Impacts of Logistics Management in Building Construction: the case of selected building projects in Addis Ababa, Ethiopia

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I, the undersigned, declare that this thesis, entitled 'Impacts of Logistics Management in Building Construction: the case of selected building projects in Addis Ababa, Ethiopia', is my original work and it hasn't been presented for a masters or any other degree in this or any other university, and all sources of materials used for the thesis are duly acknowledged.

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ABSTRACT

Efficient logistics management plays great role in the success of construction projects. Nevertheless, poor logistics management in construction projects affects the project productivity in several ways. The objective of this research was to identify impacts of construction logistics management in selected building construction projects in Addis Ababa and develop alternative solution to reduce those impacts and to increase productivity of construction projects. The research identified the top ten impacts of poor logistics management and based on the 180 respondents(project managers, consultants, site engineers, foremen and laborers) from 20 construction projects of grade one building contractors. The primary data was collected by using closed questionnaire; while secondary data was collected from literature. The gathered data was analyzed using statistical software SPSS and SCOR metrics was employed to evaluate logistics management performances. As per the respondents responses, the top ten impacts of poor logistics management in building construction projects were, delays (increased project time) , cost overruns (unnecessary cost to the system), loss of project efficiency, difficulty in checking the quantity of materials, ordered materials never arrive on time , fraudulent activities, queuing of trucks(unwise use of trucks) , transportation and environmental issues(emissions in the environment), poor quality construction and material loss (damage). The result obtained from SCOR metrics showed that, logistics management performance in building construction projects has been poor.

Key words: logistics in construction, logistics management, project productivity, impacts of poor logistics, construction efficiency

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ABREVIATIONS

SCM- Supply Chain Management

CLP- Construction Logistics Plan

CLM- Council of Logistics Management

BSRIA- Building Services Research and Information Association

CLOCS- Construction Logistics and Cyclist Safety

CSCMP- Council of Supply Chain Management Professionals

SCC- Supply Chain Council

CCC- Construction Consolidation Centre

LCCC-London Construction Consolidation Centre

SPSS- Statistical Package for the Social Sciences

JIT-Just- In- Time

MP- On site Marketplaces

ICT- Information and Communication Technology

RFID- Radio Frequency Identification

SCOR- Supply Chain Operation Reference

POF- Perfect Order Fulfillment

SCT- Source Cycle Time

CS- Cost to Source

RII- Relative Importance Index

1. Introduction

1.1. Back ground

Construction sector plays an important role in infrastructural development of countries to and enhance economic development.

According to Yimam(2011); construction sectors took 80% of total asset, 10% of growth development plan and over 50% fixed asset of economy of developing country. At same time, the construction sector is one of the key sectors which could create employment opportunity for citizens, by which they support their families (Ofori, 2006, Jekale, 2004).

This shows that construction plays a valuable role for economic development. But in another way, even if the sector being seen as icon for the drive of economy, its quality and performance are still under development and the area need good management and technological support; for the economic success of developing countries.

Due to the poor management and performance of the construction sectors in developing countries, most of the construction projects are not completed in planed completion time and budget. This failure of fulfilling planed of time and budget leads to project and unexpected extra cost. Even sometimes, some of the projects could be terminated because of the delay that causes project extra cost (Idoko, 2008, Almohsen and Ruwanpura, 2011).

Most of construction projects lose their productivity due to poor management of resources which is related to; poor logistics management controlling flow of resources (material, tools, labor force and equipments) from point of discharge to point of installation or use (The European Construction, 1994).

On construction sites ineffective management and poor flow of materials, tools and equipment, will result ultimately in project delays and cost overruns, because of cost of materials and equipment which represents a large portion of the total project budget.

Agapiou et al. (1998) stated that "Managing the flow of materials assuring its quality, checking and quantity, allocating the storage areas coordinating the overall process, triggering the orders, and updating the participants are major obstacles in construction logistics management". Accordingly, ensuring material quality and material quantity, proper management of storage place and coordination of activities on the site, giving on time order, providing timely information should be considered as logistics management activities where problems are noticed in construction sites. In general, a lot of undesirable waste could be seen in the construction site logistics process (such as queuing of trucks, damaged goods or other delays, safety and quality related issues).

Related to this problems many researchers puts attempt by identifying certain factors such as incomplete design, contractor's capacity, design change order, climate condition, finance, etc. Still the question of poor logistics management in the construction sectors has not received attention as needed. Finally this problem leads many of construction projects not complete within time and within expected budget (Regassa, 2015).

Poor logistics management in construction does not only result in delayed projects but also gives a poor image of the construction industries. If proper solutions are not given for the logistics management problems in construction projects the construction projects will be affected in terms productivity (Matouzko and Methanivesana, 2012).

Ethiopian construction sectors have obstacles impeding their productivity and competitiveness. Most of the Ethiopian constructions sectors encounter the problem of delay, cost overrun and poor quality delivery (Regassa, 2015). This confirmed the fact discussed in Vrijhoef and Koskela, (2000) "the construction industry is facing decreasing productivity and increasing cost''.

According to Tefera, (2013), " key challenges within the Ethiopian construction industry are: shortage of skilled and unskilled manpower, machineries and tools, absence of appropriate standards and guidelines, lack of strong institutional capacity to oversee the construction industry, and lack of construction project management and control skills". This shows construction project sites in Ethiopia are impacted by several factors that affect the efficiency of a workforce by reducing their overall productivity due to poor logistics management practices in building construction sectors. The study by Matouzko,(2015) confirmed that "the impact of construction logistics is underestimated by construction companies and construction logistics has impact on working environment. Even some leading construction companies are not aware of how significant the impact of construction logistics is and consequences of low logistic performance". It also understood that maintaining efficient logistics has been critical problem in construction sectors. This confirmed the fact discussed by Matouzko and Methanivesana,(2012) "poor logistics management is being one of the problems of construction sector and this impacts should need further research to identify the real impacts poor logistics management in construction sector and find solutions on how to minimize or avoid such problems".

Therefore; this research will assess the impacts of the construction logistics management problems that affecting construction projects and develop alternative measures to improve construction logistics management and increase productivity of building construction projects in Addis Ababa.

1.2. Research Question

Currently most construction projects suffer from poor construction logistics managements. This indicates that alternative measure is required to improve or reduce impacts of poor construction logistics management is needed. Thus; the research questions that should be considered are:

1. What are the main factors contributing to the poor logistics management in building construction projects?
2. What are the impacts of poor logistics management on building construction projects in Addis Ababa?
3. What are the most often poor logistics management practices currently affecting building construction projects in Addis Ababa?
4. What are the best alternative remedial measures required to improve logistics management in order to increase productivity of building construction projects?

1.3. Objectives

The main objective of this research was to assess impacts of logistics management problems in selected building construction projects in Addis Ababa and suggest improvements based on the results.

The specific objectives were to:

1. Identify the main factors affecting logistics of building construction projects
2. Identify and prioritize the impacts of poor logistics management in building construction project.
3. Develop recommendation based on findings; how to improve construction logistics management in order to increase performance and productivity of building construction projects

1.4. Significance of the study

Most construction projects are not delivered within the planed schedule and expected construction costs due to poor logistics management. When the projects are delayed the construction costs (cost overrun) are increasing as well. Because of this most of the constructions projects in Ethiopia incur extra costs that suffer client, government and community as whole.

Improving logistics management in building construction projects enables the projects to be finished on time, within the budget and within the scope of contract specifications. Further, knowing each impacts of poor logistics management and ensuring efficient logistics management is a crucial factor to increase labor productivity and also assist the integration

and coordination among contractors, sub-contractors and suppliers, which could increase construction workers productivity.

Therefore, knowing the impact of poor logistics management which leads the building construction project in loses of productivity will safeguard the construction sectors from time and cost overrun.

With having this perspective, the primary benefit of this research is to provide additional scientific knowledge that enables the stakeholders to know how poor logistics management impacts the productivity of building construction projects. Moreover, it promotes the construction sectors to develop alternative measures to improve their logistics management systems in order to increase productivity of building construction projects

1.5. Scope of Research and Expected Outcomes:

The scope of this research was:

- ✓ Focused on selected building construction projects in Addis Ababa.
- ✓ Focused on the respondent's perspective on the impacts of logistics management building construction projects.

2. Literature Review

2.1. Definitions of logistics

Logistics have several definitions but for the purpose of this research the most three definitions are elaborated below *(Lundesjö, 2015*).

Logistics:

- *"Logistics is 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 consumer requirements"*(Council of Logistics Management, 1998)
- *"Logistics is the positioning of resource at the right time, in the right place, at the right cost, the right quantity and at the right quality" (*Chartered Institute of Logistics and Transport, 2005).
- *"Logistics is the time-related positioning of resource" (*The Chartered Institute of Logistics and Transport, 2005).

The first definition is widely used elaborates the concept of logistics management it describes that the resource and information flow from origin to the user in planed way to satisfy the end user. The second definition shows that the required resource should be delivered when needed, at the right places with right quantity and quality. The third definition is similar to the second definition but expressed in condensed form.

According to Silva and Cardoso, (1999) and Regassa(2015) in construction terms logistics can be defined as a "a multidisciplinary process that seeks to guarantee at right time, cost and quality of 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". According to the authors this can achieved when proper planning, organizational, directing and controlling activities before and during the construction works are maintained effectively.

Logistics functions in the construction sectors are in two forms;

1. Supply logistics (related to activities that are cyclic in the production process such as: supply resources (materials, equipment and manpower) specification, supply planning, acquisition of resources, transport to site and delivery, and storage control and
2. Site logistics which is related to physical flow planning, organizing, directing and controlling on-site; such as: management of handling systems, safety equipment, site

layout, definition of activity sequence and resolution of interference among production teams activities on-site (Silva and Cardoso, 1999; Regassa, 2015)

2.2. Basics of logistics management within Construction projects

Logistics management can be defined as part of supply chain management that plans, implements, and controls the efficient, effective forward and reverses 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 (CSCMP, 2013). According this definition, logistics management is an integrating function, which coordinates and optimizes all logistics activities for proper utilization of resources and satisfying the end user.

Construction logistics as a discipline first came to prominence in the UK in 1980s with the start of construction management, procurement mechanism whereby the client directly contracts with specialist trade contractors, project management contractor to coordinate and manage the construction process. Some of the clients that utilized the construction management option recognized the value of directly engaging specialist firms to manage the essential non-core construction activities in contractual documents including site welfare ,housekeeping, safety signage, security, fire, access, cranes , hoist, traffic management, first aid, third party liaison and waste management. The result of all these essential combinations of construction systems led to the emergence of the specialist logistics contractor.

