UNIVERSITY OF EDUCATION, WINNEBA

COLLEGE OF TECHNOLOGY EDUCATION, KUMASI

EFFECTS OF MATERIALS MANAGEMENT TECHNIQUES ON CONSTRUCTION PROJECT SUCCESS: PERSPECTIVE OF MATERIAL MANAGERS IN NORTHERN REGION OF GHANA

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SEPTEMBER, 2016

DECLARATION

STUDENT'S DECLARATION

I, Kuebutornye Napoleon D. K. declare that this Dissertation, with exception of quotations and references contained in published works which have all been identified and dully 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 of this Dissertation research was supervised in accordance with the guidelines on supervision of Dissertation laid down by the University of Education, Winneba.

Name: Mr. M. K. Tsorgali

Signature…….....…….....

Date…….....…….....

DEDICATION

First and foremost, my dedication goes to the Almighty God for his guidance, protection, knowledge and understanding He's given to me throughout the period of this Dissertation work. The next dedication goes to my friends for their encouragement and assistance they provided for me.

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ABSTRACT

Construction materials management process is a key to success of a construction project; however, globally, the problem of material management is a critical issue in the construction industry; especially in the developing economies of which Ghana is no exception. This study sought to identify and assess the material management techniques required for construction firms in the Tamale Metropolis of Ghana. The study adopted descriptive quantitative survey approach. Using empirical data obtained from administration of questionnaires to 96 material management personnel in Tamale Metropolis; the data was analyzed using descriptive and inferential statistics such as factor analysis, and Pearson product moment correlation coefficient. The study indicated that the surveyed firms often employ store keepers; and security personnel on site; list of materials in project that includes for example (material name, material number and unit price), and provide clear specifications to suppliers. However, they seldom use ICT; and rarely offer training for their workers. The study further revealed that planning and monitoring of material schedule; establishing good business relations with suppliers; the use of security measures on site; use of information communication technology; and also use of competent workers as well as effective training of workers is significant for effective material management on construction site, and has direct effect on construction project delivery success. The study therefore concluded that the more the number of the material management approach adopted on a project, the higher the project delivery success. It was recommended that construction companies should make use of more than

one material management technique on construction projects so as to achieve maximum project delivery success.

CHAPTER ONE

GENERAL INTRODUCTION

1.1 Introduction

This chapter gives a brief introduction into the background of the study, statement of the problem, purpose of the study, objectives of the study, research questions, scope of the study, the significance of the study, limitations of the study, and the structure of the study.

1.2 Background of the Study

The construction industry plays an important role in the economy and the activities of the industry are vital to the achievement of national socio-economic development goals such as shelter, infrastructure and employment. Shen and Tam (2002) indicated that the construction industry plays an important role in meeting the needs of society and enhancing quality of life. Construction has been an important player in many countries economy, especially developing countries. The sector currently accounts for more than 11% of global GDP (Betts et al., 2011).

The construction industry is becoming increasingly competitive and materials management is now considered to be one of the frontiers for cost reduction to improve profitability and productivity, as construction materials constitute a major cost component in any construction project. The total cost of installed materials (or value of materials) may be 50% or more of the total cost (Stukhart, 1995), even though the factory cost may be a minor part of the total, probably less than 20-30%. This is because the item must be stored, transported, and re-stored before it is put in place or "consumed" at the

site. The total cost of materials includes, in addition to the manufacturer's selling cost, the cost of procurement (cost of placing, processing and paying the material, physical distribution, the distributor's cost, and the transportation of the materials), and the site-handling costs (cost of receiving, storage, issuing, and disposal) (Haddad, 2006). The efficient procurement and handling of material represent a key role in the successful completion of any project. It is important for the contractor to consider that there may be significant difference in the date that the material was requested or date when the purchase order was made, and the time at which the material will be delivered. These delays can occur if the contractor needs a large quantity of materials which the supplier is not able to produce at the time or by any other factors beyond his control. The contractor should always consider that procurement of materials is a potential cause for delay (Haddad, 2006).

Ballot (1971 as cited in Haddad, 2006), defined materials as the physical materials that are purchased and used to produce the final product and does not suggest that materials are the final product. In other words, materials are the parts used to produce the final product.

Poor planning and control of materials, lack of materials when needed, poor identification of materials, re-handling and inadequate storage cause losses in labour productivity and overall delays that can indirectly increase total project costs. Effective management of construction materials techniques can reduce these costs and contribute significantly to the success of the project (htt\\www.shodhganga.infliben).

However, achieving success in project implementation process is the major function of materials management. Modern techniques of efficient Material Management

(MM) were developed in USA during Second World War which helped them to make a spectacular progress in improving their productivity. In the last few years increased awareness in different areas of material management had been found. Many hospitals adopted these management techniques to provide efficient patient care, of which the construction industry is not an exception (Kulkarni 2010).

Nevertheless, according to Nwachukwu et al. (2010), the rate at which building construction projects fail, or are abandoned (some even under construction) is largely dependent on effective application of materials management techniques in developing economies. He further indicated that failure or abandonment of construction projects in developing economies may be attributable to inefficient material management practices on construction projects sites.

Stukhart (1995), defines material management as the activities involved to plan, control, purchase, expedite, transport, store, and issue in order to achieve an efficient flow of materials and that the required materials are bought in the required quantities, at the required time, with the required quality and at an acceptable price.

According to Ebole (2005), materials management is the planning and controlling of all necessary efforts to make certain that the right quality and quantity of materials are appropriately specified on time, are obtained at a reasonable cost and are available when needed. Dobler and Burt (1996) stated that material management is designed to improve the activities related to the flow of materials. They added that material management should coordinate purchasing, inventory control, receiving, warehousing, materials handling, planning, and transportation.

Materials management involves an integrated coordination of all material related functions. These functions can be carried out efficiently only when sufficient emphasis is placed on early project planning, use of qualified personnel, adequate personnel training and proper communication amongst those involved in the process (Keitany & Mutwol, 2014). According to Ebole (2005), the essential and desired site materials management characteristics of right quality, right quantity, right time and reasonable cost are evidently scarce on construction projects as it is characterized by emergency purchases of materials, inadequate storage, material shortages and sometimes condemnation of materials and works by consultants.

Past research has revealed that effective material management techniques contribute to construction project success with respect to delivery time, project cost, quality, and safety (Ademeso & Windapo, 2012, Keitany & Mutwol, 2014; Sundararaja & Shanmugapriya, 2014). Therefore it is believed that effective implementation of effective materials management techniques could go a long way to enhance project success in the Ghanaian construction industry.

It is against this background that this study is conducted to identify and assess the effect of effective materials management practices on construction project success to enhance the industry's development and the economy at large.

1.3 Statement of the Problem

Anecdotal evidence indicates that the essential and desired site materials characteristics (materials attribute) of right quality, right quantity, right time and reasonable cost are evidently scarce on construction project sites; particularly, in the Northern Region.

According to Association of Building and Civil Engineering Contractors of Ghana (2015), Transport difficulties, improper handling of construction materials on site, misuse of specification, lack of proper work plan, inappropriate materials delivery and excessive paperwork, all adversely affect materials management practices on most sites in the Northern Region.

Similarly an interview conducted with Architectural and Engineering Service Limited Northern Region (2016), reveal that, most construction project sites in the Northern region are characterized by emergency purchases of materials, inadequate storage, double handling of materials, material shortages, theft and sometimes condemnation of materials and works by consultants. All these problems have associations with poor materials management practices used on project sites.

Although, effective management of materials can lead to a reduction in cost, enhance project delivery time, enhance quality and reduces health and safety problems on site resulting in a significant saving, yet effective materials management techniques have not received a lot of attention on most project sites in the Northern region of Ghana. Additionally, it is found that there is a significant relationship between effective materials management practices and project delivery success hence, this project is aimed at examining the effect of effective materials management practices on construction project delivery success; as it focuses on effective materials management techniques, safety management and quality management practices on sites. The aforementioned arguments underscore the objectives of this study.

1.4 Purpose of the Study

The purpose of this study is to examine the effect of materials management techniques on construction project delivery success.

1.5 Objective of the Study

The objectives of the study are to:

1. Identify the critical challenges faced in the management of materials on construction project site in the Tamale Metropolis of Ghana.
2. Identify the critical factors for improving materials management on construction project site in the Tamale Metropolis of Ghana.
3. Evaluate the effect of the identified materials management techniques on construction project delivery success.

1.6 Research Questions

The following research questions have been formulated:

1. What are the critical materials management challenges face by construction firms in the Tamale Metropolis of Ghana?
2. What are the critical factors for improving materials management on construction project site in the Tamale Metropolis of Ghana?
3. What is the effect of the identified materials management techniques on construction project delivery success?

1.6.1 Hypothesis

There is significant relation between the identified materials management techniques and construction project success.

1.7 Significance of the Study

The study is significant for the following reasons.

I. Construction firms would be aware of the efficient materials management practices to be adopted to ensure project success.

II. Findings from the study will help the stakeholders to develop policies and practices that could improve material management on sites.

III. The study will serve as a reference material for other researchers.

1.8 Scope of the Study

This study focuses on the factors affecting materials management practices on construction project site, and their effect on construction project success. Geographically, the study was limited to contractors working on construction projects in the Northern region of Ghana.

1.9 Research Limitations

The willingness of the material managers to reveal weaknesses in their respective organizations was uncertain; the respondents might have given desired data, which made their firms look good. Nevertheless, managers' perception is frequently used in material management research (Haddad, 2006).

1.10 Structure of the Study

The study comprises of five chapters of which the current chapter is one which involves, introduction, background, statement of the problem, aim of the study, objectives of the study, research questions, significance of the study, scope of the study, research limitations and structure of the study, chapter two is the literature review, chapter three is the methodology, chapter four presents results analysis and chapter five is the summary, conclusions and recommendations.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter reviews literature on effects of effective materials management techniques on construction organizations. It covers the role of a material manager on site, the concept of construction materials, classification of construction materials, concept of material management, objectives of material management, component of material management, material management techniques, challenges of material management, benefits of effective material management, factors affecting effective materials management in construction project, and relationship between material management and construction project success.

2.2. The Role of Material Manager on Site

According to Haddad (2006), a material manager is the person in-charge of the materials management on construction project site. The material manager ensures the flow of materials from the time the materials are ordered, received, and stored until they are used in the basis of material management (Sundararajan & Shanmugapriya, 2014; Ebole, 2005).

2.3 Construction Materials

Endless quantities of materials are required at various times and in various locations, in order to complete a successful project and make significant contributions to the cost effectiveness of projects. Therefore, a deep understanding of material behavior is essential to enable efficient construction (Kini, 1999).

Ballot (2006) defines materials as; the physical materials that are purchased and used to produce the final product and does not suggest that materials are the final product. In other words, materials are the parts used to produce the final product.

Bailey et al. (2009) defined materials as the goods purchased from sources out of the organization that are used to produce finished products. Stukhart (2007) defined materials as the items that are used to produce a product and which include raw materials, parts, supplies and equipment items.

Dobler and Burt (2009) and Chandler (1978) categorised construction materials into five categories:

- **Raw materials**- materials that the company converts into processed parts (i.e. Sand, Stones, Water).
- **Purchased parts**- parts that the company buys from outside sources (i.e. ceiling, Roofing sheet, Glazing Window).
- **Manufactured parts**- parts built by the company (i.e. Blocks, Frames, Reinforcement materials).
- **Work in process**- these are semi-finished products found at various construction (i.e. Walls, Precast Concrete).
- **MRO supplies-** maintenance, repairing, and operating supplies used in the building process but are not part of the final products (i.e. Formworks, Pegs).

2.4 Classification of Construction Materials

Chandler (2001), states that construction materials can be classified into different categories depending on their fabrication and the way in which they can be handled on site. He classifies the materials into five categories.

