0.9718	19th
20	Complexity of detailing in the drawings	3.7000	0.675	20th
21	Incorrect quantity delivered	3.7000	0.8233	21st
22	Accidents due to negligence	3.6000	0.6992	22nd
23	Method of Storage of materials (On site)	3.5556	0.7265	23rd
24	Unrealistic delivery dates	3.5000	0.7071	24th
25	Poor Handling / Re-handling of materials	3.4440	0.7265	25th
26	Storage of material	3.3000	0.8233	26th
27	Poor handling / Re-handling of materials	3.3000	0.4831	27th
28	Overlapping of design and construction	3.3000	0.4831	28th
29	Monitoring of materials	3.2220	1.5634	29th
30	Attitude of workers and site foremen	3.2000	0.6325	30th
31	Unnecessary inventories on site leading to waste	3.1000	0.7379	31st
32	Selection of low quality products	2.9000	0.5677	32nd
33	Use of wrong method of transport	2.8889	0.3333	33rd
34	Availability of material	2.3000	0.6750	34th

Source : Field Study (2018)

4.4.8 Discussion

The top 3 causes as it shows in the chart can all be located under the material identification phase. This highlights the importance of the beginning stages material management. It can be observed that improper planning and preparation can have great effect on how effective or ineffective the whole material management process will be through the life cycle of the project. It therefore best that proper attention is given to the planning stages, also poor communication showing up second spells out the importance of putting in place the best communication methods and procedures to ensure that the ultimate results are achieved in identifying materials needed for the project.

4.5 Impact of Material Management on Performance

This section seeks to analyze how the management of materials on site had any impact on the performance of the project, in relation to time, cost quality and productivity. The list of activities given to respondents to answer in relation to the performance criteria sum up to form material management process. The data gathered was analyzed and Excel was used to show the distribution.

The responds for all respondents were tallied under the various criteria (cost, time, quality & productivity) for each listed activity. For an impact rating to be deemed significant it must have a respondent rating of more than 50 % according to the “half-adjusting” principle. Table 4.8 below shows a summary of the tabulation of the all the activities as indicated by the respondents.

Table 4.8 Material Management Activities on Performance

No.	Material Management Activities	Criteria of Project Performance							
		Time		Cost		Quality		Productivity	
		Freq	%	Freq	%	Freq	%	Freq	%
1	Availability and sufficient materials and equipment	9	90	2	20	0	0	10	100
2	Appropriate quality material	2	20	5	50	10	100	0	0
3	On time and reasonable time of material procurement	10	100	5	50	1	10	9	90
4	Efficient inventory system and documentation	8	80	7	70	1	10	8	80
5	Reasonable changes	5	50	7	70	2	20	0	0
6	On time delivery	10	100	2	20	2	20	7	70
7	Minimizing procurement cost	0	0	10	100	1	10	0	0
8	Appropriate site storage	5	50	2	20	1	10	9	90
9	Efficient site layout	5	50	0	0	0	0	8	80
10	Easy site access	5	50	0	0	0	0	9	90
11	Unconfined working space	5	50	0	0	1	10	9	90
12	Efficient material controlling	2	20	8	80	0	0	2	20
13	Appropriate handling	1	10	8	80	5	50	3	30

4.5.1 Discussion

This research study identified the impact of material management to the 4 criteria of project performance. The arrangement of the performance criteria is from the strongest to weakest in terms of tally.

1. Appropriate handling has impact on Cost, Quality, Productivity and Time performance.
2. Efficient material controlling has impact on Cost, Time and Productivity performance.
3. Unconfined working space Productivity, Time, Quality performance.
4. Easy Site Access has impact of Productivity and Time performance.
5. Efficient Site Layout has impact on Productivity and Time performance.
6. On time delivery impacts on Time, Productivity, Cost and Quality performance.
7. Appropriate site storage impacts on Productivity, Time, Cost and Quality performance.
8. Minimizing procurement cost impacts on Cost and Quality performance.
9. Reasonable changes impact on Cost, Time and Quality performance.
10. Efficient inventory system and documentation has impact on Productivity, Time, Cost and Quality performance.
11. On time and reasonable time of material procurement has impact on Time, Productivity, Cost and Quality performance.
12. Appropriate quality of materials has impact on Quality, Cost, Time performance.
13. The availability and sufficient materials has on Productivity, Time, Cost performance.

