

UNIVERSITY OF EDUCATION WINNEBA
DEPARTMENT OF CONSTRUCTION AND WOOD TECHNOLOGY

**EXAMINING THE INFLUENCE OF MATERIALS MANAGEMENT
PRACTICES ON BUILDING CONSTRUCTION PROJECT DELIVERY IN THE
UPPER EAST REGION OF GHANA**



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2021

UNIVERSITY OF EDUCATION, WINNEBA
COLLEGE OF TECHNOLOGY EDUCATION, KUMASI

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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 fulfilment
of the requirements for award of the Master of Technology (Construction Management)
degree.

JUNE, 2021

DECLARATION

STUDENT'S DECLARATION

I, **Angelina Kawe Dapiah**, declare that this Dissertation with the exception of quotations and references 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 guidance for supervision of Dissertation as laid down by the University of Education, Winneba.

Name of Supervisor: Dr. Nongiba Alkanam Kheni

Signature:

Date:

ACKNOWLEDGEMENT

I am grateful to the Almighty God for his blessings throughout the period of my postgraduate studies and the period of writing this dissertation. My sincere thanks go to my supervisor Dr, Engineer Nongiba A. Kheni in Construction and Wood Technology Department for his precious time for reading through my script and did all the necessary corrections. I acknowledge the effort of Mr. Seibu for typing the manuscripts.



DEDICATION

I dedicate this work to my dearly husband Mr. Solomon Anyedina (GHANA NAVY) for his encouragement and all the necessary support throughout my research work. To our lovely sons and daughter and to my precious mother for her support and care. I also dedicate this work to my late Dad Mr. Dapiah Tadura who would have been so happy to see how the good lord, our God has done for me.



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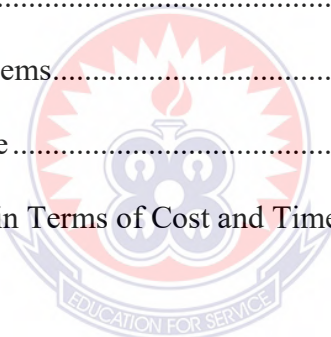
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ABSTRACT

It is long established in literature that materials management is a factor in time and cost overruns. However, research on the influence of materials management on construction project performance is often not comprehensive and, at best inconclusive. The aim of the study was to explore current material management practices and its influence on building construction projects in the Upper East Region in Ghana. The specific objectives of the study included; to investigate the current practices on materials management, to identify the root causes of ineffective material management, and determine the influence, if any of materials management on construction project delivery. The study adopted a cross sectional descriptive survey design. The target population of the study consists of construction professionals in construction industry in the Upper East Region in Ghana. Purposive sampling technique and snow ball sampling were used to select ninety-eight respondents. The response rate achieved was 41%. The findings of the study revealed that key material management practices include; construction material needs are generated before work commence on site, availability of materials in local supplier shops is checked, availability of materials in the company's warehouse is checked, procurement department is informed to plan the procurement of materials, vendor or vendors is/are selected from an approved list, and indents or purchase orders are generated. Also, the findings suggest that the causes of ineffective material management included; problems in materials identification, issues relating to vendor selection, procurement problems, and other problems experienced at the construction phase. The study's respondents agreed that ineffective materials management negatively affected construction project performance. Over half of the respondents indicated the percentage of cost overrun caused by ineffective materials management experienced in projects ranged from 5% to 15% whilst the extent of delay caused by ineffective materials management experienced in projects ranged from one month to one year. The study concluded that over ordering of materials, worker's mistakes, imperfect planning of construction and lack of waste management plan are the major causes of material wastage on construction sites. Based on the findings of the study, it was recommended among others that contractors should apply the concept of material management effectively in order to reduce the occurrence of unplanned cost which may arise as a result of improper material management. Additionally, contractors to opt for proper storage of aggregates where treated ground will be used instead of the normal bare untreated ground.

CHAPTER ONE

INTRODUCTION

1.1. Background of the Study

Construction projects are one of the most common activities we encounter in our lives, yet it is also known as one of the most difficult humankind endeavors. As a matter of fact, each project consists of sophisticated and complex processes which need to be carried out by different individuals of different professionals, who have special set of skills and knowledge. All the talent and skills have to be channeled towards a common goal to producing the project. To accomplish this goal, time and money are required. At the end these construction projects, provide us with facilities that are useful, functional, visually pleasing and enjoyable to occupy. This journey is called the project delivery process (Construction Specification Institute, 2011). Effective delivery is all about the control and management of uncertainty. Therefore, one need to identify the uncertainty related to the project and develop the best strategy to deliver the project so that the chances of success are increased.

Hence steering the way for accomplishing successful project is all about knowing all the tactics to tackle our way through the impending obstacles. So, identifying these obstacles are crucial in order to confront them. Thereby a lot of researchers have immersed themselves in various studies to identify the causes of delay and cost overrun happening in various projects. The analyses on these factors have been carried on different contexts over a long period of time. This continuous effort on finding the causes or the factors for delay and cost overrun are more or less generated similar results and only the ranking have been swapped between the different context and time. Although the repetitiveness in this approach is observed, a change in perspective can provide an interesting insight in a common pattern in these factors. For instance, issues regarding construction materials have

been highly ranked in both delay and cost overrun factors and also it is a common factor that is mentioned in almost all the research done on this area. Hence this ignites the curiosity to unfold the relationship between construction material and construction project.

The construction industry is vital for the development of any nation. In many ways, the pace of the economic growth of any nation can be measured by the development of physical infrastructures, such as buildings, roads and bridges. In the construction management site, the performance of the construction practice is very essential and it has many effects, improper handling of materials during site activities and it has the potential to severely obstacle project construction performance. There are major issues, which affect materials management activities, constraints on storage areas, site logistics concerning materials handling and distribution, and also ordering and delivery of materials to the construction site. The other issue of the effect of the performance of the construction is improper storage and need large storage. Also, transportation difficulties and inappropriate materials delivery, and include manual processes, and non-compliance with specification according to (Takim, 2002).

The main reason for construction material to be so influential in a construction project is because the cost for material handling may range from 30 – 80 % of total construction cost (Proverb, et al., 1999). Therefore, ineffective material management can cause inevitable loss for a construction project. Material management can be considered as a prime uncertainty in a construction project. Bell and Stukhart (1986) defined materials management functions which include planning and material take off, vendor evaluation and selection, purchasing, expenditure, shipping, material receiving, warehousing and inventory and material distribution. As material management is interrelated to other processes and stages of the construction project and is dependent over various other factors it has high uncertainty. Especially the nature of construction project being fragment basis

with unstructured communication and no clear responsibility between the parties, increase the challenge of implementing effective material management.

1.2. Problem Statement

A report by Ghana Investment Promotion Center (GIPC) indicates that Ghana's real estate sector has seen significant growth in the past few years (GIPC, 2017). This has been spurred by growth in demand for both residential and industrial property. There exists unmet demand leading to growth opportunities in the areas of construction and real estate development and management (GIPC, 2017). Ghana's property market is dominated by residential and commercial developments (Anim-Odame, 2014). The residential market is the most active, registering an estimated 85 000 transactions per annum over the past decade. Commercial property is the second-largest segment in the market and includes office accommodation and retail space (Anim-Odame, 2014).

Given the construction business boom, most construction firms do not have current and well-established construction material management system. The materials management practices in these countries are performed on a fragmented basis with unstructured communication and no clearly established responsibilities between the parties involved (Thomas *et al.*, 1989). This fragmentation creates gaps in information flow, which affects the decision-making process and lead to delays in material ordering and receiving, among other problems (Thomas *et al.*, 1989). The material manager needs to realize that decisions taken at four stages in the process will certainly impact other activities and processes in the supply chain, logistic, storage, problems are not realized due to this fragmentation (Perdomo-Rivera *et al.*, 2004).

Without proper materials management practices unexpected condition can affect the project. Therefore, in this research more in-depth study will be conducted to understand how materials management practice can have an impact on the construction delivery time.

Bringing imported construction materials made-to-order for a construction project is time consuming and requires high expenditure. On the other hand, those projects depending on the limited local supplier shops face the difficulty to find the right quantity and quality of materials needed for the projects. Ultimately putting the project at stake and accelerating the cost of the project. Therefore, in this research a study will be carried out to explore the relationship between different material management processes practice and project delivery in terms of cost overrun and delay.

Multiple times the researchers in the field of construction highlighted the challenges that they are facing due to the imported materials, but an in-depth study has never been conducted (Rashfa, 2014). Even though fundamental discussions have been conducted to raise concern regarding construction material, no practical and comprehensive solutions have been reached. The aforementioned arguments therefore underscore the aim and objectives of this study.

1.3. Purpose of the Study

The aim of this study was to explore current material management practices and its impact on the delivery of building construction projects in Ghana.

1.4 Specific Objectives

The specific objectives of the study are as follows:

- To investigate the current practices of material management in construction site;
- To identify the root causes of ineffective material management in Ghana's construction projects; and,
- To explore the relationship between material management process types and project delivery in terms of cost overrun and delay.

1.5. Research Questions

- a. What are the current material management practices in construction projects in Ghana?
- b. What are the roots causes of ineffective material management in Ghana's Construction projects?
- c. How do project delivery in terms of cost overrun and delay relate to the Material management practices in Ghana?

1.6. Scope of the Research

This research paper focuses only on the construction industry of Ghana. Moreover, it concentrates specifically on building projects such as; residential and non-residential hotels, restaurants. Even though projects with various project value and size are explored in this research, a special attention to building projects in Northern Ghana.

1.7. Significance of the Study

All sectors of the industry share a common ground for material management and control. Thus, the discussions presented although it is directed towards the contractor companies in construction industry it could be applied to any sector. The findings from this research will serve as a guideline to the Ghanaian construction industry stakeholders. Therefore, this study will be the first to reveal the existing material management practices and the comparison between the different approaches will give the field professions a deeper insight into these practices.

Moreover this study will generate a list of root causes for ineffective material management that can be used as a benchmark to control the existing and future projects.

In addition, how these root causes are related to the current material management practices will be made aware to the stakeholders to be more cautious.

Furthermore, the most concerning issues like cost overrun and delay in terms of project delivery and its relation with the current material management practice will reveal the weakness in the current material management practices to the stakeholders.

Apart from this research being useful to the field professionals, this study will be valuable for the academicians too. As this study will serve as a support of what the past researchers have written about material management in construction projects. Furthermore, it will also provide information for further researchers who are willing to investigate on this particular or similar case.

1.8. Organisation of the Study

This research is composed of five chapters; the content of the chapters is briefed as follows:

Chapter 1

This section introduces the research topic. It consists of the research background, research problem, research Objectives, research questions, research scope, and research significance. Finally, the chapters' outline and summary.

Chapter 2

Provides a review of literature in four areas related to this study. Current complications in construction industry in Ghana, material management processes and techniques used in construction projects, root causes of ineffective material management faced by developing countries and consequences of ineffective material management on project delivery.

Chapter3

Describes the research approach used to develop, to achieve the objectives of this research. It describes the research design, the population and sample, questionnaire development, data collection, data analyses and pilot study that were used in this research.

Chapter4

Discusses the data analysis and the result obtained from the study. This specifically includes statistical methods such as Cronbach Alpha, mean, bar charts, pie charts, tables and analytical studies. And specific discussion of each of the factors analyzed.

Chapter5

This section contains the major findings of this study, followed by contributions of this research. Furthermore, constraints and limitation of this study is summarized and also outlines recommendations for future research related to this study.

1.9 Summary

This chapter explains the current practices of materials management by seeking the views of material management practices at construction site. To suggest a good method to implement material management at construction site in Ghana that provides context in formulating the research approach taken to accomplish the objectives of the study. The contractors are in a strong position as they have the guidance to define the problems and to improving appropriate methods of materials management in construction projects. This aimed at enhancing materials management as a standard towards successful project productivity. In addition, the research also outlined the research scope and the methodology to be used in the research process. Therefore, further relevant information that relates to the research will be discussed in literature review in the subsequent chapter.

CHAPTER TWO

LITERATURE REVIEW

2.1. Introduction

This chapter presents the review of related literature and it is organized into seven main sections comprising; an introduction, concepts of construction project delivery and materials management, materials management in construction projects, materials management processes and techniques, root causes of ineffective materials management, consequences of ineffective materials management on project delivery and a summary of the literature review.

2.2 Concepts of Construction Project Delivery and Materials Management

Unlike earlier days, today the construction industry has become highly complex due to the technological developments, globalization, uncertain economic conditions, social pressures, political instability and so on (Walker, 2015). The conventional methods are incapable to meet with the demands of today's environment that is described by the authors as being more dynamic and filled with greater uncertainty (Keith, et al., 2016). With the increasing complexity and uncertainty, project delivery is not only management of three project constraints: cost, scope and time, but perceive it to be an assessment of the uncertainty within which the project is operating and its continuing ability to respond to the reason why it was needed in the first place (Melton & Iles-Smith, 2009). Effective delivery is all about the control and management of uncertainty. Therefore one need to identify the uncertainty related to the project and sculpt the best strategy to deliver the project so that the chances of success are increased.

There are certain sets of methods followed in delivering a construction project. Even though these processes vary from country to country and also from project to project

there is a common process that is mostly recognized by a country's construction industry. Likewise the current conventional process of design and construction that is used by Ghana involves the developer or the client to proceed with the detail designing of the building. The documents and drawings are usually prepared before selecting a contractor. Moreover, the construction documents needed for tendering will be prepared by the design firm, hired by the client or the developer. The design firm also will be acting as a consultant during the design and construction of the project. In addition, the design firm will represent the developer in dealing with the contractor and the government authorities. The detail design stage and the construction will take place separately (Tholhath & Ibrahim, 2013).

Therefore, different definitions can be found in different references. Material management is concerned with the planning, identification, procuring, storage, receiving and distribution of materials (Khyomesh & Chetna, 2011). The purpose of material management is to assure that the right materials are in the right place, 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.

