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**IMPORTANCE OF LOGISTICS MANAGEMENT IN
CONSTRUCTION TECHNOLOGY**

BY

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Study on Importance of Logistics Management in Construction Industry/ In Case of Addis Ababa Housing Development Project Office

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ACRONYM

GDP : Gross Domestic Product

MDG : Millennium Development Goals

UNEP : United Nations Environment Programme

PASDEP : Plan for Accelerated and Sustained Development to End Poverty

MSE : Micro and Small Enterprise

JIT : Just In Time

CLM: Council of Logistics Management

HCB : Hollow Concrete Block

AAHDPO : Addis Ababa Development Project Office

PMI: Project Management Institute

MLP: Material Logistic Plan

Abstract

This study concerns logistics management at the construction projects. Most construction projects suffer from poor logistics management, activities on site which indicates the need for improving construction logistics. Hence the purpose of this paper was to investigate, through site observations and interviews, the current logistics situation on the construction site and to suggest possible solution for improving construction logistics in one of the mega project in the country, Addis Ababa Housing Development Project Office. The main focus of this study was on material deliveries and handling, distribution and production procedure in the project office.

The study concludes, due to poor logistics planning, a lot of wastage is produced which leads to unnecessary expense and delay of project, which could be one of the causes for increment of final cost of the houses. The study showed that, by implementing other logistics solutions, and technique, it is possible to reduce the waste and storage costs.

The study actualizes the importance of construction logistics which is often underestimated. The study also showed what consequences ineffective logistics solution could have on the construction project. While, on the opposite, proper logistics planning gives benefits to the project.

Key words: Construction industry, Construction logistics, Management system

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Chapter One

Introduction

Most of construction projects are delivered at least a few days or months or even years late. As I was working in one of the public projects in Addis Ababa, at Addis Ababa Housing Development Project Office, as senior supervisor and quality control officer, I observed projects in different sites took a lot of time to be delivered, as long as two years and above, beyond expected completion time. Because of this, the stakeholders, the client, contractors, the society suffers a lot. Many reasons have been raised for project delay and cost overrun. For example, incomplete design, contractor's capacity, design change order, climate condition, finance, etc. But, problems caused by poor logistics management are not taken as one of the main reason for projects delay. Therefore, I take this as an opportunity to study influence of construction logistics in the project office, in relation to project delay and cost overrun.

Construction industry makes significant contributions to the socio-economic development process of a country [1]. Its importance emanates largely from the direct and indirect impact it has on all economic activities. It contributes to the national output and stimulates the growth of other sectors through a complex system of linkages. It is noted that about one-tenth of the global economy is dedicated to constructing and operating homes and offices (UNEP, 1996). It further observes that the industry consumes one-sixth to one half of the world's wood, minerals, water and energy. It contributes to employment and creates income for the population and has multiplier effects on the economy. The construction industry employs large unskilled labor. Throughout the developing world, the majority of employees in the industry are unskilled.

The construction industry is one of the most complex industries. The construction process consists of several phases where many different participants are involved during each phase. The uniqueness of this industry is that it is a project based industry, where each construction project could be considered as a temporary organization. [2]

The construction industry has important contributions to the Ethiopian economy, as demonstrated by its share in the GDP. For instance, the share of the sector in the total GDP averaged at about 5.2 percent in the period 2002/03- 2006/07. The construction industry also

contributes to the generation of revenue for the government. The rental income tax is one of the major revenue sources within the construction industry to the government. The rental income tax which was Birr 15.2 million in 1997/98 has increased to Birr 78.3 million in 2004/05 but lowered to Birr 32 million in 2005/06 generating nearly half a percentage point of the total government revenue.[1]

Some studies and theses have been done through the years. For example, a study by Abadir H. Yimam shows how the significance of construction industry for a country by saying, construction industry plays significant role in the economy of developing countries. For example, in many developing countries, major construction activities account for about 80% of the total capital assets, 10 % of their GDP and more than 50% of the wealth invested in fixed assets. In addition, the industry provides high employment opportunity, probably next after agriculture. Generally, “The construction industry in developing countries failed to meet expectations of governments, clients and society as a whole”. [3]

As we approached the end of the twentieth century, output from the construction industry worldwide was estimated at around \$3,000 billion per annum. The developing countries have increased their share of world output, from 10 per cent in 1965 to 23 per cent in 1998, but three-quarters of output, by value, is still generated in the industrialized countries, with only one-quarter originating in the developing countries. [5]

Logistics involves the strategic and cost-effective storage, handling, transportation and distribution of resources. It is an essential process that supports and enables the primary business activity, like the construction of a building in a city, to be accomplished. Effective logistics management can lead to the effective execution of a construction project. Nevertheless, construction logistics management is not an easy process. Construction facilities become more complex and technological advanced and the markets more dynamic and fragmented. The outsourcing and subcontracting increases the number of organizations involved in the construction supply chain. The result of the technical complexities and the number of participants in a construction project makes the management and optimization of logistics chains quite difficult. (Dimitris Papaprokopiou, 2010), [4]

Due to its nature, the construction industry is one of the most challenging to work in. The information flow in construction is complex and the process is affected by various factors. One of these factors is logistics which is defined as the management of the flow of materials, tools and equipment from the point of release to the point of use. (European Construction Institute, 1994). As the construction industry is constantly developing, production costs are rising steadily as well, but the production efficiency and the way of working have not developed that much.

Improving logistics by reducing activities that do not add value to the final product could be one possible solution to lower the production costs. Activities that do not add value to the final product are defined as “waste” which is directly related to the logistics issue. Studies show that it is possible to reduce the production costs with 30-35% by minimizing the total amount of waste.[8]

Materials supply is an important element of operation of construction enterprises and thus a factor affecting the quality of construction projects. The level of materials costs reaches up to 70% of total construction cost estimations, therefore any actions towards rationalization of size, structure and organization of material consumption, delivery, and planning are important in terms of project efficiency and require proper management. [9]

Statement of the problem

In most of private construction companies in Ethiopia including government organizations, logistics is not managed scientifically or it is practiced traditionally. This is because the sector is not given enough attention. Construction logistics has vital influence in the construction projects, in building projects, in relation to project delays and cost overrun. Therefore, this study will be conducting an investigation in one of the mega projects in Ethiopia underway for the last ten years, condominium housing projects, and how logistics management practice in the project office is influencing the overall project.

Research objectives

The main objective of the paper is to investigate how logistic management can affect the overall project in the construction industry in Ethiopia.

The research has the following specific objectives:

- To review current logistic management system of Addis Ababa Housing Development Project.
- To ascertain the feasibility of current logistic management system in Addis Ababa Housing Development Project.
- To assess factors affecting the current logistic management system from the data gathered in the Agency's office.
- To develop set of recommendable alternative logistic management systems to meet the expected management system.

Research Questions

The following research questions are designed to address the research objectives.

- To what extent logistics management practice in Ethiopia can affect the construction industry?
- Is there qualified manpower in logistics management system that can satisfy the industry? And is the subject given sufficient attention?
- How does the participation of Micro and Small Enterprises in the construction industry can affect the overall project?
- Are there any policies in relation to logistics management system so that it improves the current construction practice in the country?

Research Significance

The research will have significant inputs for the industry, especially, nowadays Ethiopia is becoming one of the fast growing countries in Africa, and one of the parameters for a country's development is the level of construction in different infrastructure, so most of the national budget is assigned in the construction industry. And this will show poor logistic management in the construction industry means a significant loss for the country. Therefore, this research will give

professionals in construction area to have serious thought about what is at stake. And, the research also encourages other researchers to investigate further for improved logistic management system in the industry.

Projects are planned by considering specific resources like finance, required raw materials, material logistics system, skilled and non-skilled manpower and limited time table. As widely believed projects involve large amount of money and a lot of stockholders like clients, contractors, consultants, suppliers, manufacturers, public, etc. Most projects take time and money more than they are required because of different reasons. And their delay cost a lot of money, for the client, the contractors well as the end user. So I am inspired that doing a study in one of the major variables in delaying in projects, inefficiency in logistics management.

The study also improves the understanding of people in the managerial position to give emphasis and spend enough amounts of money and time in planning and implementation of logistics management system that can save a huge amount of national budget.

Limitation of the study

The limitations with this research are:

- The study is based on Ethiopian's housing condominium construction practice.
- The study is based on one case study on Addis Ababa Condominium Housing Project.

Chapter Two

Literature Review

2.1 Projects and Their Management

2.1.1 Project and Project Management: Definition

Many scholars define projects in different ways, Abadir H. Yimam, 2011[3] research defines a project as: A temporary endeavor (that has definite beginning and end time) undertaken following specific cycle of Initiation, Definition, Planning, Execution and Close to create a unique product, service, or result through novel organization and coordination of human, material and financial resources. (Project Management Institute (PMI), 2004). (Muriithi& Crawford, 2003), (Stanleigh, 2007).

Similarly a number of definitions are given for project management, 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 ,service or result of the project on time, within authorized cost, and to the required quality and requirement, and to the satisfaction of participants.(Chartered Institute of Building , 2002), (Fewings, 2005), (Carmichael, 2004)

2.1.2 Nature and Characteristics of Construction Projects

Construction projects are managed indifferent ways from the management of other projects. (Abadir H. Yimam, 2011)[3]research indicates that the differences mainly stems from the nature and characteristics of construction projects. Some of them: they are usually capital intensive, complex; and require significant management skills, involvement and coordination of a wide range of experts in various fields. (Chartered Institute of Building, 2002). They also must address the geography and conditions of the project site and the relation of the project to the environment. (Project Management Institute (PMI), 2007). Projects are subjected to a variety of laws and regulations that aim to ensure public safety and minimize environmental impacts.

