Assessment of the construction logistics operation challenges and evaluating effects on performance
(In the case of grade one contractors)

SUBMITTED BY

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DEPARTMENT OF LOGISTICS AND SUPPLY CHAIN MANAGEMENT

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DECLARATION

I declare that this project report entitled "Assessment of the construction logistics operations challenges and evaluating effects on performance (In the case of grade one contractors) is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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TABLE OF CONTENTES

LIST OF TABLES

LIST OF FIGURES

LIST OF EQUATIONS

Equation 3.1: $MOE = Z\sqrt{(1-f)*\frac{PQ}{(n-1)}}$

Equation 4.1: Firm performance = 4.727- 0.110Material procurement coordination problems+ .024waste reduction + .008accident reduction +0.023Misplacement Reduction + 0.233theft reduction+ 0.102 delivery improvement

ABBREVIATION AND ACRONYMS

EEA - Ethiopian Economic Association

GTP- Growth and Transformation Plan

UNDP- United Nations Development Programme

GC- General Contractors

BC- Building Contractors

RC- Road Contractors

ECIDP- Ethiopian Construction Industry Development Policy

MoWUD - Ministry of Works and Urban Development

OED- Oxford English Dictionary

LIST OF APPENDICES

ABSTRACT

This study examined the influence of challenges in implementing the logistics operations in the construction industry being the independent variables, on the performance of construction firms being the dependent variable. Previous researches showed that current systems adopted in carrying out logistics operations in the construction industry is relatively inefficient when compared with other industries such as retail and manufacturing in which, it was considered as a basis for carrying out the research. The factors considered as a root cause to this inefficiency were examined by studying their effect on the performance of the firm.

This study aims to examine the performance of construction industry from logistics perspectives. It tries to identify the challenges in construction projects logistics and propose possible solutions to address the inefficiencies. The study used both descriptive and explanatory research designs based on data from primary and secondary sources. The target population for this study was the grade one contractors operating in Ethiopia who are either registered or have upgraded their license from Ministry of Works and Urban Development (MoWUD) by the end of the year 2016 and the respondents were either from the logistics or engineering departments of the firm. Questionnaire was administered through the e-mail survey and hand delivery. After the questionnaire was tested for validity and reliability analysis using both quantitative and qualitative techniques were used with the assistance of SPSS software program version 22.

The study implied that reduction in construction wastes and theft were the most significant predictors of firm performance. The results support the current theories related to the study. Based on previous researches the rest of the variables considered also affect the performance of construction firms as a whole but needs further study to verify their effects on the performance of the firms in different settings. Consequently, this study provides firms' managers the challenges that are expected in construction firm regarding the logistics department which enables them to plan ahead and devise ways that they could alleviate these challenges from their system so that their companies could develop a competitive edge.

Keywords:

Logistics operations, performance of construction firms, warehousing, transportation and material handling.

CHAPTER ONE: INTRODUCTION

1.1 Background of the Study

Activities of the construction industry are vital to the achievement of national socio-economic development goals by providing shelter, infrastructure and employment. Activities by the construction industry affect nearly every aspect of the economy and the industry is one of the driving factors of the economic growth of developing countries (Betlejewska and Potkány, 2015). The construction industry plays an important role in economy of a country since it provides demand for the production of goods and services from other related industries. Because of this it generates considerable employment through multiplier effects. It has a demand for labor (unskilled, semi-skilled and skilled), land and capital. It contributes to the national output and stimulates the growth of other sectors through a complex system of linkages (EEA, 2008).

Regardless, the construction industry has not been "the engine of growth" that it was supposed to be. It is mostly characterized only by its capacity to stimulate activities in other sectors of the economy. In most developing countries, the construction industry has failed to play its expected role of providing the basis for socio-economic development, and securing improvements in the living conditions of the citizency (Ofori, 2008).

Shortcomings from the construction company can be the results of its enormous scope, uniqueness and complexity. It is characterized by the modeling of high volume production. There are more than 10,000 material deliveries that need to be organized in construction projects and construction project supply chains are essentially temporary multi organizations, arising at the start of the project, developing, and finally disbanding at the end of it (Formoso and Isatto,2009) . According to (Mossman, 2007), every project –road, hospital, school even home is a prototype. Each one is unique. Yes, there are repetitions within the construction process, but the totality is unique. Therefore, each construction project could be considered as a temporary organization with its own characteristic. The construction process consists of several phases where many different participants are involved during each phase and due to its nature information flow in construction is complex. In which case, the construction supply chain of engineered buildings is subject to particular logistical challenges.

Knowing that construction firms have an intense logistics operational demand from a logistical point of view, very little is actually done in order to affect and change the conditions in that perspective. According to (Johansson, 2013), the construction industry stuck on the traditional narrow, short-sighted view of logistics while other industries followed the paradigm shift of adopting supply chain management.

A range of studies has confirmed the inefficiency construction is dealing with. For example, workers are spending 10 % of their time waiting, and 2-10 % of ordered material is never used (Josephson & Saukkoriipi, 2005) cited by (Johansson, 2013). A study by (Agapiou et al. 1998) cited in (Johansson, 2013) showed that 45 % of arriving trucks were wrong in some way. Either it was the wrong time of delivery, wrong goods or wrong quantity. In total, (O'Brian, 1999) also cited in ((Johansson, 2013) approximated the cost of the inefficient supply chain to add 10 % to the total production cost. Problems related to logistics of incoming deliveries and material handling on site is some of the major inadequacies. In short, there is a lot of undesirable waste in the logistics process, whether it is queuing trucks, damaged goods or other delays.

For the major construction firms, this is no surprise. They are aware of the problem to some extent, and they are also familiar with terms such as supply chain management and just-in time. However, the attempts to implement any of these philosophies and tools have not worked very well, if at all. Currently, several theories for the lacking results exist. (Wegelius-Lehtonen, 2001) blames the short-term nature of construction process, (Shakantu et al., 2008) emphasizes on the fragmentation of activities in the construction process, (Jang and Skibniewski, 2008) discusses the lack of adequate and real-time tracking and monitoring facilities for materials and equipment on site.

Effects of inefficiency in construction logistics operations will not just be retained by just a particular party. As previously discussed, since it is characterized by having a system of linkages to other sectors, it is most likely that the entire stakeholders are affected in the end. For example, in the fall of 2015, the government finalized and published the current 2016-2020 five year plan, known as the Growth and Transformation Plan (GTP II) which includes new infrastructure projects, that are to include power production and distribution, roads, rails, airports and industrial parks. To support industrialization, Ethiopia plans to increase power generation by 8,320 MW, up from an installed capacity of 2,000 MW, by building three more major dams and expanding to

other sources of renewable energy. Construction is underway on an electric railway network that will connect Ethiopia to all its neighbors, with a link to the Port of Djibouti already finished and partially functioning. A tripling of capacity at the international airport in Addis Ababa to 25 million passengers will be completed in 2017, while construction of a completely new airport is being planned by 2025. Meanwhile, the domestic airport network has expanded to nineteen airports in a country (Ethiopian Economic Profile). This implies that the government is allocating much of its budget to construction industry. Therefore, if the potential contractor fails to fulfill its obligations, the loss will not just affect the government or the contractor only but also other stakeholders that utilize the output from the industry.

For all these reasons, effective construction project execution requires more responsive production chains and closer coordination between the members of the project. Effective management of the construction logistics will mean effective execution of the construction project (Formoso and Isatto, 2009). Therefore, evaluating logistical operations of a certain industry as well as the performance can benefit an industry by coping with quality, cost, and lead time issues by devising ways that alleviate existing problematic issues.

1.2 Statement of the problem

Considering the importance and contribution of the construction industry to the economy of Ethiopia, the government planned to undertake mega projects that demand huge finance on its Growth and Transformation Plan. To make this idealistic view a reality the nation funded major projects from domestic sources. But despite the dedication of lots of the countries resources, several defects are being noted in the construction sector raising doubts about the sector‘s capacity to meet the goals set and results in requiring an immediate action (ECIDP, 2014; Nega, 2008). On the research of (Zewdu, 2016) it was identified that most construction projects face top five delay factors. Those were improper planning, late delivery of materials and equipment, slow decision, mismanagement by the contractor and cash flow problem during construction. The first three areas indicate a gap in the logistical perspective. Late delivery of material and equipment is a logistical problem associated to the construction firms which result in the delay of construction projects by the contractors. Materials deliveries to the predetermined locations involve the three

logistics components of the logistics operation namely, materials handling, warehousing and transportation. But previously discussed studies showed that deliveries of materials in construction site are hardly ever scheduled. The supply of building materials to site without suitable planning is fraught with obstacles. For example the need for unloading equipment interrupts other activities in production and requires storage of material which takes space that could be used to make other production activities run more smoothly. Material handling becomes a supply bottle-neck. The second component, i.e. transportation, also often account for a significant part. Between one-third to two-third of the cost of logistics in many industries is accounted to transportation. Hence, it is an area of concern regarding the logistics of a construction project. Finally, there is warehousing as part of logistical operation in construction site, according to (Bertelsen and Nielsen, 1997) there exist a situation in which high cost is incurred due to extra handling of large/unnecessary quantities material stored on site. This will not just incur costs but also leads to interruption of works and waste.

Nonetheless, previous studies on this area had tended to focus more on the developed world. Evidence showed that cultural, social, economic and environmental aspects of each country did influence the link between logistics and performance. Findings of US firm could not represent the universe of companies nor could findings be generalized to other countries. Furthermore, first world such as Europe, America and part of Asia had more developed infrastructure and business structures that easily supported the implementation of logistics as opposed to developing countries. The effort to achieve generalization of the causal relationship between problem areas of logistics operations and performance of construction firms called for empirical confirmation in diverse environments, especially developing economies such as Ethiopia. This study therefore intended to empirically examine how the challenges of logistic operations such as, material procurement coordination problems, construction wastes, theft, materials misplacement, accident and problems in delivery improvement influenced performance of construction firms in the Ethiopian setting.

1.3 Basic research questions

Most construction projects especially suffer from unnecessary activities on site which result in the elongation of the completion periods of most construction projects and escalations on the contract amount which are one of the performance measures of construction firm. Therefore, carrying out a research to evaluate the current situation is mandatory to fill the gaps. Thus the research questions that are assessed in this research are:

- What are the challenges encountered in carrying out the logistics operations in a construction industry?
- What are the performance indicators of construction industry relating to the logistical operations of the organization?
- How does the current practice adopted affect the performance of the construction industry as a whole?
- How can the outcomes of the research contribute to the industry's current trend adopted?

1.4 Objective of the study

1.4.1 General Objective

- Develop a theoretical understanding of the current situation of logistics. That is, determining the challenges of logistics operations in the construction industry then developing a framework for analyzing the related effect on the performance of the industry based on literature review and existing case studies.

1.4.2 Specific Objectives

- To investigate on the basis of the theory and practice logistical operations carried out by the construction industry.
- The research also investigates current system adopted in the logistics of a construction process and the challenges encountered while carrying out the operations.
- Assess the performance of Grade one contractors operating in Addis Ababa, Ethiopia.
- Describe the relationship between those challenges of the logistics operations of grade one Contractors and the performance of the companies,
- Identify areas of improvements that could be recommended.

1.5 Hypothesis

1. H1: Reduction of construction wastes significantly influence Construction firm performance.
2. H2: Reduction of accidents in construction significantly influences Construction firm performance.
3. H3: Reduction of materials misplacement in construction significantly influence Construction firm performance
4. H4: Reduction of theft in construction significantly influence Construction firm performance
5. H5: Improvement in delivery system significantly influence Construction firm performance
6. H6: Material Procurement Coordination Problems significantly influence Construction firm performance

1.6 Significance of the thesis

Construction demands lots of inputs and as it was previously discussed the government of Ethiopia is allocating lots of the public resources into construction. Projects are planned by considering specific resources like finance, required raw materials, material logistics system, skilled and non-skilled manpower in a limited time table. As widely believed projects involve large amount of money and a lot of stakeholders like clients, contractors, consultants, suppliers, manufacturers, public, etc. Most projects take time and money more than they are required because of different reasons and delay in completions of the projects cost a lot of money, for the client, the contractors, the end user, overall, the stakeholders.

Therefore, this research is expected to give professionals in construction area to have serious thought on what is at stake. The research also encourages other researchers to investigate further for determining ways to improved logistic management system.

The findings from the study are expected to improve the understanding of people in the managerial position to give emphasis and spend enough amounts of money and time in planning,

implementing and control of logistics management system, that is, efficient logistics system that can save a huge amount of national budget.

1.7 Limitation of the thesis

The study faced a number of limitations as it employed descriptive and explanatory research design which allowed for both observational data and formulating a problem for more precise investigations. Therefore the finding of the study was based on the observed population and developing hypothesis from operational point of view. However, the researcher had clearly defined what she wanted to measure and had an inbuilt flexibility when designing research questions to come up with more precise meaning in order to gather relevant data.

As it is with all self-report surveys, this one has limitations. Only a single respondent from each firm did the evaluations. While that respondent was in most cases a senior person in the construction firm, they represent only a single perception of a member within the firm and is not necessarily indicative of other firm member‘s perceptions. The sample frame, while slightly broader than a single professional association, is still primarily from organizations that do not necessarily represent the universe of companies/construction logistics employees in Ethiopia, and are not representative of what happens in other parts of the world. This study‘s sample was drawn from all construction firms in Ethiopia; therefore, the conclusions inferred can only be generalized to the population of construction firms in Ethiopia and must exclude other categories of firms like manufacturing, service and hospitality industry. Another limitation acknowledges that firm performance may be affected not only by the challenges of the logistics operations, but also by various variables not considered in this study. Proper Logistics operations system needs to be integrated with other functional areas of the firm such as marketing, finance, or operations to better support firm performance.