Said *et al.* (2010) suggested that the development of a new optimization model for construction logistics planning that is capable of simultaneously integrating and optimizing the critical planning decisions of material procurement and material storage on construction sites. The model utilizes genetic algorithms to minimize construction logistics costs that cover material ordering, financing, and stock out, and layout costs. The model incorporates newly developed algorithms to estimate the impact of potential material shortages on-site because of late delivery on project delays and stock-out costs. Also explained that Material procurement and storage on construction sites need to be properly planned and executed to avoid the negative impacts of material shortage or excessive

material inventory on-site. There are several factors within the scope of material management and each of these factors can give rise to potential problems (Said *et al.*, 2010). The more factors are divided, the more potential problems that exist. There are many factors which contribute to poor material management in construction projects.

Construction industry such as housing, infrastructure facilities use a large quantity of materials. There is a large demand in building material due to population growth and there is a gap between demand and supply management. In this situation, researchers try to find a good solution for construction material management. Valuable management of materials signifies an area with immense potential for enhancement efficiency of work and also controlling expenses. This is important for building professionals and the general public because it would not only explain but also make awareness of the extent to which inadequacies in material management that can negatively affect project performance. The study aims to help the contractors, clients, consultants and all parties involved in construction projects about the ways of improving their present techniques and methods of material management (Mehr *et al.*, 2014).

Finally, Kasim *et al.* (2005) defined materials management as an important function in order to improve productivity in construction projects. Also, 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 (Kasim *et al.*, 2005). 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. Material management involves the planning, identification, procuring, storage, receiving and distribution of materials (Kasim, 2008).

2.3 The Construction Industry

It is a generally accepted phenomenon that the construction industry plays a key role in the development of socio-economic growth of a country. This extends to the development goals of making necessary infrastructure available, providing employment opportunities and also shelter for society. Among these socio-economic development goals are urban infrastructure, highways, schools, hospitals, houses, townships, roads, railways, airports, seaports, power systems, agriculture systems, telecommunications and others (Chileshe and Berko 2010; Osei 2013). A large part of the economy of a country is constituted by the construction industry which contribute up to 10% of the gross domestic product (GDP) and also employs about 10% of the working population. The construction industry deals with the creation, repair, renovation or extension land improvements, of buildings of an engineering nature referred to as the fixed assets of the country. About half of the gross fixed capital formation of an economy is also constituted by the construction industry which shows how relevant the construction industry is to the country's economy (Ofori-Kuragu, Owusu-Manu, and Ayarkwa 2016). With the government being responsible for majority of the investment in the construction industry, the level of spending can be regulated in order to make some expected changes in the economy as the industry is seen as a potential economic regulator. Although the construction industry has complex linkages to several other sectors in the country, these linkages can be used as stimulants for activities of the sectors. This is because inputs from these sectors are necessary for the operations in the construction industry and in return the sectors need infrastructure to Function. This shows that the linkage is a two-way mechanism which if well harnessed will Help boost the economy of the country. By holding huge potential for boosting the export of Projects, stimulating growth and also employment generation, the construction industry is one of the fastest growing sectors amassing an average of 7-8%

growth per annum (Ofori 2012; Osei 2013). This research work seeks to understudy the Ghanaian construction industry.

The Ghanaian construction industry which is patterned on the UK built environment is not an exception as it contributes largely to the economy of the country. This is evident from the observation of the regulatory and legal documents of the building regulations used in the Ghanaian construction industry. According to the submission of Frimpong, Oluwoye, and Crawford (2003) and Osei (2013) the construction industry in Ghana can be likened to the UK Construction industry of twenty (20) years ago owing to the serious shortfall experienced in Safe working practices, material handling, quality and the timeliness of construction projects in the industry. Similar to the construction industry of every developing country, labour in the Ghanaian construction industry is comparatively cheap. The industry is characterized by asset-based-lending and physical infrastructure which serves as a means of development and growth.

There are various key stakeholders involved in the activities of the industry which are main contractors and sub-contractors of every tier; design community; client community (private and public); economic drivers (financial corporations and banks); supply chain (machinery manufacturers and material suppliers); trade unions; professional associations; technological Institutions and universities (Ofori, 2012; Osei, 2013). These stakeholders can be categorized into four groupings which are discussed below.

2.3.1 Users and Consumers of the Ghanaian Construction Industry

The largest user and consumer of the construction industry is the government that owns most of the costliest housing, infrastructure and tertiary buildings. In Ghana, the Ministry of Works and Housing oversee the activities of the construction industry together with state-owned corporations and ministries. Even though government is responsible for

the activities of the construction industry, the private sector is the driver of the expansion of the construction industry. These private sectors include civil society and non-governmental organisations; individual home owners; business organisations; unregistered business owners and residents (Ofori-Kuragu, Owusu-Manu, and Ayarkwa 2016; Osei 2013).

2.3.2 Demand Side Operator

This category involves the users and consumers of the industry. Real estate developers and property agents invest in the construction industry in order to make provision for both speculative and client proposed developments while government, businesses and state-owned corporations also invests in the construction industry (Ofori 2012; Osei 2013).

2.3.3 Regulators

There are building regulations and planning schemes developed for the Ghanaian construction industry which are fashioned after the UK system. Environmental Protection Agency (EPA) through Environmental Impact Assessments (EIAs) developed environmental regulations and are in charge of enforcing these in the construction industry. District assemblies and metropolitan officials are responsible for development control through guidelines put in place for the submission and approval of plans (Osei 2013).

2.3.4 Supply Side Operator

The Ghanaian construction industry has supply side operators which can be referred to as traditional professional groups. These include civil engineers, architects, quantity surveyors, electrical and mechanical engineers; and material/machinery suppliers

for construction projects. The professionals register with their professional bodies which accredit them for professional practice in the construction industry. These professionals also make up the contracting organisations coupled with trade union members who plays a major role being the most visible stakeholders of the construction industry (Duah 2016; Ofori 2012; Osei 2013). This review research study employed the use of SCOPUS and ISI Web of Science databases to access published articles using the keywords: “Ghanaian Construction Industry”; “Road Construction in Ghana”; and “Construction Industry in Ghana”. This assisted in gathering 47 related and relevant articles used in carrying out the review study.

2.3.5 Challenges Facing the Ghanaian Construction Industry

With Ghana being a developing country, the challenges facing the Ghanaian construction industry are similar to those reported from other developing countries. Even though developing countries attribute the development of the country’s economy to the construction industry, the industry is yet to be given the acknowledgement that it deserves. The industry is not planned holistically which has resulted in its operations being carried out in fragments, using of conflicting components with inefficiency, wastage and inability to make proper plans that will lead to development. With the government being the major client of the Ghanaian construction industry, there is limited financial commitment from them to meet the large demand for several categories of outputs expected from the industry (Ofori, 2012; Osei, 2013). Some of the challenges facing the Ghanaian construction industry are explained below.

2.3.5.1 Delayed Payments

Since government are the main client of the construction industry in Ghana, payments by government agencies for construction projects executed have been observed to be delayed which has a negative impact on the credibility of local contractors in obtaining loans from their creditors for future projects. Payments delayed by clients to contractors always result in late completion of projects, reduce contractors' profit margins, promotes corrupt practices, contractors' attention being divided and capital being tied up. Delayed payments are influenced mostly by the improper classification of contractors and lack of technical assistance on the part of government agencies (Amoatey and Ankrah 2017; Frimpong, Oluwoye, and Crawford 2003; Mensah, Adjei-Kumi, and Nani 2016; Osei 2013).

2.3.5.2 Land Tenure Challenges

This is a challenge faced by most African countries and it is not peculiar to Ghana alone however, the nature of this challenge varies based on each locality and culture. In Ghana, customary ownership of land is family-based in that the decisions about the use of land is determined by the customs of individual families. These decisions are mostly not taken up into written records which makes it difficult to obtain the evidential basis for the use rights. Therefore, this results in the uncertainty of ownership in most cases (Agyeman and Ampadu 2016; Osei 2013; Owusu-Bio, Frimpong, and Duah 2016).

2.3.5.3 Preference for Imported Raw Materials

The construction industry clients and stakeholders in Ghana prefer the use of imported raw materials to proven alternative local materials. This has resulted in the inadequate use of vast quantities of local materials which are readily available in the

country. Government can assist with the promotion of locally produced materials by evolving strategies that will exploit the local resources (Danso and Antwi 2012; Ofori-Kuragu, Owusu-Manu, and Ayarkwa 2016; Osei 2013; Tefe and Jones 2013).

2.3.5.4 Lack of Technology

Incorporation of new technologies into the Ghanaian construction industry is still low as this is evident on construction sites around the country. There are new technologies which has been put in place to assist in the construction process and improve the productivity and quality of the products of the construction industry. The implementation of these technologies will no doubt increase development of the construction industry which will in turn improve the economy of the country (Assibey-Mensah 2009; Forster and Mensah 2013).

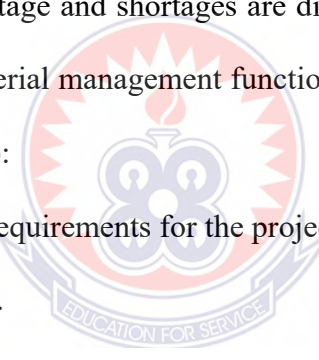
2.3.5.5 Financial Constraints

The Ghanaian construction industry operates on donor-funding for construction projects. Inadequate credit facilities to the necessary players of the industry (private sector) by financial institutions result in little growth of the industry owing to it relying too much on government funding. The unavailability of appropriate funding for projects reduces the performance of the industry. Therefore, this poses problems in mobilizing workforce and equipment for massive construction projects (Amoatey and Ankrah 2017; Osei 2013). Some other identified challenges associated with the Ghanaian construction industry include but are not limited to the following: insufficient capacity in engineering; poor level of workmanship; shortfall of management abilities; low productivity; inadequate operating cash flow; inadequate maintenance culture; inadequate revenue base for construction project funding; ineffective reporting and information management system; incapability

of local contracting and consultancy; serious management gap; lack of training opportunities; long gestation period for loans; and low scale of professional fees (Amoatey and Ankrah 2017; Mensah, Adjei-Kumi, and Nani 2016; Ofori 2012; Osei 2013).

2.4 Material Management in Construction Project

Materials Management has been defined as the management system for planning and controlling all necessary efforts to make certain that the right quality and quantity of materials and equipment are specified in a timely manner, are obtained at reasonable cost and are available when needed. In the past, construction managers have been more consumed with the control of labor and the control of plant. There is now a growing awareness that materials' wastage and shortages are diluting the profit to the contractors more than other reasons. Material management functions can be generally categorized as follows (Dawood *et al.*, 1994):

- 
- (i) Defining material requirements for the project.
 - (ii) Vendor evaluation.
 - (iii) Purchasing.
 - (iv) Storage on site.
 - (v) Site distribution.

Construction material is recognized to be a major component in the construction project cost. Depending on different project it is assumed that the material cost can represent from 30% to 70% of the total project (Donyavi & Flanagan, 2009). Construction materials consist of various raw materials extracted from different markets. Sadly, the prices and availability of these materials are highly vulnerable to the turbulences of the varying market conditions (Christopher, 2011). Thereby making the construction materials a highly uncertain component in the construction project.

The range and variety of construction material are accelerating with the advancement of technology. This has resulted the construction industry to shift away from localized use of materials to centralized worldwide production. Gradually the simple materials are being replaced by the introduction of engineered composites and mixed assemblies. Moreover, chemical additives have enhanced the materials producing a wider array of properties (Calkins, 2009). The ample options of materials with varying properties have been considered as an accomplishment to the construction industry however the availability of too many options have caused complications in making the right choice. Experts and specialists are required to select the most compatible construction material to compliment the project. The material choice will determine the machinery and workmanship required and making the right choice from initiation can pave the path for a smoother delivery.

After the selection of material till the final product is erected it involves a series of processes, which is referred as material management. This involves storage, identification, retrieval, transport and construction methods (Pellicer, et al., 2013). Material management is the system of planning and controlling to ensure the right quality and quantity of materials and equipment are specified in a timely manner. (Donyavi& Flanagan, 2009). All these process posses' high uncertainty, as they are interlinked with other series of activities with unknown variables. Therefore, according to many authors effective materials management is the key to the success to construction project (Gulghane&Khandve, 2015). More researches even eloboratethat effective material management can improve the productivity of the project and thus can lead to success (Pande&Sabihuddin, 2015).

Even though having an effective material management is highly crucial to building projects, there has been no such study done on this area in Ghana. The uncertainty

involving in material management is inconceivable, especially because construction materials are not locally available in Maldives. Depending on imported construction material, increase the complexity in the process. These are the general problems faced by the construction industry and Ghana as a country that were repeatedly emphasized in these publications as follows:

- Limited skilled professionals
- Lack of unskilled laborers so depending on foreign laborers
- Unavailability of local construction materials (rely on imported materials)
- Few suppliers in market
- Poor infrastructure
- Lack of space/storage

2.5 Material Management Processes and Techniques

Material management consist of a series of processes that need to be integrated, coordinated and synchronized well to ensure that material are available at their point of use when needed. Material management process begins from need generated from site followed by this information conveyed to store department and material is ordered in the store, indent is generated. Usually vender selection is to be carried out for the least value and best items. Materials are received at store departments and inspection is carried out. Below in Figure 2 is a material management process flow chart (source from Patil & Pataskar, 2013).