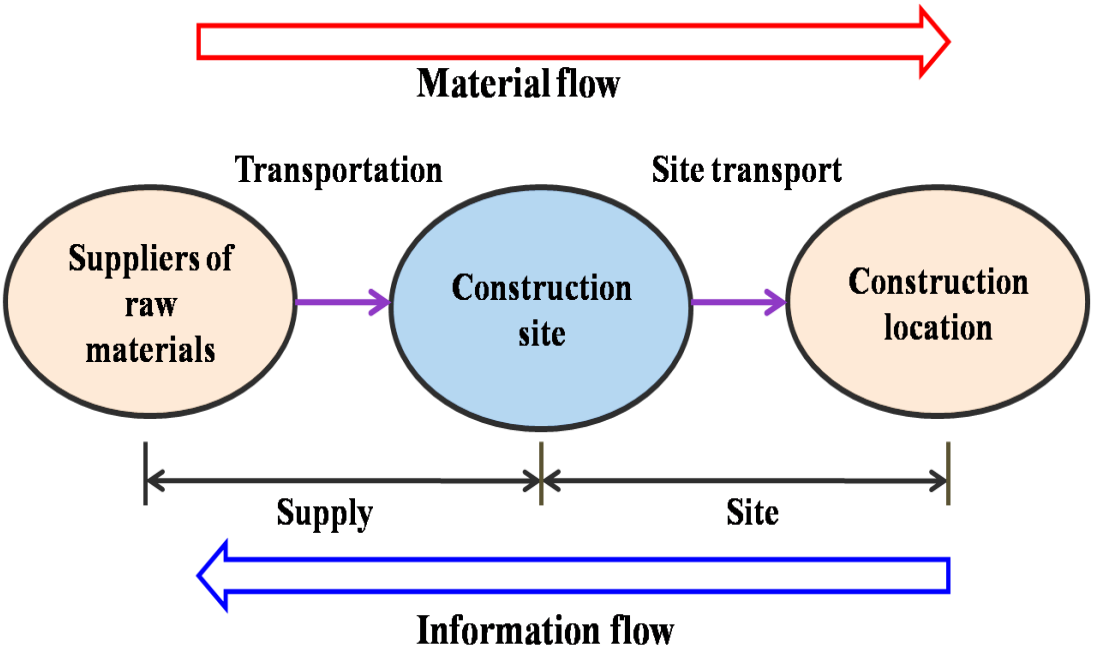
Logistics is managing the supply chains or a network of organizations linked by material and information flows bounded with a product (project) life cycle from the procurement of raw materials through processing and handling the products and the final product, distribution and sales to the end-user and finally, to waste utilization. All the processes flows form a logistic system.

Construction logistics is a very challenging area in which the ranges of logistics activities, to need to be managed, including inventory control, transport recovery of waste, recycling and etc.

Construction project logistics is a multidisciplinary process which includes physical distribution of materials and equipments, purchase, transportations, warehousing, loading and unloading and stockpiling or storage, allocating information processing etc.(Kagioglou et al., 1999).

According to Christopher(1999) construction logistics activities start with proper planning, organizing, commanding or controlling materials at right time, right place, low cost and high quality guaranteed and then the purchased material should appropriately transported, stored

and distributed for site construction work. As illustrated in **Figure1,** the information flows from contractors (construction location) to supplies raw materials while the required material is transported from source to construction site.



Figire1: Logistics process of construction project (Source: Duiyong et al., 2014)

2.3. Factors affecting productivity of construction projects

Every construction site has a different set of factors that affect construction operation, including logistics. The nature of the factors will depend on a number of situations, such as location of the site, the nature of the working environment, the potential for construction activity to affect site neighbors and social policy of the client, contractor's ability to deliver a project, ability of contractors to devise and implement a sustainable construction strategy from the start (Sullivan et al., 2011).

At construction sites logistics activities which are the most important activities since work force productivity levels depend upon the actual delivery of mechanical equipment and materials.

The delivery of the equipment and materials may be affected by factors "on and off" of characteristics of construction site (Sullivan et al., 2011). Since construction activity is not permanent on the same project site, when the site location changed; every logistic situation also changed as well. Therefore, construction site logistics systems should be organized based on situation of projects.

According to Sullivan et al (2011) the following factors are considered as the main problems of productivity of construction projects.

- **Physical factors:** 'off site' factors such as low link/relationship/ or means of approach and 'onsite' factors such as the lack of storage space or restricted access due to narrow corridors and existing structures etc.
- **Legislative factors**: the town and country planning act, environmental act, manual handling operations regulations
- **Environmental and social factors**: the construction strategy has to consider minimizing noise, dust and disruption and construction site consider the proximity of watercourses, neighbors and exiting structures and roads etc.
- **Financial factors**: factors which might restrict the development of mechanical resources etc. that a contractor is able to use on project.
- **Site Situation factor (i.e. congested site):** managing construction logistics for the construction that is carried out in the main center of cities and towns are too difficult because of the site is congested, the street are too crowded, the storage area not available, high density of pedestrian and business activities around the site.

2.4. Influence of logistics management on construction projects

Logistics is becoming the heart of construction activities and received much more attention since the late 1990s. A considerable amount of waste is incurred in the construction industry as a result of inefficient logistics in the sector (Strategic Forum for Construction, 2002). If there is poor construction logistics management, there is no way to properly allocate and manage the resources. Moreover, inefficient logistics management affects transport, storage and coordination.

Inefficient construction logistics results in: queue due to poorly loaded vehicles (because scheduling was not well organized), unavailability of materials on site (leading to poor time utilization), excessive stockpiling of materials with extra costs and the greater risk of deterioration and damage, lack of coordination between activities; and high proportion of damaged and returned items (The Strategic Forum for Construction Logistics Group, 2005).

Logistics is one of the most important elements of a construction projects that can influences construction projects in different ways; such as: critical site performance factors (cost, speed of construction and plan reliability) and industry performance indicators (accident statics and contribution to landfill). Therefore, construction logistics is the critical issue that needs

considerable attention when construction strategy is developed. **Figure.2** shows the project performance indicators that can be influenced by construction logistics.

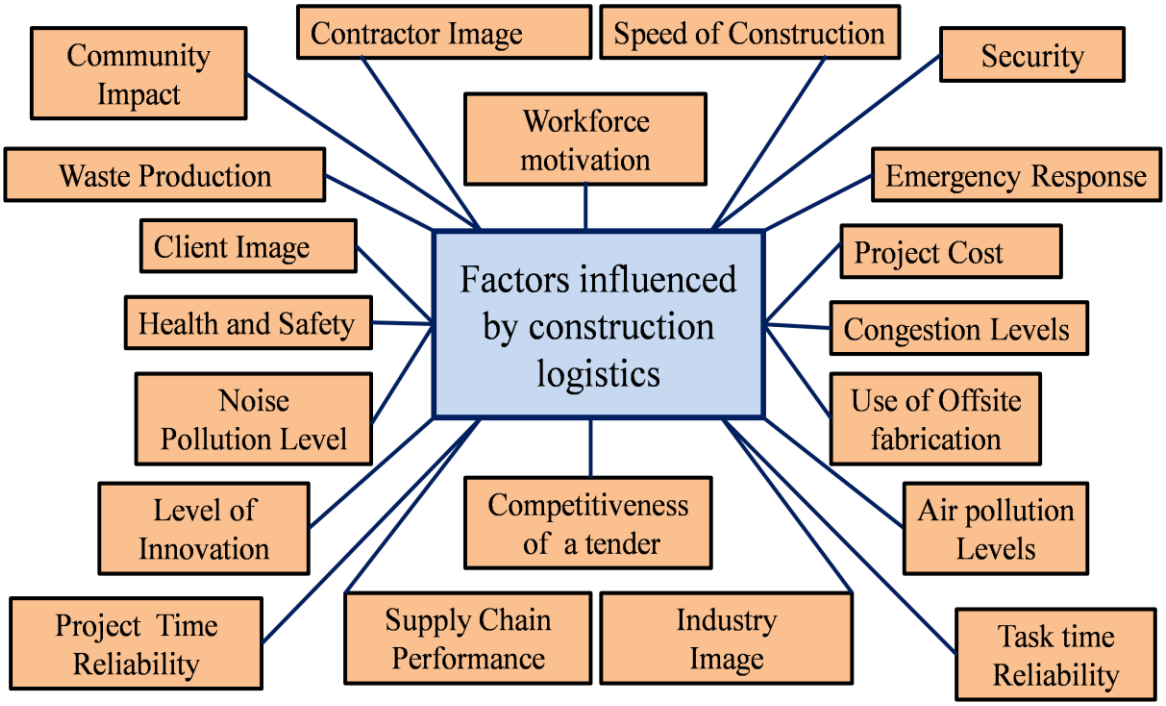


Figure 2*:* Construction project performance indicators influenced by construction logistics (Source: Sullivan et al., 2011)

As it was shown on the **Figure 2,** construction logistics can influences construction project in many ways. Therefore every construction projects should give attention to planning of site logistics; because the success of construction projects is maintained only if efficient logistics management is used on construction sites.

2.5. Factors contributing to inefficient (poor) logistics in the construction industry

According to Strategic Forum (2005) cited in study by Fediya(2012) and Regassa(2015), the following factors, as currently practiced, contribute to inefficient logistics in the construction industry.

- **Short-term nature of construction process:** construction work is seen as a temporary work (one-off job) in which teams or organizational structure involved in one construction project is formed or built for short period of time. Different projects have different plans or design and approach to implement it. This makes it difficult to build optimized logistics system in construction sectors. The temporary nature and

other uncertainties in the industry have a negative impact to build efficient and fixed logistics management systems in construction industry.

- **Fragmentation of activities within the construction process**: The construction projects involve many small teams or companies (subcontractors). Several teams, such as design team and construction team, involved in construction process are fragmented in some construction projects. 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 coordination at construction work could leads to considerable wastage at project site (the culprit of much rework on-site, material damage, theft etc.
- **Lack of transparency in costs:** Costing in construction is less transparent than in other industries like retail and manufacturing. The way costs are recorded does not portray the benefit of logistics in removing non-value-added activities from construction process. Most of the time contractors prefer the way how to minimize the construction cost to increase its benefits at all. Therefore it is difficult know exactly the cost of logistics in the sector.
- **Inadequate tracking facilities on site:** There is lack of sufficient and real-time tracking and monitoring facilities for materials and equipment on construction site. At construction site level there is no enough material tracking and controlling system to easily identify quality and quantity of materials or how much is left in stockpiling (store) area. The key objective of this tracking system is to know and record about information regarding construction trucks, travel time, travel routes, onsite queuing times, and unloading times. Having such data will provide valuable input for keeping quality control, analysis of logistical efficiency in construction sector.
- **There is no clear definition of responsibility and authority for logistics, expected in a supply chain; in the construction industry.** Most construction sectors have no separate logistics department in their construction projects. It was considered as, if the contractor's increase numbers of professionals on site, final benefits from project will decreases. But indirectly because of poor logistics management on onsite; the costs were going more than cost of hiring logistics professional onsite. This makes the sector difficult to maintain efficient logistics system in the sector.
- **There is lack of proper performance measurement for construction logistics.** The construction logistics performance in delivery material, stock availability, timeliness of waste removal, quality and site storage quantity, material receiving time, vehicular

, order cycle time and etc are not easily measured on construction site. In general the trend of measuring logistics performances in construction sector is negligible. This because the bidding system in the construction industry competitive based. So, the lowest bidder gets the contract and the project is rejected or accepted based only on conformance to technical specification. But other performance measure such as logistics performance is not yet considered as criteria in hiring contractors. Therefore, to make the construction industry more productive; logistics performance should be considered and well improved in the sector.

Croydon Council (2012) also puts different factors that affect construction site logistics. Some of these factors are: Vehicle types (size, weight, and specification), routes used to and from the construction site for delivery of materials and vehicle and safety of other road users (pedestrians and cyclists), frequency of deliveries anticipated at each phase of construction, transport arrangements, materials required at each stage of construction and storage facility.