Bulk materials- these are materials that are delivered in mass and are deposited in a container.

Bagged materials- these are materials delivered in bags for ease of handling and controlled use.

Palleted materials- these are bagged materials that are placed in pallets for delivery.

Packaged materials- these are materials that are packaged together to prevent damage during transportation and deterioration when they are stored.

Loose materials- these are materials that are partially fabricated and that should be handled individually.

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

- Engineered materials- these materials are specifically fabricated for a particular project or are manufactured to an industry's specification in a shop away from the site. These materials are used for a particular purpose. This includes materials that require detailed engineering data.
- Fabricated materials- these are materials that are assembled together to form a finished part or a more complicated part. Examples of such materials include steel beams with holes and beam seats.

Table 2.1: Classification of Materials (Adopted from Chandler, 1978 as in Enshassi, 2007)

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

Chandler, 1978 as in Enshassi, 2007

2.5 Objectives of Materials Management

Materials management on site should seek to reduce loss of profit due to theft, damage and waste due to unfavourable weather conditions, as well as running out of stock. It is also important to ensure that the right quality and quantity of materials and installed equipment are appropriately specified in a timely manner, obtained at a reasonable cost and are available when needed. Quality is a very important aspect that the materials manager has to keep in mind. When specifications require a high quality product, quality could become the most important objective. Khyomesh (2011) outlined the following objectives of materials management;

- Efficient materials planning
- Buying or Purchasing
- Procuring and receiving
- Storing and inventory control
- Supply and distribution of materials
- Quality assurance

- Good supplier and customer relationship
- Improved departmental efficiency

To fulfill all these objectives, it is necessary to establish harmony and good co-ordination between all the employees of material management department and this department should have good co-ordination with the other departments of the organization to serve all production centers.

2.6 Importance of Construction Materials on Construction Project

Materials are critical elements in construction projects and can make significant contributions to the cost effectiveness of projects. This is because the amount spent on materials is higher than other inputs, and may account for 60%–70% of the total cost of a typical project (Christopher, 1998). A deep understanding of material behaviour is essential to enable efficient construction.

Economic reports showed that the construction industry is amongst the largest and the most active sectors that contributed to a steady economic growth such as Malaysia (Betts *et al.,* 2011; GBI-Research, 2010). The global construction industry is reported to be worth around $12 trillion in 2020 dominated by Asian countries. They are expected to increase their share of the market to $7 trillion (Betts et al., 2011); where a total of $97.7 trillion will be spent on construction globally during the next decade and by 2020, construction will account for 13.2% of the world's Gross Domestic Product. If materials constitute 50 – 60% project cost as established above, then, this is how important material is to every project and the country at large.

2.7 Concept of Materials Management

Different researchers provide different definitions for material management. Therefore, different definitions can be found in different references. Sundararajan and Shanmugapriya (2014) defined material management as planning, identification, procuring, storage, receiving and distribution of materials. Arnold and Chapman (2004) materials management can be defined as an organizing function responsible for planning and controlling the materials flow.

Stukhart (1995) defines material management as the activities involved to plan, control, purchase, expedite, transport, store, and issue in order to achieve an efficient flow of materials and that the required materials are bought in the required quantities, at the required time, with the required quality and at an acceptable price.

Ebole (2005) defines materials management as the planning and controlling of all necessary efforts to make certain that the right quality and quantity of materials are appropriately specified on time, are obtained at a reasonable cost and are available when needed. The purpose of material management is to control the flow of materials effectively.

Christopher (1998) defined material management as a process that coordinates planning, assessing the requirement, sourcing, purchasing, transporting, storing and controlling of materials, minimizing the wastage and optimizing the profitability by reducing cost of material. He further argued that, building materials account for about 60 to 70 percent of direct cost of a project or a facility, the remaining 30 to 40 percent being the labour cost.

According to Haddad (2006), material management is concerned with the planning, identification, procuring, storage, receiving and distribution of materials. He further indicated that the purpose of material management is to assure that the right materials are in the right place, in the right quantities when needed. Thus, the responsibility of material management department is to ensure flow of materials from the time the materials are ordered, received, and stored until they are used.

2.8 Management of Construction Materials

The management of materials in construction projects is an important function that significantly contributes to the success of a project. As projects grow in scale and complexity, materials management becomes more difficult, often requiring the use of appropriate tools and techniques to ensure, amongst other things, that materials are delivered on time, stock levels are well managed, the construction schedule is not compromised, and that wastage is minimized.

Over the years, materials management in construction project has become a critical component of successful project execution (Song et al., 2006). Materials are the main component of any construction projects; therefore, if the materials in construction projects are not managed properly it will create a major project cost variance (Keitany & Mutwol, 2014**;** Fugar & Agyakwah-Baah, 2010). Studies have shown that materials and installed equipment can make up 60–70% of the total project cost and impact 80% of its schedule (Song et al., 2006).

Ineffective material management practices are evident on many projects and cause considerable waste in time and money (Ademeso & Windapo, 2012; Keitany et al.,

2014). The materials management system in any project ensures that the right quality of material and quantity of materials are appropriately selected, effectively purchased, properly delivered and safely handled on site in a timely manner and at a proper reasonable cost (Ademeso & Windapo, 2012; Donyavi & Flanagan, 2009).

2.9 Components of Materials Management

This section deals mainly with the attributes of material management and the responsibilities of those involved in carrying out the material management functions. A detailed understanding of each contributing function is required in order to comprehend the interfaces between material management functions. A materials management system includes the major functions of identifying, acquiring, distributing, and disposing of materials on a construction site (Stukhart, 1995). By definition, material management system is the management system for planning and controlling all of the efforts necessary to ensure that the correct quality and quantity of materials are properly specified in a timely manner, are obtained at a reasonable cost, and are available at the point of use when required. Each firm has its particular materials management system where the responsibility for the various activities is spread between engineering, purchasing, and construction. Some assign full responsibility and accountability to a material manager, but for most firms the responsibility is divided and therefore prone to problems.

Components of material management includes; planning, material estimation, purchasing and procurement, storage, identification and retrieval, handling and transport, stock and waste management, material variance analysis, security systems and construction methods. Each of the above is indelibly linked to ensure safety, productivity,

and schedule performance. Material planning considers materials in the order of requirement at site (Ebole, 2005). Material procurement and storage on construction sites need to be properly planned and executed to avoid the negative impacts of materials shortage or excessive material inventory on-site, deficiencies in the supply and flow of construction materials (Kanimozhim et al., 2014).

In order to better understand MM, the following processes of planning, material estimation, request for quotation (RFQ), purchasing and procurement, logistics, transporting, handling, stock and waste control, material variance analysis, and security systems are discussed.

2.9.1 Materials Planning in Construction

Stukhart (1995) stated that there is the need for an appropriate materials planning to be done concurrently with engineering, construction, and other project plans. Material planning provides guides to all the subsequent activities and has a great impact on the project plan. The materials planning process covers records, inventory levels, and delivery frequency (Ademeso & Windapo, 2012). During the planning stage a contractor has to check the availability of materials, quantities, the quality of construction required, the allocation of material to various parts of the project, material purchase and delivery, the size and dimension of the required materials, communication methods and interpretation of drawings and specification.

Planning of access and routing of materials within construction site also has an important implication for the development of an effective materials management strategy

(Faniran et al., 1998), particularly in terms of increasing productivity and profit, and facilitating the timely completion of construction projects (Wong & Norman, 1997).

2.9.2 Materials Estimation in Construction

According to Anil (2001 as cited in Haddad, 2006), benchmarking processes and techniques can be applied to develop yardsticks for wastage control of building materials. After the selection of a project, the following steps are adopted. Estimated quantities of materials required either from the first or final drawings. From site records or accounts records, actual quantities of material consumed is obtained. Interviews are held with project managers and owners concerned, to collect other related information.

2.9.3 Request for Quotation (RFQ)

Specifications and drawings are needed to implement the request for quotation process successfully. The specifications and drawings are utilized by a rather diverse group of participants. The specifications and drawings help the contractor to estimate, control, manage and direct the works. Also they help the purchasing department to purchase materials and equipment that are described in the drawings and specifications; finally they help the owner to know what to buy and what he is entitled to receive. There are relations between the specifications and drawings which is clear and generally show the following information and items. From drawings one can obtain information about the location of materials, equipment, fixtures, details and overall dimensions, interrelation of materials, equipment and space, sizes of equipment, identification of materials at its locations and other alternatives. And from specifications we can obtain type and quality

of materials, equipment and fixtures, quality of workmanship, methods of fabrication, installation, erecting, test and code requirements, unit, options and alternatives (Ahuja & Dozzi, 1994).

2.9.4 Procurement of Construction Materials

The term procurement encompasses a wide range of activities that includes purchasing of equipment, materials, labour and services required for construction and implementation of a project (Stukhart, 1995). The objective of procurement in materials management is to provide the materials in the right time, place, quality and an agreed budget. Donyavi and Flanagan (2009) state that procurement is about organizing, purchasing and issue delivery schedules to suppliers and following-up to make sure that suppliers deliver on time. Canter (1993) indicated that failure in the purchasing process or in overseeing and organizing the buying functions could result in:

- Over-ordering of materials (wastage problems);
- Over-payments for materials (inadequate administration procedures);
- Loss of benefits (lack of skilled negotiating procedures);
- Lack of knowledge (when and where the best service/source might be available at any particular time).

2.9.5 Purchasing of Construction Materials

The purchasing function is central to material management. Purchasing has the responsibility and the authority to commit project funds for materials, equipment, and services. This activity may be accomplished by the home office, the field, or a

combination of both depending on the size and the scope of the project. The home office must maintain planning, procedural and policy direction over the field operations in order to ensure consistent purchasing practices (Nagar, 2011).

Selection of vendors for projects forms the foundation for the success or failure of the project. Vendors must be selected on the basis of their capabilities, geographical location, prior experience, and owner preference. Measurement of capabilities includes such considerations as past performance, financial condition, bargaining agreements, capacity, competitiveness, responsiveness, and schedule adherence. Several methods of contracting are available to the purchasing organization, depending on the commodity or service required. Purchasing orders are the most common form of contract utilized on projects. Although blanked orders and other forms of agreement are used in varying degrees (Nagar, 2011).

Standard or general terms and conditions of the order or contract generally address various commercial aspects of transaction; they define the respective rights, duties, and obligations of the contracting parties. Special terms and conditions also must be incorporated into the body of the purchase order or contract. Items such as schedule test information, data submittals, drawing approvals, expediting, and terms of payment are typical information which must be clearly specified. Purchase orders often require technical service agreements to complete the scope of work when the vendors' technical representative is required at the site to supervise installation and or erection. According to Nagar (2011) purchasing procedure can be described as below:

Step 1 – Material Indent

Step 2 – Enquiry to Vendors

Step 3 – Vendor Comparison

Step 4 – Vendor Selection and Negotiations

Step 5 – Purchase Order

Step 6 – Vendor Evaluation

2.9.6 Expediting of Construction Materials

Several types of expediting exist, each with a different level of intensity and cost. The least intense type of expediting is simple status reporting. Periodic telephone contact is made with the vendor to determine the status or progress of an order, and the information is reported to the project in some systematic format. This type of expediting provides basic information to the project, but does little to prevent or overcome delays or problems with an order. Reactive or correction expediting is more intense than the simple status reporting. But it is initiated only in response to some event or action. Vendor contact may be made in response to a problem of delayed or late delivery (Ahuja & Dozzi, 1994).