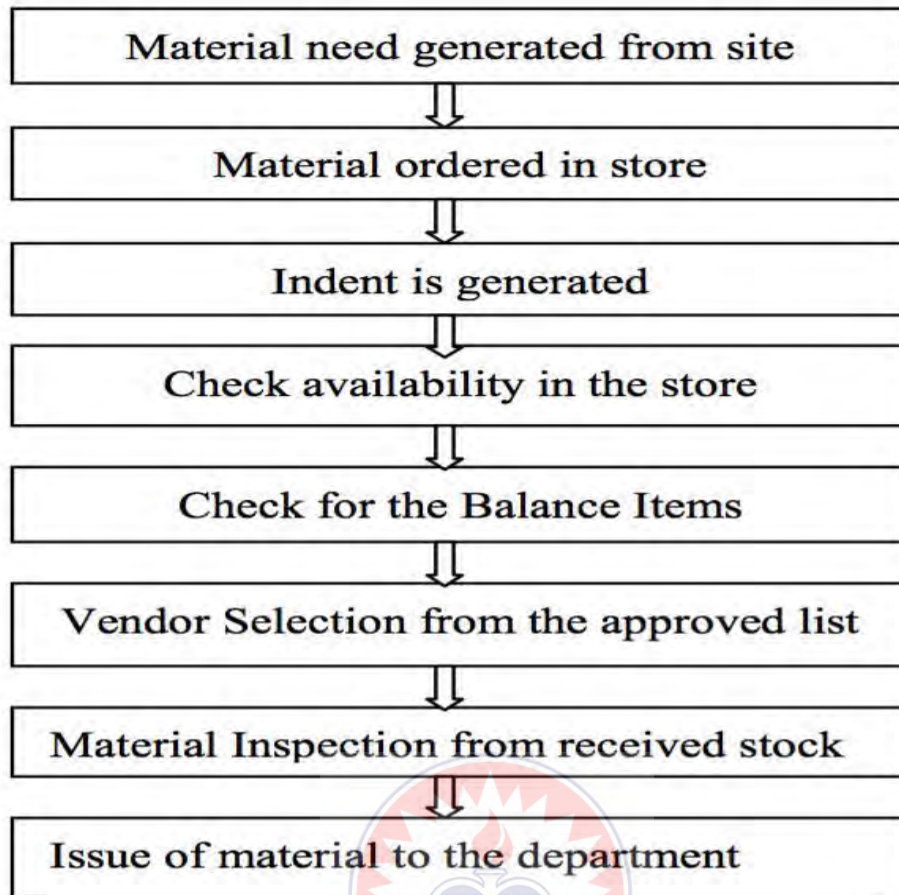


Figure 2.1: Material Management Processes

Source from Patil & Pataskar, 2013

Phu et al. (2014) suggested that factors such as waste, transport difficulties, improper handling on site, misuse of the specifications, lack of proper work plan, inappropriate material delivery and excessive paperwork all adversely have effect on material management. Factors related with material management can be mostly found in the following areas in local construction projects

- (i) Planning and Scheduling
- (ii) Monitoring and Controlling
- (iii) Organization and Personnel
- (iv) Procurement
- (v) Delivery

- (vi) Storage and Storage facilities
- (vii) Usage and Surplus and Waste control

2.5.1. Planning

Material planning is the initial process that needs to be carried out accurately in order to provide guide to all the subsequent activities. According to Gulghane & Khandve (2015) material planning includes quantifying, ordering and scheduling. The materials planning process covers the set up maintenance of records and determines the target levels and delivery frequency. Adopting a good material management plan can increase productivity and profit. Hence, it can help to increase the success of project delivery (Kasim, et al., 2005).

In construction scheduling is concerned with the regulation of the flow of construction units through their preconceived plans of operations, material. Scheduling involve the establishment of time tables for the ordering of all materials requirement for maintaining the flow of materials must be schedule to coincide with the flow of all construction of activities involved in the actual construction of each project (Albert *et al.*, 2014).

2.5.2. Testing

Quality is a prime factor to measure the performance of a project. Quality assurance of building materials is vital in order to create strong durable and cost effective structures (Savitha, n.d.). Each construction project has a different set of specification and requirements. The contractors are required to select and procure suitable construction materials so that they can meet the contract specification. Unless a specific brand and model number is stated, it is advisable to conduct thorough study and analysis of the

different material properties to check for its compatibility in the different zones of the building. The materials are only ordered after receiving approval (Low & Ong, 2014). Proper assessment of the various materials is important to ensure quality and durability of the final product.

2.5.3. Procurement

Procurement is not only about appointing contractors and preparing contract, but is also very much a starting point in the process of delivery (Mead & Gruneberg, 2013). Activities included in the procurement process range from purchasing of equipment, materials, labour and services required for construction and implementation of a project (Kasim, et al., 2005). Another author has defined procurement as identifying and analyzing user requirements and type of purchase, selecting suppliers, negotiating contracts, acting as liaison between the supplier and the user, and evaluating and forging strategic alliances with suppliers. For many organizations, materials and components purchased from outside vendors represent a substantial portion of the cost of the end product, and hence effective procurement can significantly enhance the competitive advantage of a project (Morris & Pinto, 2007).

Many authors have suggested that choosing best option of procurement can help to reduce the impact of uncertainties such as late deliveries, substandard raw material qualities, resource constraints and so on (Morris & Pinto, 2007). Therefore, to successfully deliver a project it is not about adopting a procurement system with best practice tactic to fix all problems, but to embrace an approach that has the best-fit tactic that gets the job done most efficiently (Keith, et al. 2016).

(i) *Material Purchase*

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 all business are administered or managed by coordinating and integrating those six functions: -Creation, the idea of design function, Finance, the capital acquisition records function, Personnel, the human resources and labor relation function, Purchasing, the buying of required equipment, material, and services, Conversion, the changing of material to economic goods, 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. Sometime good material can be purchased at lower unit cost through large order size purchases According to (Lamer, 2007).

(ii) *Purchasing Departments*

In large organization the purchasing group may include purchasing analyst, traffic expert expedites as well as management. In some cases, purchasing is expanded to include all logistics involve in the moving handling storing of material. The purchasing department on the order hand has the responsibility and authority to schedule outside production the purchasing department is an organization unit of firm whose duties include some part or all of the purchasing function (Lamer, 2007).

(iii) *Purchasing Documentations and Records*

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. 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, address should be included in the form's design for best control (Lamer, 2007).

2.5.4. Logistics

Logistic is defined as concept that includes movement and it may encompass planning implementing and controlling flow and storage of all goods from raw materials to the finished product to meet customer requirements (Kasim, et al., 2005). For smoothly handling the materials, space need to be carefully allocated for material handling equipment, access roads, warehouses, workshop, and laydown materials in the construction site (Pellicer, et al., 2013). Planning these tasks accurately can help to formulate an efficient construction site layout that can provide easy access and routing of materials within the construction site. Moreover, introducing slopes in the construction site can ease the circulation of materials because of the gravity effect. To control access and to increase the security of the site, setup wall or fence can be considered as a requirement for the construction site. Optimum forecasting for material movement (Mahdjoubi & Yang, 2001) and planning of access and routing of materials within construction site (Faniran & Caban, 1998) are factors that need to be taken consideration during logistics process for effective material management.

In general, construction logistics can be divided into supply logistics and site logistics. Supply logistics are related to activities in the production process that are cyclic such as the specification of supply resources such as materials, equipment, and labour, supply planning, acquisition of resources, transport to a site and delivery, and storage control. Site logistics are related to the physical flow of on-site processes such as the

management of handling systems, H&S equipment, site layout, defining activity sequence, and resolving conflicts among various production teams related to the on-site activities (Jang *et al.*, 2003).

Given the above mentioned outcomes in the construction industry, it is imperative to advocate the objectives and advantages of logistics management. In other sectors of the economy, the objective of logistics management is to design, develop, and implement an overall process that will be completely responsive to customer requirements. These merits are transferable to the construction industry that is faced with increasing demand from clients relative to performance and conformance to requirements. In this context, logistics management enable requirements that will lead to minimizing the overall response time from when a need is first identified to delivery and installation of the finished product at the user's site, minimizing the number of steps in the decision-making process, minimizing the step sand time required in the materials purchasing process; increasing asset visibility, and minimizing inventory requirements; the number of warehouses necessary and storage requirements, minimizing packaging and transportation times, and minimizing cost from a system life cycle perspective (Emuze *et al.*, 2011).

It follows that the realization of the abovementioned objectives is dependent on reliable information flow and logistics requirements in Supply Chain Management (SCM) activities including the forward and reverse flows. Client's demand for improvement and new technologies makes the adoption thorough logistics practices imperative in the industry. The literature shows that efficiency gains accrue if the concept of logistics management is optimized in construction as logistics adds value to economic activities in the construction process through place and time utility. Logistics also provides place utility by moving goods from production surplus points to where demand exists and time utility by making sure the goods are available when they are needed. Logistics creates place

utility primarily through transportation, and time utility through proper inventory maintenance and strategic location of goods and services (Emuze *et al.*, 2011).

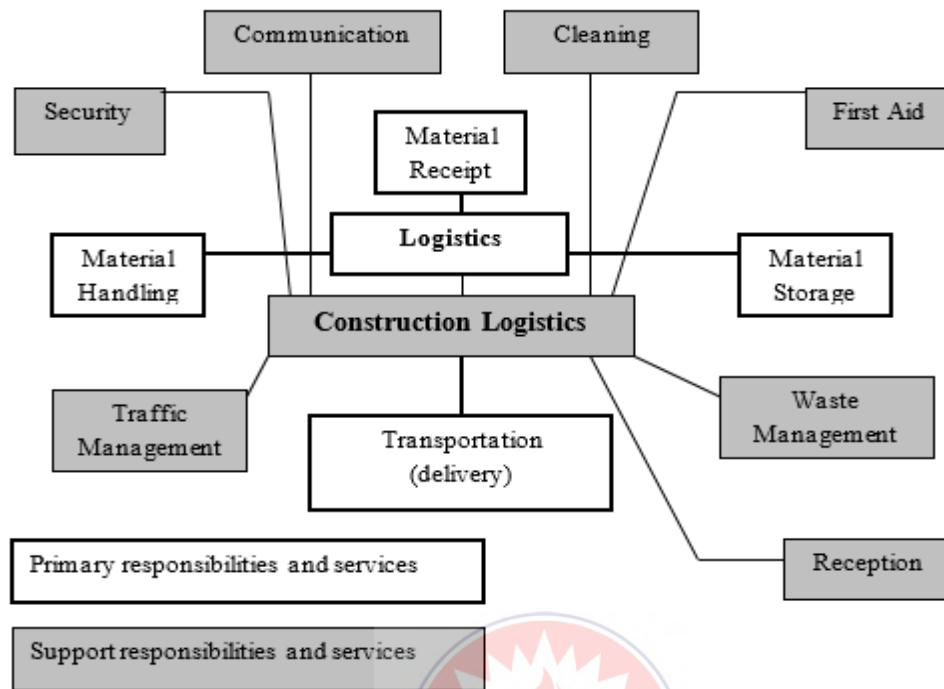


Figure 2.2: Integration of Logistics Functions in Construction Logistics System

(Sullivan *et al.*, 2010)

2.5.5. Handling

Various materials possess different features and properties, that makes the handling of materials critical. Effective material handling involves handling, storing and controlling of construction material (Kasim, *et al.*, 2005). Proper protection during storage is often ignored, and this can result in poor material quality or material deterioration. Moreover, it is also advised that transportation, loading and unloading of material should not be conducted in the rain. It is also recommended that the storage area needs to be enclosed, clean and dry with good air circulation and for some materials need to be stacked on pallets, not more than a certain safe height to prevent dampness and so on (Low & Ong, 2014). By adopting proper material handling and storage will help to keep the material intact and in

good quality. And also will reduce loss of profit due to theft, damage and wastage as well as running out of stock (Kasim, et al., 2005).

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. 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).



Figure 2.3: Handling, Storing, and Controlling of the Construction Materials

(Chan, 2002)

2.5.6. Stock and waste control

Material waste is a significant factor in construction cost, Calkins (2009) states material waste is 9% by weight in the Dutch construction industry and 20-30% of purchased materials in the Brazilian construction industry. Material wastes are caused by several sources such as design, procurement, material handling, and operation and so on. Shen et al. (2003) defined building material wastages as the difference between the value of materials delivered and accepted on site. Moreover, material waste has been recognized as a major problem in the construction industry and it can also implicate inefficiency in project delivery. Adopting a proper stock control will help to increase the productivity and also can be one of the way to improve waste control in the construction site. By introducing minimizing strategies to reuse materials in both design and construction phase can be a mean to reduce waste (Dainty & Brooke, 2004).

Some authors simplify these stages into distinctive phases. As a matter of fact one of the research done by Manteaux (2007) on the material management practices in Ghana explains that the current material management phases in Ghanaian construction industry are bidding phase, sourcing phase, material procurement phase, construction phase and post construction phase. A study conducted in India by Patel & Vyas (2011) has summarized the material management processes into 8 main parts. They were planning, benchmarking, purchasing, receiving, inspection, storage, issuing material and inventory control.

Therefore, it is very evident that in various countries these processes are carried out in different ways. There can be many factors that might influence these processes such as culture, work environment, belief and so on. Moreover, different groups have learnt to deal with uncertainty in different ways, often because they find themselves faced with different levels of uncertainty. Adams (1965) writes of 'risk thermostat' in relation to

individuals' ability to deal with and be comfortable when exposed to risk. Therefore, already established material management processes that are being practiced by other countries can be used to identify the processes that are being practiced and those that are neglected in Ghana's construction industry.

2.6. Root Causes of Ineffective Material Management

During the past years, various academics researchers have conducted studies investigating to find out the issues causing ineffective materials management in construction projects. These studies are discussed to put the present study in perspective. A study carried out Zakeri et al (1996) suggested that transport difficulties, waste, improper handling on site, misuse of specification, lack of proper work plan, inappropriate materials delivery and excessive paperwork all have an immense effect on materials management. Another researcher, Dey (2001) emphasized that the common issues regarding material management are as follows:

- Receiving materials before they are required which may increase inventory cost and may increase the chance of deterioration in quality;
- Not receiving materials during the time of requirement causing to decrease motivation as well as productivity
- Incorrect materials take-off from design and drawing documents;
- Constant design changes
- Theft or loss of item
- Choice of type of contract for specific material procurement
- Vendor evaluation criteria
- Piling up of inventory and controlling of the same
- Management of surplus material.