2.6. Impacts of poor construction logistics managements

The study made by Fadiya, (2012), Usman and Muhammad (2015) showed that the consequences of current inefficient logistics practice in the construction industry results the following impacts.

- **Materials Loss:** improper management of logistics in construction projects leads large amount of material to be lost or damaged. On site storage system and mechanism, wrong choice of selecting transporting mechanisms, having excess amount of material and etc. has been considered as the result of poor logistics management.
- **Delay in construction project delivery**: the delay of construction material delivery and material availability on construction site makes construction process to be interrupted. This interruption of construction makes the whole construction project delivery time to delay.
- **Operatives/plant collision:** poor logistics systems make the construction site disorganize and leads to onsite accidents such construction equipment/plant/ collision. This makes the construction process to be disrupted and behind the schedule.
- **Inaccurate data:** manual documentation system and mechanism makes the difficulty of accurate data filling and convey when needed. Inaccuracy of information regarding inventory, storage location and inaccurate reports makes construction process too difficult.

- **Excessive cost of construction:** Inefficient logistics makes the cost of construction to be excessively high because excess supply of materials, theft and materials damage are non-value-added costs

- **Poor image of the construction industry:** if logistics management not good the image of construction sectors are not good. Because poor logistics results in large quantity of onsite wastage, construction vehicles are not properly managed it increase urban traffic congestion truck accident and environmental pollution. This all contributes bad impression about the construction industry in society.

- **Poor quality construction:** if the logistics management is not good in construction sites maintaining quality is difficult. Allocating less skilled laborers', not properly handling material, less coordination and communication are the factors that contribute to poor quality construction in construction projects.

- **Promotes of corruption & robbery**: luck of non appropriate storage place, hiring of not well skilled laborers, onsite material production, using less quality materials and unavailability of material trucking systems are considered as main factors of inefficient logistics management that contributes to corruption and robbery in construction projects.

- **Fragmentation of activities within the construction process**: There are several construction teams who are involved in one construction projects. Such as design team and construction team and suppliers' teams. Absence of good communication and coordination systems because of poor logistics management in between those parties leads the construction process to be fragmented and untidy.

Papaprokopiou, (2010), Usman and Muhammad, (2015) prove that the poor consideration of logistics in a construction project may result to:

- **Traffic congestion due to trucks**: now days because of expansion of construction projects in urban areas (developing country) there are large number of construction trucks moves on urban road networks. Those trucks are moving around the city for delivering to construction or moving from site. The movement the number traffic volumes will be increased and traffic congestion could be created. Even on some large construction project sites; trucks makes queue for loading or unloading of materials when arrived on the site because of poor logistics management.

- **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.
- **Additional costs (unnecessary cost to the system):** all onsite wastages (project delivery time delay, material wastage, poor coordination among parties and etc leads the construction project to extra cost (cost overrun). The study by (BSRIA, 2002) 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. And it is given that site operations account for about 30 per cent of construction costs".
- **Transportation and environmental issues**: uncontrolled construction vehicles movement in urban areas or loading or unloading material causes increase of traffic congestion that will result to pollution (increased emissions in the environment).
- **Poor quality construction:** unorganized construction projects leads to poor construction works. If the quality of materials is not properly maintained and trained workers are not assigned appropriately it will inevitably make the production of quality construction more difficult and leads the project for poor quality outcome.
- **Increased project time:** construction projects will be not delivered in planed schedule if logistics management was not maintained efficiently.
- **Added risks to health and safety:** improper material storing, handling on site inevitably bring additional potential hazards. Manual material handling loading or unloading (either because product is in the wrong part of the site or because the right equipment is not available) adds to the health risks to those on site.

2.7. Methods and techniques to Improving poor construction logistics managements

There are various logistics technologies used by various construction projects in the different part of the world. These logistics techniques are used to simplify the logistics process and managements. According to Anthony et al. (2007) and Matouzko (2015) those logistics technologies are:

a) Just-In-Time delivery (JIT)

The JIT logistics were developed by the Japanese automobile manufacturer system Toyota as an essential part of The Toyota Production System. The basis of this system is the absolute elimination of waste (Bertelsen and Nielsen, 1997). Moreover, authors stated that; JIT delivery is a service of regular delivery or supply of materials to the construction site without

any delays. It is the mechanism of continuous supply of right quantity of material at right quality, in right time and at right place. In this case there is no as such onsite storage is needed. Therefore risk of material damage and loss, site congestion and safety issue will be minimized

b) Construction Consolidation Centre (CCC)

A Construction Consolidation Centre, also called Building Logistics Centre, is a distribution facility through which material deliveries are channeled to construction sites. It is the way of storing material from suppliers at some strategic places that will be at appropriate distance from all construction projects sites. Then from these centers materials are transported to each construction projects sites JIT deliveries systems.

According to Lundesjo (2011) consolidation centers has much advantage for construction sites. Such as: reduces freight traffic to site by up to 70%, increases productivity of site labor by 30 minutes per day leading to a 6% productivity gain and reduces onsite waste by 7-15% through less material damage and shrinkage. As it was stated here; efficient logistics management in construction projects can be achieved by applying construction consolidation center and through this, site congestion reduction, increase of productivity and reducing of material wastage; will be achieved.

c) Demand Smoothing

Demand smoothing is a way of looking on the project activities in the entire chain and identifying whether the performance can be "smoothed" to decrease transport resourced, materials and labor needed to carry out the activity. It helps to identify peaks and gaps in the materials' needs over a time period (Lundesjo, 2011). This indicates that, balancing of material, work force availability and work at hand allows to know for how long material will be enough who will be assigned on which activity and help know when another order should be made.. According demand smoothing concept any resources should be allocated when needed at appropriate time and place. Resources are not to be excess or shortage

d) On-site Marketplaces (MP*)*

This method is the way allowing the trade worker to bring their products on construction site and stored daily used materials (such as screw, bolts, drill bits, nuts, saw blades and etc.in a temporary ware house. Then the materials distributed to appropriate place when it is required. The major advantage with onsite market place is the guarantee of available supplies and material in the right and safe place. And also help the contractors/subcontractors not to have their own material storages on-site. Therefore; this enhance performance increase and

construction cost reduction (decrease transportation cost, decrease chance of material loss etc (Lundesjo, 2011).

e) Pre-assembled and offsite fabrication

Prefabrication is a good method for smoothing construction logistics. Because of all the components used for building construction is produced in factory and transported to the construction site for assembly. It ensures better quality, less material wastage, minimizes labor force cost, reduces onsite congestion and reduces construction time, lower amount of errors and decreases transport cost (Lundesjo, 2011).

f) Information and Communication Technology (ICT) Systems

ICT Systems are used to keep track and monitor materials through entire supply chain process (starting from production place until it is used or installed onsite). Tag systems was used to manage material deliveries with the help of different sort of information technology (bar code).Then Radio frequency identification (RFID) is used for reading of tags or barcode of that material on site for checking the material. The tag system, having relatively low cost, allows the monitoring of material to the point of final use and can offer detail information about how is it going on site. It helps to know easily how much material was used and how much material is left in the store (Lundesjo, 2011)

g) Third Party Logistics

It is way of involving the third person, rather than supplier and consumer in the logistics system for making better logistics system. The main purpose of such companies is to create safe, clean and work-efficient working place by efficient and better planed logistics. Therefore; contractors and subcontractors do not need to spend more time on rework and moving material within the site. The most of the material transportation is done by this third party during evening when the workers are away and cranes are available (to reduce work interruption for loading and unloading materials, to reduce onsite and urban congestion etc.). Every next working day workers have ready material in right quantity and on the right place. It makes safer and clean construction environment (Matouzko, 2015).

h) Applying Integrated/Systematic Construction Logistics

To improve construction project delivery system, construction industry had to develop an integrated project process, which is used to integrate all essential support services associated with construction projects (Egan, 1998).

The implementation of integrated logistics with a dedicated logistics team will benefit the construction industry for four important reasons: First, it can maximize the productivity and efficiency of skilled workforce. Second; It can maximize the quality of service by enabling a trained logistics service team Third, it minimize the negative environmental and social impacts that construction projects create by enabling the efficient flow of materials which can minimize the indiscriminate queuing of delivery vehicles around the construction site and minimize waste generation. Fourth, it can enhance the attainment of the highest possible standards of health and safety, for by minimizing collision accidents which can result from the chaotic distribution of materials on construction site (Egan, 1998).

Fadiya(2012);Usman and Muhammad (2015), puts primary and support logistics functions and services for integrated construction logistics. Primary logistics function and services are: material receipt, material storage, transportation (people and material) and material handling. Support construction logistics function and services are: cleaning, first aid, fire marshalling, waste management, reception, welfare, health and safety, traffic management, security and communication.

i) Using the Supply Chain Operations Reference(SCOR) model's performance measurements to improve construction logistics

SCOR model was created by the Supply Chain Council. The first version was developed in 1996. It is a framework for examining the supply chain in detail through defining and categorizing the processes that make up the chain, assigning metrics to such processes and reviewing comparable benchmarks. The supply chain operations reference model (SCOR) is a management tool used to address, improve, and communicate supply chain management decisions within a company and with suppliers and customers of a company(Thunberg,2013).

The purpose of SCOR model for construction sector is to find methods of improvement that can reduce costs or in any other way increase profitability or reduces the environmental impact of a construction project. The SCOR model composed of five main integrated processes: Plan, Source, Make, Deliver and Return. Performance of most processes is measured from 5 perspectives: Reliability, Responsiveness, Flexibility, Cost and Asset (Supply Chain Council, 2004)

Construction logistics can be improved using the SCOR model's predefined performance metrics related to the delivery process of the supplier and the source process at the construction site. This model was contains well-defined and standardized processes and

metrics for performance measurements such as: Perfect order fulfillment (POF), Source cycle time (SCT) and Cost to source (CS) (Thunberg and Persson, 2014).
POF, SCT and CS are SCOR model metrics that are used for process improvements and performance measurements.

Perfect order fulfillment (POF): The SCOR model defines the metric POF as the number of delivered orders that meet a customer's requirements in terms of order quantity and items, delivery date/time/ place, documentation and condition as a percentage of the total number of delivered orders. What is considered 'perfect' is agreed to by both the customer and supplier.
For one delivered order to be seen as perfectly delivered, the right product has to be delivered in the right quantity, at the right time and place, with the correct documents and in the right condition. If at least one of these conditions is not met, it is not a 'perfect' delivery (Thunberg and Persson, 2014).
Source cycle time(SCT): The aspects involved in assessing the SCT are the time it takes to identify sources of supply (if applicable), select supplier and negotiate (if applicable), schedule product deliveries, receive product, verify product, transfer product to closest inventory-holding area and authorize supplier payment. It is assessing responsiveness to calculate the order fulfillment time, i.e. the total elapsed time for receiving an order, producing the products and delivering the products.
Sourcing time increased in some construction site because ,contractors orders some materials for a long period and to get discounts, this often results in a lot of material to unload and store.
Even at large construction site it is difficult to distinguishing one activity from another in receiving and transferring products. Sometimes, the activity of transferring unloaded materials to the inventory area can occur at the same time as the activity of unloading (i.e. receiving) the materials. The unloaded materials may first be stored temporarily on the ground before being transferred to the inventory area (Thunberg and Persson, 2014).