(Bennett, 2003). And also compared to most other industries, construction projects involve relatively intensive labor use, and consume large amount of materials and physical tools. (Jekale, 2004).

2.2 Logistics Management and Construction Project

2.2.1 Project and construction logistics management: Definition

Logistics

The concept of logistics in its modern form dates back to the second half to the 20th century. Since then, it has developed into a widely recognized discipline of significant importance to both theory and practice. This development is not yet completed, however, and the debate on the true meaning of logistics and its exact specifications is still ongoing: Especially in the logistics industry it becomes apparent that neither a standardized logistics concept nor a consistent notion of logistics exists. While some reduce their understanding to simple transporting-, handling-, and warehousing operations, others view logistics more broadly as a management function. Logistics literature supports this finding of notional heterogeneity with a multitude of different logistics definitions. Especially recognized is the 2005 definition by the Council of Supply Chain Management Professionals (CSCMP 2005, p. 63), where logistics management is seen as part of supply chain management (SCM). It is the part “... that plans implements, and controls the efficient, effective forward and reverse flow and storage of goods, services, and related information between the point of origin and the point of consumption in order to meet customers’ requirements.” This definition directly refers to the importance of economic considerations (efficiency, effectiveness) and at the same time underscores the functional character of logistics.[10]

Logistics is often defined as managing the supply chains, the latter being a network of organizations linked by material and information flows bounded with a product (project) life cycle (from the procurement of raw materials through processing and handling the products and the final product, distribution and sales to the end-user and finally, to waste utilization). All the processes and relations concerning the above flows form a logistic system. A company, being a member of a larger supply chain of suppliers and customers, has its own system of internal logistics also in the form of supply chains (Anna Sobotka, 2005).[7]

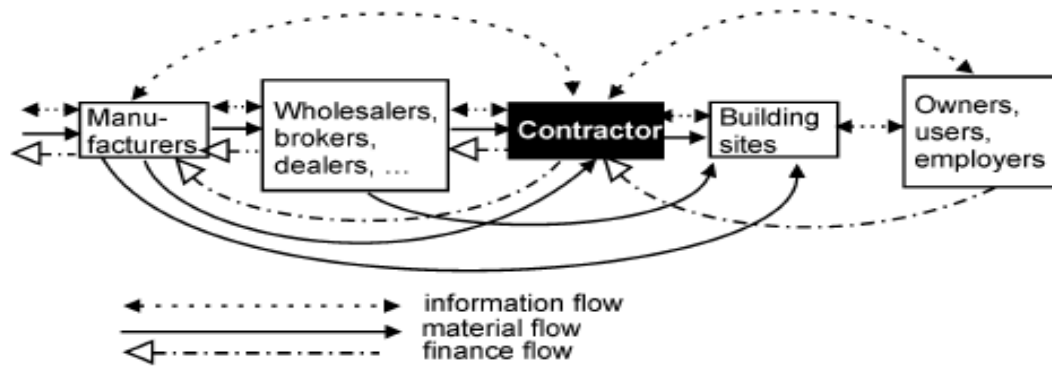


Figure.1 A building contractor within a supply chain of materials and participants of a project.

The Council of Logistics Management (CLM) (1992), gives the most recent definition of logistics as “the process of planning, implementing, and controlling the efficient, effective flow and storage of goods, services, and related information from point-of-origin to point-of consumption for the purpose of conforming to customer requirements.” In construction terms logistics can be understood as a multidisciplinary process that seeks to guarantee at right time, cost and quality:

- ✓ material supply, storage, processing and handling;
- ✓ manpower supply;
- ✓ schedule control;
- ✓ site infrastructure and equipment location;
- ✓ site physical flow management;
- ✓ management of information related to all physical and services flow.

This is achieved through planning, organizational, directing and controlling activities before and during the construction works.[11]

Abdulmohsen Almohsen and Janaka Ruwanpura[6] shows that construction logistics can be defined as “the management of the flow of materials, tools, and equipment (and any related object) from the point of discharge to the point of use or installation (The European Construction 1994). Bringing together and coordinating the management of these three vital components between the project’s principal parties would increase productivity substantially. On a construction site, these components must be properly managed in order to ensure a project’s success (Kini 1999; O’Brien 1989; Stukhart 1995).

Ineffective management, on the other hand, will result in conflicts between these aspects. These conflicts will ultimately cause project delays, and cost overruns. 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. 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 (Agapiou et al. 1998).

2.2.2 Nature and Characteristics of logistics in Construction Projects

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.[12]

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.[11]

Reports and reviews on the UK construction industry have highlighted the inefficiencies and waste of the industry due to poor logistical performance. The “Improving Construction Logistics” report published by the Strategic Forum for Construction Logistics Group (2005) [2] recognizes the following factors preventing the industry from properly addressing logistics:

- ✓ The lack of incentive to change, as there is no real “problem owner”
- ✓ Construction projects seen as one-off and as a result difficult to optimize logistics for long term benefit
- ✓ The fragmented nature of construction industry and the lack of direct employment
- ✓ Inadequate advanced planning of projects and short lead times
- ✓ The lack of cost transparency in the construction process that hinders the identification of potential savings from improved logistics
- ✓ Inadequate information flow
- ✓ Lack of trust, confidence and understanding of the constraints of the supply chain
- ✓ Clients believe that project costs already include for appropriate logistics resources to be committed to projects.

The improper consideration of logistics in a construction project may result to a high proportion of trucks moving around the road network either empty or with part-loads of materials, traffic congestion due to trucks that arrive on site and have to wait to gain access or be unloaded and skilled craftsmen that often use their skills for less than 50% of their time on site due to their involvement with non-skilled tasks such as unloading a truck or moving products around site.[4]

2.2.2.1 Factors contributing to inefficient logistics in the construction industry

The following factors, as currently practiced, contribute to inefficient logistics in the construction industry (Strategic Forum, 2005): [2]

- Short-Term nature of construction process: Construction work is seen as a one-off job in which teams are built for a short period of time. This makes it difficult to build optimized logistics system in a way that is possible in manufacturing and retail industries. Each project is regarded as unique; every project is a prototype and because each site is different, hence the design is different.
- Fragmentation of activities within the construction process: The various teams, such as design team and construction team, involved in construction process are fragmented. This may cause suppliers not to fully understand the implications of design, materials

and components choices making them, sometimes, to supply wrong materials and/or wrong quantities of material to site. The primary focus of logistics functions in construction is to improve **coordination and communication** among project participants during the design and construction phases.

- Lack of transparency in costs: Costing in construction is less transparent than in other industries like retail and manufacturing because decisions are often based on cash flows. The way costs are recorded does not portray the benefit of logistics in removing non-value-added activities from construction process.
- Inadequate tracking facilities on site: There is lack of adequate and real-time tracking and monitoring facilities for materials and equipment on site (Jang and Skibniewski, 2008). At site level, research has shown that very few major contractors have any systems, either paper or computer-based, for tracking and controlling materials. Hence, they have almost no data that give any information on the quantities, values or location of materials on site, or anywhere else in the supply chain (Hill and Ballard, 2001). Inadequate tracking facilities can also affect the quality of construction because a material such as ready-mixed concrete requires timely delivery and placing in the construction area. Therefore, concrete mixer trucks require real-time positioning and tracking. One key objective of that will be to automatically record important events of the truck so as to derive operations data such as travel times along designated travel routes, on-site queuing times and unloading times. Such data will provide valuable input for keeping quality control, analysis of logistical efficiency of ready-mixed concrete deliveries and simulation modelling of concrete production-delivery-placing operations for productivity improvement (Lu *et al.*, 2007)
- There is no clear definition of responsibility and authority for logistics, expected in a supply chain, in the construction industry.
- There is lack of proper performance measurement for construction logistics e.g. delivery performance, stock availability, timeliness of waste removal, quality and site storage quantity. Because of competitive bidding in the construction industry, the lowest bidder gets the contract and the project is rejected or accepted based only on conformance to

technical specification. Other performance measures which relate to the process itself are then neglected. Therefore, the construction industry has to find new process oriented approaches to improve its operations.