In another study conducted by Sohrab Donyavi (2009) states the common problems in material management are as follows:

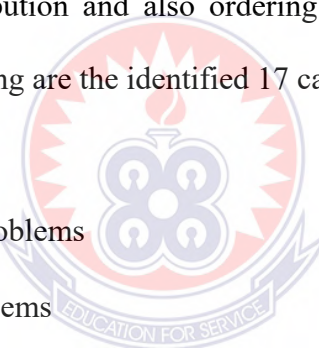
- Failure to order on time which may cause delay in the projects;
- Delivery at the wrong time which may interrupt the work schedule;
- Over ordering;
- Wrong materials or wrong in direction of materials requiring re-work;
- Theft of materials from delivery into production;
- Double handling of materials because of inadequate material

Moreover, a study conducted Kasim (2008) highlighted that problems could emerge due to human error, especially because some construction firms still rely on manual methods for material management which involves paper based techniques. In addition, she states that problematic use of paper based reports for exchanging information relating to materials component with supply chain can result misunderstanding and poor coordination.

In another research done by Gulghane & Khandve (2015) state that problematic management of material are due to overstock materials because of improper planning, damaged materials due to logistics, handling or in application, loss of materials because of improper supervision, waiting of the materials to arrive in location due to improper tracking system, frequent movement of materials due to improper site layout, inflation, material changes in buying or purchasing situation starting from the prepared cost estimation, bulk construction material, the shortage and changes of construction materials quantity required, material inefficient on site, stealing and loss of construction material, material shipment, work repairing, delay in updating or posting storage system on site, in accurate estimation of shipment quantity of materials, uneconomical order quantity of materials poor shipping time, increasing transport cost of materials, material over usage in

location of project, choosing the wrong materials for construction, the increasing storage cost of materials, the poor buying ability of managers, delay of payment for materials.

A study done by Kasim (2008) investigates the problems in material management by conducting a research on 6 case studies. Case study A and B are two small projects from two different construction companies, while the other 4 case studies are larger or more complex studies. The interviewees under study were experience constructional professionals ranging from 8- 32 years' experience. Moreover, the cost of the projects ranged from £ 1.78 million to £ 4.2 billion. 17 possible issues causing ineffective material management were revealed. The major problems that were discovered are material management activities related to constraints site storage, site logistics with regards to material handling and distribution and also ordering and delivery of materials to the construction site. The following are the identified 17 causes:

- 
- The logo of the University of Education, Winneba, is a circular emblem. It features a central four-petaled flower-like symbol in blue and white, set against a red background with a white sunburst pattern. Below the emblem is a banner with the motto "EDUCATION FOR SERVICE".
- Late delivery
 - Site storage problems
 - Logistics problems
 - Incorrect delivery
 - Inadequate loading area
 - Site access problem
 - Regulation consideration
 - Congestion time
 - Others: Incomplete delivery
 - Constraints storage compound
 - Material damages
 - Lack of materials
 - Improper handling

- Tower crane distribution problem
- Supply chain challenge
- Project size challenge
- Project location challenge

A study done by Patel & Vyas (2011) had an interesting approach to identify the problems occurring in the material management process. They have used 3 projects from Hyderabad, India to reveal the problems in the material management. Initially they divided material management process into 4 main phases, which are material identification, Vendor selection, Procurement and Construction phase. Next the problems associated with each phase were clearly identified, disclosing the usual problems occurring in these phases, this is shown in the below Table 2.1 (source is from Patel & Vyas, 2011).

Table 2.1: Causes of ineffective material management

A	Material Identification
	A1 Undefined Scope
	A2 Lack of communication
	A3 Incomplete drawing
	A4 Lack of conformance to requirements
	A5 Nonstandard specification
	A6 Incomplete/ ineffective meeting
	A7 Difference between plans and specification
B	A8 Not determining what and when materials needed
	Vendor selection
	B1 Uncontrollable bid list
C	B2 Incomplete proposal
	B3 Time spent in investigating non-qualified suppliers
	Procurement Problem
	C1 Availability of material

D	C2 Availability of quality	
	C3 Matching price to competitors' price	
	C4 Late deliveries	
	C5 Late or incorrect submittals	
	C6 Poor communication	
	C7 Lack of conformance to requirements	
	C8 Unrealistic delivery date	
	C10 Re handling of material	
	C11 Storage of materials	
	C12 Theft	
	C13 Damage of material	
	<hr/>	
	Construction Phase	
<hr/>		
D1 Incorrect type of material delivery		
D2 Incorrect sizes delivered		
D3 Incorrect quantity delivered		
D4 Keeping track of material		
D5 Re-handling of material		
D6 Storage of material		
D7 Loss of material		
D8 Damage of material		
D9 No supplier quality assurance		
D10 Poor communication		
D11 Receiving handling and storage of unused materials		

Source is from Patel & Vyas, 2011

Ghana and India share a lot of similarities in material management processes as well as in the work environment. Therefore, these material management problems identified in India can be used to reveal the issues in the Ghana's construction industry. Even though we understand all these issues are usual problems in material management in construction industry, we need to further identify the threats and the vulnerabilities associated in Ghana's construction industry related to material management. It has been

identified that in Ghana's problems such as limited skilled professionals, lack of labors and unavailability of local constructional materials are major issues faced by the construction industry (Rashfa, 2014). However, the relationship between these issues and ineffective material management are not recognized. Therefore, to improve the construction project delivery in Ghana, further research needs to be conducted to find the major root causes of ineffective material management at each phase.

2.7. Consequences of Ineffective Material Management on Project Delivery

A success of a construction project lies in the ability of all the stakeholders to plan effectively, as well as properly manage the resources. Furthermore, this grand plan encompasses of sub plans, which helps to determine, sequence, strategize how to allocate the resources effectively. Construction projects are well known for being complex and are subjected to high uncertainty and variability. Construction materials are involved throughout the construction project and variability and uncertainty can be traced back to construction material. Therefore, formulating a good material management plan is highly mandatory to support the grand plan.

Unavailability of materials when needed can affect the productivity and it may cause delay and difficulties to meet the schedule. On the other hand, having excessive materials on site will also create problems to the managers. Storage of materials can increase cost of production thus increasing the overall cost of the project. Furthermore, if the site lacks space to store all the materials may burden the managers to rent alternative storage areas which will cause more trouble and cost (Haddad, 2006).

In most contracts, the cost and time requires to complete the specified scope of works are defined in project documents. Control of quality of materials and workmanship is achieved through proper quality control plan and its implementation through a preset

level of quality control and inspection of various activities and materials. Budget control is done through monitoring progress payments and variation costs. The schedule is monitored by ensuring timely approval of materials, shop drawings, timely procurement of materials and execution of works as planned. Quality control and safety are achieved through inspection of works during the construction process, ensuring the use of approved materials and workmanship (Rumane, 2011).

It is a fact that those construction projects that are unable to use their resources efficiently will reduce their productivity reflecting their poor management skills. According to a study done by Baldwin & Bordoli (2014) state that 40% of the time lost on the site can be attributed to bad management, lack of materials when needed poor identification of materials and inadequate storage. By formulating an ineffective materials management plan can have a negative impact on cost, quality and time, which will affect the project delivery.

There have been various studies conducted in different countries to identify the factors causing cost overrun, delay and quality issues in construction projects. Surprisingly, the factors are more or less very similar in various cases, but the ranking of the factors were different. The fact that cannot be ignored is that factors related to construction material appeared in most of these list of factors causing cost overrun, delay and quality issues.

In a study conducted by Wanjari & Dobariya (2016), the highest factor causing cost overrun in India construction industry was identified as price escalation of raw material. In another study done by Cheng (2014) about an exploration into cost influencing factors on construction projects revealed that material shortage or supply delay is a prominent project risk that will influence the project cost. Similarly, study conducted to identify the delay factors in construction projects of Turkey found out that material is a

significant factor causing project delay (Gunduz, et al., 2013). Furthermore, it was explained that problems such as late delivery of materials, poor procurement of construction material and shortage of construction materials are prime factors causing project delay.

Unlike cost and time, quality is more subjective. The factors affecting the quality of a project are perceived differently by the contractor, consultant and client. This is because due to individual interest, knowledge and their own judgment. Therefore, in this study the impact of project delivery will be explored in terms of cost and time. So the cost overrun and delay in current Ghana's construction project will be explored to find out its relationship with the existing material management processes that are practiced in Ghana. Furthermore, this study can help to justify the significance of improving material management processes in construction industry of Ghana to implement more successful project.

2.8 Limitations of Current Practices

In the construction management site, the performance of the construction, practice is very essential and it has many effects. Improper handling of materials during site activities and it has the potential to severely obstacle project construction performance. There are major issues, which affect materials management activities, constraints on storage areas, site logistics with regards to materials handling and distribution, and also ordering and delivery of materials to the construction site.

The other issue of effect of the performance of the construction is improper storage and need large storage. Also transportation difficulties and inappropriate materials delivery and include manual processes, and non-compliance with specification. Previous research developed prototype system, for example Intelligent Materials Tracking System

(I-MATRACS) to improve on-site construction material management. This software helps to manage or handling construction material management practices in construction site (Kasim, 2012). Therefore, it is opportunity for the knowing of this software has to be for upcoming implements in construction site. It obviously smarts tools and techniques currently is not in use in materials management most of them are an available with a few being used on international corporations basic, but it will help the company in the long run by providing solutions to the key problems like lack of specification, delay, improper handling.

2.9 Summary of Literature Review

The systematic literature review identified that Materials management in construction project is a major cost component. The processes require a transformation to improve the overall in handling of materials for more efficiency and effectiveness on the construction site. This is because poor handling of construction materials affects the overall performance of construction projects in terms of cost, time, quality, and productivity. From the literature review it is understood that material management process begin from need generated from site followed by this information conveyed to store department and material is ordered in the store, indent is generated. Vender selection is carried out to inspect materials in store department. Review also identified the following as material management process; planning, testing, procurement, logistics, handling, stocking and waste control. Again the root causes of ineffective material management blamed on improper handling on site, transport difficulty, waste, manual methods for material management, lack of proper work plan among others. These ineffective strategies have given rise to delay and difficulties to meet the schedule, causing cost overrun and quality issues.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1. Introduction

This chapter explains the method and design that was used to conduct the research. Determining a good research strategy will help to reach to a productive conclusion. There are two types of research strategy. They are qualitative and quantitative research. Quantitative research is 'objective' in nature. It is defined as an inquiry into a social or human problem based on testing a hypothesis or a theory composed of variables, measured with numbers and analysed with statistical procedures (Gounder, 2012). Naoum, (1998) therefore this research method can be achieved through questionnaires, surveys etc.

In the most general terms, quantitative research does three main things, which are, it conceptualizes reality in terms of variables, it measures these variables and it studies relationships between these variables (Punch, 2014). Collecting data for quantitative can be time consuming as the sample size is usually greater compared to qualitative, but analysis is usually easy as it is mostly straightforward and repetitive compared to qualitative. The other type of research strategy is qualitative research. Unlike quantitative, qualitative is subjective in nature. It emphasizes meanings, experiences, descriptions and so on. This can be achieved through interviews, attitudinal surveys and so on (Creswell, 2003). Where the questions are designed to be more general or explanatory answers. Conducting a qualitative research is believed to be more challenging than quantitative research especially if it needs to be done in a shorter span of time (Creswell, 2003). As a matter of fact, qualitative research is an in depth study which needs to be done slowly to absorb and explore to the depth of its core, revealing new theories. Moreover, unlike quantitative research, qualitative research is multidimensional and pluralistic with respect to paradigms (Punch, 2014).

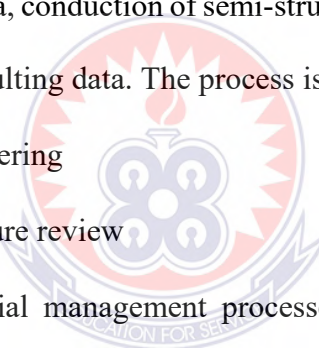
Beside these two types, nowadays it is very common to find researchers using mixed method. This research method is a combination of both qualitative and quantitative methodologies (Clark & Creswell, 2008). It is believed that adopting a mixed method approach has the advantage of gaining a stronger research design and achieving more valid and reliable findings. Moreover, it is recognized that adopting a mixed method strategy can compensate the weakness and strengths of both qualitative and quantitative research approach. For example, quantitative research is well known for conceptualizing variables and using large representative samples, while qualitative approach has the strength to reveal the in-depth meaning and explore the context with smaller samples (Punch, 2014). Therefore, by combining the strong areas of these two methods can help to give a strong logic to an underlying rationale.

The mixed method is further classified into 4 major design methods. The first one includes a qualitatively driven core component and a quantitative supplementary component, where the core and the supplemental components are conducted sequentially. The second type is a quantitatively driven core component and a qualitative supplementary component, where the core and the supplement components are conducted sequentially. The third type of design consists of a qualitatively driven core component and a quantitative supplementary component where the core and the supplementary component are conducted simultaneously. The next type of design is qualitatively driven core component and a quantitative supplementary component, where the core and the supplemental components are conducted simultaneously (Clark & Creswell, 2008). In other words, mixing of qualitative and quantitative can formulate triangulation designs, which can either be sequential or simultaneous. As a matter of fact, using triangulation method would involve the use of multiple methods to examine the same dimension of a research problem (Clark & Creswell, 2008). Even though many researchers have praised

mixed method, some avoid doing it because following a mixed method research can be costly and time consuming.