Therefore, to project firm performance solely based on challenges of logistics operations of construction firm may skew any attempted generalization. Furthermore, all participants responded within a particular time frame and were only given a single opportunity to respond. Therefore, it cannot be reliably established whether such data would hold true over time, especially in an unstable business environment. In particular, different firms have distinct strategic goals in the

short-term, such as customer satisfaction, market share, growth, financial performance and many more. However, the research's feasibility, validity and reliability were tested.

1.8 **Scope of the thesis**

The study focused on construction firms that were registered in MoWUD as Grade One Contractors. It was limited to evaluating influence of challenges of logistics operations on firm performance among the selected firms. The respondents of the study were anyone either from the logistics department or from the engineering department with a wide range of experience in the sector. The study considered only six core aspects of logistics that were considered as challenges of the logistics operation or areas of improvement in construction logistics and it included: material procurement coordination problems, Reduction in construction waste, Reduction in Accident, Reduction in materials misplacement, reduction in theft and delivery improvement. These variables were most favorable to use because according to (Shakantu *et al.,* 2008) logistics in construction is the integration of activities which are transportation, warehousing/site storage and materials handling. Challenges in these components of logistics were classified into the above variables.

1.9 Organization of the thesis

The research report is organized under five chapters

In the first chapter starts by an introduction of the general background of study. The scope of the research along with its limitations is also stated in this part of the research. The problem of the research and the objective at which the research has aiming at are presented. The second chapter of the research is literature review. In this chapter related concepts and theories from different books, previous researches are presented and discussed. The third chapter of the research is methodology. This chapter deals with reporting the population of the study along with how the data is collected and how they are analyzed to arrive at the objective. This is to be followed by the results and discussion, where the data collected through the questionnaire are presented, analyzed and discussed. The final chapter of the research is for summary of major findings, conclusion and recommendations. In this chapter summary of the output of the analysis are presented, conclusions are drawn and recommendations will be put forth.

CHAPTER TWO: LITERATURE REVIEW

2.1 Overview of Construction Logistics

2.1.1 What is a Construction Project? How is it managed?

Research by (Lester, 2006) defines a project as a unique set of coordinated activities, with definite starting and finishing points, undertaken by an individual or organization to meet specific objectives within defined schedule, cost and performance parameters. (Yimam, 2011) defined project as a temporary endeavor that has definite beginning and end time undertaken next to specific cycle of initiation, definition, planning, and execution and which is a result of novel organization and coordination of human, material and financial resources. It is the application and integration of modern management and project management knowledge, skills, tools and techniques to the overall planning, directing, coordinating, monitoring and control of all dimensions of a project from its inception to completion, and the motivation of all those involved to produce the product or service on time, within the authorized cost, and to the required quality and requirement, and to the satisfaction of participants.

Construction, national or international, stands or falls by the quality of its project management. A project that is not properly managed can quickly head for disaster. Construction projects are managed in different ways from the management of other projects and the difference mainly stems from the nature and characteristics of construction projects. Some are usually capital intensive, complex; and require significant management skills, involvement and coordination of a wide range of experts in various fields.

In general, in most of researches, management of a project is generally perceived to be concerned with the planning, organizing, and control of an ongoing process or activity such as the production of a product or delivery of a service. Project management is different in that it reflects a commitment of resources and people to a typically important activity for a relatively short time frame, after which the management effort is dissolved. Projects do not have the continuity of supervision that is typical in the management of a production process. As such, the features and characteristics of project management tend to be somewhat unique. Projects are subjected to a variety of laws and regulations that aim to ensure public safety and minimize environmental impacts. Compared to most other industries, construction projects involve relatively intensive labor use, and consume large amount of materials and physical tools.

2.1.2 Construction Firm Performance

In order to understand firm performance it was prudent to first understand what performance measurement was all about since it was through performance measurement that firm performance could be realized. According to (Prathap and Mittal, 2010), Performance measurement is a crucial criterion for evaluating the competence and achievement of an organization. (Tuttle & Heap, 2008) defined performance measurement as ―the process of quantifying action, where measurement is the process of quantification and action leads to performance. They emphasized the importance of satisfying customer requirements with greater efficiency and effectiveness than the competitors. Here the effectiveness referred to the extent to which customer requirements were met, largely with the essence that customer was always right and the efficiency referred to the measurement as to how economically the firm‘s resources were utilized (i.e. total output against total input) to provide a specific level of customer satisfaction (Islam & Sunders, 2013).

Firm performance comprised the actual output or results of an organization as measured against its intended outputs (or goals and objectives), it involved the recurring activities to establish organizational goals, monitor progress toward the goals, and make adjustments to achieve those goals more effectively and efficiently (Richard, *et al*., 2009).

Looking back on the evaluation of performance measurement before 1980s, the performance measurement process was mainly concentrated with cost accounting approach which consisted of financial key performance indexes such as return on investment, profit plus earning per share. However, focusing on the financial indicators alone had been exposed to the critics that other non-financial indicators which contributed towards firm performance had been neglected and only lead to short-term thinking (Thrulogachantar & Zailani, 2011). It was suggested that the stress should be on application of problem-specific approaches on their research that was an essential processes and leaving room for flexibility in measurement as an answer to address the market volatility and to fulfill the diverse customer needs.

In recent years, firms viewed time as a source of competitive advantage, based upon the observation that firms were competing effectively in time tended to excel at improving quality, understanding evolving customer needs, exploiting emerging markets, entering new businesses, and generating new ideas and incorporating them into innovations. Thus, firms started to focus on

eliminating waste in the form of time, effort and defective units (Njambi & Katuse, 2013). In fierce time and quality-based competition, logistics capabilities become critical. Study on industry performance revealed that most of the researchers evaluating industry were sharing common understanding that needed to have multiple performance measurement.

In general, to clarify the multidimensional relationship between problems encountered in logistics operation and firm performance, a clear definition of firm performance was required. According to (Richard, Devinney, Yip, and Johnson, 2009), firm performance encompasses three specific areas of firm outcomes: a) financial performance (profits and return on assets); b) market performance (market share and the overall performance of the company); and, c) customer satisfaction/value added (Richard, *et al.,* 2009). In this study customer satisfaction is measured by the Construction Company's ability to complete projects ahead of time, complete projects within budget and resist compromises on safety or quality standards. Therefore, performance in this research is measured using these parameters.

2.1.2.1 In the Ethiopian Context

Ethiopia has a rich history of magnificent construction endeavors. The obelisks of Axum the rock-hewn churches of Lalibela and the castles of Gondar are a few examples of this expertise. With the advent of modern civilization, particularly during the reign of Emperor Menelik, there have been some significant developments in this regard. The Addis-Djibouti railway line is one example where such a venture has been successfully carried out. During the Italian occupation of the 1930"s there were some construction activities, particularly in the development of long trunk roads. After the Italian occupation and before the 1960's, expatriate contractors generally dominated most of the medium and small civil and building projects (Kahssay, 2003).

Now a days the construction industry in Ethiopia has been providing a wide variety of buildings, ranging from houses to high rise buildings and from schools and hospitals to factories and shopping centers, and has been carrying out an equally wide variety of engineering construction projects, ranging from highways to hydro – electric dams and irrigation dams / canals. Construction in Ethiopia has also been affording various job opportunities. It keeps employees working full time, and thus, enables many to work over 40 hours a week to earn more money. But studies on construction firms of Ethiopia showed that of the factors considered as a performance indicators above are not being met by the construction industries. On the research of (Regassa,

2015), it was indicated that most construction projects are delivered at least a few days or months or even years late beyond expected completion time which affects stakeholders, clients, contractors and the society as a whole. Main reason for the delay of projects indicated on the research was poor logistics management. (Zewdu, 2016) also identified delay factors associated with a construction project by providing evidence that there is an occurrence of delay which is the performance indicator of a construction projects.

2.1.2.2 Contracting companies in Ethiopia

The construction industry in Ethiopia consists of various sectors. These are the building and residential development sector, civil engineering sector, professional services sector and self-building sector. Construction firms must be registered and licensed in order to undertake any construction work in Ethiopia. Basically, domestic construction capacity refers to the potential construction volume/value that could be undertaken by domestic construction companies in a given period of time. This, in turn, depends on number and quality of machinery and equipment that is available, and skilled man-power, ranging from design to supervision (EEA, 2008). According to (MoWUD, 2016) the local construction firms are broadly classified based on trend of work as follows: General Contractors, GC; Building Contractors, BC; Road Contractors, RC; Specialized Contractors, SC. The first three categories are again divided into ten grades based on equipment, man-power and turnover requirement. However, it is common to come across self-declared contractors without any professional competence and license registration in many construction sites. The self-building sector is characterized by an informal sector, consisting of informal groups that supply materials and labor. These informal groups are not licensed or registered. However, they employ a great number of people. Now a day according (MoWUD , 2016) there are over 5565 contracting companies registered under G1 up to G10 in Ethiopia comprising general, building and road contractors .

The professional services sector consists of architects, civil engineers, electrical engineers, sanitary engineers, and mechanical engineers, quantity surveyors and surveyors who provided the design expertise (MoWUD, 2016). The services of these consultants are not utilized in the informal and self-build sectors. There exists a great separation between the design consultants and the contractors. This generates poor project management and wastage of materials in the

construction process and results in project over cost and environmental impact due to poor waste management system.

2.1.3 Logistics in a Construction Project

The term logistics in a construction industry can be defined as getting construction materials, equipments and labor to site before they are required. Logistics functions in a construction firm can be divided into supply logistics and site logistics. Supply logistics are related to activities that are cyclic in the production process. These activities are basically: supply resources (materials, equipment and manpower) specification, supply planning, acquisition of resources, transport to site and delivery, and storage control. Site logistics are related to physical flow planning, organizing, directing and controlling on-site. This means, management of handling systems, safety equipment, site layout, definition of activity sequence and resolution of interference among production teams activities on-site (Silva and Cardoso, 1999).

Construction project site logistics is an important part of logistics. Logistics management requires accurate delivery date material plans to suit the actual site plan and storage arrangements. Otherwise, it will lead to the construction schedule delays and interruptions, or resulted in the storage, handling and transportation process waste of resources (Duiyong, Shidong and Mingshan, 2014). The multidisciplinary processes that comprise construction logistics include material supply, storage, processing and handling, manpower supply; schedule Control, Site infrastructure and equipment location, site material flow management on a construction site and management of information related to all physical and services flows. Good construction logistics is all about optimizing those processes to enhance efficient delivery, movement and installation of materials and components on the construction site.

2.1.3.1 Integrated/Systematic Construction Logistics

A systematic approach to construction logistics has led to the emergence of a dedicated logistics contractor who assumes the single point responsibility to integrate all the essential support services associated with construction project (Sullivan *et al.*, 2010). Figure 2-1 shows the integration of logistics functions expected in a typical construction logistics system. Egan (1998)

stated that to improve construction project delivery, construction industry had to develop an integrated project process.

The implementation of integrated logistics with a dedicated logistics team will benefit the construction industry for four important reasons:

- Integrated and dedicated approach can **maximize the productivity and efficiency of skilled workforce**. For example, in a traditional approach, some skilled workers may be diverted to help out in materials delivery while construction work will be suspended.
- Integrated and dedicated approach to logistics can **maximize the quality of service by enabling a trained logistics service team to provide a holistic support service for the construction project.**
- To minimize **the negative environmental and social impact that construction projects create by enabling the efficient flow of materials which can minimize the indiscriminate packing of delivery vehicles around the construction site and minimize waste generation.** Integrating the supply logistics and site logistics will enable the dedicated logistics team on site to plan for delivery well in advance.
- Systematic construction logistics can enhance the **attainment of the highest possible standards of health and safety, for example, by minimizing collision accidents** which can result from the chaotic distribution of materials on construction site.