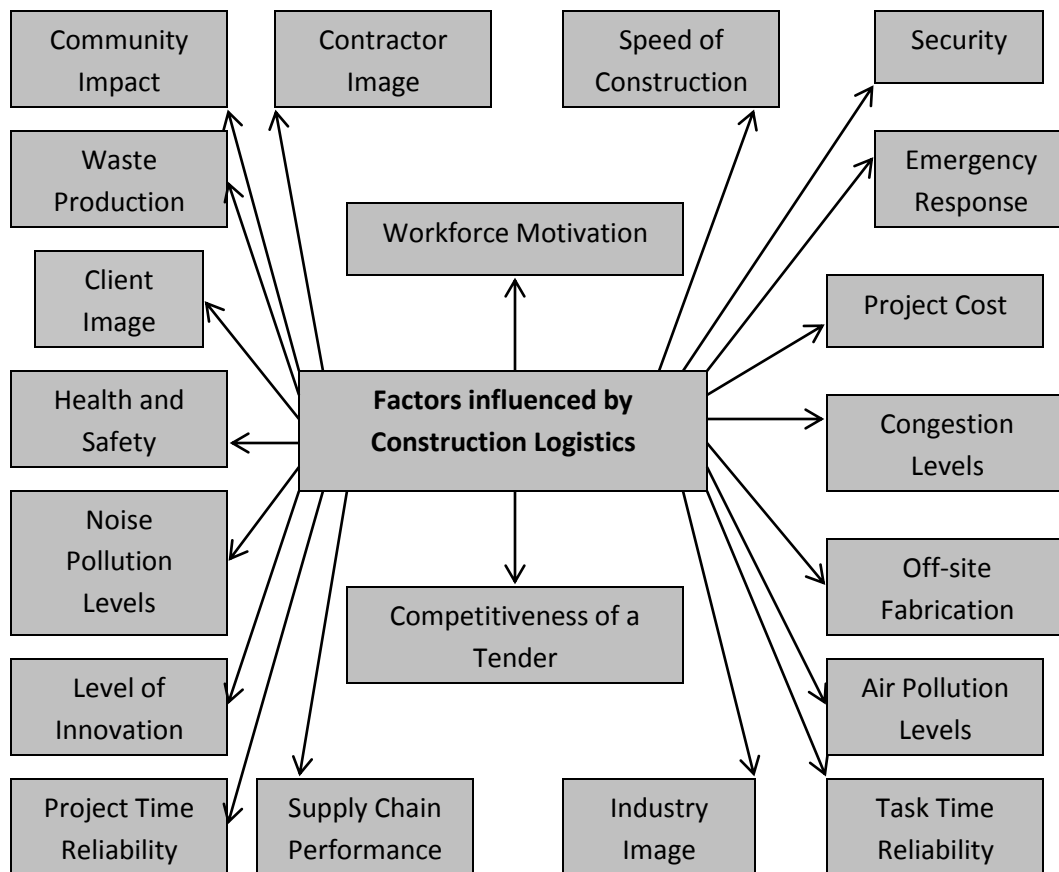


Figure2: Factors influenced by Construction Logistics (Source: Sullivan *et al.*, 2010)

2.2.2.2 Effect of inefficient logistics in the construction industry

As consequences of current poor logistics practice in the construction industry, the following effects have been identified:[13]

- **Materials Loss:** A large quantity of construction materials is lost to damage and/or theft as a result of improper storage, poor handling, wrong transportation carrier choice and excess materials and components that could have been optimized right from the design stage. The UK

construction industry generates a staggering over 70 million tons of waste every year (Kwan, 2001)

- **Delay in construction project delivery:** A lot of quality time will be wasted when materials run out of stock because construction activities may have to stop while waiting for the next delivery of materials. One of the causes of construction delay is delivery lateness. Also, the manual process of assessing materials at the point of delivery on construction site is time consuming (Sullivan *et al.*, 2010).
- **Operatives/plant collision:** Collision accident is the second highest cause of fatality on site after falls from a height. 248 fatalities were recorded from 1996/97 to 2008/09 (HSE, 2010).
- **Inaccurate data:** One of the prevailing problems of materials storage is the inaccuracy of information regarding inventory, storage location and generation of inaccurate reports (Jang and Skibniewski, 2008; Poon *et al.*, 2009).
- **Excessive cost of construction:** Poor logistics makes the cost of construction to be excessively high because excess supply of materials, theft and materials damage are non-value-added costs (Navon and Berkovich, 2005).
- **Poor image of the construction industry:** Poor logistics can result in large amount of waste being removed from the site and a lot of construction vehicles move about empty or half-empty. These contribute to environmental pollution and degradation. Also, materials delivery vehicles packed in inappropriate places outside the construction site do not give a good impression about the construction industry (Strategic Forum, 2005).

2.2.2.3 Requirements of an efficient construction logistics

Construction logistics should be designed to deliver client's needs in the most efficient way possible and it is a process that should have the following characteristics [13]

- **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.

2.2.2.4 Path to the improvement of construction logistics

Three major resources that need to be managed and are used to achieve efficient construction logistics and overall success of a project are (Hill and Ballard, 2001):

1. **People:** People drive change and they are needed to be trained and well managed so that they can contribute their best to the success of the project.
2. **Process:** Processes create the environment in which people work and also form the basis of opportunity for improvement.
3. **Technology:** Technology gives people the tools to carry out processes and improve processes

2.2.3 Delays, cost overrun in projects and construction logistics

One of the problems observed in construction project is delay. Delay occurs in almost every construction project and the magnitude of delay varies considerably from project to project. Some projects are only a few days behind the schedule: some are delayed over a year. So it is essential to define the actual causes of delays in order to minimize or if possible avoid the delays in any construction projects.

Normally, most construction projects comprise of two distinct phases; the pre-construction and the construction stages. Y. Frimpong, J.Oluwoye and L. Crawford [14] noted that —delay and cost overruns occur in both phases however, major causes of project overruns usually take place in the construction phase

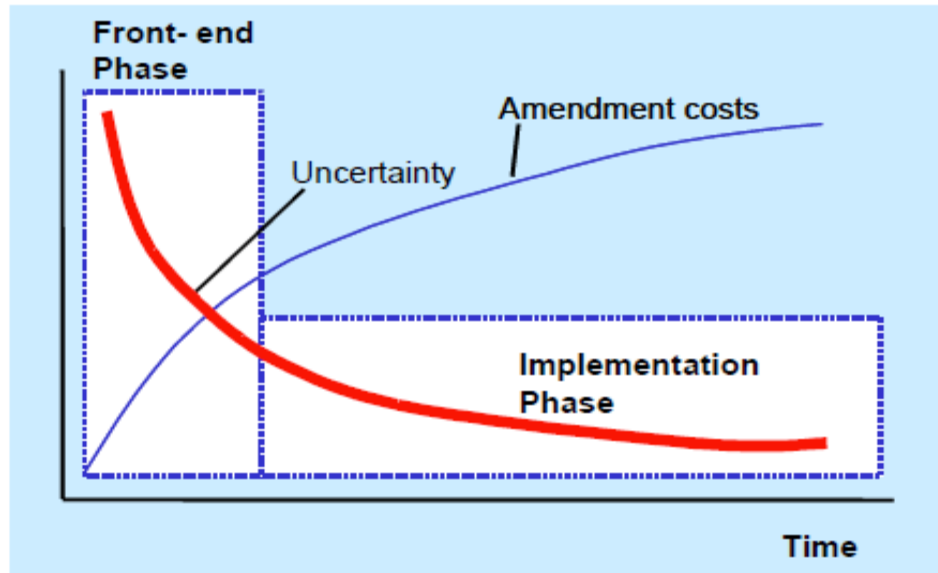


Figure 3. The Implementation Phase Is Characterized By High Amendment Cost. Source: Olsson Et All (2003)

There are a number of reasons for a project to be delayed. JTRP Technical Reports, 2004 [15] indicated that Majid and McCaffer utilized findings from eight studies related to construction delays. This involved 900 construction contracting organizations from both developed and developing countries between 1964 and 1995. The study results included the information which provides the main reasons for non-excusable delays sorted by frequency showing that “late delivery or slow mobilization” is the main factor that leads to contractors’ poor performance as it was ranked first in the eight studies.

The report also indicated regarding cause of cost overruns in the project, the three main causes were identified as contractor related problems, material-related problems, and owners’ financial constraints

2.3 Policy in Logistics management system

Background

Logistics involves the strategic and cost-effective storage, handling, transportation and distribution of resources. It is an essential process that supports and enables the primary business activity, like the construction of a building in a city, to be accomplished. Effective logistics

management can lead to the effective execution of a construction project. Nevertheless, construction logistics management is not an easy process. Construction facilities become more complex and technological advanced and the markets more dynamic and fragmented. The outsourcing and subcontracting increases the number of organizations involved in the construction supply chain. The result of the technical complexities and the number of participants in a construction project makes the management and optimization of logistics chains quite difficult. [4]

Nowadays, it is familiar to hear about wastes and delays and cost overruns in projects, especially in construction projects like building, roads, irrigation and other projects. Considerable amount of waste is incurred in the industry as a result of poor logistics'. The report also indicates research by BSRIA and this report also supported by another research by Yuan Fang and S. Thomas Ng, in the 10 years since 2004 has shown that on average 10% of the working day of site operatives in all trades is lost due to waiting for materials, or collecting materials, tools, and equipment. Given that site operations account for about 30% of construction costs, this would suggest that this inefficiency alone is adding about £3billion to the annual cost of construction.[2]

It is clear that there is no typical or best system of project logistics. In a longer perspective each system must be readjusted to the external conditions or even completely redesigned. New, effective solutions have to be implemented to reach the expected efficiency of a project. Currently, the employer dominates the highly competitive construction markets and his decisions are binding for any actions of designers, contractors and suppliers, which reflects in the network of relations of project participants. The ultimate relation model depends also on the delivery system of the project.[7]

Material Logistics Plan Good Practice Guidance [2] states, typically 10 to 15%, but up to 45% for some materials of the total materials ordered for construction projects are either unused or end-up as waste. A 35% reduction in material wastage could be achieved by adopting more efficient logistic practices and the key to achieving this is the development and implementation of a robust Material Logistic Plan (MLP). These plans are an important tool for the construction sector to help ensure the right materials are in the right place at the right time in the right

quantity. This is achieved through rigorous attention to design, materials specification, estimating and ordering as well as preventing the generation of waste from damaged, lost or surplus materials e.g. from poor storage or resulting from multiple handling of materials.

The Good Practice Guidance [2] also explains logistics can be handled by employing dedicated, trained logistics specialists who can provide valuable experience and knowledge to a construction project. Logistics specialists can either be employed internally by the client or main contractor or can be hired from specialist external organizations for either a key task or for the entire duration of the project. Nowadays, there are a number of logistics techniques that are practiced and each technique is helpful for specific site.

Regarding the project logistics, four basic models of supply systems are possible:

- I. Independent supply chains for individual contractors, where selection of suppliers, supply planning and scheduling is the duty of each contractor,
- II. centralized supply system managed by general contractor or other party managing the whole project, by means of their own logistics departments,
- III. centralized supply system managed by an external logistics company,
- IV. Combination of the above.