Table 4.9 Impact of material management activities on project performance (Summary)

No.	Material Management Activities	Criteria of Project Performance			
		Time	Cost	Quality	Productivity
1	Availability and sufficient materials	√			√
2	Appropriate quality material		√	√	
3	On time and reasonable time of material procurement	√	√		√
4	Efficient inventory system and documentation	√	√		√
5	Reasonable changes	√	√		
6	On time delivery	√			√
7	Minimizing procurement cost		√		
8	Appropriate site storage	√			√
9	Efficient site layout	√			√
10	Easy site access	√			√
11	Unconfined working space	√			√
12	Efficient material controlling		√		
13	Appropriate handling		√	√	

4.6 Conclusion

Based on this research on construction project sites, we distinguished that material management processes used and followed are very closely related. The relationship between the activities under these process for the various are not far from each other. For the causes of ineffective management of materials faced, the top causes ‘not

determining what and when materials are needed', 'poor communication' and 'undefined scope' where both under the material identification phase.

Finally, it was found that most of the materials management activities had an effect on time performance more than the other criteria and a few than it affected quality.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

Aside all the difficulties and challenges in the construction industry, lack of proper understanding and implication of certain process/activities prevents us from overcoming the problems encountered. This study identified the material management process that exists within the construction industry, the causes of no effectively managing materials on site and finally the impact material management has of performance in relation to productivity, time, cost and quality. By unveiling these, professionals can have a better insight into some of the causes of the ineffectiveness as perceived by those handling management of materials on site then find the best was to tackle them.

This chapter seeks to summarize all the issues addressed through the research. It looks at how the research objectives have been achieved and contributions. This chapter finally ends with some recommendations to enable others conduct better and improved study into the subject matter.

5.2 Study Objective and Findings

This section is envisioned to look at the objectives that were intended to be achieved at the beginning of this study. The review of these objectives is intended to help answer them as they were the guide for the entire research.

Objective 1: To identify material management processes used on construction project sites.

This section began by identifying some material management process used on construction sites through review of literature. With this a designed questionnaire was then applied to the identified group to address this objective. The identified processes being used to manage materials is key, since materials make up a huge percentage of the total cost of construction projects. These processes need to be effective in every possible way in order to achieve the best out of them. With the aid of the questionnaire it was observed that all the companies follow carefully organized processes, most from the planning stages all through to inventory and waste control.

Objective 2: To identify the causes of ineffective material management on construction sites.

This part of the study sought to find influencing factors leading to ineffective management of materials on construction site. The uncovering of these factors was intended to help in developing better plans and have a better approach to minimize or cut them out completely. The study identified that mostly activities under the 'material identification phase' had a high percentage of causing ineffectiveness. 'Poor communication', 'undefined scope' and 'not determining what and when materials are need' came up as the highest-ranked in causing effectiveness of material management.

Objective 3: To assess the impact material management activities has on project performance.

In light of this, a set of activities which sum up to form the material management activities where assessed as to the impact they have on performance. In order to narrow down the scope, performance was looked at in relation to time, cost, productivity and quality. All the data from the various respondents was tallied and tabulated. This indicated the activities that had impact on particular performance criteria. With the use of half-adjusting principle, the impact rating was at 50 %. After assessment the data showed that most of the respondents indicated most activities had strong impact on time performance on site.

5.3 Recommendations

The primary purpose of this research was to assess material management on construction project sites. This was consequently achieved through the set objectives and in view of the attained results of this study, these recommendations are suggested for a positive and better management of materials.

- Materials needed should be determined and also made available on time
- Proper communications measures and procedures should be put in place to enable effective information flow.
- Contractors should apply the processes of material management appropriately in order to avoid or reduce wastage which could cause ineffectiveness in the management of materials.
- Much attention must be given to material identification during the planning stages of projects.

- Individuals should be designated to handle all activities concerning material management, it should be assigned as a secondary role but a primary one

5.4 Conclusion

Material management processes used in construction can easily be affected due to the introduction of new technologies and the acceptance of new best practices. Some of the causes of ineffectiveness may even vary as the environment changes. Project performance criteria includes more than the four criteria used in this research, others can also look into the kind of impact management of materials on project site is having on other performance criteria other than the ones used in this research.

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APPENDIX

APPENDIX A: QUESTIONNAIRE

KWAME NKRUMAH UNIVERSITY OF SCIENCE OF TECHNOLOGY, KUMASI

INSTITUE OF DISTANCE LEARNING (IDL)

DEPARTMENT OF CONSTRUCTION TECHNOLOGY AND MANAGEMENT

Hello Sir/ Madam,

I am a graduate student of the Kwame Nkrumah University of Science and Technology pursuing a Master's degree program in Project Management through distant learning. As part of the requirement for me to be able to graduate, I have the responsibility of writing a thesis on a research topic I choose (Assessment of Material Management on Construction Project Sites).

The following questionnaire will require about 20 minutes to complete. In order to ensure that all information will remain confidential, please do not include your name or company name. Copies of this work will be made available to my supervisors.

If you choose to participate this project, please answer all questions as honestly as possible and return the completed questionnaires. Participation is strictly voluntary and you may refuse to participate at any time.

In light of that I would plead your indulgence in answering this questionnaire to help me efficiently and successfully complete this program.

Thank You.