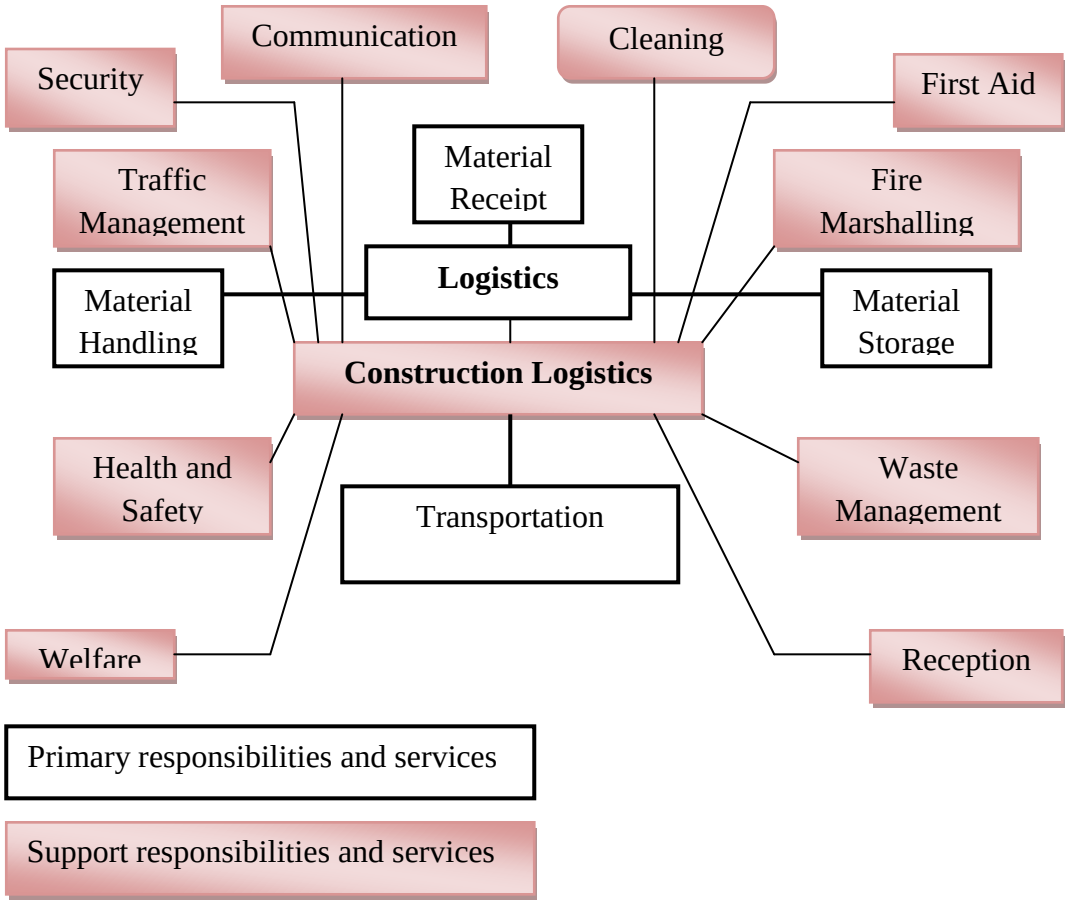

Figure 2.1: Primary and support logistics functions and services (Source: Sullivan et al., 2010**)**

2.1.3.2 Systems concept in construction logistics

A System is an embodiment of interacting elements, components, parts and variables that function dependently on one another and form a coherent entity. Every part of a system has to be designed in harmony with other parts of the system. The idea of system concept in logistics is that the focus is not on individual variables of logistics but how the variables interact with one another. Improvement of any component must involve trade-offs with other components of the system (Coyle *et al.*, 2003). Effective construction logistics should provide a systems framework for decision-making that integrates **transportation, inventory, storage space and other related activities** that together encompass appropriate trade-offs involving cost and service in the supply chain (Shakantu *et al.*, 2008)

2.1.3.3 Characteristics that distinguish Construction logistics from other types of logistics

Logistics in the construction industry has some notable characteristics that distinguish it from the general logistics and these are

i. Disposable, just exist for a construction project;
ii. Uncertainty;
iii. Supply chain end when the project completion,
iv. High risk, the occurrence of risk always leads to serious financial loss;
v. System reliability is complex, and controllability is weak.

In construction terms logistics is all about ensuring that design, procurement and construction practices are optimized to enhance efficient delivery, movement and installation of materials and components on the construction site. This requires multidisciplinary processes that seek right cost, right time and right quality. Construction logistics can be defined as "the management of the flow of materials, tools, and equipment from the point of discharge to the point of use or installation. Bringing together and coordinating the management of these three vital components between the project's principal parties would increase productivity substantially. Because the cost of materials and equipment represents a large proportion of the total project budget, it is vital to manage these costs effectively. Several studies show that these two components consume between 60 and 70% of a project's total budget. On a construction site, these components must be properly managed in order to ensure a project's success. Ineffective management, on the other hand, will result in conflicts between these aspects. These conflicts will ultimately cause project delays, and cost overruns. Managing the flow of materials, assuring its quality, checking the quantity, allocating the storage areas, coordinating the overall process, triggering the orders, and updating the participants are major obstacles in construction logistics management (London, Kenley and Agapiou, 1998).

Organizing and administering a construction site so that the right resources get to the right place in a timely fashion demands strong leadership and a rigorous process. Good construction logistics on construction sites saves time and construction costs. To plan construction logistics, numerous interferences between configuration of construction site and construction work have to be

considered. In particular in outfitting processes, their countless possible work sequences and many involved companies govern production logistics.

2.1.3.4 Inefficiency in construction logistics

According to (Mossman, 2008) there are many factors that result in inefficient logistics. Some of the factors mentioned in the research as unnecessary logistical waste were long distances for staff to reach the toilets and other facilities, multiple handling of materials required later so that current operations can proceed, damage to and pilfering of materials stored on site, operational delays caused by late delivery of materials, information, plant or equipment and movement of skilled trades people so that they can utilize their skills.

Therefore, it is clear that logistics is one of the most important elements of a construction project, influencing critical site performance factors such as cost, speed of construction and plan reliability, and industry performance indicators such as accident statistics and contributions to landfill. However, little attention has been paid to supply chain management (SCM) or logistics and the construction industry only recognizes the final leg of materials delivery as being important.

2.1.3.5 Success factors of a construction logistics

Effective logistical planning is imperative for any construction project as it can provide massive benefits in efficiency and productivity that significantly reduces the overall cost of the project. There's nothing more frustrating than having a workforce not being able to continue because they are missing or waiting on the arrival of materials. Construction logistics should be designed to deliver client's needs as well as satisfy the performance requirements of the contractor in the most efficient way possible and it is a process that should have the following characteristics

- Rationalized supply base: The number of suppliers should be minimized to ensure efficient delivery. Reasonably few suppliers can be better managed and logistical constraints will be reduced.

- Involvement of strategic suppliers at the design stage: There is need for full understanding of the implications of design, components and material choices. Involving strategic suppliers early enough will enhance the compliance of procurement and logistics with design specifications.
- Selection of supply chain members based not only on their low price but also their willingness to contribute to team effort.
- Effective, fast and accurate inter-team communication and flow of information. This will promote team spirit and sense of belonging among team members.
- Efficient tracking and control of materials and performance measurement.

Logistics is an essential process that supports and enables primary business activity such as a construction project to be accomplished (Sullivan *et al*., 2010). A logistical view is a solid basis for productivity improvement and every construction project can be seen as an order-delivery process where all parties along the logistics chain, such as supplier, constructor and client/buyer, are involved (Wegelius-Lehtonen, 2001). The logistics of the supply and delivery of materials to site has been identified as an area of construction supply chain management that could benefit from sustained improvement. While a few enlightened companies within the construction industry have begun to see that good logistics practices and a supply chain management view of business are essential to achieving sustainable improvement, most construction companies have yet to realize the benefits that can be achieved (Hill and Ballard, 2001).

2.2 Logistics System Analysis

Construction logistics is concerned with the transportation of materials from supplier/manufacturer's warehouse to the construction site storage and movement of materials within the site from the storage to the point of use. Therefore, application of the concept of nodes versus links is the most suitable concept in this case. Nodes are spatial points where materials are stored or processed while links are the transportation networks that connect the nodes together. The nodes versus links model is illustrated in Figure 2.2. The Figure 2.2 shows a simple logistics system network that facilitates the delivery of materials to the construction site and subsequent shipment of materials from the storage to the construction area.

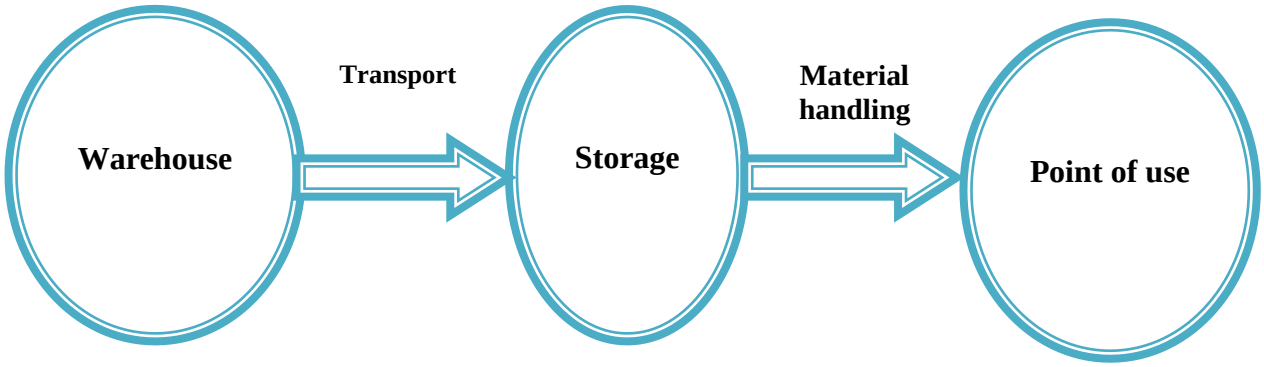

Figure 2.2: Nodes versus Links Logistics System

2.2.1 Transportation

This is the link between the spatial nodes in a logistics system through which materials are moved from one node to another. In construction, transportation enhances the flow of material from the supplier or manufacturer to the construction site. It is the physical distribution channel which connects various important geographically dispersed operating components together within the logistics system. The basic modes of transportation are rail, road, water, air and pipeline (for fluidic materials) (Coyle *et al.*, 2003).

The requirement for transportation of materials to construction sites is very significant because the construction process consumes enormous quantities of materials (Shakantu *et al.*, 2008). Apart from the need to convey large quantities of materials, transportation often account for a significant part, between one-third to two-third, of the cost of logistics in many industries. On other research, transportation of construction materials accounts for about 10-20 per cent of construction cost. This cost is intensified if the cost of the energy consumed for the transportation of materials to the construction site is included.

Selection of mode of transportation

The choice of any mode of transportation and carrier type for the delivery of materials to the site affects the efficiency of the construction process and contributes significantly to the overall cost of construction. Transportation adds value by creating time and place utility i.e. materials are

made available at the appropriate place at the appropriate time. Therefore, the quality of transportation affects the availability of material and equipment on site and bears on the pace and quality of work on site.

The fundamental factors that determine the choice of transportation carrier are cost and time. There must be trade-off between cost and time because selecting a low cost carrier that takes longer time to deliver materials to site will cause delay of work if materials run out on site before delivery and this will definitely increase the cost of construction.

The overall parameters that determine the choice of transportation carrier stem from the cost-time principle and they are described as follows (Coyle *et al.*, 2003):

1. **Transportation Cost:** Transportation cost analysis is an important criterion in selecting the mode of conveying materials and equipment to the construction site and the analysis involves evaluating the basic modes of transportation. Transportation cost includes the rate, minimum weights, loading and unloading facilities, packaging and blocking, damage in transit and stopping in transit and the implication of selecting any of them. These are cost factors to be considered before selecting any materials carrier.
2. **Transit Time:** Transit time is the time required for the pick-up of delivery, and terminal handling of materials i.e. the time of movement between origin and destination terminals. Transit time affects the storage level on site. While shorter transit times result in lower storage cost, longer transit time can result in materials stock out (which can cause operation down time)
3. **Reliability:** This is the consistency of the transit time a carrier provides. More reliability on the service provided by any carrier will require lower storage level than an unreliable and inconsistent delivery service. This will definitely reduce storage cost
4. **Capability:** Capability is the ability of the vehicle to provide the facilities and equipment required for the movement of the materials. Examples of capability factors include equipment that can provide required temperature, humidity or special material handling facilities.
5. **Accessibility:** Accessibility is the ability of the vehicle to reach the point of delivery. The accessibility of a carrier is affected by the construction site location, geographic limits of the carrier's route network and constraints placed by regulatory authorities.

6. **Security:** Security is concerned with the arrival of materials in the same condition they were in when tendered to the carrier. Unsafe carrier service can result in the delivery of damaged materials, which may no longer be useful for the construction work.

2.2.2 Warehouse/Site Storage

This is a node component within nodes versus links logistics system where materials are stored. It is a place where materials are kept prior to being used or fixed on the construction site. In spite of the importance of storage, site inventory should be kept at the minimum level to reduce cost because the unnecessary storage of large quantities of materials on site will lead to interruption of work, extra handling and waste (Bertelsen and Nielsen, 1997). Materials that are procured in large quantities without complying with the production needs on site will result in waste of resources during stocking, handling and transporting (Agapiou *et al.,* 1998). However, construction contract must make provision for temporary storage because of some uncertainty in the period between ordering and receiving materials. Material buffers on construction sites will help to manage unpredictability in the construction process (Hill and Ballard, 2001).

Furthermore, contractor's ability to carry inventory is often limited due to restricted storage capacity that can be provided on site especially in major cities (Sullivan *et al.*, 2010). The inability of contractors to provide adequate inventory can result in inefficiencies such as backlogs, capacity mismatch and unavailability of materials. The ordering of materials after construction comes to a halt due to lack of required materials leads to delays and additional cost charged by express delivery (Bertelsen and Nielsen, 1997). However, the problem of materials unavailability on construction sites goes beyond inadequate storage. Frequently, materials are not registered in any inventory control system which will enhance visual control of materials and ensure they are available

2.2.3 Materials handling

Materials' handling on a construction site is the short distance movement of materials within the confines of the site. It is a construction logistics system component that links storage or point of delivery with the construction area. Material handling may be manual, mechanical or

combination of both. As Shapira *et al.* (2007) emphasized, today's construction projects are highly mechanized and the working environment is dominated by materials handling equipment. The typical applications of plant and equipment include materials handling and lifting operations (Riaz *et al.*, 2006). The utilization of plant and equipment improves the productivity, efficiency and cost effectiveness of construction projects. An efficient materials handling equipment strongly improves competitiveness through reduction of handling cost, enhances production process, provides effective utilization of manpower and reduces lead time.