Supply systems based on independent chains or services of an external logistics company are possible in any type of project delivery systems. In the case of delivery systems with a general contractor or other party that disposes of necessary logistic resources, it is reasonable to use them to create and manage the whole project supply system, such party benefits directly from any improvement of logistics. Integrated logistics for the whole project means the possibility of optimizing supply chains and coordinating deliveries, which is significant for sizeable construction projects that involve many contractors working in confined space. Shifting responsibility for supplies to many subcontractors may result in the building site congestions, excessive expenses and delays.

Business organizations offering service in the field of logistics may existing the form of independent companies or be created especially for the needs of construction project. According to their scope of activities they may take over all the logistic processes within the project's life

cycle or focus on some functions, e.g. supply control, transport and warehousing. The complete logistic service of construction project may comprise:

1. Developing logistic concepts for designing and planning:

- ✓ feasibility study of logistic alternatives,
- ✓ plans of logistic processes and information flows,
- ✓ economic efficiency study,
- ✓ environmental impact assessment.

2. Developing strategic guidelines for bidders:

- ✓ preparing bidding requirements,
- ✓ assisting bidders and supervision over their logistic solutions,
- ✓ Evaluating bids, participating in contractors' selection.

3. Assisting bidders (potential suppliers, forwarders and contractors) in bid preparation:

- ✓ developing specific logistic solution to improve the quality of service,
- ✓ developing logistic standards for bid preparation.

4. Developing plans of the building site logistic and supervising their execution, integrating purchase, transport and execution of construction works:

- ✓ creating operational logistic centers servicing a complex of projects,
- ✓ implementing IT systems,
- ✓ constructing IT networks to improve information flows and to optimize them,
- ✓ implementing ideas of the supply chain management on the building site.

5. Controlling

- ✓ developing and implementing systems of quality assessment for logistic processes,
- ✓ recording feedback information on the effects of implementing integrated logistic systems.

6. Optimizing supply and purchasing process

- ✓ within the scopes of manufacturers, general contractors and subcontractors,
- ✓ Benchmarking logistic systems of other industries.

The scope of the above logistic services partly complements and partly overlaps the constituents of the logistic plan for the whole construction project life cycle

Logistics Techniques

As background some logistics techniques are presented in order to get better understanding of the logistics topic. There are different logistics techniques used by different companies in different countries. Some of these have been published and described by WRAP (2007) in the report Material logistics plan good practice guidance. These techniques follow below (Harker et al., 2007):

- Just-In-Time Delivery (JIT)
- Demand Smoothing
- On-site Marketplaces (MP)
- Pre-assembled and offsite fabrication
- Construction Consolidation Centres
- Information and Communication Technology (ICT) Systems
- Inventory Management Optimization (IMO)

Construction Consolidation Centers

Construction Consolidation Centers are centers that are used to supply and distribute materials to several construction projects. These centers provide safe and efficient material flows from supplier to the construction site which makes it an effective supply chain management solution. The initial idea with the concept was to supply construction projects in challenging environments such as overloaded urban areas. Construction Consolidation Centers distribute materials in a right time, to the right place and in the required quantity.

This is possible due to goods being combined from multiple part-loads to single shipments. This further contributes to better certainty of supply, reduced number of deliveries to site, reduced amount of stored materials and finely reduced waste. The figure below illustrates the concept of Construction Consolidation Center.

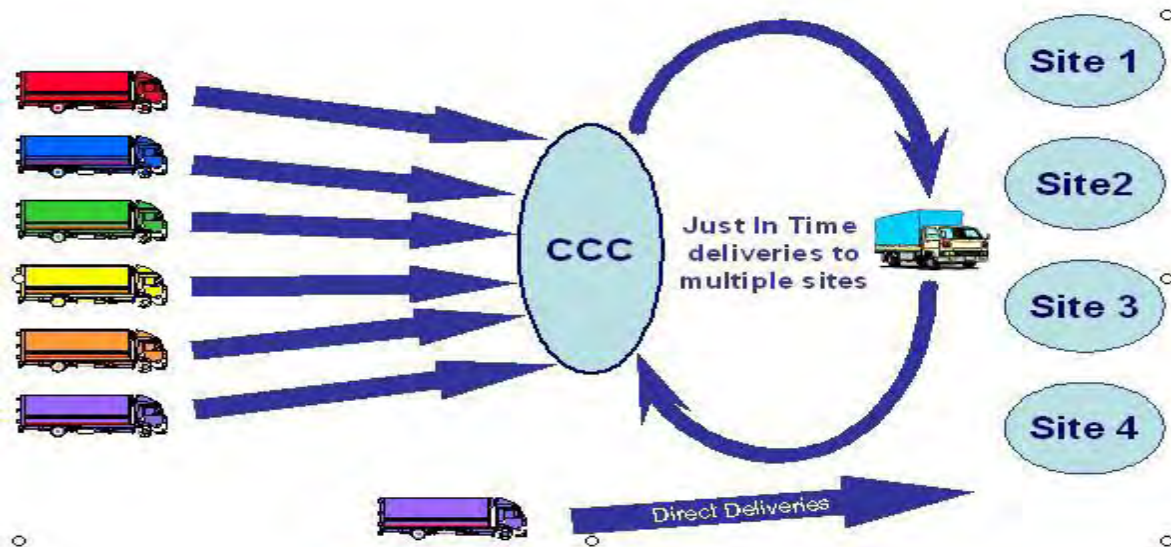


Figure 4. Construction Consolidation Center Model (Source: Waste & Resources Action Programme, Harker et al., 2007)

Just-In-Time Delivery

Just-In Time delivery relates to frequent deliveries in work packages or loads delivered in time for usage. That helps to perform the next task without suffering from any delay. The best way of doing that is through a Construction Consolidation Centers or by suppliers themselves.

Advantages with Just-In-Time deliveries are that it reduces on-site storage of materials, reduces the risk of damage of materials kept on site and even reduces risk for safety incidents.

Demand Smoothing

Demand smoothing is a way of looking on the project activity plan as the whole and identifying how those activities could be balanced in order to reduce the amount of resources needed for transport, materials and labor to manage the actual task. Demand smoothing could be done both by contractors and clients and at any level in the supply chain.

On-site Market Places

A temporary storage space for consumable materials and small tools is defined as On-site Market Place. This space is only for widely used and shared between contractors materials and tools and includes normally threaded rod, metal channel, nuts, anchor fixings, screws, bolts, small drill bits

and similar. Each contractor/subcontractor put their equipment and supplies to the MP for storage and distribution where a store-man is responsible when needed. When stocks become low they are refilled by the contractor individually or by the store-man who will order on their behalf.

With On-site Market Places, contractor/subcontractor will be sure where the required material is located, thus removing with that the need for individual small material storages on site. This results in to higher productivity and lower costs.

Pre-assembled and Offsite Fabrication

It is considered good practice when materials, where possible, arrive to site prepared as far as possible for their final use. For example, it could be prefabricated bathroom modules where everything is installed on the factory including tiles, bathtub, mirrors and cupboards. In a smaller scale it could be materials prepared in packages where each package includes the right material type and right quantity appropriate to a room or a floor. The main point with this is to reduce the amount of thinking time during production stage and to do most of the thinking earlier in the planning stage. Also, doing as much work as possible on the factory contributes to better quality, time saving and lower transport requirements.

Information and Communication Technology (ICT) Systems

ICT Systems are used to tag and track materials through manufacture, distribution, assembly and installation. Commonly referred to as Tag systems they help to manage material flows by using various forms of information technology. Radio frequency identification allows a rapid and accurate reading of tags on the site. This can be done from a distance and through many materials without a direct line of site being required. The Tag system allows the tracking of materials to the point of use and can provide considerable detail about what actually happens on-site. Suitable IT systems are relatively low cost and are becoming more widespread on construction sites.

Inventory Management Optimization (IMO)

IMO software systems are proactive planning tools to optimize inventory levels and the utilization of site /warehouse space and transport facilities. The software is designed to distribute materials to the right place at the right time, with supply measured against actual and forecast demand for each individual supply Centre. IMP software can model demand and supply scenarios, assess areas like lead time variability and undertake this analysis for multiple sites at the same time. IMO is more commonly used in the automotive industry but is becoming increasingly popular within the construction sector.

Third Part Logistics

On site construction logistics is an important and often underestimated topic within the construction industry. Third part logistics companies were the first who realized possibilities for financial benefits by focusing on logistics issues earlier in planning stage. The main point with third part logistics services is to create a safe, clean and effective workplace where contractors and subcontractors do not need to transport their materials. This gives more time for skilled workers to do valuable work what makes production more effective.

The most of material transporting on site is done during evenings meaning that lifts and cranes will be more available during the day time. When skilled workers come to their workplace next day, they can start working immediately without losing time for material handling. They have already got their materials in right quantity and on the right place (SvenskBygglogistik AB, 2012).[16]

According to study [11], facing all the challenges to develop logistics management some general guidelines are proposed as follows.

These guidelines are organized in three different levels: strategic, structural and operational. Although the companies have different production rationalization strategies it is believed that this proposition is valid for all of them.

Some **strategic guidelines** for logistics improvement are:

- ✓ Decision of customer service level desired, what means, desired stock levels and acquisition request attendance time;
- ✓ Decision of logistics goals to be reached in short, middle and longtime and performance indicators for them;

- ✓ Decision of relationship politics with suppliers, seeking supply chain process integration and partnering.