Finally, proactive or preventative expediting is the most intense aggressive type of expediting. Here, vendor and sub vendor contact is initiated as soon as the order is issued and continues through the life of the order. The expeditor will review all elements of the order to ensure that the vendor understands the various submittal, testing, and delivery requirements. The expeditor will seek to gain a thorough understanding of the vendor's engineering, purchasing, and manufacturing operations as they relate to the particular order. This enables the expeditor to monitor all elements of the vendor's performance with the intent of anticipating and resolving problems before they seriously impact the

projects. Experienced professional expeditors serve as a key bridge between the engineering and purchasing activities that specify and order materials and the field operations that are dependent on those materials for their progress. Accurate and dependable expediting information is essential for informed management of the projects, and facilitates the mobilization of buyer and vendors resources in response to problems or delays (Ahuja & Dozzi, 1994).

2.9.7 Logistics

Logistics is a concept that emphasizes movement and it may encompass planning, implementing, and controlling the flow and storage of all goods from raw materials to the finished product to meet customer requirements (Mahdjoubi & Yang, 2001). Construction projects require active movement of materials from the suppliers to the production areas in both the factory and the worksite (Faniran et al., 1998; Yang et al., 2003). Previous research suggested that the routing of materials is one of the main points which affect cost and time during construction projects (Faniran et al., 1998; Yang et al., 2003). Hence, these factors should be taken into consideration during the logistics process for effective materials management;

- Optimum forecasting for materials movement (Mahdjoubi & Yang, 2001);
- Planning of access and routing of materials within a construction site (Faniran et al., 1998).

2.9.8 Transportation of Construction Materials

The movement of equipment, materials, and personnel to the job site represents a unique and specialization element of materials management. Experienced traffic personnel can have a positive impact on the execution of the project while minimizing transportation cost (Ahuja & Dozzi, 1994). Significant saving is possible with negotiated project transportation, and through various commercial arrangements for the transportation of goods, materials, documentation, or personnel.

The prime contract, especially insurance clauses, may have a direct impact on the purchasing terms and conditions concerning transportation. Early specialized activities in the project planning phases, such as properly performed route survey and consideration of local traffic conditions, can significantly affect later execution of the work. These front end efforts affect engineering by defining shipping envelopes, weight limits, and schedule limitations, the traffic function or group significant input to purchase documents including packing specifications, shipping instructions, invoicing instructions, and document requirements. This group's expertise is necessary in developing routing guides, shipments progress reports, and troubleshooting as transportation problems develop. Transportation or traffic expertise aids the materials management team in handling numerous types of special loads from delicate electronics to massive modules, each requiring transport and equipment that is specially designed or of limited availability. Knowledge of requirements, source and availability of this equipment may be critical to successful execution of the work. Transport permitting requirements also must be considered early in the project. Assigning the above responsibilities to suppliers may present an easy upfront decision, but can later lead to painful lessons if the expertise is

not available to the materials management team to ensure that traffic functions are handled properly.

Traffic or logistics for foreign sites present an added dimension to the transportation requirements for a project. Each phase of the transportation effort is more complex, with often-stringent requirements due to ocean shipment and transportation to remote areas of the world. Each country's customs requirements are unique with potentially significant duties, taxes, and delays that must be considered in the planning efforts.

2.9.9 Handling of Construction Materials

Handling involves storing and controlling of the construction materials. This involves taking note of the use and inventory of materials on site. Handling records include the loading and off-loading, transit and handling of materials on site (Khyomesh, 2011). It is recommended that arrangements be made for materials to arrive on time. When a construction material is delivered to a site, it should be checked for damage, quantity, quality and specification (Khyomesh, 2011). The importance of appropriate handling of materials is highlighted by the fact that construction materials are expensive and needs critical decisions. Due to the frequency of handling materials there are quality considerations when designing materials handling system. Material handling equipment selection is an important function as it can enhance the production process; provide effective utilization of manpower, increase production and improve system flexibility (Chan, 2002).

2.9.10 Stock and Waste Control of Construction Materials

The European Construction Institute's Total Productivity Management report (ECI1994:34-38) states that "materials delivery to site is a critical, productivity-related aspect which demands the introduction of a carefully developed system of monitoring and control as early as possible". The bulk of construction materials delivery requires proper management of stock control. Stock control is a technique devised to cover and ensure all items are available when required and can include raw materials, processed materials, and components for assembly, consumables, maintenance materials and spares, finished products. Material storage on site requires close attention in order to avoid waste, loss and any damage of materials which could affect the operation of the construction project. Problems always arise during materials supply because of improper storage and protection facilities (Canter, 1993). Studies have identified that building materials often require a large storage capacity which is rarely available on site (Agapiou et al., 1998). However, Stukhart (1995) suggested that, there are a few considerations to take into the planning of the storage space such as timing of the initial buy, and historical information and experience.

Construction activities can generate an enormous amount of waste (Teo & Loosemore, 2001) and materials waste has been recognized as a major problem in the construction industry (Formoso et al., 2002). Waste in construction projects can arise at any stage of the construction process from inception, right through to design, construction and operation of the built facility (Faniran & Caban, 1998).

2.9.11 Surplus of Construction Materials

All projects can expect a certain amount of surplus, however, the key to successful surplus materials management is a well-conceived and well-executed materials management plan. Various shortcomings in the engineering, materials control, procurement, and field materials management phases of the work may results in surplus materials. Understanding and anticipating these potential problems areas are the first in minimizing surplus.

Surplus can be caused by a poorly performed materials take off (MTO). Engineering revision and changes are another cause of surplus, particularly if the MTO occurs early and systems are not adequately responsive to changes. Inadequate construction materials management practices also may lead to surplus, particularly on fast track projects. According to Ahuja and Dozzi (1994) the primary cause of material surplus is duplicate buying and poor control systems or procedures leading to procurement of unnecessary materials.

Minimizing surplus on a project requires a proactive and timely system of communication among all functions involved in the materials acquisition and installation cycle. Option for disposal include using the surplus in the alternative services, using the surplus materials on other projects, returning them to the vendor, or selling them to a third party. All options require complete records and timely reporting to achieve optimum results. The best option is to do the necessary planning and to implement the necessary materials management system to reduce surplus at the source (Ahuja & Dozzi, 1994).

2.9.12 Responsibilities of the Participants Involved in Materials Management Process

The purpose of clearly establishing the responsibilities and authority of the participants is not for attaching blame should something go wrong in the process, but to communicate clearly what is expected and avoid misunderstandings as to who does what and when. The scope of each participant's involvement must be clearly defined. If not, an increased effort will be expended to rectify missed expectations in quantity, quality, or cost. Unexpected effort reduces productivity of the operation. A quality effort is required in all parts of the project otherwise poor quality in the material management process becomes apparent immediately at the point of use. By comparison, poor quality of engineering, for example, may not become apparent at all (Ahuja & Dozzi, 1994). Several participants contribute to the material management process and the scope of their involvement should be clearly stipulated in the contractual document. An efficient material management system leads to improve productivity.

2.10 Critical Success Factors for Material Management on Construction Site

In the construction project, material management is the most important factor to be considered in the planning of every project. The aim of a project is to be finished on time, within budget and to achieve other project objectives such as quality and safety (JHA & IYER, 2006). Ineffective materials management for projects can result in significant cost blow-outs and delays in project completion. Such cost inefficiencies will negatively impact on construction project success. Researchers have identified strategies

needed for effective materials management in order to save cost and project delivery time.

In a study conducted by Abdul-Rahman and Alidrisyi (1994), on the perspective of material management practices in a fast developing economy: the case of Malaysia, the basic material management approach was listed as follows:

- The preparation and monitoring of material schedule.
- Recording of the usage and inventory of materials during construction.
- Employment of security measure on site to safeguard materials on site.
- Performing material variance analysis.

Ebole (2005) also postulated that efficient materials management on site can be achieved through;

- Early project planning
- Use of qualified personnel
- Adequate personnel training and
- Proper communication amongst those involved in the process

Haddad (2006), indicated that effective material management techniques on construction site includes;

- Providing a list of materials in project that includes for example (material name, material number unit price)
- Daily recording of using materials in the project
- Providing material cards at site store that contain for example (input-output balance).

- Providing materials purchase order including for example (order number-material description-required quantity-price).
- Recording the received materials on site, the record shows for example (delivery number-supplier name-material description- quantity).
- Reporting the situation of materials in the projects' store, the report shows (supplier name-order number-quantity input-quantity output-balance).
- Reporting the problems for examples (wastage and breakage-thief and loss-shortage in delivery).
- Following up the prices in the market and recording the variation of prices.
- Using basic technology like mobile telephony or laptop or internet for knowing the new materials and their prices and for tracking materials.

2.10.1 Scheduling Method

According to Abdul-Rahman and Alidrisyi (1994), scheduling is the programming technique used to note date of material requirements and deliveries. During the planning stage a contractor has to check the availability of materials, quantities, the quality of construction required, the allocation of material to various parts of the project, material purchase and delivery, the size and dimension of the required materials, communication methods and interpretation of drawings and specifications

Project scheduling is vital to project execution success and in accomplishing the objectives and goals of a project (Graham, 2006). The failure to employ proper project scheduling might result in high risk of project being delayed, and project financial lost (Ademeso & Windapo, 2012).

2.10.2 Materials Recording Methods

This involves taking note of the use and inventory of materials on site. Records include the loading and off-loading, transit and handling of materials (Abdul-Rahman & Alidrisyi, 1994). It is recommended that arrangements be made for materials to arrive on time. When a construction material is delivered to a site, it should be checked for damage, quantity, quality and specification (Ademeso & Windapo, 2012).

2.10.3 Security Systems

Security of materials on-site is of paramount importance. Pilferage and theft are issues of concern to project managers. Loss of materials through pilferage and theft represent financial lost to the project as a whole, and in the end it increases the cost of the project. Materials are prone to be stolen despite being in store. Also, some materials may not require indoor storage. Therefore, a well designated vigilante must be maintained 24 hours onsite. The most common method is the employment of security personnel on site and providing lighting systems at vintage points. There could be a standby generator at the site in case the light goes off (Abdul-Rahman & Alidrisyi, 1994; Khyomesh, 2011; Ademeso & Windapo, 2012).

2.10.4 Materials Variance Analysis

According to (Khyomesh, 2011; Ademeso & Windapo, 2012) material variance analysis is the comparison of actual material usage against the estimate. It is also a means to track and examine the variability on material cost, quantity and wastage.

2.10.5 Early Project Planning

According to Stukhart (1995) appropriate materials planning should be done concurrently with engineering, construction, and other project plans. He also mentioned that material planning provides guides to all the subsequent activities and that this could have a great impact on the project plan. The materials planning process covers the set up and maintenance of records and determines the target inventory levels, and delivery frequency. It also involves planning of access and routing of materials within the construction site. Studies indicate that the ability to design and accommodate adequate logistics plans, site layout plans and materials management plans are all essential in transportation of materials both unto and around site (Yang et al., 2003). Where such site layout plans are not implemented, the movement of materials on-site is significantly restricted, resulting in increased manual handling, double handling, waste, lost productivity, increased health and safety risks and inevitably, at the extreme, project failure (Mawdesley et al., 2002).

2.10.6 Use of Qualified Personnel

The use of qualified personnel by construction firms greatly help to achieve an efficient material management on project sites (Ebole, 2005). The use of competent personnel improves supervision, reduces design changes, and improves workmanship. More so, use of qualified and experienced personnel greatly reduces errors in estimation or wrong specification.

2.10.7 Adequate Personnel Training

Ebole (2005), indicates that adequate training of personnel involved in the management process of materials on site is necessary to achieve efficient materials management on site. For instance, adequate training of personnel responsible for handling of materials on site (including loading and offloading) will go a long way to improve their health and safety. Donyavi & Flanagan (2009), also suggested that personnel involved in materials management process should be trained on the use of information communication technology (ICT) tools in order to ensure effective communication amongst those involved in the process.