There are four attributes which impart the efficiency of material handling: movement, time, quantity and space (Johnston, 1984). Efficient material handling requires the use of appropriate handling equipment or method to move an appropriate quantity of materials within a minimum space and over the shortest period of time possible. Materials handling equipment should be operated at its highest rated speed subject to the site condition and without affecting safety.

- **Movement:** The movement dimension of materials handling involves the conveyance of materials into the storage facility, within the storage facility and from the storage facility to the construction areas.
- **Time:** The time dimension of materials handling is concerned with making materials ready for use at the point of use. The shorter it takes to get materials to the point of use the lower the chance of work stoppage. This also makes it possible to create more space quickly in the storage facility.
- **Quantity:** The quantity dimension of materials handling deals with the different usage of handling equipment. Materials handling equipment is designed to carry appropriate quantity of loads, and move them to the point of use.
- **Space:** The space dimension of materials handling has to do with the conformity of the handling equipment with the space within the storage facility and within the site compound. Since the storage and site space are fixed, the material handling system must maximize the use of this space.

Construction site materials handling equipment include fork lift trucks, dumpers, hoists and cranes. The selection of equipment can affect the effectiveness and efficiency of the construction site depending on the operating environment of the equipment. In a construction environment

where only limited number of materials handling equipment is available, careful planning for the operation of equipment is needed for efficient logistics management on site.

2.3 Conceptual Framework

Based on the systems view to logistics, components comprising the logistics in the construction sector were briefly discussed above. Those are materials handling, warehousing/site storage and transportation. Accordingly, components that could be considered as tribulations of these logistics systems which are challenges of the logistics operations affecting the overall performance of the firms are discussed below. In each of the systems there are some logistical tribulations/problems associated with the logistics operation. In the warehousing/ site storage of the system, the warehouse should be characterized by its protection and security system, inventory control and storage organization. Inadequate security and protection leads to material loss through theft or damage from the weather. Therefore, problems encountered in warehousing system of logistics are theft and waste.

Inventory control also being the main feature expected to be carried out in warehouses, inefficient inventory or lack of material procurement coordination causes materials running out and which means that there is a delay in the construction process. The other component in systems view is transportation, the factors to be considered in this component are transit time and reliability and accessibility. Inefficient monitoring of delivery vehicle makes delivery time unpredictable and can result in construction process delay if delivery fails to turn up and materials run out of storage. Therefore, to alleviate the problems to be encountered because of the inefficient monitoring of a delivery vehicle, there should be delivery improvement in which its absence is considered as the problems encountered in logistics operations.

Last but not least is the material handling; operations in this systems view of logistics are movement, quantity and space. Inefficient utilization of material handling resources can result in slow material distribution, material damage, add to construction cost and poor image of the industry. Therefore, expected problems in materials handling are accidents and materials misplacement in the construction sites.

In general, from the above discussion one can understand that the problems of a logistics operations of a construction firm that affect the performance of a firm and minimized to the extent that is possible include reduction of construction wastes, reduction of misplacement of materials, reduction of accidents, reduction of theft, improvement in the delivery systems and material procurement coordination problems.

2.3.1 Construction Waste Reduction and performance of the firm

Construction wastes are materials that are on site/ delivered to site which have been damaged and meant for disposal, reuse or recycling. According to the study of (Egan, 1998), up to 30% of all construction is rework, labor is used to half its potential efficiency and at least 10% of building materials are wasted. Also, it was indicated that construction and demolition contribute roughly 17% of the total waste production in construction industries. This extent of waste generation can be attributed to the lack of mechanism at the project planning stage of construction to anticipate, identify and prioritize for action the waste stream that will be generated during the construction work.

There are different causes that attribute to the creation of a construction waste. These are design, logistics and construction processes. In order to have adequate record of waste and come up with ways to mitigate construction wastes, there is a need to identify the sources of wastes. Construction waste is very important to quantify because cost reduction caused by preventing the generation of construction waste is of direct benefit for most of the participants that work on a construction project. Of the main causes of construction waste relating to the logistics part are the following

- Ordering error, over ordering, under ordering
- Supplier's error
- Damage during transportation to site/on site
- Inappropriate storage leading to damage deterioration
- Error by trades person

From the above mentioned, problem relating the warehousing system of logistics is inappropriate storage leading to damage and deterioration.

2.3.2 Theft Reduction and performance of the firm

Theft is defined as the unauthorized removal of any material or equipment from a job site. Thieves and vandals can directly impact the success of a project and diminish the potential profitability of the project under construction. Since large number of materials, equipment and personnel are involved in construction activities, the issues of theft and provision of adequate security becomes very important. Unprofessional opportunists, professional thieves and a few construction operatives are involved in construction theft. These people may take away things for use in their own houses and not return, may steal items that can be resold in an unregulated second-hand market such as ceramics, tiles, faucets, toilets, doors and windows or may take tools and small equipment or items that require some skill or effort to remove (Boba and Santos, 2006). In general, even in advanced countries building site has always been a target for thieves and vandals because valuable items are left on site over a long period, site location are easily approachable both night and on weekends and, most times security system are defeated, ineffective or extremely expensive for contractors to buy . Control and management is often difficult particularly on large construction sites, where workers are often casual laborers and not easy to keep track of, and where large amounts of equipment, tools and building materials are difficult to monitor.

The occurrence of theft is mainly the result of lack of security/ protection of the warehouses or site storage. Having discussed about theft in the construction site it is considered as one of the main problems in carrying out logistics operations in a construction site.

2.3.3 Misplacement Reduction and performance of the firm

The fundamental function of site materials management is to assure the availability of materials when they are needed for installation and make such availability information readily accessible for crew level work planning. This means site materials management should be capable to track materials accurately and in a timely manner. Site accounting of materials should produce a complete record of all transactions throughout the project and thus provide advance warning of material shortages on site and indication of excess use of specific materials (Johnston, 1984).

Song *et al.* (2006) found out that 2% of prefabricated materials for a single project are misplaced on site. In addition, constructor's search for a single misplaced prefabricated material can take up to 24 hours on average because the initial search in the constructor's storage might be unsuccessful requiring the fabricator to join in the search by searching own factory storage facility. Such delay in locating prefabricated materials coupled with high cost of reproducing them, if not found, makes misplacement reduction an important attribute of construction logistics systems contributing to the performance of the construction company which mainly relates to the materials handling process of the logistics system of a construction firm.

2.3.4 Accident Reduction and performance of the firm

Though construction industry uses extensive labor resources, it is increasingly becoming reliant upon mechanization. Typical application of plant and equipment in construction include material handling and lifting operations. As the market for construction equipment has been expanding, a growing concern for practitioners has been the level of plant and equipment related accidents. Plant and equipment operation is one of the leading causes of accident and injuries in construction due to the increased reliance on mechanical resources to execute operations. From the accident categories that can be directly linked with plant and equipment operations are contact with moving machinery and struck by moving vehicle. Therefore, accidents relate to the materials handling operations of the construction site.

But this is not the only logistics system in which accidents happens, when transporting materials to the site people, materials and equipments are also vulnerable to the occurrence of accidents in the logistics system.

2.3.5 Material procurement coordination problems and performance of the firm

Materials should be delivered to site at the right time and in the right quantity; materials must be supplied in accordance with design specifications. Some problems are encountered in the ordering and delivery of materials to construction site due to inefficient communication among the participants such as site management, materials planning department, purchasing department and suppliers. Site management and materials planning raise requisition; purchasing places orders and suppliers deliver materials to site. There is need for adequate information to circulate efficiently

among these participants to ensure smooth supply of materials and continuous availability of materials for construction work.

Some of the problems that exist in the coordination of materials procurement to construction site are: late delivery of materials, incomplete delivery, sudden changes of lead-time for the supply of materials, materials being ordered too early leading to damage/theft and short notice of materials call-off from site and similarly postponement of orders.

Management of materials supply side of construction process could be improved substantially by readily and regularly providing data such as call-off dates and delivery schedules to the suppliers. These data could only benefit both the contractor and the suppliers if they are made available well in advance for the suppliers or manufacturers to include all delivery requirements in their production schedules. Therefore, the tendency for site managers to call-off materials earlier than necessary will also be reduced.

Where there is an improvement in delivery system, there would be no need to order materials too early because adequate information would be quickly communicated across the logistics channel through an integrated supply chain management system and the delivery adequately monitored through the fleet management system; because there is an enhanced the selection of the right materials for the right order, incomplete delivery problem will be eliminated; integrated supply chain management system will reduce significantly the tendency for late delivery of materials; and supply chain simulation will also enhance the reliability of lead-time because bottlenecks in the production of make-to-order materials would be identified earlier before master production schedule is executed. Therefore, lack of coordination in the material procurement affects the performance of a firm.

2.3.6 Delivery Improvement and performance of the firm

Transportation plays a connective role among the several steps that result in the conversion of resources into useful goods in the name of the ultimate consumer. It is the planning of all these functions and sub-functions into a system of goods movement in order to minimize cost maximize availability of materials to the site for further processing that constitutes the concept of

construction logistics. The system, once put in place, must be effectively managed. Therefore, one of the components of logistics operation that affects performance of a firm and that should be properly implemented is continuous improvement in the delivery systems.

2.4 Research Gaps

The first rationale for conducting the current study comes from the fact that most studies conducted in the areas of projects efficiency in construction sector in Ethiopia are more than 5 years old and the booming of the construction industry needs up to-date investigation (Ali and Kamaruzzaman, 2010; Azhar et al., 2008; Chabota et al.,2008; Nega, 2008). Besides, most of the studies are conducted outside Ethiopia and are limited to part of the civil construction like road or building. While some of the surveys are small size which might affect the reliability of the result. Moreover, available studies do not include the degree of difficulty and summarize accordingly the potential solutions (Luka and Muhammad, 2014; Ibrahim and Nabil, 2013; Mahamid and Amund, 2012; Abadir, 2011; Ali and Kamaruzzaman, 2010; Olawale and Sun, 2010; Azhar et al., 2008; Chabota et al.,2008).

Construction industry in Ethiopia is believed to be a key pillar in promoting economic and social development of the country. However Ethiopia‘s construction sector enjoyed modest growth rates averaging. Efforts have been made to improve the performance of the construction industries of Ethiopia and many developing countries as a whole (Ofori, 2008). These have taken many forms but studies show that the industries continue to face problems including poor cost, time and quality performance; lack of work opportunities; poor level of professionalism and entrepreneurship; obsolescence of some statutes and codes; ineffectiveness of implementation of existing statutes and codes; and bureaucracy in formal procedures relating to project planning and administration. In terms of performance, the industries in developing countries fall short when compared with other sectors of the economy, as well as with their counterparts in elsewhere with regard to productivity, quality, safety and health, and environmental performance. Whereas construction industries in all countries face problems and challenges (Ofori, 2000a, 2001), those in the developing

nations face the additional general difficulties of economic stress, resource shortages, and institutional and legal weaknesses.

CHAPTER THREE: RESEARCH DESIGN AND METHODOLOGY

Research as defined by many authors (Bashir, Afza l& Azeem, 2008; Creswell, 2003; McMillan and Schumacher, 2006; and Best, 2006) is the systematic application of scientific method to the problem under consideration. Research methodology therefore presents the overall framework on how research results may be achieved through data collection and analysis. This chapter presents the research philosophy, research design, target population, sample size and sampling technique, data collection procedure and instruments and finally data analysis and reporting.

3.1 Research Philosophy

Research philosophy outlines the way data of a certain phenomenon should be gathered and analyzed (Saunders, Lewis, & Thornhill, 2007). According to Saunders, *et al.,* (2007), research philosophy can be divided into three categories namely; positivism, interpretivism and realism. The philosophy that best suits this research's objective is Positivism. Because in positivism research philosophy, the research reflects the belief that reality is stable. This reality can be observed and described from an objective viewpoint without necessarily interfering with the phenomenon itself. Positivists'belief that hypothesis developed from existing theories can be tested by measuring observable social realities, thus positivism is derived from natural sciences. Based on previously observed, explained realities and their interrelationships, it is then possible under positivism research philosophy to make predictions. (Hatch and Cunliffe, 2006) asserts that positivism research philosophy can be used to investigate what truly happens in organizations through scientific measurement of people and system behaviors. This research philosophy can be used to investigate the effect of the challenges of logistics operations of the construction firm on performance of the firms in Ethiopia.

Since positivism research philosophy enables the testing of hypothesis, first there is a need to translate the underlying concepts into measurable forms (Saunders *et al.,* 2007), and then the findings can be generalized (Alavi and Carlson, 1992). For instance, in this study challenges of the logistics operation is a construct that needs to be properly measured in order to test its effect on performance of construction firms.

3.2 Research Methods

The study adopted both descriptive and explanatory research designs. On one hand, descriptive research design combined with graphical illustrations was used to describe various variables of interest. According to (Cooper and Schindler, 2006) descriptive research design enables the researcher to narrate how various behaviors and events occur. It describes a phenomena occurring in a population without influencing the subjects been studied. For instance, descriptive research design can be used to describe performance of construction firms over time or at a point in time. On the other hand, explanatory/inferential research design has been used to establish the magnitude, direction and significance of various challenges of the logistic operation on performance of construction firms in Ethiopia in this research.