These strategic guidelines are general logistics management politics and procedures for decision making. The firm must understand what logistics is and must establish clear objectives to control its performance.

Structural Level

Structural level guidelines are related to structural organization of firms through a systemic view. Some of them are:

- ✓ Determination of agents' responsibilities in logistics process, especially the logistics coordination responsible. Here it is suggested two ways to structure logistics within a company's organization. The firms can operate to develop a new administrative function that will be responsible to coordinate these activities or can create a "logistic pole", which consists of a collective forum involving multiple agents for logistics coordination.

- ✓ Definition of an information system design and a mechanism for information exchange among actors of logistic process. Firms must seek in a later future to implement tools, which will permit information exchange in "real time".
- ✓ Definition of a general procedure for purchase practice (centralized or decentralized).

Operational Level

In an operational level it is necessary at least to develop the following guidelines:

- ✓ Definition of critical materials for physical flow rationalization;
- ✓ · Elaboration of supply plans considering the three hierarchical levels of planning. It should be developed a general initial plan, an intermediate plan for a shorter period and a commitment plan in a weekly basis for daily activities;
- ✓ Elaboration of site layout planning considering technical and economic feasibility of several internal transport alternatives for handling materials and previewing different arrangements for the different site phases;
- ✓ Planning of vertical transport equipment use in a daily schedule;
- ✓ Elaboration of designs for production for critical services;
- ✓ Incorporation of constructive system changes seeking to let them more rationalized or industrialized.

2.3.1 International Experience of Logistics Management System in the Construction Industry

Logistics management in Europe

1. Poland's experience

Logistic processes are present in various fields of activity within a company (purchase, production, sale etc.). Isolating and integrating logistic tasks performed by all organizational units of a company results in creating logistics departments that coordinate all the flows. Three basic models of logistic systems are to be observed in building companies:[7]

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

The study was focusing on a particular model of logistics selected according to the current organization structure of the company, its targets and management strategy. The actual size of company is also important. 97% of all Polish contractors employ up to 20 people and, therefore, have no logistics department in their structure. The semiformal model with a single specialist is preferred. Larger enterprises that used to have well-developed logistics departments tend to go back to the semiformal model (reduce the number of employees) or decide to outsource their procurement. Numerous surveys on logistic systems in construction indicate dynamic changes in this domain [7]

Contractors in Poland are usually only single links of logistic chains that provide a project with products, services, information and finance. In contrast to manufacturing industries, which profit with long-lasting partnership with suppliers and customers, logistic chains in construction are considerably more difficult to manage and to optimize. This results from:

- ✓ Diversification of projects (various materials, methods, location of each project means a new constellation of supply chain members each time) technical complexity of a project,
- ✓ Number of participants in the project,
- ✓ Domination of the bidding system of contractor acquisition (random partnership within the chain),
- ✓ Difficulty in adjusting each member's logistic routines to the logistic system of the project.

Therefore, the co-operation within the framework of the project supply chain is short-term. The participants of a construction project (builders, suppliers, employer etc.) tend to compete among one another to make the most of the project.

The study presents results of a ten-year survey of logistic systems of building contractors and construction projects. Considering contractors, the data were collected in years 1992 – 2003 and relate to: sources of supply, delivery contract routines, criteria of supplier's selection, reasons of delivery inaccuracies, bases of material demand forecast and distribution of responsibility for logistic decisions.

The study shows an average share of value of purchase according to source of supply for years 1996 – 2002. There is a tendency of decreasing direct purchase from manufacturers for the benefit of wholesalers. This is related to other trends of reducing own transport and using suppliers' delivery services. Manufacturers often concentrate on production and offer no transport services.

In most cases, delivery contracts concern single projects and there are no exclusive suppliers, but a long-time co-operation with a number of suppliers occurs quite often. Such partnership allows the contractor to negotiate better terms of contract (discounts, terms of payment). The long-time contracts usually regard selected ranges of goods.

Delivery inaccuracies occur quite often in spite of the consumer domination in the market. Basic grounds for them are the financial difficulties caused by employers' delay in payment and change of sequence of works on the building site. Further reasons are errors in the design, errors in orders, and difficulty in obtaining non-typical materials. Typical supplier failures such as problems with transport are rare. Bases of contractors' forecast of material demand are:

the construction schedule (57%), the bill of quantities (14%) and experience (29%). As for logistic decisions, there are usually a number of decision-makers within the organization whose scope of actions differ according to the structure of the enterprise. With regard to the supplies, most decisions are made by construction or site managers and purchasing departments

2. Sweden experience

Logistics knowledge is seldom represented in the organizations in the industry, and trained logisticians are in principle not seen, at least not in the construction companies. This makes difficulties related to logistics hard to solve, since there is a lack of terminology as well as ideas of possible solutions. And in the Swedish as well as international research related to the construction industry, logistics is an almost non-existing field. A number of studies have come to the conclusion that there is an enormous potential concerning logistics in the construction field.[17]

Study conducted shows there is a lack of knowledge regarding the costs associated with material logistics in construction. Studies focusing on the handling of material and waste at the construction site have often failed to include many on-site activities and cost items. Likewise, studies related to the supply-chain have seldom included unconventional ways of arranging buyer-supplier relationships.

The study concerns the achievement of efficacious material logistics in the construction industry in general, taking example from the construction of an apartment block in Göteborg, Sweden. This construction project is analyzed from two angles: first, on-site material handling and second, supply of materials to the site. The analyses are presented in two separate papers. Common obstacle encountered for most of Swedish housing construction projects is to plan purchasing based on immediate material unit prices and not on the total price for material considering supply chain costs including ordering, order surveillance, quality assurance, wrapping, pallets, packages, intern transportation, extern transportation, assemble techniques, unit price etc. Purchasers often subscribe to the economy of scale philosophy and order in bulk to get volume discount and reduce per unit prices. What is not taken into consideration is the extra cost this behavior causes because of the waste it generates.

Another obstacle mentioned on the study was the purchase cycle in construction projects. Each material purchased has its own tendering phase comprising stages such as enquiry, proposal evaluation and supplier selection. Once the supplier or manufacturer is chosen for each material

the acquisition phase starts, to order, coordinate, forecast, and distribute and to manage the materials in terms of quality, quantity, time and price. The time used for these activities could be used to add more value to the project and to focus on what the contractor does best: building houses. At present, suppliers have the knowledge to perform some of the activities of the purchasing cycle such as ordering, coordinating, forecasting etc. and are willing to take the responsibility and risk associated with doing these but contractors are not asking them to do it. The study showed that the importance of construction logistics is underestimated by construction companies. In Swedish construction industry companies are not aware of how important logistics is and what could be the consequences of poor logistics planning.

3. Brazil's experience

Increasing competition among Brazilian building companies has led them to develop new strategies focused on production aspects of construction. They are giving more importance to constructive rationalization, quality management systems, labor productivity, and material loss studies[11]. The study indicates logistics improvement also becomes an important element for building companies wishing to develop competitive advantage.

The paper discusses how logistics concepts and management tools can be applied to building construction in order to achieve competitive advantage.

From random selection of construction companies in Brazil selected, three case studies were conducted in order to identify: (1) general difficulties in logistics management process; (2) new visions, methods and tools that are being applied on building companies; (3) the opportunity of using these visions, methods and tools in building companies.

Some key points for logistics efficiency improvement identified in the first company are:

- ✓ Strategic politics for suppliers relationship definition;
- ✓ Site layout planning considering the different site phases;
- ✓ Agent's roles and responsibilities definition in site logistics activities;
- ✓ Duplicity elimination and velocity increasing in data processing and information

exchange.

For the second case the company concentrates efforts on developing management techniques to obtain reduction costs and competitive advantage. Some key points for logistics efficiency improvement identified in the second company are:

- ✓ Logistics coordination function definition;
- ✓ General procedures for acquisition process definition;
- ✓ Supply plans elaboration;
- ✓ Duplicity elimination and velocity increasing in data processing and information exchange.

In the third case study taken, the main key points for logistics efficiency improvement identified are:

- ✓ Process integration with suppliers increase;
- ✓ Information vehicles improvement including Electronic Data Exchange (EDE) implementation;
- ✓ Interference reduction among subcontractors and agents roles and responsibilities definition in site logistics activities.

Although the three companies have different strategies and different challenges for logistics improvement, it was possible to notice that in all of them some philosophies, methods and tools for logistics management are somehow being used.

But recently, the “Quality Movement” and, in a certain way, the diffusion of Just In Time (JIT) principles among Brazilian building companies have been influencing positively the supply logistics process.

Quality Movement has been involving hundreds of companies in the very different Brazilian States. Actually it consists basically on the diffusion and implementation of Quality Management Systems in these firms. These systems, based on ISO 9000 series, can help supply logistics improvement, particularly, through a standardization of procedures, that are in fact operational tools, like: (1) specifications and purchase orders; (2) suppliers selection and qualification; (3) material quality assurance; (4) materials and components deliveries inspection; (5) criteria for divergences solution in the relationships between the company and suppliers.

According to this study, some management practices that are associated to JIT philosophy are (1) Defects elimination; (2) self-quality control and immediate feedback information; (3) waiting time between activities reduction; (4) material handling volumes reduction; (5) transparency by visual control; (6) adjustment of the suppliers to the same ideas.

None of the three companies adopt JIT systems. But most of management practices mentioned above are in the scope of their production strategy objectives in order to reduce stocks. So it is possible to identify JIT philosophy influence in their current practice.