Cost to source (CS): cost to make, cost to deliver, cost to plan, cost to return and cost to mitigate supply chain. The aspects involved in assessing the CS are the costs of managing suppliers and material acquisition. The cost variables considered when calculating the CS for one order and all incoming deliveries. The included costs are cost to order, cost to receive, cost to verify materials, cost to transfer and cost to authorize supplier payment (Thunberg and Persson, 2014).

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3. Methodology

3.1. Research design

A descriptive research was employed to obtain a comprehensive understanding of the impacts of poor logistics management in the building construction projects.

A mixed concurrent embedded strategy with big emphasis was given to quantitative method was employed to collect data of both qualitative and quantitative types (Assefa, 2016). This method has been chosen to support the quantitative data by the information obtained through qualitative data.

3.2. Data sources

The data for the research was obtained from both primary and secondary sources. Primary data was collected from respondents (project manager, project consultant, site engineer, site foreman and laborers) through close ended questionnaire and secondary data was obtained from literature review.

3.3. Study Area

Addis Ababa city, capital of Ethiopia is situated in the plateau of central Ethiopia in the North-South oriented mountain systems neighboring the Great Rift-Valley. It is located between the geographical coordinates of 09°02'N latitude and 38°44'E longitude, with an elevation ranging from 2000-2800msl and it is the highest capital in Africa and the third highest capital in the World. It has total population of 3,384,569 according to the 2007 population census, with annual growth rate of 3.8%.

The city has a decentralized system of municipal government that is composed of 10 sub city administration (total of 99 kebeles which is smallest local unit of the city administration).The crude map provided in **Figure-3,** indicates the bounderies of Addis Ababa and its ten sub cities which are, Arada, Addis ketema , Lideta, Kirkos,Yeka, Akki-Kality, Nfas Silk –Lafto, Kolfe Keranyo and Gulalle.

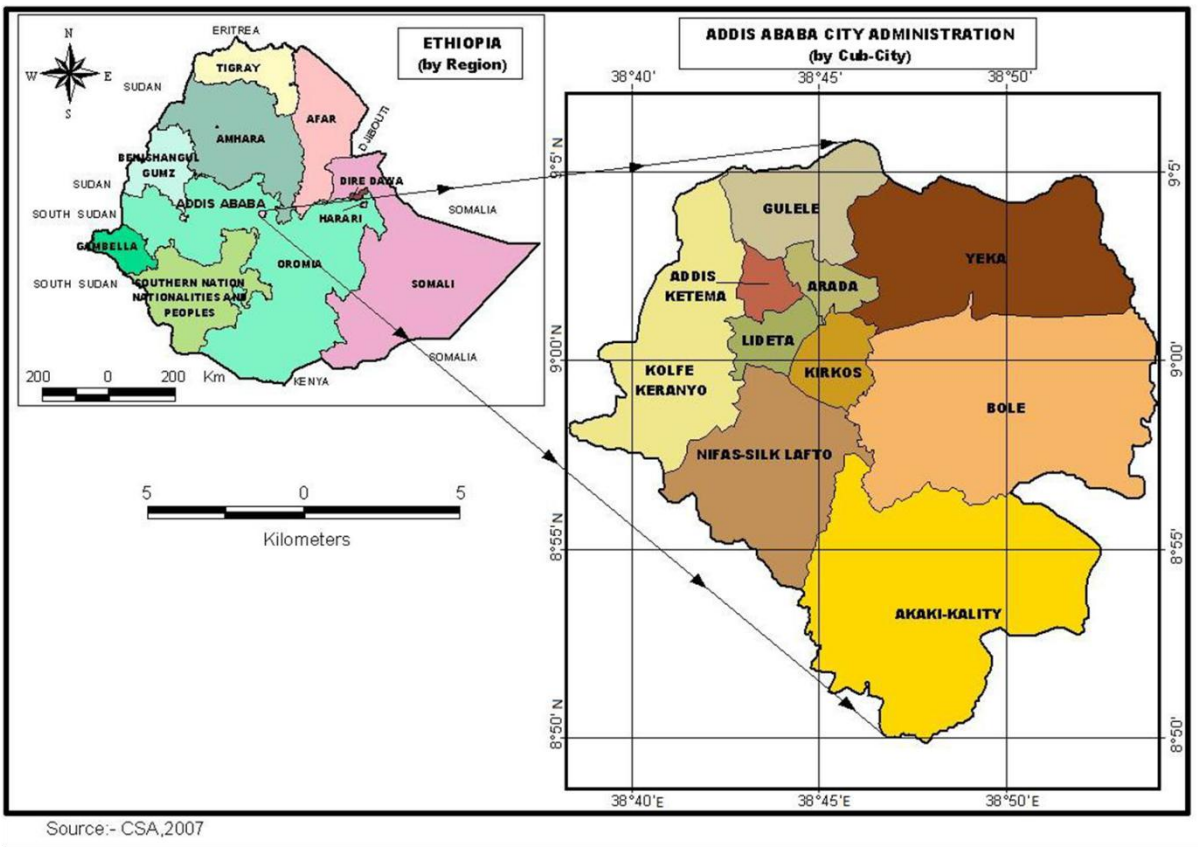

Figure 3. Location map of Addis Ababa in relation to the Ethiopia (Source:CSA2007)

The target group considered in the research was selected grade one building contractors in Addis Ababa who were registered and renewed their license. Based on this, the researcher obtained list of grade one building contractor those who were registered and renewed their licensee from July 8 /2016 up to Februry7/2017; budget year at Ministry of Urban Development and Housing constructions.

Building contractors are contractors who are qualified to undertake building construction and supplementary works to buildings. Grades of building contractors categorized based on equipment, man power and turnover requirement. To be registered as grade one building contractor; each contractor should fulfill minimum requirement of capital more than 210 million ETB, professionals (one professional engineer-III, one associate engineer III, one engineering Aid II), equipments (six loader, two excavator, one tower crane or telescopic mobile crane with boom extendable, six dam truck & three pick up) (Ministry of Urban Development and Construction, 2013)

Based on the obtained list, there were 52 contractors in number who were registered and renewed license in specified time. From these 52 grade one building contractors from eight sub city of Addis Ababa; 2 of them were from Addis Ketama subcity, 4 of them were from

Akaky Kality, 20 of them were from Bole, 3 of them were from Gulale, 7 of them were from Kirkos, 3 of them were from Lideta, 7 of them were from Nifas Silk Lafto and 6 of them were from Yeka subcity.

In order to limit researcher bias and reduce number of the sample size for the convenience of the research, the major criterion in selecting the firms was based on comparing the number of grade one building contractors from each sub city who were registered and renewed their lenience in specified time and picked those contractor from Bole sub city because they are more in number. Finally; convenience sampling was used to pick one project site from each selected contractors because the homogeneity of construction projects in Ethiopia and time and resource limitation (Tefera, 2013, Tebeje and Teka, 2015).

3.4. Sampling technique and sample size

Purposive sampling and cluster sampling techniques was used to select target respondents acting in the construction projects (project manager, project consultant, site engineer, site foreman and laborers were identified for the questionnaire as the target population of the study.

Based on this; 20 grade one building construction projects purposively (homogeneous sampling) were selected and 1 project manager, 1 project consultants, 1 site engineers, 1 foreman, purposively and 5 laborers randomly, selected from each project to fill out the questionnaire. The questionnaire was designed to analyze the perspective of construction site actors toward the impacts of poor logistics management in building construction projects.

The overall sampling frame of the research contained 180 participants. These different respondent categories; were used to obtain fair answer from different perspective and to support scientific analysis based on their responses.

3.5. Methods and procedures of data collection

For the purpose of collecting primary data by structured survey, the questionnaires on the Impacts of poor logistics management in building construction projects was designed, mostly based on literature review on previous works by (Agapiouet al., 1998; Papaprokopiou, 2010; Fadiya , 2012; Usman and Muhammad, 2015; Regassa,2015; Lundesjö ;2015)

The questionnaires were structured to provide relevant information on impacts of poor logistics management on building construction projects. These questions were made simple and straight forward in order to ensure maximum responses from the respondents. The addresses of the selected contractors were identified and each particular contractor was contacted to ask the willingness to respond to question. Finally, information of the location of their particular building projects in Addis Ababa (10, 8 and 2 of them were in Bole, Yeka and

Arada sub-city respectively) was obtained from each building contractor. The process of data collection by the questionnaire was administered by close follow up, and necessary clarification for respondents during filling questionnaire in manner to minimize data collection time and to avoid confusion.

3.6. Method of data analysis

The collected data has been analyzed using statistical software SPSS version 24 and Microsoft office excels 2007. Moreover, the SCOR model metrics was employed to evaluate the performance of logistics management of building projects included in the survey based on some of the identified poor logistics management impacts.

Both descriptive and inferential statistics have been employed to summarize and draw conclusions about the population from the sample data.

For ease of analysis, the response distribution on the 5 point Likert scale of *["Very High =5, High=4, Medium=3, Low =2, Very low=1"] were used (Tabaje and Teka 2015).* Hence, the statistical tool frequency distribution has been employed to see the response distributions on the 5 point Likert scale.

The scores assigned to each impact of poor logistics managements by the respondents were entered in to and consequently the responses from the questionnaires were subjected to statistical analysis for further insight. The contribution of each of the impacts of poor logistics managements to overall construction project productivity was examined and the ranking of the attributes in terms of their criticality as perceived by the respondents. Relative Importance Index (RII) was employed to empirically determine the impact of poor logistics management in building construction projects. It used to know the extent each impact have on the performances of the project based on the perspectives of the building constructions site main actors (respondents) was seen individually and in combination. Relative Importance Index (RII) or weight is a type of relative importance analyses.

According to Johnson and LeBreton(2004), RII aids in finding the contribution a particular variable makes to the prediction of a criterion variable both by itself and in combination with other predictor variables.

RII was computed using Equation (1) and the results of the analysis are presented in Table 2 and 3.

$$RII = \frac{\sum W}{A*N} (0 \leq RII \leq 1) \cdots\cdots\cdots\cdots \quad (1)$$

Where:

W- is the weight given to each factor by the respondents and ranges from 1 to 5, (where "1" is "Very low" and "5" is "Very high")

A-is the highest weight (i.e. 5 in this case) and;

N - Is the total number of respondents (180, in this case)

4. Result

4.1. Gender of the respondents

The relevant socio demographic variables of respondents that the research covered include, gender, level of education, occupational status and work experience.

The survey shows that; from the total respondents who were involved in the survey 69.4 % of the respondents were males and the remaining 30.6 % were females (**Figure-4**).