In general, it aims at providing a better understanding of a situation without coming up with final answers or decisions. Explanatory research design helps a researcher to come up with hypothesis about the happenings in a given situation. This research design does not follow a structured process, it is loosely defined and its findings are only tentative.

Finally, explanatory research design also known as casual research design seeks to establish relationships between variables. This design is used to establish relationships between two or multiple variables of interest. (Creswell, 2003) asserts that explanatory research design can be used to predict an outcome such as performance of construction firms. Consequently, explanatory research design can be used to investigate the influence of the challenges of the logistics operations on performance of construction firms by estimating the relationships between various aspects of the challenges of logistics operations and performance of construction firms.

Given the objectives and as illustrated in chapter two under conceptual framework, this study therefore used both descriptive and explanatory research design. According to (Kothari, 2004), those two research designs may facilitate research to be as efficient as possible yielding maximum information. Descriptive research design and explanatory research design provides the collection of relevant evidence with minimal expenditure of effort, time and money; the purpose of the study happens to be an accurate descriptive of situation and analysis of the relationship between variables (Kothari, 2004). Further, (Greene, 2012) recommends use of regression techniques to uncover the relationships between variables. This study sought to investigate the relationship

between of the challenges of the construction logistics operations and performance of construction firms thus explanatory research design is very relevant.

3.3 Target Population and sample design

As it was indicated in the introductory part, the populations under study are Grade one General Contractors. Total number of Registered Contractor's for 2009 Budget Year collected from MUDHo, Assessment and Competency Certification Bureau was 5565 contractors. But the target population of this research is Grade one contractors of all categories only. The reason behind was that since the grade of the contractors decreases, it means that the construction firm is characterized with high turnover and capacity which indicates that there is large amount of logistics operations in the company. Therefore, population is 160 contractors, which is the summation of GC1, BC1 and RC1 contractors.

Subsequent to the determination of the total population, suitable sample size was selected. Therefore, since the population is small in number, the following formula by (Orme, 2010) was used to determine the size of the sample respondent companies from the calculated figure will be selected at random

Equation 3.1. $$MOE = Z\sqrt{(1-f)*\frac{PQ}{(n-1)}}$$

Where:

MOE = Margin of Error

Z = standardized variable, for confidence level of 95% Z score associated with it is =1.96

Q = (1-P)

f = Finite Population Correction (FPC) =n/N, where n=sample proportion and N= population size

A confidence level of 95% and +/-5% of margin of error is assumed for this research because of the need to find balance between the level of precision and availability of resources. As previously stated, for 95% confidence level, z = 1.96. If we consider the worst case scenario, the

largest standard error, the expected proportion is set to be 50% of the proportion. Based on the aforementioned assumptions, the sample size was calculated as follows:

$$0.05 = 1.96\sqrt{(1-n/160)*\frac{0.5*(1-0.5)}{(n-1)}}$$

$$= 113.25$$

Equation 3.1 gives sample size of 113 construction firms. Therefore, the study was sought to gather information from 113 construction firms located in different parts of the country. This sample was deemed good representation of the populations since the sample size is greater than 10 percent of the target population. (Mugenda and Mugenda, 2003) argue that for a sample to be a good representative of the population it should be at least 10 percent of the target population. Thereafter simple random sampling was used to select the names of construction firms in which data was to be collected.

3.4 Data Collection Procedure and Instruments

The study used questionnaires to collect data from 113 construction firms in Ethiopia. The questionnaire is common instrument for observing data beyond the physical reach of the observer and in the questionnaire there may be open and closed questions (Davies & Dodd, 2002). This study used closed questions which is one where responses are restricted to small set of responses that generate precise answers to develop the empirical study. In designing the questionnaire, a five point likert-type scale was used in order to provide the extent of the respondents feelings or opinions on the impact of the various problems of the logistics operations under consideration on firm performance where by a scale of one implies strong disagreement with an issue or statement while a scale of five implies a strong agreement in that order (Patton, 2002). Questionnaires were administered either to the engineering department or the logistics department in each of the selected 113 firms and were able to collect data's only from 103 construction firms.

After the completion of data collection, the researcher entered data in Statistical Package for Social Sciences (SPSS) version 20 using uniform codes. Thereafter, the researcher conducted data cleaning and analysis.

3.5 Data Processing and Analysis

As illustrated in the previous section, questionnaires were used to collect primary data and analysis was done in SPSS version 20. The data collected is a cross section data since it is collected at a point in time. Cross sectional survey is a data collection and analysis approach where respondents are asked questions that were developed in advance (Saunders *et al.*, 2007). The study therefore used cross sectional data analysis techniques to test the hypotheses stipulated in chapter one. The researcher started data analysis by first conducting descriptive analysis with the aim of describing various patterns of the key variables. This is in line with (Trochim, 2006), who argues that descriptive statistics are the preliminary for any quantitative analysis. Additionally, to test the significance of the challenges in logistics operation on performance of construction firms, the study conducted inferential statistics. Worth noting is that most of the measures of challenges of logistics operations constructs were used in the regression model.

This study then used the indices generated from factor analysis to run a multiple regression analysis. This approach enabled us investigate the relationship between various measures of logistic operation challenges and firm performance.

CHAPTER FOUR: FINDINGS AND DISCUSSIONS

This chapter presents the findings from data analysis and is divided into five sections. Section 4.1 presents results from pilot study and descriptive statistics, section 4.2, presents the types of contracting organizations, 4.3 respondents Background Information, 4.4 reliability of responses is checked, section 4.5 presents frequency for firm performance and the related challenges in logistics operations of a the company, section 4.6 presents results for factor analysis and section 4.7 presents regression results and their interpretation.

4.1 Response Rate Respondents

The study sought to collect data from 113 construction firms in Ethiopia but the researcher managed to collect 103 questionnaires. This represents a response rate of 91 percent which is very good for analysis. According to (Babbie, 2004) a response rate of 60 percent is good and that of 91 percent is very good.

4.2 Types of surveyed Contracting Organizations

Table4.1 shows the percentage breakdown of types of organizations which responded to the questionnaire. From the total sample of 103 companies: 64.08% were Building Contractors; 32.04%General Contractors and 3.88 road contractors. The purpose of this study was to identify the effects of logistic operations related to construction sites and evaluating the effects on the performance of companies. Of the collected survey 80% of the questionnaire was responded by the Engineering department of the firm while the rest 20%, by the logistics department.

Indicator	Frequency	Frequency	Percentage
Contractor	GC1	33	32.04
	RC1	4	3.88
	BC1	66	64.08
Department	Engineering Department	82	80%
	Logistic Department	21	20%

Table 4.1.Frequency of types of the respondent firms and department of the respondents

4.3 Respondents Background Information

This section presents background information of the responding firms. The study found that majority (66.99%) of the firm had an experience that ranged from 6 years to 10 years followed by 27.18 percent of the construction firms have been in the sector for more than ten years. Only 5.83 percent of the responding companies indicated that they established on the past one to five years. Therefore, 94.16 percent of the respondent companies were established more than 6 years ago (Figure 4.1). This suggests that the respondent companies have wide and long experience in the sector. Consequently demands and existing operations to the logistics perspective of the firms is well understood concept by those companies.

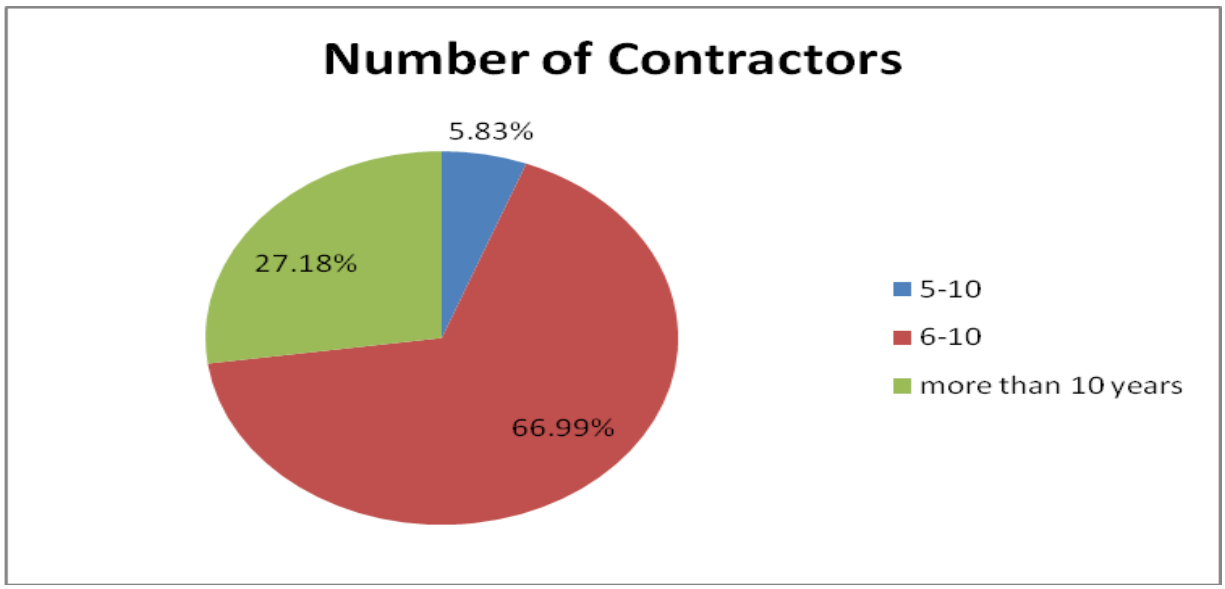

Figure.4.1. Number of years that the contractors existed in the construction sector.

The study also sought to find whether a particular firm had logistics or supply department. The results indicated that 96 percent of the firms had logistics/ supply department (Figure 4.2). The rest of the respondents indicated that their firm did not have a logistics/ supply department.

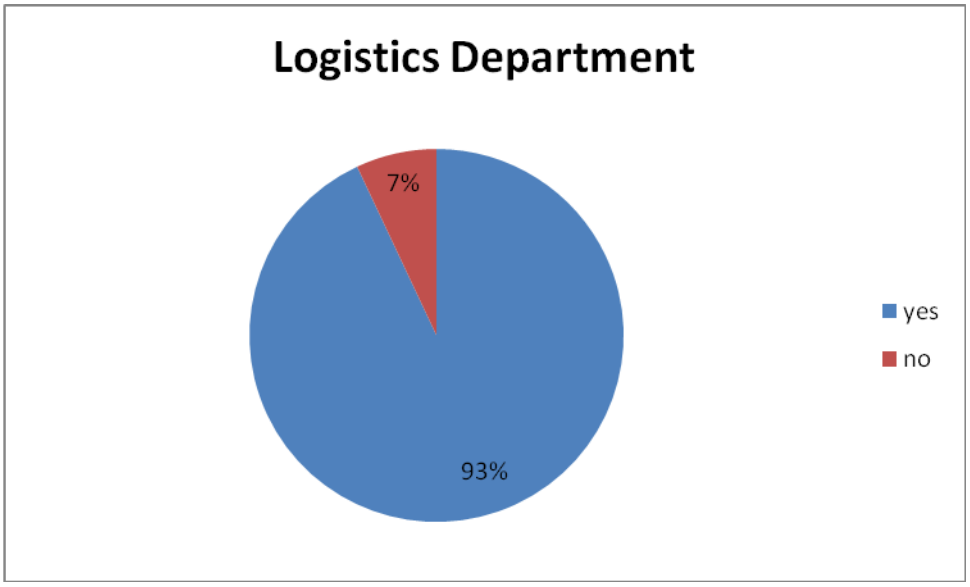

Figure 4.2: The Firm Has Logistic Department

4.4. Reliability and Validity Test

As stated by (Hair et al., 2007) reliability indicates the extents to which a variable or set of variables is consistent in what it is intended to measure" Cited by (Siddiqi, 2011). Reliability analysis is used to measure the consistency of a questionnaire. There are different methods of reliability test, for this study Cronbach's alpha is considered to be suitable. Cronbach's alpha is the most common measure of reliability. For this study the Alpha coefficient for the overall scale calculated as a reliability indicator is 0.861, shown in Table 4.2 below. As described by Andy (2006) the values of Cronbach's alpha more than 0.7 is good. The alpha values in this study are far from 0.7 and which are; therefore it had very good reliability for the questioners.

Reliability Statistics

Cronbach's Alpha	N of Items
.861	56

Table 4.2.Reliability Test Result

4.5. Descriptive Analysis

This section presents descriptive analysis for variables used in the model. The section is divided into two sections namely; descriptive analysis for the independent variables and the dependent variable. The key independent variables of this study are challenges of logistics operations. Challenges expected in the construction Logistic operation have different constructs namely; Material Procurement Coordination's problems, Misplacement of construction materials and equipment, reduction of construction waste, reduction of theft, reduction of accidents and delivery improvement. The dependent variable in this study is Construction firm performance. Each of these constructs is discussed below.

Measuring performance is a crucial criterion of evaluating the competence and achievement of an organization. Hence, the research investigated the performance of the construction firms using three different tools that measure performance. Namely, market share of the Construction

Company, profit and customer satisfaction and results from the survey found that the firm's performance shows that it was only to a moderate extent and the respondents have a common understanding about firm performance amongst each other i.e. (Mean = 3.47, S.D = 0.32).