4. South Africa's experience

Emuze, F.A. and Smallwood, J.J.[18] reports on research conducted with the overall aim of identifying issues contributing to construction performance impediment, and their effects in South Africa. In terms of logistics related problems, contributors to inadequate management of logistics in construction are, lack of site management competence, lack of formal training, poor site material flow management, poor work schedule control, poor material supply, storage, and handling, and poor infrastructure and equipment location contribute more of a major extent to the incidence of inadequate management of logistics in South Africa. The findings further reveal lack of site management competence relative to logistics is perceived to contribute the most, while poor site layout is perceived to contribute the least to inadequate management of logistics. In particular, with the exception of poor site layout, the research shows that other identified practices above contribute, albeit at varying degrees, to inadequate management of construction logistics.

Furthermore, the study indicates effects of inadequate management of logistics in construction. These are poor quality and time management, and added cost in the project, to be the most likely effects of the failure to manage construction logistics properly in South African construction. Equally important, underutilization of construction vehicles, material loss due to defects and theft, and high level of construction waste on site could eventuate due to poor construction logistics practices. To be brief, the study indicates that added risks relative to H&S, poor image of the industry in terms of climate change, and long material off-loading time on site could manifest as a result of inadequate management of logistics in South African construction.

5. Ethiopia's experience

Logistics management practice in Ethiopia is in its infant stage. Ethiopian logistics system is characterized by poor logistics management system and lack of coordination of goods transport, low level of development of logistics infrastructure and inadequate fleets of freight vehicles in

number and age, damage and quality deterioration of goods while handling, transporting and in storage.

Inadequate human capacity in the emerging economic and supply chain management system in governmental and private organizations is among the major bottlenecks in the field of freight transport and logistics activities in Ethiopia. In order to realize the objectives and ensure that the country's vision and dream come true, a coordinated and concerted effort on innovative transport and logistics system at national level is critical to aspire beyond what is required by the MDGs. Some of the constraints associated with logistics system in Ethiopia are, under development of logistics management system, damage of goods and quality deterioration while in storage, Packaging, transporting and, lack of organization and management tools that is required to promote intermodal system.[10]

Finance and Economy Development Bureau has released manual 'Stock management manual' has been developed in 2010. In previous years; stocks were handled traditionally and using different techniques not in organized and systematic way. According to the bureau, it was difficult to manage logistics work without systematic working environment and still there are a lot of problems in implementing this manual. The manual has described in detail how stock can be handled and has created different checklists to facilitate stock controlling procedures.[19]

The manual has a description on

- Verification and identification of items
- Stock distribution
- Stock inventory
- Personnel's responsibility and who does what
- Methods for stock control and
- Stock pile management

According to a research by Abebe Zeluel and Solomon Berhe [5], The Urban Development Policy and the Plan for Accelerated and Sustainable Development to End Poverty (PASDEP) strategy, have the objectives of promoting the role of urban areas in the overall national development. The policy and the strategy are further articulated in the Integrated Housing Development Program (IHDP), which has multi-sectorial goals, viz., provision of affordable and low-cost housing,

empowering urban residents through property ownership, job creation and income generation, and improvement of quality of the urban environmental, infrastructure development, etc. and the urban renewal program.

Out of the total population of Ethiopia 16% or 11.7 million people are believed to dwell in urban areas while the annual population growth rate is estimated to be 4.3% or more than half a million. In relation to this, as studies indicate, there was a deficit of about 900 thousand housing units in urban areas. Since 2005 Ethiopia has been implementing an ambitious government-led low- and middle-income housing program: The Integrated Housing Development Program (IHDP). The initial goal of the program was to construct 400,000 condominium units, create 200,000 jobs, promote the development of 10,000 micro - and small - enterprises, enhance the capacity of the construction sector, regenerate inner-city slum areas, and promote homeownership for low-income households. From the 400 thousand house units to be constructed which the construction of more than 150 thousand housing units was completed, this shows the program is behind schedule. [20]

One of the main reasons for the less housing construction performance, as specifically indicated above is less construction materials and less logistics support. In relation to resolving these bottlenecks mentioned above, various efforts with regards to providing skill training, finance, machinery and equipment in addition to the extensive supply of construction materials and logistics that brought increased capacity of implementing agencies, contractors, consultants and professionals.

But still the progress of constructing these condominium houses is not as expected. The project delay has reached up and above 200 percent, and also there is cost overrun which makes the low cost houses expensive.

2.3.2 Summary

Construction industry makes significant contributions to the socio-economic development process of a country [1]. The study also elaborates further, by taking UNEP data, its importance emanates largely from the direct and indirect impact it has on all economic activities. It contributes to the national output and stimulates the growth of other sectors through a complex system of linkages. It is noted that about one-tenth of the global economy is dedicated to constructing and operating homes and offices. It further observes that the industry consumes one-sixth to one half of the world's wood, minerals, water and energy. It contributes to employment and creates income for the population and has multiplier effects on the economy. The construction industry employs large unskilled labor. Throughout the developing world, the majority of employees in the industry are unskilled. [3]

Similar to other developing countries, the construction industry has important contributions to the Ethiopian economy, as demonstrated by its share in the GDP. The share of the sector in the total GDP averaged at about 5.2 percent in the period 2002/03- 2006/07. The construction industry also contributes to the generation of revenue for the government. The rental income tax is one of the major revenue sources within the construction industry to the government. The rental income tax which was Birr 15.2 million in 1997/98 has increased to Birr 78.3 million in 2004/05 but lowered to Birr 32 million in 2005/06 generating nearly half a percentage point of the total government revenue.[1]

Construction industry plays significant role in the economy of developing countries. For example, in many developing countries, major construction activities account for about 80% of the total capital assets, 10 % of their GDP and more than 50% of the wealth invested in fixed assets. In addition, the industry provides high employment opportunity, probably next to agriculture.[3]

Despite its multiple benefits to country's' GDP, the construction industry is one of the most complex industries. The construction process consists of several phases where many different participants are involved during each phase. The uniqueness of this industry is that it is a project based industry, where each construction project could be considered as a temporary organization. [1]

The concept of logistics in its modern form dates back to the second half to the 20th century. Since then, it has developed into a widely recognized discipline of significant importance to both theory and practice. It is apparent that neither a standardized logistics concept nor a consistent notion of logistics exists. While some reduce their understanding to simple transporting-, handling-, and warehousing operations, others view logistics more broadly as a management function. [10]

Abadir H. Yimam, and Olusanjo Olaniran Fadiya, (2011, 2012)[2,12] defined construction project as temporary endeavor (that has definite beginning and end time) undertaken following specific cycle of Initiation, Definition, Planning, Execution and Close to create a unique product, service, or result through novel organization and coordination of human, material and financial resources. Due to the nature of the projects, some of them are usually capital intensive, complex; and require significant management skills, involvement and coordination of a wide range of experts in various fields. They also must address the geography and conditions of the project site and the relation of the project to the environment.

Logistics management refers to the strategic and cost-effective storage, handling, transportation and distribution of resources, that means managing one of the main activities in construction industry. It is an essential process that supports and enables the primary business activity, like the construction of a building in a city, to be accomplished.[4]

The cost of materials in a typical construction project can take up around 65 per cent of the total construction costs. In order to minimize the cost of construction materials, managers and planners should not only strive to reduce the wastage and rework but they shall also cut down on the costs pertinent to the logistics of materials especially those which are of bulky nature.[22]

Managing logistics in the construction sector can be considered as major issue when we see how it influences the cost in projects. Different countries have different practices that can affect their projects positively or negatively.

Experiences of many countries in Europe show that logistics management department is not established in Construction Company's organization, not considering logistics as main part of the construction work.[7]. For example, construction companies in Poland and Sweden prefer semiformal model with a single specialist. Bulk order is quite often in Sweden which would lead

to waste and damage of the materials due to handling. But this practice is seen in most of construction companies in the world for the benefit of discount in unit price and transportation easiness. Common practice in most of the countries in the world; a lot of time will be consumed for the purchase cycle in construction projects that causes the contractor loses focus on building houses.

Brazil is a country that has advanced in managing logistics in its construction companies. Some philosophies, methods and tools for logistics management were being used in most of construction companies [6]. Most building companies has been influenced by Just In Time (JIT) principles, that are, defects elimination; self-quality control and immediate feedback information; waiting time between activities reduction; material handling volumes reduction; transparency by visual control; adjustment of the suppliers to the same ideas.

Quality Management Systems has also been practiced in hundreds of companies in the very different Brazilian States. The system can help supply logistics improvement, particularly, through a standardization of procedures, like (1) specifications and purchase orders; (2) suppliers selection and qualification; (3) material quality assurance; (4) materials and components deliveries inspection; (5) criteria for divergences solution in the relationships between the company and suppliers.

Regarding Africa's experience, the challenge is not much different from others. For example, In identifying logistics related problems in South Africa [18], contributors to inadequate management of logistics in construction are, lack of site management competence, lack of formal training, poor site material flow management, poor work schedule control, poor material supply, storage, and handling, and poor infrastructure and equipment location contribute more of a major extent to the incidence of inadequate management of logistics. Underutilization of construction vehicles, material loss due to defects and theft, and high level of construction waste on site could eventuate due to poor construction logistics practices.

Ethiopia also does not have well developed policy or guideline for logistics management for the construction sector. Companies could have their own way of managing their logistics, from my

experience most of the work is done not in systematic way. But I could not find any written documents or study showing how construction companies in Ethiopia can handle their logistics.

Chapter Three

The case study

Addis Ababa Housing Development Project Office has started its program ten years ago, in 2003, building condominium houses and managing its logistics with no policies and strategies until 2010. By taking a manual developed by Finance and Economy Development Bureau as a reference the project office has developed its own check list, as a guideline for the management of logistics. Using this check list, the office tried to ease problem related to material supply, distribution and handling.