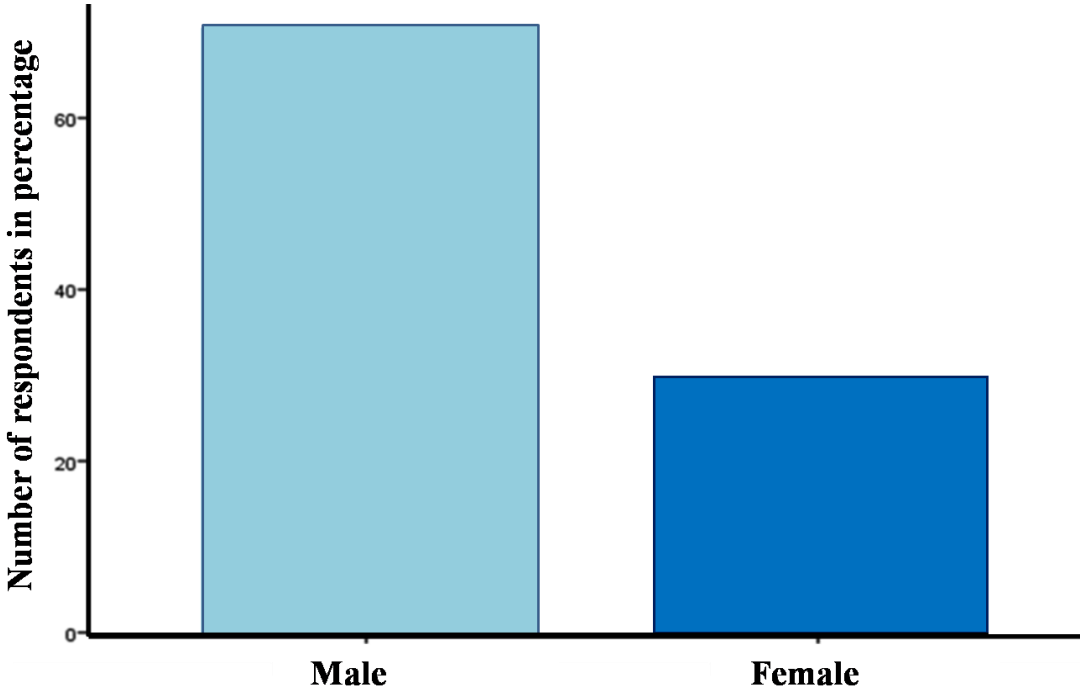

Figure 4. Respondent in terms of gender

4.2. Respondent's level of education

As it can be seen from **Figure 5**, from the total 180 respondents who participated in the research; 39.4% had primary school level education, 12.8% secondary school level education, 5 % had technical school level education, 10% had advanced diploma, 26.1% had bachelor degree and 6.7% had master's degree complete.

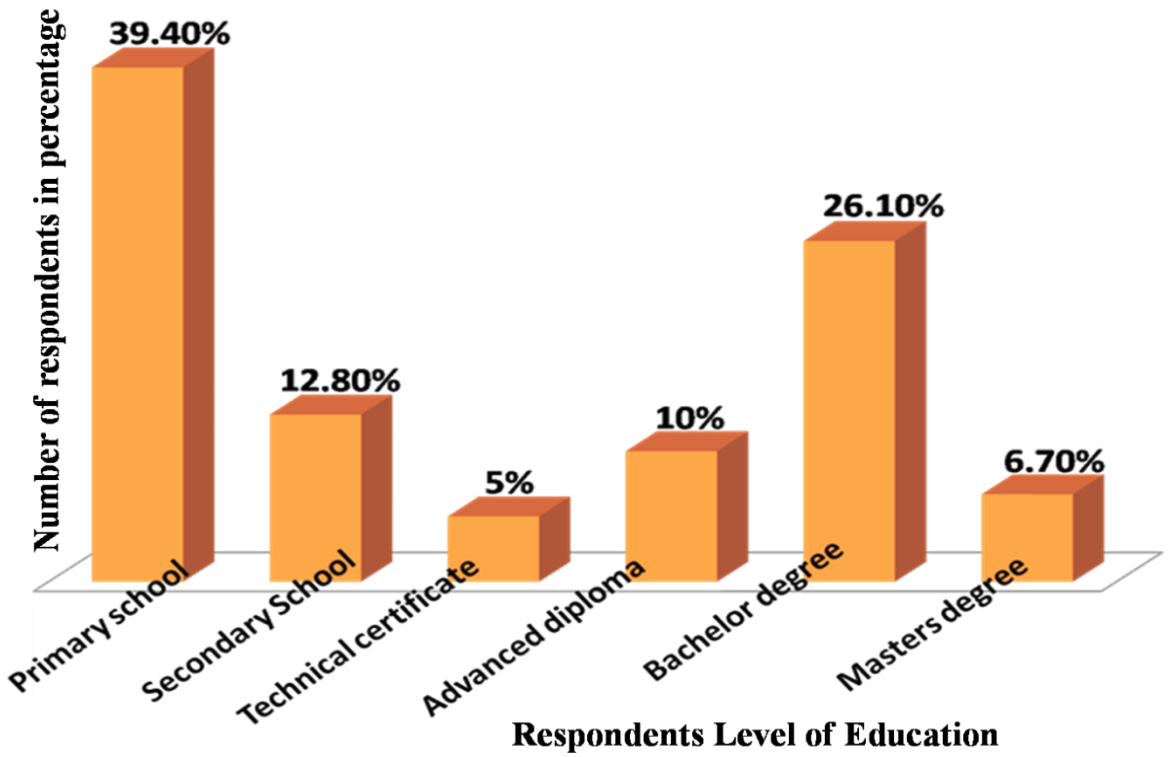

Figure 5. Respondent's level of education

From this **Figure 5**, it is noticed that only few (5%) of the respondents had technical training. This indicates that there is a need to increase chance of technical training which could contributes to the performance of construction projects.

4.3. Experience of respondents

As it can be seen from the survey result; more number of the respondents has less than 5 years of experience. More than 16 years of experience were few in number and also have been worked on project manager position. The profile and experience of the respondents suggest that there were sufficient exposure to make the information acquired trustworthy (see **Figure 6**).

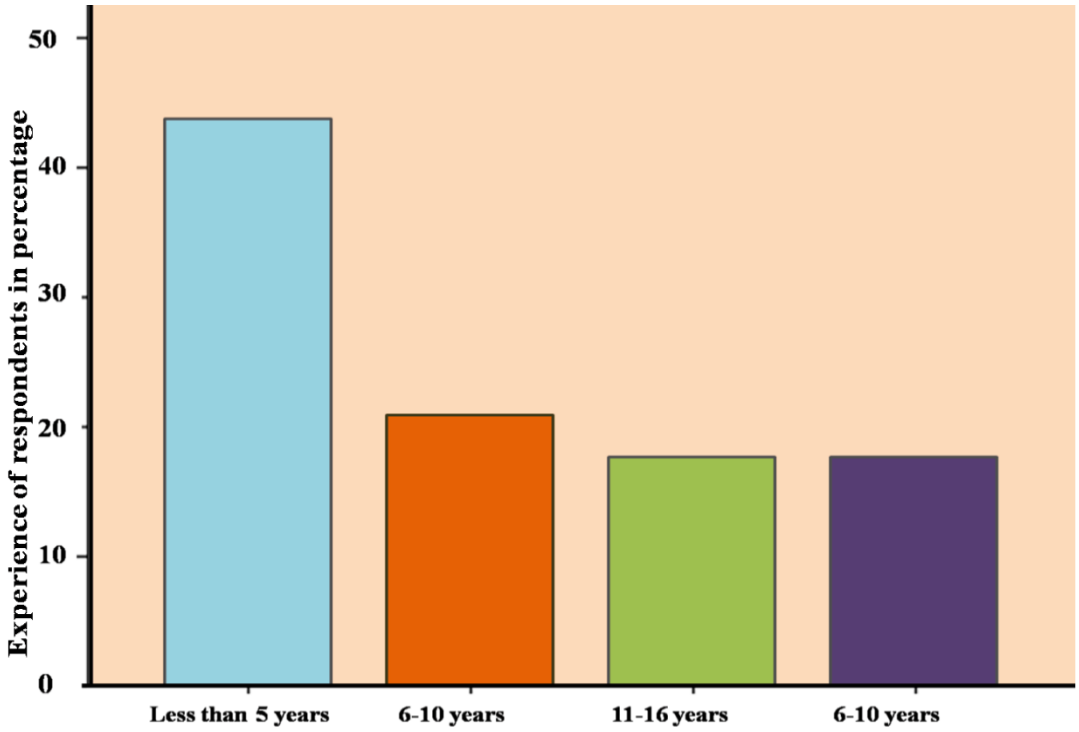

Figure 6. Experience of the respondents

4.4. List of aggregate RII and Rank for each impacts based on weight given by respondents

Based on survey conducted, the total aggregate RII and Rank of each variable was calculated and presented. Accordingly, based on the respondents perspective and weight given for each variables and calculated RII; the first top ten impacts of poor logistics management in building construction projects were taken as the major problems in project sites and the last ten out of impacts with lower ranks were not considered as major problems in the construction projects sites (see **Table-1**)

Table 1. Aggregate RII and Rank for each 30 variable by 180 respondents

Impacts	Weighted Average	
	RII	Rank
Delays (Increased project time)	0.931	1
Cost overruns (Unnecessary cost to the system)	0.909	2
Loss of project efficiency	0.761	3
Difficulty in checking the quantity of materials	0.746	4
Ordered materials never arrive on time	0.730	5
Fraudulent activities	0.725	6
Queuing of trucks, (unwise use of trucks)	0.722	7
Transportation and environmental issues(emisions in the enviroment)	0.717	8
Poor quality construction	0.715	9
Material loss (damage)	0.714	10
Accidents	0.709	11
Poor image of construction industry	0.708	12
Improper allocating the storage areas or improper storage	0.700	13
Challenge of planning and efficient coordination of materials, tools, and equipment	0.700	13
In accuracy of data (poor information flow)	0.699	15
Traffic congestion	0.690	16
All ordered material never used (excess ordering or wastage)	0.687	17
Difficulty in managing the flow of materials	0.687	17
Low concentration of workers on their main activity	0.686	19
Disorganized site	0.685	20
Difficulty in assuring its quality of materials	0.685	20
In efficiency of construction site security, storage and work areas etc.	0.682	22
Inefficient handling of materials(increase costs and decrease productivity)	0.682	22
In efficient safety equipment	0.679	24
Difficulty in updating the stakeholders(poor communication)	0.676	25
Work interruption due to material delivery delay	0.676	25
Too late material ordering	0.674	27
Difficulty in coordinating the construction process	0.667	28
Wrong time delivery of materials	0.661	29
Reduction of workers productivity(half of their working time by moving material)	0.646	30