The first independent variable, which is material procurement coordination's problem, leads to a lot of damage in all firms rather than just the construction firm. Hence, understanding the occurrence as well as its significance in affecting the firms' performance is mandatory. As it can be seen on the table 4.3 below, it's occurrence in construction firms is a great extent and most respondents have homogeneous responses on the concept of material procurement coordination problems(Mean = 3.56, S.D = 0.59).

Construction waste has different rationale to its existence but its existence in construction sector is undeniable. Therefore, the firm has to devise way in order to mitigate it. As per the survey, firms shows an average effort to mitigate waste and most respondents of the firms have similar idea on the variable (Mean = 3.44, S.D = 0.56).

Accident is one of the major factors that affect performance of the firm and also an independent variable on the research. But as it can be seen below on the table, firms are showing moderate effort in order to alleviate its existence but the understanding about the situation among the firms is uniform (Mean = 2.76, S.D = 0.80).

Instant identifications of materials and equipment on site enable works to progress smoothly. Therefore, materials misplacement is one of the factors that should be mitigated on a construction site. From the mean showing the responses of respondents, firms show moderate extent effort to alleviate the problem and have a common understanding about misplacement reduction (Mean = 2.91, S.D = 0.85).

The existence of a lot of material and equipment deliveries, and high number of stakeholders involving in the construction sector makes it vulnerable to theft. Therefore, any construction firm has to devise ways to control their firms from such problems. Accordingly, firms were asked if they have good ways of controlling theft. The survey shows that the control is being done to a moderate extent and respondents have a uniform understanding about theft (Mean = 3.46, S.D = 0.38).

delivery improvement is one of the factors affecting firms' performance. The survey shows construction firms lack proper planning their delivery systems but most respondents have a uniform understanding.

Indicators	Mean	Std. Deviation
Construction firm performance	3.4773	0.32510
Material Procurement Coordination problems	3.5612	0.59281
Reduction of construction Waste	3.4377	0.55825
Reduction of accidents in Construction	2.7573	0.79787
Reduction of materials Misplacement	2.9078	0.85103
Reduction of theft	3.4604	0.38258
Delivery Improvement	2.1780	0.48014

Table 4.3.Mean and Standard deviations of dependent and independent variables

4.6. Correlation analysis

Correlation analysis is used to identify how closely related two variables are to each other. A numeric value ranging from -1 to +1 indicates if the correlation between the two variables is positive or negative and the strength of the relationship. The closer the correlation is to negative or positive one the stronger the relationship. A correlation of zero would indicate that absolutely no relationship exists.

In this research, the researcher looked for the correlation that exist between the dependent variable which is construction firm performance and independent variable which are Material procurement coordination problems, Reduction of waste, Reduction of Accident, Reduction of materials misplacement, Reduction of theft and Delivery Improvement. Using SPSS, the researcher ran multiple correlation analysis between the dependent and independent variables.

The statistical significance of each of the independent variables mentioned above corresponding to each of variables is .004, .006, .919, .305, .001 and .239 respectively (Table 4.4). Hence, from the correlation analysis result material procurement coordination problems, reduction in construction wastes and reduction in theft has significant correlation with the performance of a construction firm.

Based on the Pearson Correlation analysis of the variables, the result shows that material procurement coordination problem is just the single variable out of the three significant variables that performance of the construction firm has a negative relation with. That is, as material procurement coordination problem in the construction sites increases, the performance of the construction firm decreases. Therefore, performance is affected by material procurement coordination problem.

The second independent variable having significant correlation with the dependent variable, reduction in construction waste, has a significant correlation with the performance of the firm. This means, us firms come up with ways of reducing construction waste or if they are mitigating waste in the construction sites, it contributes in improving the performance of the firm. Therefore, reducing construction waste has a positive significant relationship among the firms.

Finally, the last independent variable having significant correlation with the dependent variable is reduction in theft and as it is indicated in the table 4.4 below it also has a significant correlation with the performance of the firm. This means, if construction firms control the existence of theft

and vandalism or eliminate thievery from the construction sites, the performance of firms will be perk up. Thus, reduction of theft and performance of the firm has a positive correlation with each other.

But the rest of the independent variables, that are; reduction in accidents and delivery improvement, initially selected as a potential variable affecting firms performance have no significant correlation with firms performance to this study.

		Construction firm performance	Material Procurement Coordination problems	Reduction in Construction waste	Reduction in Accidents	Reduction in Materials Misplacement	Reduction in Theft	Delivery Improvement
Construction firm performance	Pearson Correlation	1	-.284**	.271**	.010	.102	.316**	.117
	Sig. (2-tailed)		.004	.006	.919	.305	.001	.239
	N	103	103	103	103	103	103	103

**. Correlation is significant at the 0.01 level (2-tailed).

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

Table 4.4.Coorelations of the dependent and independent variables

4.7. Regression analysis

The study used Ordinary Least Squares (OLS) estimation method to test the significance of logistic operations on firm performance with logistic performance moderating the relationship. The study calculated the factor scores for each construct and used the factor scores in the regression analysis. Factor scores have been widely used to represent a construct in regression analysis (Eyduran,*et al.,* 2009; Tabachnick &Fidell, 2001). The regression results are discussed as follows

The study sought to investigate the effect of material procurement coordination's, reduction of misplacement, reduction of construction Waste, reduction of theft, delivery improvement and reduction of accidents have on firms' performance. Regression analysis was done with firm performance as the dependent factor and the above mentioned variable as tested predictor factor. Data from one hundred and three respondents were tested. The results are illustrated in Table 4.5.

Table 4.5: Relationship between the independent and dependent variables

Coefficients[a]

Model		Un-standardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	4.727	0.351		13.475	0
	Material Procurement Coordination problems	-0.11	0.287	0.202	0.387	0.7
	Reduction of Construction Waste	0.024	0.011	0.04	2.23	0.024
	Reduction of accidents	0.008	0.49	0.021	0.17	0.866
	Reduction of materials Misplacement	0.023	0.047	0.061	0.491	0.625
	Reduction of Theft	0.233	0.095	0.274	2.438	0.017
	Delivery Improvement	0.102	0.082	0.15	1.236	0.22

a. **Dependent Variable: Construction firm performance**

R-Square = 0.38, F= 2.703, p-value = 0.018

From the above regression result the fitted model is

Equation 4.1 Firm performance = 4.727- 0.110Material procurement coordination problems+ .024waste reduction + .008accident reduction +0.023Misplacement Reduction + 0.233theft reduction+ 0.102 delivery improvement

The r-square value 0.38 shows 38% of the variation of firm performance that can be explained by material procurement coordination problems, reduction of waste, reduction of theft, Improvement in delivery system, reduction of construction accidents and reduction of misplacement. This result is in line with the study of (Kendo & Getuno, 2016) in which they carried out a study regarding the 'factors affecting tendering process in state corporations: A case of Kenya literature Bureau'. That is, based on the regression analysis of their study, the value of the R-squared was 0.415 which implied 41.5% of factors on the study affected the tendering process in state corporations.

Accordingly, the rest 62% of the variation of firm performance that can be explained by other factors like, support from senior management, skilled designers, skilled project managers, troubleshooting, project team motivation, and commitment of all project participants, strong/detailed plan effort in design and construction, adequate communication channels, effective control, such as monitoring and updating plans, effective feedback and adequate financial budget (Alias, Zawawi, Yusof, Aris, 2014).

Hypothesis of the study

H1: Material procurement coordination problems had significant contribution for construction firm performance.

The study sought to investigate the effect of material procurement coordination problems on performance. Regression analysis was done with firm performance as the dependent factor and material procurement coordination problems as tested predictor factor. Data from one hundred and three respondents were tested. The results are illustrated in Table 4.5.

From the regression analysis the p-value for Material procurement coordination problems, 0.700 which is greater than the level of significant value 0.05; this indicates that Material procurement coordination problems had no significant contribution for firm performance for this study.

As it was previously discussed in the first chapter, this research can only represent the perception of the respondents only from the selected population; it cannot be generalized to the universe of

companies and also excludes other categories of firms like manufacturing, retail, hospitality industries and etc.

H2: Reduction of waste in construction had significant contribution for construction firm performance

The study sought to investigate the effect of reduction of waste on performance. Regression analysis was done with firm performance as the dependent factor and reduction waste as tested predictor factor. Data from one hundred and three respondents were tested. The results are illustrated in Table 4.5.

From the regression analysis the p-value for Reduction of waste in construction is 0.024, which is less than the level of significant value 0.05. This indicates that Reduction of waste in construction had significant contribution for firm performance for this study.

The model shows that Reduction of waste in construction positively affects the firm‘s performance, i.e. an increase in mean index of Reduction of waste in construction increases the performance of the company by a positive unit mean index value of 0.024.

The study sought to establish the effect of reduction of waste in construction as a function of challenges in logistics operations on the performance of the construction firms in Ethiopia. Numerous studies have posited that minimizing wastes lead to improvement of the performance of firms in both financial and non-financial fronts. The study findings indicate that firms that have internalized reducing waste within their operations experience improvement in their performance outcomes. The multiple regression analysis results indicate that reduction of waste in construction has a positive statistically significant predicts the performance of construction firms; $p < 0.05$ i.e. an increase in mean index of reduction of waste in construction increases the performance of the company by a positive unit mean index value of 2.4 percent. Hence reduction of waste in construction significantly influences the performance of the construction firms in Ethiopia. Therefore, the hypothesis reduction of waste in construction significantly influence Construction firm performance holds true.

H3: Reduction of Accidents in construction had significant contribution for construction firm performance.

One of the hypothesized contributors to the performance of a construction firm was reduction of accidents to the construction firm. Regression analysis was done with firm performance as the dependent factor and reduction of accidents as tested predictor factor. Data from one hundred and three respondents were tested. From the table 4.5 depicted, the analyzed data can be interpreted as follows.

The p-value for reduction of accidents, 0.866 which is greater than the level of significant value 0.05; this indicates that reduction of accidents had no significant contribution for firm performance for this study.

As it was previously discussed in the first chapter, this research can only represent the perception of the respondents only from the selected population; it cannot be generalized to the universe of companies and also excludes other categories of firms like manufacturing, retail, hospitality industries and etc.

H4: Reduction of materials misplacement in construction had significant contribution for construction firm performance.

The study sought to investigate the effect of reduction of materials misplacement on performance. Regression analysis was done with firm performance as the dependent factor and reduction of materials misplacement as tested predictor factor. Data from one hundred and three respondents were tested. The results are illustrated in Table 4.5.

From the regression analysis the p-value for reduction of materials misplacement, 0.625 which is greater than the level of significant value 0.05; this indicates that reduction of materials misplacement had no significant contribution for firm performance for this study.

As it was previously discussed in the first chapter, this research can only represent the perception of the respondents only from the selected population; it cannot be generalized to the universe of companies and also excludes other categories of firms like manufacturing, retail, hospitality industries and etc.

H5: Reduction of theft in construction significantly influence Construction firm performance

From the regression analysis the p-value for Reduction of theft in construction is 0.019, which is less than the level of significant value 0.05. This indicates that Reduction of theft in construction had significant contribution for firm performance for this study.

The model shows that Reduction of theft in construction positively affects the firm‘s performance, i.e. an increase in mean index of Reduction of theft in construction increases the performance of the company by a positive unit mean index value of 0.233.

The study sought to establish the effect of reduction of theft in construction as a function of challenges of logistics operations on the performance of the construction firms in Ethiopia. Numerous studies have posited that minimizing wastes lead to improvement of the performance of firms in both financial and non-financial fronts. The study findings indicate that firms that have internalized reducing theft within their operations experience improvement in their performance outcomes. The multiple regression analysis results indicate that reduction of theft in construction has a positive statistically significant predicts the performance of construction firms; $p < 0.05$ i.e. an increase in mean index of reduction of theft in construction increases the performance of the company by a positive unit mean index value of 23.3 percent. Hence reduction of theft in construction significantly influences the performance of the construction firms in Ethiopia. Therefore, the hypothesis reduction of theft in construction significantly influence Construction firm performance holds true.

H6: Delivery Improvement had significant contribution for construction firm performance.

The study sought to investigate the effect of delivery improvement on performance. Regression analysis was done with firm performance as the dependent factor and delivery improvement as tested predictor factor. Data from one hundred and three respondents were tested. The results are illustrated in Table 4.5.

From the regression analysis the p-value for delivery improvement, 0.22 which is greater than the level of significant value 0.05; this indicates that delivery improvement had no significant contribution for firm performance for this study.

As it was previously discussed in the first chapter, this research can only represent the perception of the respondents only from the selected population; it cannot be generalized to the universe of companies and also excludes other categories of firms like manufacturing, retail, hospitality industries and etc.

CHAPTER FIVE: SUMMARY, CONCLUSION AND RECOMMENDATIONS

This study was based on all construction firms in Ethiopia registered by MoWUD as of the year 2017. It examined the influence of challenges of logistics operations in construction sites namely: material procurement coordination problems, construction wastes, construction accidents, construction materials misplacement, theft and delivery improvement on firm's performance. This chapter is therefore divided into four sections. Section 5.1 presents summary of the study, section 5.3 presents conclusion and section 5.4 presents policy implications while section 5.5 presents limitations and areas of further research.

5.1 Summary of the Research findings

The study intended to achieve six specific objectives and based on these specific objectives, research hypothesizes were formulated for testing in response. The specific findings relating to the study objectives are summarized in the following section.