The check list has favored bulk transaction for the major construction materials. The most important sector in the management of logistics is its skilled manpower and communication between the stakeholders. But the check list has indicated that gaps were still identified, under payments (may lead to corruption) for its workers, qualified personals still in short and continuous upgrading trainings are not enough (system not being automated). In managing the MSE, producing and delivering construction materials like HCB for slab and wall, precast beams, floor tiles, window and door frame, roofing work, etc... for the project, quality control and material distribution strategies have not been set in detail that would create gaps related to material wastage and delay in material delivery.

Addis Ababa Housing Development Project Office (AAHDPO) is handling almost all the logistics supply and delivering to the site. These includes,

Construction materials: cement, reinforcement bars, coarse aggregate (02), prefabricated elements like beams, HCB, tiles, sanitary fittings, electrical fittings, roofing elements, windows and doors, etc...and most of the materials are produced by Micro and Small Enterprises. These enterprises joined the sector for the reason, one to create job opportunity, two to satisfy a huge demand for the construction material. Accordingly, about 10 thousand enterprises with various trades of construction and production have been participating in the program creating job opportunity to about 200 thousand members embraced by the enterprises.[16]

According to the project office training and technical support has been given to the enterprises, so that they could acquire the skill and accommodate the demand from the project office, but actually which is not enough.

The project office is using the manual by Finance and Economy Development Bureau released 'Stock management manual' as a reference to produce procurement check list for its logistics management system.

Check-list prepared by Addis Ababa Housing Development Project Office indicated that the main problem which has been observed regarding logistics management is that the office did not have any procurement manual before. Because of this the project office is obliged to prepare a check-list in managing its logistics. These check-lists are expected to:[17]

- ✓ Manage government properties in the main and project office in modern way,
- ✓ Deal with the material procurement, material handling and distribution system,
- ✓ Highlight for solution which was encountered previously,
- ✓ Indicate the benefits due to procuring, storing and distributing materials,

The document has twelve parts,

- I. Material requisition and permission
- II. Materials delivery
- III. Manpower management and storage preparation
- IV. Material distribution
- V. Payment deduction due to construction material
- VI. Materials movement and monitoring
- VII. Material recording and handling, supervision and control
- VIII. Waste prevention and minimization
- IX. Inventory system
- X. Material reduction
- XI. Setting labor price for construction material loading and unloading
- XII. Formats (check-list) for different activities

Part One

Material requisition and permission

1.1 Stock control and procurement

- ✓ Policy for identified stocks with items and time of requirement
- ✓ To make the policy systematic the following strategies were identified

1.1.1 material requirement plan

1.1.2 decide on stock pile volume

1.2 Procurement request

1.2.1 Request for procuring materials on main office

1.2.2 Requesting for procuring materials on branch project office

- ✓ Materials will be produced by MSE (Micro and Small Enterprises)

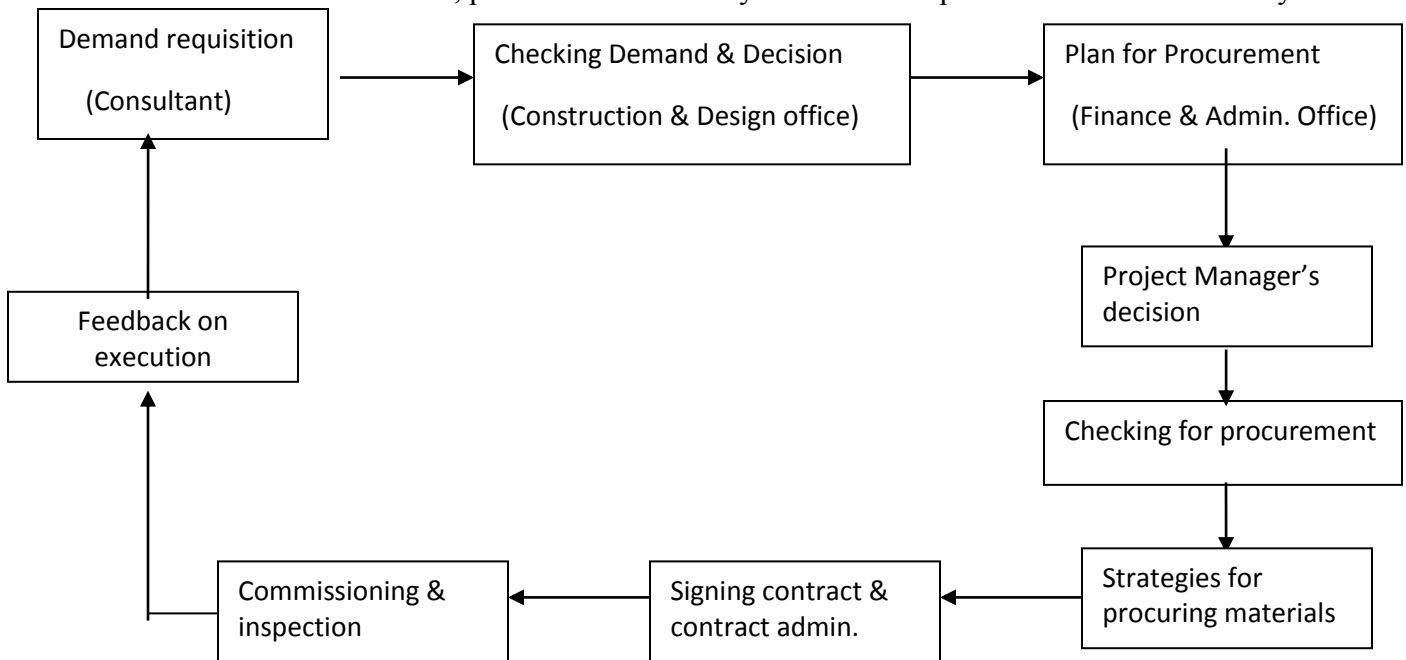
1.3 Material procurement execution with the main and branch project offices

1.3.1 Central (main) office procurement

- ✓ International transaction
- ✓ Bulk transaction for all materials for the benefit of discount

1.3.2 Branch office Procurement

For materials, production is made by MSE that the price will be fixed centrally



Demand request and procurement execution process

Part Two

II. Materials delivery

2.1 Centrally procured

2.2 Branch office procured

2.3 Material Handover b/n branch offices

Part Three

III. Manpower Management for Store Keeping

3.1 Preparation for store establishment

3.1.1 Identifying materials for stock and prepare manpower accordingly

3.1.2 Store location and layout

- a. Open store system
- b. Partially closed store system
- c. Closed store system

3.2 Stock controller's management

- ✓ there is shortage of skilled manpower
- ✓ not enough salary for the controller's
- ✓ equivalent & continuous training not given

3.3 material handling precaution

- ✓ For materials like cement, HCB, Rebars, Aggregate, electrical installation, sanitary installation,

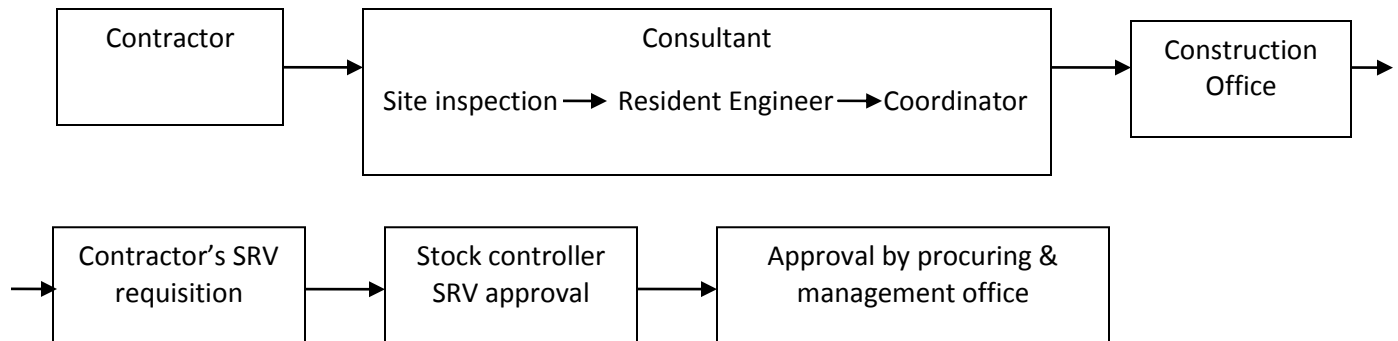
3.4 Safety for Materials

Part Four

IV. Material Distribution and Bookkeeping

4.1 construction material requisition

4.2 Procedures for material requisition for contractors



4.3 Materials Requisition requirement for Micro and Small Enterprises

4.4 Material issue for government and non-government organizations

4.5 Fixed asset and temporary fixed asset issue

4.6 Fuel distribution

Part Five

V. Conditions for deduction for construction material from payment

Part Six

VI. Construction material distribution and bookkeeping

6.1 store requisition voucher

6.2 store issue voucher

6.3 issue for material on maintenance and rent

6.4 Stock Control Card and Bin Card controlling system

6.5 Voucher printing, distribution and usage

Part Seven

VII. Documentation for material handling, supervision and controlling report

7.1 Reporting system for material handling

7.2 Material supervision and controlling

7.3 Material reporting for overage, shortage, damaged, missed, items

Part Eight

VIII. Material wastage management

8.1 Cause for material wastage

8.2 Wastage prevention and control

Part Nine

IX. Material Inventory

Part Ten

X. Material reduction

Part Eleven

XI. Setting wage for material loading and unloading

Part Twelve

XII. Different format

Considering the significant contributions of construction industry to the national economies of developing countries; its major construction activities account for about 80% of the total capital assets, and looking at the percentage construction material consumes, which is up to 70 percent in a project, it is vital to give a very good look into gaps. In studying the above check list there are policies which can be useful for the logistics management process if they are implemented correctly. The gaps identified include, bulk order for major construction materials, like, cement, reinforcement bars, sanitary fixtures, electrical fixtures, etc., not assigning skilled manpower to the sector and non-systematic material distribution. Furthermore, handling materials in storage and quality control in design and production for construction elements, especially, in the case of Small and Medium Enterprise SME who are the major material supplier to Addis Ababa Housing Construction project has been identified as critical gaps. This study therefore intends to prove working on these gaps would significantly save wastage, enable to deliver better quality construction work with minimized delay.