Training programs attempt to teach employees how to perform particular activities or a specific job. Education, on the other hand, is much more general, and attempts to provide employees with general knowledge that can be applied in many different settings (Ebole, 2005). The importance of training is recognized by most material management expert. Customized training plans or programmes should be organised for material management personnel, as well as field labourers in line with materials management objectives and goals of the organisation. The training can be in a form of in-service, external experts on material management, seminars on quality improvement programmes. In order to have effective learning activities, a firm should continually encourage employees to accept education and training. If education and training on MM concepts become widely accepted throughout the construction industry, workers switching from one company to another should require less MM training since all workers would have received basic MM awareness in their previous employment (Arditi & Gunaydin, 1997).

2.10.8 Good Contractor/ Supplier Relations

Suppliers play an important role in any organization. Many companies rely greatly on outside suppliers for the materials needed for production. Good relations with suppliers might be influential for a company to be in business. Companies that have good relations with suppliers could be more successful in attracting customers, than companies that have bad relations with suppliers. When a company has good relations with its suppliers, it could benefit from cost reductions, cooperative environment from the employees of the supplier, and willingness to help with materials ordered and orders pending (Mccord, 2010). When a company has bad relation with their suppliers, it might be possible that it experiences late deliveries or wrong materials delivered.

The understanding and management of buyer-supplier relations is growing in importance and can create a competitive advantage in a globalized construction market. According to Mccord (2010) and Imbeah (2012) good contractor/supplier relations in construction project include: prompt payment to suppliers, offering closer and long term working relationship with suppliers, harmonisation (mutual trust), and providing clear specifications to suppliers.

2.10.9 Use of Information Communication Technology (ICT)

According to Donyavi and Flanagan (2009), basic technology like mobile telephony or laptop is the most common available at the moment. Some other technologies such as internet, RFID (radio frequency identification), GIS (geographic information system), GPS (global positioning system), tracking technology are available in which have the capability of tracking materials. Use of IT has the capability for

changing a cultural structure with an objective by reducing barriers between different functionality. IT also is a great opportunity for communication between different parties and different activities. Electronic data interchange (EDI) and Electronic funds transfer (EFT) are some other technologies in IT that enable a retailer to electronically do some functionality such as purchasing orders, paying invoices and processing credit checks. On site positioning and tracking technologies facilitate arranging for the arrival of materials just in time with right quality and quantity on construction job site while keeping the work in process inventory on the site to minimum the cost and time. Radio frequency base information and communication technologies, such as global positioning system (GPS), radio frequency identification (RFID) tags and Bluetooth have matured and become commercially available to potentially support resource positioning and tracking and automated data collection in construction. GPS technologies have the capability of tracking, managing and controlling earth moving and mining operations which occur in relatively open areas (Lu et al., 2006).

According to Donyavi and Flanagan (2009), the affordable, reliable, and available technologies to improve material management techniques that is straightforward to use is Bluetooth, which is an open wireless protocol for exchanging data over short distances from fixed and mobile devices, creating personal area networks (PANs). It was originally convinced as a wireless alternative to RS232 data cables. It can connect several devices, overcoming problems of synchronisation. The Bluetooth technology is originally designed as a short range wireless connectivity solution for personal, portable, and hand-held electronic devices. The Bluetooth radio operates on a license-free, globally available 2.400-2.4835 GHZ industrial, scientific and medical (ISM) band, which is divided into 79

channels. In addition, Bluetooth employs a fast, frequency-hopping spread spectrum (FHSS) technology (with incremental frequency being 1600Hz) to avoid the interference in the ISM band and ensure the reliability of data communications. Bluetooth radio can be classified into three power classes by the RF transmission power. The typical working distance of Bluetooth ranges from 10m to 100m, depending on the power class of the device. At present, class 3 Bluetooth with a 10 m radius is embedded in most commercial applications of Bluetooth. A Bluetooth device assumes the role of either a master or a slave. Bluetooth is an industry specification for ensuring compatibility in wireless connectivity of electronic devices, allowing one manufacture's device to control the slave device made by another.

2.11 Benefits of Effective Materials Management

An effective material management system can bring many benefits for a company. Previous studies by the Construction Industry Institute (CII) concluded that labor productivity could be improved by six percent and can produce 4-6% in additional savings. According to (Bernold & Treseler, 1991; Ebole, 2005; Haddad, 2006; Donyavi & Flanagan, 2009; Keitany & Mutwol, 2014; Bell & Sturkhart, 2007; Enshassi et al., 2007; Sundararajan & Shanmugapriya, 2014) benefits of effective materials management includes

- Reducing the overall costs of materials
- Better handling of materials
- Reduction in duplicated orders
- Materials will be on site when needed and in the quantities required

- Improvements in labor productivity
- Improvements in project schedule
- Quality control
- Improved cooperation and communication
- Better relations with suppliers
- Reduce of materials surplus
- Reduce storage of materials on site
- Labour savings
- Stock reduction
- Purchase savings
- Better cash flow management
- Reduction of accident rates on sites
- Increased profitability

2.12 Variation in Scheduled Completion Time of Building Projects

Construction time can be regarded as the elapsed period from the commencement of site works to the completion and handover of a building to the client (Choudhury & Phatak, 2004). The construction time of a building is usually specified prior to the commencement of construction. It can be deduced from the client brief or derived by the construction planner from available information, such as design drawing, bill of quantities, method statement, specification and bar chart program (Ademeso & Windapo, 2012).

According to Aibinu and Jagboro (2002), it is not uncommon for the delays to happen during the design and construction phase. Delay is a situation when the contractor and the project owner jointly or severally contribute to the non-completion of the project within the original or the stipulated or agreed contract period. When projects are delayed, they are either accelerated or have their duration extended beyond the scheduled completion date. These are not without some cost consequence (Aibinu & Jagboro, 2002).

In Ghanaian construction industry, time overrun is one of the critical problems faced in the construction project (Fugar & Agyakwah-Baah, 2010). Hamzah et al. (2011) mentioned that, time overrun often causes disorder in workflow and reduces of productivity. Consequently, projects are completed beyond the contract time which can result in budget overrun, contractual claims or also abandonment of the projects (Abedi et al., 2011).

Kraiem and Dickman (1987 cited in Ademeso & Windapo, 2012) classified delay into three categories: compensable, excusable and non-excusable. Generally, a delay is deemed compensable to the contractor when its cause is within the control, is the fault of or is caused by the negligence of the owner. Excusable delays occur when the contractor is delayed by occurrence that is not attributable to either the contractor or owner. Non-excusable delays are caused by the contractor's own action or in action. These can result from the fault of the contractor, or his subcontractors, material, work force or supplier. The owner could conceivably be able to recover delay damage from the contractor (Ademeso & Windapo, 2012).

2.13 Challenges Affecting Materials Management in Construction Projects Delivery

Materials management is an important function required to improve productivity in construction projects delivery. Proverbs et al. (1999) stated that, costs for materials handling may range from 30-80% of total construction costs. In addition, Dey (2001) indicated that, almost 60% of the total working capital of any industrial organization consists of materials costs. Therefore, there is a need for efficient materials management in order to control productivity and cost in construction projects delivery. There are many factors which contribute to poor MM in construction projects. Zakeri et al. (1996) suggested that factors such as waste, transport difficulties, improper handling on site, misuse of the specification, and lack of proper work plan, inappropriate materials delivery and excessive paperwork all adversely affect materials management. Koushki and Kartan (2004) examined and quantified project related variables affecting the on-time delivery of material to the construction site, the material selection time, type of material, their availability, in the local market and presence of a supervising engineer all have significant impact on-time delivery of materials to construction sites. Furthermore, Dey (2001) noted that, the common factors affecting materials management are as follows:

- Receiving materials before they are required, causing more inventory cost and chances of deterioration in quality;
- Not receiving materials at the time of requirement, causing loss of productivity;
- Incorrect materials take-off from drawing and design documents;
- Subsequent design changes;
- Damage/loss of items;
- Selection of type of contract for specific materials procurement;

- Piling up of inventory and controlling of the same; and
- Poor management of surplus materials.

Sundararajan and Shanmugapriya (2014), categorise challenges in material management into two categories. These include:

Organization Structure

Main issues in organization structure are Undefined scope; Lack of communication between parties involved; Incomplete drawings; Plans are not completed and details are missing; Lack of conformance to requirements; Nonstandard specifications that are not commonly used; Incomplete/ineffective meetings; Difference between plans and specifications; Ineffective communication.

Procurement Problem

Availability of material; Availability of quantity; Price reduction to match competitor's price; Late deliveries; Materials are not delivered as per schedule; Late or incorrect submittals; Poor communication between parties; Lack of conformance to requirements; Unrealistic delivery dates; Re-handling of materials; Storage areas are limited or are far from working area; Theft or damaging during handling or other conditions.

2.14 Relationship between Materials Management and Construction Project Success

According to Fugar and Agyarkwah (2010) shortage of materials and late delivery of materials and equipment are some of the main causes of delay in project execution in Ghana. A study carried out by Manavazhi et al. (2002) on material and

equipment procurement delays in highway projects in Nepal, pointed out the significant contribution of material to project performance.

Ogunlana and Proukumtong (1996) studied construction delays in a fast growing economy: comparing Thailand with other economies and some of the construction delays were attributed to material management: the study blames material shortage on site and unreliable supply from material suppliers occasioned by the general shortage in the industry, although there were specific instances in which poor communication between sites and head office purchasing, planning and co-ordination could be cited.

Assaf et al (1994) studied the causes of delay in large building construction projects in Saudi Arabia, the causes were attributed to shortage of construction material, material changes in type and specification during construction, slow delivery of material, damage of material in storage and delay in the special manufacture of building materials out of Saudi Arabia as the material contributor.

In a recent research conducted by Thomas and Sudhakumar (2014) factors influencing construction labour productivity in India, timely availability of materials at the worksite was ranked the highest among the top five factors identified.