3.2. Research Design and Research Strategy

The research design adopted for this study is cross sectional descriptive survey and the research strategy adopted for this research is triangulation. Triangulation, also termed mixed methods was necessary in this study as it helps to achieve the objectives of this research. As a matter of fact, data collected from one part is essential to formulate and analyses the data from the other part. The process followed comprised critical literature review, development of questionnaires, mailing questionnaire to stakeholders of construction industry in Ghana, conduction of semi-structured interview and statistical and qualitative analysis of the resulting data. The process is summarized as follows:

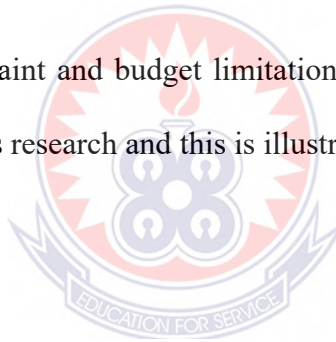
- 
- Literature gathering
 - Prepare literature review
 - Identify material management processes and root causes in ineffective material management in other countries to formulate the questions
 - Preparation of the questionnaire
 - Identify the targeted response group
 - Distribute the questionnaire to the targeted response group
 - Conduct semi-structured interview
 - Data collection
 - Data analysis

A questionnaire survey (refer to Appendix A) and structured interview (refer to Appendix H) were used as the main tools to collect data from the targeted response group. The questionnaire was designed into 4 sections, where the second section was enlightened

by structured interview. Both the questionnaire survey and the structured interview helped to meet the 3 objectives of the study. Section-A consisted question to determine the respondent's background.

One of the main aims of this research is to examine the material management processes used in construction industries in Ghana. Collecting a set of statistical data is not enough to reveal the existing practice in Ghana, therefore material management processes used in other countries were gathered and analysed in the literature review. From the extensive literature review, series of pre-established questions with pre-set response categories were formulated. With the limitation of the short span of time for this research, structured questions helped to minimize flexibility and variation while standardization was maximized (Punch, 2014).

With the time constraint and budget limitation this research methodology is the best approach to conduct this research and this is illustrated in Figure 3.1.



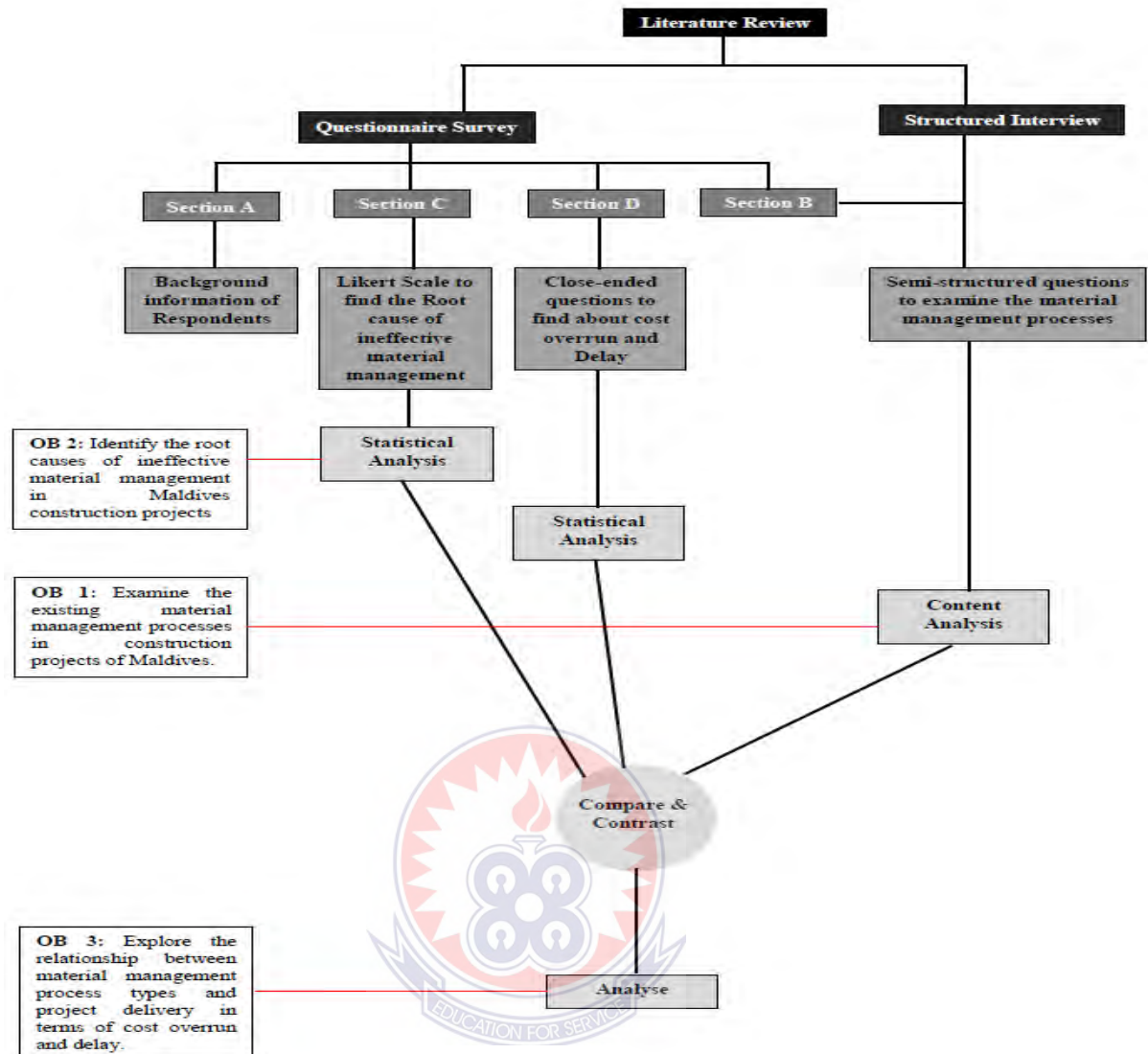


Figure 3.1: Research Design

3.3. Target Population of the Study

The population of the study consists of clients, contractors and consultants of construction industry in Ghana. It is impossible to test everyone in the population so it is highly crucial to select a good sample to represent this population. Moreover, this sample should consist of potential participants who are able to contribute to the research. Even though client and consultants represent a significant portion of the construction industry population, their involvement in material management is insignificant. Therefore, this narrowed down the population into contractors and subcontractors. Moreover, contractors

and subcontractors having experience over 10 years and high qualifications were purposely selected for this research. As these respondents have filled high positions in construction field, their long exposure to the work environment and their educational background helped to provide fruitful information and insight for this research.

It is a common myth to believe that increasing the sample size and frame can help to capture more data that can help to enlighten a research area. This can be very applicable if the research is concentrating very much on quantitative or statistical analysis. However, in this study, the main focus is on a specific field of interest and is more concentrating on adopting a more qualitative approach. Hence increasing the number was not the main target of this research, but selecting a considerable number with high potential sample was more important. Therefore, with the time and cost constrain even though it was targeted to gain 50 respondents to the study, the researcher was able to gain successful response from 40 stakeholders. This brought the population size to 40 respondents, which included 20 contractors and 20 subcontractors. The population was narrowed down to this number to effectively maximize the cost and time allocated for the research. Moreover, this survey consisted of many questions that required thoughtful answers. The time consuming nature of the survey might discourage some respondents from participating. In addition, this survey is concentrating more on construction material management and this might not be within the competence of some of the construction stakeholders. However purposive selection of the target respondents with competence and experience helped to overcome these challenges in data collection.

3.4. Sampling technique and Sample Size

In this study purposive sampling technique was used as this research followed a mixed method strategy. Usually purposive sampling is used in qualitative studies where,

the participants are purposely selected based on specific purposes associated with answering a research study question (Naoum, 1998).

In this research the sample size depended on two things. Firstly, in order to examine the material management process types that is practiced in Ghana, data needed to be collected until the saturation point. Therefore, this is the first element to decide the sample size. Next is that even though saturation point is reached within a sample size of for example 10, the data collection cannot be stopped at that point because quantitative analysis is also conducted in this research. Therefore, a minimum of 30 sample is needed to conduct a statistical analysis. Furthermore, according to Morse & Niehaus (2009), if the research design follows qualitative and quantitative design, the sample size can be larger (at least 30). Hence in order to satisfy all these conditions 40 respondents were selected. Some of the respondents were first reached out from the registered contractors' list that is published on Ghana's Ministry of works and housing website. This list helped to provide contacts of the field professional, but not all the people on the list were competent to provide their input into this research.

Moreover, careful consideration was given to select a wide array of contractors. Therefore, among contractors, main contractors who are involved in different project value were carefully selected. Unlike contractors, sub-contractor's details were not accessible from the ministry's website, so snowball sampling technique was used to select the subcontractors. Snowball sampling is a non-probability sampling technique that is used by the researcher to identify potential subjects in studies where it is hard to find (Punch, 2014). So, with the help of the contractors and other professional contacts, sub-contractor samples were selected. Furthermore, another significant criterion that was considered in this research while selecting the sample was that to select respondents who are involved in

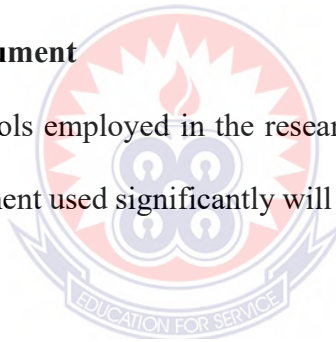
building projects. By clearly defining these boundaries helped to gather a sample that can provide a data that is more focused on this research.

3.5. Data Collection

The weight and the authenticity of the research rely greatly on the validity and reliability of the collected data. Data are often thought as ‘the facts’ – the things that are known to be true. But the truth is that data are social products. “The records created are not reality itself; rather they are a result of researchers’ attempts to observe or measure traces or evidence of phenomena situated within a complex system” (Byrne, 2002). In this study, data was obtained using 2 different methods, through interview and questionnaire.

3.5.1 Data Collection Instrument

This describes the tools employed in the research to collect relevant data for the research. The type of instrument used significantly will depend on the research design and the nature of data required.



3.5.1.1 Questionnaire

Questionnaire was used to gather primary data. Primary data collection refers to the first-hand information collected directly by the researcher for the use of his/her study (Kent, 2015). Only the researcher gains the first accessibility for this information. Moreover, this information can be obtained by conducting personal investigations through respondents and survey using questionnaires. Among the advantages of this method includes that it will provide highly accurate and reliable data. Furthermore, this type of data collection is the best fit for in-depth investigations. On the other hand, the disadvantage of this method is that it is time consuming and costly. As this study is

following a mixed method strategy, the primary data was collected using questionnaires. The questionnaires were emailed to the targeted respondents.

For the ease of the respondents the questionnaires were transformed into a Google form, where the respondents can fill the form directly and do not have to go through the vigorous procedure of scanning and mailing it back. But some of the respondents who are not familiar with the Google form just followed the old procedure of filling the questionnaire and mailing it back to the researcher. Providing this flexibility for the respondents made the data collection procedure easy for both parties. In order to gather the data within the time frame, the respondents were constantly given gentle reminder through emails as well as by calling them. Only questionnaires that were fully completed were accepted while the partially filled ones were discarded. However, the number of questionnaires that were fully completed was enough to provide valid and reliable results.

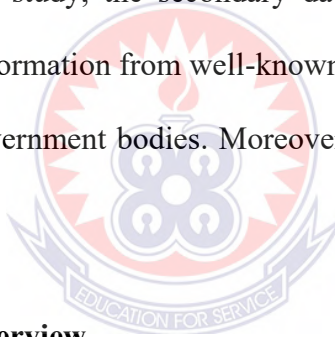
3.5.1.2 Semi- Structure Interview

Semi-structured interviews is a meeting in which the interviewer does not strictly follow a formalized list of questions (Clark & Creswell, 2008). Instead, they will ask more open – ended questions, allowing for a discussion with the interviewee rather than a straightforward question and answer format. The semi- structured interview guide provides a clear set of instructions for interviewers and can provide reliable, comparable qualitative data. The key characteristics of this data collecting instrument is loose, flexible structure, deep exploration of participant thoughts and experiences, insight into participant perspectives. This instrument elicits people’s own views and descriptions and has the added benefit of uncovering issues or concerns that have not been anticipated by the researcher. The researcher therefore conducted the semi- structured interview via phone

calls to reduce contact with individuals as covid 19 keep soaring. Moreover, interviews were also arranged accordance with the respondent's convenience.

3.5.1.3 Literature Search

Unlike primary data, secondary data refers to the information that have been already collected, analysed, documented and published by another researcher or institute (Kent, 2015). This information is usually used to support the current research of the researcher. Gathering this information is not as hectic as collecting primary data, as this information can be easily accessible from libraries, archives, online journals and so on. But the pitfalls of secondary data collection are that some information may be false or outdated. Therefore, in this study, the secondary data was collected cautiously from authentic sources such as information from well-known publishers, university library and reports published by the government bodies. Moreover, a special attention was given to obtain recent information.



3.5.1.4 Semi-structured Interview

The Section-B of the questionnaire survey was reinforced by conducting a structured interview. The interviews were conducted through phone. The time and date were set according to the convenience for the interviewees. The time frame allocated to conduct the interview was set. The participants who fill the questionnaire survey and agreed to take part in the interview were included in the present interview study. Participants were informed that only interviewer knew about their identity and their participation was voluntary. They were assured that they could withdraw from the study anytime without giving any explanation. The interviews were recorded to make it useful for the further analysis.

The questions that were asked to the entire participant lasted 20- 40 minutes per session, but the participants were given opportunity to talk as much as they wish without time restriction. The main focus of this interview was to examine the material management processes that are currently in practice in construction projects in Ghana. To unfold the substance in the transcribed text a manifest content analysis was conducted.