5.1.1 Influence of Material Procurement Coordination Problems on Performance of Construction Firms in Ethiopia

This objective was built on the hypothesized statement that ― Material Procurement Coordination problems have significantly influence the performance of the construction firms. The study findings rejected the hypothesis and established that firm performance was not significantly influenced by Material Procurement Coordination problems. Performance was measured based on market share, firm profit and customer satisfaction. This study therefore established that construction firms are not affected by material procurement coordination problems.

5.1.2 Influence of reduction of construction wastes on the performance of the Construction firms in Ethiopia

This study objective is founded on the hypothesized statement that ―Reduction of construction waste significantly influence the performance of construction firms. The finding shows that when market share, firm profits and customer satisfaction are used as the dependent variables and the

indications were that there is percentage of variations in performance explained by the Reduction of construction waste and the coefficients for Reduction of construction waste construct were all significant at 5 percent ($p<0.05$). This implies that Reduction of construction waste positively influences performance of construction firms in Ethiopia. The finding therefore concurs with hypothesis that states: ―There is significant relationship between Reduction of construction waste and performance of construction firms in Ethiopia. In construction, Reduction of construction waste is even more important to keep the construction process running. Every minute that is spent down because of the waste encountered is additional costs on company‘s unplanned expenses. In this way, Reduction of construction waste is more than a means to control costs; it becomes a way to promote the construction process. Due to this, every firm must focus and take into serious the Reduction of construction waste towards their business.

5.1.3Influence of reduction of accidents on the Performance of the construction Firms in Ethiopia

This objective is centered on the hypothesized statement that ― reduction of accidents significantly affect the performance of construction firms, the finding shows that reduction of accidents does not significantly influences firm performance. The finding therefore calls for rejection of the hypothesis that states: ―There is significant relationship between reduction of accidents and performance of construction firms in Ethiopia.

5.1.4 Influence of Reduction of materials misplacement on the Performance of the Construction Firms in Ethiopia

This study objective is formed on the general hypothesized statement that ―reduction of materials misplacement significantly influence performance of construction firm. The study findings rejected the hypothesis and established that the influence of reduction of materials misplacement on firm performance was statistically insignificant. This finding submits that reduction of materials misplacement would not necessarily lead to an increase in mean index of reduction of materials misplacement increases the performance of the company by a positive unit.

5.1.5 Influence of reduction of theft on the performance of the Construction firms in Ethiopia

This study objective is founded on the hypothesized statement that ―Reduction of theft significantly influence the performance of construction firms. The finding shows that when market share, firm profits and customer satisfaction are used as the dependent variables and the indications were that there is percentage of variations in performance explained by the Reduction of theft and the coefficients for Reduction of theft construct were all significant at 5 percent ($p<0.05$). This implies that Reduction of theft positively influences performance of construction firms in Ethiopia. The finding therefore concurs with hypothesis that states: ―There is significant relationship between Reduction of theft and performance of construction firms in Ethiopia. In construction, Reduction of theft is even more important to keep the construction process running. Every minute that is spent down because of the delivered material based on plan will not be available to use in the time of demand for that particular item which causes delays and additional cost. In this way, Reduction of theft is more than a means to control costs; it becomes a way to promote the construction process. Due to this, every firm must focus and take into serious reduce/eliminate theft.

5.1.6 Influence of delivery improvement on the Performance of the Construction Firms in Ethiopia

This study objective is formed on the general hypothesized statement that ―delivery improvement significantly influences performance of construction firm. The study findings rejected the hypothesis and established that the influence of delivery improvement on firm performance was statistically insignificant. This finding submits that delivery improvement would not necessarily lead to an increase in mean index of delivery improvement increases the performance of the company by a positive unit.

5.2 Conclusion

The study aimed to evaluate challenges of logistics operations of a construction firms and their influence on the performance of construction firms. The study established that only two out of the six challenges of the logistics operation significantly influenced firm performance. This study provided evidence that reducing construction wastes and reducing theft in construction significantly and positively influence the performance of construction firms in Ethiopia. This implies that an increase in performance of construction firm is likely through reducing construction wastes and reducing theft within the logistics operations of a construction project. As a result, the study concludes that only theft and waste reduction positively influence firm performance. The rest of the challenges; accidents, construction materials misplacement, material procurement coordination problems and delivery improvement does not significantly influence firms' performance.

The study finding provides basis to conclude that reducing waste and theft do moderate the relationship between logistics operations and firm performance. This is, in agreement with some of the existing literature. This study provides substantive support for previous findings in the problems encountered in logistics operation of the captioned firm literature and fresh insight about problems of logistics operation in construction industry and performance construction firms. The rest of problem areas that were disproved in this study do not necessarily apply to all sectors out there and also the construction industry as a whole. In general, challenges in logistics operations were not found to be collectively significantly influencing the performance of the construction firms; just theft and waste were influencing most of the construction firm's performance.

5.3 Recommendations

Based on the study findings, the following recommendations are given under the study specific objectives:

According to the study it was established that reduction of waste and theft positively predict the performance of construction firms. Therefore, the study recommends that managers in construction firms of Ethiopia should incorporate ways of reducing wastes and theft in their construction process which starts from the procurement of raw materials, transportation, storage

and movement within the construction site for actual use in other words the whole supply chain of the construction process. There are some methods that can be employed to alleviate such challenges from the construction sites proposed in previous researches. For example on the research of (Jang and Skibniewski, 2008) they proposed a wireless sensor network system that can help protect materials from damage by real-time temperature measurement of humidity sensitive materials which results in mitigating waste from the construction site. The other factor that was confirmed having an effect on the performance of the firm was theft. In this regard, Carmichael *et al.*, 2007; Donkor, 2008 proposed Radio Frequency Identification Devises and wireless sensor network system that can help to improve security through real-time localization of materials which can help in preventing theft from the construction industry. But these technologies are not yet applicable in our country. But findings from the research might initiate contractors and other concerned parties to further investigate or carry out researches on this area and investors might be interested in importing this technology to make available in our country.

Rejection of the other challeges in the logistics operations of the construction industry does not necessarily mean that these factors do not generally affect the performance of the construction firms as a whole. As it was previously discussed in the previous sections, the research has some limitations. For example, only a single person was chosen from each company to represent their ideas on the questionnaire about the firms they are working in. Therefore, the research is based only on a single perception of a member within the firm and this does not necessarily indicate other firm member‘s perceptions. The other limitation was that all participants responded within a particular time frame and were only given a single opportunity to respond. Therefore, it cannot be reliably established whether such data would hold true over time, especially in a construction environment where it is characterized by its uniqueness from other sectors. Therefore, the researcher recommends taking other researchers in considering the variables that were rejected also because their studies might find this variables being significant because some of the limitations of this research may not apply in the researches that they are going to carry out.

5.4 Areas of Further Research

Apart from addressing the limitations listed in the previous section, future research possibilities based on the findings from this study are interesting and exciting. Possible future research paths concentrate on theoretical issues, investigation of new conceptual questions, and the execution of new empirical studies to improve upon the conclusions of the findings. These future research trails are discussed in details in the next section.

Additional variables in the model could be explained through the insertion of moderators to the hypothesized relationships. Due to global supply chain management trends, over time, some new issues/ challenges of the logistics operations influencing firm performance are likely to appear and there is need to be able to identify when that happens, especially barriers and learn how to deal with them. This can only be possible when there is continuation of research on logistics operations of a construction industry.

Risk factors also impact managerial decisions about the allocation of resources towards mitigating problems around the logistics operations and the significance they have on firm performance may be different. Other studies could be conducted looking into other factors like; service industry, firm size, and global ownership to assess if there are differences among groups that make up these demographics. For example, how do the challenges in logistics operations impact firm performance in multinational firms, as opposed to firms with a local ownership? Does the theoretical model change when the sample is split into large firms and small/medium sized and in what ways do these two groups compare? Does top management influence the impact of challenges of the logistics operations on performance of construction firms?

External validity cannot be ensured in a single study and therefore, an additional empirical research is needed to test the primary components of external validity. One way to do this is by expanding the sample to include both service and manufacturing firms in Ethiopia. Using longitudinal survey data to see how the challenges in logistics operations may be a critical issue in some markets but not very significant in others. Thus, it would be quite beneficial to examine the influence of problems encountered in logistics operations on performance of other markets or industries.

References

Alavi, M., & Carlson, P. (1992). A review of MIS research and disciplinary development: Journal of Management Information Systems, 8 (4), 45–62.

Alias, Z., Zawawi, E.M.A., Yusof, K., Aris and NM, (2014). Determining Critical Success Factors of Project Management Practice*:* A conceptual framework. *AMER International Conference on Quality of Life,* Social and Behavioral Sciences 153, 61 – 69

Babbie, E. (1990), *Survey Research Methods 2nd Ed. Belmont*, CA, Wadsworth

Bashir, M., Afzal, M. T., &Azeem, M. (2008). Reliability and Validity of Qualitative and Operational Research Paradigm: *Pakistan Journal of Qualitative and Operational Research,* 4, (1), 35-45

Bertelsen, S. and Nielsen. J, (1997). Just-in-time Logistics in the Supply of Building Materials Accessed http://www.bertelsen.org/strategisk_r%E5dgivning_aps/pdf/Just-InTime%20Logistics%20in%20the%20Supply%20of%20Building%20Materials. pdf

Best, J.W., & Kahn, J.V. (2006), *Research in Education* (10th Ed.), New York, USA

Betlejewska, R.S and Potkány, M., (2015). Construction Costs Analysis and Its Importance to the Economy, Procedia Economics and Finance 34, 35 – 42

Boba R. and Santos R. (2006) Burglary at single-family house construction sites. Online: http://www.cops.usdoj.gov/files/ric/Publications/e08064509.pdf

Cooper, R., & Schindler, P. (2006). *Marketing Research*. New York: McGraw–Hill.

Coyle, J.J., Bardi, E.J. and Langley, C.J. (2003). *The Management of Business Logistics: A Supply Chain Perspective*, 7th Edition. South-Western Thompson Learning

Creswell, J. W. (2003). Research Design: *Qualitative, Quantitative and Mixed Methods Approaches* (2nd Ed).London: Sage Publications.

Cuturela. S.C, (2013). A *Short Historical Perspective on the Evolution of Logistics and its Implications for Globalization: National Defense University*

Davies, D., & Dodd, J. (2002). Qualitative research and the question of rigor: *Qualitative Health research*, 12(2), 279-289.

Donkor, P. (2008). Theft and vandalism on industrial and roofing construction projects. *Graduate School the University of Florida. Master of Science in Building Construction Thesis*

Duiyong, C., Shidong, J. and Mingshan S., (2014). Engineering construction project site logistics management, *Journal of Chemical and Pharmaceutical Research*, 6(7):353-360 USA.

Egan, J. (1998) Rethinking construction: the report of the Construction Task Force to the Deputy Prime Minister, Department for Trade and Industry

Ethiopian Economic Association (2008). *The Current State of the Construction Industry*, Volume VI, Addis Ababa, Ethiopia.

Ethiopia Economic Profile Accessed on: *http://www.indexmundi.com/ethiopia/economy_profile.html*

Formoso, C.T and Isatto, E.L, (2009). Production Planning and Control and the Coordination of Project Supply Chains*: Construction Supply chain Management Handbook*, CRC Press:Taylor & Francis Group

Greene, H., (2012). *Econometric Analysis* (7th Ed.). Upper Saddle River, N. J: Prentice Hall.

Hatch, M. J., &Cunliffe, A. L. (2006).*Organization Theory (*2nd Ed.).Oxford: Oxford University Press.

Hill R.M. and Ballard R., 2001, Construction Logistics*: An introduction*, ISBN 1-86081-513-8

International Labor Organization, (2001). The construction industry in the twenty first century*: Its image, employment prospects and skill requirements,* Geneva

Islam D.Z. &Zunder T. H. (2013).Performance evaluation of an online benchmarking tool for European freight transport chains, Benchmarking: *An International Journal* 20 (2), 233-250

Jang, W.-S., Healy W.M. and Skibniewski M.J. (2008). Wireless sensor networks as part of a web-based building environmental monitoring system: *Automation in Construction*, 17 729-736

Johansson E., (2013) Finding and reducing obstacles for implementing new logistics systems in the construction industry, *Business Administration Master's Thesis*

Johnston, J.E. (1984). *Site Control of Materials*. London, Butterworths

Kahssay G., 2003, *Claims in International project in Ethiopia: Case study*. Addis Ababa, University

Kaliba, C., Mundia, M. and Mumba, K., (2008). Cost escalation and schedule delays in road construction projects in Zambia. *International Journal of Project Management*

Kenado,E.and Getuno, P., (2016), Factors affecting tendering process in state corporations: A case of kenya literature Bureau, *International Journal of Current Business and social sciences, 1(5), 415-428.*

Kothari, C. R. (2004). *Research methodology – Methods and techniques*, 2nd edition new Age Tecno Press, New Delhi, India

Lester, A., (2006). Project Management planning and Control*: Managing Engineering, Construction and Manufacturing Projects to PMI, APM and BSI Standards.*

London K., Kenley R. and Agapiou A., (1998). Theoretical Supply Chain Network Modelling in the Building Industry*: Association of Researchers in Construction Management, Vol. 2*, 3052, Australia.

McMillan, J. H., & Schumacher, S. (2006). *Research in education: Evidence-Based Inquiry*. New York. Pearson Education, Inc.