Figure 2.1 shows the conceptual framework for the study

Independent Variables

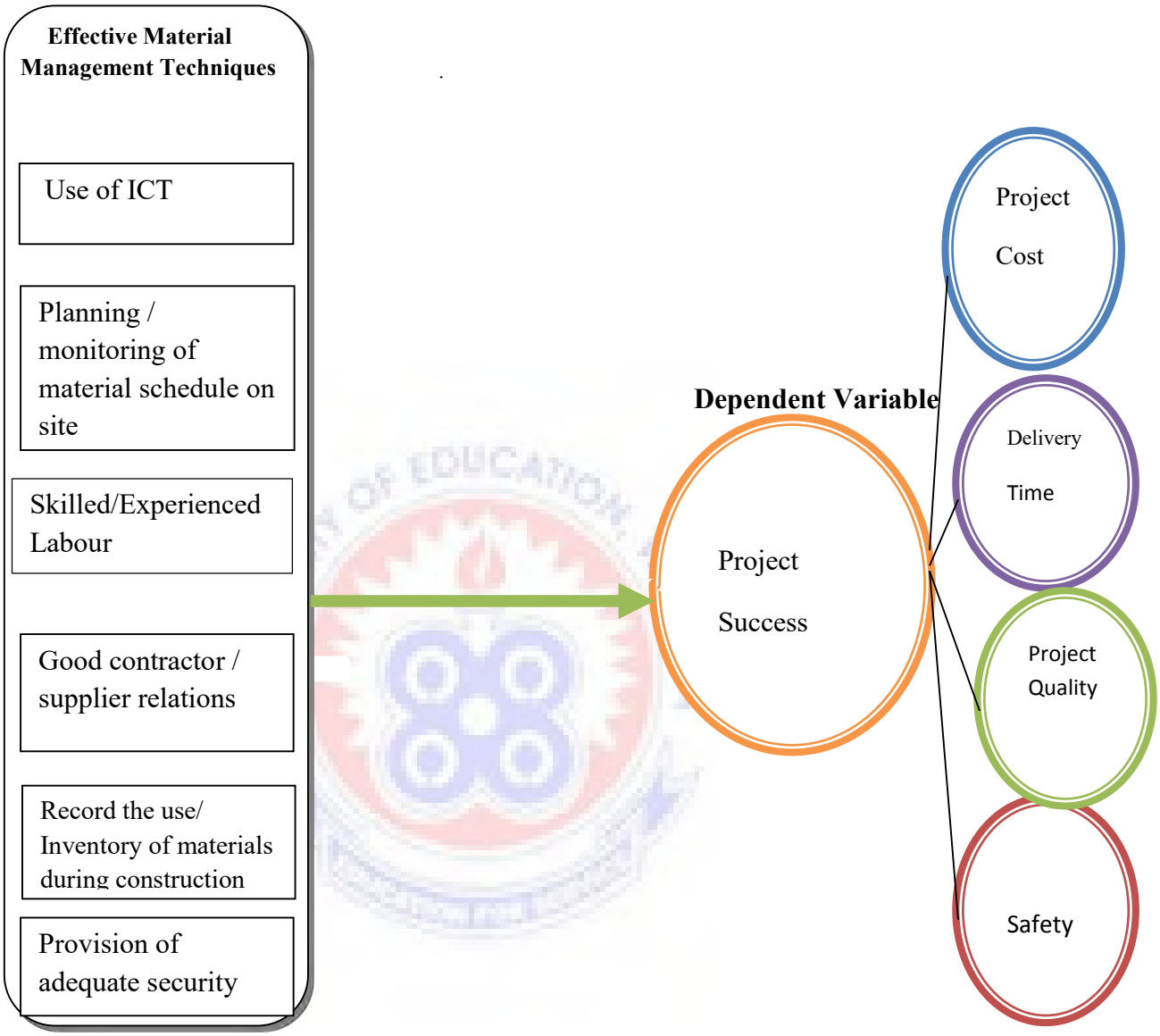

Fig. 2.1: Conceptual Framework for the study

Hypothesis - There is significant relationship between the effective material management technique identified and construction project success (Abdul-Rahman & Alidrisyi, 1994; Mawdesley et al., 2002; Ebole, 2005; Donyavi & Flanagen, 2009; Khyomesh, 2011; Ademeso & Windapo, 2012; Keitanye & Mutwol, 2012).

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter presents the various methods and techniques used to collect and analyze the data collected for the study. Consequently, this section describes the research design, targeted population, sample techniques and sample size determination, sources of data, and method of data collection. It also examines the questionnaire design, and reliability of the instrument that was used to collect data for the study and method of data analysis.

3.2 Research Design

The study made use of both quantitative and qualitative (mixed) research design strategy. Quantitative research is objective in nature and it is an inquiry into a social human problem, based on testing a hypothesis or a theory composed of variables (Naoum, 2007). Thus, the study sought to test a hypothesis; whether there is significant relation between the identified materials management techniques and construction project success.

The quantitative survey design was also chosen because the study sought to examine the effect of material management technique on construction project delivery success; hence, quantitative survey approach using structured questionnaire was deemed appropriate (Haddad, 2006).

The qualitative aspect of the design took the form of structured interview and the use of open-ended questions to obtain in-depth information from the survey respondents.

3.3 Population

The population for the study comprised material managers of construction firms in the Tamale Metropolis of Ghana currently registered with the Association of Building and Civil Engineering Contractors of Ghana (ABCECG). The main reason for using this category of people is that their activities directly or indirectly have a bearing on material management techniques practices in their various firms.

3.4 Sampling Techniques and Sample Size

The sampling method used for data collection was quota and purposive sampling technique. The sampling was done to ensure that there was no bais or subjectivity in the selection process.

The sampling frame for the study was drawn from construction firms of various classifications of 184 materials managers according to (ABCECG, 2015). The sample size was scientifically determined using an acceptable formula from published literature (Yamane, 1967). Formula:-

$$\mathbf{n} = \frac{N}{\{1+N(e)^2\}}$$ Where N=Population size

n = Sample size

e = Level of precision

A 95% confidence level and P=0.05. The sample size was thus derived as follows:-

$$n = \frac{N}{\{1+N(e)^2\}}.$$

$$n = \frac{184}{\{1+184(0.05)^2\}}.$$

Sample size = material managers of 126 construction firms

A 40% allowance was considered to cater for non-responses. The adjusted sample size taken into consideration non response was:

$\frac{140}{100} \times 135 = 1.4 \times 126 =$ material managers of 176 construction firms

3.5 Data Collection Instruments

Both qualitative and quantitative data were collected. Structured questionnaires of 176 were used to solicit data from the materials manager's, because the study assumes that these groups of people are in charge of materials and are literate and can therefore read, understand and also answer the items on the questionnaire accordingly.

3.5.1 Pilot Study

A pilot study was conducted to evaluate the questionnaire; the researcher distributed the questionnaire to five construction material managers in five different contracting companies to fill them. The purpose of this step was to verify if the questions were easy to understand, and also to find out any problem that may arise in filling the questionnaires (Naoum, 2007).

3.5.2 Interviews

The interviews enabled the researcher to easily reach out to materials managers nearby due to proximity and also obtain elaborations on the survey responses and to establish the potential problems/constraints affecting materials management on construction project sites in the Tamale Metropolis of Ghana.

Five of the material managers (three of the exemplars of materials management practices as well as two of poor implementers) were purposively sampled and interviewed face-to-face using an interview guide.

3.5.3 Questionnaire

Preliminary contacts with potential respondents and information from the literature review served as a basis for questionnaires design for the materials managers.

Structured questionnaires of 176 were used to solicit primary data from the materials managers. The questionnaire was built mainly using closed-ended questions, and it was divided into three sections as follows. Section One covered the demographic profile of the respondents and company. Section Two - Application of construction materials management tools and techniques in construction projects. Section Three - Problems in Material Management on sites.

With the aid of three research assistance, the questionnaires were delivered and hand collected from the selected construction firms who were in turn requested to deliver them to the one in-charge of materials management for completion.

3.6 Method of Data Analysis

The data was analyzed using descriptive statistics which include mean, standard deviation, frequency and percentages. This was done with the aid of Statistical Software called SPSS (Statistical Package for Social Sciences). Kothari (2004) asserted that descriptive survey data is represented through use of means, standard deviation, frequency, graphs, pie-charts and frequency table. The results of the data analysis were presented in the form of tables and percentages to ease comprehension. In addition to

descriptive statistics, Factor Analysis and Pearson's product moment correlation coefficient (PMCC) were used (Keitanye & Mutwol, 2014, Ademeso & Windapo, 2012)

3.6.1 Factor Analysis

Factor analysis is a method of quantitative multivariate analysis with the main aim of representing the interrelationships between a set of continuously measured variables (usually represented by their interrelationships) by a number of underlying linearly independent reference variables called factors (Pallant, 2005; Guar & Guar, 2009). The method seeks to collapse various variables into a few dimensions of interrelated attributes called principal components. The Eigenvalue determines the principal components, which are orthogonally varimax, and are rotated to obtain more evenly distributed factor loadings within the components. The factor analytical approach was adopted to group the interrelated factors of the 15 factors identified from literature into components.

3.6.2 Correlation Technique

The major statistical measure of the association was the correlation coefficient. Correlation analysis is primarily concerned with finding out whether an association exists between the dependent variable (project success) and the independents variables (material management techniques) and determining its magnitude and direction (Saunders et al., 2007; Hair et al., 2006).

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

In this section the results of the empirical analysis are reported and presented. The presentation proceeds with an analysis of the descriptive statistics on the variables under consideration. The data was analyzed and interpreted by using Statistical Package for Social Science (SPSS) version 16. Descriptive statistics such as tables, percentages, simple means and standard deviation as well as Factor Analysis, and Pearson's Product Moment Correlation Coefficient (PMCC) were employed.

4.2 Results and Discussion from the Interview of Materials Managers

Background of the Participants

The background of the participants provided descriptive information on Qualification, and Experience of the participants as well as their company sizes.

The content of Table 4.1 indicates that, 2 of the participants had Bachelors degree, while 2 possess Masters and HND level of education respectively. Regarding their working experiences, all the participants were within 5-10 years bracket. This is an indicative that the participants have requisite qualification and experience; suggestive that they have fair knowledge in materials management. With respect to their company size, one (1) of the participants was in medium size firm, while two (2) of the participants were in small and large firms respectively. Three (3) participants had their firms undertaking only building construction; while two (2) had their firm undertaking both road and building construction.

Table 4.1 Background of the Participants for the Interview

Educational Qualification	**Frequency**
HND	1
BSC	2
Masters	2
Experience	
5-10 years	5
Company Sizes	
Small	2
Medium	1
Large	2
Nature of Work Undertaken by their Firms	
Building Construction	3
Building & Road	2
Total	**5**

The Role of a Materials Manager

Materials manager is a person in-charge of material management on sites (Haddad 2006). According to the participants, materials managers ensures efficient materials planning, procuring and receiving, storing and inventory control as well as supplying and distribution of materials on site. One participant said "I ensure that materials required are available and in right quality and quantity" participant (A).

Another participant said "I am responsible for procuring, storing, and distribution of materials on site" participant (C) (Sundararajan & Shanmugapriya, 2014; Ebole, 2005).

Issues Regarding Materials on Site

On how the firms of the material managers address material issues on site, the participants indicated that materials issues are addressed by the materials manager and the director of the firm or material management department in the case of large companies.

Problems in Material Management

The participants mentioned the following as problems in material management on construction project sites in their firms:

Late Delivery of Materials by Suppliers

The participants mentioned late delivery of materials as one of the potential problems they face in the management of materials on site. This, they attributed to "price reduction to meet competitors price". They indicated that often suppliers reduce their price in order to win the bid. However, after procuring the bid they are unable to meet the supply timeliness due to weak financial capacity. Other reasons assigned included delayed payment to the suppliers by contractors or client due to lack of funds; and shortage of materials on market.

Too much Documentation of Materials on Site

Traditional system of material management requires more paper work as recordings are made manually. The participants indicated that they still employ manual recording system using forms due to unavailability of basic communication tools like computers, printers, and fax machines at their offices. This was however, reported by

material managers from small and medium firms. One of them lamented “we are still using the traditional recording system which is very stressful and time consuming”. On contrary, the large firms do not have this problem because they are equipped with modern communication tools and equipment.

Availability of Materials on Market

Steady flow of materials throughout project duration is among the primary function of material management. However, this can be affected by market availability of the material for work. Occasionally manufacturers can run out of raw material or be affected by government policy to the extent that production may have to be slow or suspended; the participants cited the recent energy crises as a major contributory factor for this situation in recent times. According to the participants, unavailability of materials for work on market affects material management by either increasing competition in material purchase or delay the general work progress.

Storage Space of Materials on Construction Site

Large number of materials is required depending on the magnitude of the project. And the term storage space implies both enclosed and open space that can be used to keep materials of work safe until the need for it arise. All materials need protection against many threats such as pilferage, theft, damage or loss. Material such as aggregates, bricks/blocks may not require enclosed storage protection than proper outdoor positioning and stacking. However, other materials such as reinforcement bars, steel columns, timber, and galvanized steel for trusses must be protected against contact with

water in order to avoid rust/corrosion. The size of proposed building may occupy 60% of the total project site, enabling the remaining 40% to be used for temporary access and site facilities. According to the material managers interviewed, this situation compels them to arrange for periodic delivery of certain materials to avoid congestion, and maintain constant operation. They also reported that due to limited space, their storage areas are sometimes far from the working area resulting in double handling.