3.5.1.5 Content Analysis of the interviews

The collected interview data was analysed qualitatively at the end of data collection. Content analysis was used to analyse the collected data (Hsieh & Shannon, 2005). Every respondent has been asked the same question in the same order, so the different types of “courses of typical interviews” were tabulated (Morse & Niehaus, 2009). Processes that were not followed were identified and respondents who share similarities were tabulated. Saturation helped to categorize the different material management processes. Further analysis helped to distinguish each material management type and define each type more distinctively. The analysis was performed according to the following steps.

- The text was first read and simultaneously the author listened to the recorded interviews several times to grasp a sense of whole
- After reading and listening to interviews, meaning units were recognized and summarized the content, but essence was maintained.
- The condensed units were coded and then grouped into sub-categories and categories so as to organize the text in a way that reflected the central content in the interviews.

3.5.1.6 Questionnaire survey Section C

Next objective of the study was to identify the root cause of ineffective material management in Maldives construction projects. Root causes of ineffective material management identified by other countries' construction projects are discussed in the literature review. This information helped to formulate the questions for the section C. The questions were designed based on 5-point Likert Scale, which measures from 1- 5 according to the level of contribution and impact of each factor (Jackson, 2012). The interpretation of the responses are as follows:

- Strongly Agree (5)
- Agree (4)
- Neutral (3)
- Disagree (2)
- Strongly Disagree (1)

Use of Likert scale is very common as it is very simple to develop. Section C consists of subjective questions, where opinions vary according to their various experience in the field therefore using a scale helps to measure it. This data can be analysed statistically using SPSS. To ensure that the data is consistent and reliable, Alpha Cronbach test can be conducted.

3.5.1.7 Questionnaire survey Section D

The last objective of this research is to explore the relationship between project delivery and existing material management processes in practice. Section D included close ended questions to find out about cost overrun and delay in construction project. The data from this section are cross-analyzed with the findings of section B and section C. This analysis will help to find out the impact of material management on the project delivery.

The main reason for choosing simultaneous triangulation for this research was because the aim of this research is not to examine material management solely or investigate project delivery only, but to enrich our understanding from multiple perspectives by allowing a deeper relationship to emerge between these two elements (Clark & Creswell, 2008).

3.5.2. Pilot test

To ensure that the data constructed enable the researcher to address the objectives of which the research was undertaken, a pilot test was conducted. This test involved testing the questionnaire with a subset of the targeted respondent population. Therefore, the questionnaire was given to 10 respondents. The main aim to conduct this test was to identify any mistakes in the questionnaire and also to make sure that questionnaire is easily comprehensible to the respondents.

The pilot test was conducted in the Upper East Region of Ghana, where questionnaire was distributed to the contractors and sub-contractors in the northern sector. These respondents gave feedbacks regarding the layout and the content in the questionnaire. The questionnaire was modified and adjusted according to the feedbacks. Conducting this pilot test helped to improve the questionnaire to get better response from the respondents (refer to Appendix B). A total of 50 questionnaires were prepared and emailed to the sub-contractors and contractors of construction industry. Telephone interviews were conducted with the sub-contractors and contractors to gain more insight about material management processes in Ghana. Out of 50 questionnaires, 43 were retrieved representing 86% response rate. Among these 43 respondents, 3 people were not available for the interview. Hence data from 40 respondents were used for this research study. All the questionnaires were returned via email after 4 weeks. But the phone

interviews were continued for 8 weeks. The results were obtained and analysed qualitatively and statistically based on the research objectives. The results were presented using tables and descriptive statistics such as bar graph and the mean.

3.5.3 Ethical Considerations

The researcher sought for the consent of participants before administering the questionnaires and interview on them. Consent was given freely (voluntary), subjects were made to understand what is being asked of them, and persons involved were competent enough to consent. All participants in the research study were adequately informed about the research, comprehended the information and had the power of freedom of choice to allow them to decide.

The potential participants were individually given an explanation of the purpose of the study and data collection process. It was explained that as their participation was voluntary, refusing to participate or withdraw from the study while it was in progress would not have any consequences for them. The potential participants were given appropriate time (in this case: 24 hours up to one week) to read the information sheet and to decide whether or not they wanted to be involved in this study.

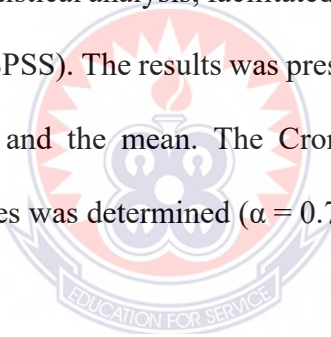
The anonymity and confidentiality of the participants were preserved by not revealing their names and identity in the data collection, analysis and reporting of the study findings. Privacy and confidentiality of the interview were managed carefully during telephone communication, interview session, data analysis and dissemination of the findings.

Since the eligible participants (women with postnatal depressive symptoms) were contacted through phone to know their decision whether or not to participate in the interview study, proper safeguards were taken. There were a few cases where the phone

call was answered by the third party (husband/ mother). In this situation, I did not expose details of the study. Instead, I explained that the purpose of the phone call was to follow up the information that had been given during the previous visit to the respective clinic. I left the contact number with that person and asked for a better time to call back each interview was conducted individually in a private and quiet room in the respective clinic or participant's home without access by outsiders. I am the only one who should be able to match the identity of the participants and voice recordings.

3.6 Data Analysis

The data collected using the questionnaire was analysed using an array of descriptive and inferential statistical analysis, facilitated by Microsoft excel and Statistical Package for social scientist (SPSS). The results was presented using tables and descriptive statistics such as bar graph and the mean. The Cronbach Alpha test that shows the reliability of the questionnaires was determined ($\alpha = 0.7$).



CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.0 Introduction

The aim of this study was to explore current material management practices and its impact on the delivery of building construction projects in Ghana. The specific objectives of the study include to investigate the current practices of material management in construction site. Secondly, to identify the root causes of ineffective material management in Ghana's construction projects; and thirdly, to explore the relationship between material management process types and project delivery in terms of cost overrun and delay.

4.1 Biographical Data

Gender of Respondents

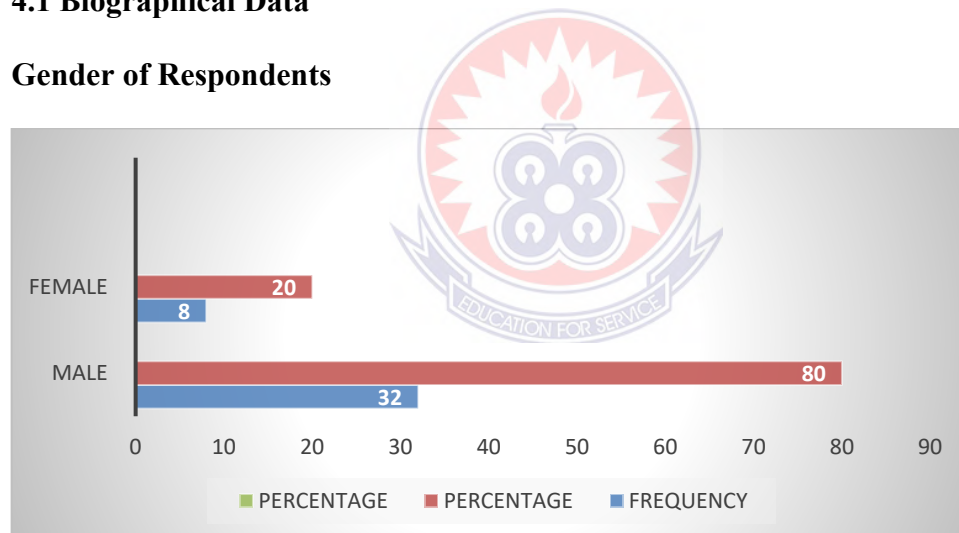


Figure 4.1: Gender of Respondents

Source: Field work 2021

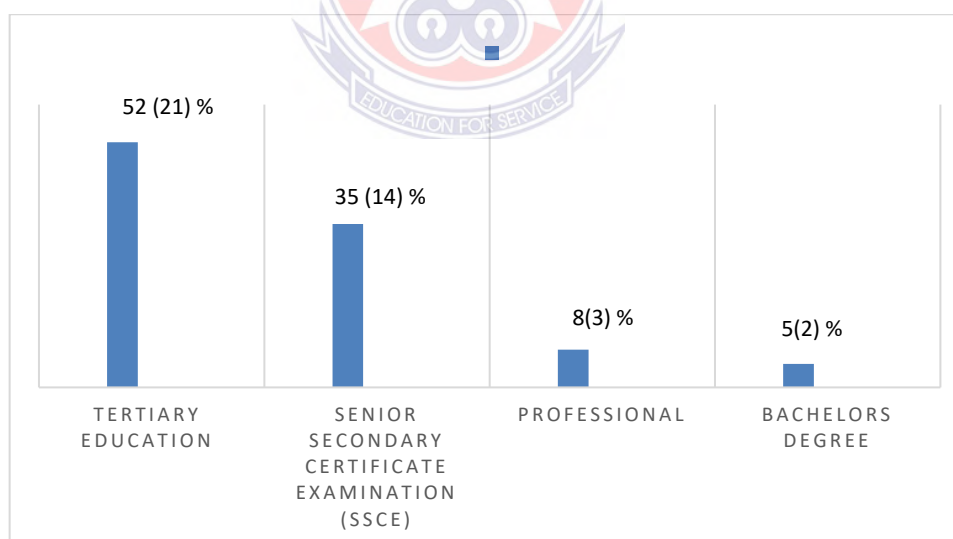
The Figure 4.1 shows the gender of respondents engaged by the researcher with the questionnaire. From the Figure it can be realised that 32 respondents representing 80% of respondents are males while the remaining 8 representing 20% of respondents are females.

Table 4.1: Age range of respondents

Age Range	Frequency	Percentage (%)
18 - 25 Years	10	25
26 - 30 Years	4	10
31 - 35 Years	6	15
36 - 40 Years	8	20
40+ Years	12	30
Total	40	100

Source: Field work 2021

The Table 4.1 shows the age range of respondents. From the Table, majority of respondents representing 30% are above the age of 40 years. This is closely followed by those within the age range of 18 – 25 years with 25%. Respondents with ages between the ages of 36 – 40 years represented 20% of respondents while 15% and 10% respectively for respondents aged between 31 – 35 years and 26 – 30 years as shown on the table above.

**Figure 4.2. Educational Level of Respondents**

Source: Researcher's field data, 2021

The Figure 4.2 shows the level of education of respondents. From the Figure, majority of respondents comprising 52% have completed their tertiary education, while

35% are with Senior Secondary Certificate Examination (SSCE). 8% of respondents hold certificates in professional courses while 5% of the respondents hold a second degree as their highest educational level. No one however responded to none. This shows the quality of responses to be derived from respondents.

Table 4.2: Working experience in the construction industry

Working experience in the construction industry	Frequency	Percentage (%)
Below 5 years	5	12.5
5-10years	11	27.5
11- 15 years	13	32.5
More than 15 years	11	27.5
Total	40	100

Source: Researcher's field data, 2021

Table 4.2 shows that majority 13(32.5%) revealed that they had 11-15 years working experience in the construction industry, 11(27.5%) of the respondents had 5-10 years and more than 15 years working experience, while 5 (12.5%) of the respondents had less than 5 years working experience.

Table 4.3: The type of building projects

The type of building projects	Frequency	Percentage (%)
Residential Building	37	92.5
Non- Residential Building	3	7.5
Total	40	100

Source: Researcher's field data, 2021

Table 4.3 revealed that majority 37(92.5%) of the respondents said that they mostly construct residential building projects while 3(7.5%) of the respondents said that they construction residential buildings.

Table 4.4: The monetary value of the building projects

The monetary value of the building projects	Frequency	Percentage (%)
Less than GHC1M	4	10
GHC1M- GHC10M	16	40
GHC10M- GHC40M	17	42.5
More than GHC40M	3	7.5
Total	40	100

Source: Researcher's field data, 2021

Table 4.4 indicates that 17(42.5%) of the respondents said that the monetary value of the building projects they undertake was between GHC10M- GHC40M, 16(40%) of the respondents revealed that the monetary value of the building projects they undertake was between GHC1M- GHC10M, 4(10%) spent Less than GHC1M on the building projects while 3(7.5%) spent More than GHC40M on building projects. 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.

Research Question One: What are the current material management practices in construction projects in Ghana?

Table 4.5: The Material Management Practices on Construction Site

Factors enabling informal methods of financing housing projects	Mean (X)	Standard Deviation (SD)
Construction material needs are generated before work commence on site.	4.81	0.76
The availability of materials in local supplier shops is checked.	4.76	0.78
The availability of materials in the company's warehouse is checked.	4.72	0.83
The procurement department of my company is informed to plan the procurement of materials.	4.63	0.87
A vendor or vendors is/are selected from an approved list.	4.62	0.89
Indents or purchase orders are generated.	3.98	0.95
Inspections of the received stock is conducted by my company.	4.51	0.96
Materials requested by construction sites are supplied to the site from a warehouse or the company's yard.	3.67	0.98
Warehouse stock is updated regularly or upon receipt of new materials.	3.84	0.99

Source: Researcher's field data, 2021, n= 40

The study results indicate that most of the respondents strongly agreed the material management practices on construction site where construction material needs are generated before work commence on site (mean score of 4.81, SD - 0.76), Construction material is recognized to be a major component in the construction project cost. Depending on different project it is assumed that the material cost can represent from 30% to 70% of

the total project (Donyavi & Flanagan, 2009). Construction materials consist of various raw materials extracted from different markets. Sadly, the prices and availability of these materials are highly vulnerable to the turbulences of the varying market conditions (Christopher, 2011). Thereby making the construction materials a highly uncertain component in the construction project.