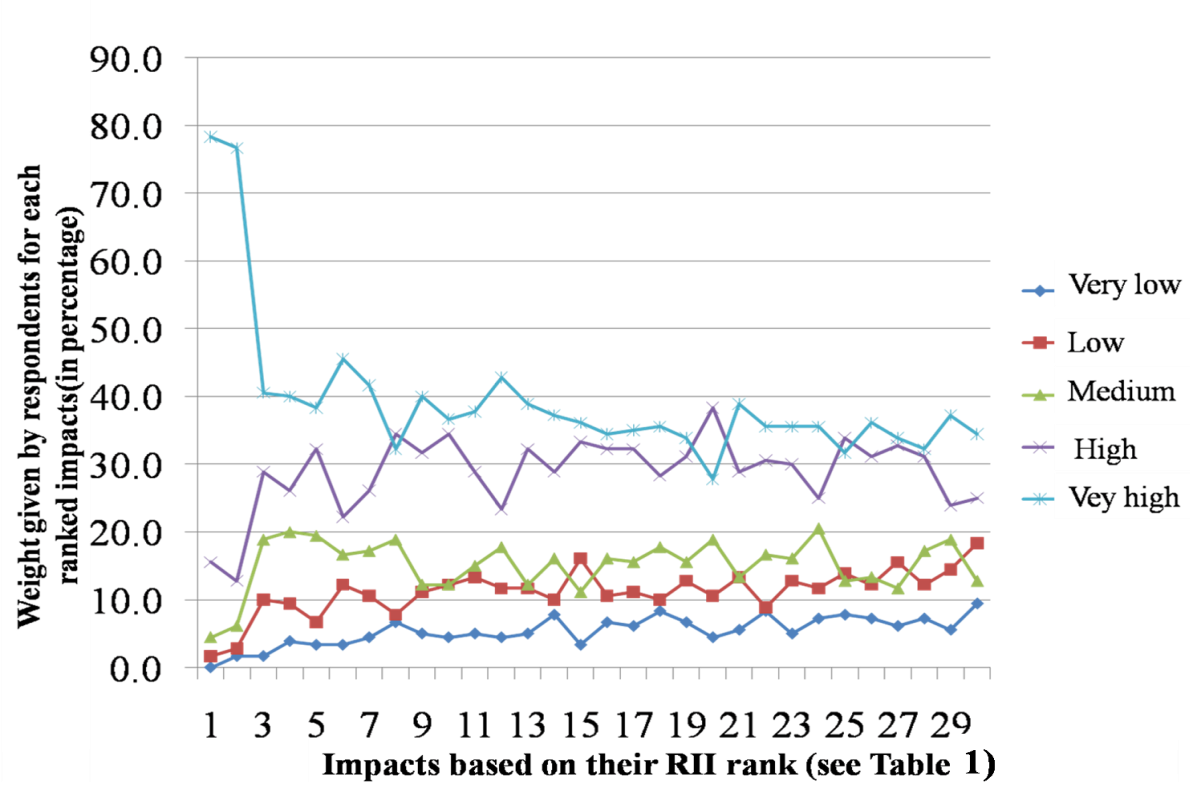

Figure-7. Percentage of weight given by respondent based on Likert scale (1- Very low and 5-very high) for each impacts of poor logistics managements (Numbers in x-axis is indicate impacts order in (**Table-1**)

As it can be seen from the **Figure-7** more than 75 % of the respondents give vey high weight for more of impacts poor logistics managements. This indicate that, the impacts that ranked as very low weight is less in percentage and logistics management problems are one of the critical issue in building construction projects in Addis Ababa.

4.5. Rank for each impacts of poor logistics managements based on respondent's occupational category perspective.

The conducted survey shows that, the RII of each variable (30 impacts of poor logistics management) was calculated separately for project managers, project consultants, site engineers, foreman and laborers. Finally after RII and Rank was calculated based on respondents' occupation, the final aggregate RII and Rank was given for each variable based on computed results (**Table 2**). As it can be seen from the table, the RII and Rank given by the individual occupation for different variables were varying.

Table 2: Computed RII and Rank for each impacts of poor logistics management based on occupational category (project managers group, project consultants group, site engineers group, foreman group and laborers group)

Impacts	Project Managers		Project Consultants		Site Engineers		Formans		Laborers		Weighted Average	
	RII	Rank	RII	Rank	RII	Rank	RII	Rank	RII	Rank	RII	Rank
Delays (Increased project time)	0.940	1	0.930	1	0.890	1	0.930	1	0.966	1	0.931	1
Fraudulent activities	0.660	19	0.640	10	0.720	5	0.730	10	0.874	5	0.725	6
Cost overruns (Unnecessary cost to the system)	0.930	2	0.930	1	0.830	2	0.910	2	0.944	2	0.909	2
Loss of project efficiency	0.670	17	0.780	3	0.650	10	0.860	3	0.846	18	0.761	3
Difficulty in managing the flow of materials	0.690	14	0.610	17	0.650	10	0.660	22	0.824	26	0.687	17
Difficulty in assuring its quality of materials	0.610	28	0.590	21	0.650	10	0.700	17	0.874	5	0.685	20
Difficulty in checking the quantity of materials	0.720	8	0.720	4	0.740	3	0.710	14	0.838	20	0.746	4
Difficulty in coordinating the construction process	0.670	17	0.540	28	0.610	21	0.680	20	0.836	22	0.667	28
Poor quality construction	0.690	14	0.630	11	0.650	10	0.730	10	0.876	4	0.715	9
Challenge of planning and efficient coordination of materials, tools, and equipment	0.680	16	0.620	13	0.640	16	0.720	13	0.838	20	0.700	13
Inefficient handling of materials(increase costs and decrease productivity)	0.550	30	0.600	19	0.700	6	0.690	19	0.868	8	0.682	22
In efficiency of construction site security, storage and work areas etc.	0.640	22	0.610	17	0.680	7	0.630	27	0.852	14	0.682	22
Reduction of workers productivity(half of their working time by moving material)	0.610	28	0.500	30	0.650	10	0.660	22	0.808	29	0.646	30
Low concentration of workers on their main activity	0.730	5	0.580	23	0.580	29	0.710	14	0.830	25	0.686	19
Poor image of construction industry	0.720	8	0.650	8	0.640	16	0.660	22	0.868	8	0.708	12
Disorganized site	0.630	24	0.620	13	0.610	21	0.730	10	0.836	22	0.685	20
Work interruption due to material delivery delay	0.740	4	0.540	28	0.610	21	0.640	25	0.852	14	0.676	25
Queuing of trucks, (unwise use of trucks)	0.620	27	0.700	6	0.660	8	0.770	5	0.858	10	0.722	7
Improper allocating the storage areas or improper storage	0.730	5	0.590	21	0.630	19	0.670	21	0.880	3	0.700	13
Ordered materials never arrive on time	0.710	11	0.690	7	0.740	3	0.640	25	0.872	7	0.730	5
All ordered material never used (excess ordering or wastage)	0.720	8	0.580	23	0.660	8	0.620	29	0.856	11	0.687	17
Material loss (damage)	0.650	20	0.720	4	0.550	30	0.800	4	0.852	14	0.714	10
In efficient safety equipment	0.700	12	0.580	23	0.590	27	0.700	17	0.824	26	0.679	24
Transportation and environmental issues(Traffic problem increase of emisions in the enviroment)	0.790	3	0.630	11	0.610	21	0.750	6	0.806	30	0.717	8
Traffic congestion	0.650	20	0.620	13	0.590	27	0.740	7	0.848	17	0.690	16
Accidents	0.700	12	0.620	13	0.650	10	0.740	7	0.834	24	0.709	11
Difficulty in updating the stakeholders(poor communication)	0.730	5	0.600	19	0.620	20	0.620	29	0.812	28	0.676	25
In accuracy of data (poor information flow)	0.640	22	0.650	8	0.610	21	0.740	7	0.854	13	0.699	15
Too late material ordering	0.630	24	0.550	27	0.640	16	0.710	14	0.840	19	0.674	27
Wrong time delivery of materials	0.630	24	0.580	23	0.610	21	0.630	27	0.856	11	0.661	29

5. Discussion

It could be stated that most building construction project productivity in Addis Ababa is not efficient because of management of construction logistics at construction site is relatively inefficient based on the results of current thesis works. Even one impacts of poor logistics managements results in other impacts which mainly increases inefficiency of construction projects.

As it can be seen from the (**Figure 8**), late delivery of construction material causes work interruption, decrease workers productivity and loss of project efficiency. Poor communication in construction projects caused wrong delivery of materials and also ordered materials not arrive on time on construction site. Generally each impacts on each construction processes sum up and made the project to be delayed and finally leaded to the project to cost overrun.

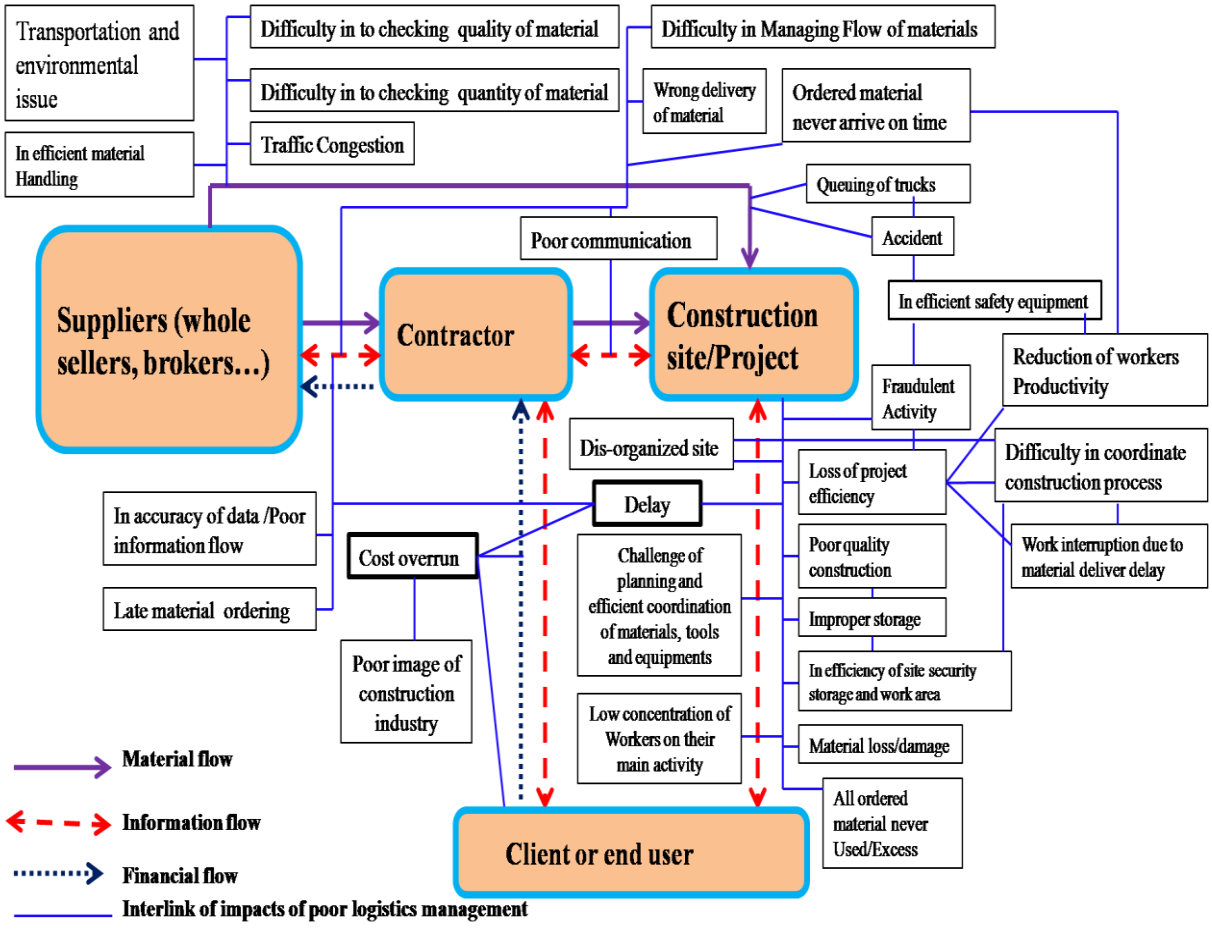

Figure -8. Interlink of impacts of poor logistics management in building construction projects