SECTION A: BACKGROUND INFORMATION

Kindly respond to the questions by ticking [√] the appropriate response.

1. Which of the following best describe your profession or area of specialization in the construction industry?
   [ ] Architect [ ] Quantity surveyor [ ] Structural engineer
   [ ] Electrical/mechanical engineer [ ] Project Manager

   Other (Please Specify) …….

2. Which of the following best describes your area of specialization in the construction industry? (Optional)
   [ ] Contractor [ ] Sub Contractor

3. Current Position Held
   [ ] Project Manager
   [ ] Site Supervisor
   [ ] Foreman

   Other (Please Specify) …….

4. Which of the following best describes your highest academic qualification in construction industry?
   [ ] BECE [ ] SSCE [ ] NVTI [ ] HND
   [ ] Bachelor's Degree [ ] Masters [ ] PhD

   Other (Please Specify) …….

5. Which of the following best describe your work experience in the construction industry?
   [ ] Less than 5 years
   [ ] 6 - 10 years
   [ ] 11 - 15 years
   [ ] 16 - 20 years
   [ ] More than 20 years

6. Which of the following best describe your work experience in **material management**?
   [ ] Less than 5 years
   [ ] 6 - 10 years
   [ ] 11 - 15 years
   [ ] 16 - 20 years
   [ ] More than 20 years

SECTION B: MATERIAL MANAGEMENT PROCESS

Please select the construction material management process that you/your company currently following in this project:

S/N	Process Type	Followed	Not Followed
P1	Construction Material need generated from site		
	Check availability from the company warehouse		
	Check availability from local supplier shops		
	Inform the procurement department		
	Indent is generated (Purchase Order)		
	Vendor is selected from an approved list		
	Conduct inspection from the received stock		
	Update the ware house stock the requested materials are supplied to site		
P2	Plan and Schedule for materials		
	Monitoring & Controlling of all material activities		
	Organization of material management structure		
	Procurement		
	Delivery of requested materials		
	Storage		
	Issue out materials (Usage)		
	Surplus and Waste control		

S/N	Process Type	Followed	Not Followed
P3	Define Material requirements for the project		
	Vendor Evaluation		
	Purchasing of materials		
	Storage and Inventory on Site		
	Site distribution		
P4	Plan for materials		
	Purchasing		
	Receiving of materials on site		
	Inspection of received stock		
	Stacking and storing		
	Issuing out of materials		
	Inventory control		
P5	Planning		
	Purchasing		
	Logistics		
	Handling		
	Stock & Waste control		
P6	Kindly state the process you follow if not stated above.		

SECTION C: CAUSES OF INEFFECTIVE MATERIAL MANAGEMENT

Please tick the most appropriate response.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

MATERIAL IDENTIFICATION	1	2	3	4	5
Undefined Scope					
Poor communication leading to mistakes and errors					
Not determining what and when materials needed					
Complexity of detailing in the drawings					
Lack of information in the drawings					
Difference between plan and Specification					
Poor/ wrong specifications					
Selection of low quality products					
Overlapping of design and construction					
PROCUREMENT (Orders/Purchase/Delivery/Transportation)	1	2	3	4	5
Availability of material					
Late Deliveries					
Late or Incorrect submittals of material request					
Storage of material					
Poor handling / Re-handling of materials					
Use of wrong method of transport					

Damage of materials					
Poor Communication					
Unrealistic delivery dates					
Unsuitability of materials supplied to site					
Ordering errors (e.g., ordering significantly more or less)					
CONSTRUCTION PHASE	1	2	3	4	5
Incorrect type of materials delivered					
Incorrect quantity delivered					
Monitoring of materials					
Poor Handling / Re-handling of materials					
Method of Storage of materials (On site)					
Petty stealing by workers (Theft)					
Damage of materials					
Waste resulting from cutting uneconomical shapes					
Lack of onsite materials control					
Errors by tradesmen or operatives					
Accidents due to negligence					
Use of incorrect material, thus requiring replacement					
Attitude of workers and site foremen					
Unnecessary inventories on site leading to waste					

SECTION D: IMPACT OF MATERIAL MANAGEMENT ON PROJECT PERFORMANCE

The under listed are possible impacts of material management on project performance in relation to time, cost, quality and productivity. Kindly tick the performance

criterion/criteria that is/are by the listed impacted factors. You can select more than one for an activity.

No.	Material Management Activities	Criteria of Project Performance			
		Time	Cost	Quality	Productivity
1	Availability and sufficient materials				
2	Appropriate quality material				
3	On time and reasonable time of material procurement				
4	Efficient inventory system and documentation				
5	Reasonable changes				
6	On time delivery				
7	Minimizing procurement cost				
8	Appropriate site storage				
9	Efficient site layout				
10	Easy site access				
11	Unconfined working space				
12	Efficient material controlling				
13	Appropriate handling				