The availability of materials in local supplier shops is checked (mean score of 4.76, SD - 0.78), The availability of materials in the company's warehouse is checked (mean score of 4.72, SD - 0.83), The procurement department of my company is informed to plan the procurement of materials (mean score of 4.63, SD - 0.87), A vendor or vendors is/are selected from an approved list (mean score of 4.62, SD - 0.89), Indents or purchase orders are generated (mean score of 3.98, SD - 0.95), Incorporation of new technologies into the Ghanaian construction industry is still low as this is evident on construction sites around the country. There are new technologies which has been put in place to assist in the construction process and improve the productivity and quality of the products of the construction industry. The implementation of these technologies will no doubt increase development of the construction industry which will in turn improve the economy of the economy of the country (Assibey-Mensah 2009; Forster and Mensah 2013).


Inspections of the received stock is conducted by my company (mean score of 4.51, SD - 0.96), Materials requested by construction sites are supplied to the site from a warehouse or the company's yard (mean score of 3.67, SD - 0.98), and Warehouse stock is updated regularly or upon receipt of new materials (mean score of 3.84, SD - 0.99).

The range and variety of construction material are accelerating with the advancement of technology. This has resulted the construction industry to shift away from localized use of materials to centralized worldwide production. Gradually the simple materials are being replaced by the introduction of engineered composites and mixed

assemblies. Moreover, chemical additives have enhanced the materials producing a wider array of properties (Calkins, 2009). The ample options of materials with varying properties have been considered as an accomplishment to the construction industry however the availability of too many options have caused complications in making the right choice. Experts and specialists are required to select the most compatible construction material to compliment the project. The material choice will determine the machinery and workmanship required and making the right choice from initiation can pave the path for a smoother delivery.

Research Question Two: What are the roots causes of ineffective material management in Ghana’s construction projects?

Table 4.6: Materials identification



Materials identification	Mean	Standard Deviation (SD)
Undefined scope	4.77	0.76
Incomplete drawings	4.65	0.79
Lack of communication	4.61	0.83
Lack of conformance to requirement	4.55	0.87
Incomplete/ineffective meetings	4.52	0.96
Differences between plans and specification	4.48	0.98
Nonstinging specification	4.32	1.07
Not determining what and when materials needed	4.22	1.23

Source: Researcher’s field data, 2021, n= 40

Table 4.5 indicates that material identification causes of ineffective material management were listed as undefined scope (mean score of 4.77, SD - 0.76), incomplete drawings (mean score of 4.65, SD - 0.79), Lack of communication (mean score of 4.61, SD - 0.83), As a matter of fact one of the research done by Manteau (2007) on the material management practices in Ghana explains that the current material management phases in

Ghanaian construction industry are bidding phase, sourcing phase, material procurement phase, construction phase and post construction phase. A study conducted in India by Patel & Vyas (2011) has summarized the material management processes into 8 main parts. They were planning, benchmarking, purchasing, receiving, inspection, storage, issuing material and inventory control.

Lack of conformance to requirement (mean score of 4.55, SD - 0.87), incomplete/ineffective meetings (mean score of 4.52, SD - 0.96), Differences between plans and specification (mean score of 4.48, SD - 0.98), Nonstanding specification (mean score of 4.32, SD - 1.07) and not determining what and when materials needed (mean score of 4.22, SD - 1.23). 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.

Table 4.7: Vendor Selection

Vendor Selection	Mean	Standard Deviation (SD)
Uncontrolled bid list	4.55	0.87
Incomplete proposal	4.52	0.96
Time spent in investigating non-qualified suppliers	4.48	0.98

Source: Researcher's field data, 2021

Table 4.6 shows that the vendor selection causes of ineffective material management were listed as uncontrolled bid list (mean score of 3.54, SD - 0.78), Incomplete proposal (mean score of 4.52, SD - 0.96) and Time spent in investigating non-qualified suppliers (mean score of 4.48, SD- 0.96). The other issue of effect of the performance of the construction is improper storage and need large storage. Also transportation difficulties and inappropriate materials delivery and include manual processes, and non-compliance with specification. Previous research developed prototype system, for example Intelligent Materials Tracking System (I-MATRACS) to improve on-site construction material management. This software helps to manage or handling construction material management practices in construction site (Kasim, 2012).

Therefore, it is opportunity for the knowing of this software has to be for upcoming implements in construction site. It obviously smart tools and techniques currently is not in use in materials management most of them are an available with a few being used on international corporations basic, but it will help the company in the long run by providing solutions to the key problems like lack of specification, delay, improper handling.

Table 4.8: Procurement Problems

Procurement Problems	Mean (X)	Standard Deviation (SD)
Availability of material	3.54	0.78
Availability of quality	3.52	0.82
Matching price to competitors' price	3.51	0.85
Late deliveries	3.43	0.87
Late or incorrect submittals	3.41	0.92
Damage of materials	3.39	0.94
Poor communication	3.37	0.97
Lack of conformance to requirements	3.35	0.99
Unrealistic delivery dates	3.24	1.23
Vague stated requirements	3.21	1.28
Re handling of materials	3.39	0.94
Storage of materials	3.37	0.97
Theft	3.35	0.99

Source: Researcher's field data, 2021, n= 40

Table 4.7 shows that the procurement problems of ineffective material management were listed as Availability of material (mean score of 3.54, SD - 0.78), Availability of quality (mean score of 3.52, SD - 0.82), in the construction management site, the performance of the construction, practice is very essential and it has many effects. Improper handling of materials during site activities and it has the potential to severely obstacle project construction performance. There are major issues, which affect materials management activities, constraints on storage areas, site logistics with regards to materials handling and distribution, and also ordering and delivery of materials to the construction site.

Matching price to competitors price (mean score of 3.51, SD - 0.85), Late deliveries (mean score of 3.43, SD - 0.87), Late or incorrect submittals (mean score of 3.41, SD - 0.92), Damage of materials (mean score of 3.39, SD - 0.94), In another research done by Gulghane & Khandve (2015) state that problematic management of material are due to overstock materials because of improper planning, damaged materials due to logistics, handling or in application, loss of materials because of improper supervision, waiting of the materials to arrive in location due to improper tracking system, frequent movement of materials due to improper site layout, inflation, material changes in buying or purchasing situation starting from the prepared cost estimation, bulk construction material, the shortage and changes of construction materials quantity required, material inefficient on site, stealing and loss of construction material, material shipment, work repairing, delay in updating or posting storage system on site, in accurate estimation of shipment quantity of materials, uneconomical order quantity of materials poor shipping time, increasing transport cost of materials, material over usage in location of project,

choosing the wrong materials for construction, the increasing storage cost of materials, the poor buying ability of managers, delay of payment for materials.

Poor communication (mean score of 3.37, SD - 0.97), Lack of conformance to requirements (mean score of 3.35, SD - 0.99), Unrealistic delivery dates (mean score of 3.24, SD - 1.23), during the past years, various academics researchers have conducted studies investigating to find out the issues causing ineffective materials management in construction projects. These studies are discussed to put the present study in perspective. A study carried out Zakeri et al (1996) suggested that transport difficulties, waste, improper handling on site, misuse of specification, lack of proper work plan, inappropriate materials delivery and excessive paperwork all have an immense effect on materials management.

Vegue stated requirements (mean score of 3.21, SD - 1.28), Re handling of materials (mean score of 3.39, SD - 0.94), Storage of materials (mean score of 3.37, SD - 0.97) and Theft (mean score of 3.35, SD - 0.99). 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.

Table 4.9: Construction phase

Construction phase	Mean	Standard Deviation (SD)
Incorrect type of material delivery	1.4595	.68625
Incorrect sizes delivered	1.4730	.66668
Incorrect quantity delivered	2.0811	.90291
Keeping track of materials	2.2027	.79346
Re-handling of material	2.0000	.90660
Damage of materials	1.5946	.75705
Storage of materials	1.6486	.78396
No supplier quality assurance	1.4730	.66668
Loss of material	2.0811	.90291
Poor communication	2.2027	.79346
Receiving handling and storage of unused materials	2.0000	.90660

Source: Researcher's field data, 2021 n= 40

Table 4.8 shows the that the construction phase problems of ineffective material management were listed as incorrect type of material delivery (mean score of 1.4595, SD - 0.68625), Moreover a study conducted Kasim (2008) highlighted those problems could emerge due to human error, especially because some construction firms still rely on manual methods for material management which involves paper-based techniques. In addition, she states that problematic use of paper based reports for exchanging information relating to materials component with supply chain can result misunderstanding and poor coordination.

Incorrect sizes delivered (mean score of 1.4730, SD - .66668), Incorrect quantity delivered (mean score of 2.0811, SD - .90291), Keeping track of materials (mean score of 2.2027, SD - .79346), It is a fact that those construction projects that are unable to use their resources efficiently will reduce their productivity reflecting their poor management skills.

According to a study done by Baldwin & Bordoli (2014) state that 40% of the time lost on the site can be attributed to bad management, lack of materials when needed poor identification of materials and inadequate storage. By formulating an ineffective materials management plan can have a negative impact on cost, quality and time, which will affect the project delivery.

Re-handling of material (mean score of 2.0000, SD - .90660), Damage of materials (mean score of 1.5946, SD - .75705), Storage of materials (mean score of 1.6486, SD - .78396), In most contracts, the cost and time requires to complete the specified scope of works are defined in project documents. Control of quality of materials and workmanship is achieved through proper quality control plan and its implementation through a preset level of quality control and inspection of various activities and materials. Budget control is done through monitoring progress payments and variation costs. The schedule is monitored by ensuring timely approval of materials, shop drawings, timely procurement of materials and execution of works as planned. Quality control and safety are achieved through inspection of works during the construction process, ensuring the use of approved materials and workmanship (Rumane, 2011).

No supplier quality assurance (mean score of 1.4730, SD - .66668), Loss of material (mean score of 2.0811, SD - .90291), Unavailability of materials when needed can affect the productivity and it may cause delay and difficulties to meet the schedule. On the other hand, having excessive materials on site will also create problems to the managers. Storage of materials can increase cost of production thus increasing the overall cost of the project. Furthermore, if the site lacks space to store all the materials may burden the managers to rent alternative storage areas which will cause more trouble and cost (Haddad, 2006).

Poor communication (mean score of 2.2027, SD - .79346) and Receiving handling and storage of unused materials (mean score of 2.0000, SD - .90660).

With Ghana being a developing country, the challenges facing the Ghanaian construction industry are similar to those reported from other developing countries. Even though developing countries attribute the development of the country's economy to the construction industry, the industry is yet to be given the acknowledgement that it deserves. The industry is not planned holistically which has resulted in its operations being carried out in fragments, using of conflicting components with inefficiency, wastage and inability to make proper plans that will lead to development. With the government being the major client of the Ghanaian construction industry, there is limited financial commitment from them to meet the large demand for several categories of outputs expected from the industry (Ofori, 2012; Osei, 2013).

Research Question Three: How do project delivery in terms of cost overrun and delay relate to the material management practices in Ghana?

Table 4.10: Project Delivery in Terms of Cost and Time

Participating in projects that have experienced cost overrun	Frequency	Percentage (%)
Yes	40	40
No	0	0
Total	40	100
The usual percentage of cost overrun experienced in those projects		
Less than 5%	14	35
5%- 10%	8	20
11%- 15%	10	25
16%- 20%	6	15
More than 20%	2	5
Total	40	100
Participating in projects that have experienced delay		
Yes	40	100
No	-	-
Total	40	100

Degree of delay that you have experienced in those projects		
Less than 1 month	13	32.5
1-6 months	11	27.5
7-12 months	14	35
More than 1 year	2	5
Total	40	100

Source: Researcher's field data, 2021

Table 4.9 indicates that majority 40(100%) of the respondents said that they have participated in projects that have experienced cost overrun. There have been various studies conducted in different countries to identify the factors causing cost overrun, delay and quality issues in construction projects. Surprisingly, the factors are more or less very similar in various cases, but the ranking of the factors were different. The fact that cannot be ignored is that factors related to construction material appeared in most of these list of factors causing cost overrun, delay and quality issues.

The usual percentage of cost overrun experienced in those projects were ranked as less than 5% (35%), 11%- 15% (25%), 5%- 10% (20%), 16%- 20% (15%), and more than 20% (5%). In a study conducted by Wanjari & Dobariya (2016), the highest factor causing cost overrun in India construction industry was identified as price escalation of raw material. In another study done by Cheng (2014) about an exploration into cost influencing factors on construction projects revealed that material shortage or supply delay is a prominent project risk that will influence the project cost. Similarly, study conducted to identify the delay factors in construction projects of Turkey found out that material is a significant factor causing project delay (Gunduz, et al., 2013). Furthermore, it was explained that problems such as late delivery of materials, poor procurement of construction material and shortage of construction materials are prime factors causing project delay.

All the respondents said that they have participated in projects that have experienced delay. To add more, the degree of delay that you have experienced in those projects were 7-12 months 14(35%), Less than 1 month (13(32.5%), 1-6 months (11(27.5%), and more than 1 year (2(5%). Unlike cost and time, quality is more subjective. The factors affecting the quality of a project are perceived differently by the contractor, consultant and client. This is because due to individual interest, knowledge and their own judgment. Therefore, in this study the impact of project delivery will be explored in terms of cost and time. So the cost overrun and delay in current Ghana's construction project will be explored to find out its relationship with the existing material management processes that are practiced in Ghana. Furthermore, this study can help to justify the significance of improving material management processes in construction industry of Ghana to implement more successful project.