Security Problem of Materials on Construction Site

Security of materials onsite is of paramount importance. Gradual pilferage and theft are issues of concern to the material managers. Loss of materials through pilferage and theft represent financial lost to the project as a whole, and in the end it increases the cost of the project. Materials are prone to be stolen despite being in store. And some materials (reinforcement bars, steel columns, timber, and galvanized steel for trusses) may not require indoor storage and therefore, needs a well designated vigilante to be maintained 24 hours onsite. Meanwhile, most of their project sites have no light or well trained security persons. One of the participants said “we are compelled to use generators whenever we are to light our site; which comes with extra cost” (material manager of company D). On why their security men and other workers not trained, they said that training is rarely given to the workers because of the casual nature of employment of the workers, “there is lack of job continuity” remarked one material manager.

Incorrect Material take-off and Frequent Changes in Designs

Incorrect material take-off from drawings and design documents leads to overestimation or under estimation of materials required for the project. This problem occurs as a result of incompetency on the part of the quantity surveyor or the estimator. Additionally, frequent changes in designs and specifications lead to "accidental" purchases of materials on site; according to the participants.

Perception of Site Workers about Material Management Procedures on Site

On the perception of workers about material management procedures on site, the interviewed participants indicated that site workers perceive material management to be only controlling theft and material availability and not necessary to them. This might partly be attributable to ignorance on the part of the workers on the functions of their material management department.

4.3. Results and Discussion of Questionnaire from the Materials Managers

Response Rate

A total of 176 questionnaires were distributed to the materials managers of registered contractors of Tamale Metropolis with the aid of three research assistance. A total of 104 questionnaires representing 59.09% were received however, 72 questionnaires accounting for 40.91% were unable to be collected from the respondents, 8 questionnaires representing 7.69% of the received data were also incomplete therefore were discarded. Hence, the usable response rate was 96 accounting for 92.31% of the total valid data received.

Company Size of the Firms of the Respondents

Table 4.2 shows that twelve (12) of the respondents materials managers representing 13 percent were from large sized construction firms (D1K1). Thirty six (36) of the respondents' material managers representing 37 percent were from medium size construction firms (D2K2) while forty eight (48) respondents' materials managers representing 50 percent were from small size construction firms (D3).

Table 4.2 Company Size of the Respondents

Firm	Frequency	Percentage
Large (D1K1)	12	13%
Medium (D2K2	36	37%
Small (D3)	48	50%
Total	**96**	**100%**

Type of Construction Work Undertaken by the Firms of the Respondents

Fig. 4.1 shows that twenty four (24) of the respondents accounting for 25 percent have their firms undertaking both building and civil works while majority, thus, seventy two (72) of the respondents accounting for 75 percent have their firms undertaking building works only.

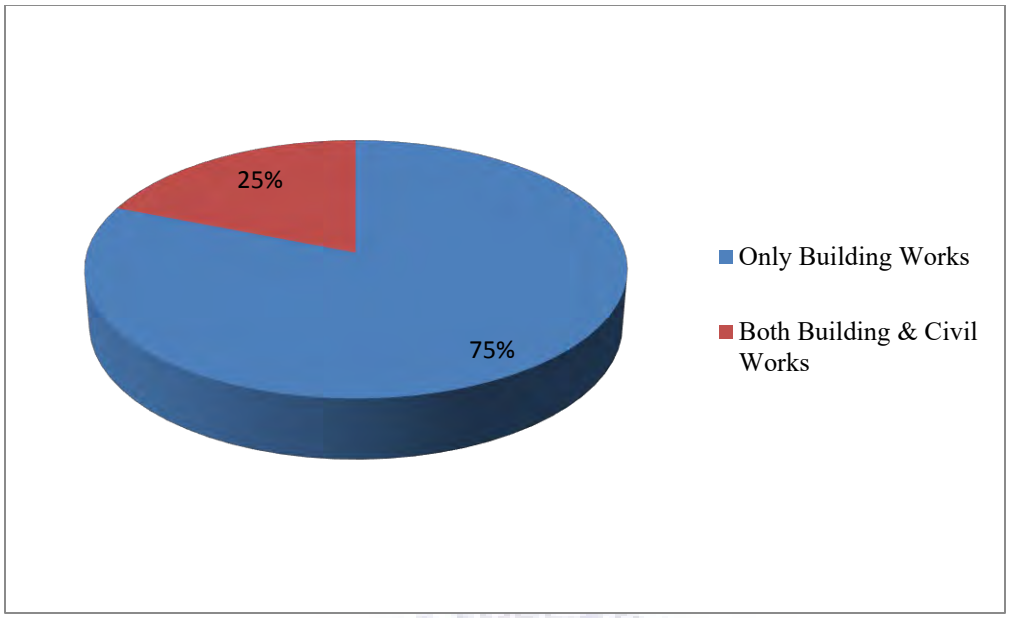

Fig. 4.1: Construction Work Undertaken by the Material Managers' Firms

Demographic Characteristics of the Respondents

The demographic characteristics of the respondents provided descriptive information on Qualification, and Experience of the respondents. This information was necessary to ascertain the validity of the results obtained and to develop an understanding of the background of the respondents with respect to their qualifications and experience.

Respondents' Professional Qualification

Table 4.3 indicates that most of the respondents had Bachelors and HND level of education that is, 44 percent and 35 percent respectively; whereas a small proportion of the respondents had CTC and Masters level of education i.e. 15 percent and 6 percent respectively. This is an indicative that majority of the material managers have requisite qualification required of the industry. It is also suggestive that they had a better understanding of the research instrument; thus enhancing the validity and reliability of the response.

Table 4.3 Respondents' Professional Qualification

Educational Qualification	Frequency	Percentage
CTC	14	15%
HND	34	35%
BSC	42	44%
Masters	6	6%
Total	**96**	**100%**

Respondents' Working Experience

Table 4.4 indicates that majority of the respondents, thus, seventy eight (78) representing 81 percent have more than 5years working experience. This is an indicative that majority of the respondents have adequate experience. Hopefully, this should provide some reasonable conviction that the respondents have credible basis for the data elicited.

Table 4.4 Respondents' Working Experience

Experience	Frequency	Percentage
Under 5years	18	19%
5 – 10 years	54	56%
Above 10 years	24	25%
Total	**96**	**100%**

Critical Success Factors for Materials Management on Construction Site

Factor analysis was used to establish the underlying interrelations existing among the many variables identified from literature and materials managers. This makes it possible to reduce the variables to a more meaningful framework to support effective management and policy decisions (Amoah, Ahadzie & Dansoh, 2012).

The rotated component matrix of the significant factors is presented in Table 4.5. In the preliminary analysis, the Kaiser-Meyer-Olkin (KMO) test of sampling adequacy which measures the degree to which variables are measuring a common concept, achieved a high of 0.815. Furthermore, Bartlett's test of sphericity, which tests the hypothesis that the variables are collinear, was significant at the $p < 0.01$ level (see Table 4.5). Hence, PCA was found to be a suitable data reduction technique. PCA was conducted and five (5) components were extracted using Kaiser's criterion, which retains only those components whose variance is greater than 1.0.

A Varimax rotation was applied to the components to ensure the components were uncorrelated. Observation of the correlation matrix of the significant factors indicate that they all have significant correlation at the 5% level, indicating that there would be no need to eliminate any of the variables for the principal component analysis. These five (5) components explained almost 84.64% of the variation in the data (see Table 4.6). Table 4.7 shows the extracted components and the variables most strongly correlated to each one. With respect to component 1, providing a list of materials in project that includes for example (material name, material number and unit price) and recording/inventory of materials during construction emerged highest with a factor loading of (0.917). This is followed by adequate pre-construction survey on material (0.901), providing material cards at site store that contain for example (input-output balance) (0.865), providing materials purchase order including for example (order number-material description-required quantity-price) (0.747), as well as planning the access rout and site lay out before delivering materials to site (0.727) follow in that order. The combined effect of the above variables on construction materials management is 42.33%.

With respect to component 2, Table 4.7 shows that good business relationship (open and mutual trust) with suppliers emerged highest with a factor loading of (0.924). This is followed by prompt payment to suppliers (0.912), offering closer and long term working relations with supplies (0.828), and providing clear specification to suppliers (0.689) follow in that order. The combined effect of the variables on construction material management is 16.97%.

Table 4.7 further indicates that, employment of security personnel on site emerged highest in component 3 with a factor loading of (0.871). This is followed by employment of store keeper (0.778); and providing lighting systems at vintage points (0.768) follow in that order. The combined effect of the above variables on construction material management is 10.77%.

Table 4.7 shows that use of skilled and experienced workers emerged highest in component 4 with a factor loading of (0.910); this was followed by training of workers (0.838). The combined effect of the variables on construction materials management is 7.75%.

Table 4.7 indicates that using basic technology like mobile telephony or laptop or internet for knowing the new materials and their prices and for tracking materials in the opinion of the respondents should be the 5th most significant factor for construction materials management with a factor loading of (0.858). The effect of the above variable on construction materials management is 6.81%.

Given that most of the variables in factor 1 are directly linked to adequate planning and monitoring material schedule, the researcher decided to name this factor as planning and monitoring materials schedule-related factor. A cursory look at factor 2

shows that the variables are linked to good business relations, hence, the researcher named it good contractor/supplier relations -factor. Similarly, the variables in factor 3 are directly linked to security; therefore, this factor is labelled provision of adequate security-related factor. The variables in factor 4 are directly linked to the use of competent workers/training, the researcher labelled this component as competent manpower or training-related factor. The 5th factor is labelled adoption of information communication technology (ICT).

The results therefore reveal that the significant factors for construction materials management in the Tamale Metropolis of Ghana could be categorized into five (5) main themes; namely: adequate planning and monitoring of materials schedule-related factor, good contractor or supplier relations-factor, adequate security-related, manpower or training-related factor, and adoption of ICT. This finding corroborates with the studies reported by authors such as (Ebole, 2005; Haddad, 2006; Donyavi & Flanagan, 2009; Maccord, 2010; Imbeah, 2012; Ademeso & Windapo, 2012) in similar studies.

Table 4.5: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.815
Bartlett's Test of Sphericity	Approx. Chi-Square	1.745E3
	Df	105
	Sig.	.000

Table 4.6 Total Variance Explained

Component	Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	6.350	42.331	42.331	3.652	24.347	24.347
2	2.546	16.974	59.305	3.564	23.757	48.104
3	1.616	10.772	70.077	2.249	14.993	63.097
4	1.162	7.749	77.825	2.060	13.735	76.832
5	1.022	6.812	84.637	1.171	7.806	84.637
6	.619	4.125	88.762			
7	.461	3.076	91.839			
8	.353	2.355	94.194			
9	.258	1.721	95.915			
10	.189	1.261	97.176			
11	.135	.899	98.076			
12	.132	.881	98.957			
13	.073	.488	99.445			
14	.047	.312	99.757			
15	.037	.243	100.000			

Extraction Method: Principal Component Analysis.

Table 4.7: Principal Component Analysis of Construction Material Management Technique

Item	Factor loadings 1	2	3	4	5
Planning & Monitoring Material Schedule					
Providing a list of materials in project and recording/inventory of materials during construction	0.917				
Adequate pre-construction survey on material	0.901				
Providing material cards at site store that contain for example (input-output balance).	0.865				
Providing materials purchase order including for example (order number-material description-required quantity-price).	0.747				
Planning the access route and site lay out before delivering materials to site	0.727				
Good Contractor/Supplier Relations					
Good business relationship (open and mutual trust)		0.924			
Prompt payment to suppliers		0.912			
Offering Closer and long term working relationship with suppliers		0.828			
Providing clear specification to suppliers					
Provision of Adequate Security		0.689			
Employment of security personnel on site					
Employment of store keeper			0.871		
Providing lighting systems at vintage points			0.778		
Use of Competent Manpower /Training			0.768		
Skilled and experienced workers					
Training of workers					
Use of ICT				0.910	
Using basic technology like mobile telephony or laptop or internet for knowing the new materials and their prices and for tracking materials				0.838	
					0.858

4.3.1 Application of Material Management Techniques on Construction Sites

The responses of the materials managers on the level of practice of the material management techniques to project success delivery were compared, and the results showed no significant difference at 5% significance level. The responses of the groups (small, medium and large) were therefore combined. The mean value of respondents who evaluated the level of practice of the various techniques from "rarely" to "very often" are shown in Table 4.8,4.9,4.10,4.11, and 4.12.