→ Damaged precast beams discarded because of size or quality defects.



→ Cement stored without proper storage system, Not elevated min 30cm from floor, or aerated.



→ Rebar prepared for precast beams just laid exposed on site wasted



→ PVC window frames scattered on grass for weather effects.

Chapter Four

4.1 Data Analysis and Discussion

In the check list above plans for material requisition order has been set. Material procurement execution is identified if it is centrally or in branch offices. But bulk transaction is done only for the benefit of discount, not analyzing the disadvantage, which is, waste and damage encountered.

Even though the check list explains in detail how materials for production are distributed for the MSE, how production is supervised by the consultant, and delivery is performed with the confirmation and signature of the supervisors. Quality of production is still a major problem observed in production sites. The document states there is a penalty set by the project office if the enterprises do not comply with but, I could not find any written evidence.

In selecting location for establishing stores for the materials, even though store types and standard are set, project sites are changed every time, some near other far distance from store to the project site is one factor which could affect the project in terms of delay in delivery time which can be related to cost, traffic congestion related to environmental degradation. Materials which are stored in open area, which are not given enough protection against weather, theft, etc..., which could lead to unnecessary waste.

Regarding manpower assigned for the material stock management in receiving and distribution process, the document stated that the assigned people are not enough in quantity and quality. These are not assigning the right person on the right place, inadequate salary scale, which could lead to incompetency and corruption, not giving continuous upgrading training for the employee.

In material wastage management, causes for wastage could be, procured materials could not be incompatible with work plan, and demand is different with distribution. Material could be in damage for the reason improper transportation system. Materials are distributed after keeping stock not direct distribution system, leading to damage when loading/unloading. The project

office is not insured for expensive materials in case if there is any damage encountered. In loading/ unloading, materials will get damaged because of mishandling of the labors.

Material like chemicals for agro stone are exposed for wastage, original container is large so during distribution to the sub city branches smaller container will be used, so that it will spill off and wasted.

During inventory, different methods are mentioned in the document for sudden and scheduled inventory system. Still workers assigned in the stock controlling system are in short and their work is not supported with modern technology communication system and their capacity is not upgraded with continuous trainings. Also the check list identified different cause of wastes and how to control this. For example, in the production of agro stone, major waste source is the standard size of the material delivered from production, which is not compatible with the demand in the construction site. This problem comes from communication gap between the production team and team in the project site. The other major source of waste is material stock system in the construction site that is storing the material exposed to weather. But still this situation can be observed in site. Even this observation is confirmed in the document the project office is using.

In material reduction, the office is trying to do some work regarding reduction of wastage in different construction materials. Related to this, the project office tried to establish associations for labor for loading/unloading of the material and the rate. The concept by itself is good, but its improper management causes many problems. These are, the employees in the stock management and material distribution spend much of their working hours by interfering in the negotiation between the labors. Carelessness and undisciplined behavior of labors in the loading/unloading is observed which could cause damage to the materials and even disturbing the working atmosphere.

Regarding production in the MSE, material is produced with the order received from the project office. Materials which are produced in the enterprises include precast beams, HCB for the slab and wall, different flooring tiles, door and window frames, RHS roof structure, etc.... The raw materials are delivered from the project offices with production order. But delivery of product

from the enterprises to the ordered site is late most of the time and also precession of product is in question, which could cause delay in the construction and lots of wasted materials are observed in site. The main cause for this is, unqualified people in the production site, shortage of knowledge which could be attained with contentions training, lack of discipline which could create communication gap between the MSE and project office.

The other major problem which could be raised in relation to wastage of materials is compromising in quality of products. This can be observed in project sites even though quality of production is supervised by the consultant and also by the project office, this issue has been repeatedly observed.

Chapter Five

5.1 Conclusions

Most of construction projects are delivered at least a few days or months or even years late beyond expected completion time. Because of this, the stakeholders, the client, contractors, the society suffers a lot. Many reasons have been raised for project delay and cost overrun. For example, incomplete design, contractor's capacity, design change order, climate condition, finance, etc. But, problems caused by poor logistics management are not taken as one of the main reason for projects delay.

Construction industry makes significant contributions to the socio-economic development process of a country. Its importance emanates largely from the direct and indirect impact it has on all economic activities. It contributes to the national output and stimulates the growth of other sectors through a complex system of linkages.

The construction industry is one of the most complex industries. The construction process consists of several phases where many different participants are involved during each phase. The uniqueness of this industry is that it is a project based industry, where each construction project could be considered as a temporary organization.

The main objective of this study is in identifying the major role of logistics management in the construction industry and its significance in construction projects specially in building projects. As discussed in the literature review, one of the indicators in a country's development is level of its infrastructure development. And major characteristics of construction projects are its huge amount of budget which is assigned to it, and also which absorbs a lot of manpower, skilled and unskilled. Due to uniqueness of projects and lots of stakeholder's involvement, managing logistics is a very difficult task.

Logistics management in the construction industry is the discipline which is very important, but we can see from this study that it is not given the attention it deserves. From the study we can conclude that,

1. From different countries experiences, we can see that considering logistics management as independent department is a waste of money. Logistics knowledge is seldom represented in the organizations in the industry, and trained logisticians are in principle not seen, at least not in the construction companies. This makes difficulties related to logistics hard to solve, since there is a lack of terminology as well as ideas of possible solutions. Study conducted shows there is a lack of knowledge regarding the costs associated with material logistics in construction.
2. The study clearly shows the construction industry has important contributions to the Ethiopian economy, as the rest of the others countries in the world. And still managing the logistics in the construction industry is not given much importance considering huge budget (more than 60%) of the construction is engaged with construction material.
3. Improving logistics by reducing activities that do not add value to the final product could be one possible solution to lower the production costs. Activities that do not add value to the final product are defined as “waste” which is directly related to the logistics issue.
4. We can clearly see that material supply is an important element of operation of construction enterprises and thus a factor affecting the quality of construction projects. The level of materials costs reaches up to 70% of total construction cost estimations, therefore any actions towards rationalization of size, structure and organization of material consumption, delivery, and planning are important in terms of project efficiency and require proper management.
5. One of the common practices in the AAHDPO, which can be taken as main cause for waste is bulk purchase for major construction material which the project office is supplying for the project. Even the main idea for this system is discount and transportation easiness, the drawback is much higher.
6. Communication between the project office and branch project offices is underestimated considering huge amount of materials and items are at hand. The reasons for this are, there is no detail guideline in the check list how to go about it, no continuous training for the staffs in upgrading their skills, and introducing them to the

modern systematic approach how to handle new stock, material at hand and distribution to the project sites.

7. One main problem which was observed regarding work discipline around logistics in the project office is bribe and theft, which is taken as major crises even which the project office recognized. Though some disciplinary action was taken in the last few years, the problem won't go away.

8. This paper raise points regarding MSE, which are main partner to the project office, are huge in number and managing them is a very difficult task. The government has organized this institution in creating job opportunity to the young, which is good, but without giving them enough preparation and training about what is the quality of productions they are delivering, which the downside is much more obvious. Lack of Work discipline, problems in quality, not to be responsible in what they are delivering (product precession) and not keeping time frame for delivering the product, are problems which can be observed. These all will sum up to project delay, delivering product not to the required quality, material wastage in most of construction sites, and not responsible for their wrong actions.

5.2 Recommendations

This study shows how logistics management is very important in the construction industry. To improve logistic management system in the project office, the first thing which needs to be changed is the attitude towards it. This includes, not just establishing independent logistics department in project offices, but strengthening it with appropriate equipment and man power, which can be functional.

Concerning material procurements, bulk purchase order is one of major cause of wastage, this can be avoided by doing this bulk purchase for selective items not for all materials. Just In Time technique can be used instead, but this would need precession and very well coordination between the project office and suppliers to avoid delay.

To improve disciplinary problems like theft and bribe, some corrective measures must be done, like competitive salary for the employees in the stock controlling areas, establishing transparent and easy systems and controlling mechanisms, giving continuous relevant training and establishing competitiveness between the workers and give some incentives.

In production area for materials in MSE, better quality controlling mechanism must be established,

- Assigned quality controlling supervisors must be given authority, so that they can accept or reject products which failed the standard tests before it is distributed to the site.
- Strong inventory system must be established for construction materials like cement and reinforcement, which are distributed to the production site from main project office. Because these are materials mostly exposed to theft and bribe.
- The workers in the enterprises should be given contentious technical assistance regarding materials behaviour, precast element dimensions, storage, handling, transporting, and distribution.
- Preparing the workers in taking responsibility for their actions. (penalized when doing wrong like fail to deliver materials on time, elements not to the standard size and quality)
- The project office needs to revise their perspective about how to manage the logistics considering it plays major role in the project cost as well as quality of work.
- The project office the Ministry as a whole needs to formulate policy regarding logistics management, and before practicing it concerning parties should participate in critics and accessing the document.

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