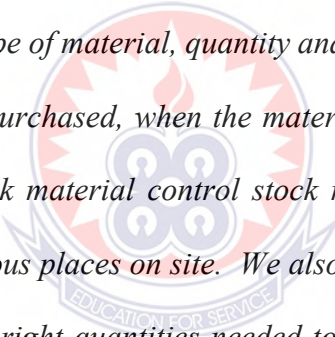
Results and Discussion of Interviews

Interview was one of the data collection instruments used in soliciting data for analysis. Contractors and sub-contractors were also interviewed. The main issues discussed during the interview were; the current material management practices in construction projects, the roots cause of ineffective material management and how project delivery in terms of cost overrun and delay relate to the material management practices in Ghana

According to interviews with subcontractors; most construction companies understand material management procedures, monitoring measures such as proper protection and storage of materials, good supervision, preparation of a timetable for material distribution, and maintaining records for all transactions are taken to quantify material management on site. Again, the construction team meets frequently, especially when security reports of some suspicious situation are received. In order to finish the job

on time, the schedule is created to match the project owners. Addition to these, poor handling of materials, poor stock control techniques and inadequate security account for mismanagement of materials (Field Survey, 2016). 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).

Participants shared their views on the current material management practices in construction projects. Although the opinions had some variations, the responses shared similarities that are central to material management as some as participant articulates: For example a respondent remarked:



We usually plan the type of material, quantity and time they are needed, after which they are purchased, when the materials get to us, we also keep them in our stock material control stock rooms before they are distributed to the various places on site. We also make sure we control waste, by sending the right quantities needed to the right place at the right time.

Other participants also specify that we have inventory system for tracking materials in-flow and out-flow in record books. The quality of the goods is frequently tested and counted, and any defective or incorrectly delivered materials are returned to the supplier. The construction materials are again placed on site, either in the site, the shop, or outside, and in the event of a material shortage, the site manager informs the suppliers. We also keep track of the materials released, follow up on them, and ensure that the remainder are returned. Workers are often given tips about how to properly use their materials.

Others also indicated that, planning is a very major factor in the management of material hence, it is the most frequently used material management process in our various construction sites. During the planning state, we take care of all the process and at the same time coordinate the rest of the processes. It's during the planning stage that measure, order and prepare the calendar for the purchase and distribution of the materials which in a way helps to increase productivity.

These responses were given by participants when their views were sought regarding the roots cause of ineffective material management practices on construction sites:

We have a lot of issues causing ineffective materials management in construction projects sites, these include transport difficulties, waste, improper handling on site, misuse of specification, lack of proper work plan, inappropriate materials delivery and excessive paperwork all have an immense effect on materials management in our construction sites.

Others also emphasized that the common issues regarding material management are as follows: receiving materials before they are required which may increase inventory cost and may increase the chance of deterioration in quality; not receiving materials during the time of requirement causing to decrease motivation as well as productivity, incorrect materials take-off from design and drawing documents; constant design changes, theft or loss of item, choice of type

of contract for specific material procurement, vendor evaluation criteria, piling up of inventory and controlling of the same and management of surplus material.

These responses indicate that willingness of all stakeholders to prepare efficiently and manage resources is critical to a construction project's success. Furthermore, this grand plan includes sub plans that aid in determining, sequencing, and strategizing how to best distribute capital. Construction projects are notorious for their complexity and high levels of ambiguity and variability. Construction materials are used in the project, and construction material can be traced back to cause variability and confusion. As a result, a successful material management plan is critical to the success of the overall strategy.



CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

The study explored current material management practices and its impact on the delivery of building construction projects in Ghana. The research design adopted for this study was cross sectional descriptive survey and the research strategy adopted for this research quantitative approach. The population of the study consists of clients, contractors and consultants of construction industry in Ghana. The population size was 40 respondents, which included 20 contractors and 20 subcontractors. Questionnaire was the main instrument used to gather primary data. The data collected using the questionnaire was analysed using descriptive and inferential statistical analysis, facilitated by Microsoft excel and Statistical Package for social scientist (SPSS). The results was presented using tables and descriptive statistics such as bar graph and the mean.

5.2 Summary of Major Findings

The Material Management Practices on Construction Site

The study results indicate that most of the respondents strongly agreed the material management practices on construction site were construction material needs are generated before work commence on site (mean score of 4.81, SD - 0.76), The availability of materials in local supplier shops is checked (mean score of 4.76, SD - 0.78), The availability of materials in the company's warehouse is checked (mean score of 4.72, SD - 0.83), The procurement department of my company is informed to plan the procurement of materials (mean score of 4.63, SD - 0.87), A vendor or vendors is/are selected from an approved list (mean score of 4.62, SD - 0.89), Indents or purchase orders are generated (mean score of 3.98, SD - 0.95),

Inspections of the received stock is conducted by my company (mean score of 4.51, SD - 0.96), Materials requested by construction sites are supplied to the site from a warehouse or the company's yard (mean score of 3.67, SD - 0.98), and warehouse stock is updated regularly or upon receipt of new materials (mean score of 3.84, SD - 0.99).

Causes of Ineffective Material Management

Materials identification

The study results indicate that material identification causes of ineffective material management were listed as undefined scope (mean score of 4.77, SD - 0.76), incomplete drawings (mean score of 4.65, SD - 0.79), Lack of communication (mean score of 4.61, SD - 0.83), Lack of conformance to requirement (mean score of 4.55, SD - 0.87), incomplete/ineffective meetings (mean score of 4.52, SD - 0.96), Differences between plans and specification (mean score of 4.48, SD - 0.98), Nonstinging specification (mean score of 4.32, SD - 1.07) and not determining what and when materials needed (mean score of 4.22, SD - 1.23).

Vendor Selection

The study findings show that the vendor selection causes of ineffective material management were listed as uncontrolled bid list (mean score of 3.54, SD - 0.78), Incomplete proposal (mean score of 4.52, SD - 0.96) and Time spent in investigating non-qualified suppliers (mean score of 4.48, SD- 0.96).

Procurement Problems

The study results revealed that the procurement problems of ineffective material management were listed as availability of material (mean score of 3.54, SD - 0.78),

availability of quality (mean score of 3.52, SD - 0.82), matching price to competitors price (mean score of 3.51, SD - 0.85), late deliveries (mean score of 3.43, SD - 0.87), late or incorrect submittals (mean score of 3.41, SD - 0.92), damage of materials (mean score of 3.39, SD - 0.94), poor communication (mean score of 3.37, SD - 0.97), lack of conformance to requirements (mean score of 3.35, SD - 0.99), unrealistic delivery dates (mean score of 3.24, SD - 1.23), vague stated requirements (mean score of 3.21, SD - 1.28), re handling of materials (mean score of 3.39, SD - 0.94), storage of materials (mean score of 3.37, SD - 0.97) and theft (mean score of 3.35, SD - 0.99).

Construction Phase

The study results show that the construction phase problems of ineffective material management were listed as incorrect type of material delivery (mean score of 1.4595, SD - 0.68625), Incorrect sizes delivered (mean score of 1.4730, SD - .66668), Incorrect quantity delivered (mean score of 2.0811, SD - .90291), Keeping track of materials (mean score of 2.2027, SD - .79346), Re-handling of material (mean score of 2.0000, SD - .90660), Damage of materials (mean score of 1.5946, SD - .75705), Storage of materials (mean score of 1.6486, SD - .78396), No supplier quality assurance (mean score of 1.4730, SD - .66668), Loss of material (mean score of 2.0811, SD - .90291), Poor communication (mean score of 2.2027, SD - .79346) and Receiving handling and storage of unused materials (mean score of 2.0000, SD - .90660).

Project Delivery in Terms of Cost and Time

The study results indicate that majority 40(100%) of the respondents said that they have participated in projects that have experienced cost overrun. The usual percentage of cost overrun experienced in those projects were ranked as less than 5% (35%), 11%- 15%

(25%), 5%- 10% (20%), 16%- 20% (15%), and more than 20% (5%). All the respondents said that they have participated in projects that have experienced delay. To add more, the degree of delay that you have experienced in those projects were 7-12 months 14(35%), Less than 1 month (13(32.5%), 1-6 months (11(27.5%), and More than 1 year (2(5%).

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

To address the findings, the following recommendations are made:

1. Contractors should apply the concept of material management effectively in order to reduce or exterminate the occurrence of unplanned cost which may arise as a result of improper material management.
2. Contractors to opt for proper storage of aggregates where treated ground will be used instead of the normal bare untreated ground.
3. Clients and consultants should include a penalty in the contract to punish contractors who do not effectively manage their materials and causes extra cost or duration to the project.

4. 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.
5. 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.
6. To overcome materials management challenges on construction sites, material managers should work to do the following;
7. Plan and monitor material schedule on all projects.
8. 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.
9. As much as possible material managers should make adequate pre-construction survey on materials before commencement of any construction project.
10. Closed circuit television (CCTV) cameras should be installed to increase the securities on site, especially the stores to reduce theft.
11. Material managers or experts should advise the project managers to raise proper structure with adequate storage space to keep materials on safe places.
12. 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.
13. 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.

14. 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
SURVEY ON THE IMPACT OF MATERIAL MANAGEMENT ON
CONSTRUCTION PROJECT DELIVERY IN GHANA
QUESTIONNAIRE

Dear Respondent,

I am an M.Tech. Student of UEW University of Education undertaking a study on the impact of material management on construction project delivery in Ghana. This study is for educational purpose and your readiness to respond appropriately will make its outcome beneficial to other students. I wish to assure you that your identity and whatever information you provide will not be disclosed to anyone.

Thank you for your cooperation and assistance.

Dapiah Kawe Angelina

SECTION A: Biographical Data

1. Which of the following best describes your highest academic qualification in the construction

Industry? *Please tick (✓) one.*

WASSCE/ Intermediate

HND

Bachelor's Degree

Master Degree

PHD

2. Which of the following best describe area of specialization of your company? *Please tick (✓)*

Contractor

Sub Contractor

3. Which of the following best describes the number of years of your work experience in the construction industry? *Please tick (✓) one.*

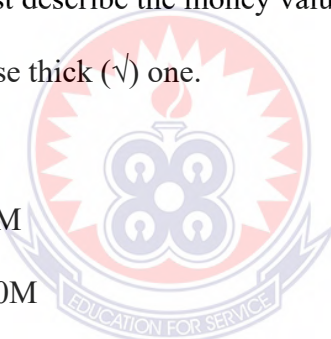
- below 5 years
- 5-10years
- 11- 15 years
- more than 15 years

4. Which of the following best describe the type of building projects that you are mostly involved in? Please tick (✓) one.

- Residential Building
- Non- Residential Building

5. Which of the following best describe the money value of the building projects that you are mostly involved in ? Please tick (✓) one.

- less than GHC1M
- GHC1M- GHC10M
- GHC10M- GHC40M
- More than GHC40M



SECTION B: MATERIAL MANAGEMENT PROCESSES

6. To what extent do you agree on the implementation of the following materials management processes by your company/ organization? Please rate using a scale of 1 to 5: strongly disagree (1), disagree (2), neither agree nor disagree or neutral (3), agree (4), and strongly agree (5). *(Please tick the box which best reflects your view).*

<i>Factors enabling informal methods of financing housing projects</i>	<i>Score</i>				
	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>
Construction material needs are generated before work commence on site.					

The availability of materials in the company's warehouse is checked.					
The availability of materials in local supplier shops is checked.					
The procurement department of my company is informed to plan the procurement of materials.					
Indents or purchase orders are generated.					
A vendor or vendors is/are selected from an approved list.					
Inspections of the received stock is conducted by my company.					
Warehouse stock is updated regularly or upon receipt of new materials.					
Materials requested by construction sites are supplied to the site from a warehouse or the company's yard.					
Others processes (please specify)					

SECTION C: Causes of Ineffective Material Management

7. To what extent do you agree on the following causes of ineffective materials management in construction projects? Please rate using a scale of 1 to 5: strongly disagree (1), disagree (2), neither agree nor disagree or neutral (3), agree (4), and strongly agree (5).
(Please tick the box which best reflects your view).

S/N	Causes of ineffective materials management	Rating				
		1	2	3	4	5
A. Materials identification						
16.	A1. Undefined scope					
17	A2. Lack of communication					
18	A3. Incomplete drawings					
19	A4 Lack of conformance to requirement					
20	A5. Nonstanding specification					
21	A6. Incomplete/ineffective meetings					

22	A7.Differences between plans and specification					
23	A8.Not determining what and when materials needed					
B. Vendor Selection						
24.	B1. Uncontrolled bid list					
25.	B2. Incomplete proposal					
26.	B3.Time spent in investigating non-qualified suppliers					
C. Procurement problems						
27.	C1. Availability of material					
28.	C2. Availability of quality					
29.	C3. Matching price to competitors price					
30.	C4. Late deliveries					
31.	C5. Late or incorrect submittals					
32.	C6. Poor communication					
33.	C7. Lack of conformance to requirements					
34.	C8. Unrealistic delivery dates					
35.	C9. Vague stated requirements					
36.	C10. Re handling of materials					
37.	C11. Storage of materials					
38.	C12. Theft					
39.	C13. Damage of materials					
D. Construction phase						
40.	D1. Incorrect type of material delivery					
41.	D2. Incorrect sizes delivered					
42.	D3. Incorrect quantity delivered					
43.	D4. Keeping track of materials					
44.	D5. Re-handling of material					
45.	D6. Storage of materials					
46.	D7. Loss of material					
47.	D8. Damage of materials					
48.	D9. No supplier quality assurance					
49.	D10. Poor communication					
50.	D11. Receiving handling and storage of unused materials					

SECTION D: PROJECT DELIVERY IN TERMS OF COST AND TIME

8. Currently have you participated in projects that have experienced cost overrun? (* If yes go to 53 and if no go to 54). *Please tick (✓) one.*

Yes

No

9. If yes, what is the usual percentage of cost overrun experienced in those projects?

Please tick (✓) one.

Less than 5%

5%- 10%

11%- 15%

16%- 20%

More than 20%

10. Currently have you participated in projects that have experienced delay? (* If yes go to 55 & if no go to 56). *Please tick (✓) one.*

Yes

No

11. If yes, what is the usual degree of delay that you have experienced in those projects?

Please tick (✓) one.

Less than 1 month

1-6 months

7-12 months

More than 1 year

Thank you for participating in the questionnaire survey.

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