Table 4.8 indicates that provision of adequate security had the highest mean (3.92) while the use of competent manpower or training had the lowest mean (2.70). Provision of adequate security (mean = 3.92, std = 0.50) rank first followed by planning and monitoring material schedule on site (mean = 3.53, std = 0.52); Good contractor or supplier relations (mean = 3.39, std = 0.62), Use of ICT (mean = 2.75, std = 0.54), and Use of competent manpower or training (mean = 2.70, std = 0.56) in that order.

Table 4.9 shows that with regard to provision of adequate security category, employment of store keeper (mean = 4.68), followed by employment of security personnel on site (mean = 4.62), while providing lighting systems at vintage points had a mean of (2.45).

Table 4.10 shows that on planning and monitoring material schedule category, providing a list of materials in project that includes for example (material name, material number and unit price) and recording or inventory of materials during construction emerged highest with a mean of (4.64). This is followed by providing materials purchase order including for example (order number-material description- required quantity-price) (mean = 3.74), adequate pre-construction survey on material (mean = 3.46), providing

material cards at site store that contain for example (input-output balance) (mean = 2.94), while planning the access route and site lay out before delivering materials to site had a mean of (2.89).

Table 4.11 indicates that the use of basic information communication technology (ICT) like mobile telephony or laptop or internet for knowing the new materials and their prices and for tracking materials had a mean value of (2.75).

Table 4.12 shows that regarding good contractor supplier relations category, providing clear specification to suppliers emerged highest with a mean of (4.28). This is followed by offering closer and long term working relations with suppliers (3.86); good business relationship (open and mutual trust) with suppliers had a mean of (2.84), while prompt payment to suppliers had a mean of (2.58). Table 4.15 indicates that with respect to manpower or training, the use of skilled and experienced workers emerged highest with a mean of (3.42); while training of workers had a mean of (1.98).

Table 4.8: Ranking of Application of Material Management Techniques Category Surveyed

Category	Mean	Rank
Provision of Adequate Security	3.92	1
Planning /Monitoring material schedule	3.53	2
on site	3.39	3
Good Contractor/Supplier Relations	2.75	4
The Use of ICT		
Manpower/Training	2.70	5

Table 4.9: Ranking of Application of MM Techniques in the Provision of Adequate Security Category

MM Techniques	Mean	Rank
Employment of storekeeper	4.68	1
Employment of security	4.62	2
personnel	2.45	3
Provision of lighting system		

Table 4.10: Ranking of Application of MM Techniques in the Planning or Monitoring Materials Schedule Category

Material Management Techniques	Mean	Rank
Providing a list of materials in project	4.64	1
Providing material order	3.74	2
Adequate pre-construction market survey	3.46	3
Providing material Card at site	2.94	4
Planning the access rout and site layout	2.89	5
before delivery of material to site		

Table 4.11: Application of MM Techniques in the Use of ICT Category

Material Management Technique	Mean	Rank
Use of ICT	2.75	1

Table 4.12: Ranking of Application of MM Techniques in the Contractor or Supplier Relations Category

Material Management Techniques	Mean	Rank
Providing clear specifications to suppliers	4.28	1
Good business relations with suppliers	3.86	2
Offering closer and long term relations with suppliers	2.84	3
Prompt Payment to suppliers	2.58	4

Table 4.13: Ranking of Application of MM Techniques in the Manpower or Training Category

Material Management Techniques	Mean	Rank
Use of Skilled & Experienced workers	3.42	1
Training of workers	1.98	2

Table 4.14 shows that all the 4.13 material management techniques fall into four main categories, thus categories 1 – Rarely practiced, 2- seldom practiced, 3-occasionally practiced, and 4-often practiced). "Employment of storekeeper", "providing a list of materials in project site", "employment of security personnel ", and "providing clear specification" are categorized as often practiced on construction sites in Tamale Metropolis. closer long term relations with suppliers ", "providing material order", "adequate pre-construction market survey", and" use of skilled and experienced workers" are categorized as occasionally practiced. "Providing material card at site store", "planning the access route & site layout before delivering material", "Good business relations with suppliers", "use of ICT", "prompt payment to suppliers", and "provision of lighting system to vintage points" are categorized as seldom practiced; while "training of workers" is categorized as rarely practiced.

Table 4.14: Overall Ranking of Application of MM Techniques Surveyed

Material Management Techniques	Mean	SD	Rank
Employment of storekeeper	4.68	0.46	Often
Providing a list of materials in project site	4.64	0.54	,,
Employment of security personnel	4.62	0.46	,,
Providing clear specification	4.28	0.52	,,
Offering closer long term relations with suppliers	3.86	0.52	Occasionally
Providing material order	3.74	0.55	,,
Adequate preconstruction market survey	3.46	0.58	,,
Use of skilled and experienced workers	3.42	0.56	,,
Providing material card at site store	2.94	0.48	Seldom
Planning the access rout & site layout before delivery material	2.89	0.50	,,
Good business relations	2.84	0.62	,,
Use of ICT	2.75	0.56	,,
Prompt payment to suppliers	2.58	0.54	,,
Provision of lighting system	2.45	0.60	,,
Training of workers	1.98	0.50	Rarely

4.3.2 Effect of the Identified Material Management Techniques on Construction Project Delivery Success

The respondents were given propositions on the effect of the material management approach identified on their project delivery success and asked to indicate their level of agreement. Their responses are presented in Table 4.15. The respondents pointed out that the material management techniques identified are important factors for construction project success. From Table 4.15, the various descriptive statistics on the effects of the identified material management approach on construction project success were performed. The effect with the highest mean was improvement in labour productivity (4.24), implying that the respondents strongly agree that improved productivity was an effect of material management approach on construction project delivery. This was followed by improvement in project schedule (3.88), better relations

with suppliers (3.84), improved cooperation and communication (3.82), reduces the overall cost of materials (3.78), Increased profitability (3.75), improved the quality of the project (3.72), and reduces accidents rates on site (3.65) in that order.

The mean of all the responses exceeded the mid-point (3). Impliedly, the respondents "Agree" with those effects. All the responses were with lower standard deviations. This implies that the responses were not varied and thus were significant. The study therefore deduced that the identified materials management approach have effect on construction project delivery.

Table 4.15: Effect of the Material Management Techniques on Project Delivery Success

Effect	Mean	SD
Improvement in labour productivity	4.24	0.55
Improvement in project schedule	3.88	0.54
Better relations with suppliers	3.84	0.50
Improved cooperation and	3.82	0.48
communication	3.78	0.42
Reduces the overall cost of materials		
Increased profitability	3.75	0.54
Improved the quality of the project	3.72	0.56
Reduces accidents rates on site	3.65	0.52

4.3.3 Test of Hypothesis

Correlation technique was used to analyze whether there is significant association between the identified material management approach and construction project delivery success in terms of project cost, delivery time, quality, and safety in order to aid the direction of the study. The results of the Pearson Product Moment Correlation coefficient

computed between the material management approach used and project delivery success of selected construction projects sites in the Tamale Metropolis of Ghana is shown in Table 4.16. The result showed that there was a positive association between the material management approach used and construction project delivery success ($r = 0.782$, $p = 0.001$). Thus, there was a strong positive association between the material management approach used and project success of Tamale Metropolis construction firms. The correlation of the study variables were computed at 0.05 significant levels.

Table 4.16: Pearson Product Moment Correlation Coefficient between Materials Management Approach Used and Project Delivery Success

	Project Delivery Success
Material Management Approach Used	0.786**
Significant (2-tailed)	0.000

**Correlation is significant at the 0.05 level (2 tailed)

4.3.4 Problems Affecting Material Management in the Respondents' Organizations

The third objective was to identify the challenges affecting material management, and this is indicated by the respondents as listed in order of priority (based on total number of responses received against each option).

1. Late delivery of materials
2. Too much documentation or paper work
3. Unavailability of materials
4. Limited Storage Space
5. Security Problem
6. Incorrect materials take-off from drawings and design documents

7. Frequent Changes in Designs
8. Delivery of wrong quantity of materials

These problems have been discussed in the results and discussion of the interview.

4.4 Discussion of Results of Questionnaire from the Respondents

This section presents the discussion of the results of the study. The results are discussed in the context of the literature reviewed in chapter 2, to further explain the findings on the subject of material management techniques in construction, in the context of the Tamale Metropolis; which is regarded to have relevance to other regions of Ghana as well as other developing countries.

Critical Success Factors for Construction Materials Management on Site

The first statement in the objective was to identify significant material management techniques for construction project sites. Factor analysis was used to establish the underlying interrelations existing among the many variables identified from literature and field experts. This makes it possible to reduce the variables to a more meaningful framework to support effective management policy (Amoah, Ahadzie & Dansoh, 2011). The results indicated that each of the 15 variables has a loading above 0.60. Since all the loadings exceeded the cut-off point of 0.50, the loadings can be considered as both statistically and practically significant (Hair et al., 2006). The finding shows that the material managers believe all factors shown in Table 4.9 are important techniques for managing materials on construction project sites. It is also clear from the factor analysis that the underlying construct of the critical factors for material

management; in the perspective of the respondents material managers, are directly linked to five (5) main themes; namely: planning and monitoring material schedule-related techniques, good contractor or supplier relations-techniques, provision of adequate security-related techniques, Use of competent manpower or training techniques, and Use of Information Communication Technology.

Planning and Monitoring Material Schedule-Related Technique

The result of the study revealed that in the opinion of the respondents, planning and monitoring material schedule-related techniques is the most significant material management technique in the opinion of the respondents. This implies that providing a list of materials in project that includes for example (material name, material number unit price), recording the received materials on site for example (delivery number-supplier name-material description- quantity), recording the used materials during construction, reporting the situation of materials in the projects' store (supplier name-order number-quantity input-quantity output-balance), and reporting the problems for examples (wastage and breakage-thief and loss-shortage in delivery) adequate pre-construction survey on material, providing material cards at site store, providing materials purchase order including for example (order number-material description- required quantity-price), and planning the access route and site lay out before delivering materials to site) are significant material management approach for construction project delivery. This finding is consistent with (Haddad, 2006; Ademeso & Windapo, 2012; Donyavi & Flanagan, 2009) study.

Good Contractor/Supplier Relations -Technique

The result of the study revealed that in the opinion of the respondents; good contractor supplier relations-technique is the second most important material management technique. This implies that good business relationship (open and mutual trust) with suppliers, prompt payment to suppliers, offering closer and long term working relations with suppliers, and providing clear specification to suppliers are significant for material management on construction project sites. This finding is in agreement with the reported studies of the following authors (Mudambi & Helper, 1998; Errasti et al., 2009; Maccord, 2010; Imbeah, 2012).

Provision of Adequate Security-Related Technique

The result of the study further revealed that in the opinion of the respondents, Provision of adequate security-related technique is the third most significant material management technique. This implies that employment of security personnel on site, employment of store keeper, and providing lighting systems at vintage points are significant for effective material management for construction project delivery. This finding also agrees with the reported studies of the following authors (Ademeso & Windapo, 2012; Haddad, 2006).