Meraghni, L., Ross, A. and Jagger, D. (1996). The development of an object-oriented software prototype for a requisitions and purchase orders management system. Online: http://www.rics.org/site/download_feed.aspx?fileID=2708&fileExtension=PD F

Ministry mikir bet, (2014). *Publication o*f *Ethiopian Construction Industry Development Policy (ECIDP*), Addis Ababa, Ethiopia

Mossman, A., (2008). More than materials*: Managing what's needed to create value in construction,* Paper for the 2nd European Conference on Construction Logistics - ECCL, Dortmund

Mugenda & Mugenda, (2003). *Research Methods*, Acts Press, Nairobi, Kenya

Njambi, E. & Katuse, P. (2013). Third party logistics in distribution efficiency delivery for competitive advantage in fast moving consumer goods companies in Kenya. *International Journal of Social Sciences and Entrepreneurship* 1 (8), 15-27.

Nega, F. (2008), Causes and effects of cost overrun on public building construction projects in Ethiopia, Master Thesis, Addis Ababa University.

Ofori, G., (2008), Revaluing Construction in Developing Countries: *A Research Agenda*, Penerbit Universiti Sains Malaysia,11(1)

Olusanjo Fadiya, Panos Georgakis, Ezekiel Chinyio, Chris Nwagboso, (2015) "Decision-making framework for selecting ICT-based construction logistics systems", *Journal of Engineering, Design and Technology*, Vol. 13 Issue: 2, pp.260-281, doi: 10.1108/JEDT-07-2011-0047

Orme B., (2010), Getting Started with Conjoint Analysis: *Strategies for Product design and pricing Research*. (2nd edition), Madison, Wis.:Research Publishers LLC

Patton, M. Q. (2002). *Qualitative evaluation and research methods* (3rd Ed.), Thousand Oaks, CA: Sage Publications, Inc.

Prathap, G., & Mittal, R. (2010). A performance index approach to library collection: *Performance Measurement and Metrics* 11 (2), 259-65. Print.

Riaz, Z., Edwards, D.J. and Thorpe, A. (2006). Sight Safety: A hybrid information and communication technology system for reducing vehicle/pedestrian collisions. *Automation in Construction*, 15(6), 719-728

Richard, P.J., Devinney, T.M., and Yip, G.S., & Johnson, G. (2009).*Measuring Organizational Performance as a Dependent Variable*: Towards Methodological Best Practice

Saunders, M., Lewis, P., & Thornhill, A. (2007). *Research Methods for Business Students*, (4thEd.). Prentice Hall Financial Times, Harlow

Shakantu W., Muya M., Tookey J. and Bowen P. (2008) Flow Modeling of Construction Site Materials and Waste Logistics. *Engineering, Construction and Architectural Management*, 15(5), 423–439

Shapira, A., Lucko, G. and Scexnayder, C.J. (2007). Cranes for building construction projects. *Journal of Construction Engineering and Management*, 133(9), 690-700

Siddiqi K.O, (2011), Interrelations between Service Qualities Attributes Customer Satisfaction and Customer Loyalty in the Retail Banking Sector in Bangladesh, *International Journal of Business and Management*. 6(3), 12-36

Silva. F.B and Cardoso. F.F, (1999), Applicability of Logistics Management in Lean Construction*: a Case Study Approach in Brazilian Building Companies,* vol. 61, issue 3, pages 188-198

Song J., Ergen E., Haas C. T., Akinci B. and Caldas C. (2006) Automating the Task of Tracking the Delivery and Receipt of Fabricated Pipe Spools in Industrial Projects. *Automation in Construction*, 1(2), 166–177

Sullivan, G., Barthorpe, S. and Robbins, S. (2010). Managing *Construction Logistics*. UK: WILEY-BLACKWELL

Tabachnick, B. G., &Fidell, L. S. (2001). *Using Multivariate Statistics*. Allyn and Bacon Pearson Education Company Boston: USA.

Tebeje, Z., (2016). Construction Projects Delay and Their Antidotes: The Case of Ethiopian Construction Sector. *International Journal of Business and Economics Research*, Vol. 5, No. 4, 2016, pp. 113-122. doi: 10.11648/j.ijber.20160504.16

Trochim, W. (2006). *The Research Methods Knowledge Base* (2ndEd.). Atomic Dog Publishing, Cincinnati, OH.

Thrulogachantar, P.,& Zailani S. (2011). The influence of purchasing strategies on an empirical study in Malaysia, *Journal of Manufacturing Technology Management* 22(5), 641-663

Tuttle, T. Heap, J. (2008). Green Productivity: Moving the Agenda: *International Journal of Productivity and Performance Management* 57, (1) 93-106.

UNDP (2014), *Ethiopia: quarterly economic brief*, Accessed on http://www.et.undp.org/content/dam/ethiopia/docs/Economic%20Brief-%20Third%20Quarter-2014.pdf.

Vrijhoef. R., Koskela. L., (2000). The four roles of supply chain management in construction*: European Journal of Purchasing & Supply Management*, (6), 169-178.

Wegelius-Lehtonen, T. (2001). Performance Measurement in Construction Logistics*:* *International Journal of Production Economics*, 69, 107-116

Yimam, A.H, (2011). *Project management maturity in the construction industry of developing countries (the case of Ethiopian contractors)*, University Of Maryland, College Park, 299 pages

APPENDIX I: QUESTIONNAIRE SURVEY

Assessment of Construction Logistics Operation Challenges and evaluating effects on performance (In the case of grade one contractors)

All answer will be kept confidential. Only group results will be presented or documented, not individual answers. Your help with this research is strictly voluntary. You do not have to answer any questions you don't want to. Return of an answered survey will indicate your consent to participate in this study. the questionnaire is partially adopted from (Fadiya, Georgakis, Chinyio, Nwagboso, 2015)

SECTION A: BACKGROUND OF RESPONDENT (Please tick √ options where applicable)

Name of company ……

Department ……

Work experience …….. (Years)

E-mail …….

1. **What of the following type of contractor is your company?**
   a. General Contractor ☐ b. Building contractor ☐ c. Road Contractor ☐
2. **Does your firm have a logistics department?(Please tick √ one box)**
   a. Yes ☐ **b.** No ☐

SECTION B: FIRM PERFORMANCE (Please tick √ options where applicable)

1. **Year of establishment of the company?**
   a. Within the past 5yrs ☐ b. Within the range of 5-10yrs ☐ c. >10yrs ☐
2. **How many employees does your firm have?(Please tick √ one box)**
   a. <10 staff ☐ **b.** 11-50 staff ☐
   c. 50-249 staff ☐ **d.** >250 staff ☐
3. **Please give an indication of the size of your company in terms of annual revenue on the previous year** (Please tick √ one) in Birr
   a. 5m - 50m ☐ b. 50m - 100m ☐ c. 100m-350m ☐ d.> 350m ☐
4. **Please indicate the extent to which your firm has shown a realization towards improved performance in the logistical area, over the last 5 years (*1 (Not at all), 2 (Small extent), 3 (Moderate extent), 4 (Great extent) and 5 (very great extent)*).** (Please tick √ box as appropriate)

a. ☐ b. ☐ c. ☐ d. ☐ e. ☐

Performance in terms of Market share

5. **Rate your firm's growth in the market share over the past five years (*1 (Not at all), 2 (Small extent), 3 (Moderate extent), 4 (Great extent) and 5 (very great extent)*).** (Please tick √ box as appropriate)

a. ☐ b. ☐ c. ☐ d. ☐ e. ☐

6. **Rate the overall performance of your firm (*1 (Not at all), 2 (Small extent), 3 (Moderate extent), 4 (Great extent) and 5 (very great extent)*).** (Please tick √ box as appropriate)

a. ☐ b. ☐ c. ☐ d. ☐ e. ☐

Performance in terms of Firms profits

7. **Rate your firm's growth in profitability over the past five years (*1 (Not at all), 2 (Small extent), 3 (Moderate extent), 4 (Great extent) and 5 (very great extent)*).** (Please tick √ box as appropriate)

a. ☐ b. ☐ c. ☐ d. ☐ e. ☐

8. **Rate your firm's return in asset growth over the past five years (*1 (Not at all), 2 (Small extent), 3 (Moderate extent), 4 (Great extent) and 5 (very great extent)*).** (Please tick √ box as appropriate)

a. ☐ b. ☐ c. ☐ d. ☐ e. ☐

Performance in terms of Customer Satisfaction

9. **Do projects get finalized with the amount that was agreed upon? Yes/No_____**
10. **If your answer to the above question is no to what extent do most projects escalate? (*1 (Not at all), 2 (Small extent), 3 (Moderate extent), 4 (Great extent) and 5 (very great extent)*).** (Please tick √ box as appropriate)

a. ☐ b. ☐ c. ☐ d. ☐ e. ☐

11. **Do projects get finalized within the contract period? Yes/No_____**
12. **If your answer to the above question is no to what extent do most projects take more time than contract time? (*1 (Not at all), 2 (Small extent), 3 (Moderate extent), 4 (Great extent) and 5 (very great extent)*).** (Please tick √ box as appropriate)

a. ☐ b. ☐ c. ☐ d. ☐ e. ☐

13. **How do you rate the escalation and elongation to the duration of the projects relate to the performance of logistical operations? (*1 (Not at all), 2 (Small extent), 3 (Moderate extent), 4 (Great extent) and 5 (very great extent)*).** (Please tick √ box as appropriate)

a. ☐ b. ☐ c. ☐ d. ☐ e. ☐

Section C: Rating logistical practices employed in Grade One Contracting Companies.

Please rate the following statements in terms of their weight as to their applicability/occurrence in the firm i.e. in the construction sites as well as the head office (*1 (None), 2 (Little), 3 (Moderate), 4 (Great) and 5 (Extreme)*). (Please tick √ box as appropriate)

1. **Material Procurement Coordination Problems**

a. Late delivery of materials

1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐

b. Incomplete delivery

1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐

c. Materials being ordered too early

1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐

d. Sudden change of lead-time

1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐

e. Materials call-off on short notice

1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐

2. **Rate the following statements in terms of waste reduction**

a. Prevention of materials abandonment which mitigates waste.

1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐

b. Prevention of materials from damage due to temperature and humidity such as cement hardening.

1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐

c. Prevention of materials from damage due to vandalism

1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐

d. Procurement such as ordering error and supplier's error due to inaccurate data

1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐

e. Design such as changes to design and contract document errors

1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐

f. Materials handling such as damage during transportation, off-loading, on-site distribution and inappropriate storage

1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐

g. Operation such as tradesperson's error and equipment malfunction

1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐

h. Damage due to weather such as temperature and humidity.

1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐

i. Security such as damage on construction site due to vandalism.

1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐

k. Materials misplacement on site

1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐

l. Residual such as off-cuts from cutting materials to length and packaging

1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐

m. Others such as lack of site materials control and waste management plans

1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐

3. Rate the following statements in terms of accident reduction

a. Systems that recognize identities of operatives enabling site managers issue warnings to individuals in collision accident prone zones.

1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐

4. Rate the following statements in terms of misplacement reduction

a. Continuous awareness of materials location on site which prevents misplacement

1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐

b. Logistics system with ease of installation and application.

1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐

5. Rate the following statements in terms of theft reduction

a. Recovery of stolen equipments.

1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐

b. Prevention of intrusion into construction site

1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐

c. Theft prevention being provided at relatively less expensive cost

1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐

d. Remote immobilization of plant to prevent theft or enhance recovery.

1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐

e. Covert security measure and unique identification of stolen plant.

1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐

f. Residual (i.e. depreciated) value or replacement (i.e. 'new-for-old') value of stolen plant

1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐

g. Emergency cost e.g. repair of damaged plant storage area

1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐

h. Short term hire of replacement plant

1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐

i. Loss of productivity and output

1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐

j. Increased labour to recover negative impact on work programme

1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐

k. Loss of client goodwill

1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐

l. Administration of the process e.g. dealing with police, reporting and recovery

1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐

m. Insurance policy excess and increased insurance premiums

1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐

n. Social cost such as trauma, de-motivation and stress

1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐

o. Lack of effective plant security measures

1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐

p. Mobility of construction plant and equipment

1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐

q. Compact size of construction plant and equipment

1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐

r. Location of construction site

1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐

6. Rate the following statements in terms of delivery improvement

a. Ability to track the location of delivery vehicles en-route construction site.

1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐

b. Planning of alternative routes for delivery vehicles en-route construction site

1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐

c. Instant identification of multiple materials delivered on site which improves delivery vehicle turn around

1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐

Section D: Factures that can be considered as criteria's to measure the performance of a construction logistics system and ranking of those criteria's in order of importance (Please tick √ box as appropriate)

NB: Two ratings are required in this question:

1. **Rating of criteria in terms of their importance (***1 (No Importance), 2 (Little Importance), 3 (Moderate Importance), 4 (Much Importance) and 5 (Extreme Importance)***)**

a. Cost

1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐

b. Waste Reduction

1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐

c. Accident Reduction

1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐

d. Misplacement Reduction

1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐

e. Theft Reduction

1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐

f. Delivery Improvement

1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐

g. Time Saving

1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐

h. Data Accuracy

1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐

2. **Ranking of the same criteria in order of importance.**

Please rank the attributes in order of importance relative to each other (*1* being *most important* and *8* being *least important*)**.**

a. Cost……..

b. Waste Reduction……..

c. Accident Reduction……..

d. Misplacement Reduction……..

e. Theft Reduction……

f. Delivery Improvement …….

g. Time Saving ……

h. Data Accuracy……..