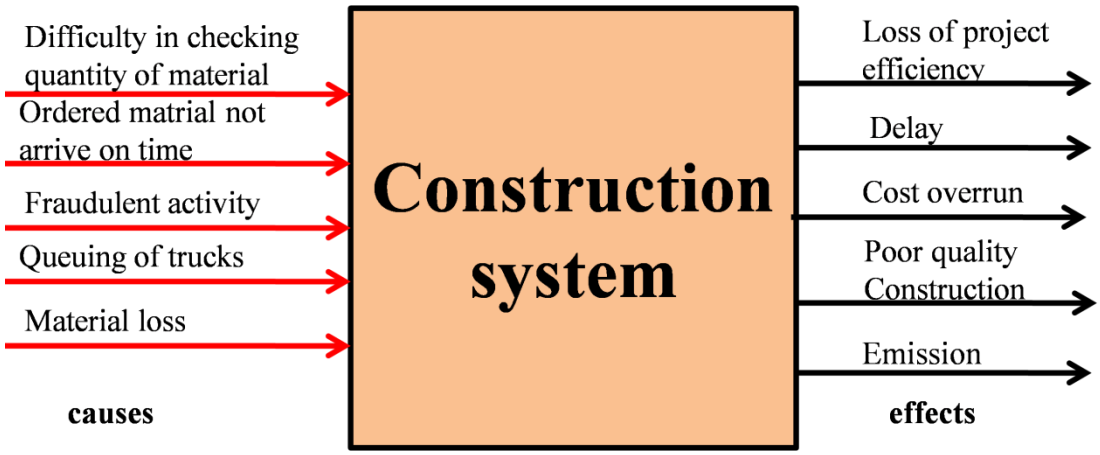

Figure 9. The causes and effect **top ten** impacts of poor logistics management in building construction projects based on RII rank from respondents opinion

As it is illustrated on **Figure 9,** loss of project efficiency, difficulty in checking quality of materials, ordered materials never arrived on time, fraudulent activities, queuing of trucks and material loss (wastage) were considered as the main cause (imputes) for output(such as: project delay, cost overrun, poor quality construction and transport and environmental problems). This showed that, how poor logistics management impacts construction system of building construction projects.

As it was seen from the result, it could be confirmed that; logistics management that construction sectors uses are not developed well. Such result has also been reported by earlier researchers (Strategic Forum, 2005, Fediya, 2012, Regassa, 2015). According to the authors the main factors that had impacts on poor logistics management on construction projects were: short-term nature of construction process, fragmentation of activities within the construction process, lack of transparency in costs, inadequate tracking facilities on site, non existence of clear definition of responsibility and authority for logistics in construction industry, lack of proper performance measurement for construction logistics etc. In line with this Croydon Council (2012) reported that vehicle types (size, weight, and specification), routes used to and from the construction site for delivery of materials and vehicle and safety of other road users (pedestrians and cyclists), frequency of deliveries anticipated at each phase of construction, transport arrangements, materials required at each stage of construction and storage facility are the major factors that affects construction logistics managements.

The result obtained in the current work based on survey conducted on selected 20 construction project sites and result obtained (See Table- 3) shows that most construction projects are impacted by poor construction logistics managements.

Delay:

As it can be seen from **Table 2**, the result suggested that project delay with average weighted RII (0.931) is ranked as first impact of poor logistics management on construction site projects. It was selected as first impacts by project managers, consultants, site engineers and laborers. This shows how the delay affects the construction projects. Most of the construction projects in Addis Ababa are not completed on expected time.

Based on the respondent ranks, delay is the first impacts of poor logistics management on construction projects with average value of RII (0.931). This shows that poor logistics management has been delayed the construction projects and makes the projects not to meet the intended purpose. In line with this; Usman and Muhammad (2015) confirmed that, poor construction logistics management affected construction sites by different obstacles resulted into delay. Poor logistics can cause bottlenecks which literally strangle the life out of project. It impacts production and productivity causing delays and adding to costs. An unexpected delay will extend the overall duration of the project activities and entails an increase in project costs. It produces time-associated cost effects that will increase the resource consumption and will require extra time to reach project success. Matouzko, (2015), also confirmed that logistics results in delayed projects and Lundesjo (2015) agrees that most of those features of construction projects that point to poor logistics will add to the time of construction projects (delay). Regassa,(2015) confirmed that; most of the government construction projects are not delivered on time (delay) because of poor logistics management in the construction sector.

Cost overrun: As it can be observed from the **Table-2** cost overrun is ranked as second major impact of poor construction logistics management, with total average weight of (RII=0.909). It was ranked as first by consultants and the second by project managers, site engineers and laborers. The variation in rank shows that consultants always needs to minimize the project costs, as cost of the project determine the productivity of the contractors.

The conducted survey shows that cost overrun is ranked as the second the impacts of poor logistics management. Based on results obtained cost overrun was becoming problems of most of the construction projects. This caused because poor planning and forecast material cost and labor, luck of coordination and communication. The result also supported by Usman, Ahmad Muhammad Ibrahim (2015) construction sites project was affected construction

logistics management by different obstacles resulted into project cost overruns. Fadiya (2012) also shared these ideas that, the inefficiency of construction logistics creates excessive cost (cost overrun). In line with Navon and Berkovich,(2005)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. By adding Matouzko (2015) material flow, project management situation adds a lot of uneasy costs and environmental impacts due to the poor logistics on sites.

Loss of project efficiency: As indicated in **Table -2**, loss of project efficiency is ranked as the third main impacts of poor logistics management in construction projects with weighted Average of (RII=0.761).It was ranked as 17^{th} ,10^{th} and 18^{th} by project managers, site engineers and laborers respectively. However, it was ranked as third by weight given by consultants and foreman. The difference in this regards shows that project managers and site engineers do not give attention to project efficiency and related loss

The research shows that based on respondents perspective rank loss of project efficiency due to poor logistics management were ranked at third. The result confirmed that if construction site logistics is poor, the project cannot be maintaining its efficiency. Because of this reason most construction are not meet the expected goal. In line with Usman, Muhammad (2015); Ineffective management of logistics will result in affecting the efficiency of workforce, by reducing their overall productivity. Such a loss of efficiency interferes with the performance of an entire project.

Because luck of equipment, material an availability, material, not assigning write person at right place, lack of human power, workers dissatisfaction(low payment) in construction,some of the construction project efficiency is very low. Almohsen and Ruwanpura (2011) confirmed that such a loss of efficiency interferes with the performance of an entire project, and reduces management's chances of meeting project quality, budget, and time objectives.

Difficulty in checking quality of materials: As indicated in the result (**Table-2**), difficulty in checking quantity of materials is one of the top impacts of poor logistics management on construction site. It was ranked as fourth, based on average weighted (RII=0.746). It was ranked 8th, 4^{th}, 3rd, 14th and 20^{th} by project managers, consultants, site engineers, foreman and laborers respectively. The rank given by consultants is closer to total average weight rank given by all respondents. This could be because consultants are mostly assigned by client to supervise the construction projects. The consultant has the responsibility to check the quality of material used and construction. But constructors, making some mechanism how to reduce

the numbers, quantity specified on document to maximize their benefit. The consultant has responsibility of checking whether the material is used and progress of construction. But from contractor's side there is less transparency regarding the quantity specified on document and as contractors often tends to maximize their benefits. Therefore consultants have responsibility of controlling the quality of construction projects. When project is complex and volume of material used on the site is large in number, the quality control needs more attention as it is difficult to check quantity and quality different materials used on construction site.

Because good method and procedures were not established at construction site, the way of checking the quality of the material is very difficult. If material quality deficiencies are not discovered in time, extensive reworks could be a fact if the materials are assembled (Vrijhoef and Koskela 2000).

If the number of the number of supplier is maximum and the project scope is complex; ensuring quality was difficult on project site. Some suppliers show the real material for samples and brought the other phony material that is completely similar to the previous one. Because of the complexity and tidiness of the construction site sometimes it is too difficult check all material one to one on site. When the volume of the material supplied on the site increases it also very difficult to check each piece quality of material (e.g reinforcement bar). Poor logistics management in construction site brought the difficulty in checking quality of material.

Ordered materials are never arrived on time: The conducted survey result (**Table-2**) shows that ordered materials never arrive on time is ranked as 5^{th} with average weight (RII=0.730). This shows most of the construction projects suffers material delivery problems. It was ranked 11^{th}, 7^{th}, 3^{rd}, 7^{th} and 5^{th} by project managers, consultants, site engineers, foreman and labors respectively. The rank showed that given for this impact is more of nearest to each another, which shows material delivery is as was considered as major problems in construction site in Addis Ababa.

Most of the time; material ordered for construction projects never arrived on time and the work was stopped for some times. When the wok stopped, it leads the project to delay and cost increase because of poor logistic management especially in material procurement, the material used for the construction projects .This the survey also showed that ordered materials were not arrived on time because of poor logistics management. The reason why ordered material were not arrive on time is: supplies problems, unavailability of material on market, retailers hide material in their store to make shortage on market and to sell with higher price when customer has no chance to buy from other place(e.g. cement, some

materials as per the specifications), brokers fabrication on sale price of material. Temporary social instability and weather conditions, luck transportation facility, road infrastructures problems, traffic congestion, supplier performance, market inflation, distance of the site from material production or supply, makes material not to arrive on time when needed at construction site. The result also supported by Sullivan et al., (2010) that; 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. Baladhandayutham and Venkatesh (2012) describe that only about 16 % of the incoming deliveries are arrived on time.

One of the causes of construction delay is delivery lateness. It should be mentioned that these authors regard a delivery as on time if it arrives within 60 days before the desired delivery date. It can be argued that this is a quite extensive period. Therefore, the result confirms that, in construction, material delivery has been a problem and also, the manual process of assessing materials at the point of delivery on construction site is time consuming.

Fraudulent activities: As indicated in the result (**Table-2**) fraudulent activity is one of the top impacts of poor logistics management on construction site. It was ranked as sixth, based on average weighted (RII=0.746). It was ranked 8^{th} , 4^{th} ,3^{rd} ,14^{th} and 20^{th} by project managers, consultants, site engineers, foreman and labors respectively. The consultant ranks the same with total average weight (RII=0.725). Therefore the results show that consultants have awareness out the about severity of the fraudulent activities in the construction projects. Site engineers' rank also shows that fraudulent is one of existing problems in construction projects. This is one of problems which some contractors use as a means of increasing their profits comprising quality of buildings. Construction sector is complex sector in which maintaining construction fraudulent activity is difficult without promising efficient logistics management. The result from the survey also shows that fraudulent activity is one that affecting construction activity in construction sector. Fraudulent activity such as bribe, using less standard material, paying for extra time to rented machine for the time they are not operated, unclear overtime payment for daily labor. In line with this idea; Usman and Muhammad (2015) confirmed that "Ineffective management of logistics will result due to certain obstacles that affect the construction logistic management which resulted into fraudulent activity in the sector". According to the respondents, the construction site frauds are not seen, but their result. The major fraudulent activities of construction sites are: false billing (Purposely overstating the amount of labor, materials and other equipment required completing a project), Bid/contract rigging (When suppliers in the market collude to fix prices or direct customers to use certain contractors. This can include bribery or kickbacks,

Bribery/corruption (Often collusion by two parties entering into a secret agreement whereby a financial incentive is made for securing a particular outcome. Examples include the awarding of a public or private contractor purchasing property on 'favorable' terms. Fraudulent activity is often controlled by an employee but can also be done by external entities through falsified company documentation or email addresses, change order manipulation (diverting lump-sum cost to time and material cost by initially budgeting expenses as a lump sum then billing for time and materials related to change orders, Theft or substitution of materials(taking material from the work site for personal use or using lower-grade material than quoted, which might result in subsequent repairing or replacement), False representation(This might involve using undocumented workers; falsifying minority content reports, test results or insurance certificates; non-compliance with environmental regulations.