Use of Competent Manpower Training of Site Personnel

The result of the study further revealed that in the opinion of the respondents, Use of competent manpower training is the fourth most significant material management technique. Impliedly, the use of skilled and experienced project personnel (designers,

estimators, supervisors, and craft men) as well as effective training of site personnel on material handling is significant for material management in construction project delivery. This finding agrees with (Ebole, 2005; Enshassi, 2007) assertions.

Use of Information Communication Technology

The result of the study further revealed that in the opinion of the respondents, Use of Information communication technology is the fifth most significant material management technique. This implies that using basic technology like mobile telephony, laptop or internet for knowing the new materials and their prices and for tracking materials is significant for material management on construction project delivery. This finding supports the assertions of (Donyavi & Flanagan, 2009; Haddad, 2006).

Application of Material Management Techniques on Construction Sites

The study also seeks to assess the level of adoption of the identified material management (MM) techniques within the construction organizations surveyed. From Table (4.10) the means of the identified material management techniques application in the selected construction firms ranges from (1.98 to 4.68); this indicates that the respondents' firms in general, implement the identified techniques rarely, seldom, occasionally and often with the (Ebole, 2005; Haddad, 2006; Donyavi & Flanagan, 2009; Ademeso & Windapo, 2012) elements of material management techniques in their construction firms. Regarding the provision of adequate security (mean = 3.92), respondent firms often employ storekeepers and security personnel on site. However, they seldom provide lighting system at their site. This finding is not surprising as most of

the construction site of the respondents are newly developing site without access to electricity; this makes it impossible to lighting their site. The results of the interviews corroborate these findings as can be seen from one material manager's response on the constraints to material management on site "we are compelled to use generators whenever we are to light our site; which comes with extra cost" (material manager of company D).

With regard to planning and monitoring material schedule on site (mean = 3.53), the surveyed firms provides a list of materials in project, and occasionally conduct pre-construction market survey and provide material order. However, they seldom provide material card at site store, and seldom plan the access route and site layout before delivering materials to site. The surveyed firms seldom used basic technology like mobile telephony, laptop or internet for knowing the new materials and their prices and for tracking materials (ICT) (mean = 2.75). With respect to contractor supplier relationship, the surveyed firms often provide clear specifications to suppliers and occasionally offer long-term cooperative relation with suppliers. However, they seldom have good business relations with their suppliers and seldom pay their suppliers promptly. The interviewed results revealed that although, some of the surveyed firms have long-term cooperative relation with suppliers, this relation does not base on product quality. It is based on low price. Most of the firms deal by debt with suppliers, so the result will be poor product quality. Suppliers that can supply high quality products always require contractors to pay immediately. The interviewed firms did not have sufficient money for immediate payment. Regarding manpower training (mean = 2.70), the surveyed firms occasionally used skilled and experienced workers, and seldom train their workers. This finding may

be attributable to lack of motivation in the construction industry; especially among small and medium sized firms; making it difficult to attract highly qualified personnel. Also the results of the interview revealed that due to the casual nature of employment of the construction workers, training is rarely given to the workers as "there is lack of job continuity" remarked one material manager.

Effect of Material Management Approach on Construction Project Success

The second statement in the objective was to assess the effect of the identified material management techniques on project success. The inferential statistics on the study variables was performed and correlation analysis done. The result of the correlation analysis is presented in Table 4.12. The study found that there was strong significant, positive association between the identified material management approach, and construction project delivery success. The findings of this result indicate that the identified material management approach has significant influence on construction project delivery success. This implies that higher application of the material management approach significantly improves construction project delivery success. This finding is consistent with similar studies on relationship between material management approach and project success (Ebole, 2005; Haddad, 2006; Donyavi & Flanagan, 2009; Ademeso & Windapo, 2012; Keitanye & Mutwol, 2014).

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the summary of findings, conclusion and recommendations of the study.

5.2 Summary of Findings

The following are the findings from the study:

- The study revealed that, most of the construction firms in the Tamale Metropolis are small and medium sized firms and involved mainly in building works, hence they do not have the capacity to implement effective materials management techniques on site.
- Among the problems affecting materials management on construction project sites in Tamale Metropolis are, late delivery of materials, too much bureaucracy or paper work, unavailability of materials, limited Storage Space, ineffective security structures, incorrect materials take-off from drawings and documents and delivery of wrong quantity of materials.
- The study further indicated that, majority of contracting firms do not make use of materials management techniques such as, planning and monitoring of materials schedule, use of information communication technology, good contractor supplier relations, and the use of competent workers as well as effective training of workers, thereby affecting effective materials management on construction project delivery negatively .

- The study also implied that, the firms mainly the large firms employ some of the construction materials management techniques identified, therefore have the capacity to practice MM techniques onsite, but the small and medium size firms do not have the resources and the capacity to implement the MM techniques hence, resulting in ineffective materials management.
- The study showed that, most firms do not offer in-service training for their workers, therefore they lack the requisite knowledge, skills and ability to implement effective materials management techniques on sites.
- The study further revealed that, the use of information communication technology (ICT) for example mobile telephony, laptop or internet for knowing the new materials and their prices and for tracking materials is missing on most site, therefore causing delay in materials ordering and supply and further frustrating the materials management characteristics of right quality, right quantity, right time and reasonable cost.
- The study also revealed that, the benefits of material management approach which have strong positive effect on construction project delivery success in terms of project schedule, overall cost of materials, quality of the project and reduction of accidents rates on site will elude most of the firms since MM techniques is not properly practice.

5.2 Conclusion

The study has confirm that effective materials management techniques on construction site are important for project success and since there is a significant link between it and the recommendations thus, materials managers of construction firms should be more concerned about planning and monitoring of material schedule, establishing good business relations with suppliers, the use of security measures on site use of information communication technology, and also the use of competent workers as well as effective training of workers, to enhance their materials management and ultimately improve their project delivery success.

5.3 Recommendations of the Study

To address the findings, the following recommendations are made:

- The Small and Medium size firms construction firms in the Tamale Metropolis involved mainly in building works should make resources available to aid in the implementation of effective materials management techniques on site.
- To overcome materials management challenges on construction sites materials managers should endeavor to do the following;
  - Prepare and monitor material schedule on all projects.
  - Make it compulsory for the store keeper to record and use inventory of material on daily basis during the construction process, to enable him or her alert or inform the necessary authority if there is shortage of any material, for prompt ordering.

- As much as possible material managers should make adequate pre-construction survey on materials before commencement of any construction project

- Materials managers should make use of more than one materials management technique on construction projects so as to achieve maximum project delivery success.
- To ensure that, the materials managers have the requisite knowledge, skills and ability to implement effective materials management techniques on sites, top management of contracting firms can make incentives for their staff members to attend training courses or in-service training in construction materials management and its applications.
- For materials management characteristics to achieve on site materials managers should be encouraged to use computerized construction materials management systems to save effort, time and cost, and to achieve more accurate results.
- Top management should employ trained persons to secure the materials on site during the day and at night to ensure that all materials are protected from theft or pilfering.
- It is recommended that, top management of contracting firms should employ qualified and experience materials managers who better understand the dynamics of materials for effective and efficient materials management practices.
- Contractors/Clients should expedite effort to pay their suppliers promptly.

- To ensure proper implementation of effective MM techniques, public employers can contribute in improving the current construction materials management practices of the contractors by requesting them to implement construction materials management systems during construction. This could be done by adding relevant clauses in the project conditions of contract.
- For effective materials management, Universities, contractors union, and engineering associations have to put in more efforts to improve the existing construction materials management practices, which should include:
  - Encouraging the contractors to use construction materials management techniques by addressing the importance of these techniques.
  - Helping the contractors to understand the techniques by initiating training courses, lectures, seminars, and workshops.
  - Transferring of technology and experiences of other countries in the construction materials management field and adapting them to suit the local contractors.

5.4: **Future Research**

Future research could look into the impacts of IT on construction project success; and finally, the effect of employee training on material management system.

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APPENDIX I

UNIVERSITY OF EDUCATION, WINNEBA

COLLEGE OF TECHNOLOGY EDUCATION, KUMASI

DEPARTMENT OF CONSTRUCTION AND WOOD TECHNOLOGY EDUCATION

QUESTIONNAIRE FOR MATERIALS MANAGER

This questionnaire is design to provide for evaluating effectiveness of the effects of the materials management techniques on construction project success considering the perspectives of materials managers in the construction industry.

Dear respondent, thank you for taking the time to complete this questionnaire; your co-operation is appreciated. Please ensure that you read the following before answering the questionnaire:

INSTRUCTIONS

- Please do not leave out any questions. If you have difficulty understanding question please ask the researcher.
- Please answer questions honestly. Even if your answers are negative in nature.

SECTION

(Please fill, indicate with a tick [√] and comment in the spaces where appropriate)

Section one: Company/Respondent's Profile

Q1. Indicate the class of your company

Large (D1K1) [ ] Medium (D2K2) [ ] Small (D3) [ ]

Q2. What is your current highest academic/professional qualification?

MSc [ ] BSc [ ] HND [ ] CTC [ ]

Q3. The number of years you have worked in the construction industry?

0 – 1year [ ] 2 – 5years [ ] 6 – 10years [ ] Over 10 [ ]

Q4. Type of construction work under taken by your firm

……

Section two: Application of construction materials management tools and techniques in construction projects.

Q5. To which extent will you evaluate the necessity, and degree of usage/practice of the materials management techniques on construction site?

No	Techniques	Necessity					Usage/Practice				
		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Very. Often	Often	Occasionally	Seldom	Rarely
1.	Providing a list of materials in project and recording/inventory of materials during construction.										
2.	Adequate pre-construction survey on material.										
3.	Providing material cards at site store that contain for example (input-output balance)										
4.	Providing materials purchase order including (order number-material description required, quantity – price)										
5.	Planning the access rout and site lay out before delivery materials to site.										
6.	Good business relationship (open and mutual trust)										
7.	Prompt payment to suppliers										
8.	Offering closer										

	and long term working relations with suppliers										
9.	Providing clear specification to suppliers.										
10.	Employment of security personnel on site										
11.	Employment of store keeper										
12.	Providing lighting system at vintage points										
13.	Used of skilled and experienced works										
14.	Training of workers										
15.	Use of ICT										

Q6. To what extent do you agree to the contribution of the identified materials management techniques in (Q.5) to construction project delivery success?

No	Contribution	Strongly Disagree	Agree	Neutral	Disagree	Strongly disagree
1.	Improvement of labour productivity					
2.	Improvement in project schedule					
3.	Better relations with suppliers					
4.	Improved cooperation and communication with suppliers					
5.	Reduce the overall cost of materials					
6.	Increase profitability					
7.	Improved the quality of the project					
8.	Reduced accidents rates on site					

Section Three: Problems in Material Management

Q7.P lease indicate the problems/challenges you face in the management of materials on site (You may tick more than one)

1	Theft/Burglary					
2	Too much documentation or paper work					
3	Late delivery of materials					
4	Limited Storage Space					
5	Incorrect materials take-off from drawings and design documents					
6	Frequent Changes in Designs					
7	Delivery of wrong quantity of materials					
8	Unavailability of Materials					

APPENDIX II

INTERVIEW GUIDE FOR MATERIAL MANAGERS

1. What is your job description, please?

   .....

   .....

2. Could you please explain the nature of the works undertaken by your company?

   .....

   .....

3. How does your company address materials management issues relating to project it undertake?

   .....

   .....

4. What are problems/challenges faced by your company in the implementation of Effective Materials Management Techniques/System (EMMT/S)?

   .....

   .....

5. How does implementation of EMMT/S affect project performance on your construction sites?

   .....

   .....

6. What are the perceptions of your employees about material management procedures in your company? .....

   .....