Queuing of trucks:- **Table-2**, shows that this impact of poor logistics management in construction projects was ranked as 27^{th}, 6^{th}, 8^{th}, 5^{th} and 10^{th} by project managers, consultants, site engineers, foremen and labors respectively. It shows that consultants, site engineers and foremen rank are nearest to the average weight (RII=0.722). It indicated that, the problems of the trucks management in the project has been one of problems of the poor logistics management.

Trucks queue are one of the construction site, especially in conjugated site. When construction trucks are not wisely used the trucks are simply become idle on site, and make queue and make the site more congested. Sometimes if the appropriate time delivery of material is not maintained and storage place is not prepared well, it is difficult to unloading the material. When volume of the site work increases congestion and trucks queue will increases traffic during peak hour, high volume traffic in urban areas, special event traffic congestion and increase of heavy construction trucks movement in urban areas make construction trucks to queue and make idle. Amornsawadwatana (2011) shows in a study that number of unloading activities and the total waiting time for a truck on-site can be reduced with about 24 % and 33 %, respectively, if distribution centers are used. But in this case there are no mechanisms like distribution centers to solve such problems. Therefore result from the survey showed that most construction projects have the same problems of managing construction trucks. These shows there are poor logistics management in the sector.

Transportation and environmental issue**:** As it can be seen from the research results (**Table-2**) this impact of poor logistics was ranked as 3^{rd}, 11th, 21^{st}, 6^{th} and 30^{th} by project managers, consultants, site engineers, foreman and laborers respectively. This shows that there are different gaps between the ranks from different perspectives. Project managers considered

and ranked this impact as it was higher impact, but labors and foremen ranked it as it was lower impact. This difference shows that; - foremen and laborers awareness on the impacts of transportation and environmental issues of construction sectors is lower. Unplanned truck movement in building construction sector creates to use more energy and increase air pollution that contributes to global warming through emission of carbon dioxide. As it can be seen from the result transport and environmental issue is one of the construction industries problems because of poor construction logistics management. In most of the construction project the construction trucks whether they are loaded and unloaded most of them moving here and there in city of Addis Ababa. Most of the trucks moving in the city increase the impacts such as noise and carbon monoxide emissions create direct and harmful effects on the environment. This also has its impact on health.

Poor quality construction: **:** As indicated in the (**Table -2**) the rank and weight given for this impact shows that 14^{th} , 11^{th} , 10^{th} , 10^{th} and 4^{th} by project managers, consultants, site engineers, foreman and labors respectively. The result shows that the laborers were aware of quality problems in construction sites. According to the result, other than laborers, all participants ranked this impacts as it is not as major problems on the site.

the result from the study shows that poor quality construction is one of the challenging problems in the construction industry. In most of the construction project site in Addis Ababa, the quality of construction is under the standard because contractors look its own benefits by minimizing the overall project cost this could be, the methods of doing this by using unskilled workers, using substandard material, reducing the ratio of materials mixed on site to form components (like concrete work), some construction. This shows that the poor logistics management is one problem in quality of construction projects.

Material loss (damage): The research results (**Table-2**),shows that the rank and weight given for material loss(damage) by project managers, consultants, site engineers, foreman and laborers were 20^{th} ,4^{th} , 30^{th} , 4th and 14^{th} by project managers, consultants, site engineers, foreman and labors respectively. The average weight of RII ranks was given as 10^{th}. Site engineers' gave weight as if material loss was minor problem on the site. But rank by consultant and foremen indicate as if, it was serious case in building construction projects. Therefore; - there are conflicting interest of different actors in the construction project site, especially between site engineers and consultants and this needs further detailed studies

The research result shows that material loss (damage) is seen as the major problem of construction sector. This because poor logistics management in the sector. Most of the construction sector has the problem of material planning and handling and storage. Some of the materials are damaged during the material transportation whiles others are poor handling

and storage place. Some material deteriorated at storage place before using. As it was seen in some of construction projects reinforcement bar, cement and hollow block concrete are store on site at an appropriate place. This brings the material loss and damage. The research result proof that; poor logistics management brings material loss or damage

Evaluation performance of logistics management of building projects using SCOR model metrics method

Based on Perfect order fulfillment (POF) of SCOR level one metrics and reliability attributes, if one delivered order to be seen as perfectly delivered, the right product has to be delivered in the right quantity, at the right time and place, with the correct documents and in the right condition. (Thunberg, 2013)

If at least one of these conditions is not met, it is not a 'perfect' deliver (Micael Thunberg & Fredrik Persson, 2014). In line with this concept, the result obtained shows availability of delays (RII=0.931), ordered materials never arrive on time (RII= 0.730) and material loss or damage (RII= 0.714), in the building construction sector. It confirmed that logistics management performance of the building construction projects included in the survey; is relatively low.

Based on the concept of the employed metrics (used to measure orders that contained the right products and arrived in the right quantity), it was concluded that; there was difficulty in checking quantity of material, difficulty in managing the flow of material and difficulty in assuring quantity of materials. This confirmed that, because of such impacts; it could be difficult had order in full percentage.

Delivery Performance to Customer Commit Date concepts also used to measure orders that were shipped to the right geographical location and delivered on time (Orders that were arrived on time and delivered in full; according to the first level 2 metric). Therefore the result observed showed that, ordered materials never arrive on time (delayed), all ordered material are never used (excess ordering), wrong time delivery of materials and too late material ordering, accordingly this concept confirmed that orders were not arrived on time and delivered in full and showed there were poor performance of logistics management in construction projects.

Documentation Accuracy *(*this metric used to check good documentation of each only included plans for assembly. According to result obtained, there is gap in updating the stakeholders (poor communication) and in accuracy of data (poor information flow) in construction projects.

Perfect Condition (information on damaged material delivered) this metrics confirms delivered material should be in good condition. But the result showed material loss or damage were one of the construction project problems. This proved that logistics management performance in construction projects were low.

According to **Source cycle time** (SCT) of SCOR metrics; SCT is assessing responsiveness to calculate the order fulfillment time, i.e. the total elapsed time for receiving an order, producing the products and delivering the products. Sourcing time increased in some construction site because ,contractors orders some materials for a long period and to get discounts, this often results in a lot of material to unload and store(Thunberg and Persson, 2014). In line with this concept; the result obtained shows that, because of the delay were one of the observed major problems that might caused by materials delay, order delay, transportation delay and etc. the time of ordering and receiving material to the site is getting increased, this confirmed that, based on SCT metrics concept, logistics management of the building construction projects included in the survey were comparatively low.

Based on **Cost to source (CS)** of SCOR metrics, CS are the costs of managing suppliers and material acquisition. The cost variables considered when calculating the CS for one order and all incoming deliveries. The included costs are cost to order, cost to receive, cost to verify materials, cost to transfer and cost to authorize supplier payment (Thunberg and Persson, 2014). In line with this concept and based on result obtained; cost overrun is one of the major top ten of building construction projects, this shows cost overrun included all costs listed in CS concept. The availability of this cost overrun (it could be because of cost of order, receive and cost of verify material increase) confirmed that, based on CS metrics the building construction project logistics management status relatively poor.

6. Conclusion

The current study showed that poor logistics management compromises efficiency of building construction projects.

For efficient construction logistics management, an integrated process is needed to ensure that the projects to be finished on time, within the budget and within the scope of contract specifications. Further, efficient logistics management is a crucial factor in increasing labor productivity and also effective logistics management systems will also assist the integration and coordination among contractors, sub-contractors and suppliers, which could increase construction workers productivity.

Short-term nature of construction process, fragmentation of activities within the construction process, lack of transparency in costs, inadequate tracking facilities on site, non existence of clear definition of responsibility and authority for logistics in construction industry, lack of proper performance measurement for construction logistics were identified as the main factor that leads to poor logistics in construction sectors. Poor logistics management impacts building construction sector in several ways, makes construction projects to be delayed, increase construction costs, decreases the efficiency of construction projects, makes difficulty to check quality and quantity of material, it makes congested site, material delivery delay, material damage , unwise trucks management etc.

Based on the respondent opinion, the top ten of impacts with highest RII and that assigned very highest weight in percentage were:

1) Delays,78.3%,
2) Cost overruns ,76.7% ,
3) Loss of project efficiency,40.6%
4) Difficulty in checking the quantity of materials,40%
5) Ordered materials never arrive on time,38.3%
6) Fraudulent activity, 45.6%
7) Queuing of trucks,41.7%
8) Transportation and environmental issues (Traffic problem increase of emissions),32.2%
9) Poor quality construction, 40.7%
10) Material loss, 36.7%

Moreover, the SCOR based model performance measurement metrics confirmed the above results, where Perfect order fulfillment (POF), Source cycle time (SCT) and Cost to source (CS) showed the logistics management of building construction projects in Addis Ababa is poor.

7. Recommendation

Construction project is a complex and tedious process to manage each and every activity on the project sites. Efficient construction logistics management plays great role in reducing construction costs, by reducing wastage and extra costs. Therefore; if the logistics management of the construction sector is efficient, construction materials will arrive in appropriate time, place, quantity and quality and the construction work will be not interrupted by the waiting for materials. Construction sector should apply modern methods of logistics management and each sector should have site logistics plan guide. The logistics plan guide helps to accomplish each activity according to the plan. When effective logistics guide followed, site wastage will be reduced, proper material storage will be maintained and easy to locate material on the site. Appropriate construction logistics guide, speeds up the project, and improves efficiency the work force. It also makes safer and clean working environment. Good logistics management also maintains health and safety on the construction site.

To be productive every construction site: - should implement the best way improving logistics systems in the sector. To do this, the sector should reduce site traffic movement, material storage palace, and improving good communication systems on construction site, using prefabricated material to reduced onsite production, using construction consolidation center, applying material trucking system on site and finally applying SCOR model to measure supply chain performance in construction projects. For the construction sectors that are in congested urban centers like Addis Ababa introducing logistics centers and JIT is can be used to improve logistics systems in the sector which also used for improving urban traffic congestion.

This research is limited to assessing the most impacts of poor logistics management on selected building construction projects in Addis Ababa city and it reflects only the current condition of the building construction sectors. However the situation of construction sector is changing from time to time, different from project to project. The impact assessment of poor logistics management in construction sectors needs farther study in different context. Thus, in the future, Impacts assessment of poor logistics management should be done considering wider range of construction projects in Addis Ababa city in particular and in different parts of Ethiopia in general.

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